FINAL DESIGN REPORT FOR SAND CREEK RESTORATION

Prepared For:

SR Land, LLC
20 Boulder Crescent, 2nd Flood
Colorado Springs, CO 80903
(719) 491-3024

Prepared By:

JR Engineering, LLC
5475 Tech Center Drive
Colorado Springs, CO 80919
(303) 267-6240
Contact: Mike Bramlett, PE

December 7, 2023

ENGINEER'S STATEMENT:

The attached design report was prepared under my direction and supervision and is correct to the best of my knowledge and belief. Said design report has been prepared according to the criteria established by El Paso County for drainage plans and said report is in conformity with the master plan of the drainage basin. I accept responsibility for any liability caused by any negligent acts, errors, or omissions on my part in preparing this report.

Mike Bramlett, Colorado P.E. # 32314
For and On Behalf of JR Engineering, LLC

12/19/23
Date

COLORADO LICENSED
MIKE BRAMLETT
NO
32314
12/19/23
PROFESSIONAL ENGINEER

DEVELOPER'S STATEMENT:

I, the developer, have read and will comply with all of the requirements specified in this drainage report and plan.

Business Name: SR LAND, LLC

By: 12/19/23

Title: MANAGER

Address: 20 Boulder Crescent
Colorado Springs, CO 80903

El Paso County:

Filed in accordance with the requirements of the El Paso County Land Development Code, Drainage Criteria Manual, Volumes 1 and 2 and Engineering Criteria Manual, as amended.

Joshua Palmer, P.E.
County Engineer/ ECM Administrator

Date

Conditions:

TABLE OF CONTENTS

INTRODUCTION 4

A. PROJECT BACKGROUND 4
B. PURPOSE OF STUDY 4

II. GENERAL LOCATION AND DESCRIPTION 4

A. SITE LOCATION 4
B. DESCRIPTION OF PROPERTY 5

III. DRAINAGE BASINS AND SUB-BASINS 6

A. MAJOR BASIN DESCRIPTION 6
B. PREVIOUS STUDIES 6
C. IRRIGATION FACILITIES 6
D. FLOODPLAIN 6

IV. DRAINAGE DESIGN CRITERIA 7

A. REGULATIONS 7
B. HYDROLOGIC CRITERIA 7
C. HYDRAULIC CRITERIA 7

V. DRAINAGE FACILITY DESIGN 9

A. GENERAL CONCEPT 9
B. SPECIFIC DETAILS 10
C. WETLANDS 16
D. FUTURE CONSIDERATIONS 17

VI. CONCLUSION 18

VII. REFERENCES 19

APPENDICES

A. Figures and Exhibits
B. Sand Creek Existing Conditions Hydraulic Model
C. Sand Creek Proposed Conditions Hydraulic Modeling
D. Grouted Boulder Drop Structure Design Calculations
E. Detention Pond Design Calculations
F. Excerpts From Reference Material
G. Work Map
H. Wetlands Mitigation Plan

INTRODUCTION

A. Project Background

JR Engineering has contracted to provide professional services for the design of the Sand Creek Restoration in El Paso County, Colorado. This project is part of the larger Sterling Ranch development that is occurring across multiple phases and filings adjacent to the channel. Improvements to the channel include a re-alignment of the channel with a new high-performance, low maintenance, naturalized design utilizing a meandering bankfull section with a 57 foot wide flood terrace and floodplain ranging from approximately 100 to 500 feet wide. Due to the grades on-site, 8 grouted boulder drop structures are also being proposed. The design also includes the construction of the Regional Pond W-3 as proposed in the *2022 Sterling Ranch MDDP Amendment* by JR Engineering, and improvements to two existing on-site stock ponds.

B. Purpose of Study

The proposed Sand Creek Restoration was required by El Paso County for the continued development of Sterling Ranch. Sand Creek is hydraulically steep and prone to erosion through this section, and further development will only compound these issues over time. Improving Sand Creek now will ensure its long term stability through the course of all future development. This *Final Design Report for the Sand Creek Restoration* was prepared to provide a final design for the proposed Sand Creek channel within the Sterling Ranch development. The design includes proposed infrastructure plans; hydrologic and hydraulic modeling; channel hydraulic calculations for Sand Creek, design calculations for the on-line detention and retention ponds; and all relevant figures and reference information.

II. GENERAL LOCATION AND DESCRIPTION

A. Site Location

Sterling Ranch, known as “the site” from herein, is a parcel of land located in Section 27, 28, 33 and 34, Township 12 South, and Section 4, Township 13 South, Range 65 West of the 6th Principal Meridian in El Paso County, Colorado. To the west the site is bound by Vollmer Road. To the north and east, the site is bounded by undeveloped land and the Retreat at Timber Ridge. To the south, the site is bound by the Pawnee Rancheros and Woodmen Heights developments. A vicinity map can be see below and is presented in Appendix A.

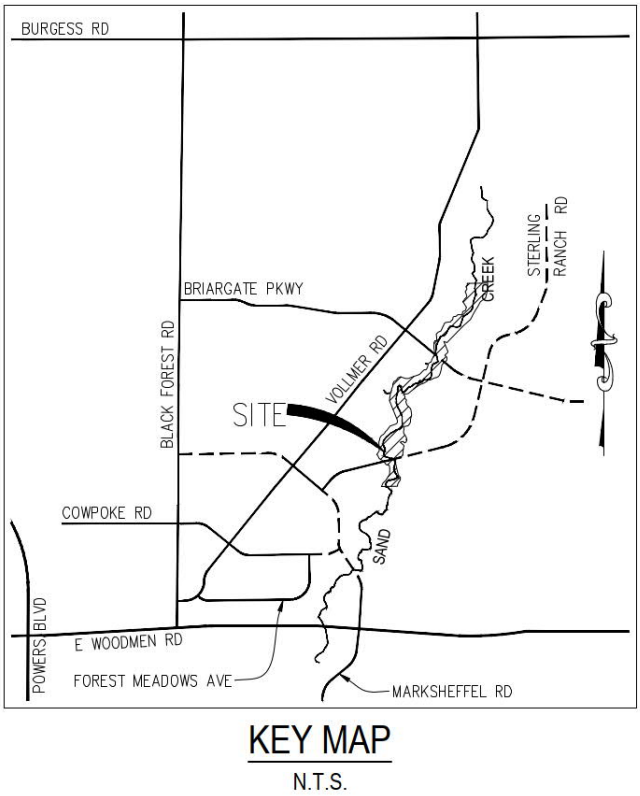


Figure 1 – Vicinity Map

B. Description of Property

Sterling Ranch is 1444 acres and is a Planned Unit Development to be built in multiple phases. The site is currently in various stages of development, with portions already in construction, with others unoccupied and undeveloped. The existing ground cover is sparse vegetation and open space, typical of a Colorado rolling range land condition. In general, the site slopes from north to south and the existing drainageways follow this topography. Ultimately, the Sand Creek channel will be located within a platted drainage tract owned and maintained by the Sterling Ranch Metropolitan District.

Per a NRCS web soil survey of the area, the site is made up of Type A and B soils. Type A soils cover roughly 65% of the site while Type B soils cover the remaining 35% of the site. Group A soils have a high infiltration rate when thoroughly wet. Type B soils have a moderate infiltration when thoroughly wet. Type D soils have a very slow infiltration rate when thoroughly wet and have a high shrink-swell potential. A NRCS soil survey map has been presented in Appendix A.

III. DRAINAGE BASINS AND SUB-BASINS

A. Major Basin Description

Sterling Ranch lies completely the Sand Creek Drainage Basin. The basin has been previously studied firstly in the 1996 Drainage Basin Planning Study (DBPS) by Kiowa, again in the 2018 Sterling Ranch MDDP by M&S, in the 2021 DBPS by Stantec (Not adopted by El Paso County), and finally in the 2022 MDDP Amendment by JR Engineering.

The Sand Creek Drainage Basin covers approximately 22 square miles and begins approximately five miles northeast of the Town of Falcon and travels approximately 15 miles to the southeast. While the majority of the area within the basin is developed and is characterized as rolling range land typically associated with Colorado's semi-arid climates, development is still actively occurring along multiple stretches of Sand Creek both upstream and downstream of the Sterling Ranch development. The proposed improvements to Sand Creek cover approximately 66 acres beginning at the southern property line of Sterling Ranch, approximately 800 feet south of Sterling Ranch Road and continue north approximately 1.67 miles to the north property line at Poco Road.

B. Previous Studies

As part of its drainage research, JR Engineering reviewed the following drainage studies and reports:

- Upper Sand Creek Drainage Basin Study prepared by Wilson in 2011
- Sand Creek Drainage Basin Study prepared by Kiowa in 1996
- Sand Creek Drainage Basin Study prepared by Stantec in 2021
- Sterling Ranch Master Development Drainage Plan prepared by M&S in 2018
- Sterling Ranch Master Development Drainage Plan Amendment prepared by JR Engineering in 2022

This Final Design Report builds upon the sub-basin delineation and design point convention from the 2022 MDDP Amendment modeling with no changes to the sub-basin hydrology or routed flow rates.

C. Irrigation Facilities

There are no existing irrigation facilities within the site. However, the Sterling Ranch Metropolitan District (SRMD) has been granted a water right to store surface flows along Sand Creek in two existing stock ponds located on Sand Creek, one just north of Sterling Ranch Road and the other north of Briargate Parkway. These surface flows are comprised of Lawn Irrigated Return Flows from excess irrigation in the developments adjacent to Sand Creek. The determination, management, and accounting of the District's water rights are outside the scope of this report.

D. Floodplain

Based on the FEMA FIRM Map numbers 08041C0533G and 08041C0535G, dated December 7, 2018, the site lies within Zone AE and Zone X of the Sand Creek floodplain. Zone AE is defined as area subject to inundation by the 1-percent-annual-chance flood event. Zone X is defined as area outside the Special Flood Hazard Area (SFHA) and higher than the elevation of the 0.2-percent-annual-chance (or 500-year) flood. All proposed development within the site occurs in Zone X. The current FIRM Map has been presented in Appendix A.

IV. DRAINAGE DESIGN CRITERIA

A. Regulations

Storm Drainage analysis and design criteria for this project was taken from "El Paso County Drainage Criteria Manual" and the Colorado Springs Drainage Criteria Manual was used as a reference. The deviations taken with the proposed design are discussed in the Specific Details and Variance sections of the report.

B. Hydrologic Criteria

The baseline report for this Final Design Report is the 2022 Sand Creek MDDP Amendment, referenced in Section III of this report. No changes to the MDDP sub-basin hydrology are proposed herein.

All hydrologic data was obtained from the aforementioned MDDP Amendment by JR Engineering, September 2022, which was prepared in conformance with the El Paso County Drainage Criteria Manual. The MDDP states:

> "Previously, the MDDP used HEC-HMS to model hydrologic conditions. With all of the on- and off-line detention present along Sand Creek, it was decided that CUHP-SWMM would be a more appropriate way to model the hydrologic conditions. All hydrologic data was obtained from NOAA Atlas 2 isopluvial maps found in the EPCDCM. Runoff was calculated using CUHP Version 2.0.0, developed by Urban Drainage and Flood Control District. The model utilizes the raingauge classified as "a 24-Hr Type II Storm" to simulate a long duration front storm common to the area, which is the same rain gauge used in the original MDDP. The following rainfall depths were utilized in the model: 2.1 inches for the 2 year storm, 2.5 inches for the 5 year storm, 3.0 inches for the 10 year storm, 3.6 inches for the 25 year storm, 4.1 inches for the 50 year storm, and 4.6 inches for the 100 year storm, which are the same point precipitation values used in the original MDDP. Using Table 5.2 from the EPCDCM, a distribution curve was created for each of the design storms to be used in CUHP. EPA SWMM 5.1 was utilized to route runoff flow rates for the sizing of stormwater storage facilities. The CUHP calculations and SWMM model are presented in Appendices B and C."

The flow rates used in the design and hydraulic analysis originated from the MDDP report and SWMM modeling files. **Table 3**, below, presents a summary of design flows for the major design storms at various design points.

Table 3: Sand Creek Flow Rates

SAND CREEK FLOW RATES								
Location	Station	Flow Rate (cfs)						
		2-YR	5-YR	10-YR	25-YR	50-YR	100-YR Design	100-YR FIS
Northern Bndy	STA: 87+10	149.3	472.6	771.4	1012.8	1386.3	1644.1	2600
SRMD Pond 2	STA:73+50	149.6	477.2	780.5	1025.8	1405.3	1667.0	2600
Briargate Pkwy	STA:61+00	146.5	512.4	847.5	1108.9	1497.6	1763.9	2600
	STA:36+05	143.9	533.2	890.8	1171.0	1589.8	1880.4	2600
SRMD Pond 1	STA:16+80	133.7	512.3	863.8	1143.6	1561.3	1848.8	2600
Sterling Ranch Road	STA:09+05	101.6	398.7	676.7	931.2	1282.9	1562.5	2600
Sterling Ranch Southern Bndy	STA:00+00	128.6	480.4	763.8	1005.4	1368.3	1585.2	2600

C. Hydraulic Criteria

The Federal Highway Administration's (FHWA) HY-8 Culvert Analysis Program (Build 7.50 July 28, 2016) was utilized to size the proposed outfall culvert for Pond W-3. The culvert analysis uses a trapezoidal channel section as tailwater to generate a tailwater depth for the analysis, the results of which are imported into SWMM as stage-discharge inputs for the Pond W-3 outfall ratings curve.

To size the outlet structures for the stock ponds, a calculation was done to iteratively determine weir and orifice capacity of various sizes of structure. Once it was determined whether the structure was weir or orifice controlled at each stage, a ratings curve based on head was modeled in SWMM to verify that the structure was large enough to prevent overtopping while still providing the static water surface necessary to maintain the water right for the stock ponds. StormCAD Version 10.03 by Bentley Software was used to size the outfall pipes from the ponds. The impact stilling basins were sized using calculations found in the Mile High Flood District Drainage Criteria Manual, January 2016 Edition.

The U.S. Army Corps of Engineers HEC-RAS program, version 5.0.3 (September 2016) was used to perform the hydraulic analysis. The final design of the Sand Creek channel and proposed culverts at Sterling Ranch Road and Briargate Parkway are modeled in HEC-RAS to evaluate flow conditions, shear stresses, and velocities for the range of flood events for the purposes of assessing drainageway stability. Five models were run to evaluate the channel:

1. The first model was an existing conditions model to evaluate the current topography with the MDDP Amendment hydrology. The existing conditions model used the FEMA cross section locations and resampled the topography based on the most recent survey by JR Engineering. Flows were taken from the above table in order to be able to directly compare the impacts of the ultimate hydrologic conditions to the current state of the channel and to demonstrate the necessity for the proposed improvements.
2. The second model was a low Manning's *n* analysis of the channel to evaluate shear and velocities along the channel using the MDDP Amendment hydrology in a subcritical flow regime.
3. The third model was a high Manning's *n* analysis of the channel to evaluate the water surface of the channel using the MDDP Amendment hydrology in a subcritical flow regime.
4. The fourth model was a mixed flow analysis of the low Manning's *n* shear stress model to design the grouted boulder drop structures.
5. The fifth model was a proposed conditions subcritical, high Manning's *n* model to evaluate the water surface of the current 100-year FIS flowrate.

For both the existing and proposed hydraulic modeling, the flows at the various design points are shown above in Table 3. Each flow change location represents a design point from the MDDP. As shown, flows accumulate further down the stream as more developed area is included in the basin area. During the major storm event flows pass through the stock pond outlet structures undetained so no additional flow change was needed at the stock pond outlets. Pond W-3 has a release rate to keep flows downstream of the pond lower than existing conditions. The HEC-RAS modeling uses these steady flows, taken from the MDDP.

In order to accurately model the stilling basin outfalls from each of the stock ponds, the vertical outlet structures were modeled as vertical open channel connecting the culverts. During all of the design storms, all of the water is directed through the outlet structure and outfalls into the stilling basin. Since HEC-RAS is unable to incorporate a vertical structure, vertical open channels ensured that all of the water exited the ponds through the stilling basin, and thus was able to accurately calculate a hydraulic jump and size the basins.

During the FIS 100-year flood event, flows overtop the emergency spillway instead of going through the outlet structure. In order to accurately model this scenario, the vertical open channel sections and culverts were removed so that all of the flows were directed down the spillway.

There were 7 different flow rates analyzed for the design based on the MDDP Amendment flows; 2-year, 5-year, 10-year, 25-year, 50-year, 100-year, and ultimately the existing FIS 100-year flows. For each of the flood events, two different scenarios were analyzed. One scenario was evaluated using higher Manning's *n* values (0.05/Native Grasses; 0.07/Gravel or Cobble Bed; 0.12/Herbaceous Wetlands) in order to calculate the extents of the respective

water surfaces and show them on the plans. A second scenario, with lower Manning's *n* values (0.032 Native Grasses; 0.035/Gravel or Cobble Bed; 0.06/Herbaceous Wetlands) was also used to more conservatively analyze velocities and shear stresses. These Manning's *n* values are taken from Table 8-5 of the USDCM.

The downstream boundary for Sand Creek is Section CU approximately 250 feet downstream of the southern property boundary of Sterling Ranch. The downstream boundary condition is taken as normal depth with a channel slope of 0.017 ft/ft for all design storms except the FIS scenario, which uses a known water surface of 6990.04 from the 1996 DBPS at Section CU. The upstream boundary condition for Sand Creek at the southern property boundary of Sterling Ranch is taken as normal depth with a channel slope of 0.018 ft/ft. While the model was extended north to Poco Road, all of the area between the Sterling Ranch property line and Poco Road is considered outside the extents of this study. That portion of channel was previously studied by Classic Engineering in support of their approved channel improvements to Sand Creek along that stretch.

Topographic mapping of the area used in the hydraulic model was done by JR Engineering on the NAD 83 Projection and NGVD29 vertical datum. The survey was used to generate a 1-foot contour interval map. The project is designed on a modified State Plane coordinate system (NAD83 Colorado State Plane, Southern Zone, U.S. Foot) and is on the National Geodetic Vertical Datum of 1929 (NGVD29 datum).

All hydraulic calculations and applicable charts and graphs are included in **Appendix E** of this report.

V. DRAINAGE FACILITY DESIGN

A. General Concept

As development has occurred along Sand Creek within Sterling Ranch, the need to stabilize the creek has increased. The additional development brings additional runoff, further degrading the conditions previously mentioned in the 1996 DBPS. All along the creek there are unstable slopes that left unattended will continue to degrade with the potential to cause damage the surrounding properties. As development continues in the future, the degradation will accelerate as more runoff is added to the creek. Stabilizing the creek now will avoid any future damage to development and ensure the long term health of the creek. Successfully mitigating this portion of stream will ensure it functions hydraulically in the future.

There are 3 main criteria that determined the initial concept. The first was the Preliminary Stream Geomorphology Report performed by 5 Smooth Stones Restoration (5SSR), PLLC in April 2021. The second was our previous experience working with the Army Corps of Engineers (USACE) and their approval process with regards to wetlands disturbances. The third main determinant was with regards to El Paso County's current channel stabilization and hydraulic criteria.

The previous DBPS was completed in 1996. In that span of time the concepts in stream design have evolved. A simple riprap lined trapezoidal channel, as previously suggested would prove to be far more intrusive than the meandering bankfull design that has been adopted along the Front Range in the last decade, and such as design was rejected by the USACE previously for this portion of Sand Creek. The meandering bankfull design is a high performance, low maintenance design. It allows for improved vegetation along the channel for hydraulic roughness and earth stabilization, while still providing proper flood control. The previous DBPS referred to Urban Drainage Flood Control District, now Mile High Flood District (MHFD), for its recommendation of check structures to aid in longitudinal stabilization and prevent headcutting. In the preceding years, MHFD has moved away from the use of vertical check structures in favor of grouted boulder or sculpted concrete drop structures as grade control structures. These structures provide a more aesthetic and long term solution, and most importantly they do not promote erosion and degradation. When the vertical check structures function as designed, they eventually turn into vertical drop structures and all the sediment is carried downstream.

For the purposes of being able to work on portions of the design separately, the channel has been broken up into three separate reaches:

1. Reach 1 is the portion of channel south of Sterling Ranch Road to the southern property line
2. Reach 2 is the portion of channel between Briargate Parkway and Sterling Ranch Road
3. Reach 3 is the portion of channel between the northern property line and Briargate Parkway.

The general concept of the channel design is to design a low maintenance, high performance channel with a meandering bankfull channel and flood terrace. Along each of the three reaches, the design cuts in a new bankfull section offset to the east from the existing thalweg, daylight the flood terrace to west taking care to leave as many existing wetlands intact as possible, and then extend a 1% floodplain to the east between 80 and 120 ft. depending on the cross-sectional channel width necessary to limit shear stresses and allowable velocities to allowable values. The below table provides a summary of the rest of the bankfull and flood terrace design criteria, which was based on the preliminary geomorphology report.

The purpose of trying to keep the existing channel hydraulically connected to the new thalweg is to maintain as many existing wetlands as possible and satisfy the USACE. A previous design effort by others followed more traditional hydraulic engineering principles and resulted in significant loss of wetlands, and this previous design was rejected by USACE. While the County's criteria are certainly a determining factor, considering the need to satisfy the USACE is the highest priority, because without their approval the project won't be granted a 404 permit.

The County review of the previous design by others states that the maximum stable longitudinal slope of the channel is 0.17%. Using this longitudinal slope would have required the use of at least 10 and possibly 15 or more GSB drop structures. This channel slope also ensures the destruction of more wetlands by taking the existing ones offline due to large changes in elevation or additional hardscapes that cannot be mitigated. It is the intent of this design report to prove that a steeper slope can remain stable long term, thus allowing for the preservation of more wetlands and appease the USACE.

B. Specific Details

Sand Creek Channel

Based on the Geomorphic Report, a four stage cross section was recommended for Sand Creek. The four proposed stages are a low flow section, bankfull with an inner berm, flood terrace, and floodplain. The low flow was sized to be 30% of the bankfull area. The low flow has an area of 4.32 sq. ft., with a mean depth of 0.68 feet and a top width of 12.90 feet with a design capacity of 7 cfs.

The bankfull has an area of 14.29 sq.ft., a width of 16.80 ft., and a mean depth of 1.54 ft. The use of an inner berm in the cross section was recommended as a way to quickly and effectively establish vegetation within the bankfull. This bankfull section was determined using regional curve information and existing site conditions, with a design capacity of 29 cfs. This is smaller than a bankfull based on county criteria which would have a required minimum capacity of approximately 180 cfs based on 10% of the 100-year design storm or 150 cfs based on the 2-year storm. Please refer to the Variance section for further discussion of this deviation.

The flood terrace is 65.4 feet wide with a depth of 1 foot and 1% cross slope. The flood terrace has been sized to convey the 2-year storm (150 cfs±). Events larger than the 2-year storm begin to expand out into the full extents of the floodplain. Using a smaller bankfull section ensures that the channel doesn't eventually cut its own low flow channel into what would have been a much larger bankfull section. The straight riffle sections of channel have a maximum grade of 3.18%, while the curved sections with the scour pools are flat from invert in to invert out. Maximum velocities in the channel were limited to 9 ft/s during the 100-year storm and 7 ft/s

during the 10-year storm, except when going over drop structures.

Per the geomorphic report, the floodplain design assumes that vegetation along each reach can provide stability up to an applied shear stress of 1.2 lb/sq.ft. The report also recommended the following treatment methods based on shear stress are listed below:

- 0 to 1.0 lb/sq. ft. – Treatment seed and straw with riparian plantings
- 1.1-1.4 lb/sq. ft. - Treatment floodplain coir matting/ seed and straw with riparian plantings
- 1.5 and 2.0 lb/sq. ft - Treatment floodplain boulder/log sills, floodplain coir matting/ seed and straw with riparian plantings
- 2.0-4.0 lb/sq. ft. – Treatment floodplain vegetated riprap, floodplain coir matting/ seed and straw with riparian plantings

Permanent geotextile solutions are proposed in areas with shears above 4.0 lb/sq. ft or Froude numbers approaching critical as a cost effective way to permanently armor large areas while achieving sheer stresses up to 6 lb/sq.ft, which is high enough to adequately protect any areas of the overbanks that are above 1.5 lb-ft. While modeling the channel, excessive velocities and shears within the riffle sections were ignored since those areas already be armored with void-filled riprap. Soil lifts were added around the outer bend of all the bankfull curves to reinforce the scour pools. Ultimately, the goal is to have vegetation established within the inner berm section all the way out to the extents of the floodplain to provide vegetative resistance to reduce velocities and shear stresses within the channel and ensure a permanently stable, albeit steeper channel.

There are 8 grouted boulder drop structures proposed within the channel. There is a 3.5’ drop and a 1.5’ drop proposed in Reach 1 at station 3+71 and 8+19, respectively. Along Reach 2 there is a 6’ drop at station 41+71 , a 4’ drop at station 50+06, and a 5’ drop at station 53+56. Along Reach 3 there is a 5’ drop at station 71+30 going into SRMD Pond #2, a 6’ drop at station 74+89, and a 4.3’ drop at station 78+00. The use of drops larger than 4’ was done in order to maintain grades close to existing so that the existing thalweg could remain connected. All of the GSB’s use a typical design across the flood terrace. For simplicity, the inner berm is not present through the drop, so only a single stage trapezoidal low flow section is used. Once outside of the flood terrace, the vertical drop of the GSB drop structure is blended into the overall channel cross-sectional width and varying longitudinal slopes of 1% to 15% are used across the channel, with soil-riprap armament and vegetative cover as required and based on shear stresses and velocities. Sheet piling with a concrete cap has been extended across the crest of the drop the full width of the FIS floodplain. Weep drains will be used to prevent any uplift or groundwater migration.

The proposed design calls for 66 riffle drops; 9 along Reach 1, 38 along Reach 2, and 19 along Reach 3. The riffles vary in length and slope in order to minimize wetlands disturbances created by grade changes. The geomorphic report called for 100 – 1 foot drop riffle pools in lieu of drop structures. The use of riffles to make up grade differences rather than more drop structures is preferable because it allows for flatter slopes to tie the riffle sections to the existing ground. Revising the longitudinal slope of the channel in order to eliminate supercritical areas necessitated the use of 8 drops, rather than the previously proposed 6. Design calculations for all of the GSBs have been provided in Appendix C.

Per County criteria, maintenance access has been provided along the entire stretch. A 15’ wide gravel trail will serve as the main access along both sides of the channel. At key infrastructure such as drop structures and ponds, spur trails have been provided to gain access to both the upstream and downstream areas of the structures. Since development is occurring on both sides of the stream, construction of the trails will occur along with different developments. The portions of the trail that will be built with this project are along the entire east side of the creek from the southern property line to the northern property line, as well as along the

western side of the creek between Sterling Ranch Road and Briargate Parkway.

Table 1. Sand Creek Design Matrix

Sand Creek Design Matrix		
	Limit	Proposed
El Paso County Criteria		
Maximum Depth outside of Bankfull Channel	5 ft	4.88 ft
Maximum Velocity 100-YR excluding drops	9 ft/s	8.10 ft/s
Maximum Velocity 5-YR excluding drops	7 ft/s	6.21 ft/s
Minimum Bankfull Capacity	180 cfs	29 cfs (150 cfs Floodterrace)
Maximum Side slopes - grass lined	4:01	4:01
Maximum Side slopes - grouted boulder	2.5:1	4:01
Minimum Bottom Width	8 ft	2.4 ft
Centerline radius - Bankfull	2.5x BF Width	2.5-3.5x BF Width
Maximum GSB Drop Height	4'	6'
Maximum GSP Drop Height with add't testing and seepage	12'	6'
Non-Juridictional Maximum Ponding Height	10'	10'
15' Maintenance Trail	Yes	Yes
Maintenance access provided	Yes	Yes
City of Colorado Springs Criteria		
Maximum Longitudinal Slope	0.17%	3.18%
Froude No 100-YR - main channel	0.8	0.9
Froude No 5-YR - main channel	0.7	0.8
MHFD Criteria		
Mannings *n* value - water surface evaluation (native grass/cobble bed/herbaceous wetlands)	0.05/0.07/0.12	0.05/0.07/0.12
Mannings *n* value - shear evaluation (native grass/cobble bed/herbaceous wetlands)	0.032/0.035/.06	0.032/0.035/.06
Geomorphologist Criteria		
Maximum Shear Stress, 100-YR main channel excluding drops/culverts	1.2 lb/sf	2.24 lb/sf
Permissible Shear Stress – Vegetated		1.4 lb/sf
Permissible Shear Stress – Coir Mat		4.0 lb/sf
Permissible Shear Stress – Geotextile		6.0 lb/sf

Table 2. Bankfull/Flood Terrace Design Criteria

Bankfull Channel	Width; ft		16.9	
	Mean Depth; ft		0.85	
	Max Depth; ft			
	Area; sqft		14.0	
	Bend to Bend Spacing; ft	4.5 -6 times Bankfull Width	76	101
	Radius of Curvature (ROC); ft	2.5 - 3.5 times Bankfull Width	42	59
	Tangent Lengths; ft	1.5 - 2.5 times Bankfull Width	25	42
	Meander Wavelength; ft	9- 12 times Bankfull Width	152	203
	Meander Beltwidth; ft	2 - 3.5 times Bankfull Width	34	59
Flood Terrace	Width; ft		64.5	
	Area (300% of Bankfull Area); sqft			
	Bend to Bend Spacing; ft	Same as Bankfull Pattern	--	--
	Radius of Curvature; ft	2 - 4 times the Flood Terrace Width	129	258
	Tangent Riffle Lengths; ft	1 - 2 times the Bankfull Width	17	34
	Meander Beltwidth; ft	1.5 - 2 times the Flood Terrace Width	97	129
	Expansion and Contraction Ratios	greater than 10:1	--	--

Discussion of Existing Conditions Hydraulic Results

In the existing conditions model, Reach 1 had velocities ranging from 4.33 ft/s to 5.72 ft/s and 6.87 ft/s to 8.45 ft/s in the 5-year and 100-year storms, respectively. Froude numbers along Reach 1 were approaching or at supercritical levels in both storms for the majority of cross sections. Reach 2 had velocities ranging from 0.47 ft/s to 7.79 ft/s and 1.25 ft/s to 9.78 ft/s in the 5-year and 100-year storms, respectively. Froude numbers along Reach 2 were approaching or at supercritical levels in both storms for the majority of cross sections. Reach 3 has velocities ranging from 0.94 ft/s to 6.32 ft/s and 1.87 ft/s to 8.79 ft/s for the 5-year and 100-year storms, respectively. Froude numbers along Reach 3 are supercritical across multiple of the cross sections. Shear stresses along Reach 1 range from 0.01 lb/sq ft to 7.10 lb/sq ft, Along Reach 2 range from 0.14 lb/sq ft to 1.95 lb/sq ft, and along Reach 3 range from 0.48 lb/ sq ft to 1.68 lb/sq ft. Results from the Existing Conditions HEC-RAS modeling can be found in **Appendix B**.

Discussion of Proposed Conditions Hydraulic Results

Based on the hydraulic analysis for shear stress and velocity, Reach 1 has velocities ranging from 0.81 ft/s to 10.16 ft/s. Outside of the drop structures, no cross section had velocities above 5.51 ft/s. Shear stresses along Reach 1 range from 0.01 lb/sq ft to 10.35 lb/sq ft (at the drop structure). The shear stresses along Reach 1 are consistently higher than the 1.2 lb/sq ft as suggested in the geomorphology report within the bankfull section and around the drop structures, but these areas are going to be armored already. There are no areas within the overbanks that have high shear stresses, so no areas in this reach will require additional armoring in the overbank sections. Froude numbers along Reach 1 are all subcritical except within the drop areas. Cross sections 1804 – 2046 represent the area downstream of the proposed bankfull to the property boundary. As the channel begins to narrow and sharply turn 90 degrees towards the property line, the channel goes supercritical in most storm events. The addition of new wetland vegetation between the end of the new channel section and the property line is not enough to get the areas into subcritical flows. What will be required in the future is the widening of the channel so that the channel does not take an abrupt 90 degree turn into its most narrow section. With the channel being on private property downstream of Sterling Ranch, any channel improvements requiring grading near the property line are currently unfeasible. To help control erosion in this portion of channel, a sheetpile with concrete cap will be placed just upstream of the property line. Bank stabilization along the east bank will aid in erosion control until channel improvements downstream of Sterling Ranch can be undertaken. Additionally, geotextile will be used between the end of the proposed improvements and the bounary within the existing channel banks to help vegetation establish and prevent erosion until future grading changes can be made to the channel around the southern boundary.

Based on the hydraulic analysis for shear stress and velocity, Reach 2 has velocities ranging from 0.99 ft/s to 10.62 ft/s. There are no areas of high velocities outside of the drop structures. Shear stresses along Reach 2 range from 0.77 lb/sq ft to 11.24 lb/sq ft, with the highest values occurring through the drop structures. The shear stresses along Reach 2 are, except for a few areas, lower than 1.2 lb/sq. ft. and will not require any significant armoring. Froude numbers along Reach 2 are all subcritical outside of the drop structures. One area of concern is the area downstream of the Briargate culvert, to the first drop structure approximately 300 feet downstream. Due to the wingwalls and the grading coming out of the culverts, the channel is narrower than necessary to produce low velocities and shear stresses. As seen in the design by Kiowa for the area downstream of the culvert, the first 40 feet of channel coming out of the culvert will all have soil riprap to help armor the channel to their proposed concrete check structure. Approximately 120 downstream of the check structure is where the meandering bankfull will begin. The channel floodplain does not begin to expand until downstream of GSB #5, so the entire area between the culvert and GSB experiences high shear stresses, and will require reinforcement from geotextile matting.

Based on the hydraulic analysis for shear stress and velocity, Reach 3 has velocities ranging from 0.24 ft/s to 15.54 ft/s. The areas of high velocities occur at the drop structures and culverts. Shear stresses along Reach 3 range from 0.01 lb/sq ft to 5.64 lb/sq ft. The shear stresses along Reach 3 are, except for a few areas, lower than 1.2 lb/sq. ft. and will not require any significant armoring. Froude numbers along Reach 3 are all subcritical. Results from the Proposed Conditions HEC-RAS modeling can be found in **Appendix C**.

Pond W-3

The MDDP Amendment hydrology confirmed that a Regional Detention Pond (Pond W-3) at Sterling Ranch Road will be required to reduce 100-year flows to less than existing conditions. Based on the revised hydrology in the MDDP Amendment, the pond is approximately 51.27 ac-ft., which is a considerable reduction in size from the previously proposed 76 ac-ft. pond in the 2018 MDDP. Conceptually, the pond will function similarly to how it was proposed in the MDDP. The county prohibits ponding at roadways, so the pond has to outfall before it reaches the proposed conspan arch culvert at Sterling Ranch Road. The proposed outfall will consist of a 3-barrel (2-13’x4’, 1-13’x2’) box culvert approximately 40 feet north of the road, with an overflow spillway that extends to the wingwalls of the road culvert, essentially creating one contiguous structure, while still avoiding ponding along the road and allowing flows to pass through the road culvert with freeboard. The smaller center barrel has an invert 0.5’ lower than the outer barrels to maintain a low flow channel, while the outer barrels will be used in higher flow events. The overflow weir is approximately 288 feet long. In order to avoid being classified as a jurisdictional dam the overflow weir was set at 10 feet above the invert with a crest elevation of 7011.17. A sheet pile wall with a concrete cap will provide reinforcement for the berm. At the invert of the culvert a 1.5’ deep plunge pool will help dissipate energy before entering the culvert at Sterling Ranch Road. The section of Sand Creek running through Pond W-3 is a meandering, 17 foot wide, 0.71 foot deep trapezoidal low-flow channel with 1.0% floodplain slopes out to the toe of the pond. Due to the outlet control structure it wasn’t possible to incorporate the typical 4 stage section used along the rest of the channel without compromising the pond depth and pond volume. Using a 0.50% cross slope in the pond bottom will allow wetlands to establish easier within the pond. With the upstream SRMD Pond #1 controlling flows during most storm events, Pond W-3 will rarely be used for flood control.

SRMD Pond 1

The large stock pond approximately 700 feet north of Sterling Ranch Road will remain in place with the stream improvements and is now defined as SRMD Pond 1. Previously, the pond was designated as “Waters of the U.S.” and Sterling Ranch Metropolitan District was granted a water right to use the pond as storage for irrigation runoff, so it was decided that the best design would be to include the pond in the channel, rather than trying to modify its dimensions or route flows around it. The water right for the stock pond was previously

determined to be a volume of 12.25 ac-ft with a surface area of 109,612 sq.ft. Since the pond's dimensions are not proposed to be modified, the water right will remain intact.

The existing stock pond has a berm elevation of 7040, which is 39 feet above the proposed invert of the culvert at Sterling Ranch Road. Using a series of drop structures would require, at a minimum, 4-10' tall drops to achieve this grade, a series of 7 drops to get to the toe of slope, or a single concrete/grouted boulder spillway from top to toe of slope. Stepping the drops would require a longer longitudinal profile which would in turn take away area from Pond W-3. The existing channel flows around the west side of the pond downstream to Sterling Ranch Road. Given the proposed development west of Sand Creek, there is no possibility to expand the channel west in this area, and so this would end up being the most constricted portion of channel.

The proposed solution to conveying water through the stock pond and also making up 39' of vertical drop was to design an outlet structure for water to discharge out of the stock pond and into Pond W-3. Using an outlet structure allows for a static water surface in the pond that maintains SRMD's water right to the pond. In minor and major storm events, water ponds up to the static WSEL of 7036, where it will outfall into a 25'x25' square orifice. Water flows through the 12'x10' RCBC outfall pipe and discharges into a grouted boulder impact stilling basin. Flows leave the impact basin and are conveyed to the Pond W-3 outfall via low flow channel. In the event of flows above the 100-year design storm or an emergency situation, flows will overtop the existing berm and down an emergency spillway to Pond W-3. The overflow spillway will be approximately 300 feet long. To reinforce the spillway, a sheetpile cutoff wall with a concrete cap will be incorporated into the design. Due to the fact that this spillway will be an online feature within the channel, it will be armored using a geotextile fabric able to withstand the FIS flow rate.

Due to the height from the toe of slope to the spillway crest, SRMD Pond 1 has been classified as a Jurisdictional Dam with the Dam ID 100600. In the event of a breach the dam would spill directly into Pond W-3, which is sized to contain the flows. Because of this, the dam is classified as a no-hazard dam.

SRMD Pond 2

Upstream of Briargate Parkway there are two existing stock ponds. The smaller of the two ponds will be removed with the stream restoration, while the larger pond will remain and is now referred to as SRMD Pond 2. Previously, the larger pond was designated as "Waters of the U.S." and Sterling Ranch Metropolitan District was granted a water right to use the pond as storage for irrigation runoff, so it was decided that the best design would be to include the pond in the channel, rather than trying to route flows around it. The water right for the stock pond was previously determined to be a volume of 4.29 ac-ft with a surface area of 53,720 sq.ft. While the pond's grading will be modified, the volume and surface area of the pond will not change, so the water right will remain intact.

The existing stock pond has a berm elevation of 7121, which is 20 feet above the toe of slope. The existing channel routes around the west side of the pond, while the pond discharges using a 24" RCP culvert. Using a series of 3 drop structures to route the exiting channel around the pond and down to the proposed channel would end up pushing the toe of slope further downstream and destroying more wetlands. Given the proposed development west of Sand Creek, there is no possibility to expand the channel west in this area while leaving the stock pond intact resulting in an extremely narrow channel that would need to be fully lined to handle the higher shears and velocities. The pond itself would also need to be shifted east and the footprint would need to be modified. Given that the pond was designated as "Waters of the U.S.", any major changes to the pond could result in significant approval hurdles.

Similar to Existing Stock Pond 1, the proposed solution to conveying water through the stock pond and also

making up 20’ of vertical drop was to design an outlet structure for water to discharge out of the stock pond and into the downstream channel. Using an outlet structure allows for a static water surface in the pond that maintains SRMD’s water right to the pond. In minor and major storm events, water ponds up to the static WSEL of 7117.75, where it will outfall into a 25’x25’ square orifice. Water flows through the 10’x10’ RCBC outfall pipe and discharges into a grouted boulder stilling basin. Flows leave the stilling basin and are conveyed south via the Sand Creek Channel. In the event of flows above the 100-year design storm or an emergency situation, flows will overtop the existing berm and down an emergency spillway to the downstream channel. The overflow spillway will be approximately 200 feet long. To reinforce the spillway, a sheetpile cutoff wall with a concrete cap will be incorporated into the design. Due to the fact that this spillway will be an online feature within the channel, it will be armored using a geotextile fabric able to withstand the FIS flow rate.

Due to the height from the toe of slope to the spillway crest, SRMD Pond 2 has been classified as a Jurisdictional Dam with the Dam ID 100601. In the event of a breach the dam would spill directly into the Sand Creek channel, which is sized to contain the flows. Because of this, the dam is classified as a no-hazard dam.

C. Wetlands

The existing Sand Creek channel has wetlands present along the entire portion within Sterling Ranch. With Sand Creek being an ephemeral stream, and development on both sides of it incomplete, there are not base flows present for many parts of the year. Wetlands are confined to areas mostly within the existing bankfull channel and around the existing stock ponds. With the goal of the proposed channel design to keep the existing thalweg intact wherever possible, it is anticipated that portions of these wetlands will remain intact.

The wetlands along Sand Creek were previously delineated with a total area of 16.29 acres, which does not include areas that will be disturbed from the proposed roadway culverts at Sterling Ranch Road and Briargate Parkway. Of these 16.29 acres, 10.68 acres will be disturbed. Disturbed wetlands are described as any area where improvements occur that causes change in finished grade of the wetland or where vegetation cannot be re-established. Of these disturbances 7.06 acres will be re-established as part of the mitigation plan. Of the 16.29 acres of on-site wetlands, 7.04 acres will be either be preserved or enhanced. Preserved wetlands are defined as areas that may or may not have been improved, but whose finished grade has not changed, while enhanced wetlands will see no disturbances in grade, but will have addition riparian plantings.

There are no designated off-channel mitigation areas within Sterling Ranch. With the design of a 64.5’ wide, 1% grade flood terrace as well as a 1% grade floodplain ranging from 100 to 500 feet, it is expected that all of the proposed flood terrace and floodplain will be mitigation area. Areas where existing wetlands are impacted but will remain will either be enhanced or re-established. The only areas not expected to be utilized for mitigation are areas of steep slopes or areas around the drop structures where grouted boulders will be placed. As development occurs and runoff increases, groundwater migration will be able to support wetland vegetation across the floodplains, while runoff from adjacent developments will also aid in the support of wetlands in the channel. Mitigation is currently proposed on-site along the entire stretch of the channel. There will be 26.18 acres of newly established wetlands. Along with the re-established wetlands, as well as the preserved and enhanced existing wetlands, a total area of 40.27 acres of mitigation is proposed for the site, giving a mitigation to permanent loss ratio of 3.77. Aiming for a ratio above 1 to 1 allows for the possibility that not all the floodplain will be able to establish wetlands, or that some of the existing ones could become disconnected over time.

D. Future Considerations

Within the Sterling Ranch development there will be more full-spectrum detention ponds constructed as development progresses. All of these ponds are expected to contribute base flows to Sand Creek within Sterling Ranch. Of those currently proposed, Pond FSD14A, which is located along Sterling Ranch Road just east of Pond W-3, FSD11B, which is located east of Sand Creek along the southern property line, as well as Ponds A, B, and C from the Homestead North development are expected to outfall directly into the channel. Future pond outfalls will need to account for the channel tailwater and provide erosion protection.

The privately owned portion of Sand Creek between the Sterling Ranch property boundary and the Aspen Meadows development remains in its existing condition, which are shown to be unstable. A check structure and slope stabilization at the property boundary will help slow erosion downstream of the project, but ultimately channel improvements similar to ones proposed with Sterling Ranch or Aspen Meadows will be necessary to ensure the long term stability of the channel through this reach. At this time, this portion of Sand Creek is on private property and no improvements are expected.

The portion of Sand Creek north of the proposed Sterling Ranch channel improvements up to Poco Road is part of the Retreat at Timber Ridge project by Classic Engineering. Design and analysis of Sand Creek in that section was completed and approved as part of that project. The results from that design show that the design is stable. The on-site investigation as part of the Timber Ridge design shows that the channel is in fact stable with dense vegetation. Adjacent to Sand Creek along the west side running from the norther property boundary to Poco Road is the Homestead North development being designed by JR Engineering. As part of that project, bank stabilization along Sand Creek will be required with the construction of the proposed maintenance trail. This bank stabilization occurs with the Sand Creek Restoration project when the entirety of the maintenance trail is constructed. This section of channel will require monitoring to ensure no erosion is occurring. Additional bank stabilization along the east bank may be necessary if erosion starts occurring.

E. Permitting

The 404 permitting for Sand Creek will be handled by Bristlecone Ecology. Prior to construction, a floodplain development permit from Pikes Peak Regional Building Department will be required. A CLOMR will also be completed through FEMA prior to final approval of the plans. Applications for the two stock ponds to be Jurisdictional Dams from the State engineer will also be approved prior to final approval of the plans. Once all of the channel improvements along Sand Creek within Sterling Ranch have been completed, a LOMR will be submitted.

VI. VARIANCES (DEVIATIONS)

Multiple variances from the County design criteria are requested as part of the design of the channel and hydraulic structures along it. The first change is the size of the low flow. Section 6.9.2 of the County criteria states that the low flow channel should be sized for either the 2-year storm or as previously stated, as low as 10% of the 100-year storm, which in this case would be approximately 150 cfs and 180 cfs, respectively. The proposed design uses a low flow capacity of 7 cfs, while the bankfull has a capacity of 29 cfs, and the flood terrace was sized to handle the 2-year event, which is approximately 150 cfs along this reach. After consulting with the geomorphologist it was decided that a narrower low flow section would be preferable. Base flows in this portion of Sand Creek are a fraction of the required low flow capacity and the required low flow channel would be far larger than necessary to deal with the base flows, eventually leading the channel to cut its own low flow section for base flows. By using a narrower multi-stage section within the bankfull, dense vegetation can establish itself, particularly along the inner berm. Instead of the bankfull being sized for the larger events, the flood terrace has been sized to convey the two year storm. The frequency that the flood terrace sees inundation will also allow for

denser vegetation within the flood terrace extents. Since the bankfull will be carrying a smaller proportion of the larger events, the floodplain is wide enough to ensure that flow depth remains low outside of the flood terrace. Shear stresses in the overbanks are low enough that seeding and riparian plantings will be sufficient to withstand the high flow events, with only a few areas requiring more substantial treatment.

The second variance requested is the maximum allowable shear stress. The criteria states that the maximum allowable shear stress for vegetated channels is 1.2lb/sq. ft. Based on recent design experiences along the Front Range, the geomorphologist provided us with a wider range of allowable shear stresses. Up to 1.0 lb/sq. ft. would just need treatment seed and straw with riparian plantings. Shears ranging from 1.1-1.4 lb/sq. ft. would need coir matting in addition to the other treatments. For areas between 1.5 and 2.0 lb/sq. ft treatment would require floodplain boulder/log sills in addition to the previously stated treatments. And in areas that are between 2.0-4.0 lb/sq. ft. will require vegetated riprap on top of coir matting and seed and straw with riparian plantings. Based on these ranges, treatments have been revised where necessary to ensure erosion is kept to a minimum.

The third variance requested is the maximum drop height allowed. The County criteria states that the maximum drop height for a grouted boulder drop structure is 4 feet, but can go up to 12 feet if approved by the County engineer. Five of the eight drop structures range between 4 and 6 feet in height. Calculations have been provided to show that the structures are capable of handling the velocities and shears present on the structure. Weep drain plans have also been provided to show how the taller structures will mitigate seepage and avoid any uplift of the structures. Prior to final design, soil borings were also taken at the locations for 6 of the 8 structures. The soil borings showed that the bedrock is shallow enough to allow a sheetpile to be sunk all the way to bedrock at all of the drop structure locations.

VII. CONCLUSION

The purpose of this report is to present the final design for the proposed Sand Creek Restoration. The design proposed herein meets the requirements of El Paso County and the city of Colorado Springs unless where stated otherwise. The design proposed in this report complies with the El Paso County Drainage Manual, City of Colorado Springs Drainage Criteria Manual, and the proposed Sand Creek MDDP Amendment, unless where stated otherwise. The proposed Pond W-3 and the revised existing stock ponds will have no adverse effect on stormwater quality, quantity, or timing and will meet the requirements of CRS §37-92-602 (8) for drain time.

The implementation of drainage concepts presented within this report will assure proper conveyance and attenuation of stormwater discharges with no anticipated adverse impacts to Sand Creek downstream infrastructure. The proposed improvements to the channel will not be injurious to water rights and will be in conformance with established decrees.

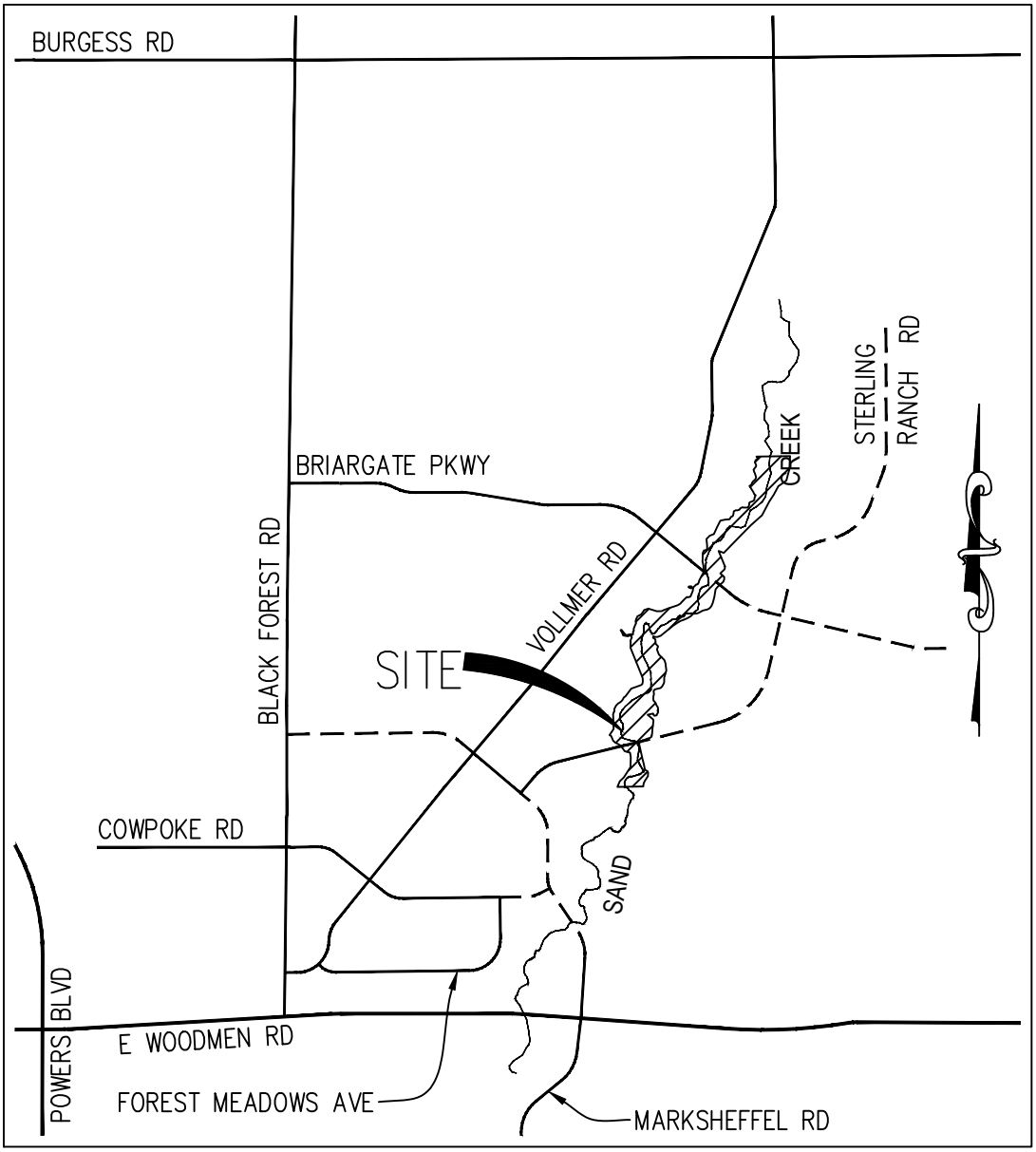
Any future off-line water quality or detention ponds shall be final-designed under separate drainage studies occurring with each specific development project or capital improvement project, and shall meet all applicable design criteria at the time of final design.

VIII. REFERENCES

1. City of Colorado Springs Drainage Criteria Manual Volume 1, City of Colorado Springs, CO, May 2014.
2. El Paso County Drainage Criteria Manual Volume 1, El Paso County, CO, June 2021.
3. Final Drainage Report for Retreat at Timberridge Filing No. 1, Classic Consulting, June 2020.
4. Sand Creek Drainage Basin Planning Study, Stantec, January 2021.
5. Sand Creek MDDP Amendment, JR Engineering, September 2022.
6. Sand Creek Channel Stabilization Project - General Guidelines for Geomorphic
7. Assessment / Design and Performance Standards, 5 Smooth Stones Restoration PLLC, April 2021.
8. Urban Storm Drainage Criteria Manual, Urban Drainage and Flood Control District, Latest Revision.

Appendix A

Figures and Exhibits



KEY MAP

N.T.S.

VICINITY MAP
STERLING RANCH
JOB NO. 25188.03
10/21/2021
SHEET 1 OF 1

J·R ENGINEERING
A Westrian Company

Centennial 303-740-9393 • Colorado Springs 719-593-2593
Fort Collins 970-491-9888 • www.jrengineering.com

X:\2510000.all\2518804\Drawings\Vicinity Map.dwg, 8.5x11 Portrait, 10/18/2021 2:40:40 PM, vaughtd

NOTES TO USERS

This map is for use in administering the National Flood Insurance Program. It does not necessarily identify all areas subject to flooding, particularly from local drainage sources of small size. The **community map repository** should be consulted for possible updated or additional flood hazard information.

To obtain more detailed information in areas where **Base Flood Elevations** (BFEs) and/or **floodways** have been determined, users are encouraged to consult the Flood Profiles and Floodway Data and/or Summary of Stillwater Elevations tables contained within the Flood Insurance Study (FIS) report that accompanies this FIRM. Users should be aware that BFEs shown on the FIRM represent rounded whole-foot elevations. These BFEs are intended for flood insurance rating purposes only and should not be used as the sole source of flood elevation information. Accordingly, flood elevation data presented in the FIS report should be utilized in conjunction with the FIRM for purposes of construction and/or floodplain management.

Coastal Base Flood Elevations shown on this map apply only landward of 0.0' North American Vertical Datum of 1988 (NAVD88). Users of this FIRM should be aware that coastal flood elevations are also provided in the Summary of Stillwater Elevations table in the Flood Insurance Study report for this jurisdiction. Elevations shown in the Summary of Stillwater Elevations table should be used for construction and/or floodplain management purposes when they are higher than the elevations shown on this FIRM.

Boundaries of the **floodways** were computed at cross sections and interpolated between cross sections. The floodways were based on hydraulic considerations with regard to requirements of the National Flood Insurance Program. Floodway widths and other pertinent floodway data are provided in the Flood Insurance Study report for this jurisdiction.

Certain areas not in Special Flood Hazard Areas may be protected by **flood control structures**. Refer to section 2.4 "Flood Protection Measures" of the Flood Insurance Study report for information on flood control structures for this jurisdiction.

The **projection** used in the preparation of this map was Universal Transverse Mercator (UTM) zone 13. The **horizontal datum** was NAD83, GRS80 spheroid. Differences in datum, spheroid, projection or UTM zones zones used in the production of FIRMs for adjacent jurisdictions may result in slight positional differences in map features across jurisdiction boundaries. These differences do not affect the accuracy of this FIRM.

Flood elevations on this map are referenced to the **North American Vertical Datum of 1988 (NAVD88)**. These flood elevations must be compared to structure and ground elevations referenced to the same **vertical datum**. For information regarding conversion between the National Geodetic Vertical Datum of 1929 and the North American Vertical Datum of 1988, visit the National Geodetic Survey website at http://www.ngs.noaa.gov/ or contact the National Geodetic Survey at the following address:

NGS Information Services
NOAA, N/NGS12
National Geodetic Survey
SSMC-3, #9202
1315 East-West Highway
Silver Spring, MD 20910-3282

To obtain current elevation, description, and/or location information for **bench marks** shown on this map, please contact the Information Services Branch of the National Geodetic Survey at (301) 713-3242 or visit its website at http://www.ngs.noaa.gov/.

Base Map information shown on this FIRM was provided in digital format by El Paso County, Colorado Springs Utilities, and Anderson Consulting Engineers, Inc. These data are current as of 2008.

This map reflects more detailed and up-to-date **stream channel configurations and floodplain delineations** than those shown on the previous FIRM for this jurisdiction. The floodplains and floodways that were transferred from the previous FIRM may have been adjusted to conform to these new stream channel configurations. As a result, the Flood Profiles and Floodway Data tables in the Flood Insurance Study Report (which contains authoritative hydraulic data) may reflect stream channel distances that differ from what is shown on this map. The profile baselines depicted on this map represent the hydraulic modeling baselines that match the flood profiles and Floodway Data Tables if applicable, in the FIS report. As a result, the profile baselines may deviate significantly from the new base map channel representation and may appear outside of the floodplain.

Corporate limits shown on this map are based on the best data available at the time of publication. Because changes due to annexations or de-annexations may have occurred after this map was published, map users should contact appropriate community officials to verify current corporate limit locations.

Please refer to the separately printed **Map Index** for an overview map of the county showing the layout of map panels; community map repository addresses; and a Listing of Communities table containing National Flood Insurance Program dates for each community as well as a listing of the panels on which each community is located.

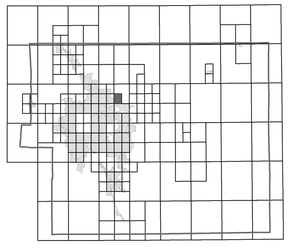
Contact **FEMA Map Service Center** (MSC) via the FEMA Map Information eXchange (FMIX) 1-877-336-2627 for information on available products associated with this FIRM. Available products may include previously issued Letters of Map Change, a Flood Insurance Study Report, and/or digital versions of this map. The MSC may also be reached by Fax at 1-800-358-9620 and its website at http://www.msc.fema.gov/.

If you have **questions about this map** or questions concerning the National Flood Insurance Program in general, please call **1-877-FEMA MAP** (1-877-336-2627) or visit the FEMA website at http://www.fema.gov/business/nfip.

El Paso County Vertical Datum Offset Table

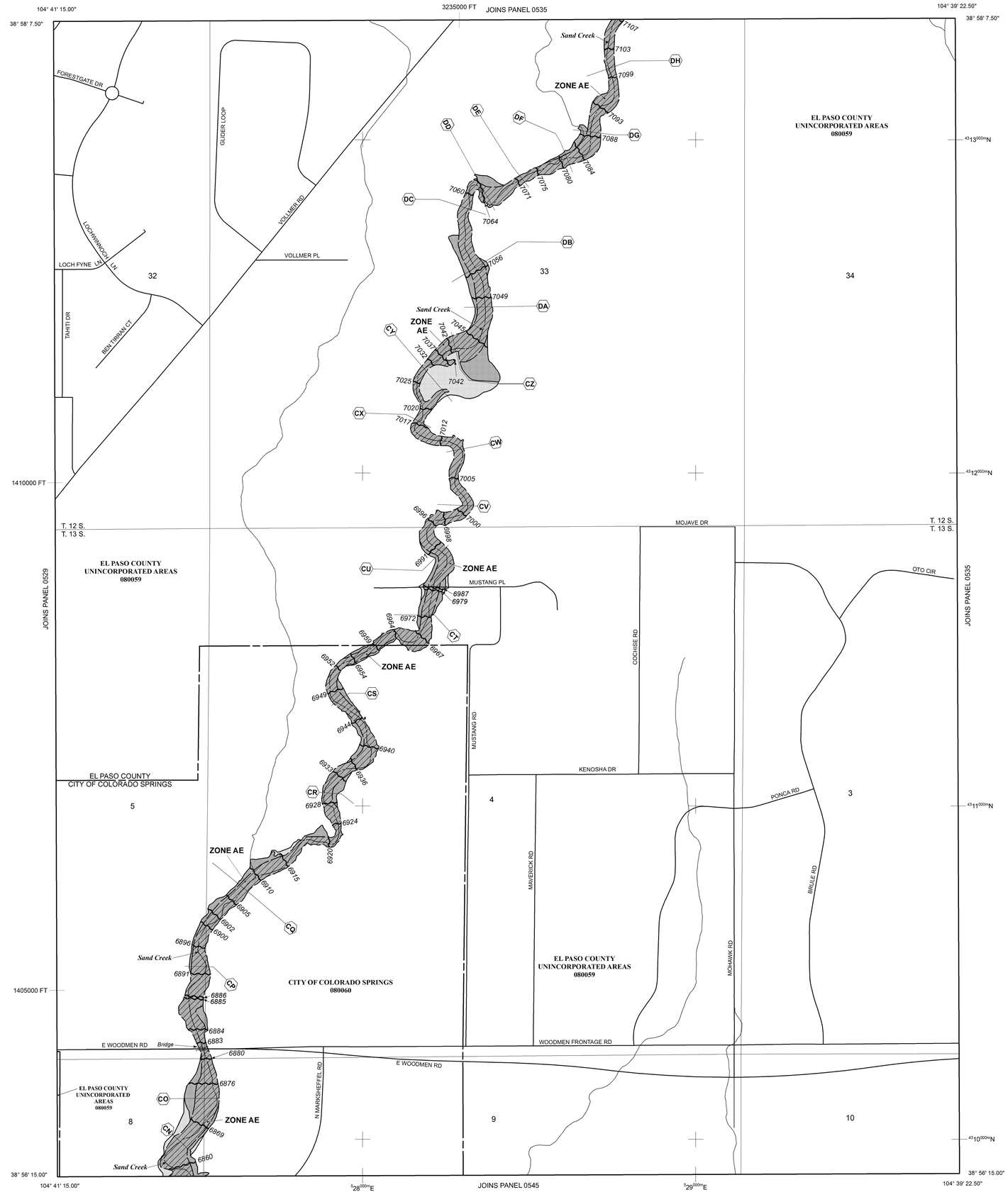
Flooding Source	Vertical Datum Offset (ft)
REFER TO SECTION 3.3 OF THE EL PASO COUNTY FLOOD INSURANCE STUDY FOR STREAM BY STREAM VERTICAL DATUM CONVERSION INFORMATION	

Panel Location Map



This Digital Flood Insurance Rate Map (DFIRM) was produced through a Cooperating Technical Partner (CTP) agreement between the State of Colorado Water Conservation Board (CWCB) and the Federal Emergency Management Agency (FEMA).

Additional Flood Hazard information and resources are available from local communities and the Colorado Water Conservation Board.



NOTE: MAP AREA SHOWN ON THIS PANEL IS LOCATED WITHIN TOWNSHIP 12 SOUTH, RANGE 65 WEST, AND TOWNSHIP 13 SOUTH, RANGE 65 WEST.

LEGEND

SPECIAL FLOOD HAZARD AREAS (SFHAS) SUBJECT TO INUNDATION BY THE 1% ANNUAL CHANCE FLOOD

The 1% annual chance flood (100-year flood), also known as the base flood, is the flood that has a 1% chance of being equaled or exceeded in any given year. The Special Flood Hazard Area is the area subject to flooding by the 1% annual chance flood. Areas of Special Flood Hazard include Zones A, AE, AH, AO, AR, A99, V, and VE. The Base Flood Elevation is the water-surface elevation of the 1% annual chance flood.

ZONE A	No Base Flood Elevations determined.
ZONE AE	Base Flood Elevations determined.
ZONE AH	Flood depths of 1 to 3 feet (usually areas of ponding); Base Flood Elevations determined.
ZONE AO	Flood depths of 1 to 3 feet (usually sheet flow on sloping terrain); average depths determined. For areas of alluvial fan flooding, velocities also determined.
ZONE AR	Special Flood Hazard Area Formerly protected from the 1% annual chance flood by a flood control system that was subsequently decertified. Zone AR indicates that the former flood control system is being restored to provide protection from the 1% annual chance or greater flood.
ZONE A99	Area to be protected from 1% annual chance flood by a Federal flood protection system under construction; no Base Flood Elevations determined.
ZONE V	Coastal flood zone with velocity hazard (wave action); no Base Flood Elevations determined.
ZONE VE	Coastal flood zone with velocity hazard (wave action); Base Flood Elevations determined.

FLOODWAY AREAS IN ZONE AE

The floodway is the channel of a stream plus any adjacent floodplain areas that must be kept free of encroachment so that the 1% annual chance flood can be carried without substantial increases in flood heights.

OTHER FLOOD AREAS

ZONE X	Areas of 0.2% annual chance flood; areas of 1% annual chance flood with average depths of less than 1 foot or with drainage areas less than 1 square mile; and areas protected by levees from 1% annual chance flood.

OTHER AREAS

ZONE X	Areas determined to be outside the 0.2% annual chance floodplain.
ZONE D	Areas in which flood hazards are undetermined, but possible.

COASTAL BARRIER RESOURCES SYSTEM (CBRS) AREAS

OTHERWISE PROTECTED AREAS (OPAs)

CBRS areas and OPAs are normally located within or adjacent to Special Flood Hazard Areas.

	Floodplain boundary
	Floodway boundary
	Zone D Boundary
	CBRS and OPA boundary
	Boundary dividing Special Flood Hazard Areas of different Base Flood Elevations, flood depths or flood velocities.
513	Base Flood Elevation line and value; elevation in feet*
(EL 987)	Base Flood Elevation value where uniform within zone; elevation in feet*

* Referenced to the North American Vertical Datum of 1988 (NAVD 88)

A — A	Cross section line
23 - - - - - 23	Transect line
97° 07' 30.00" 32° 22' 30.00"	Geographic coordinates referenced to the North American Datum of 1983 (NAD 83)
4275 000m N	1000-meter Universal Transverse Mercator grid ticks, zone 13
6000000 FT	5000-foot grid ticks: Colorado State Plane coordinate system, central zone (FIPSZONE 0502), Lambert Conformal Conic Projection
DX5510 ×	Bench mark (see explanation in Notes to Users section of this FIRM panel)
• M1.5	River Mile

MAP REPOSITORIES
Refer to Map Repositories list on Map Index

EFFECTIVE DATE OF COUNTYWIDE
FLOOD INSURANCE RATE MAP
MARCH 17, 1997

EFFECTIVE DATE(S) OF REVISION(S) TO THIS PANEL
DECEMBER 7, 2018 - to update corporate limits, to change Base Flood Elevations and Special Flood Hazard Areas, to update map format, to add roads and road names, and to incorporate previously issued Letters of Map Revision.

For community map revision history prior to countywide mapping, refer to the Community Map History Table located in the Flood Insurance Study report for this jurisdiction.

To determine if flood insurance is available in this community, contact your insurance agent or call the National Flood Insurance Program at 1-800-638-6620.

MAP SCALE 1" = 500'

250 0 500 1000 FEET

150 0 150 300 METERS

NFIP

NATIONAL FLOOD INSURANCE PROGRAM

PANEL 0533G

FIRM
FLOOD INSURANCE RATE MAP
EL PASO COUNTY, COLORADO
AND INCORPORATED AREAS

PANEL 533 OF 1300

(SEE MAP INDEX FOR FIRM PANEL LAYOUT)

CONTAINS:

COMMUNITY	NUMBER	PANEL	SUFFIX
COLORADO SPRINGS, CITY OF	080060	0533	G
EL PASO COUNTY	080059	0533	G

Notice to User: The **Map Number** shown below should be used when placing map orders; the **Community Number** shown above should be used on insurance applications for the subject community.

MAP NUMBER
08041C0533G

MAP REVISED
DECEMBER 7, 2018

Federal Emergency Management Agency

NOTES TO USERS

This map is for use in administering the National Flood Insurance Program. It does not necessarily identify all areas subject to flooding, particularly from local drainage sources of small size. The **community map repository** should be consulted for possible updated or additional flood hazard information.

To obtain more detailed information in areas where **Base Flood Elevations** (BFEs) and/or **floodways** have been determined, users are encouraged to consult the Flood Profiles and Floodway Data and/or Summary of Stillwater Elevations tables contained within the Flood Insurance Study (FIS) report that accompanies this FIRM. Users should be aware that BFEs shown on the FIRM represent rounded whole-foot elevations. These BFEs are intended for flood insurance rating purposes only and should not be used as the sole source of flood elevation information. Accordingly, flood elevation data presented in the FIS report should be utilized in conjunction with the FIRM for purposes of construction and/or floodplain management.

Coastal Base Flood Elevations shown on this map apply only landward of 0.0' North American Vertical Datum of 1988 (NAVD88). Users of this FIRM should be aware that coastal flood elevations are also provided in the Summary of Stillwater Elevations table in the Flood Insurance Study report for this jurisdiction. Elevations shown in the Summary of Stillwater Elevations table should be used for construction and/or floodplain management purposes when they are higher than the elevations shown on this FIRM.

Boundaries of the **floodways** were computed at cross sections and interpolated between cross sections. The floodways were based on hydraulic considerations with regard to requirements of the National Flood Insurance Program. Floodway widths and other pertinent floodway data are provided in the Flood Insurance Study report for this jurisdiction.

Certain areas not in Special Flood Hazard Areas may be protected by **flood control structures**. Refer to section 2.4 "Flood Protection Measures" of the Flood Insurance Study report for information on flood control structures for this jurisdiction.

The **projection** used in the preparation of this map was Universal Transverse Mercator (UTM) zone 13. The **horizontal datum** was NAD83, GRS80 spheroid. Differences in datum, spheroid, projection or UTM zones zones used in the production of FIRMs for adjacent jurisdictions may result in slight positional differences in map features across jurisdiction boundaries. These differences do not affect the accuracy of this FIRM.

Flood elevations on this map are referenced to the **North American Vertical Datum of 1988 (NAVD88)**. These flood elevations must be compared to structure and ground elevations referenced to the same **vertical datum**. For information regarding conversion between the National Geodetic Vertical Datum of 1929 and the North American Vertical Datum of 1988, visit the National Geodetic Survey website at http://www.ngs.noaa.gov/ or contact the National Geodetic Survey at the following address:

NGS Information Services
NOAA, N/NGS12
National Geodetic Survey
SSMC-3, #9202
1315 East-West Highway
Silver Spring, MD 20910-3282

To obtain current elevation, description, and/or location information for **bench marks** shown on this map, please contact the Information Services Branch of the National Geodetic Survey at (301) 713-3242 or visit its website at http://www.ngs.noaa.gov/.

Base Map information shown on this FIRM was provided in digital format by El Paso County, Colorado Springs Utilities, and Anderson Consulting Engineers, Inc. These data are current as of 2008.

This map reflects more detailed and up-to-date **stream channel configurations and floodplain delineations** than those shown on the previous FIRM for this jurisdiction. The floodplains and floodways that were transferred from the previous FIRM may have been adjusted to conform to these new stream channel configurations. As a result, the Flood Profiles and Floodway Data tables in the Flood Insurance Study Report (which contains authoritative hydraulic data) may reflect stream channel distances that differ from what is shown on this map. The profile baselines depicted on this map represent the hydraulic modeling baselines that match the flood profiles and Floodway Data Tables if applicable, in the FIS report. As a result, the profile baselines may deviate significantly from the new base map channel representation and may appear outside of the floodplain.

Corporate limits shown on this map are based on the best data available at the time of publication. Because changes due to annexations or de-annexations may have occurred after this map was published, map users should contact appropriate community officials to verify current corporate limit locations.

Please refer to the separately printed **Map Index** for an overview map of the county showing the layout of map panels; community map repository addresses; and a Listing of Communities table containing National Flood Insurance Program dates for each community as well as a listing of the panels on which each community is located.

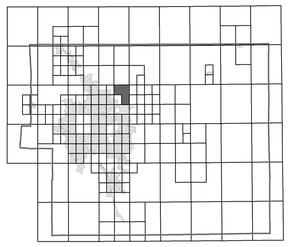
Contact **FEMA Map Service Center** (MSC) via the FEMA Map Information eXchange (FMIX) 1-877-336-2627 for information on available products associated with this FIRM. Available products may include previously issued Letters of Map Change, a Flood Insurance Study Report, and/or digital versions of this map. The MSC may also be reached by Fax at 1-800-358-9620 and its website at http://www.msc.fema.gov/.

If you have **questions about this map** or questions concerning the National Flood Insurance Program in general, please call **1-877-FEMA MAP** (1-877-336-2627) or visit the FEMA website at http://www.fema.gov/business/nfip.

El Paso County Vertical Datum Offset Table

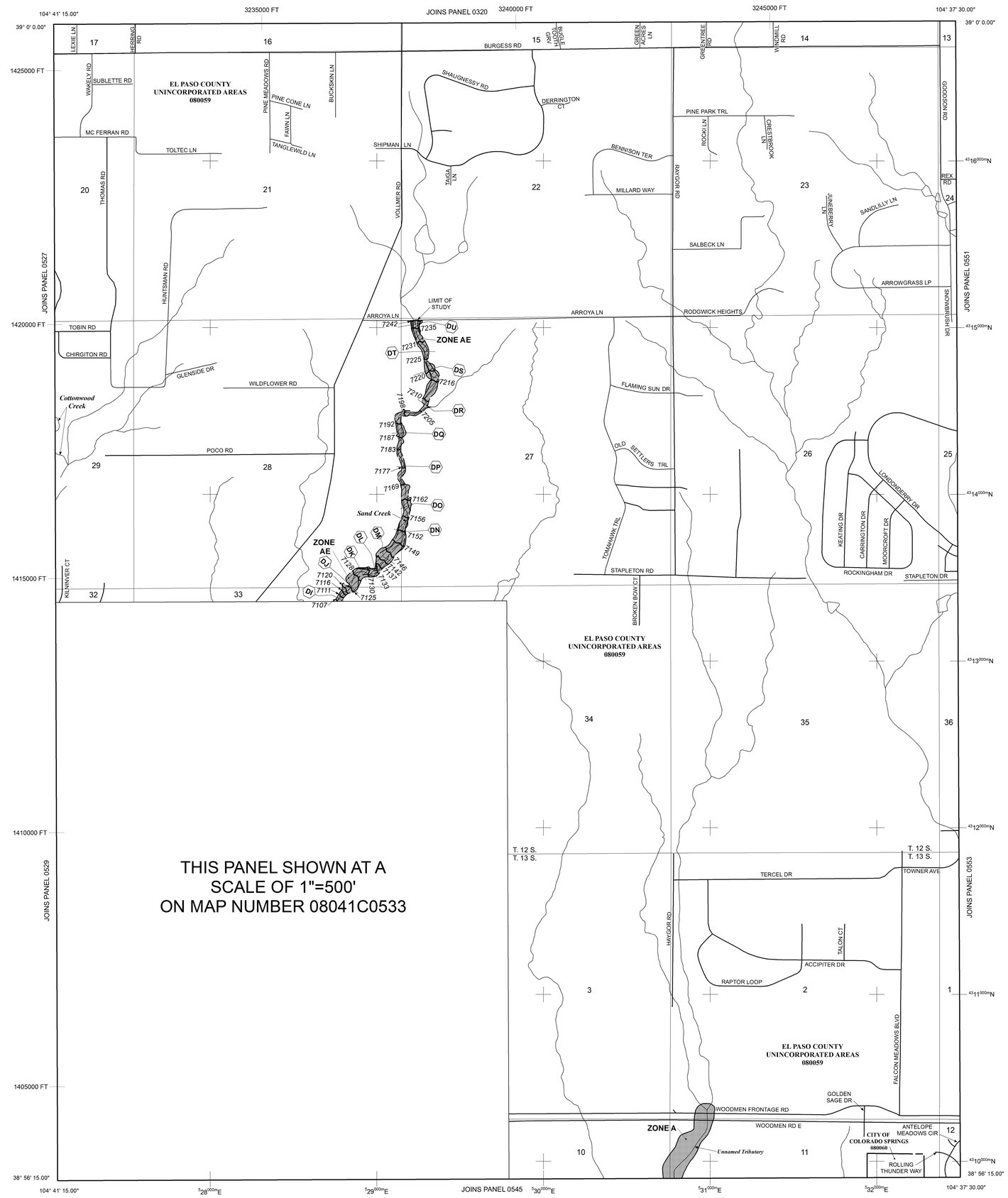
Flooding Source	Vertical Datum Offset (ft)
REFER TO SECTION 3.3 OF THE EL PASO COUNTY FLOOD INSURANCE STUDY FOR STREAM BY STREAM VERTICAL DATUM CONVERSION INFORMATION	

Panel Location Map



This Digital Flood Insurance Rate Map (DFIRM) was produced through a Cooperating Technical Partner (CTP) agreement between the State of Colorado Water Conservation Board (CWCB) and the Federal Emergency Management Agency (FEMA).

Additional Flood Hazard information and resources are available from local communities and the Colorado Water Conservation Board.



THIS PANEL SHOWN AT A SCALE OF 1"=500' ON MAP NUMBER 08041C0533

NOTE: MAP AREA SHOWN ON THIS PANEL IS LOCATED WITHIN TOWNSHIP 12 SOUTH, RANGE 65 WEST, AND TOWNSHIP 13 SOUTH, RANGE 65 WEST.

LEGEND

SPECIAL FLOOD HAZARD AREAS (SFHAS) SUBJECT TO INUNDATION BY THE 1% ANNUAL CHANCE FLOOD

The 1% annual chance flood (100-year flood), also known as the base flood, is the flood that has a 1% chance of being equaled or exceeded in any given year. The Special Flood Hazard Area is the area subject to flooding by the 1% annual chance flood. Areas of Special Flood Hazard include Zones A, AE, AH, AO, AR, A99, V, and VE. The Base Flood Elevation is the water-surface elevation of the 1% annual chance flood.

ZONE A	No Base Flood Elevations determined.
ZONE AE	Base Flood Elevations determined.
ZONE AH	Flood depths of 1 to 3 feet (usually areas of ponding); Base Flood Elevations determined.
ZONE AO	Flood depths of 1 to 3 feet (usually sheet flow on sloping terrain); average depths determined. For areas of alluvial fan flooding, velocities also determined.
ZONE AR	Special Flood Hazard Area Formerly protected from the 1% annual chance flood by a flood control system that was subsequently decertified. Zone AR indicates that the former flood control system is being restored to provide protection from the 1% annual chance or greater flood.
ZONE A99	Area to be protected from 1% annual chance flood by a Federal flood protection system under construction; no Base Flood Elevations determined.
ZONE V	Coastal flood zone with velocity hazard (wave action); no Base Flood Elevations determined.
ZONE VE	Coastal flood zone with velocity hazard (wave action); Base Flood Elevations determined.

FLOODWAY AREAS IN ZONE AE

The floodway is the channel of a stream plus any adjacent floodplain areas that must be kept free of encroachment so that the 1% annual chance flood can be carried without substantial increases in flood heights.

OTHER FLOOD AREAS

ZONE X Areas of 0.2% annual chance flood; areas of 1% annual chance flood with average depths of less than 1 foot or with drainage areas less than 1 square mile; and areas protected by levees from 1% annual chance flood.

OTHER AREAS

ZONE X Areas determined to be outside the 0.2% annual chance floodplain.

ZONE D Areas in which flood hazards are undetermined, but possible.

COASTAL BARRIER RESOURCES SYSTEM (CBRS) AREAS

OTHERWISE PROTECTED AREAS (OPAs)

CBRS areas and OPAs are normally located within or adjacent to Special Flood Hazard Areas.

	Floodplain boundary
	Floodway boundary
	Zone D Boundary
	CBRS and OPA boundary
	Boundary dividing Special Flood Hazard Areas of different Base Flood Elevations, flood depths or flood velocities.
513	Base Flood Elevation line and value; elevation in feet*
(EL 987)	Base Flood Elevation value where uniform within zone; elevation in feet*

* Referenced to the North American Vertical Datum of 1988 (NAVD 88)

A — A	Cross section line
23 - - - - 23	Transect line
97° 07' 30.00" 32° 22' 30.00"	Geographic coordinates referenced to the North American Datum of 1983 (NAD 83)
$^{42}75^{000m}$N	1000-meter Universal Transverse Mercator grid ticks, zone 13
6000000 FT	5000-foot grid ticks: Colorado State Plane coordinate system, central zone (FIPSZONE 0502), Lambert Conformal Conic Projection
DX5510 ×	Bench mark (see explanation in Notes to Users section of this FIRM panel)
• M1.5	River Mile

MAP REPOSITORIES
Refer to Map Repositories list on Map Index

EFFECTIVE DATE OF COUNTYWIDE
FLOOD INSURANCE RATE MAP
MARCH 17, 1997

EFFECTIVE DATE(S) OF REVISION(S) TO THIS PANEL
DECEMBER 7, 2018 - to update corporate limits, to change Base Flood Elevations and Special Flood Hazard Areas, to update map format, to add roads and road names, and to incorporate previously issued Letters of Map Revision.

For community map revision history prior to countywide mapping, refer to the Community Map History Table located in the Flood Insurance Study report for this jurisdiction.

To determine if flood insurance is available in this community, contact your insurance agent or call the National Flood Insurance Program at 1-800-638-6620.

MAP SCALE 1" = 1000'

500 0 1000 2000 FEET

300 0 300 600 METERS

NFIP

NATIONAL FLOOD INSURANCE PROGRAM

PANEL 0535G

FIRM
FLOOD INSURANCE RATE MAP
EL PASO COUNTY, COLORADO
AND INCORPORATED AREAS

PANEL 535 OF 1300

(SEE MAP INDEX FOR FIRM PANEL LAYOUT)

CONTAINS:

COMMUNITY	NUMBER	PANEL	SUFFIX
COLORADO SPRINGS, CITY OF	080060	0535	G
EL PASO COUNTY	080059	0535	G

Notice to User: The **Map Number** shown below should be used when placing map orders; the **Community Number** shown above should be used on insurance applications for the subject community.

MAP NUMBER
08041C0535G

MAP REVISED
DECEMBER 7, 2018

Federal Emergency Management Agency

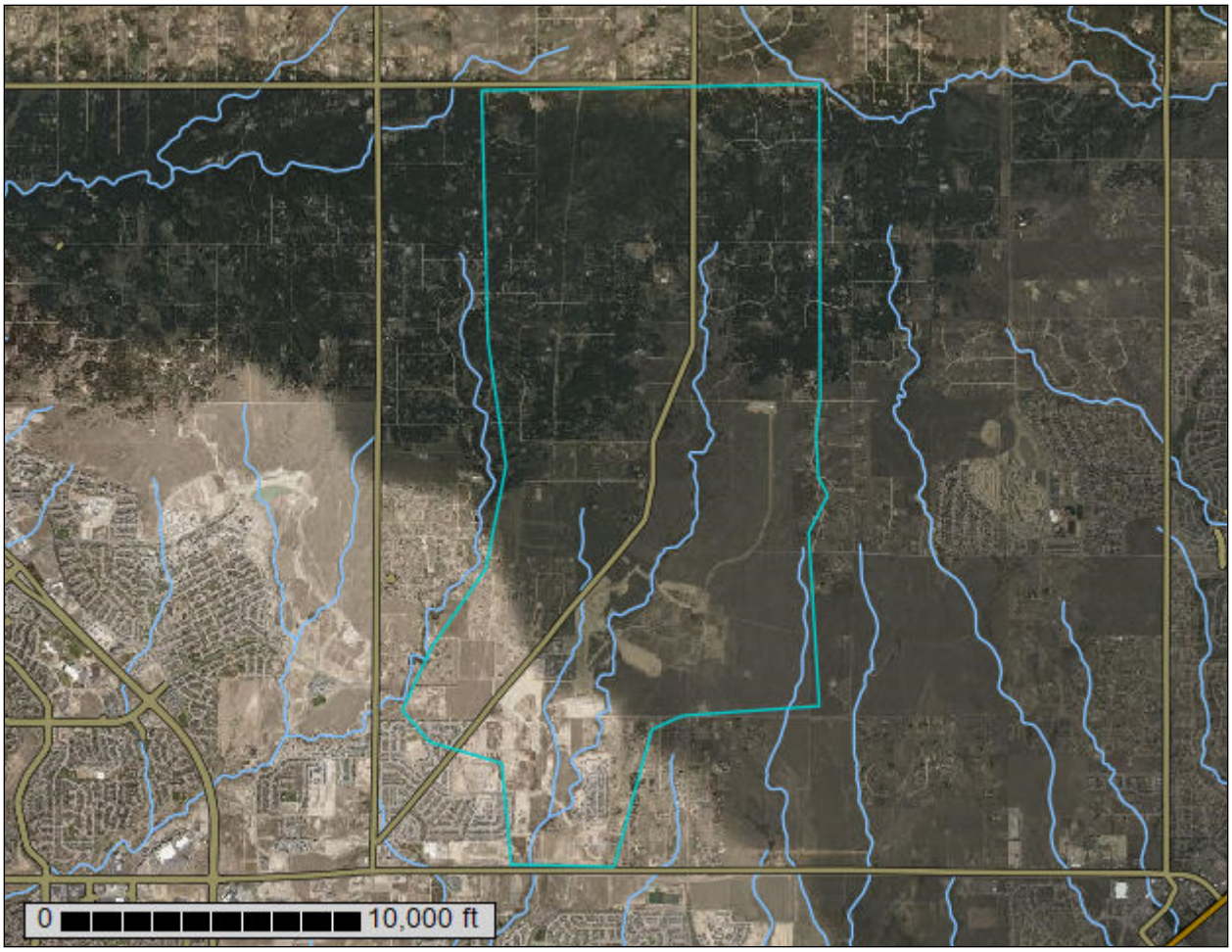
United States Department of Agriculture

Natural Resources Conservation Service

A product of the National Cooperative Soil Survey, a joint effort of the United States Department of Agriculture and other Federal agencies, State agencies including the Agricultural Experiment Stations, and local participants

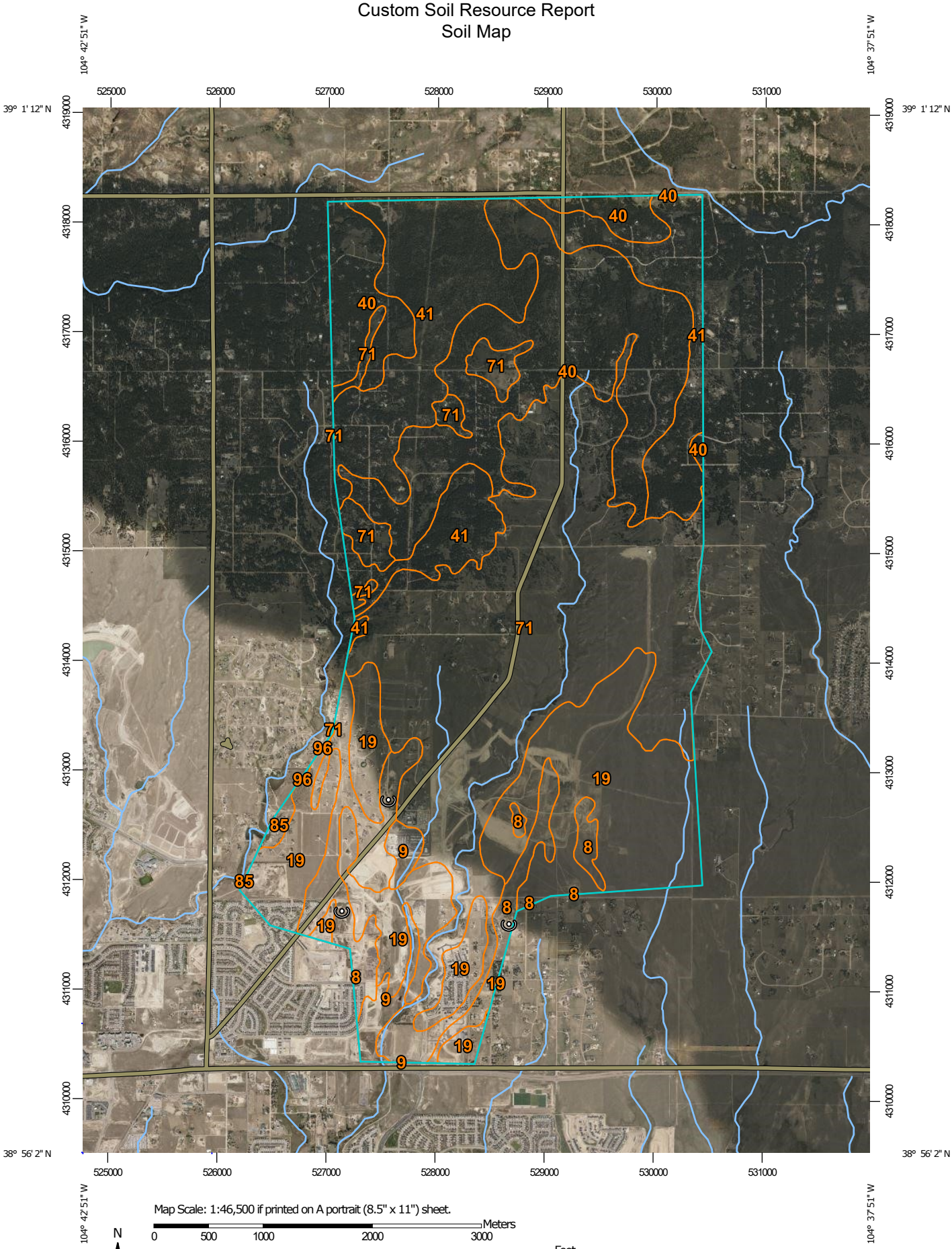
Custom Soil Resource Report for

El Paso County Area, Colorado



January 24, 2022

Custom Soil Resource Report
Soil Map



Map Scale: 1:46,500 if printed on A portrait (8.5" x 11") sheet.

N

Meters: 0 500 1000 2000 3000

Feet: 0 2000 4000 8000 12000

Map projection: Web Mercator Corner coordinates: WGS84 Edge tics: UTM Zone 13N WGS84

Map Unit Legend

Map Unit Symbol	Map Unit Name	Acres in AOI	Percent of AOI
8	Blakeland loamy sand, 1 to 9 percent slopes	385.1	6.4%
9	Blakeland-Fluvaquentic Haplaquolls	91.2	1.5%
19	Columbine gravelly sandy loam, 0 to 3 percent slopes	1,196.8	19.9%
40	Kettle gravelly loamy sand, 3 to 8 percent slopes	1,190.9	19.8%
41	Kettle gravelly loamy sand, 8 to 40 percent slopes	1,028.9	17.1%
71	Pring coarse sandy loam, 3 to 8 percent slopes	2,108.3	35.0%
85	Stapleton-Bernal sandy loams, 3 to 20 percent slopes	16.9	0.3%
96	Truckton sandy loam, 0 to 3 percent slopes	2.2	0.0%
Totals for Area of Interest		**6,020.4**	**100.0%**

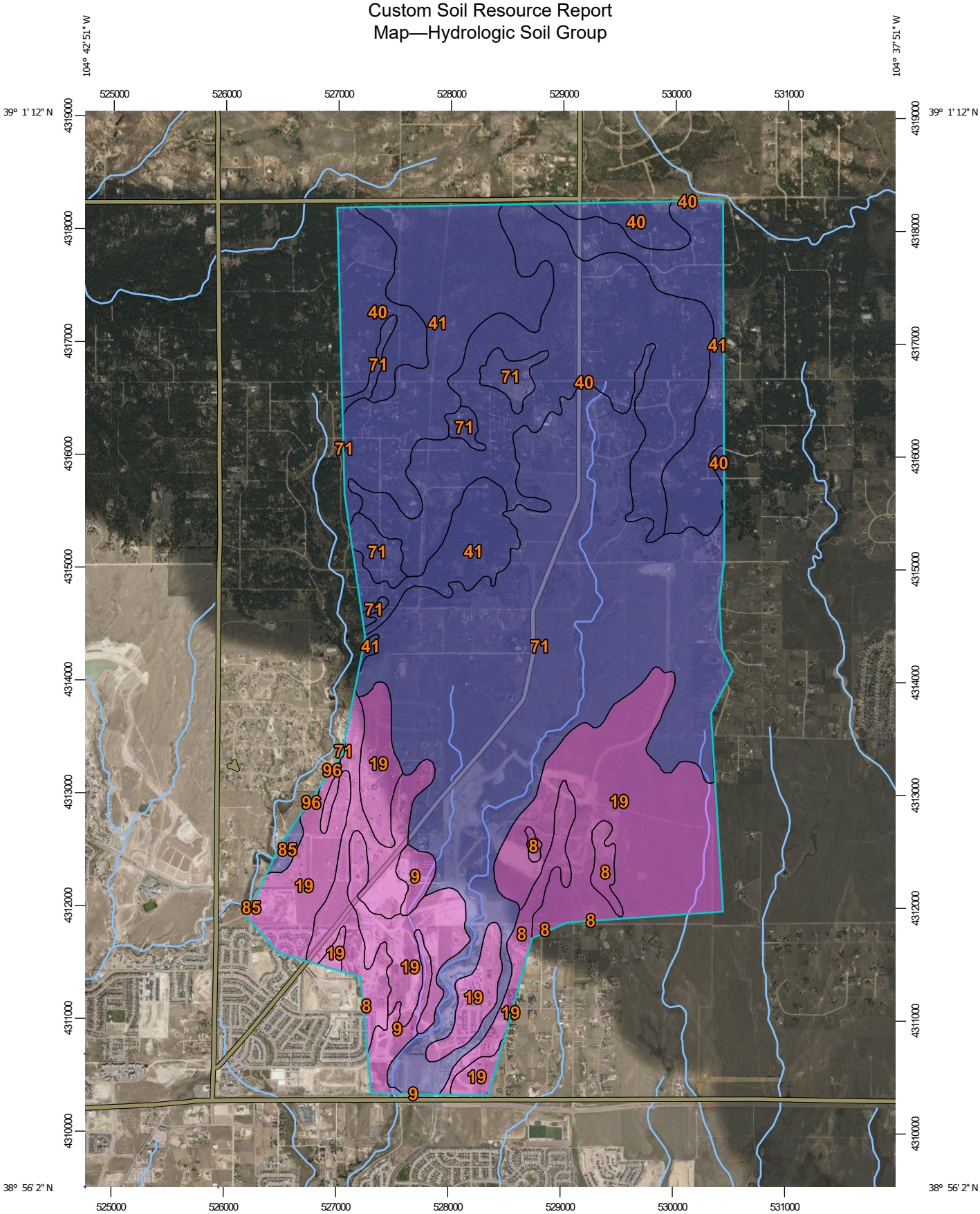
Map Unit Descriptions

The map units delineated on the detailed soil maps in a soil survey represent the soils or miscellaneous areas in the survey area. The map unit descriptions, along with the maps, can be used to determine the composition and properties of a unit.

A map unit delineation on a soil map represents an area dominated by one or more major kinds of soil or miscellaneous areas. A map unit is identified and named according to the taxonomic classification of the dominant soils. Within a taxonomic class there are precisely defined limits for the properties of the soils. On the landscape, however, the soils are natural phenomena, and they have the characteristic variability of all natural phenomena. Thus, the range of some observed properties may extend beyond the limits defined for a taxonomic class. Areas of soils of a single taxonomic class rarely, if ever, can be mapped without including areas of other taxonomic classes. Consequently, every map unit is made up of the soils or miscellaneous areas for which it is named and some minor components that belong to taxonomic classes other than those of the major soils.

Most minor soils have properties similar to those of the dominant soil or soils in the map unit, and thus they do not affect use and management. These are called noncontrasting, or similar, components. They may or may not be mentioned in a particular map unit description. Other minor components, however, have properties and behavioral characteristics divergent enough to affect use or to require different management. These are called contrasting, or dissimilar, components. They generally are in small areas and could not be mapped separately because of the scale used. Some small areas of strongly contrasting soils or miscellaneous areas

Map—Hydrologic Soil Group



Map Scale: 1:46,500 if printed on A portrait (8.5" x 11") sheet.

N

Meters: 0 500 1000 2000 3000

Feet: 0 2000 4000 8000 12000

Map projection: Web Mercator Corner coordinates: WGS84 Edge tics: UTM Zone 13N WGS84

Table—Hydrologic Soil Group

Map unit symbol	Map unit name	Rating	Acres in AOI	Percent of AOI
8	Blakeland loamy sand, 1 to 9 percent slopes	A	385.1	6.4%
9	Blakeland-Fluvaquentic Haplaquolls	A	91.2	1.5%
19	Columbine gravelly sandy loam, 0 to 3 percent slopes	A	1,196.8	19.9%
40	Kettle gravelly loamy sand, 3 to 8 percent slopes	B	1,190.9	19.8%
41	Kettle gravelly loamy sand, 8 to 40 percent slopes	B	1,028.9	17.1%
71	Pring coarse sandy loam, 3 to 8 percent slopes	B	2,108.3	35.0%
85	Stapleton-Bernal sandy loams, 3 to 20 percent slopes	B	16.9	0.3%
96	Truckton sandy loam, 0 to 3 percent slopes	A	2.2	0.0%
Totals for Area of Interest			**6,020.4**	**100.0%**

Rating Options—Hydrologic Soil Group

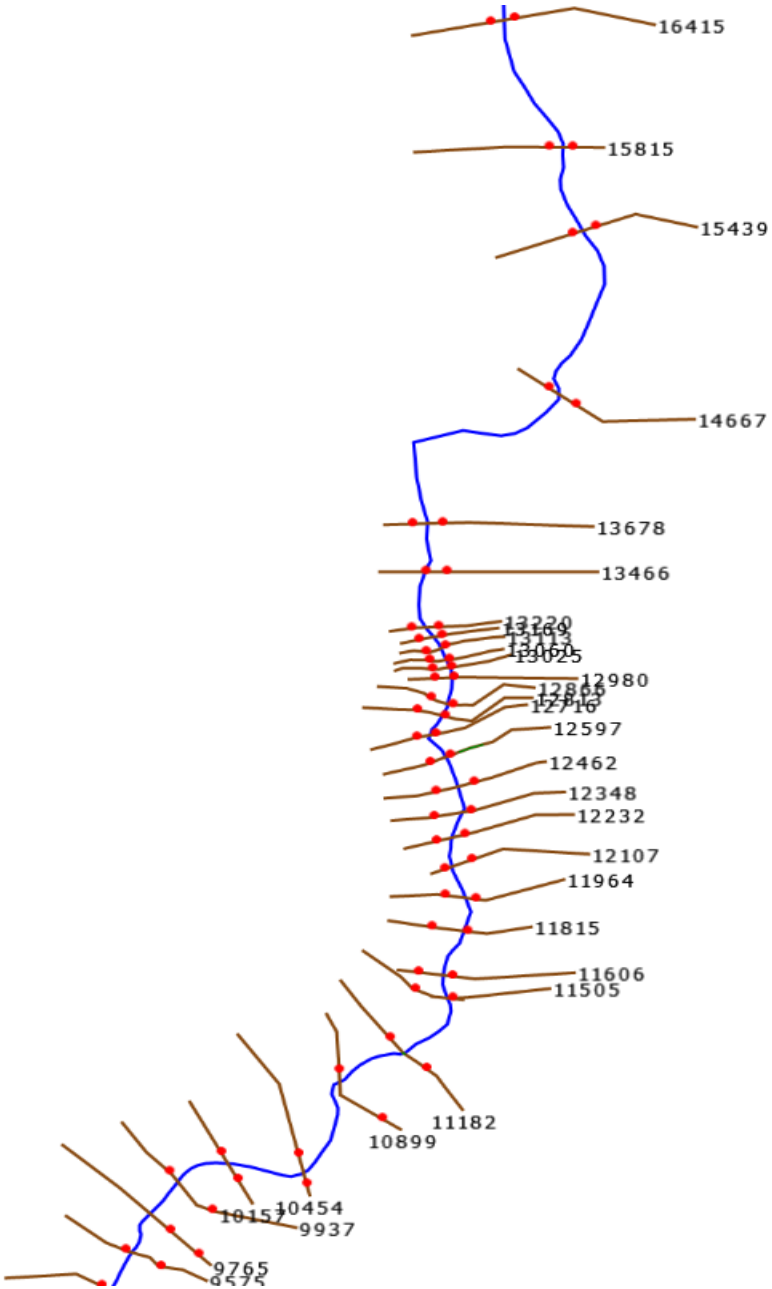
Aggregation Method: Dominant Condition

Component Percent Cutoff: None Specified

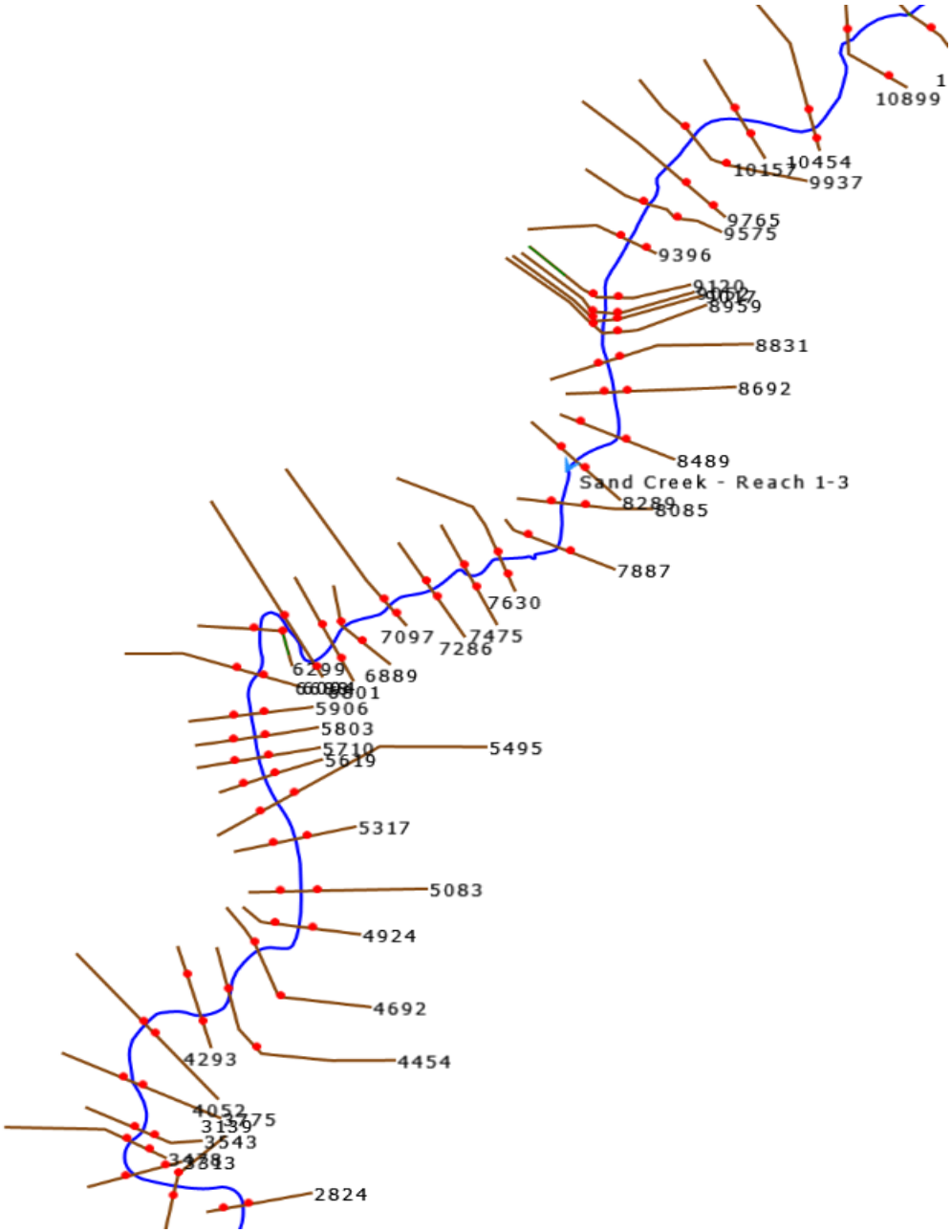
Tie-break Rule: Higher

Appendix B

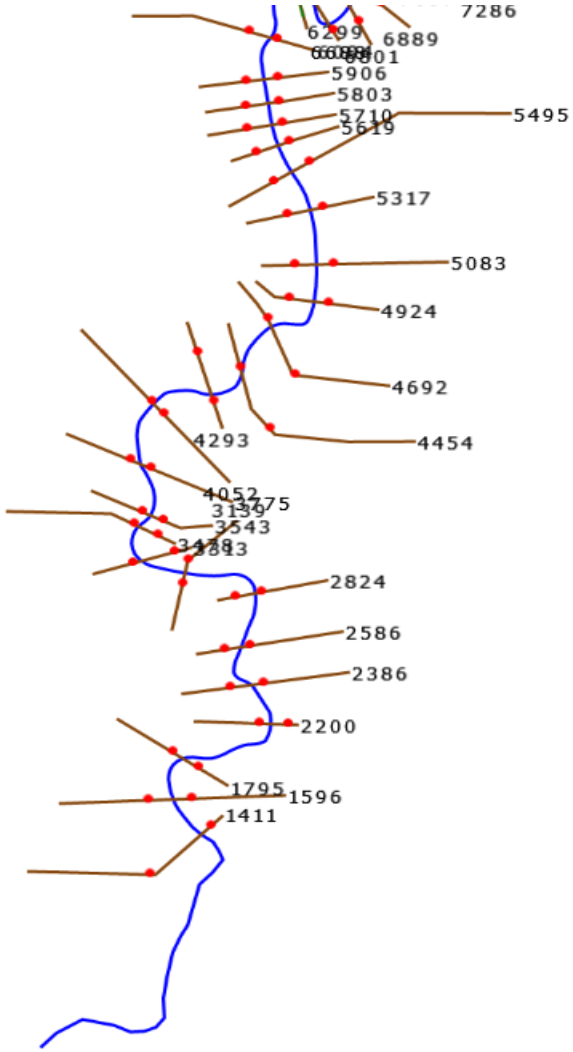
Sand Creek Existing Conditions Hydraulic Modeling



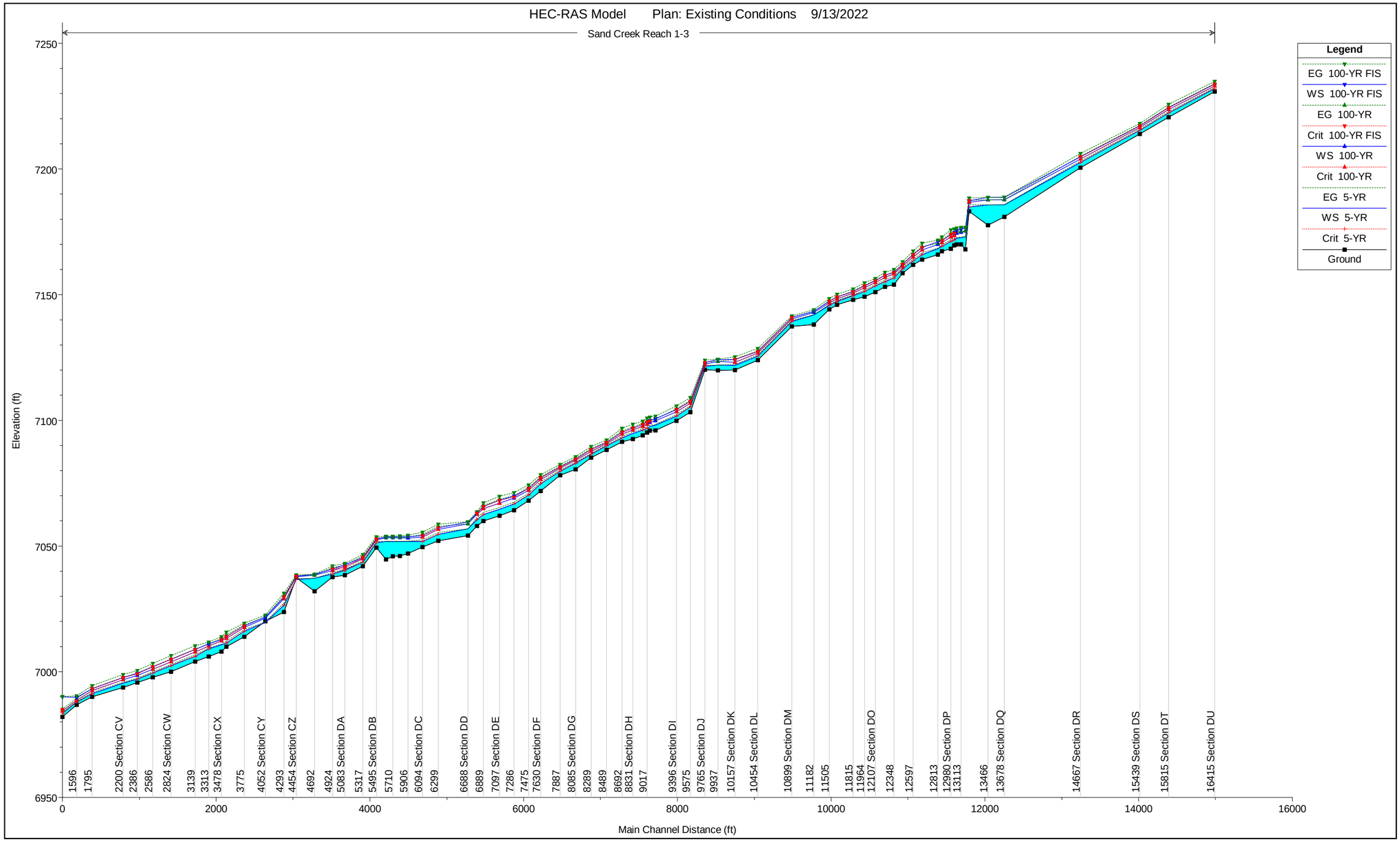
Created with GeoHECRAS v3.1.0.1170



Created with GeoHECRAS v3.1.0.1170

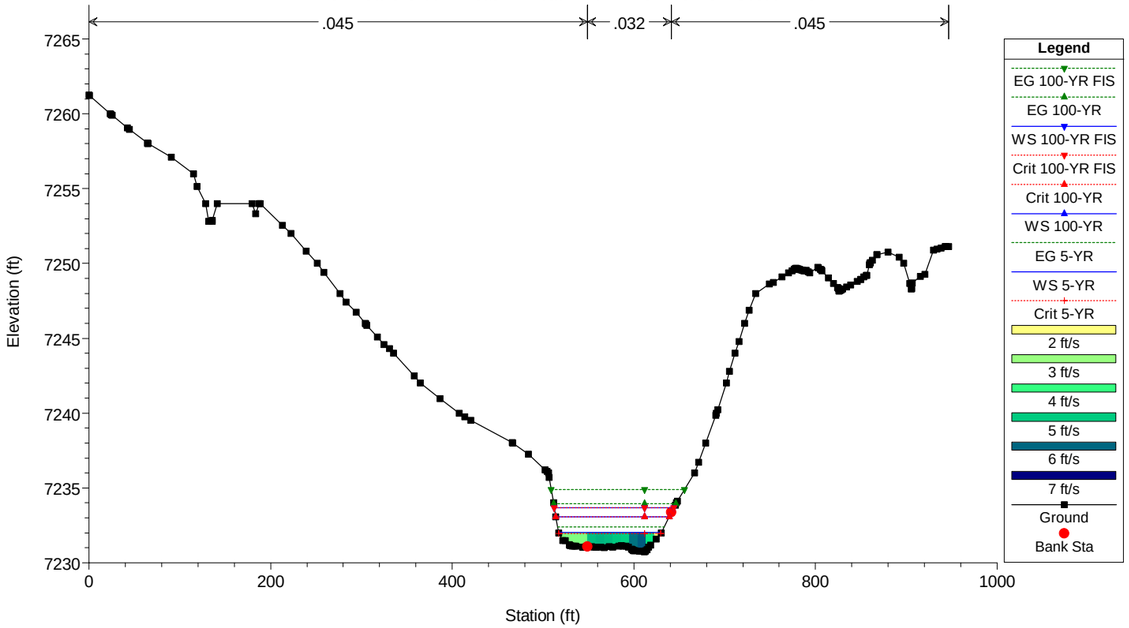


Created with GeoHECRAS v3.1.0.1170


HEC-RAS Model Plan: Existing Conditions 9/13/2022
Sand Creek Reach 1-3
Legend
EG 100-YR FIS
WS 100-YR FIS
EG 100-YR
Crit 100-YR FIS
WS 100-YR
Crit 100-YR
EG 5-YR
WS 5-YR
Crit 5-YR
Ground
Elevation (ft)
7250
7200
7150
7100
7050
7000
6950
Main Channel Distance (ft)
0
2000
4000
6000
8000
10000
12000
14000
16000
1596
1795
2200 Section CV
2386
2586
2824 Section CW
3139
3313
3478 Section CX
3775
4052 Section CY
4293
4454 Section CZ
4692
4924
5083 Section DA
5317
5495 Section DB
5710
5906
6094 Section DC
6299
6688 Section DD
6889
7097 Section DE
7286
7475
7630 Section DF
7887
8085 Section DG
8289
8489
8692
8831 Section DH
9017
9396 Section DI
9575
9765 Section DJ
9937
10157 Section DK
10454 Section DL
10899 Section DM
11182
11505
11815
11964
12107 Section DO
12348
12597
12813
12980 Section DP
13113
13466
13678 Section DQ
14667 Section DR
15439 Section DS
15815 Section DT
16415 Section DU

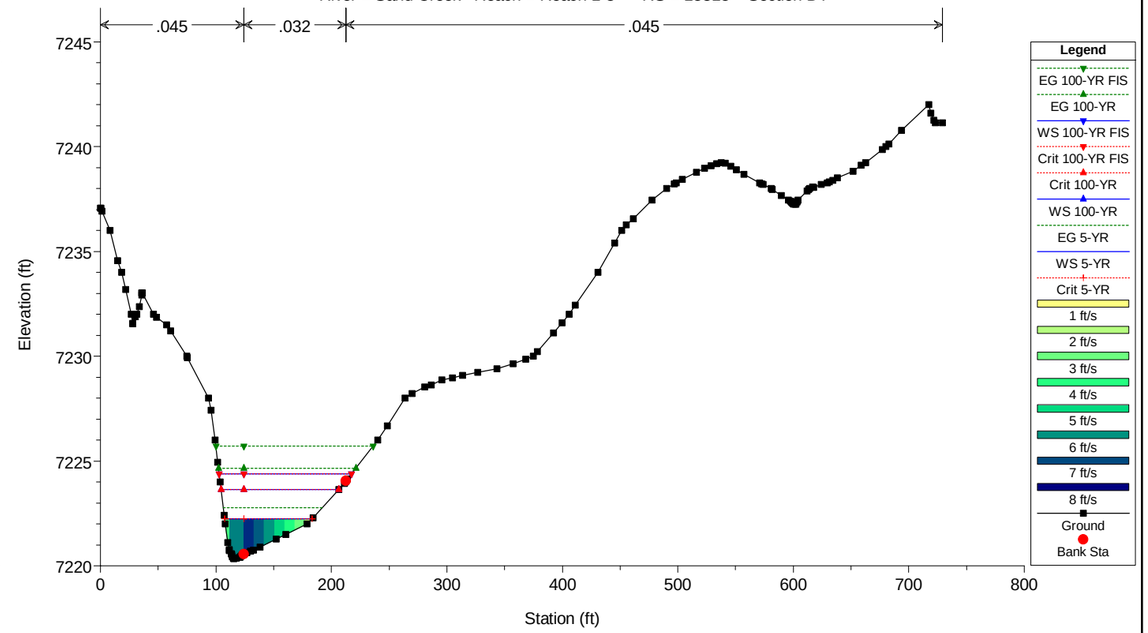
HEC-RAS Model Plan: Existing Conditions 9/13/2022

River = Sand Creek Reach = Reach 1-3 RS = 16415 Section DU



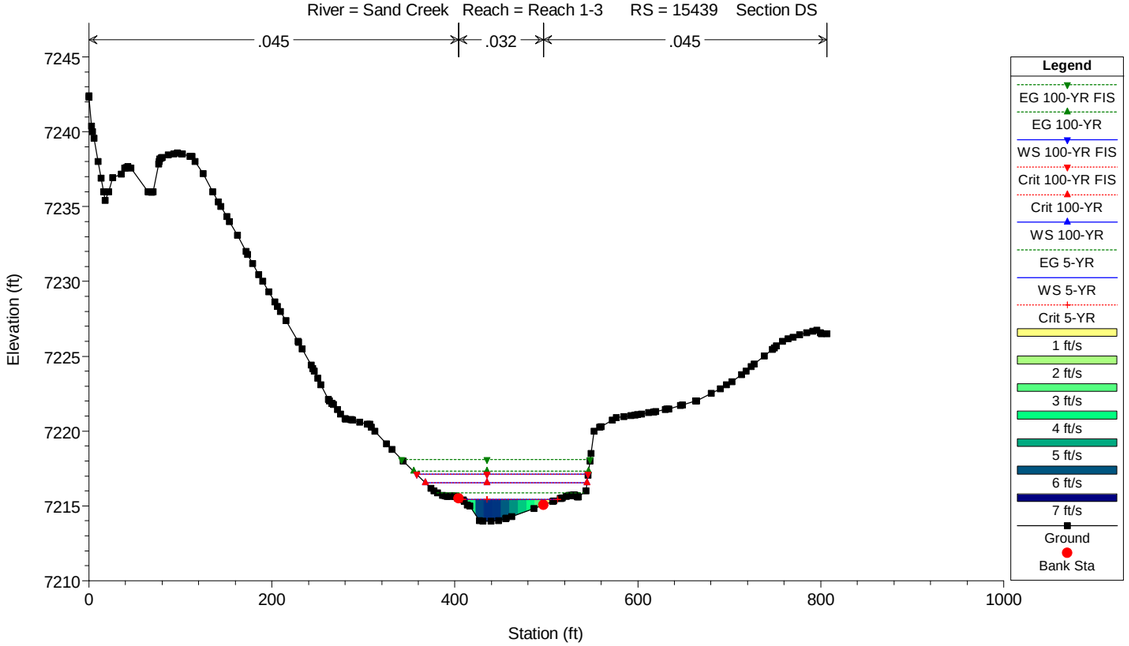
HEC-RAS Model Plan: Existing Conditions 9/13/2022

River = Sand Creek Reach = Reach 1-3 RS = 15815 Section DT



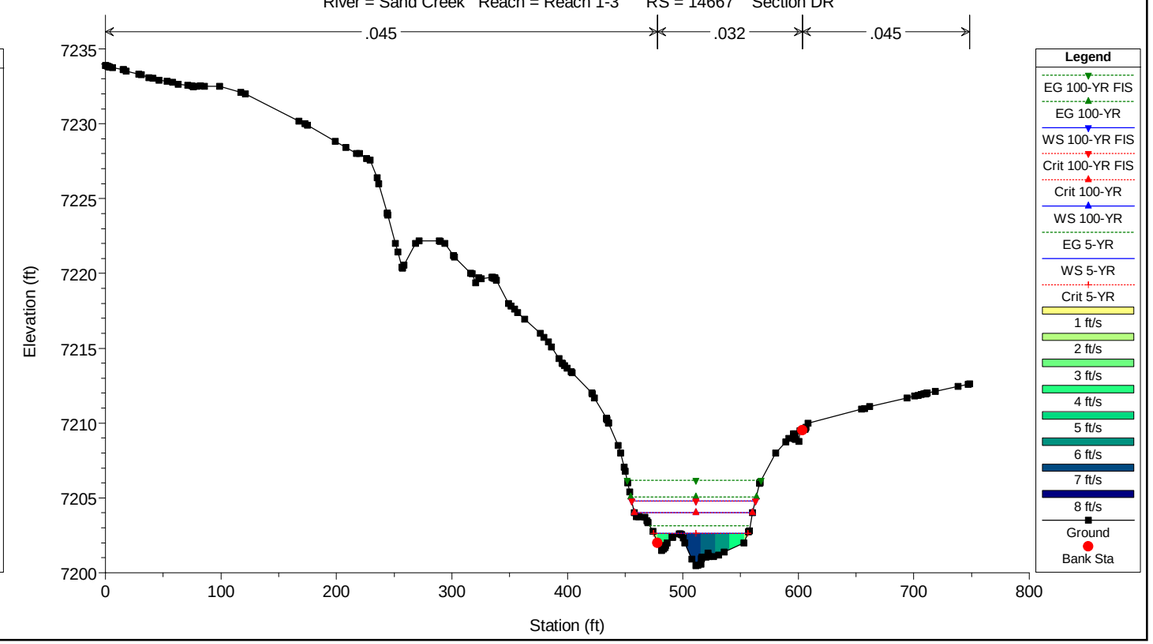
HEC-RAS Model Plan: Existing Conditions 9/13/2022

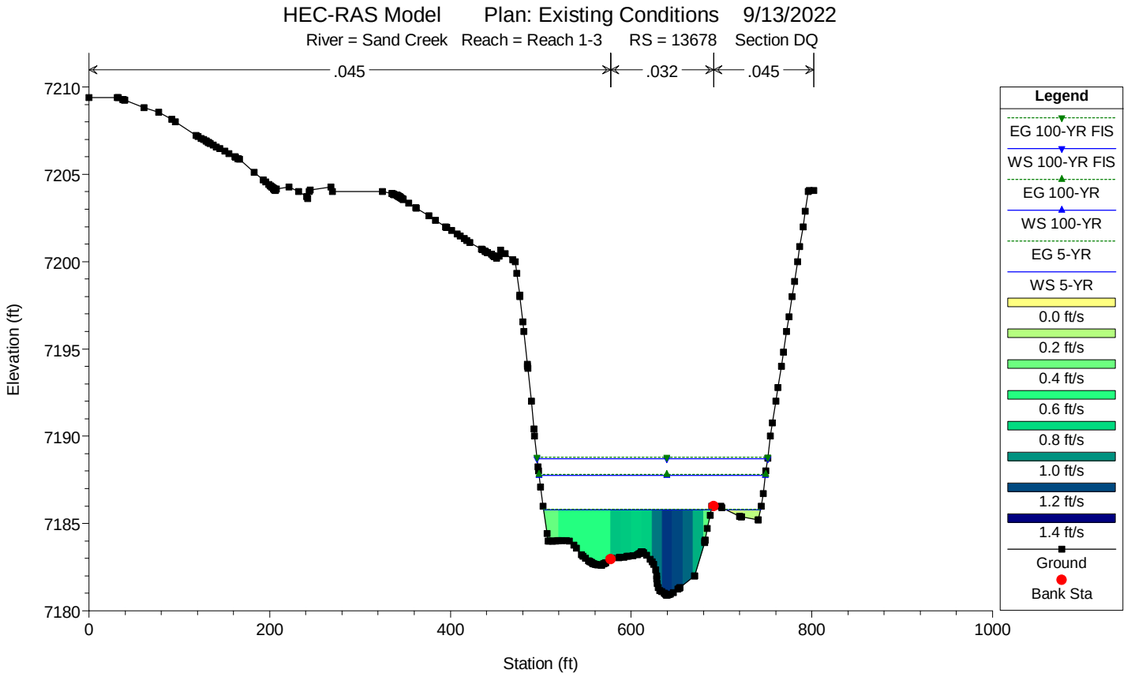
River = Sand Creek Reach = Reach 1-3 RS = 15439 Section DS

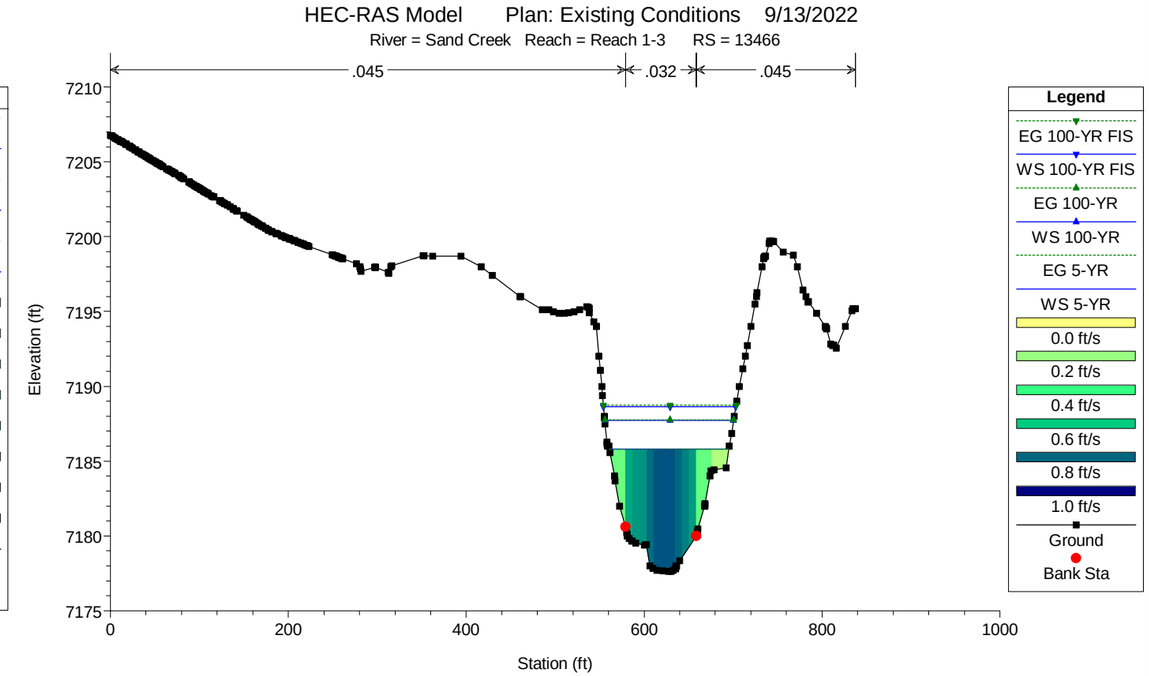


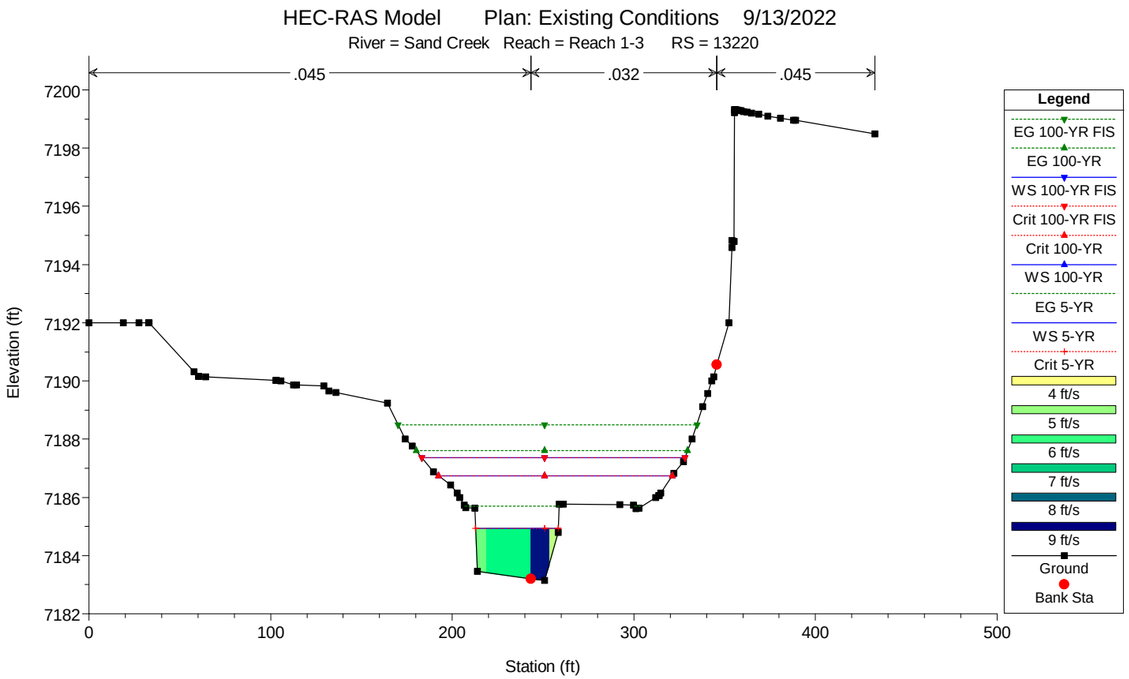
HEC-RAS Model Plan: Existing Conditions 9/13/2022

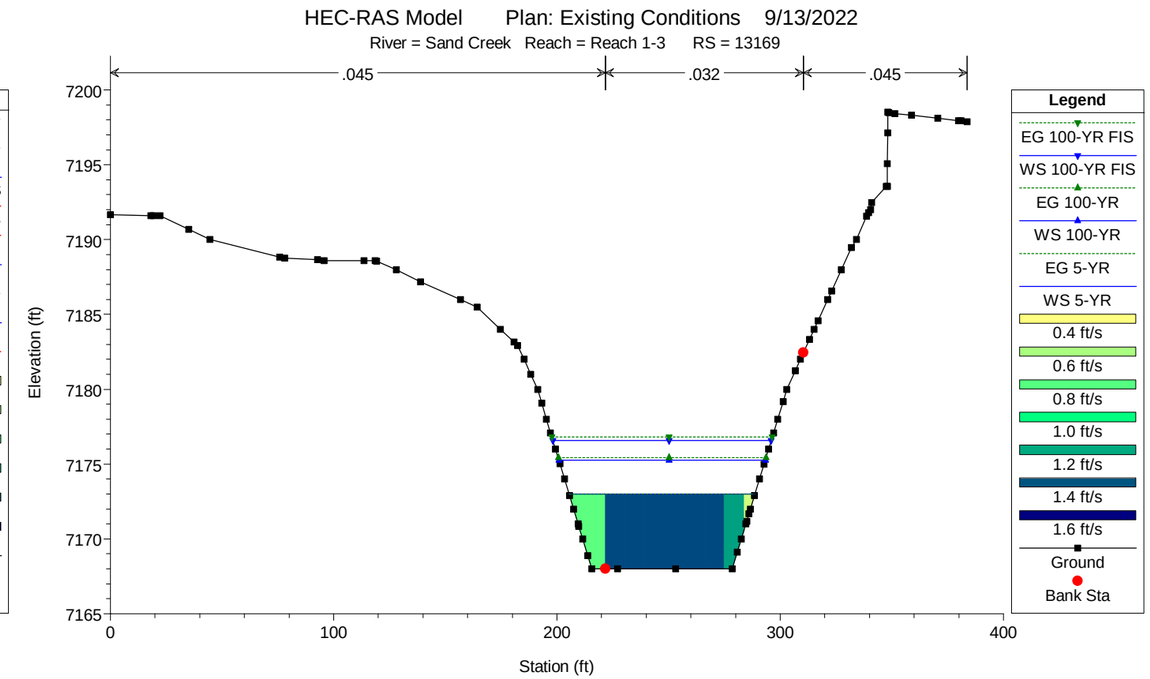
River = Sand Creek Reach = Reach 1-3 RS = 14667 Section DR




HEC-RAS Model Plan: Existing Conditions 9/13/2022
River = Sand Creek Reach = Reach 1-3 RS = 13678 Section DQ
.045
.032
.045
Elevation (ft)
Station (ft)
Legend
EG 100-YR FIS
WS 100-YR FIS
EG 100-YR
WS 100-YR
EG 5-YR
WS 5-YR
0.0 ft/s
0.2 ft/s
0.4 ft/s
0.6 ft/s
0.8 ft/s
1.0 ft/s
1.2 ft/s
1.4 ft/s
Ground
Bank Sta

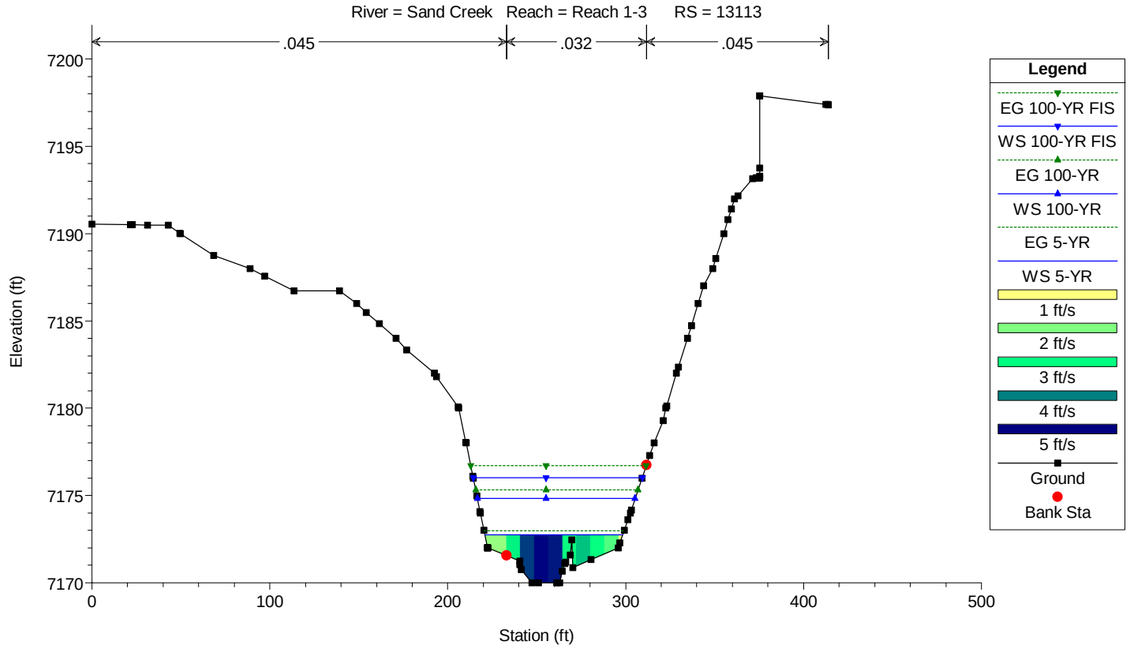

HEC-RAS Model Plan: Existing Conditions 9/13/2022
River = Sand Creek Reach = Reach 1-3 RS = 13466
.045
.032
.045
Elevation (ft)
Station (ft)
Legend
EG 100-YR FIS
WS 100-YR FIS
EG 100-YR
WS 100-YR
EG 5-YR
WS 5-YR
0.0 ft/s
0.2 ft/s
0.4 ft/s
0.6 ft/s
0.8 ft/s
1.0 ft/s
Ground
Bank Sta


HEC-RAS Model Plan: Existing Conditions 9/13/2022
River = Sand Creek Reach = Reach 1-3 RS = 13220
.045
.032
.045
Elevation (ft)
Station (ft)
Legend
EG 100-YR FIS
EG 100-YR
WS 100-YR FIS
Crit 100-YR FIS
Crit 100-YR
WS 100-YR
EG 5-YR
WS 5-YR
Crit 5-YR
4 ft/s
5 ft/s
6 ft/s
7 ft/s
8 ft/s
9 ft/s
Ground
Bank Sta


HEC-RAS Model Plan: Existing Conditions 9/13/2022
River = Sand Creek Reach = Reach 1-3 RS = 13169
.045
.032
.045
Elevation (ft)
Station (ft)
Legend
EG 100-YR FIS
WS 100-YR FIS
EG 100-YR
WS 100-YR
EG 5-YR
WS 5-YR
0.4 ft/s
0.6 ft/s
0.8 ft/s
1.0 ft/s
1.2 ft/s
1.4 ft/s
1.6 ft/s
Ground
Bank Sta

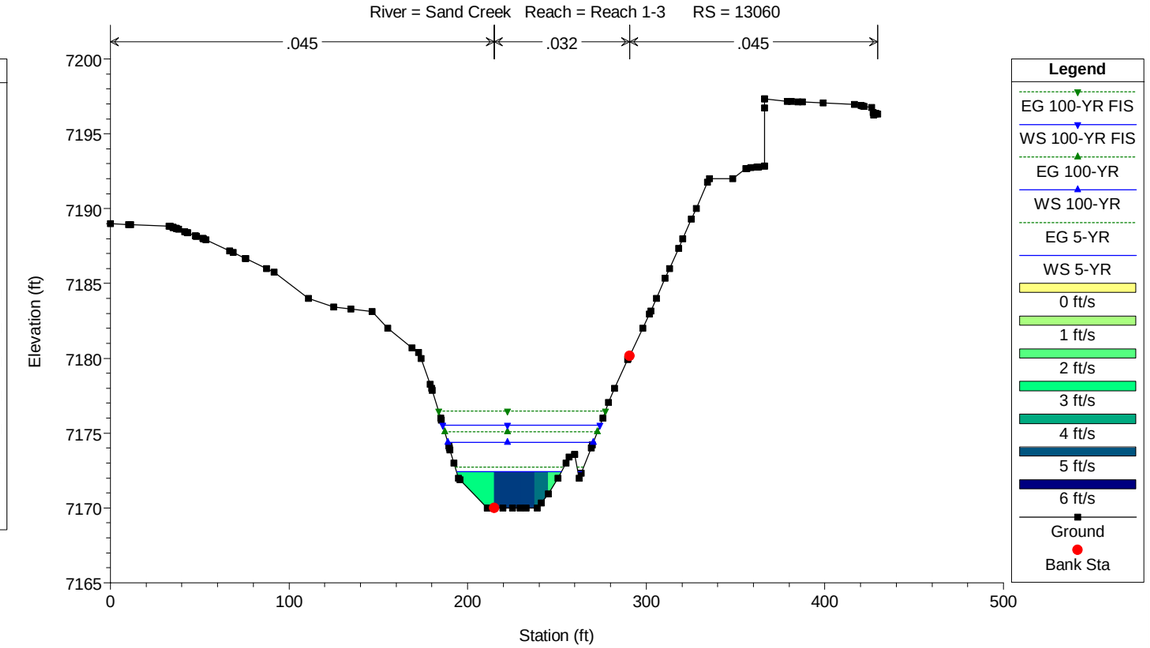
HEC-RAS Model Plan: Existing Conditions 9/13/2022

River = Sand Creek Reach = Reach 1-3 RS = 13113



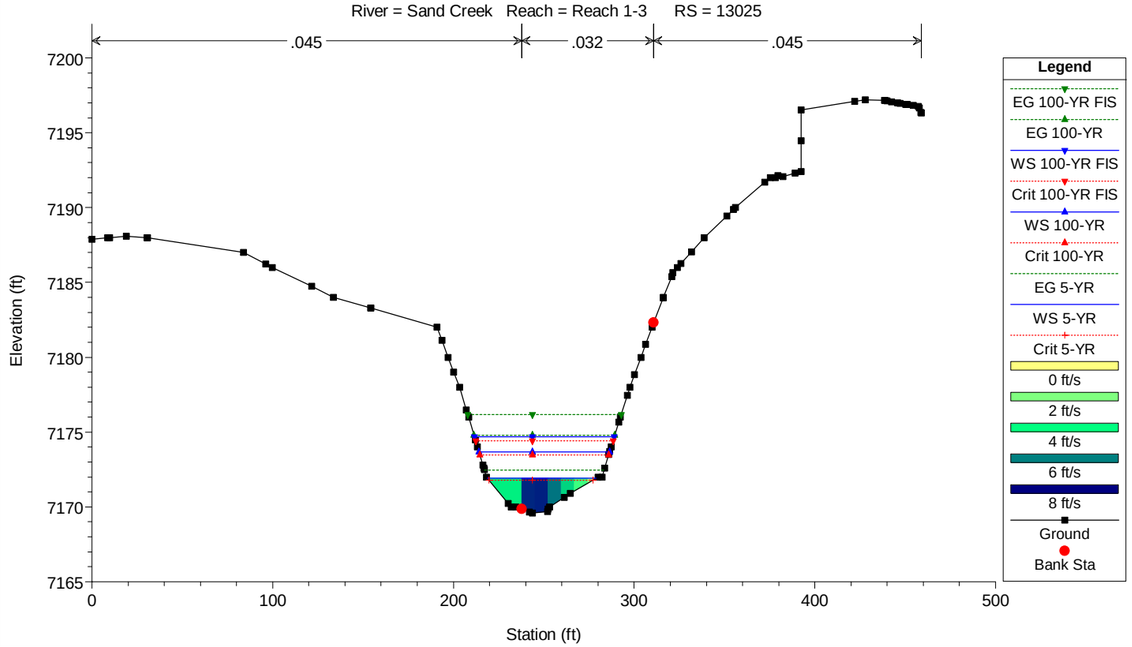
HEC-RAS Model Plan: Existing Conditions 9/13/2022

River = Sand Creek Reach = Reach 1-3 RS = 13060



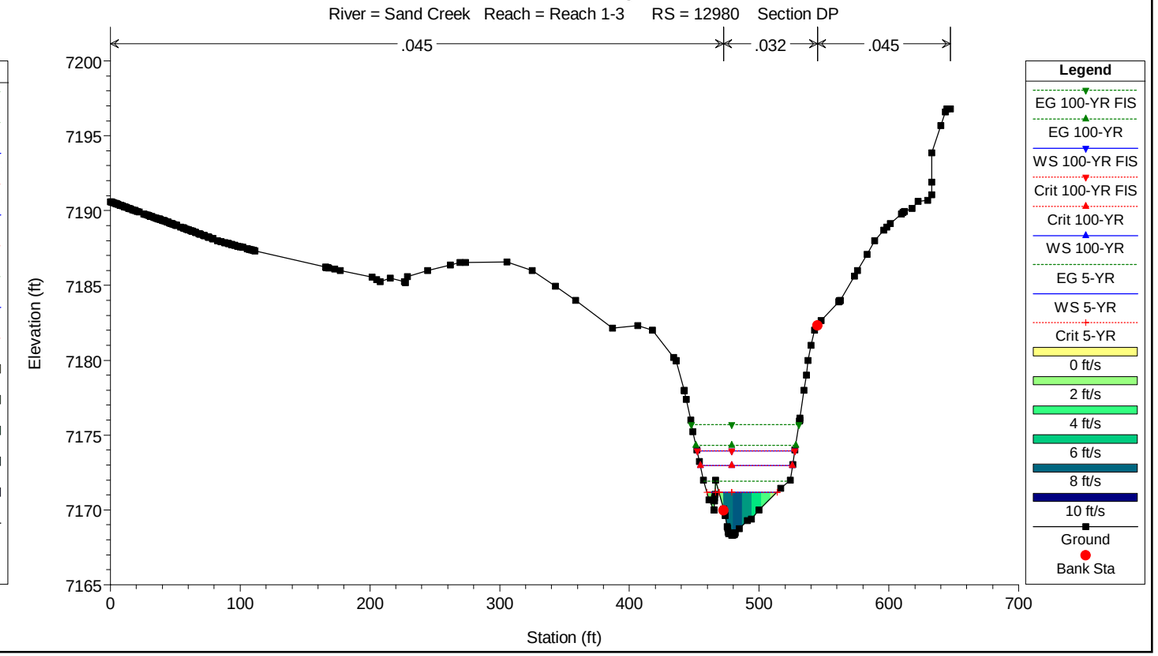
HEC-RAS Model Plan: Existing Conditions 9/13/2022

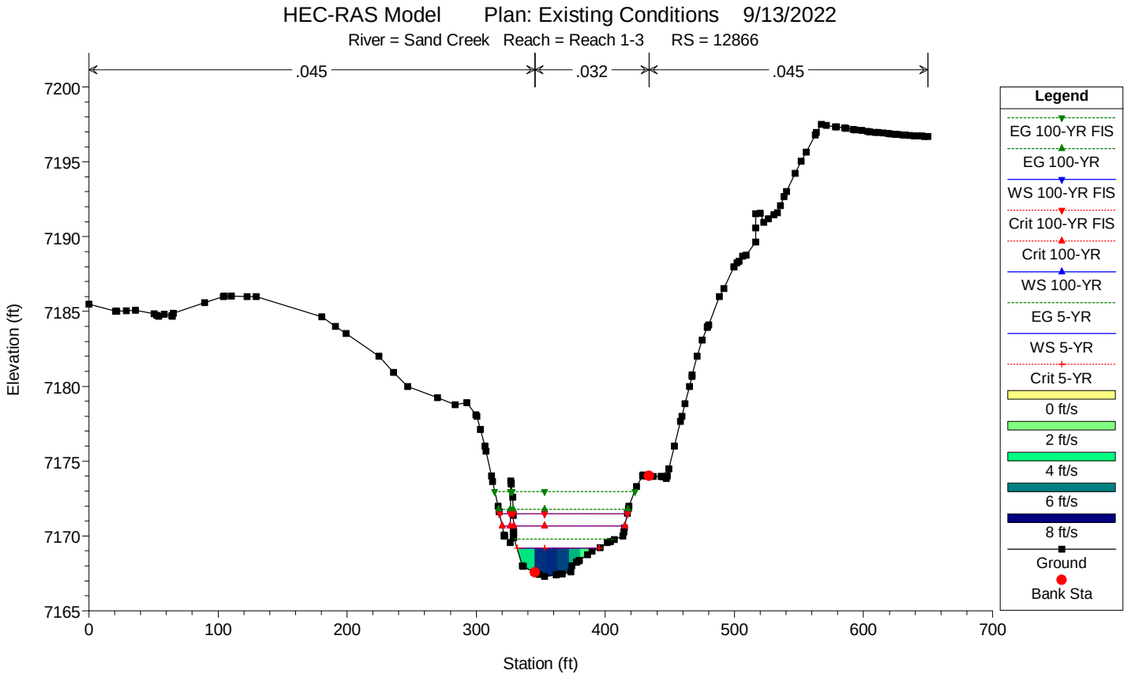
River = Sand Creek Reach = Reach 1-3 RS = 13025

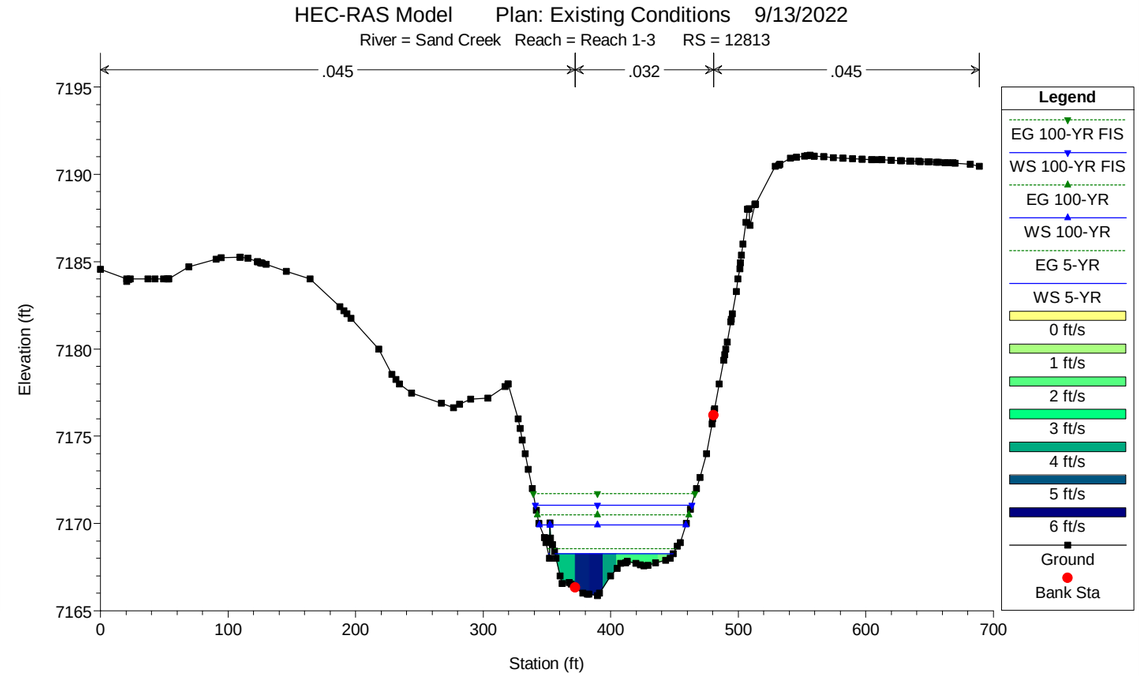


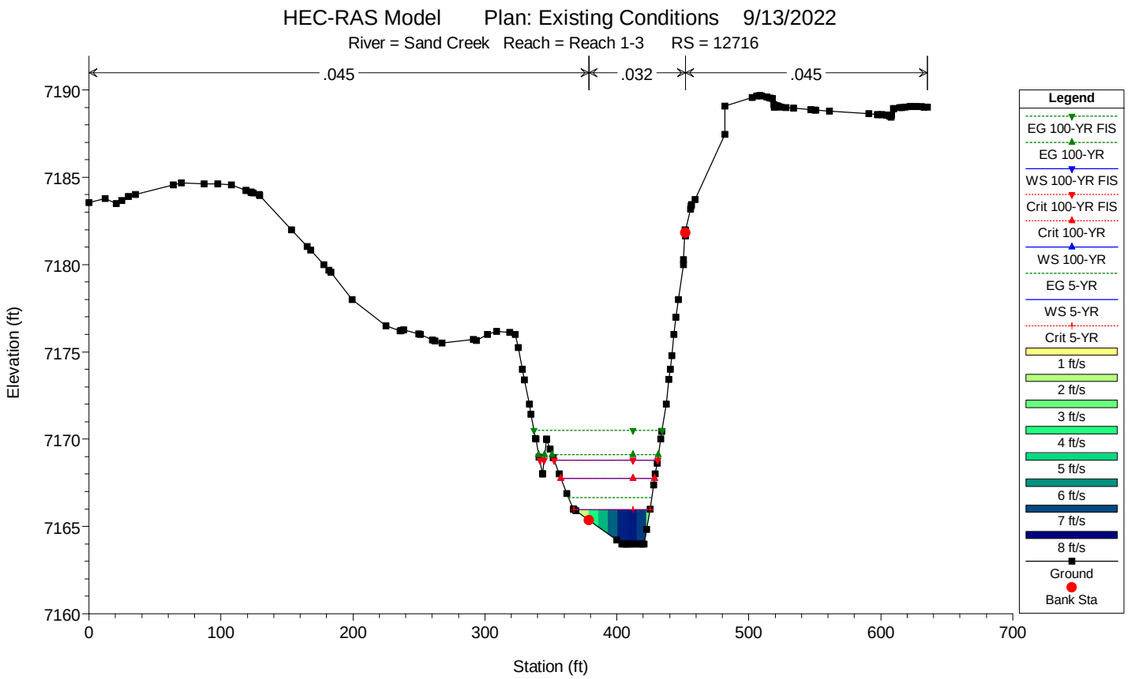
HEC-RAS Model Plan: Existing Conditions 9/13/2022

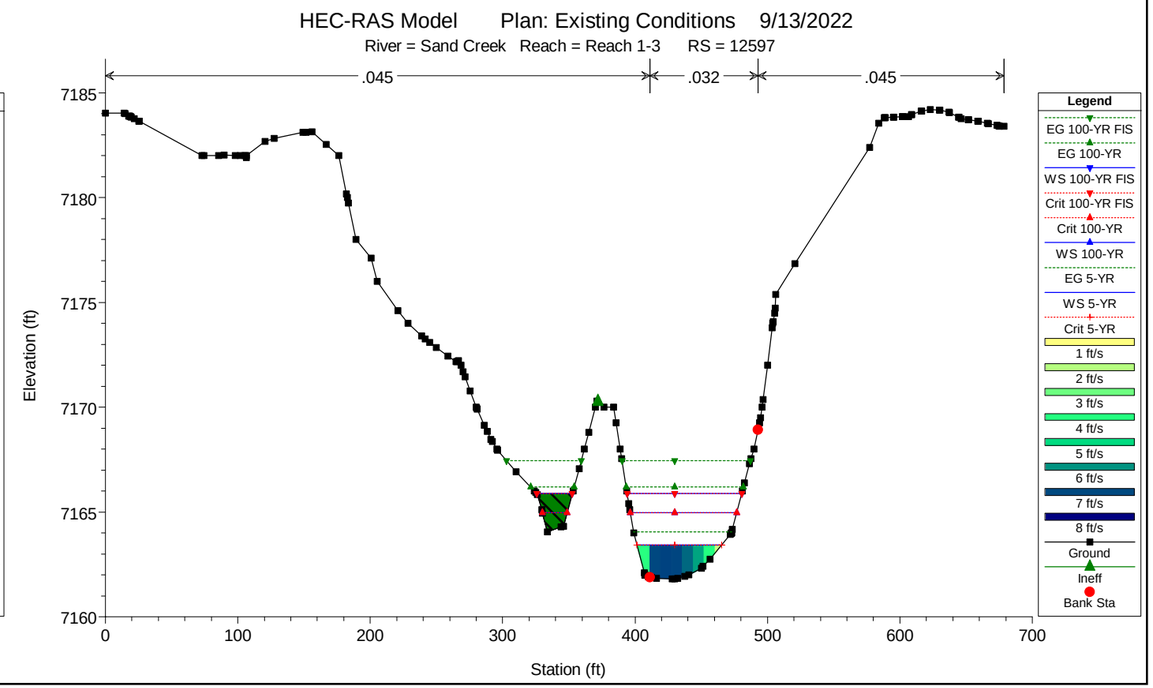
River = Sand Creek Reach = Reach 1-3 RS = 12980 Section DP




HEC-RAS Model Plan: Existing Conditions 9/13/2022
River = Sand Creek Reach = Reach 1-3 RS = 12866
.045
.032
.045
Elevation (ft)
Station (ft)
Legend
EG 100-YR FIS
EG 100-YR
WS 100-YR FIS
Crit 100-YR FIS
Crit 100-YR
WS 100-YR
EG 5-YR
WS 5-YR
Crit 5-YR
0 ft/s
2 ft/s
4 ft/s
6 ft/s
8 ft/s
Ground
Bank Sta

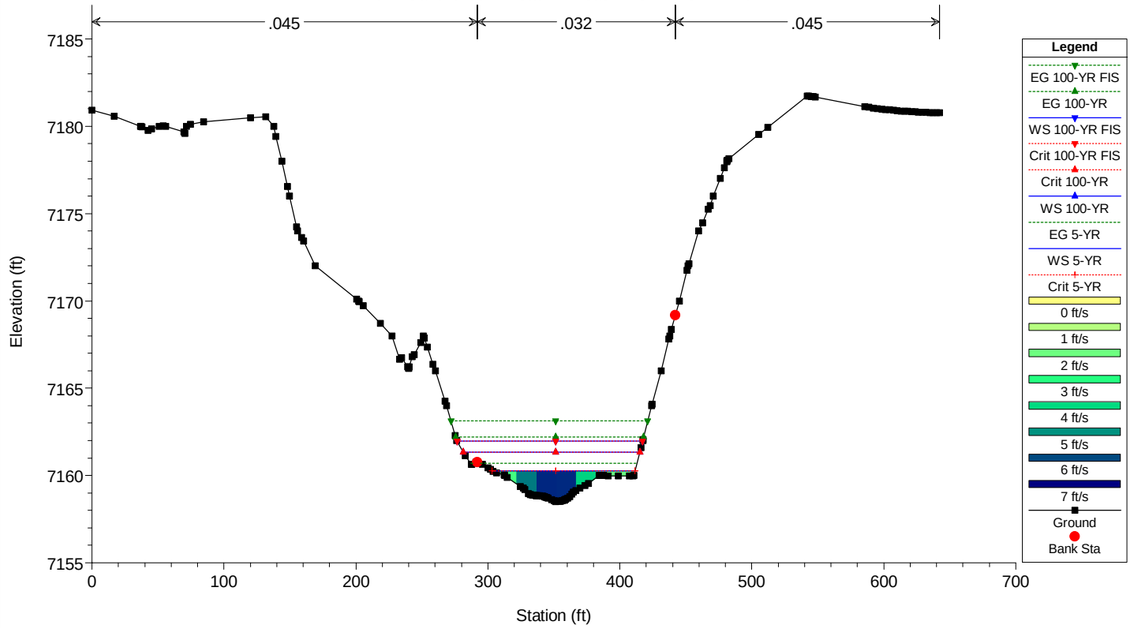

HEC-RAS Model Plan: Existing Conditions 9/13/2022
River = Sand Creek Reach = Reach 1-3 RS = 12813
.045
.032
.045
Elevation (ft)
Station (ft)
Legend
EG 100-YR FIS
WS 100-YR FIS
EG 100-YR
WS 100-YR
EG 5-YR
WS 5-YR
0 ft/s
1 ft/s
2 ft/s
3 ft/s
4 ft/s
5 ft/s
6 ft/s
Ground
Bank Sta


HEC-RAS Model Plan: Existing Conditions 9/13/2022
River = Sand Creek Reach = Reach 1-3 RS = 12716
.045
.032
.045
Elevation (ft)
Station (ft)
Legend
EG 100-YR FIS
EG 100-YR
WS 100-YR FIS
Crit 100-YR FIS
Crit 100-YR
WS 100-YR
EG 5-YR
WS 5-YR
Crit 5-YR
1 ft/s
2 ft/s
3 ft/s
4 ft/s
5 ft/s
6 ft/s
7 ft/s
8 ft/s
Ground
Bank Sta


HEC-RAS Model Plan: Existing Conditions 9/13/2022
River = Sand Creek Reach = Reach 1-3 RS = 12597
.045
.032
.045
Elevation (ft)
Station (ft)
Legend
EG 100-YR FIS
EG 100-YR
WS 100-YR FIS
Crit 100-YR FIS
Crit 100-YR
WS 100-YR
EG 5-YR
WS 5-YR
Crit 5-YR
1 ft/s
2 ft/s
3 ft/s
4 ft/s
5 ft/s
6 ft/s
7 ft/s
8 ft/s
Ground
Ineff
Bank Sta

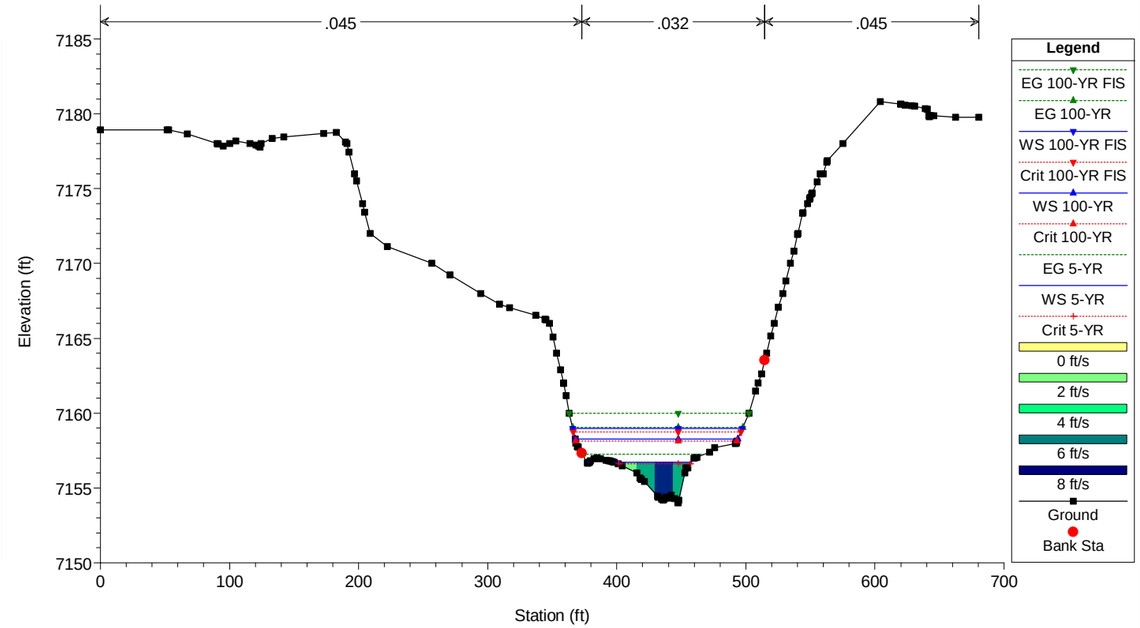
HEC-RAS Model Plan: Existing Conditions 9/13/2022

River = Sand Creek Reach = Reach 1-3 RS = 12462



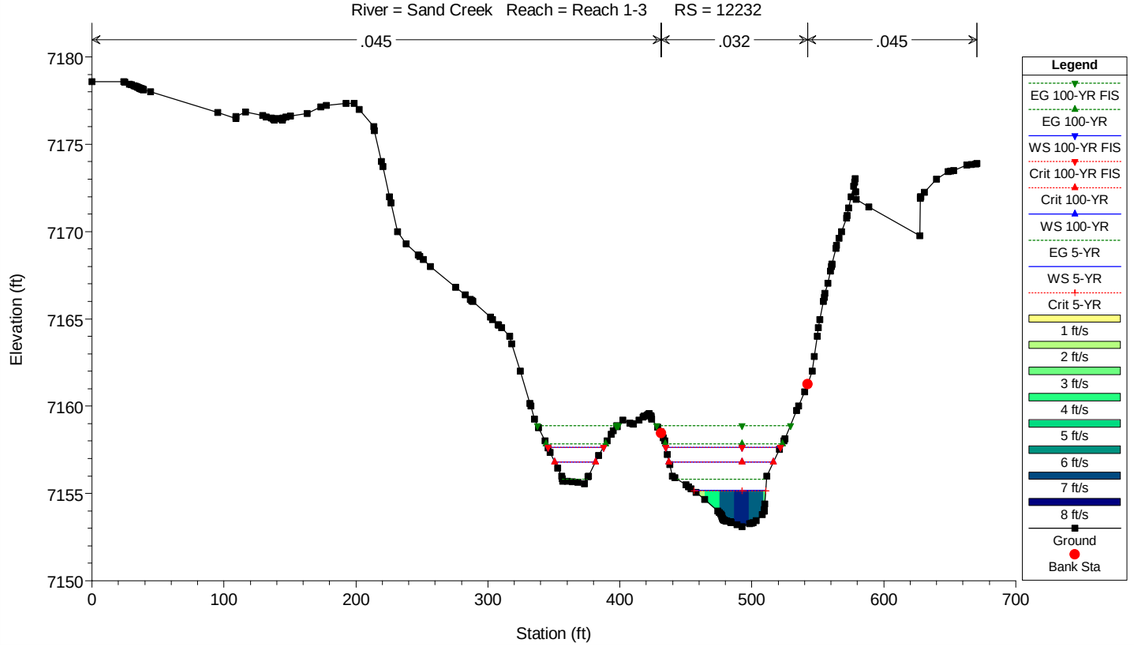
HEC-RAS Model Plan: Existing Conditions 9/13/2022

River = Sand Creek Reach = Reach 1-3 RS = 12348



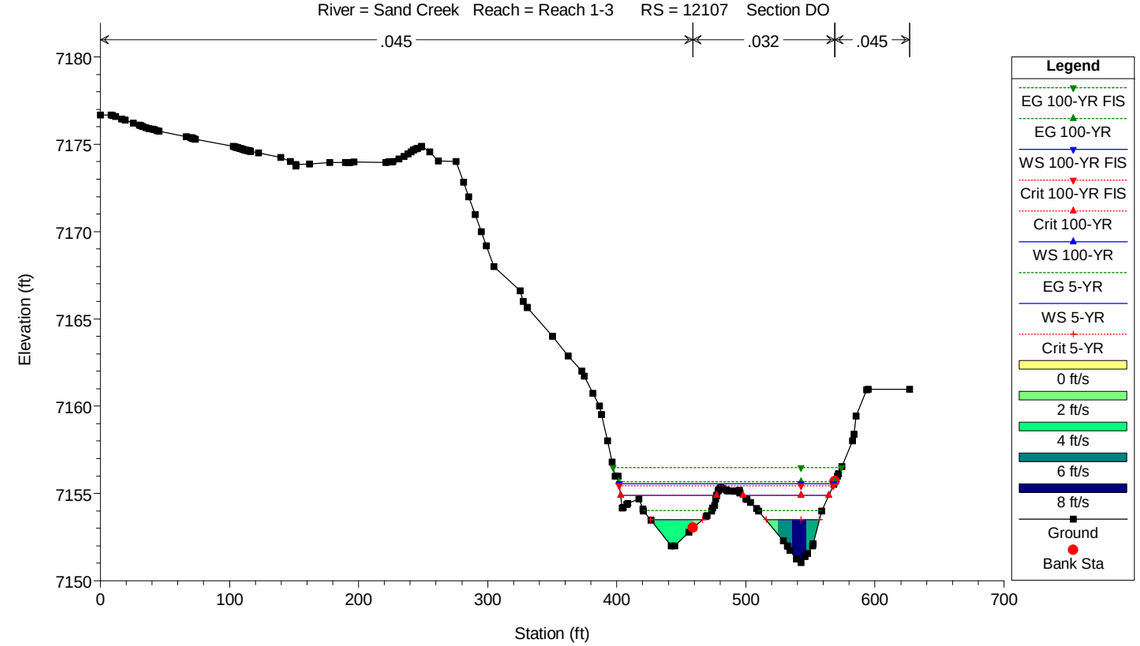
HEC-RAS Model Plan: Existing Conditions 9/13/2022

River = Sand Creek Reach = Reach 1-3 RS = 12232



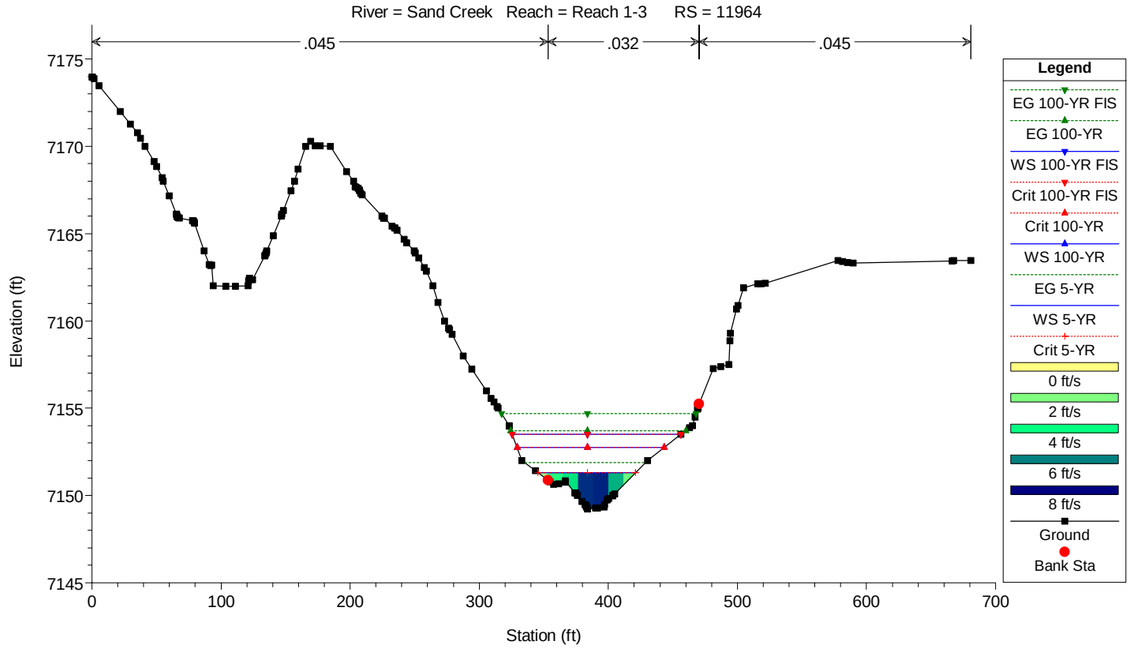
HEC-RAS Model Plan: Existing Conditions 9/13/2022

River = Sand Creek Reach = Reach 1-3 RS = 12107 Section DO



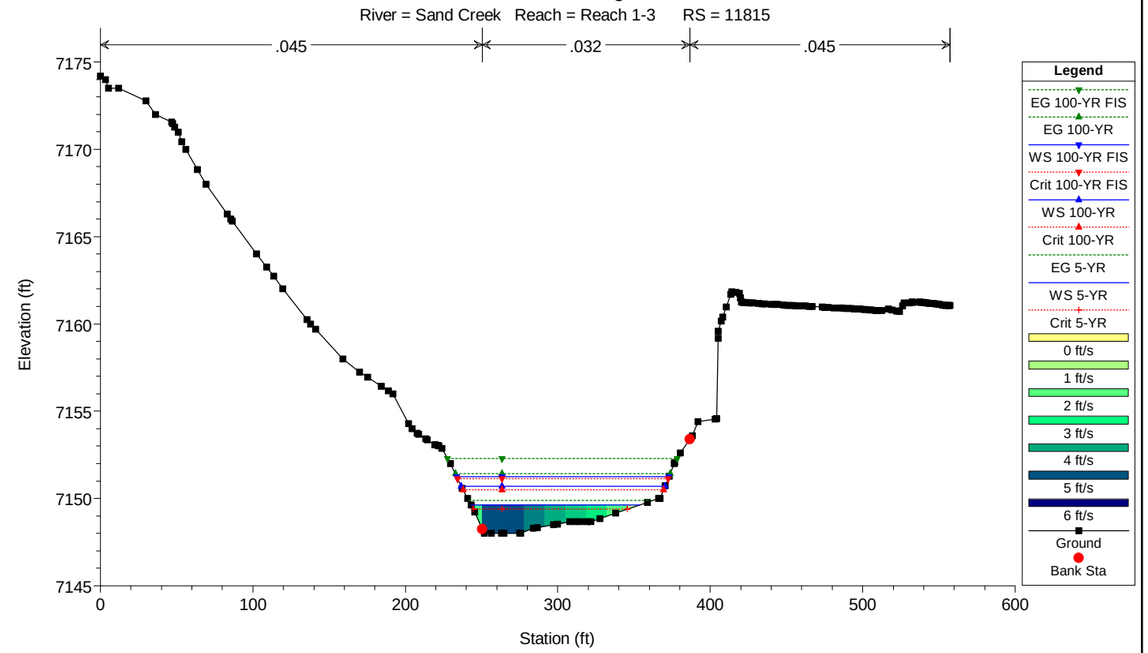
HEC-RAS Model Plan: Existing Conditions 9/13/2022

River = Sand Creek Reach = Reach 1-3 RS = 11964



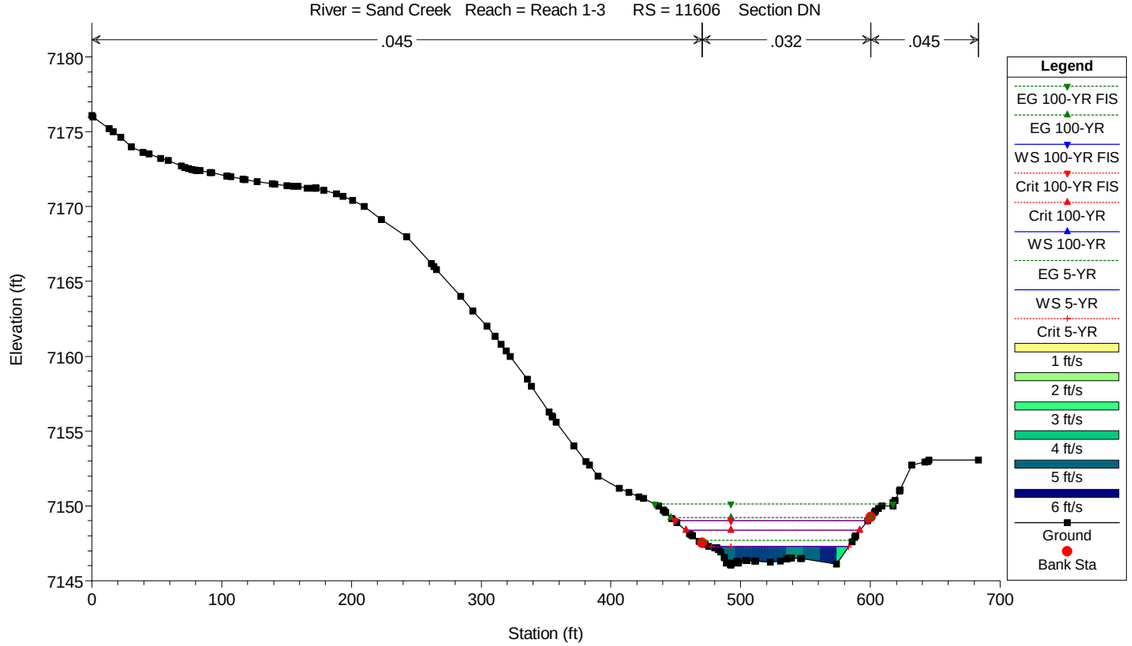
HEC-RAS Model Plan: Existing Conditions 9/13/2022

River = Sand Creek Reach = Reach 1-3 RS = 11815



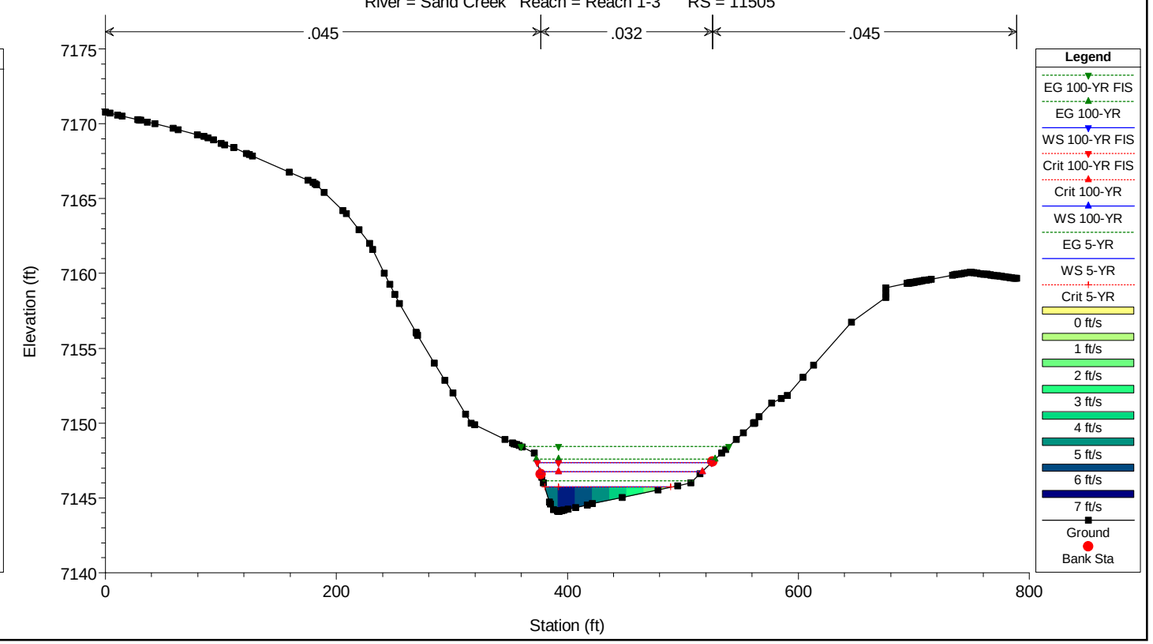
HEC-RAS Model Plan: Existing Conditions 9/13/2022

River = Sand Creek Reach = Reach 1-3 RS = 11606 Section DN



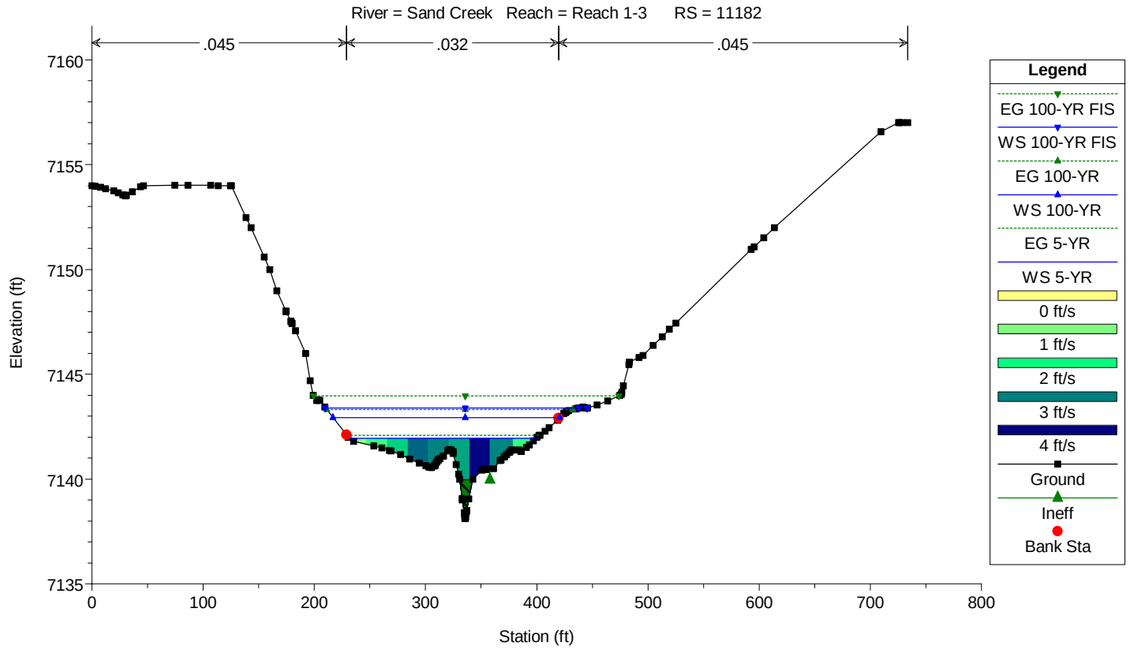
HEC-RAS Model Plan: Existing Conditions 9/13/2022

River = Sand Creek Reach = Reach 1-3 RS = 11505



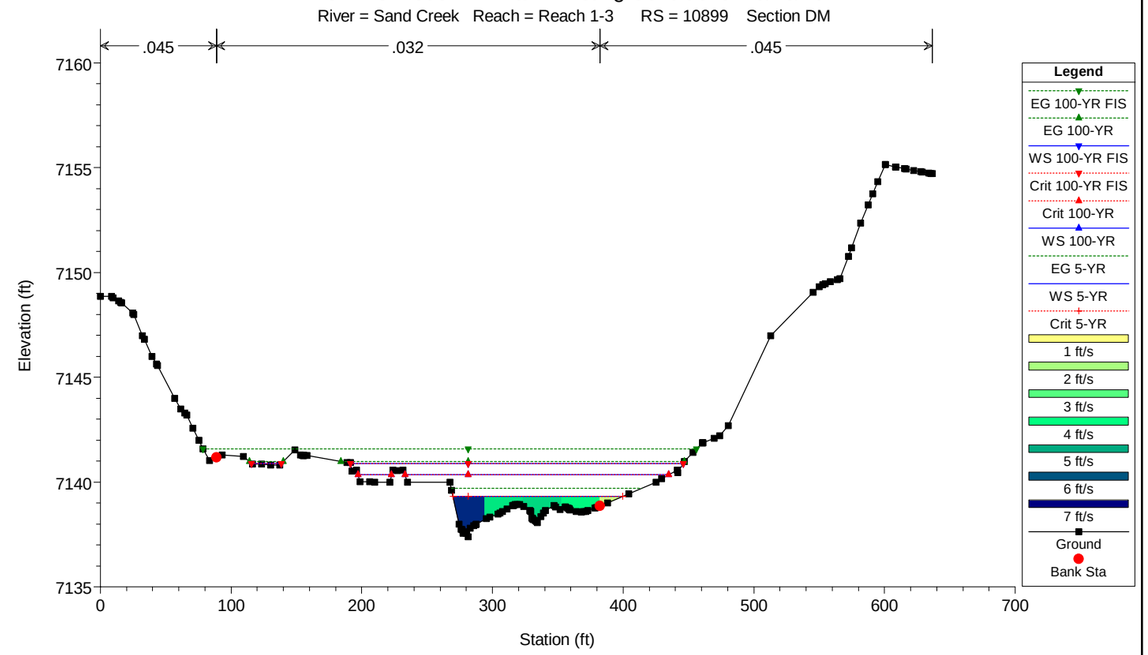
HEC-RAS Model Plan: Existing Conditions 9/13/2022

River = Sand Creek Reach = Reach 1-3 RS = 11182



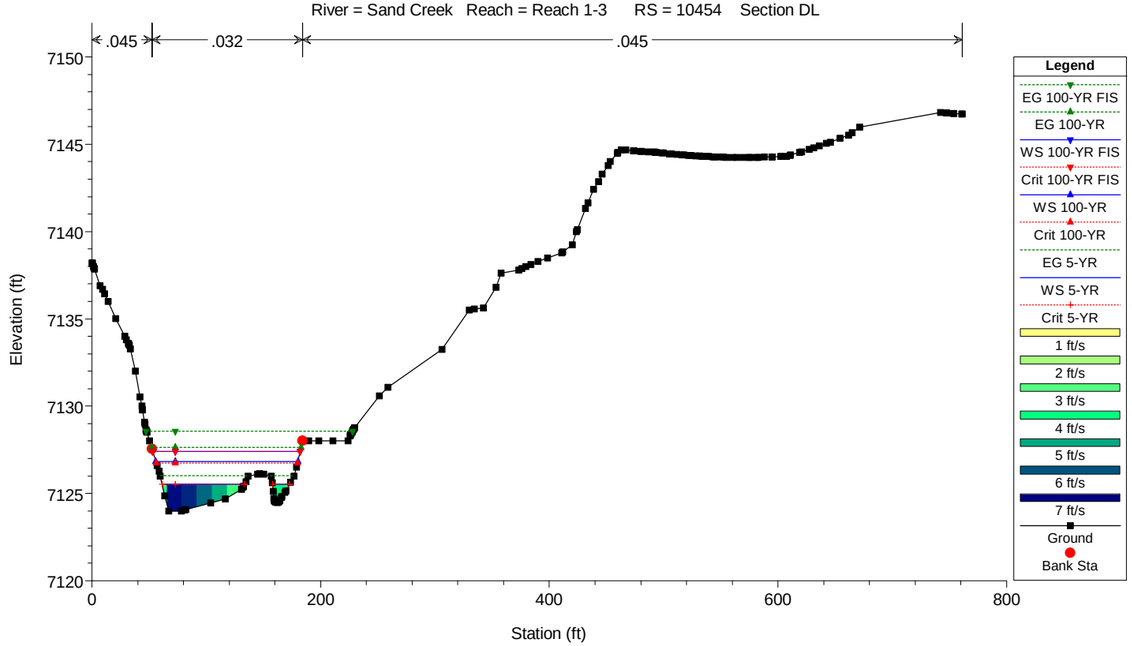
HEC-RAS Model Plan: Existing Conditions 9/13/2022

River = Sand Creek Reach = Reach 1-3 RS = 10899 Section DM



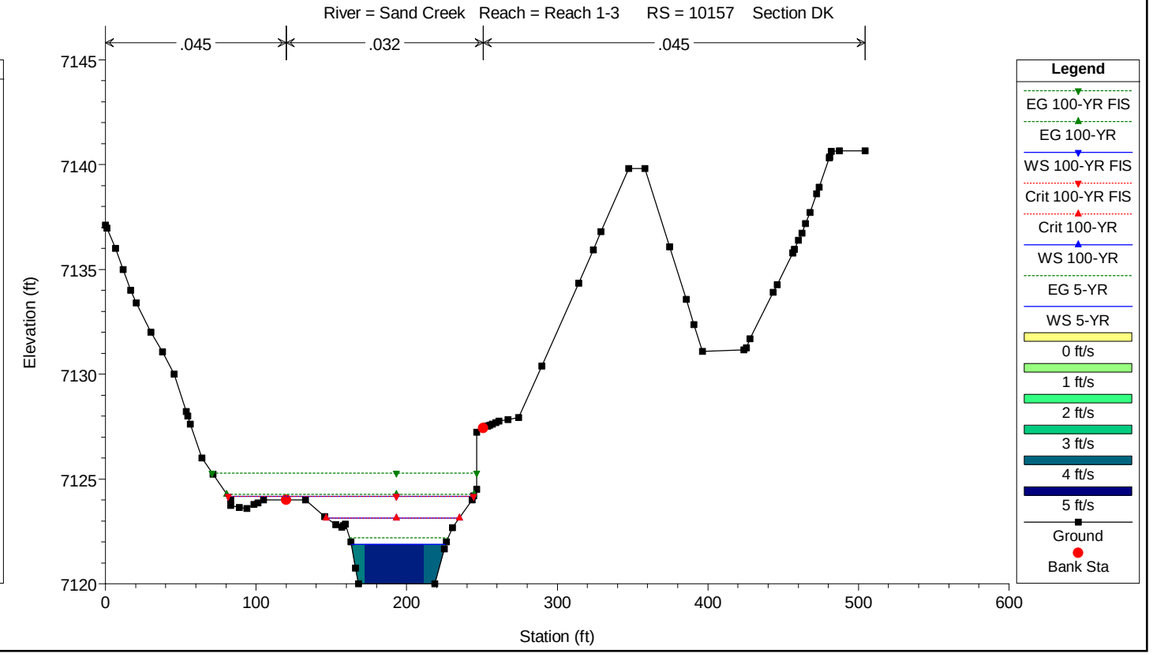
HEC-RAS Model Plan: Existing Conditions 9/13/2022

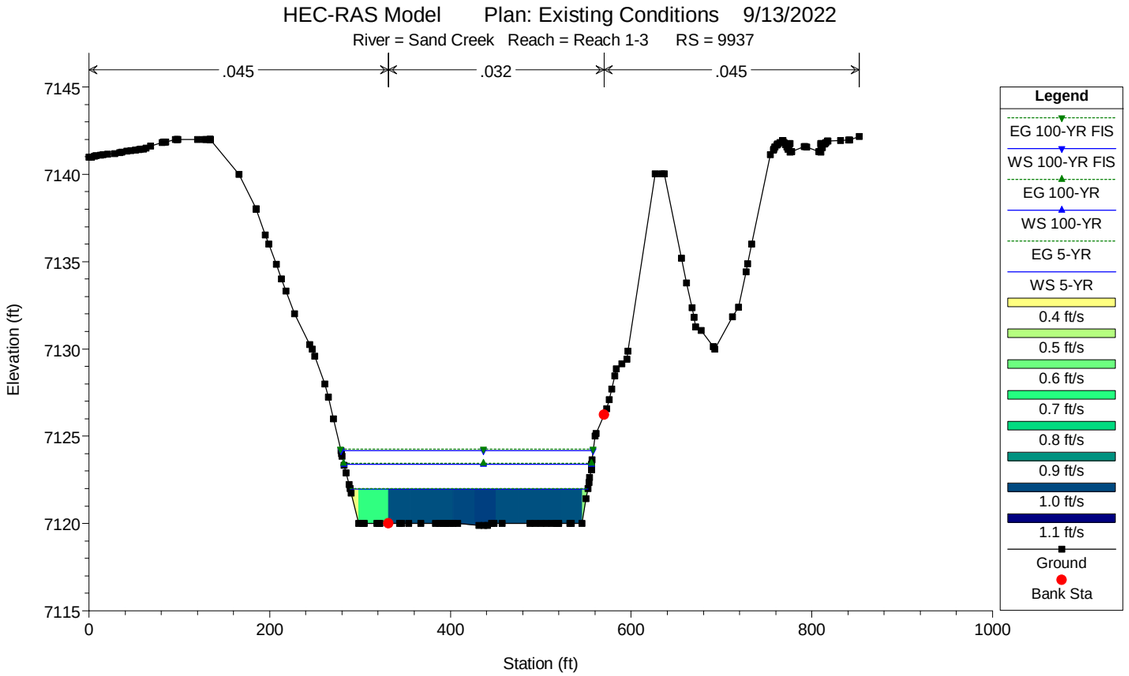
River = Sand Creek Reach = Reach 1-3 RS = 10454 Section DL

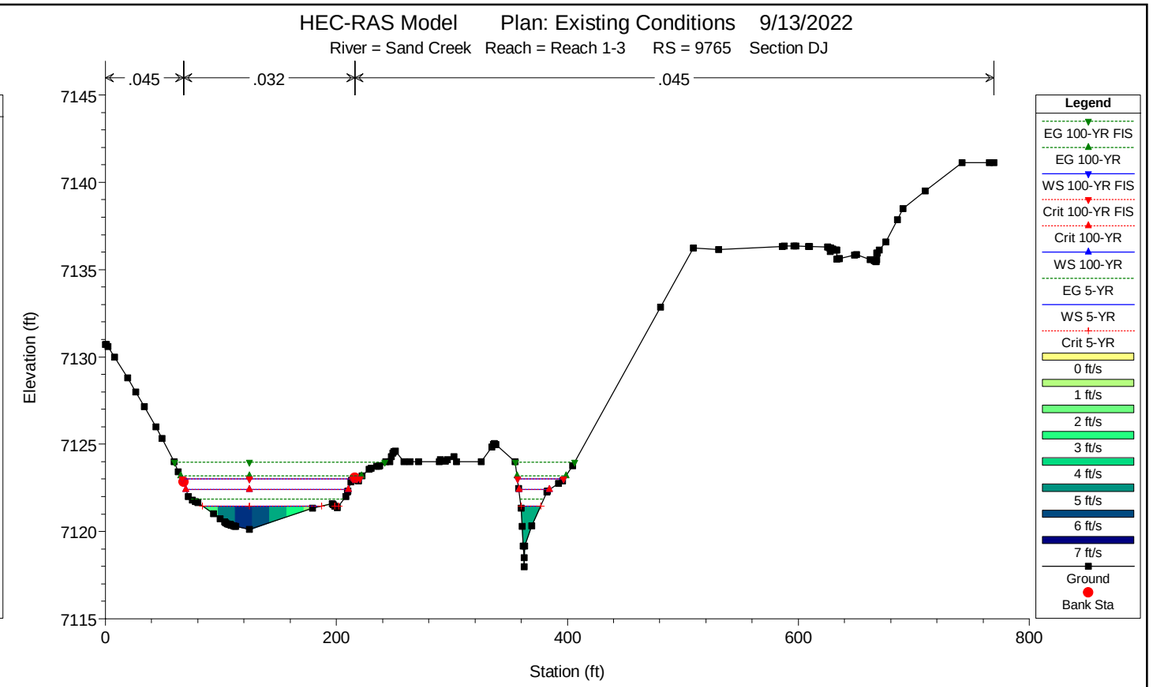


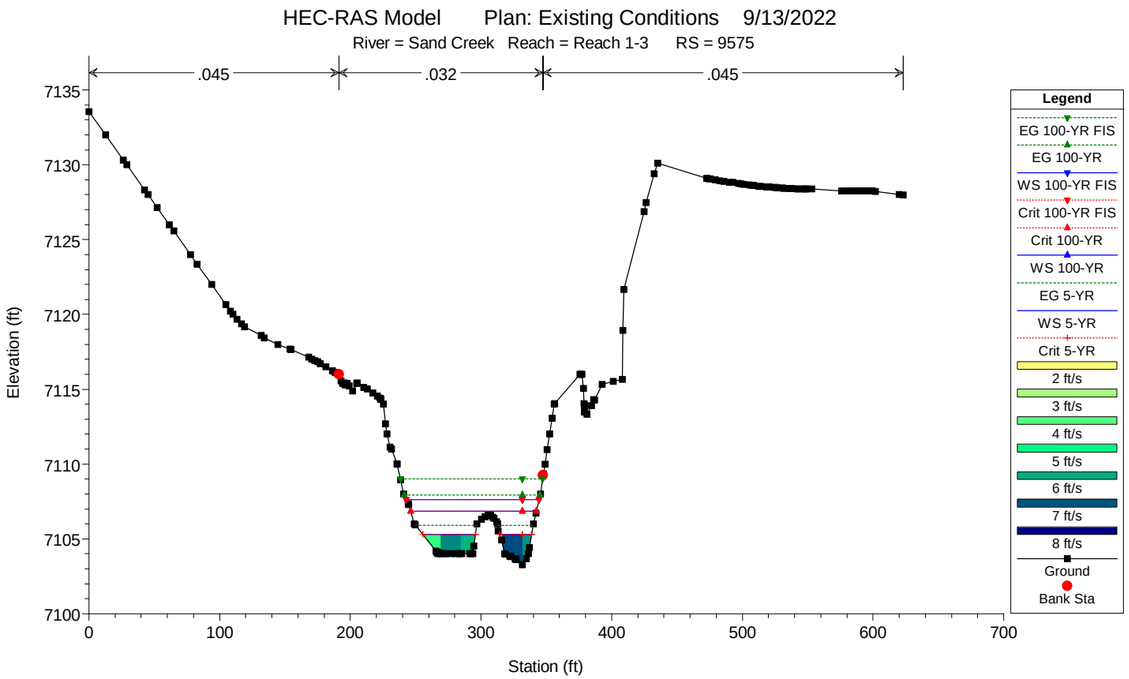
HEC-RAS Model Plan: Existing Conditions 9/13/2022

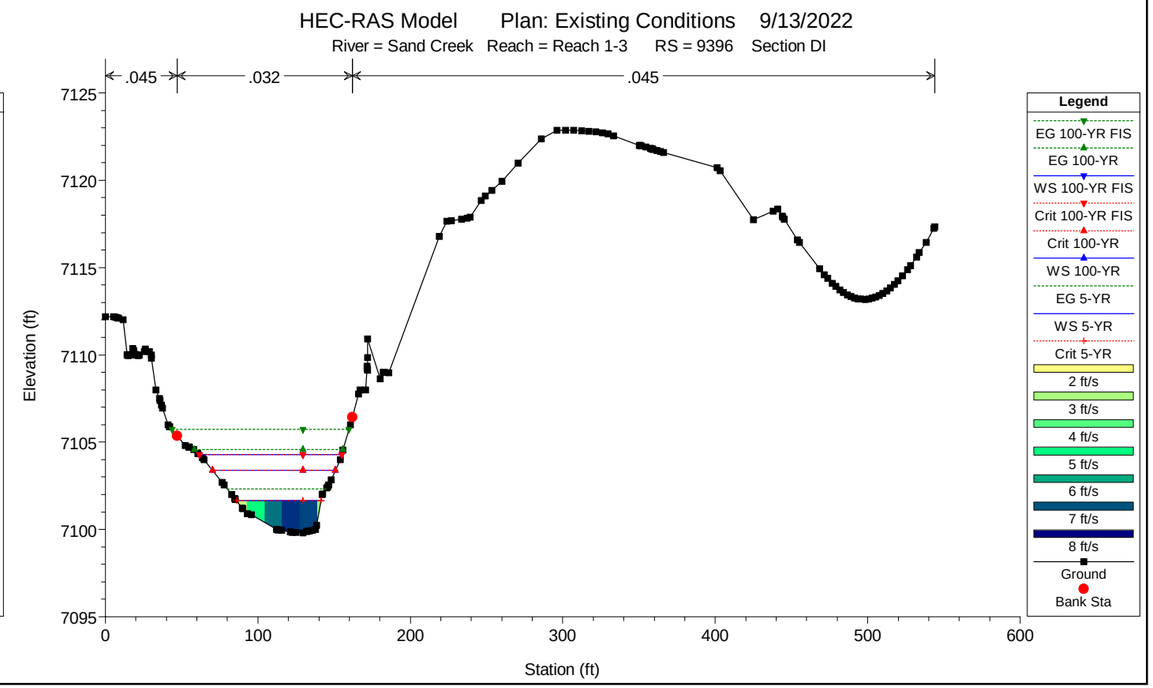
River = Sand Creek Reach = Reach 1-3 RS = 10157 Section DK




HEC-RAS Model Plan: Existing Conditions 9/13/2022
River = Sand Creek Reach = Reach 1-3 RS = 9937
.045
.032
.045
Elevation (ft)
Station (ft)
Legend
EG 100-YR FIS
WS 100-YR FIS
EG 100-YR
WS 100-YR
EG 5-YR
WS 5-YR
0.4 ft/s
0.5 ft/s
0.6 ft/s
0.7 ft/s
0.8 ft/s
0.9 ft/s
1.0 ft/s
1.1 ft/s
Ground
Bank Sta

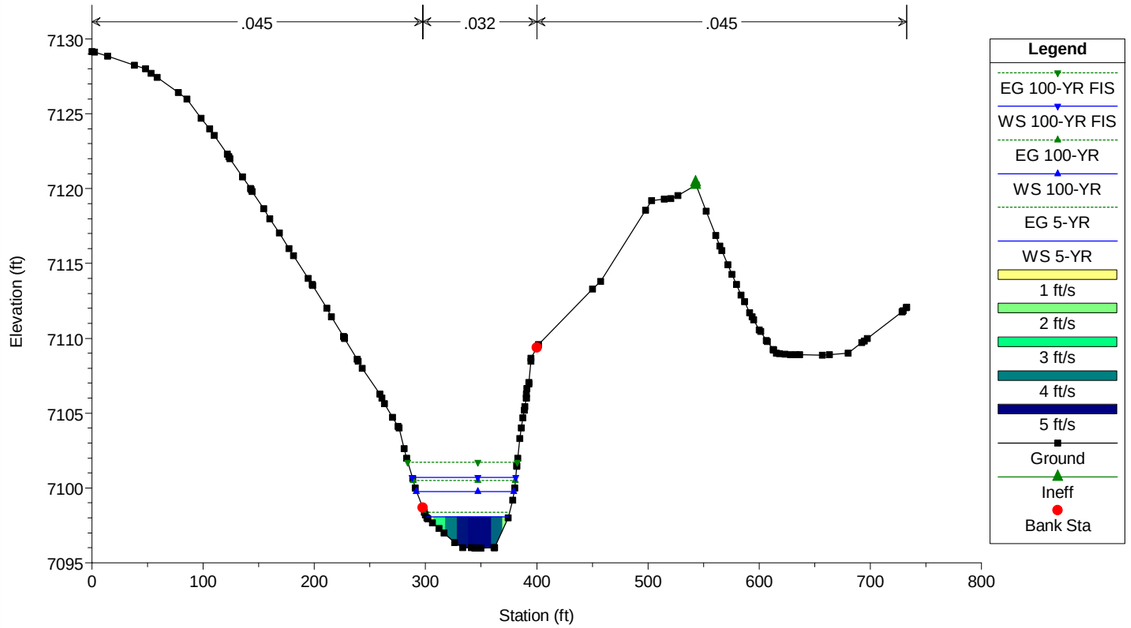

HEC-RAS Model Plan: Existing Conditions 9/13/2022
River = Sand Creek Reach = Reach 1-3 RS = 9765 Section DJ
.045
.032
.045
Elevation (ft)
Station (ft)
Legend
EG 100-YR FIS
EG 100-YR
WS 100-YR FIS
Crit 100-YR FIS
Crit 100-YR
WS 100-YR
EG 5-YR
WS 5-YR
Crit 5-YR
0 ft/s
1 ft/s
2 ft/s
3 ft/s
4 ft/s
5 ft/s
6 ft/s
7 ft/s
Ground
Bank Sta


HEC-RAS Model Plan: Existing Conditions 9/13/2022
River = Sand Creek Reach = Reach 1-3 RS = 9575
.045
.032
.045
Elevation (ft)
Station (ft)
Legend
EG 100-YR FIS
EG 100-YR
WS 100-YR FIS
Crit 100-YR FIS
Crit 100-YR
WS 100-YR
EG 5-YR
WS 5-YR
Crit 5-YR
2 ft/s
3 ft/s
4 ft/s
5 ft/s
6 ft/s
7 ft/s
8 ft/s
Ground
Bank Sta


HEC-RAS Model Plan: Existing Conditions 9/13/2022
River = Sand Creek Reach = Reach 1-3 RS = 9396 Section DI
.045
.032
.045
Elevation (ft)
Station (ft)
Legend
EG 100-YR FIS
EG 100-YR
WS 100-YR FIS
Crit 100-YR FIS
Crit 100-YR
WS 100-YR
EG 5-YR
WS 5-YR
Crit 5-YR
2 ft/s
3 ft/s
4 ft/s
5 ft/s
6 ft/s
7 ft/s
8 ft/s
Ground
Bank Sta

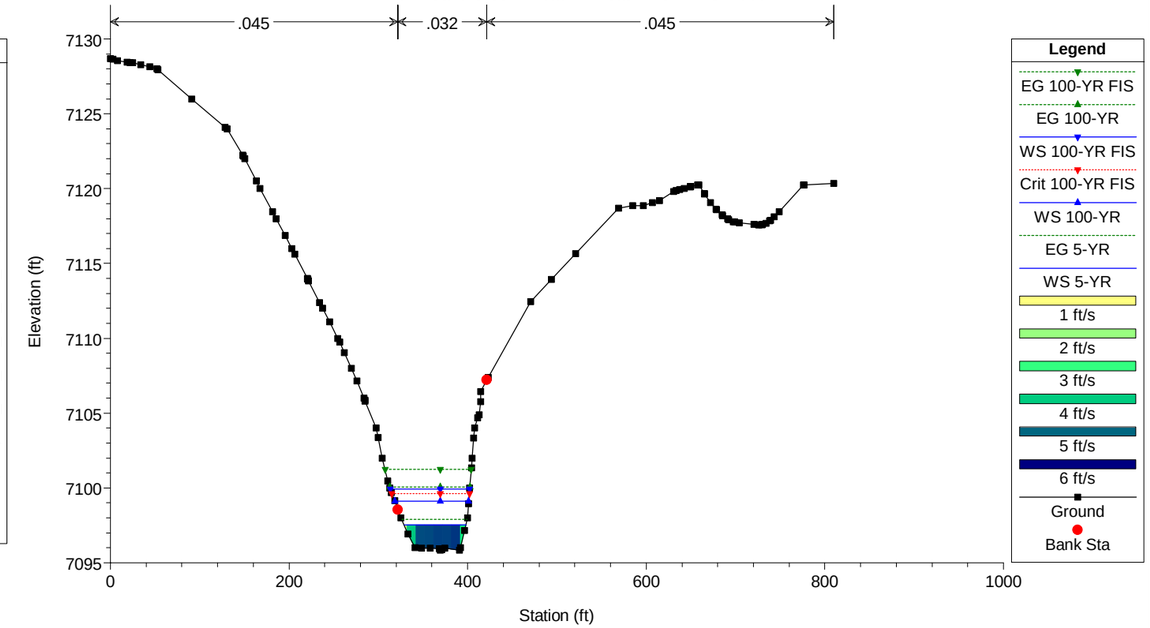
HEC-RAS Model Plan: Existing Conditions 9/13/2022

River = Sand Creek Reach = Reach 1-3 RS = 9120



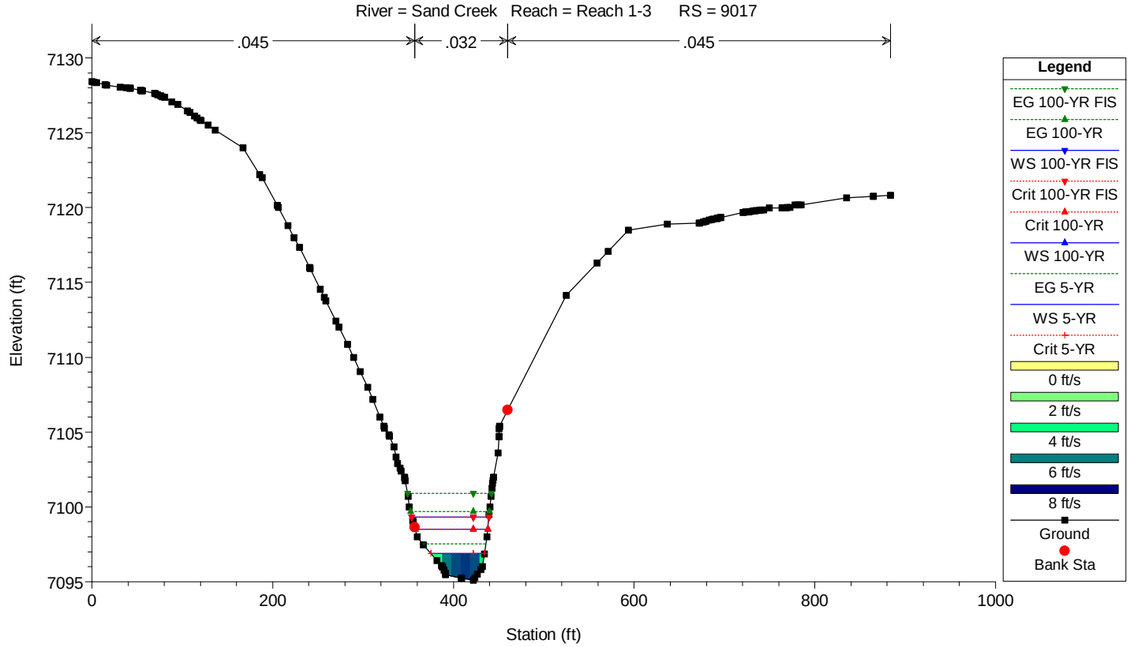
HEC-RAS Model Plan: Existing Conditions 9/13/2022

River = Sand Creek Reach = Reach 1-3 RS = 9052



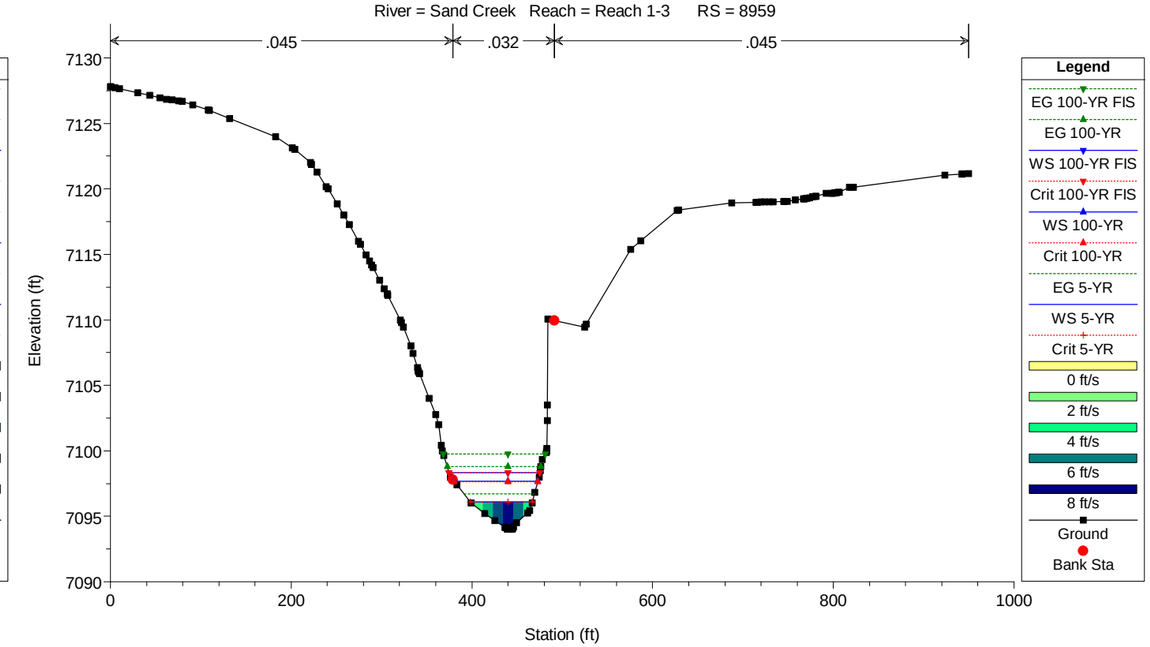
HEC-RAS Model Plan: Existing Conditions 9/13/2022

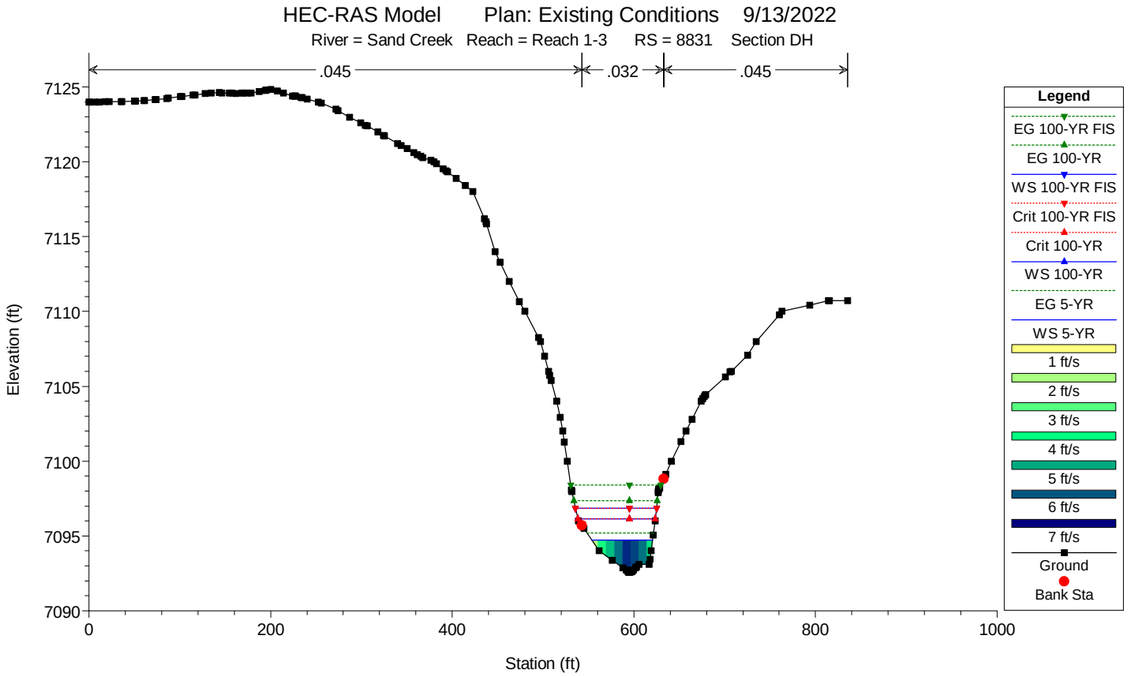
River = Sand Creek Reach = Reach 1-3 RS = 9017

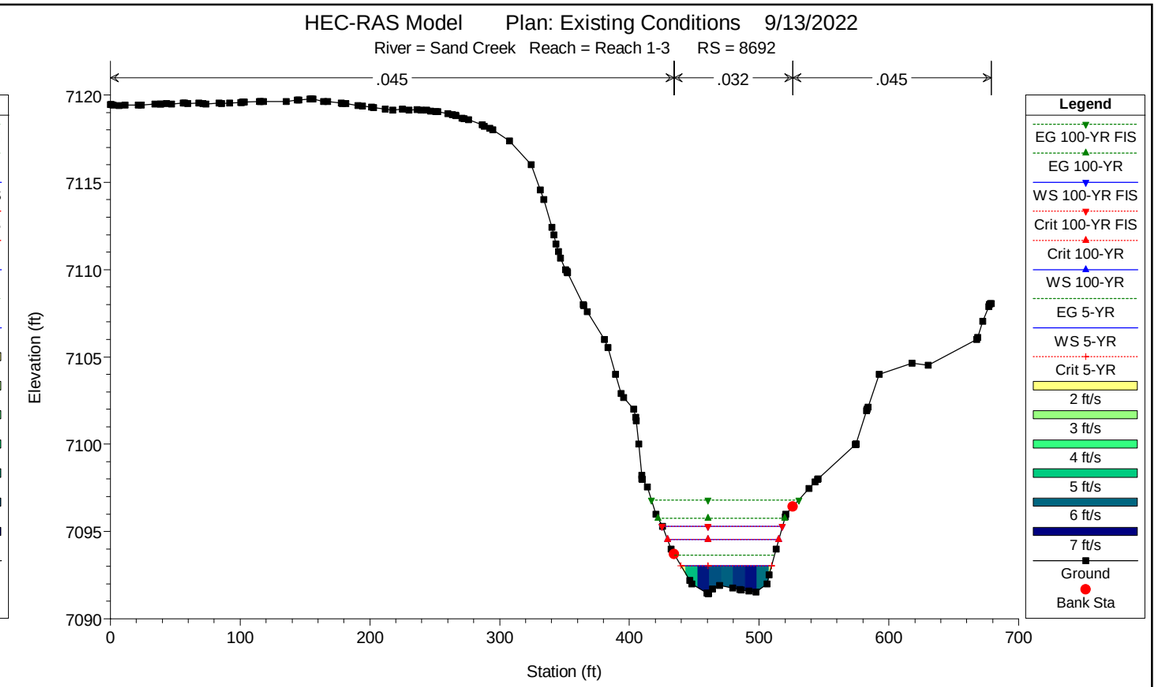


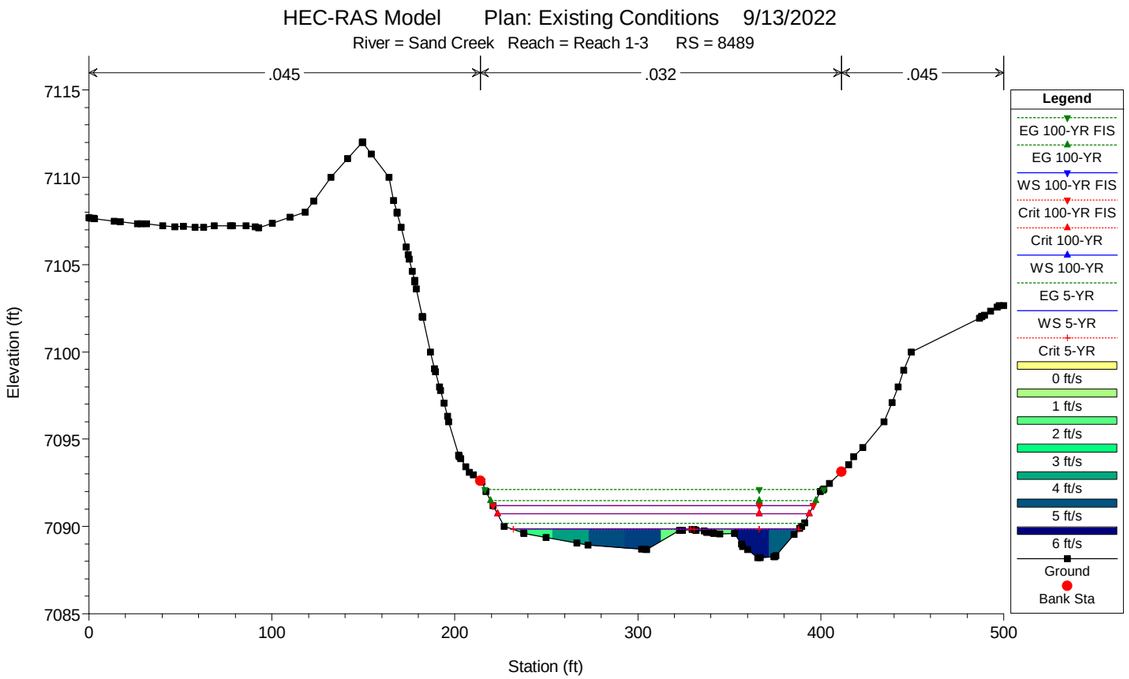
HEC-RAS Model Plan: Existing Conditions 9/13/2022

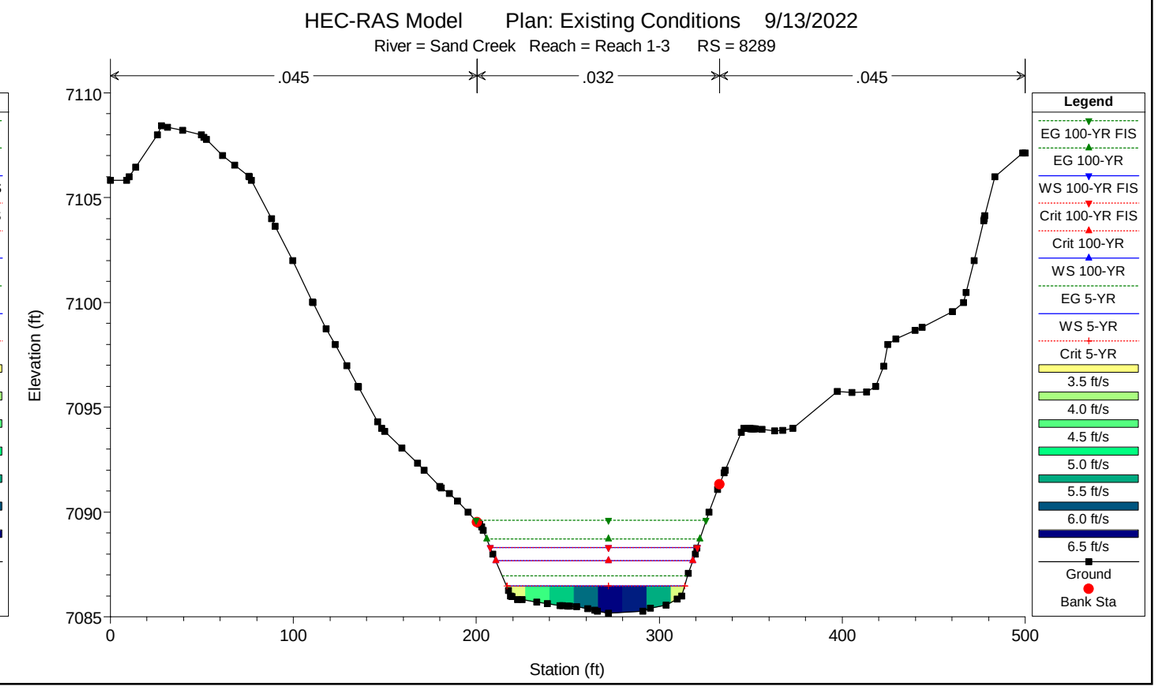
River = Sand Creek Reach = Reach 1-3 RS = 8959




HEC-RAS Model Plan: Existing Conditions 9/13/2022
River = Sand Creek Reach = Reach 1-3 RS = 8831 Section DH
.045
.032
.045
Elevation (ft)
Station (ft)
Legend
EG 100-YR FIS
EG 100-YR
WS 100-YR FIS
Crit 100-YR FIS
Crit 100-YR
WS 100-YR
EG 5-YR
WS 5-YR
1 ft/s
2 ft/s
3 ft/s
4 ft/s
5 ft/s
6 ft/s
7 ft/s
Ground
Bank Sta

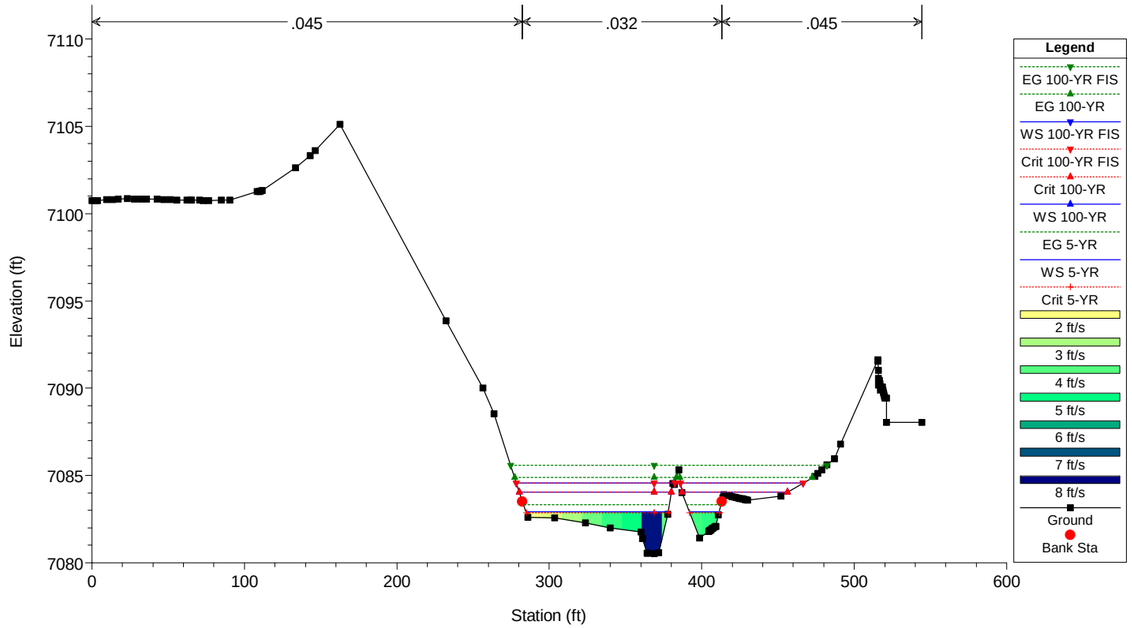

HEC-RAS Model Plan: Existing Conditions 9/13/2022
River = Sand Creek Reach = Reach 1-3 RS = 8692
.045
.032
.045
Elevation (ft)
Station (ft)
Legend
EG 100-YR FIS
EG 100-YR
WS 100-YR FIS
Crit 100-YR FIS
Crit 100-YR
WS 100-YR
EG 5-YR
WS 5-YR
Crit 5-YR
2 ft/s
3 ft/s
4 ft/s
5 ft/s
6 ft/s
7 ft/s
Ground
Bank Sta


HEC-RAS Model Plan: Existing Conditions 9/13/2022
River = Sand Creek Reach = Reach 1-3 RS = 8489
.045
.032
.045
Elevation (ft)
Station (ft)
Legend
EG 100-YR FIS
EG 100-YR
WS 100-YR FIS
Crit 100-YR FIS
Crit 100-YR
WS 100-YR
EG 5-YR
WS 5-YR
Crit 5-YR
0 ft/s
1 ft/s
2 ft/s
3 ft/s
4 ft/s
5 ft/s
6 ft/s
Ground
Bank Sta


HEC-RAS Model Plan: Existing Conditions 9/13/2022
River = Sand Creek Reach = Reach 1-3 RS = 8289
.045
.032
.045
Elevation (ft)
Station (ft)
Legend
EG 100-YR FIS
EG 100-YR
WS 100-YR FIS
Crit 100-YR FIS
Crit 100-YR
WS 100-YR
EG 5-YR
WS 5-YR
Crit 5-YR
3.5 ft/s
4.0 ft/s
4.5 ft/s
5.0 ft/s
5.5 ft/s
6.0 ft/s
6.5 ft/s
Ground
Bank Sta

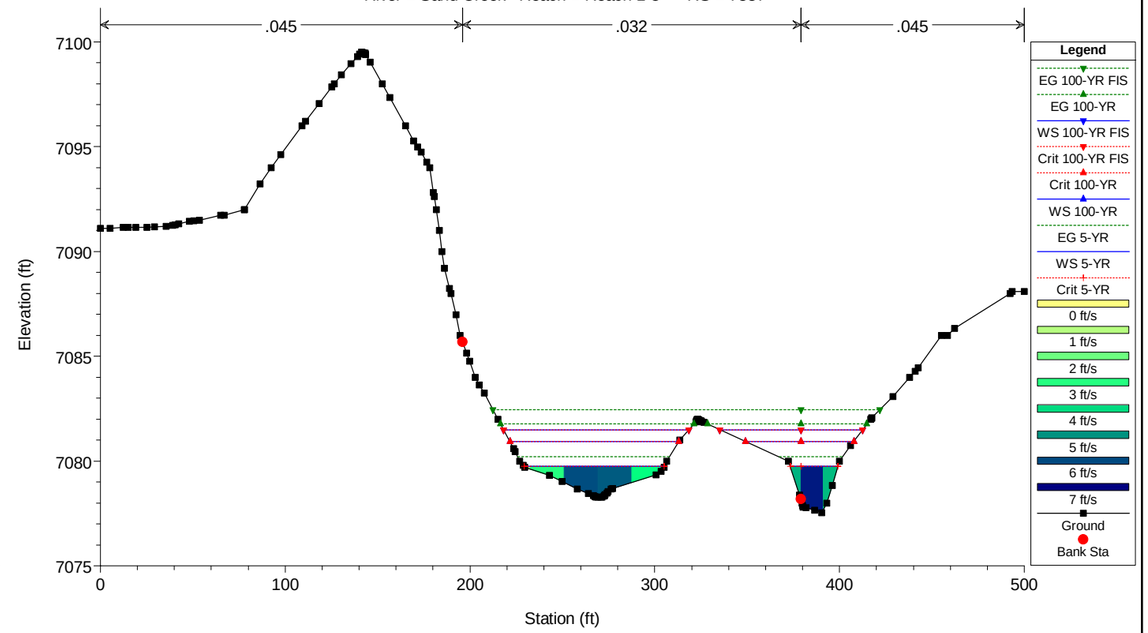
HEC-RAS Model Plan: Existing Conditions 9/13/2022

River = Sand Creek Reach = Reach 1-3 RS = 8085 Section DG



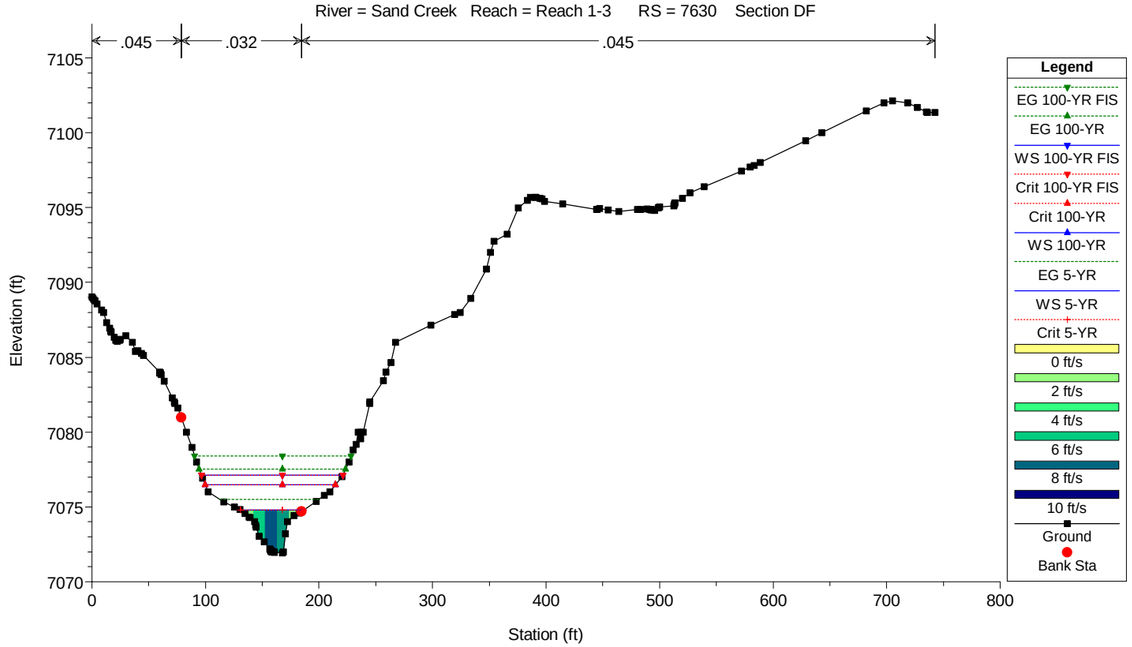
HEC-RAS Model Plan: Existing Conditions 9/13/2022

River = Sand Creek Reach = Reach 1-3 RS = 7887



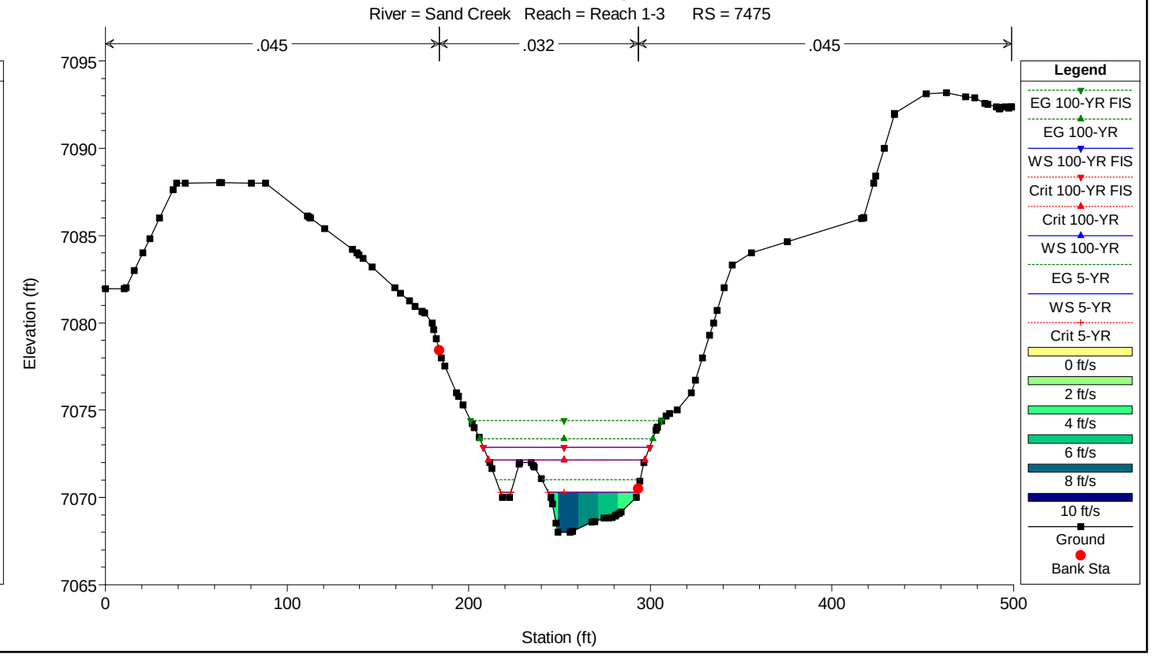
HEC-RAS Model Plan: Existing Conditions 9/13/2022

River = Sand Creek Reach = Reach 1-3 RS = 7630 Section DF



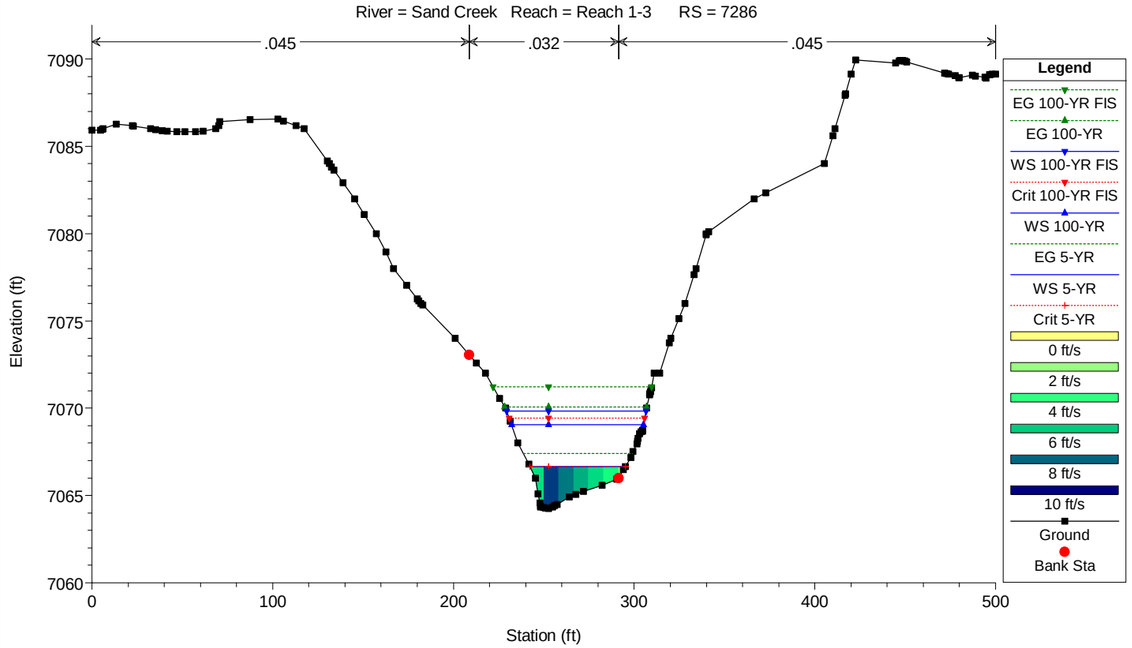
HEC-RAS Model Plan: Existing Conditions 9/13/2022

River = Sand Creek Reach = Reach 1-3 RS = 7475



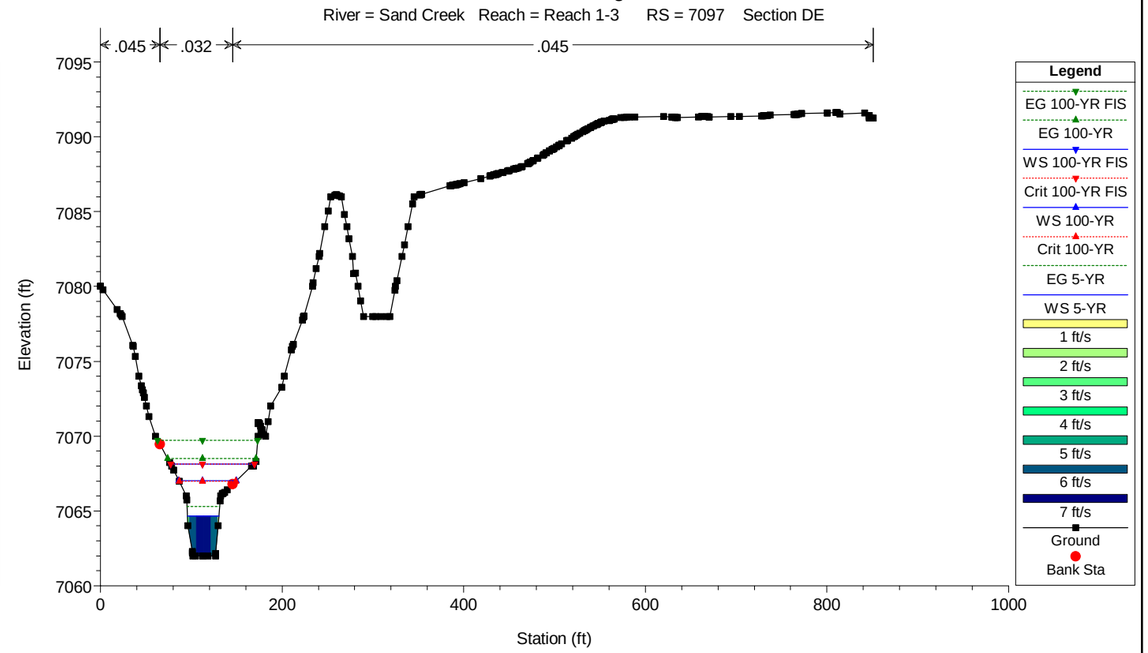
HEC-RAS Model Plan: Existing Conditions 9/13/2022

River = Sand Creek Reach = Reach 1-3 RS = 7286



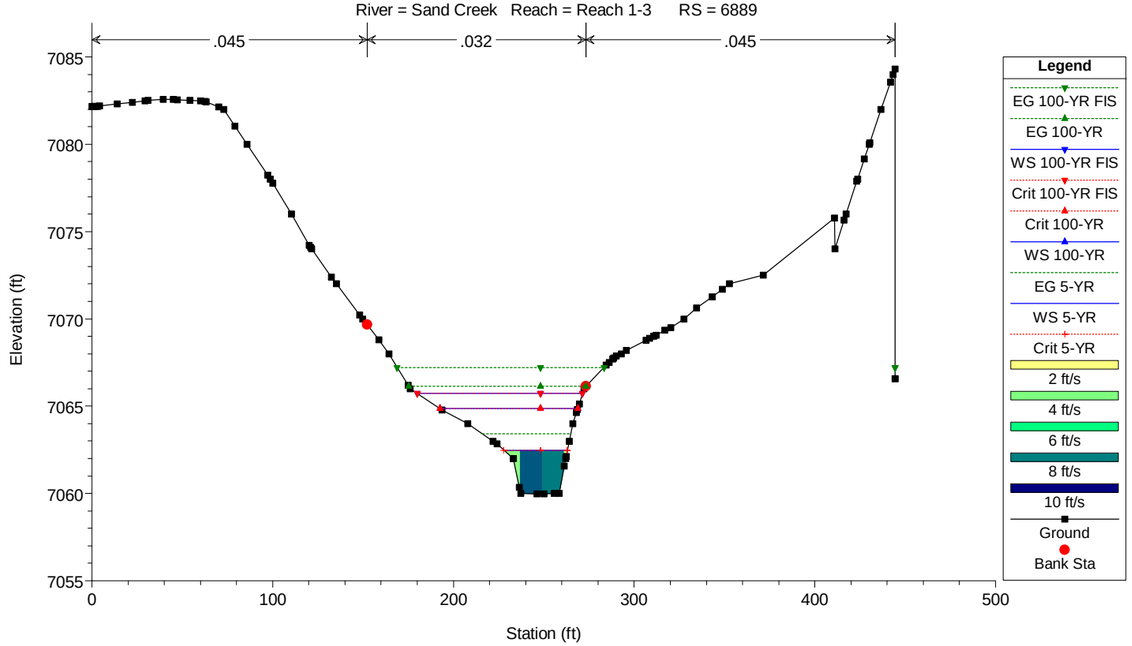
HEC-RAS Model Plan: Existing Conditions 9/13/2022

River = Sand Creek Reach = Reach 1-3 RS = 7097 Section DE



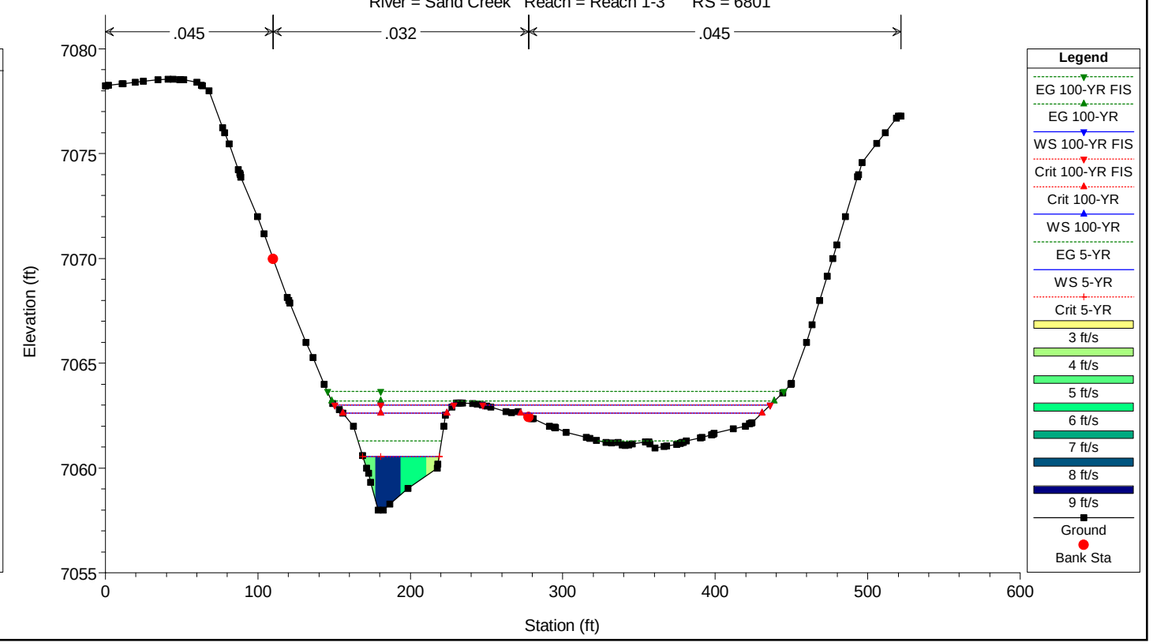
HEC-RAS Model Plan: Existing Conditions 9/13/2022

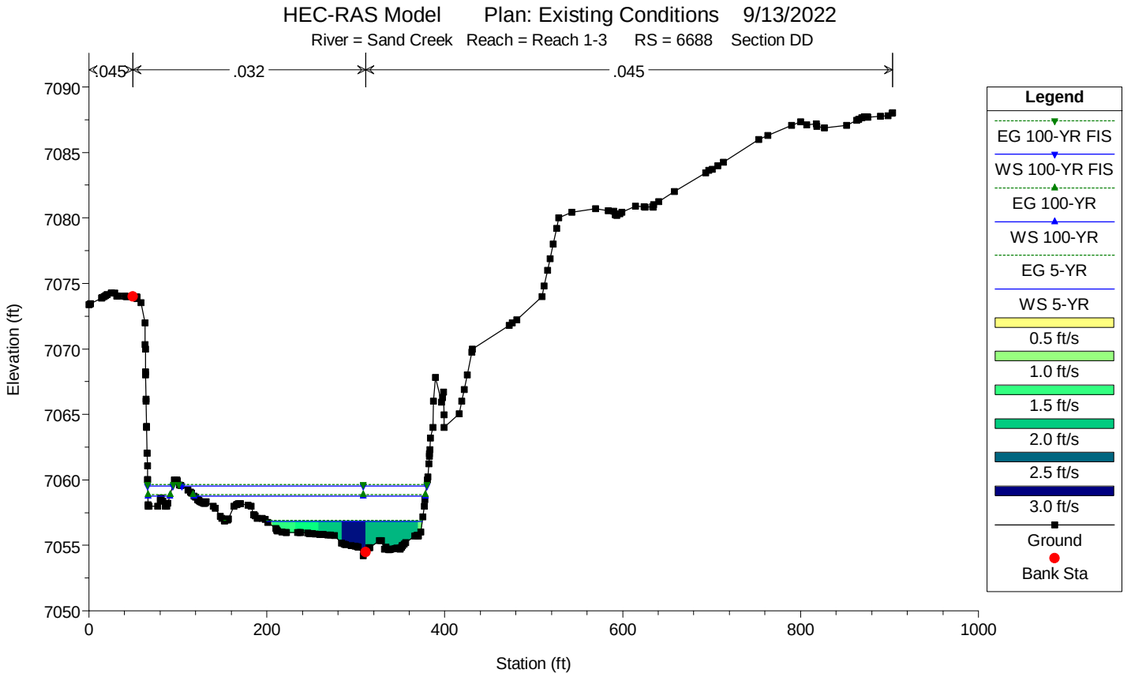
River = Sand Creek Reach = Reach 1-3 RS = 6889

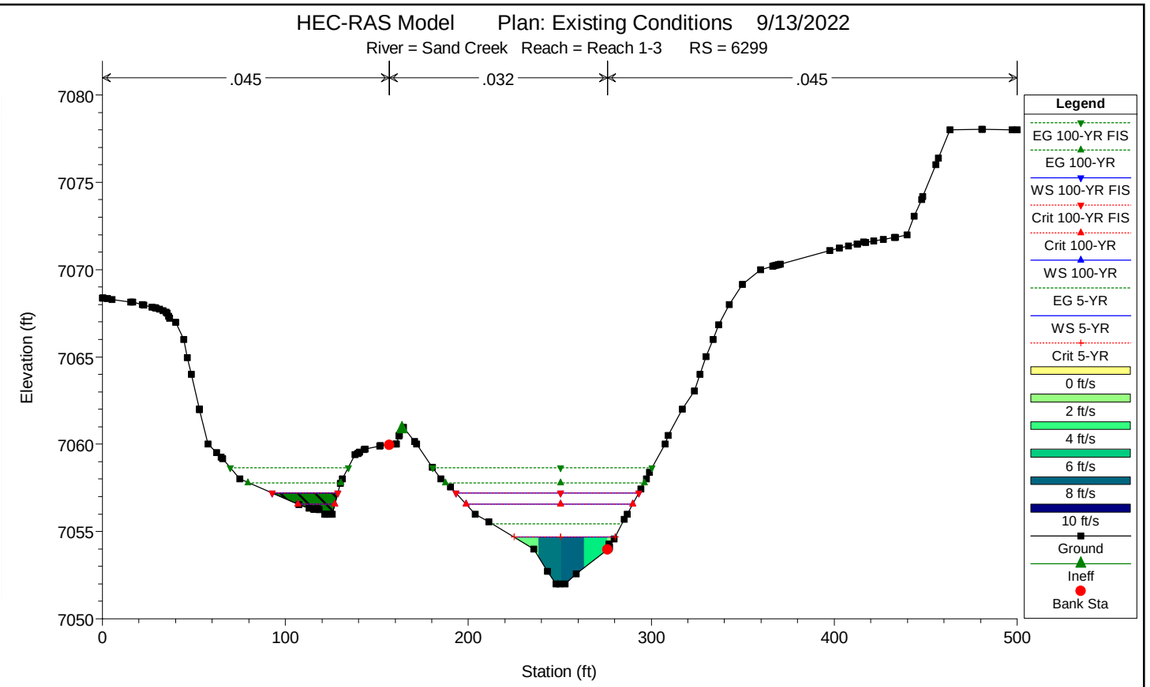


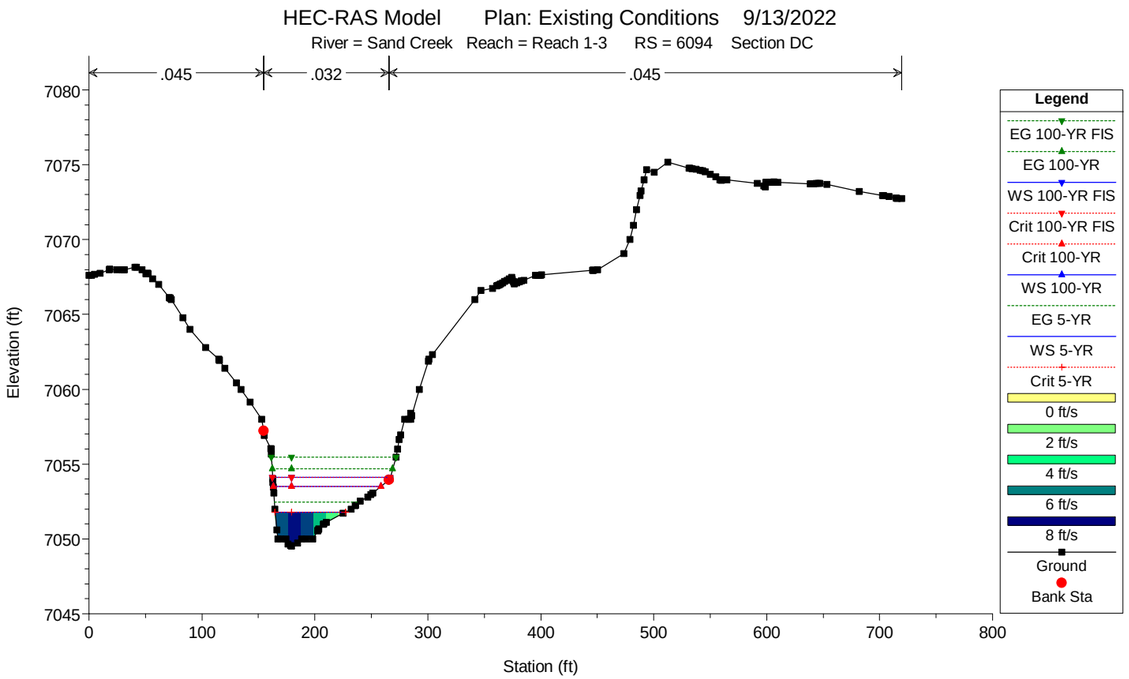
HEC-RAS Model Plan: Existing Conditions 9/13/2022

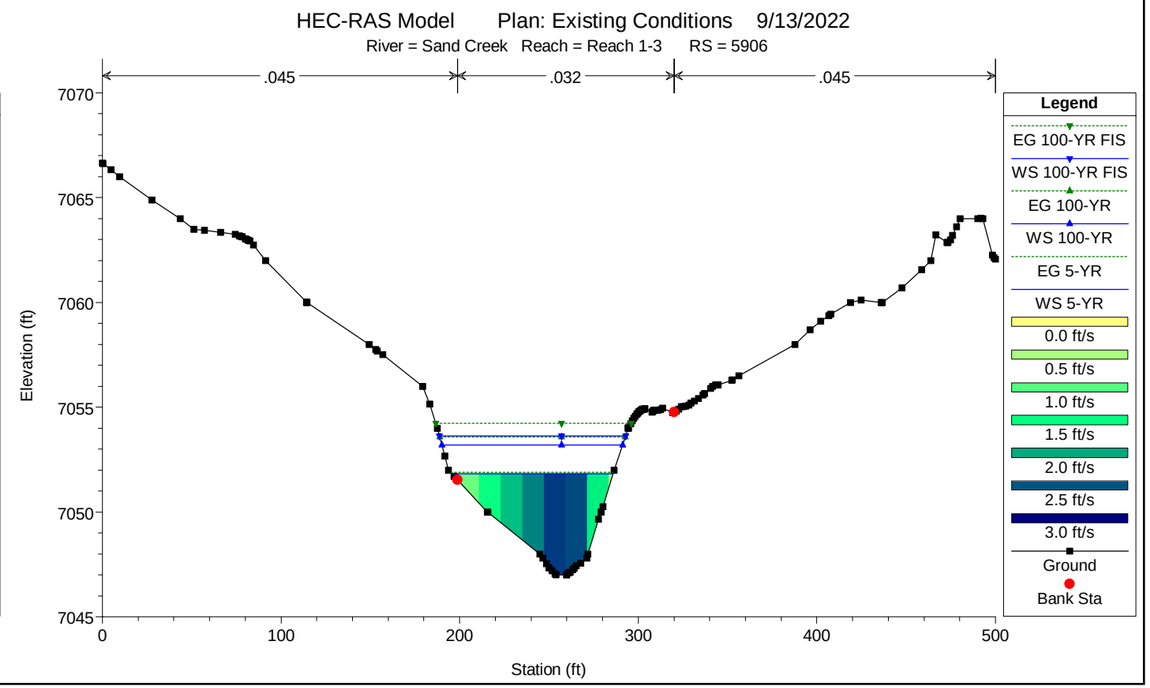
River = Sand Creek Reach = Reach 1-3 RS = 6801




HEC-RAS Model Plan: Existing Conditions 9/13/2022
River = Sand Creek Reach = Reach 1-3 RS = 6688 Section DD
.045
.032
.045
Elevation (ft)
Station (ft)
Legend
EG 100-YR FIS
WS 100-YR FIS
EG 100-YR
WS 100-YR
EG 5-YR
WS 5-YR
0.5 ft/s
1.0 ft/s
1.5 ft/s
2.0 ft/s
2.5 ft/s
3.0 ft/s
Ground
Bank Sta

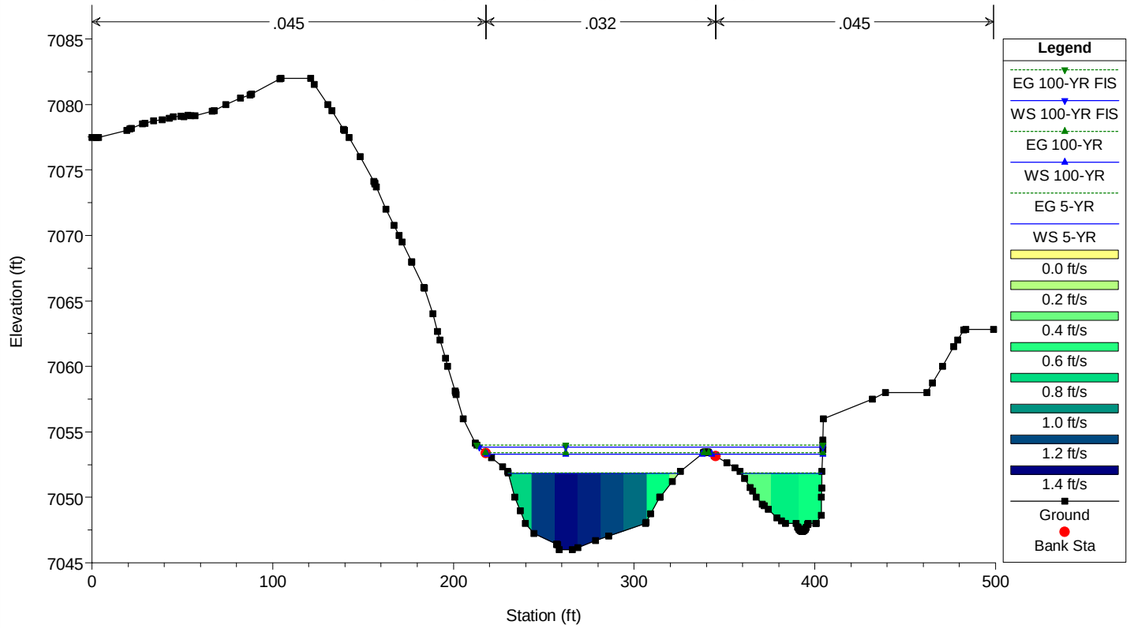

HEC-RAS Model Plan: Existing Conditions 9/13/2022
River = Sand Creek Reach = Reach 1-3 RS = 6299
.045
.032
.045
Elevation (ft)
Station (ft)
Legend
EG 100-YR FIS
EG 100-YR
WS 100-YR FIS
Crit 100-YR FIS
Crit 100-YR
WS 100-YR
EG 5-YR
WS 5-YR
Crit 5-YR
0 ft/s
2 ft/s
4 ft/s
6 ft/s
8 ft/s
10 ft/s
Ground
Ineff
Bank Sta


HEC-RAS Model Plan: Existing Conditions 9/13/2022
River = Sand Creek Reach = Reach 1-3 RS = 6094 Section DC
.045
.032
.045
Elevation (ft)
Station (ft)
Legend
EG 100-YR FIS
EG 100-YR
WS 100-YR FIS
Crit 100-YR FIS
Crit 100-YR
WS 100-YR
EG 5-YR
WS 5-YR
Crit 5-YR
0 ft/s
2 ft/s
4 ft/s
6 ft/s
8 ft/s
Ground
Bank Sta


HEC-RAS Model Plan: Existing Conditions 9/13/2022
River = Sand Creek Reach = Reach 1-3 RS = 5906
.045
.032
.045
Elevation (ft)
Station (ft)
Legend
EG 100-YR FIS
WS 100-YR FIS
EG 100-YR
WS 100-YR
EG 5-YR
WS 5-YR
0.0 ft/s
0.5 ft/s
1.0 ft/s
1.5 ft/s
2.0 ft/s
2.5 ft/s
3.0 ft/s
Ground
Bank Sta

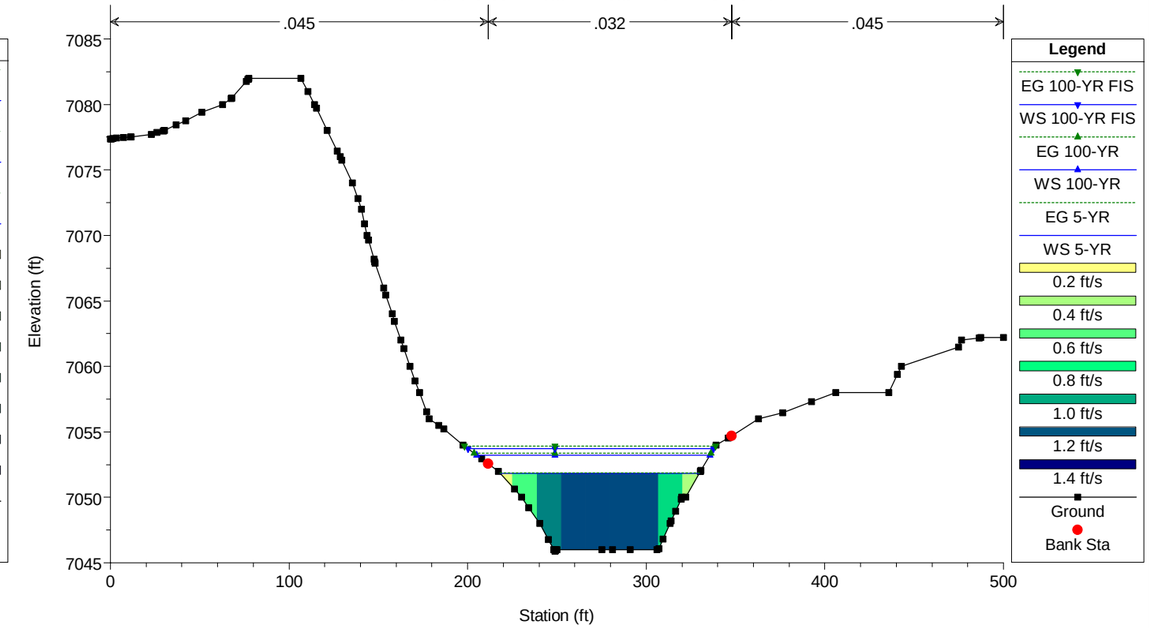
HEC-RAS Model Plan: Existing Conditions 9/13/2022

River = Sand Creek Reach = Reach 1-3 RS = 5803



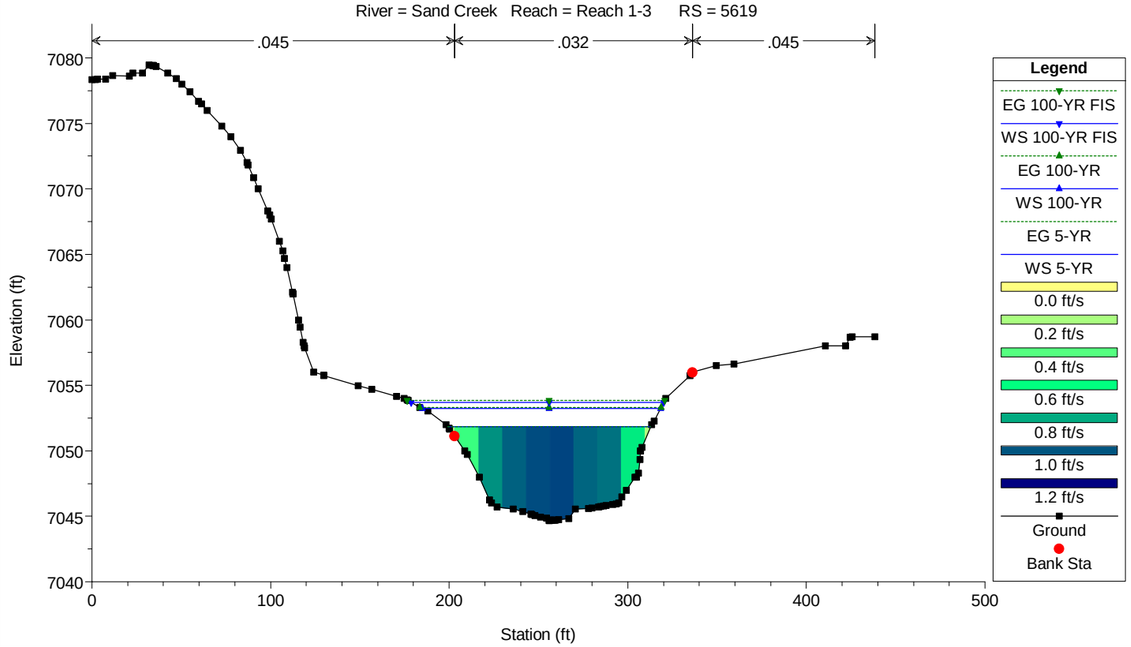
HEC-RAS Model Plan: Existing Conditions 9/13/2022

River = Sand Creek Reach = Reach 1-3 RS = 5710



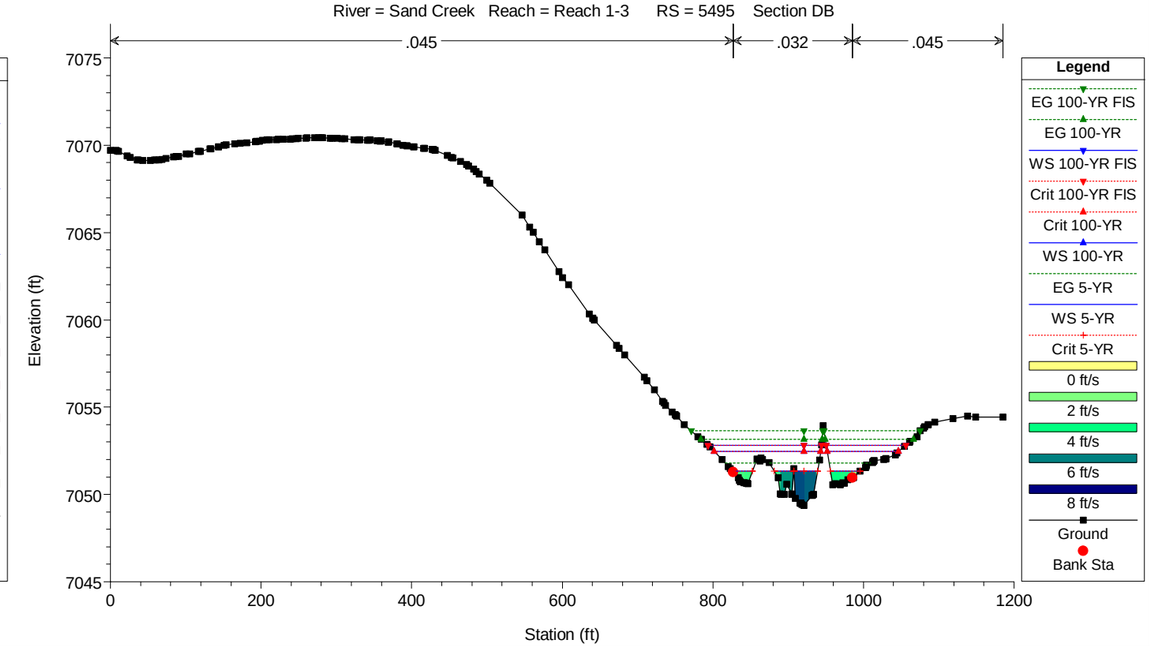
HEC-RAS Model Plan: Existing Conditions 9/13/2022

River = Sand Creek Reach = Reach 1-3 RS = 5619



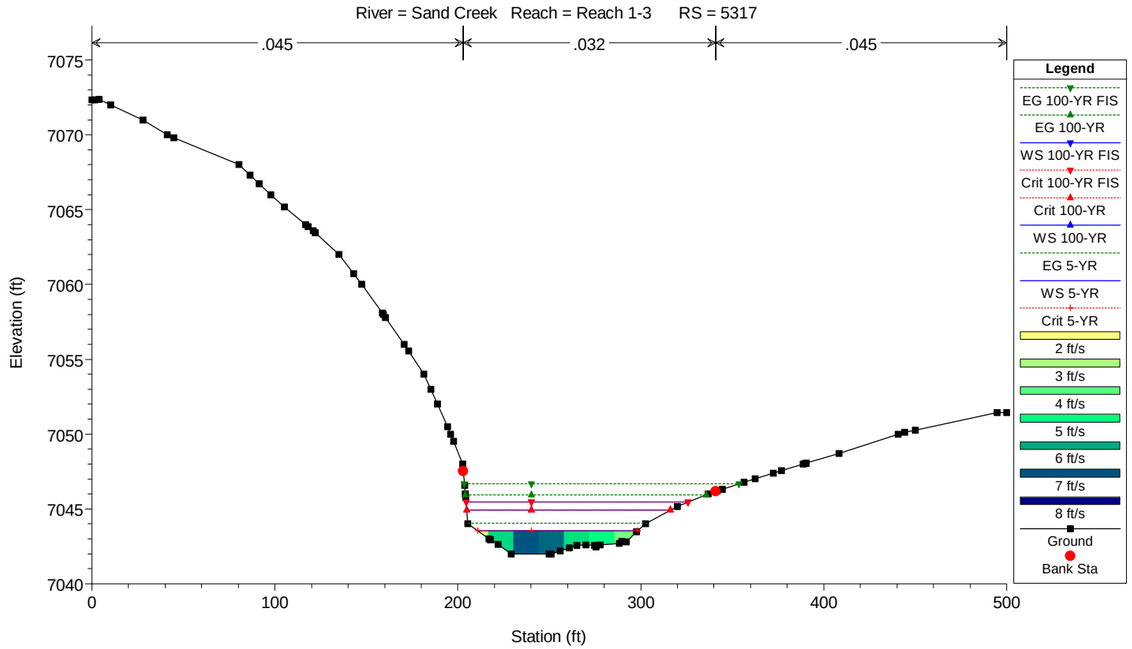
HEC-RAS Model Plan: Existing Conditions 9/13/2022

River = Sand Creek Reach = Reach 1-3 RS = 5495 Section DB



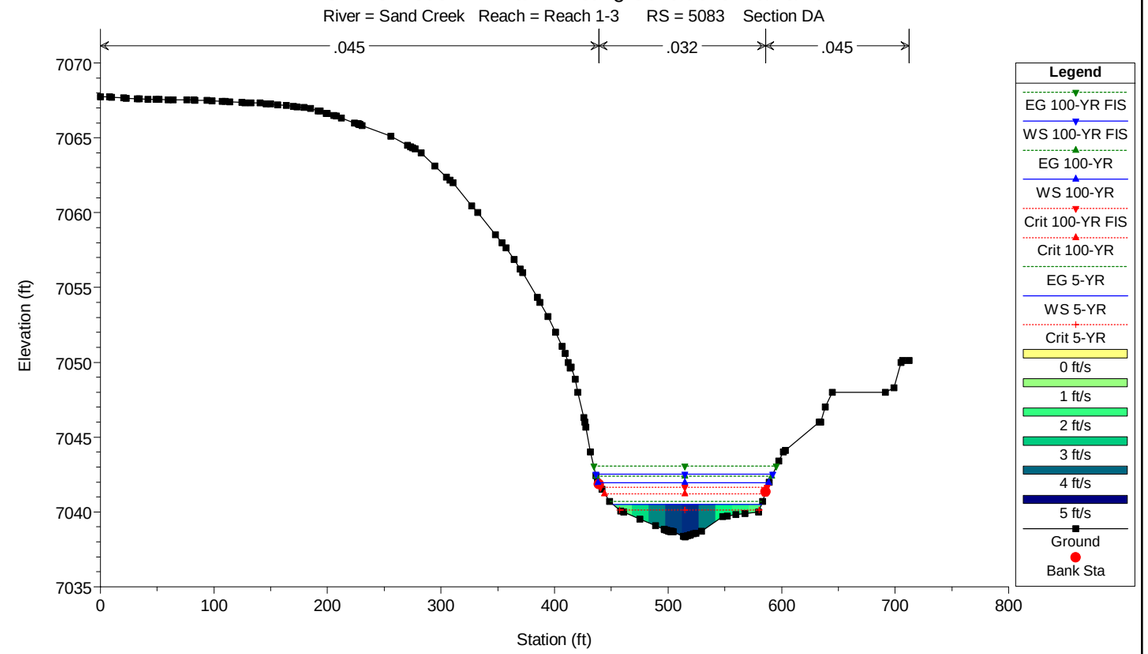
HEC-RAS Model Plan: Existing Conditions 9/13/2022

River = Sand Creek Reach = Reach 1-3 RS = 5317



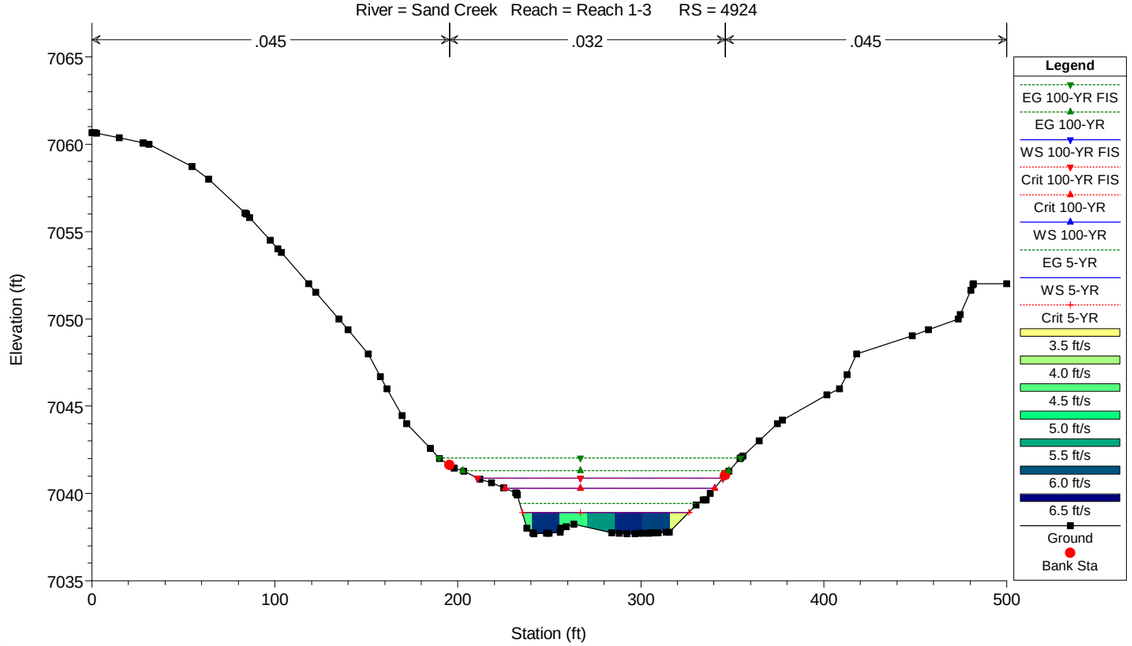
HEC-RAS Model Plan: Existing Conditions 9/13/2022

River = Sand Creek Reach = Reach 1-3 RS = 5083 Section DA



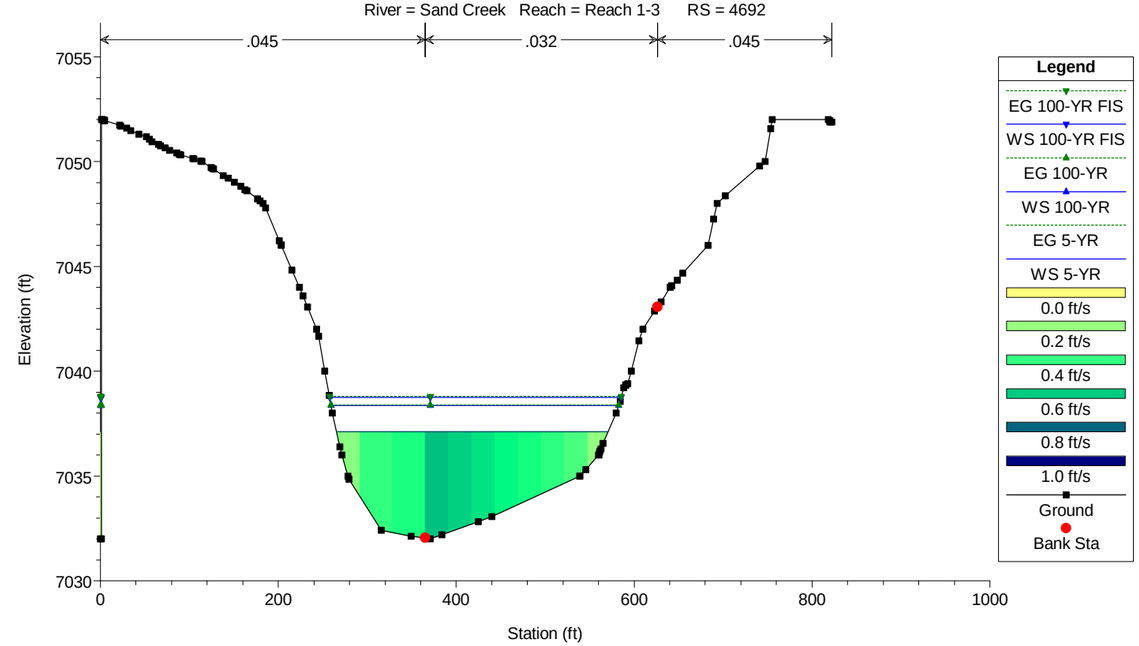
HEC-RAS Model Plan: Existing Conditions 9/13/2022

River = Sand Creek Reach = Reach 1-3 RS = 4924



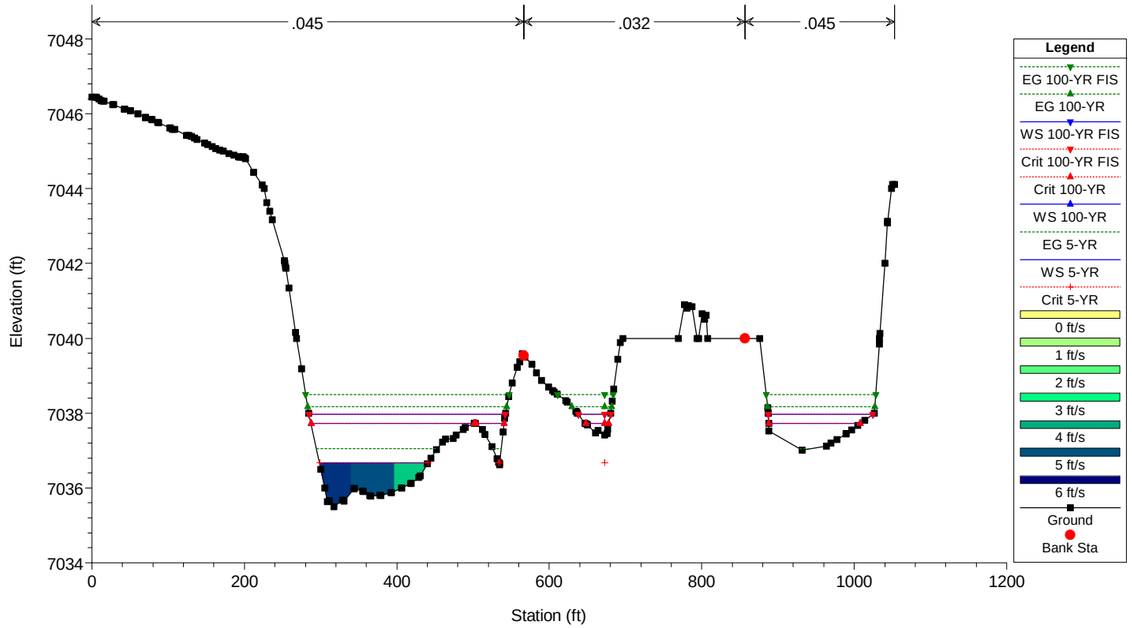
HEC-RAS Model Plan: Existing Conditions 9/13/2022

River = Sand Creek Reach = Reach 1-3 RS = 4692



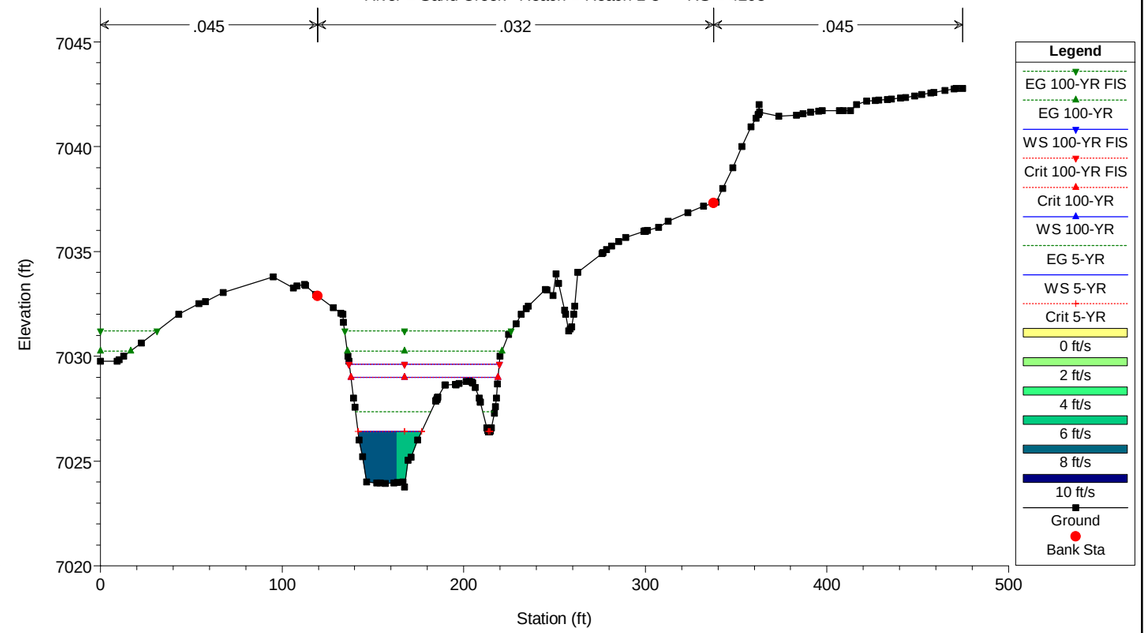
HEC-RAS Model Plan: Existing Conditions 9/13/2022

River = Sand Creek Reach = Reach 1-3 RS = 4454 Section CZ



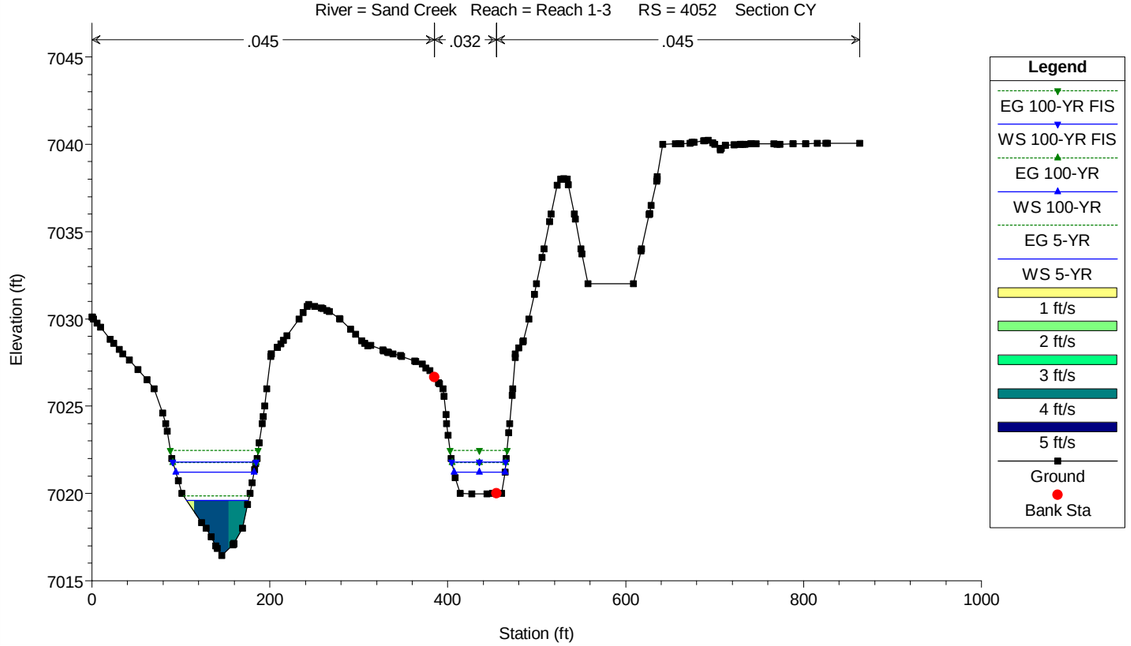
HEC-RAS Model Plan: Existing Conditions 9/13/2022

River = Sand Creek Reach = Reach 1-3 RS = 4293



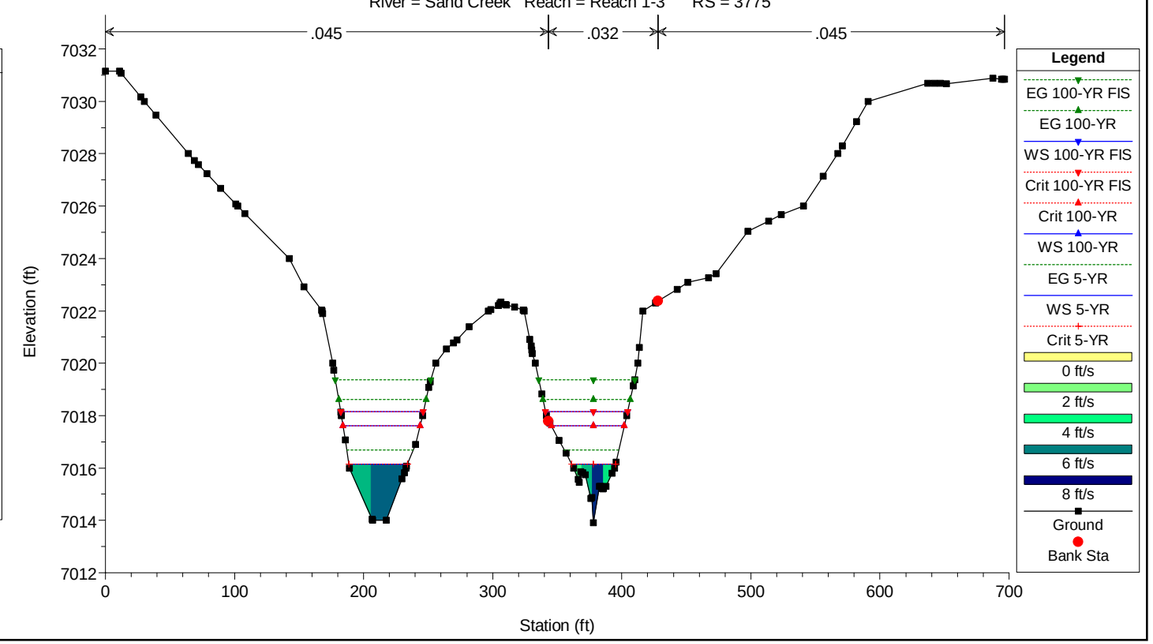
HEC-RAS Model Plan: Existing Conditions 9/13/2022

River = Sand Creek Reach = Reach 1-3 RS = 4052 Section CY



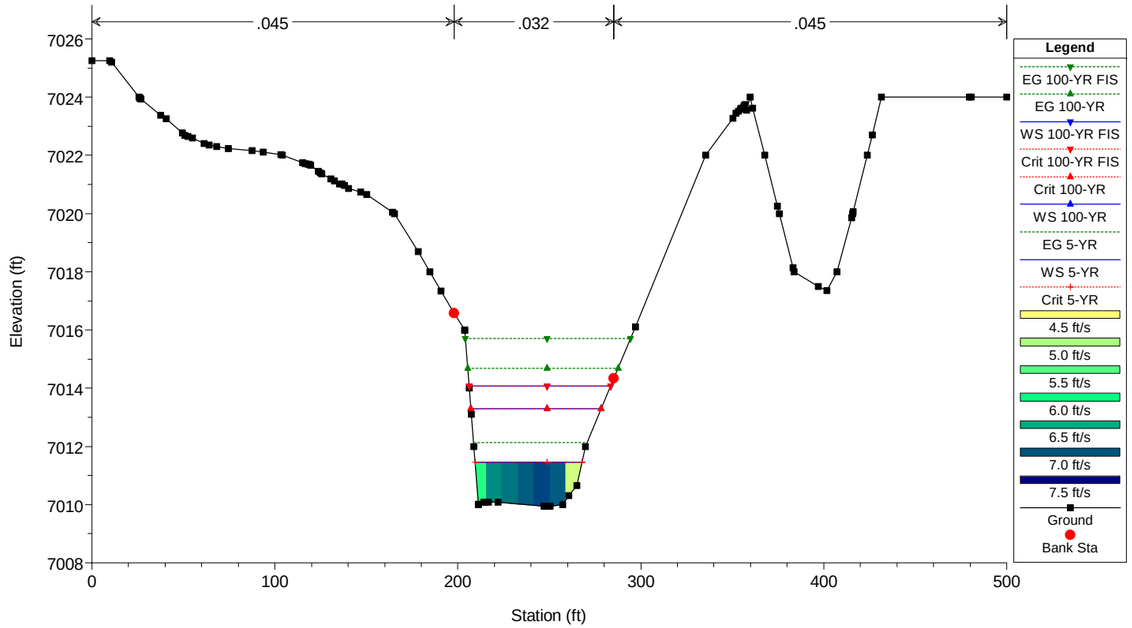
HEC-RAS Model Plan: Existing Conditions 9/13/2022

River = Sand Creek Reach = Reach 1-3 RS = 3775



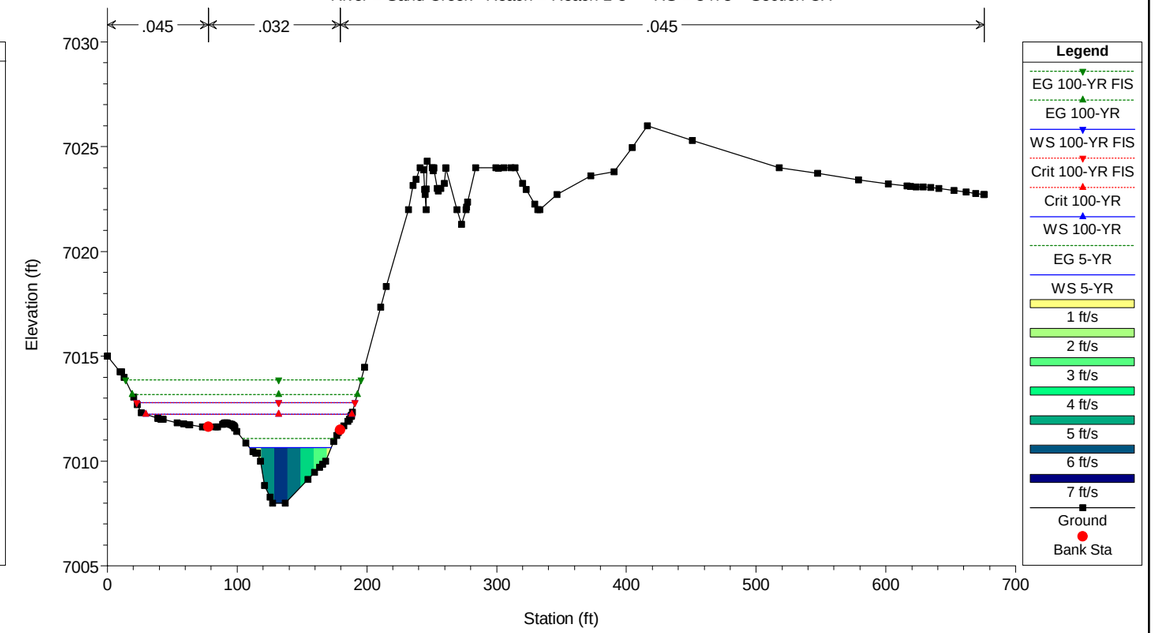
HEC-RAS Model Plan: Existing Conditions 9/13/2022

River = Sand Creek Reach = Reach 1-3 RS = 3543



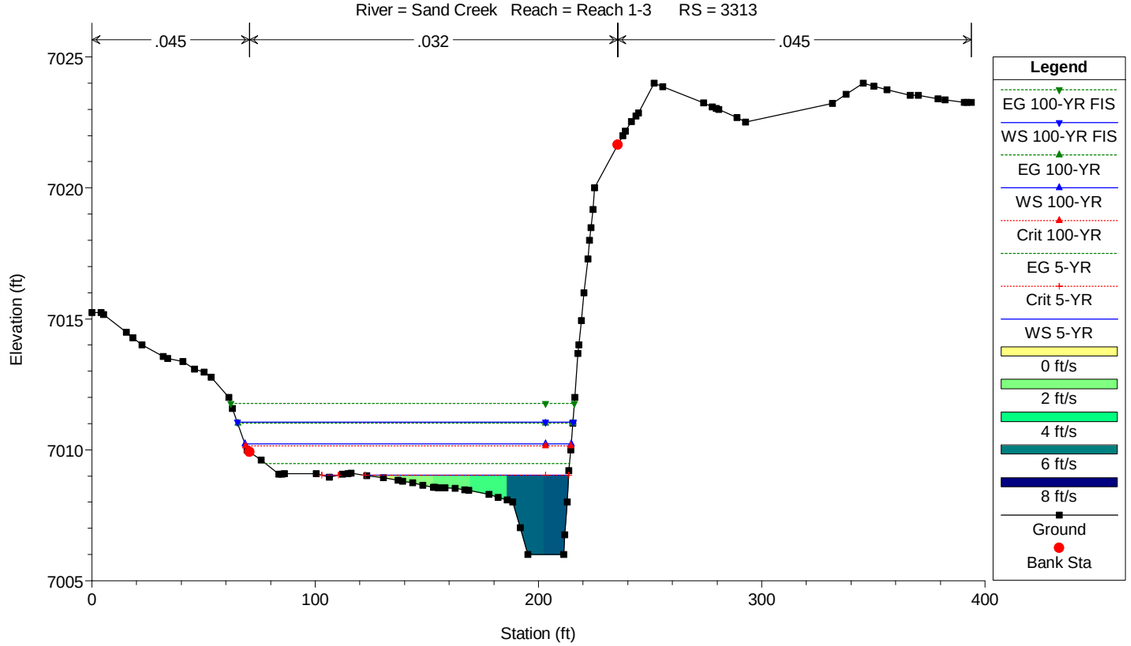
HEC-RAS Model Plan: Existing Conditions 9/13/2022

River = Sand Creek Reach = Reach 1-3 RS = 3478 Section CX



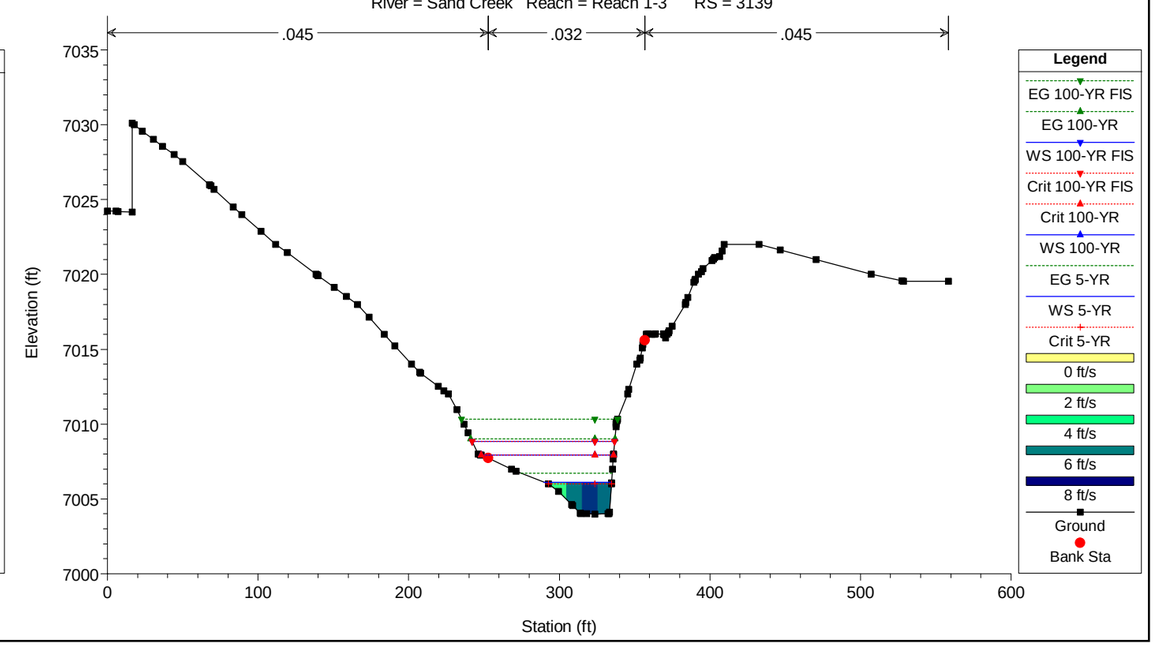
HEC-RAS Model Plan: Existing Conditions 9/13/2022

River = Sand Creek Reach = Reach 1-3 RS = 3313



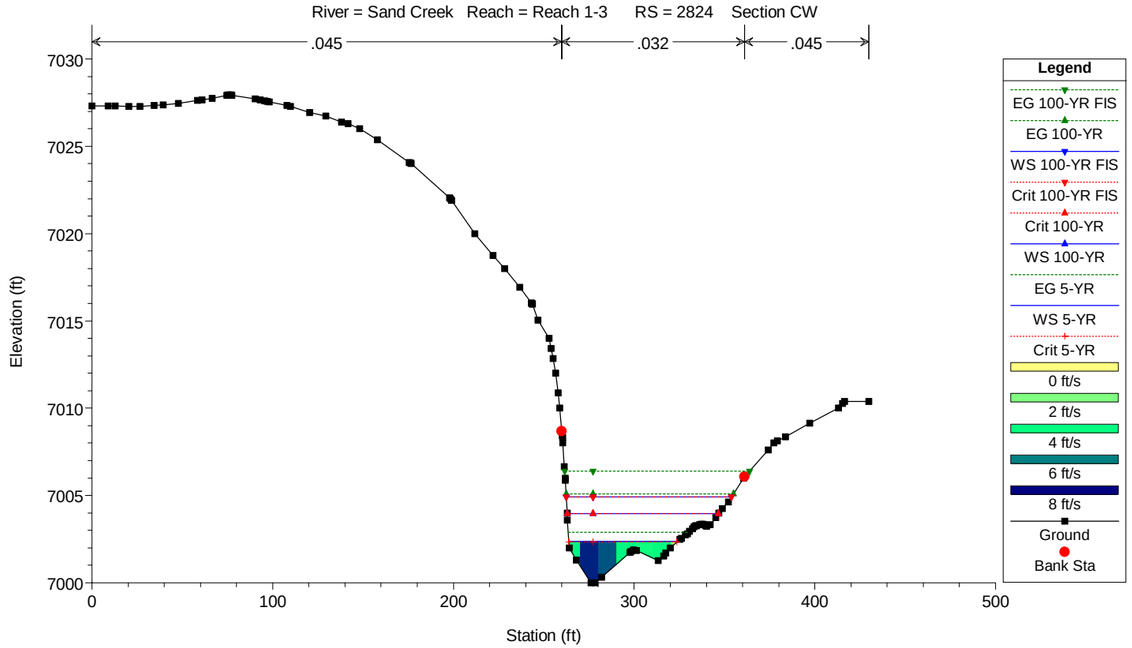
HEC-RAS Model Plan: Existing Conditions 9/13/2022

River = Sand Creek Reach = Reach 1-3 RS = 3139



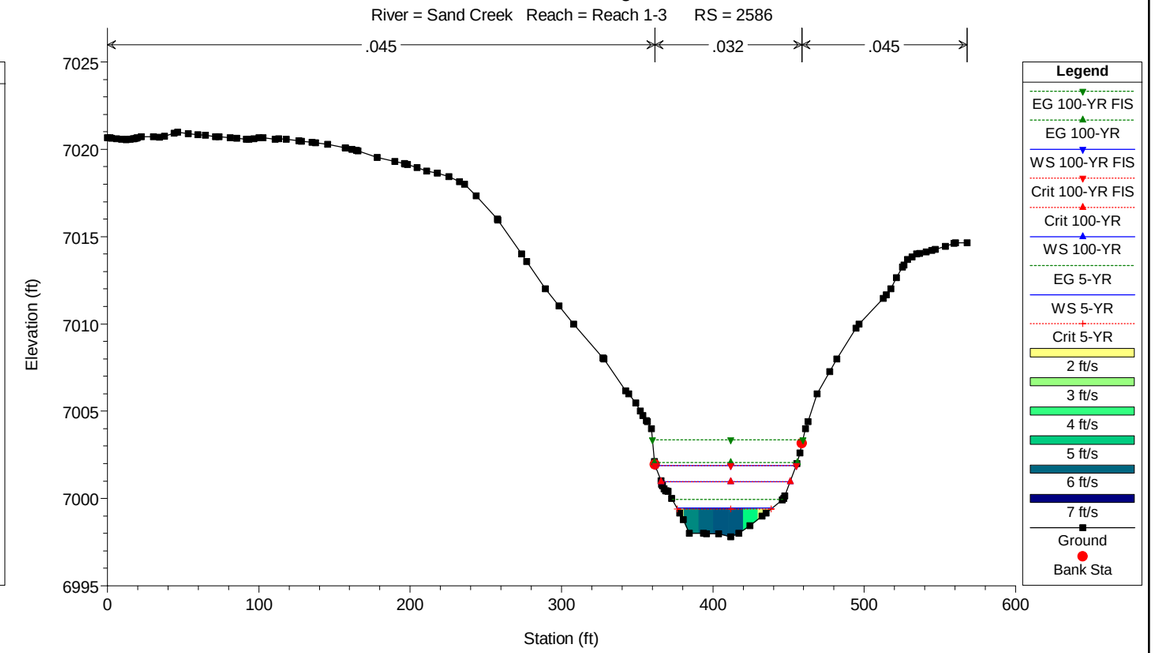
HEC-RAS Model Plan: Existing Conditions 9/13/2022

River = Sand Creek Reach = Reach 1-3 RS = 2824 Section CW



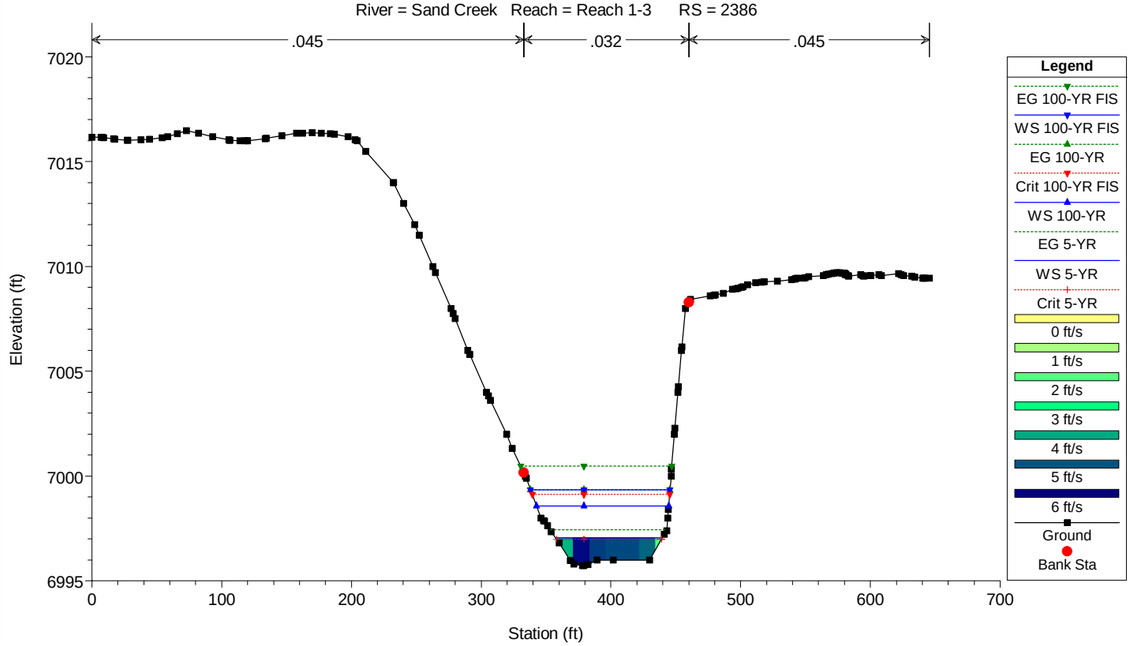
HEC-RAS Model Plan: Existing Conditions 9/13/2022

River = Sand Creek Reach = Reach 1-3 RS = 2586



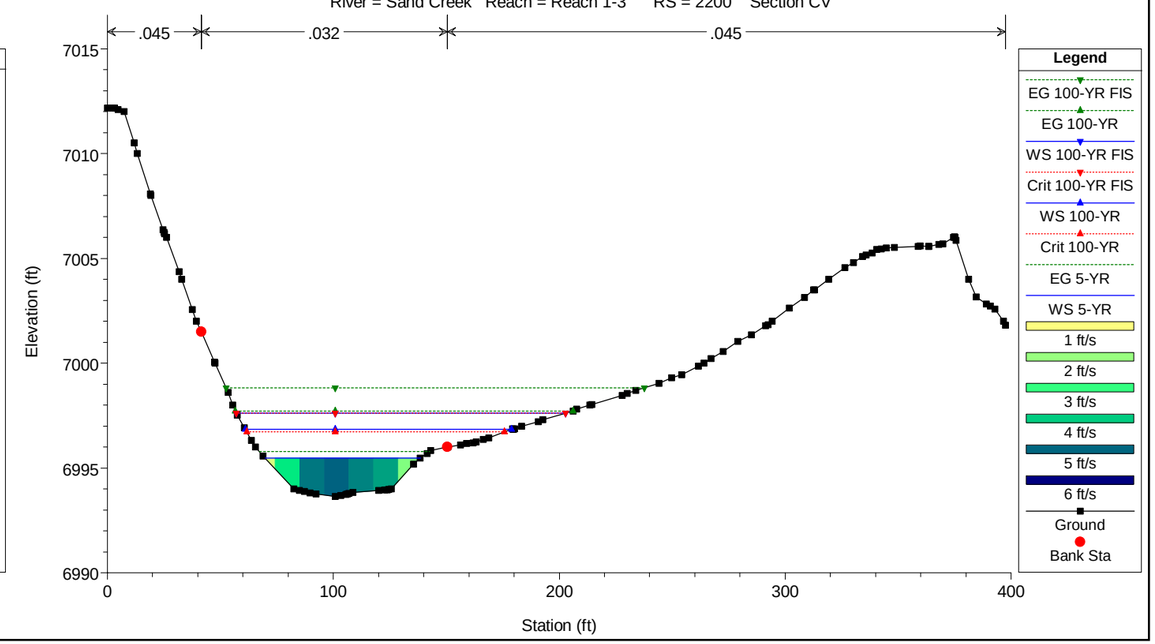
HEC-RAS Model Plan: Existing Conditions 9/13/2022

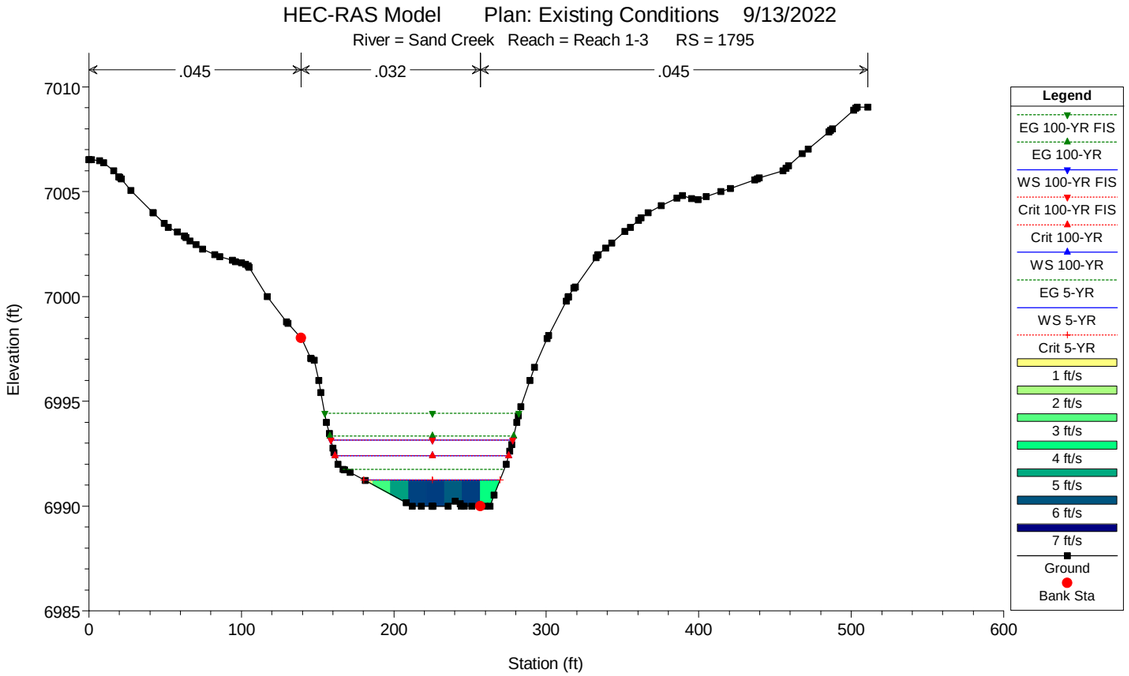
River = Sand Creek Reach = Reach 1-3 RS = 2386

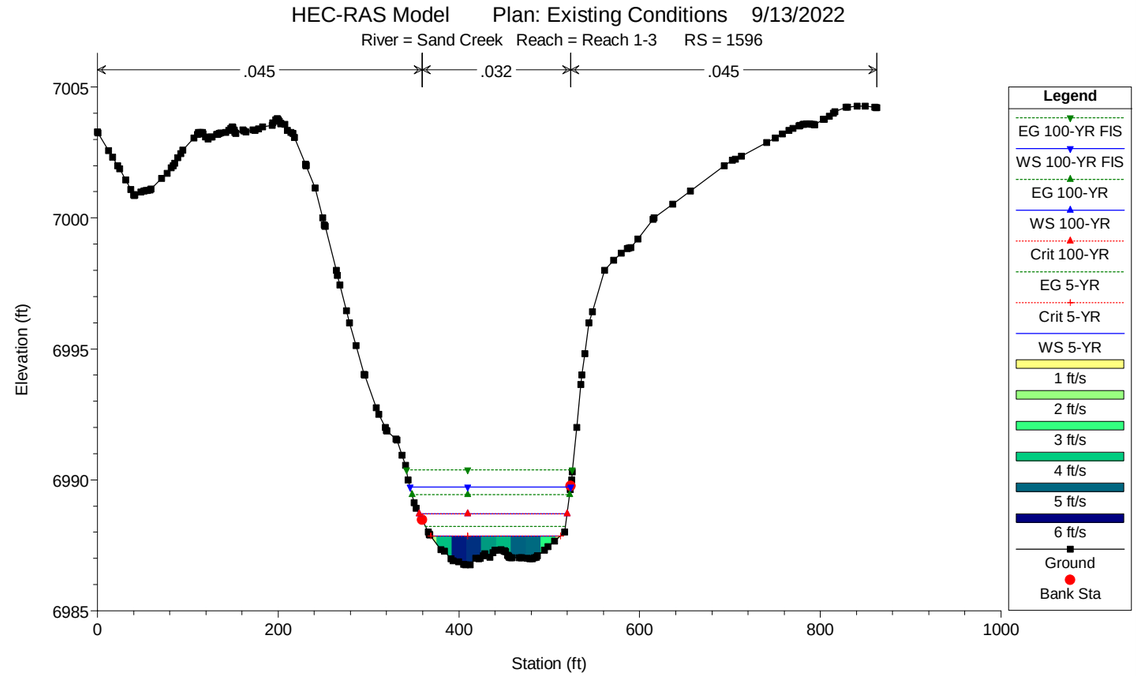


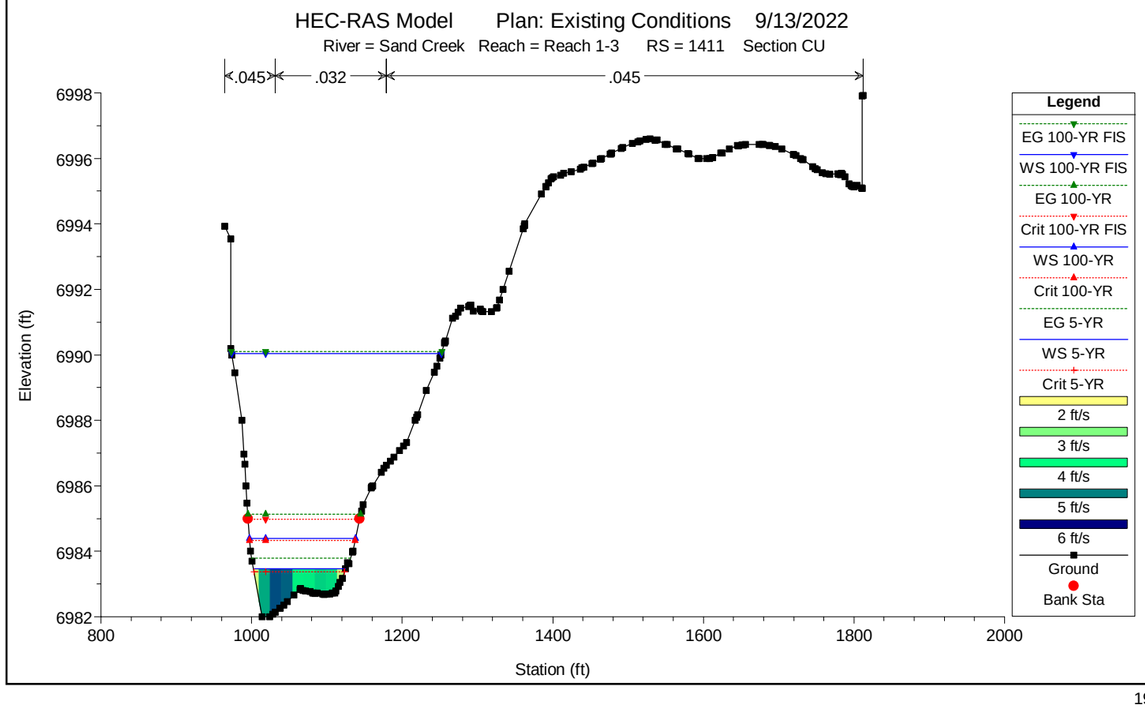
HEC-RAS Model Plan: Existing Conditions 9/13/2022

River = Sand Creek Reach = Reach 1-3 RS = 2200 Section CV




HEC-RAS Model Plan: Existing Conditions 9/13/2022
River = Sand Creek Reach = Reach 1-3 RS = 1795
.045
.032
.045
Elevation (ft)
Station (ft)
Legend
EG 100-YR FIS
EG 100-YR
WS 100-YR FIS
Crit 100-YR FIS
Crit 100-YR
WS 100-YR
EG 5-YR
WS 5-YR
Crit 5-YR
1 ft/s
2 ft/s
3 ft/s
4 ft/s
5 ft/s
6 ft/s
7 ft/s
Ground
Bank Sta


HEC-RAS Model Plan: Existing Conditions 9/13/2022
River = Sand Creek Reach = Reach 1-3 RS = 1596
.045
.032
.045
Elevation (ft)
Station (ft)
Legend
EG 100-YR FIS
WS 100-YR FIS
EG 100-YR
WS 100-YR
Crit 100-YR
EG 5-YR
Crit 5-YR
WS 5-YR
1 ft/s
2 ft/s
3 ft/s
4 ft/s
5 ft/s
6 ft/s
Ground
Bank Sta


HEC-RAS Model Plan: Existing Conditions 9/13/2022
River = Sand Creek Reach = Reach 1-3 RS = 1411 Section CU
.045
.032
.045
Elevation (ft)
Station (ft)
Legend
EG 100-YR FIS
WS 100-YR FIS
EG 100-YR
Crit 100-YR FIS
WS 100-YR
Crit 100-YR
EG 5-YR
WS 5-YR
Crit 5-YR
2 ft/s
3 ft/s
4 ft/s
5 ft/s
6 ft/s
Ground
Bank Sta

HEC-RAS Plan: EX River: Sand Creek Reach: Reach 1-3 Profile: 100-YR

Reach	River Sta	Profile	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Top Width	Froude # Chl	Shear LOB	Shear Chan	Shear ROB	Vel Left	Vel Chnl	Vel Right	Vel Total
			(cfs)	(ft)	(ft)	(ft)	(ft)	(ft/ft)	(ft)		(lb/sq ft)	(lb/sq ft)	(lb/sq ft)	(ft/s)	(ft/s)	(ft/s)	(ft/s)
Reach 1-3	16415	100-YR	1644.00	7230.74	7233.06	7233.06	7233.96	0.013371	124.70	1.05	1.41	1.53		5.41	8.04		7.34
Reach 1-3	15815	100-YR	1644.00	7220.56	7223.64	7223.64	7224.66	0.013915	101.89	1.07	2.19	1.62		7.22	8.30		8.03
Reach 1-3	15439	100-YR	1644.00	7213.99	7216.55	7216.55	7217.32	0.009916	176.92	0.92	0.43	1.27	0.62	2.58	7.46	3.28	6.24
Reach 1-3	14667	100-YR	1644.00	7200.47	7204.00	7204.00	7205.07	0.010598	102.02	0.96	0.46	1.53		2.69	8.37		7.98
Reach 1-3	13678	100-YR	1644.00	7180.91	7187.75		7187.80	0.000207	250.50	0.15	0.05	0.07	0.03	1.20	1.98	0.77	1.60
Reach 1-3	13466	100-YR	1644.00	7177.63	7187.71		7187.77	0.000100	144.60	0.12	0.02	0.06	0.02	0.80	2.00	0.81	1.69
Reach 1-3	13220	100-YR	1644.00	7183.14	7186.74	7186.74	7187.60	0.017483	128.83	1.13	2.43	1.45		7.45	7.43		7.44
Reach 1-3	13169	100-YR	1644.00	7168.00	7175.27		7175.41	0.000391	92.49	0.22	0.11	0.16		1.74	3.15		2.91
Reach 1-3	13113	100-YR	1644.00	7170.00	7174.83		7175.33	0.003051	88.65	0.55	0.45	0.66		3.25	5.86		5.51
Reach 1-3	13060	100-YR	1644.00	7169.99	7174.37		7175.09	0.005591	81.24	0.73	1.03	1.06		5.09	7.27		6.59
Reach 1-3	13025	100-YR	1644.00	7169.60	7173.66	7173.46	7174.80	0.009670	72.15	0.95	1.54	1.71		6.07	9.15		8.20
Reach 1-3	12980	100-YR	1644.00	7168.31	7172.96	7172.96	7174.31	0.010710	70.93	1.00	1.10	1.91		4.77	9.68		8.81
Reach 1-3	12866	100-YR	1644.00	7167.28	7170.67	7170.67	7171.79	0.012651	92.35	1.05	1.42	1.75		6.05	8.88		8.25
Reach 1-3	12813	100-YR	1644.00	7165.88	7169.93		7170.48	0.005136	114.60	0.69	0.63	0.82		4.16	6.24		5.80
Reach 1-3	12716	100-YR	1644.00	7164.00	7167.74	7167.74	7169.10	0.009854	71.04	0.97	0.94	1.88		4.36	9.71		8.77
Reach 1-3	12597	100-YR	1644.00	7161.80	7164.97	7164.97	7166.19	0.011673	99.13	1.03	1.41	1.79		5.54	9.14		8.59
Reach 1-3	12462	100-YR	1644.00	7158.51	7161.35	7161.35	7162.22	0.012318	133.81	1.00	0.36	1.35		2.23	7.51		7.39
Reach 1-3	12348	100-YR	1644.00	7154.00	7158.28	7158.12	7159.04	0.009542	126.19	0.89	0.32	1.14		2.15	7.01		6.95
Reach 1-3	12232	100-YR	1644.00	7153.09	7156.81	7156.81	7157.85	0.010568	110.07	0.96	0.58	1.53		3.12	8.36		7.69
Reach 1-3	12107	100-YR	1644.00	7151.03	7154.88	7154.88	7155.68	0.013295	140.82	1.03	1.31	1.47		5.17	7.82		6.84
Reach 1-3	11964	100-YR	1644.00	7149.23	7152.74	7152.74	7153.71	0.011314	113.97	0.98	0.81	1.48		3.85	8.10		7.56
Reach 1-3	11815	100-YR	1644.00	7148.00	7150.70	7150.51	7151.41	0.009042	133.66	0.87	0.67	1.09		3.51	6.85		6.62
Reach 1-3	11606	100-YR	1644.00	7146.04	7148.36	7148.36	7149.23	0.012073	134.10	0.99	0.33	1.34		2.10	7.50		7.37
Reach 1-3	11505	100-YR	1644.00	7144.13	7146.76	7146.76	7147.59	0.013049	140.50	1.01	0.08	1.31		0.78	7.29		7.29
Reach 1-3	11182	100-YR	1644.00	7138.10	7142.94		7143.32	0.005381	204.01	0.66	0.14	0.58	0.01	1.35	4.92	0.18	4.86
Reach 1-3	10899	100-YR	1644.00	7137.38	7140.34	7140.34	7140.97	0.014099	227.77	1.01		1.15	0.68		6.58	3.30	6.09
Reach 1-3	10454	100-YR	1644.00	7124.00	7126.83	7126.75	7127.65	0.010937	124.34	0.94		1.24			7.23		7.23
Reach 1-3	10157	100-YR	1667.00	7120.00	7123.14	7123.14	7124.26	0.011690	88.24	1.00		1.61			8.50		8.50
Reach 1-3	9937	100-YR	1667.00	7119.89	7123.40		7123.46	0.000369	274.14	0.19	0.07	0.08		1.27	1.99		1.87
Reach 1-3	9765	100-YR	1667.00	7120.11	7122.40	7122.40	7123.19	0.016005	167.07	1.10		1.41	1.34		7.38	5.08	7.00
Reach 1-3	9575	100-YR	1667.00	7103.29	7106.86	7106.86	7107.93	0.012252	96.39	1.01		1.56			8.28		8.28
Reach 1-3	9396	100-YR	1667.00	7099.80	7103.38	7103.38	7104.57	0.011349	80.70	1.00		1.66			8.73		8.73
Reach 1-3	9120	100-YR	1667.00	7095.99	7099.76		7100.49	0.005170	87.64	0.70	0.17	0.95		1.55	6.85		6.78
Reach 1-3	9052	100-YR	1667.00	7095.85	7099.12		7100.05	0.007384	82.82	0.83	0.13	1.24		1.22	7.73		7.70
Reach 1-3	9017	100-YR	1667.00	7095.09	7098.50	7098.50	7099.69	0.011514	80.39	1.01		1.68			8.78		8.78
Reach 1-3	8959	100-YR	1763.90	7094.00	7097.68	7097.66	7098.78	0.011160	93.07	0.99		1.56			8.41		8.41
Reach 1-3	8831	100-YR	1763.90	7092.55	7096.14	7096.14	7097.35	0.011010	85.23	0.99	0.18	1.68		1.42	8.84		8.79
Reach 1-3	8692	100-YR	1763.90	7091.45	7094.55	7094.55	7095.77	0.011059	85.97	1.00	0.32	1.69		2.07	8.86		8.78
Reach 1-3	8489	100-YR	1763.90	7088.21	7090.72	7090.72	7091.47	0.013336	170.45	1.01		1.23			6.97		6.97
Reach 1-3	8289	100-YR	1763.90	7085.18	7087.68	7087.68	7088.71	0.012133	107.79	1.01		1.52			8.13		8.13
Reach 1-3	8085	100-YR	1763.90	7080.51	7084.04	7084.04	7084.89	0.011072	168.97	0.95	0.18	1.29	0.21	1.40	7.42	1.55	7.10
Reach 1-3	7887	100-YR	1763.90	7078.18	7080.94	7080.94	7081.76	0.015224	150.10	1.08		1.41	2.02		7.45	6.74	7.27
Reach 1-3	7630	100-YR	1763.90	7071.92	7076.48	7076.48	7077.52	0.010604	114.74	0.97		1.54	0.65		8.38	3.35	7.73
Reach 1-3	7475	100-YR	1763.90	7068.00	7072.16	7072.16	7073.35	0.011301	86.15	1.00		1.68	0.49		8.79	2.73	8.71
Reach 1-3	7286	100-YR	1763.90	7064.24	7069.05		7070.06	0.006141	73.00	0.78		1.30	0.63		8.23	3.61	7.75
Reach 1-3	7097	100-YR	1763.90	7061.99	7067.02	7067.00	7068.51	0.010780	63.20	0.99		1.95	0.08		9.80	0.81	9.78
Reach 1-3	6889	100-YR	1763.90	7059.99	7064.87	7064.87	7066.14	0.011259	76.28	1.00		1.75			9.06		9.06
Reach 1-3	6801	100-YR	1763.90	7058.00	7062.62	7062.62	7063.19	0.006150	226.53	0.75		0.99	0.41		6.85	2.70	4.95
Reach 1-3	6688	100-YR	1763.90	7054.20	7058.78		7058.88	0.001202	284.66	0.32		0.15	0.26		2.58	2.62	2.60
Reach 1-3	6299	100-YR	1880.40	7052.00	7056.57	7056.57	7057.79	0.010724	111.17	0.99		1.73	0.86		9.04	4.04	8.62
Reach 1-3	6094	100-YR	1880.40	7049.53	7053.51	7053.51	7054.67	0.011772	95.21	1.01		1.65			8.64		8.64
Reach 1-3	5906	100-YR	1880.40	7047.00	7053.20		7053.59	0.001865	101.12	0.44	0.12	0.46		1.48	5.03		4.94
Reach 1-3	5803	100-YR	1880.40	7046.00	7053.30		7053.41	0.000532	180.34	0.24		0.14	0.11		2.86	1.68	2.53
Reach 1-3	5710	100-YR	1880.40	7045.88	7053.23		7053.37	0.000440	130.78	0.22	0.01	0.14		0.33	2.90		2.90

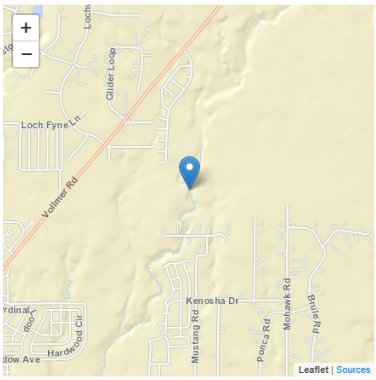
HEC-RAS Plan: EX River: Sand Creek Reach: Reach 1-3 Profile: 100-YR (Continued)

Reach	River Sta	Profile	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Top Width	Froude # Chl	Shear LOB	Shear Chan	Shear ROB	Vel Left	Vel Chnl	Vel Right	Vel Total
			(cfs)	(ft)	(ft)	(ft)	(ft)	(ft/ft)	(ft)		(lb/sq ft)	(lb/sq ft)	(lb/sq ft)	(ft/s)	(ft/s)	(ft/s)	(ft/s)
Reach 1-3	5619	100-YR	1880.40	7044.65	7053.23		7053.33	0.000257	133.34	0.18	0.01	0.10		0.48	2.53		2.49
Reach 1-3	5495	100-YR	1880.40	7049.36	7052.46	7052.46	7053.17	0.011665	235.94	0.95	0.42	1.19	0.48	2.46	6.97	2.72	6.19
Reach 1-3	5317	100-YR	1880.40	7042.00	7044.91	7044.91	7045.95	0.011879	111.33	1.00		1.52			8.18		8.18
Reach 1-3	5083	100-YR	1880.40	7038.33	7041.95	7041.22	7042.39	0.004059	150.39	0.60	0.01	0.61	0.07	0.28	5.31	0.93	5.30
Reach 1-3	4924	100-YR	1848.80	7037.69	7040.29	7040.29	7041.30	0.012077	114.42	1.01		1.50			8.07		8.07
Reach 1-3	4692	100-YR	1848.80	7032.00	7038.36		7038.38	0.000122	324.44	0.12	0.03	0.03		1.03	1.37		1.25
Reach 1-3	4454	100-YR	1848.80	7037.42	7037.72	7037.72	7038.17	0.020679	402.12	0.89	1.55	0.24	0.59	5.57	2.15	2.81	5.10
Reach 1-3	4293	100-YR	1848.80	7023.77	7028.98	7028.98	7030.25	0.011654	81.16	1.00		1.76			9.04		9.04
Reach 1-3	4052	100-YR	1848.80	7019.99	7021.23		7021.78	0.008565	145.30	0.77	1.53	0.61	0.52	6.16	4.71	2.99	5.81
Reach 1-3	3775	100-YR	1848.80	7013.90	7017.62	7017.62	7018.62	0.017858	116.26	1.17	2.56	1.78		7.69	8.49		8.01
Reach 1-3	3543	100-YR	1848.80	7009.94	7013.29	7013.29	7014.69	0.011143	71.18	1.01		1.87			9.47		9.47
Reach 1-3	3478	100-YR	1848.80	7008.00	7012.24	7012.24	7013.19	0.009757	158.87	0.92	0.23	1.37	0.25	1.69	7.88	1.82	7.35
Reach 1-3	3313	100-YR	1848.80	7006.00	7010.23	7010.15	7011.01	0.010793	146.22	0.93	0.14	1.20		1.18	7.09		7.08
Reach 1-3	3139	100-YR	1562.50	7003.99	7007.92	7007.92	7009.03	0.011822	87.94	1.00	0.07	1.60		0.74	8.45		8.43
Reach 1-3	2824	100-YR	1562.50	7000.00	7003.98	7003.98	7005.09	0.011782	83.68	1.00		1.60			8.45		8.45
Reach 1-3	2586	100-YR	1562.50	6997.81	7000.97	7000.97	7002.06	0.011639	85.24	1.00		1.58			8.40		8.40
Reach 1-3	2386	100-YR	1562.50	6995.72	6998.56		6999.33	0.008254	101.82	0.84		1.11			7.05		7.05
Reach 1-3	2200	100-YR	1562.50	6993.65	6996.84	6996.72	6997.72	0.009049	117.66	0.89		1.27	0.28		7.59	1.95	7.23
Reach 1-3	1795	100-YR	1585.20	6989.98	6992.41	6992.41	6993.35	0.013001	113.88	1.03		1.51	1.32		8.02	5.21	7.61
Reach 1-3	1596	100-YR	1585.20	6986.75	6988.70	6988.70	6989.44	0.013539	163.65	1.01	0.10	1.21		0.91	6.88		6.87
Reach 1-3	1411	100-YR	1585.20	6982.00	6984.39	6984.33	6985.14	0.014080	140.56	0.96		1.42			6.96		6.96

convert navd88 to ngvd29 - Goo | NGS Coordinate Conversion and | convert feet to meters - Google | What Is This USMNT Guy's Deal:
geodesy.noaa.gov/NCAT/index.xhtml

Select the type of horizontal coordinate: ◉ Geodetic lat-long ○ SPC ○ UTM ○ USNG

Select a height ○ Ellipsoidal ◉ Orthometric



Enter lat-lon in decimal degrees

Lat 38.9569393242

Lon -104.6738719940

or degrees-minutes-seconds

Lat N 38-57-24.98157

Lon W 104-40-25.93918

or drag map marker to a location of interest

Input reference frame (historically called 'horizontal datum') NAD83(2011)

Output reference frame (historically called 'horizontal datum') NAD83(2011)

Don't see a reference frame in the list?Click **here** *to learn more.*

Orthometric Height (m) 2,130.500

Input geopotential datum (historically called 'vertical datum') NGVD29

Output geopotential datum (historically called 'vertical datum') NAVD88

SPC zone Auto Pick (default zone)

Submit

Export Results to PDF CSV

Click blue bar(s) to expand/collapse

Transformed Coordinate

Input Coordinate		Output Coordinate		Total Change + Uncertainty	
Latitude	N38° 57' 24.98157" N385724.98157 38.9569393242	Latitude	N38° 57' 24.98157" N385724.98157 38.9569393242	Latitude	0.00000" ±0.000000" (0.000 m ±0.0000 m)*
Longitude	E255° 19' 34.06082" W1044025.93918 -104.6738719940	Longitude	E255° 19' 34.06082" W1044025.93918 -104.6738719940	Longitude	0.00000" ±0.000000" (0.000 m ±0.0000 m)*
Ellipsoid Height (m)	Not given	Ellipsoid Height (m)	Not given	Ellipsoid Height	Not given
Orthometric Height (m)	2130.500	Orthometric Height (m)	2131.690	Orthometric Height	1.190 m ±0.041 m
Reference Frame	NAD83(2011)	Reference Frame	NAD83(2011)		
Geopotential Datum	NGVD29	Geopotential Datum	NAVD88		

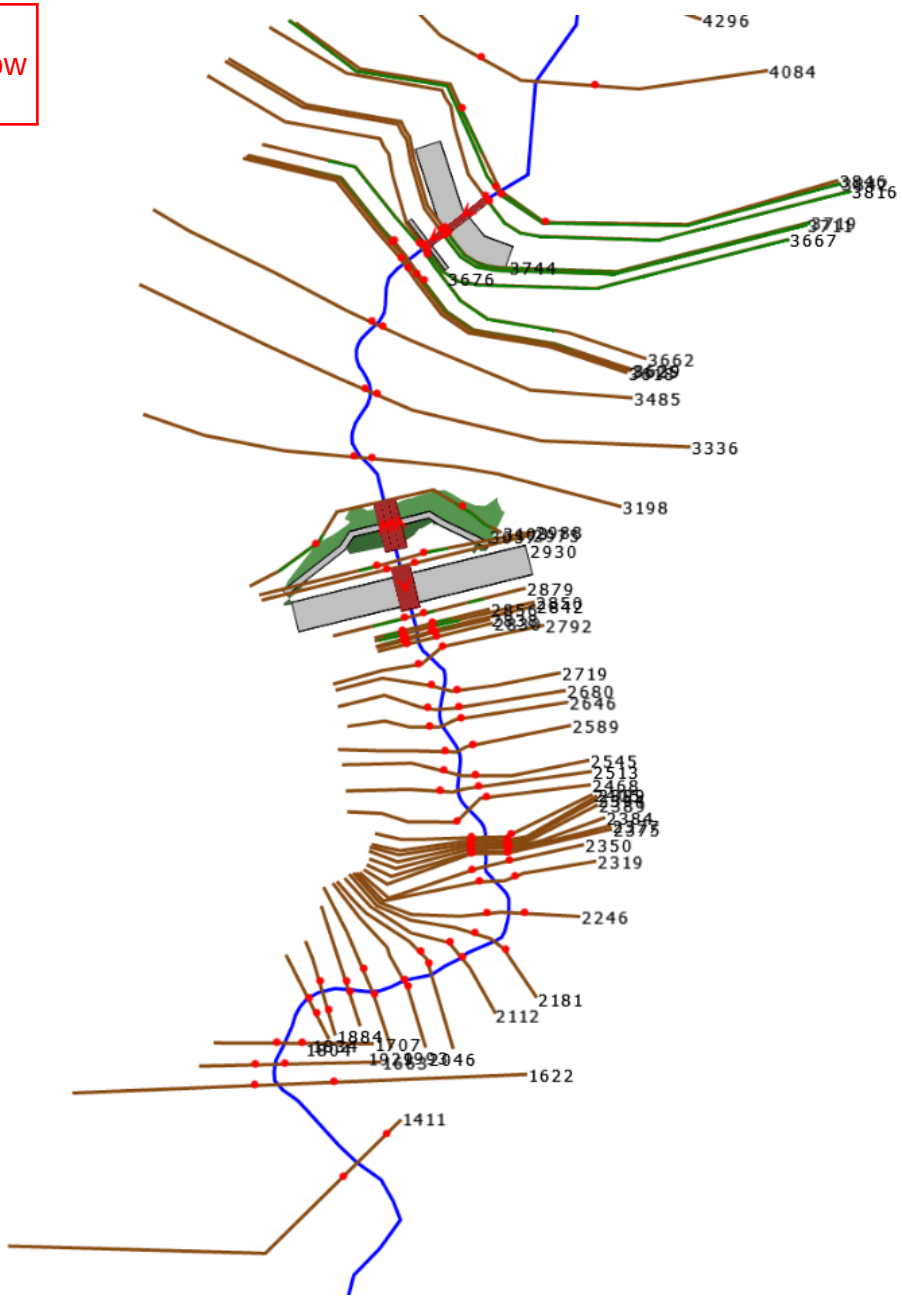
*Approximate value to aid interpretation and not an actual distance. See **TM NOS NGS 82** for more details.

Appendix C

Sand Creek Proposed Conditions Hydraulic Modeling

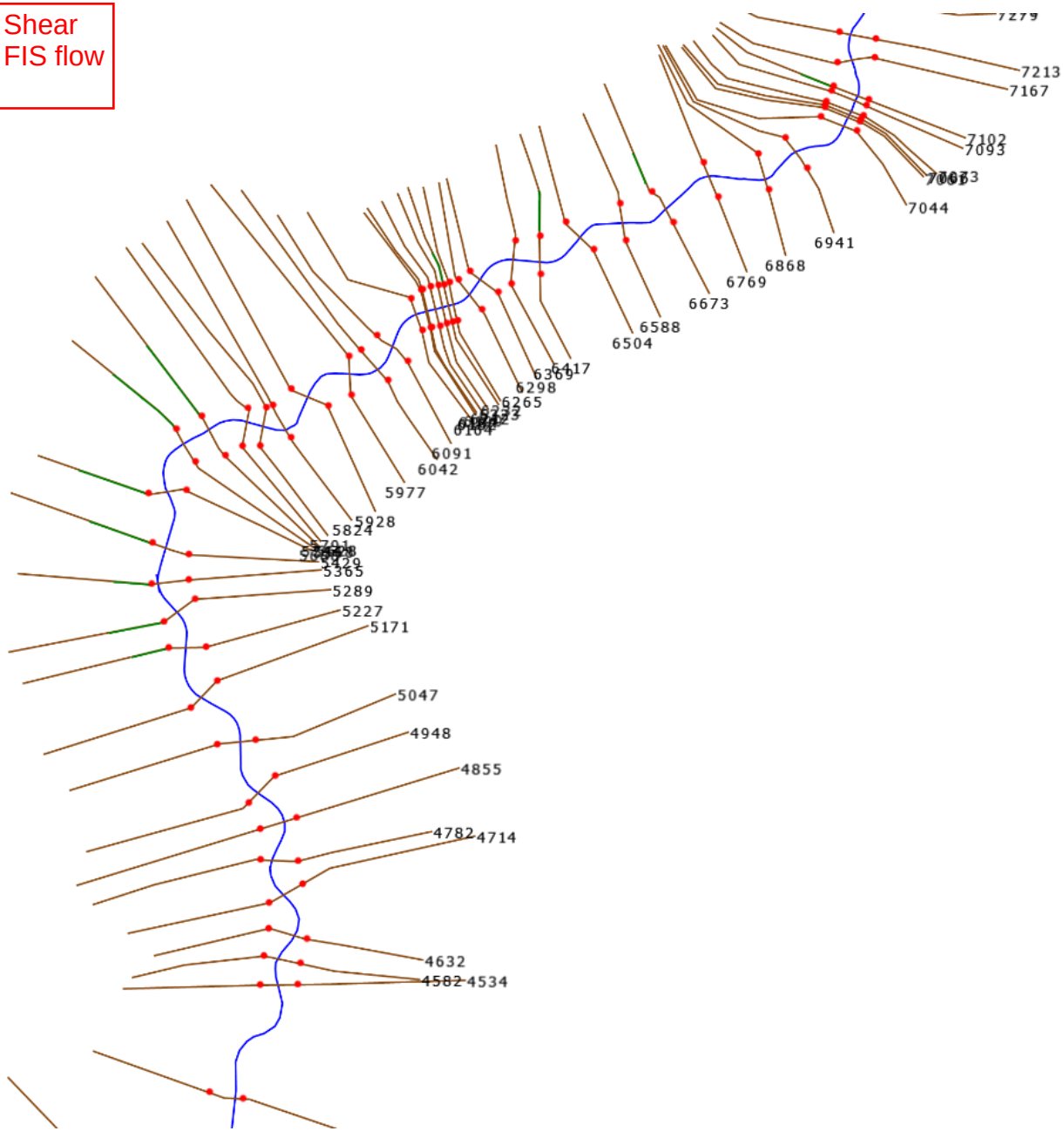
Water Surface Elevation HEC-RAS Analysis For MDDP Design Storms

Model layout for WS & Shear flow analysis except in FIS flow condition



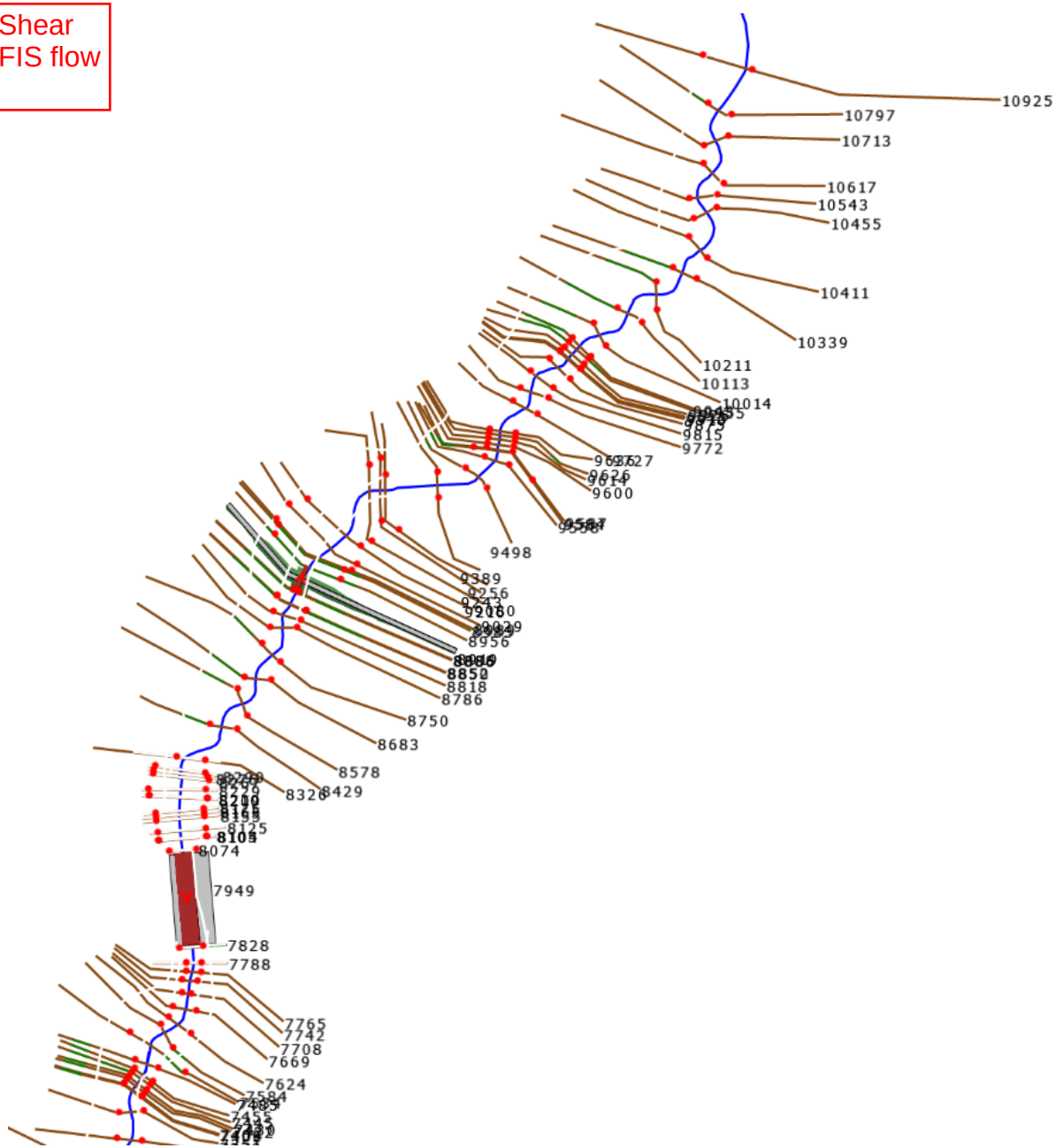
Created with GeoHECRAS v4.0.0.2094

Model layout for WS & Shear flow analysis except in FIS flow condition



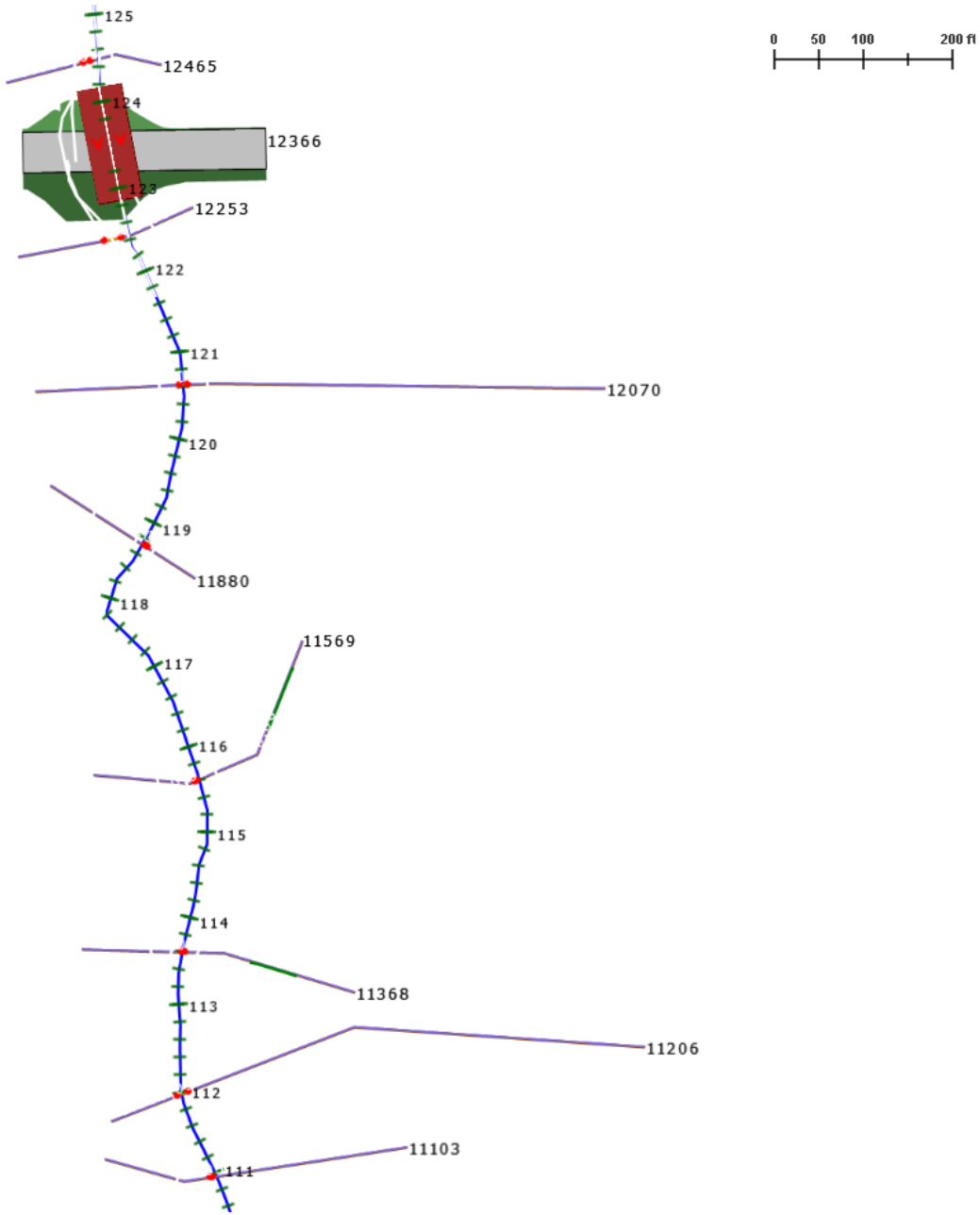
Created with GeoHECRAS v4.0.0.2094

Model layout for WS & Shear flow analysis except in FIS flow condition



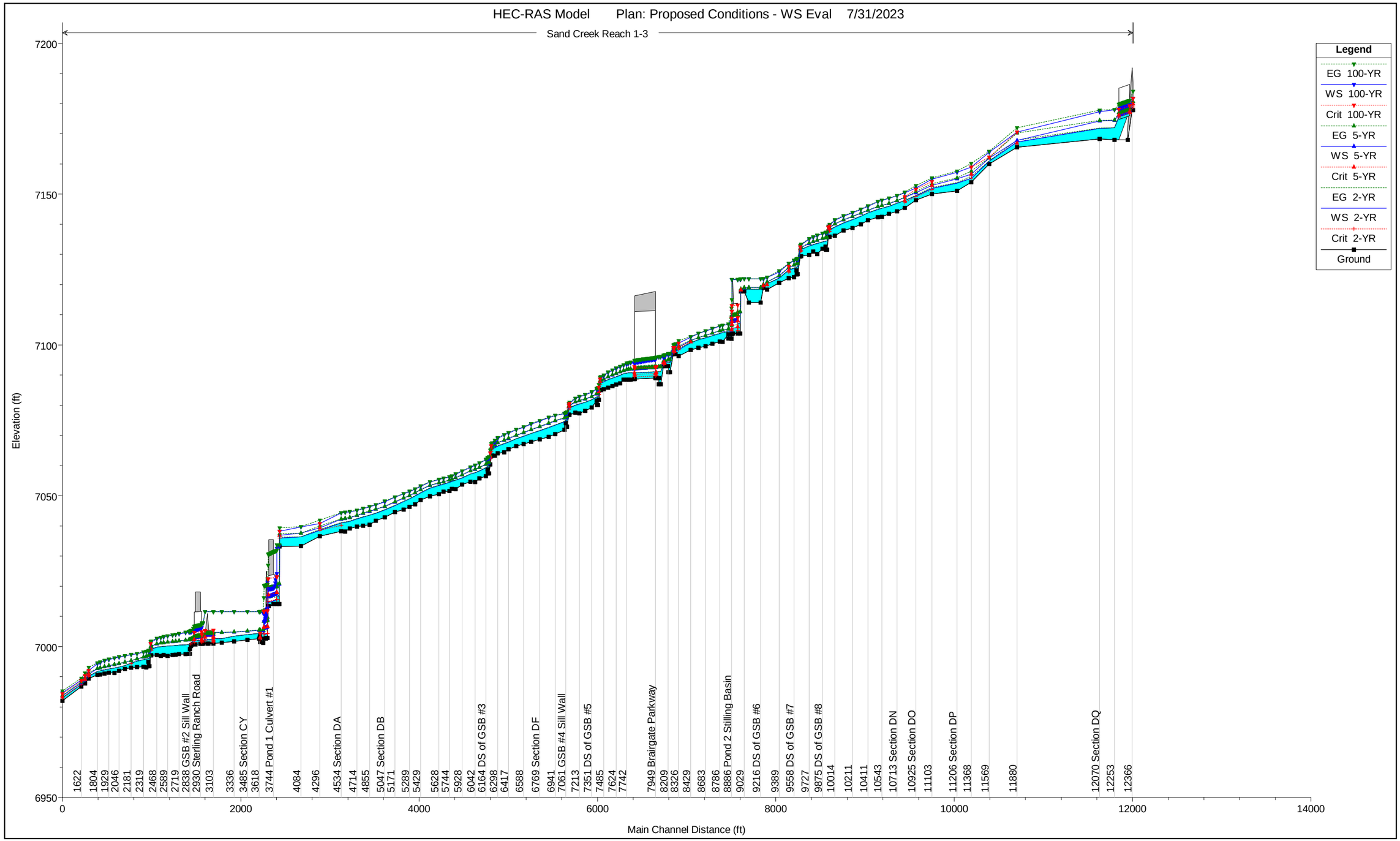
Created with GeoHECRAS v4.0.0.2094

Model layout for WS & Shear flow analysis except in FIS flow condition

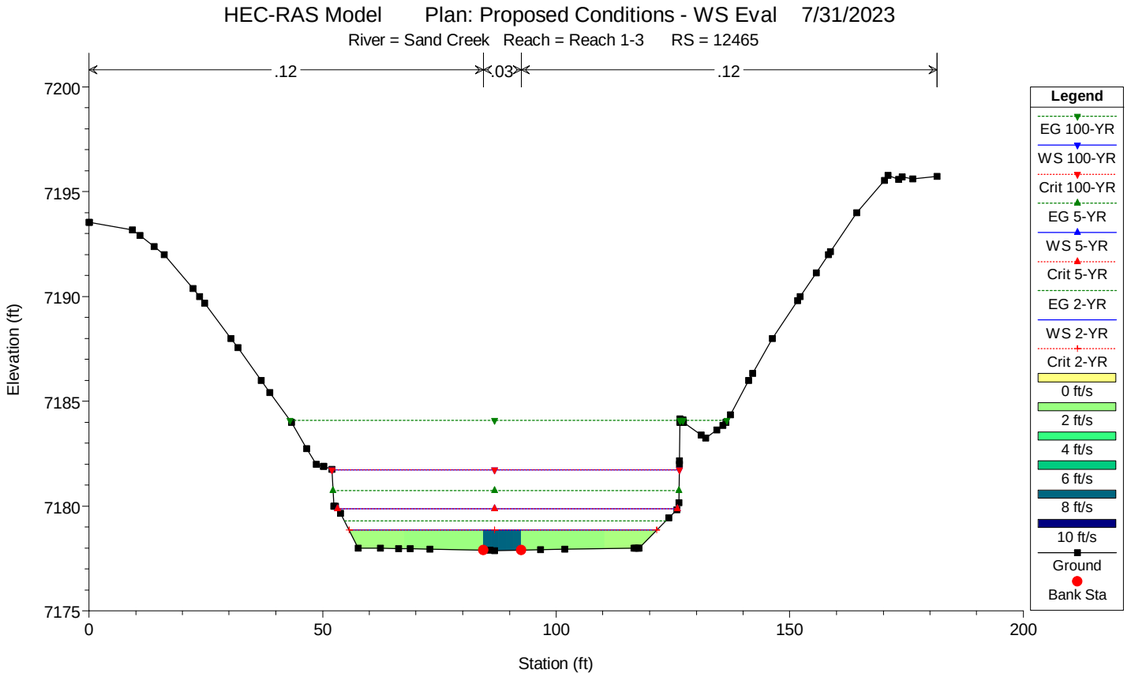


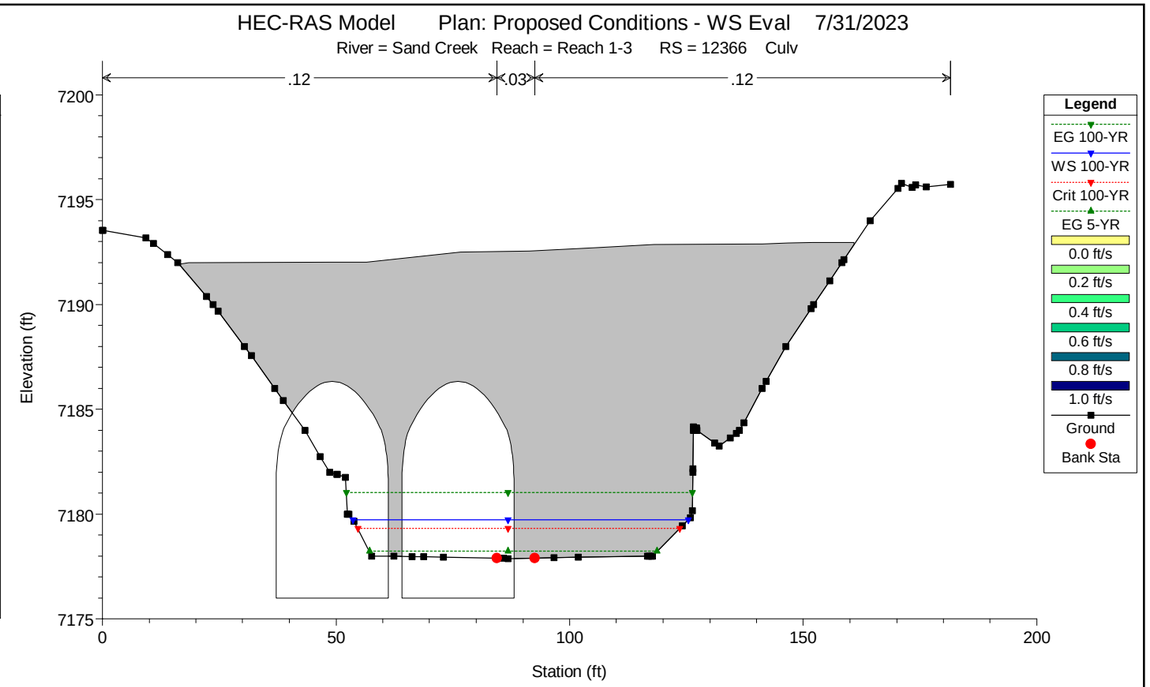
Created with GeoHECRAS v4.0.0.2094

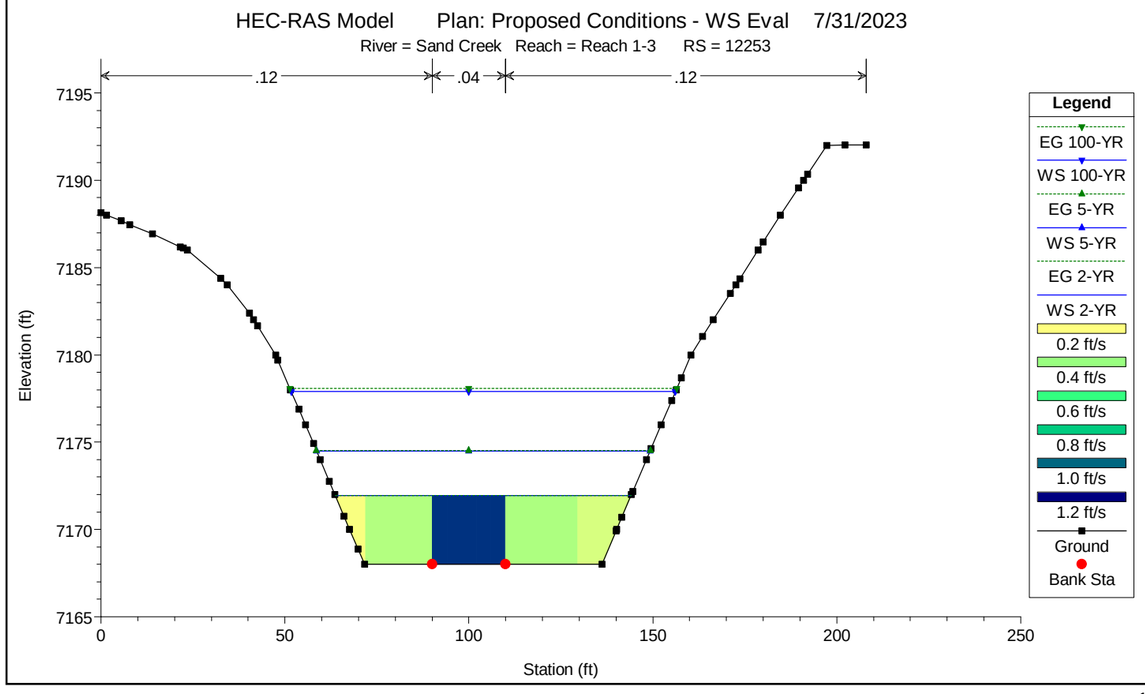
Subcritical flow analysis for Water Surface Evaluation of Naturalized Channel Design except FIS flow rate

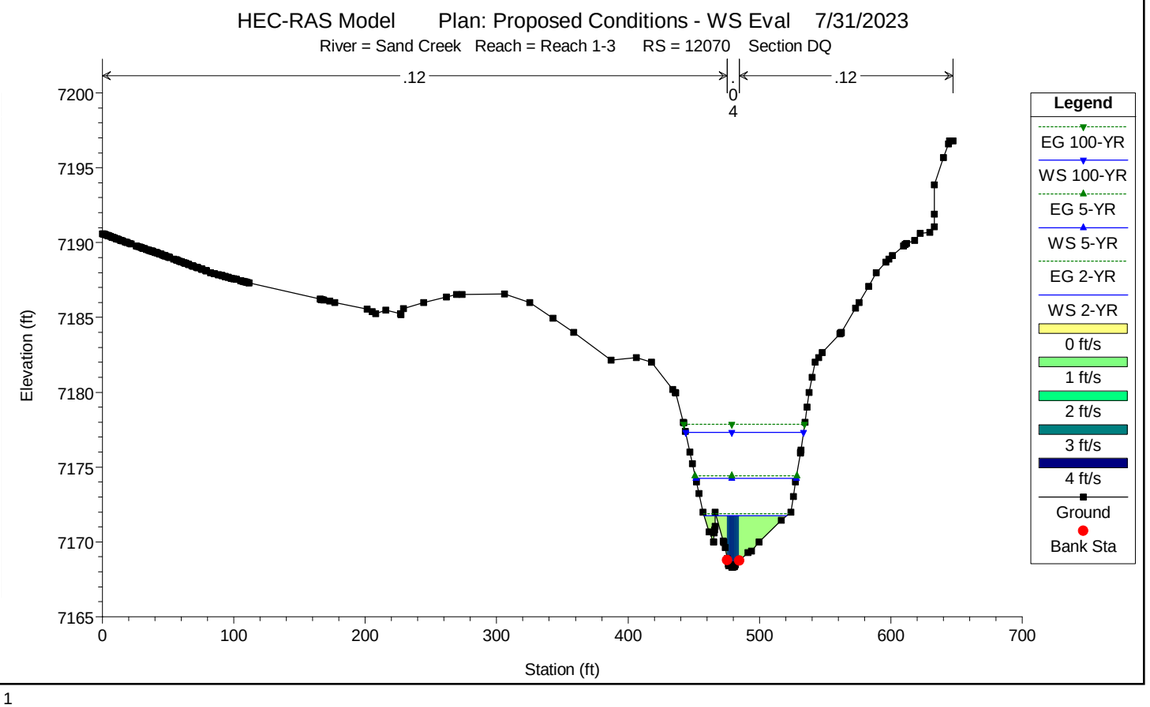


Subcritical flow analysis for Water Surface Evaluation of Naturalized Channel Design except FIS flow rate

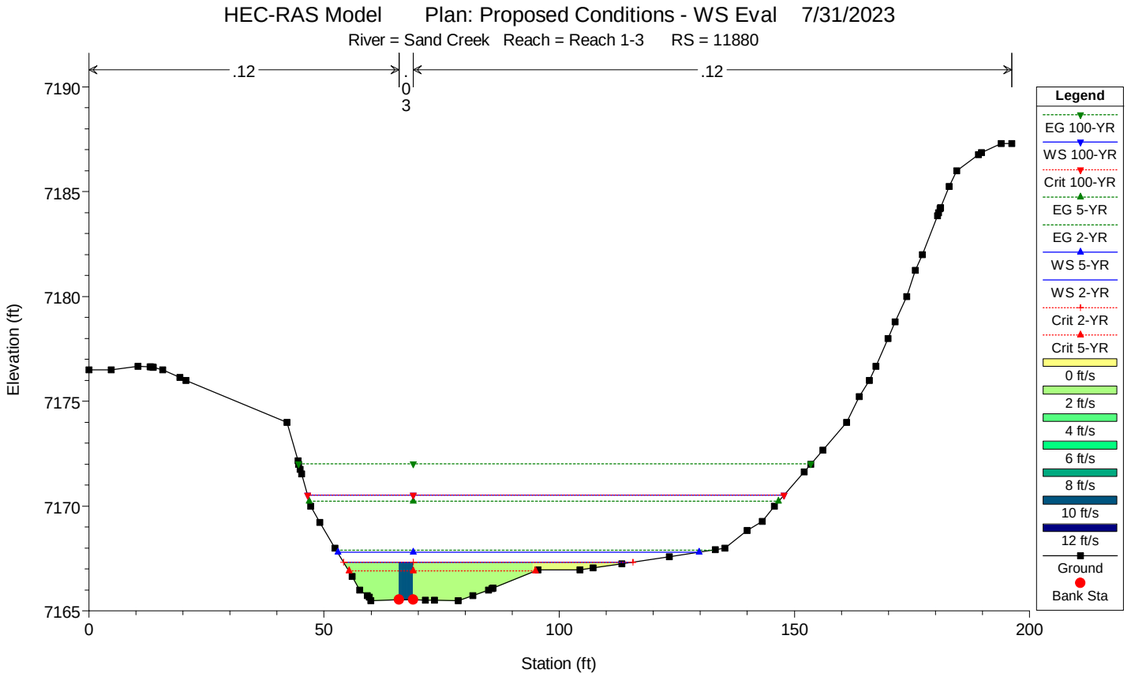


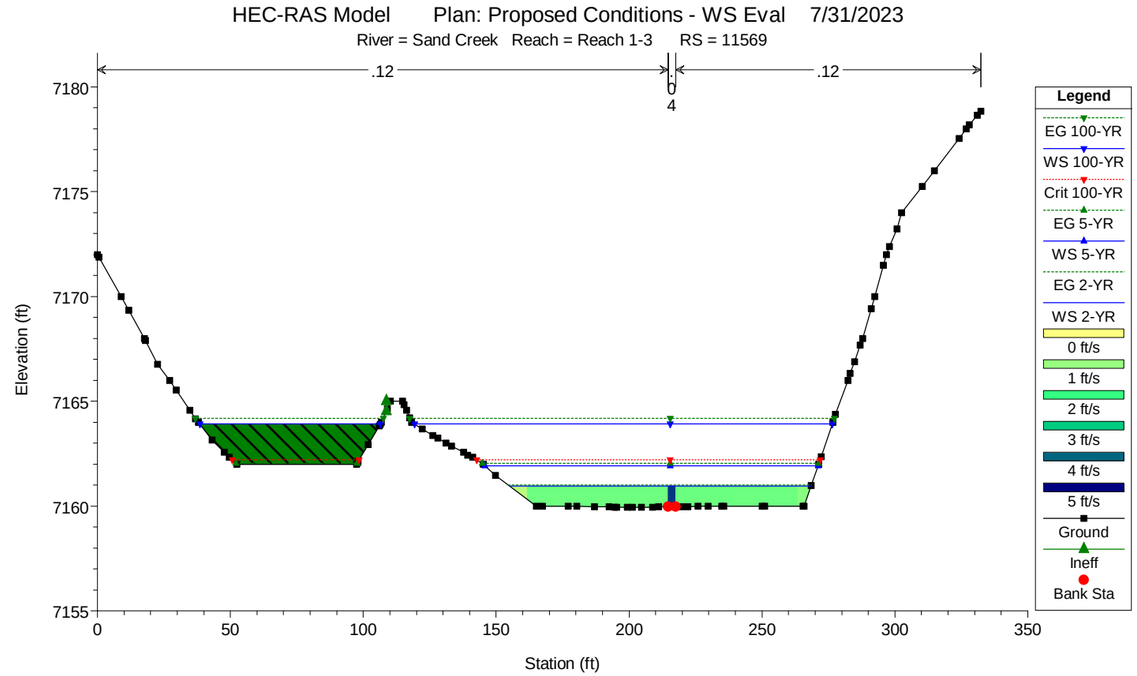


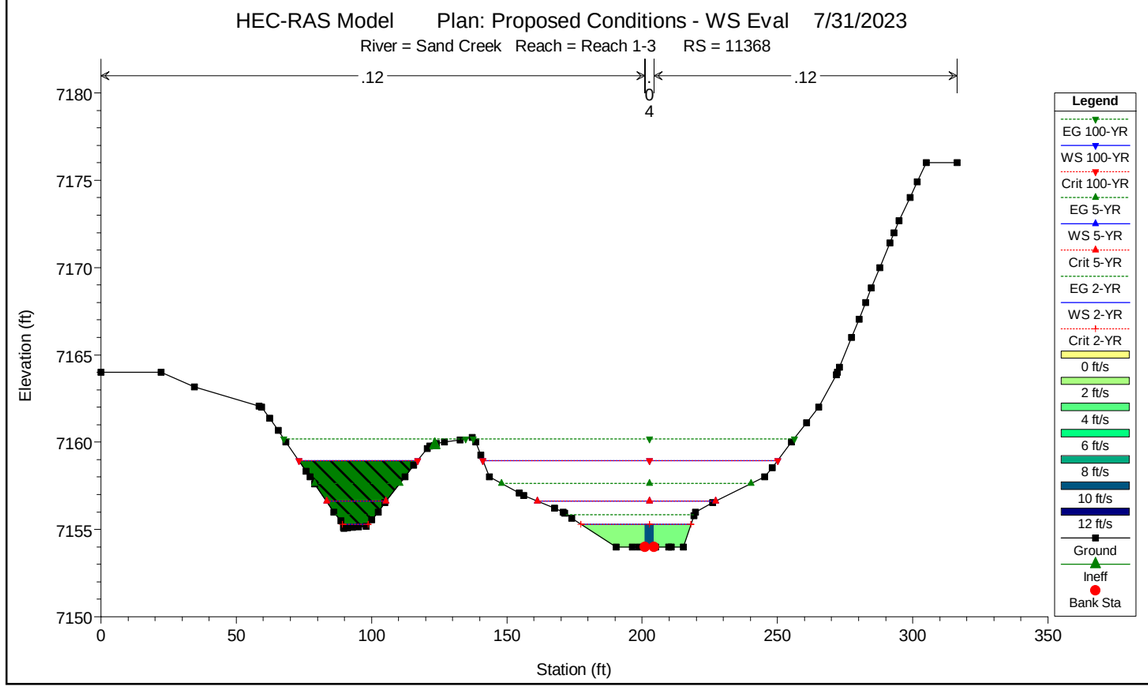


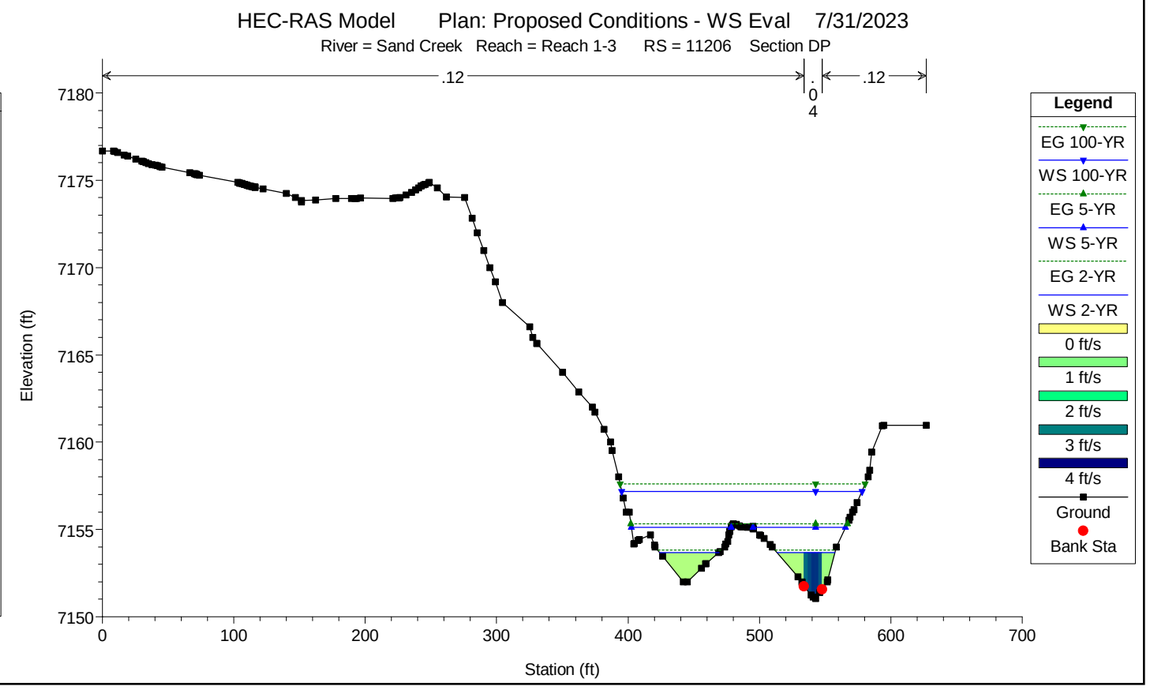


Subcritical flow analysis for Water Surface Evaluation of Naturalized Channel Design except FIS flow rate

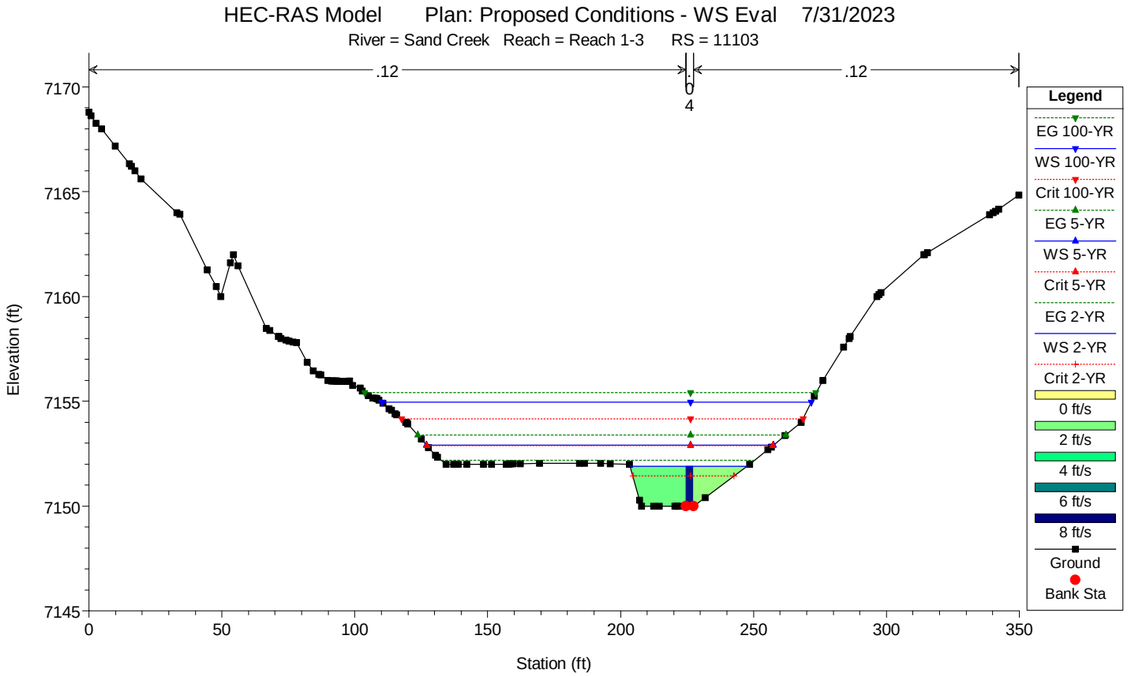


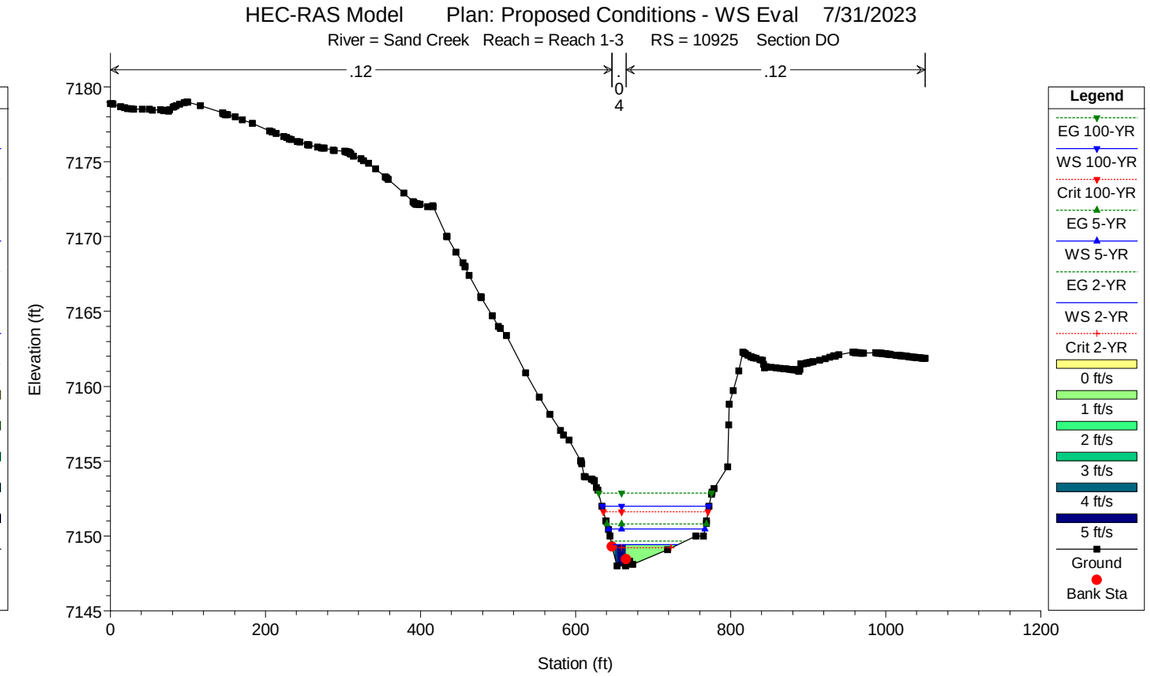


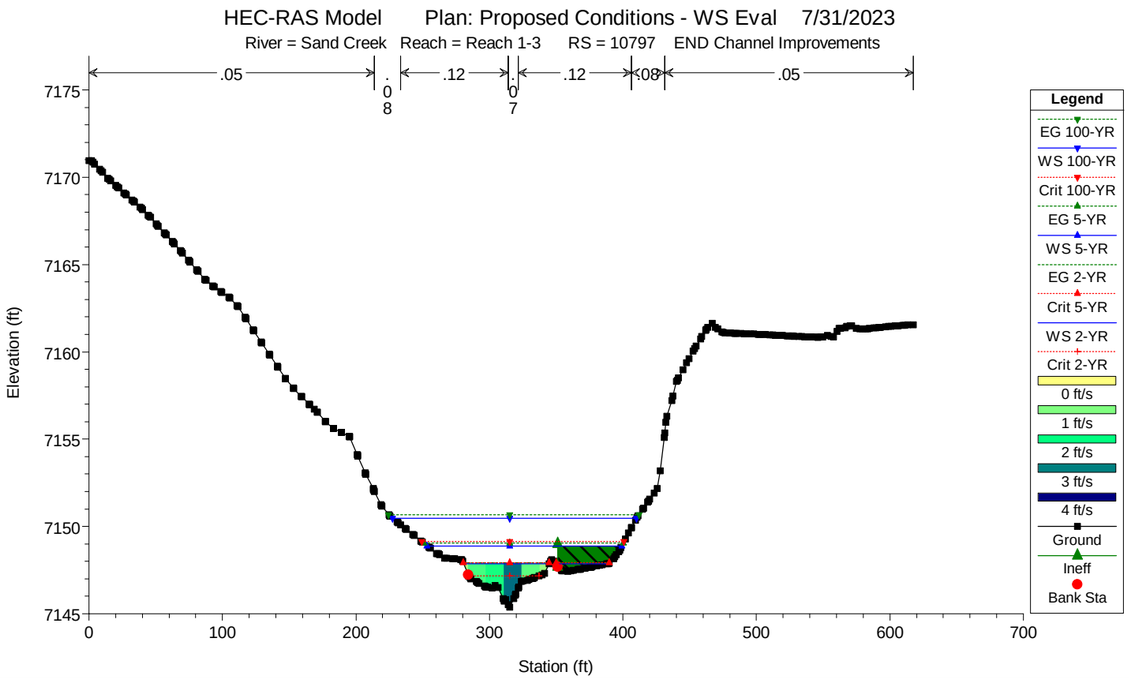


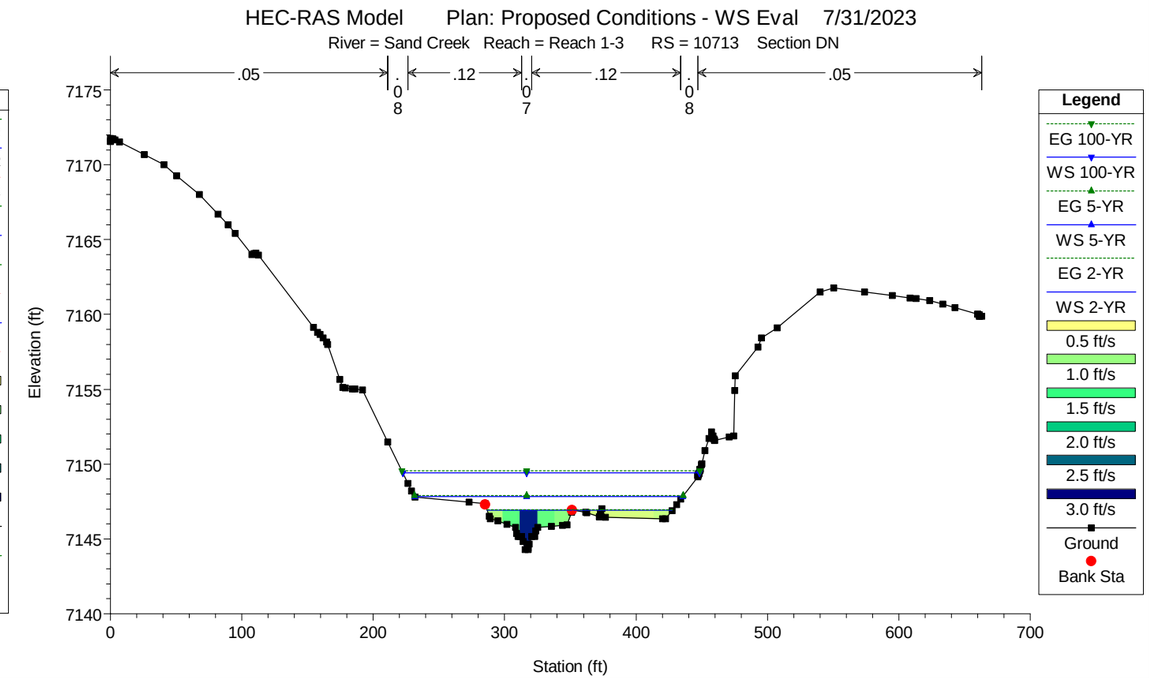


Subcritical flow analysis for Water Surface Evaluation of Naturalized Channel Design except FIS flow rate

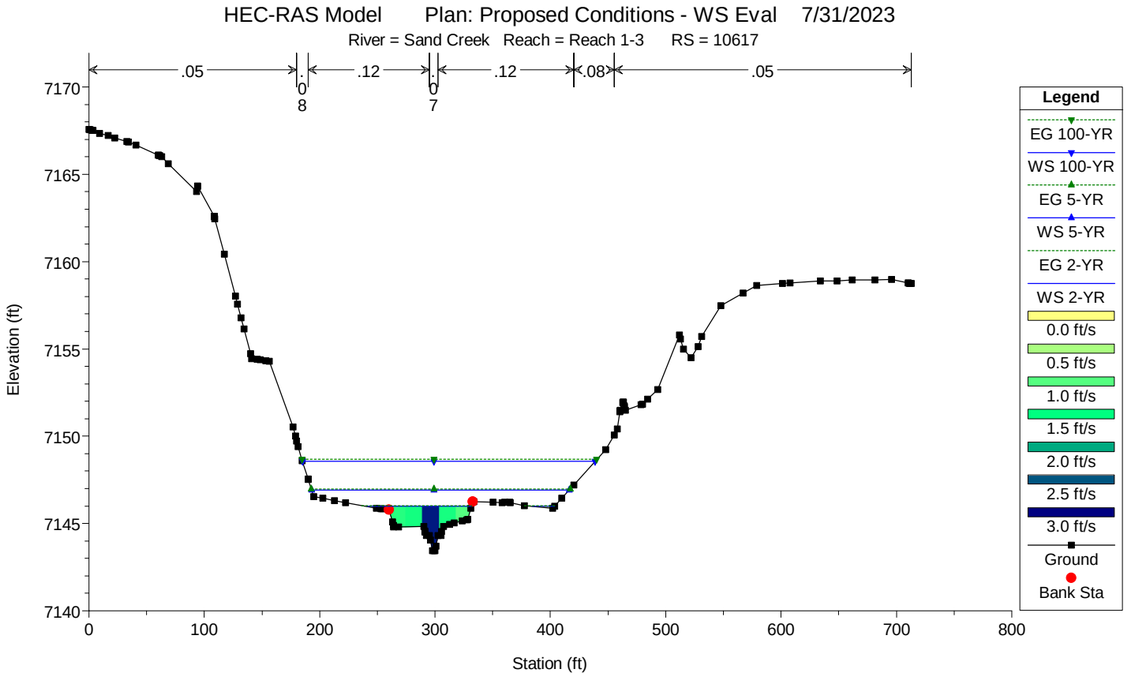


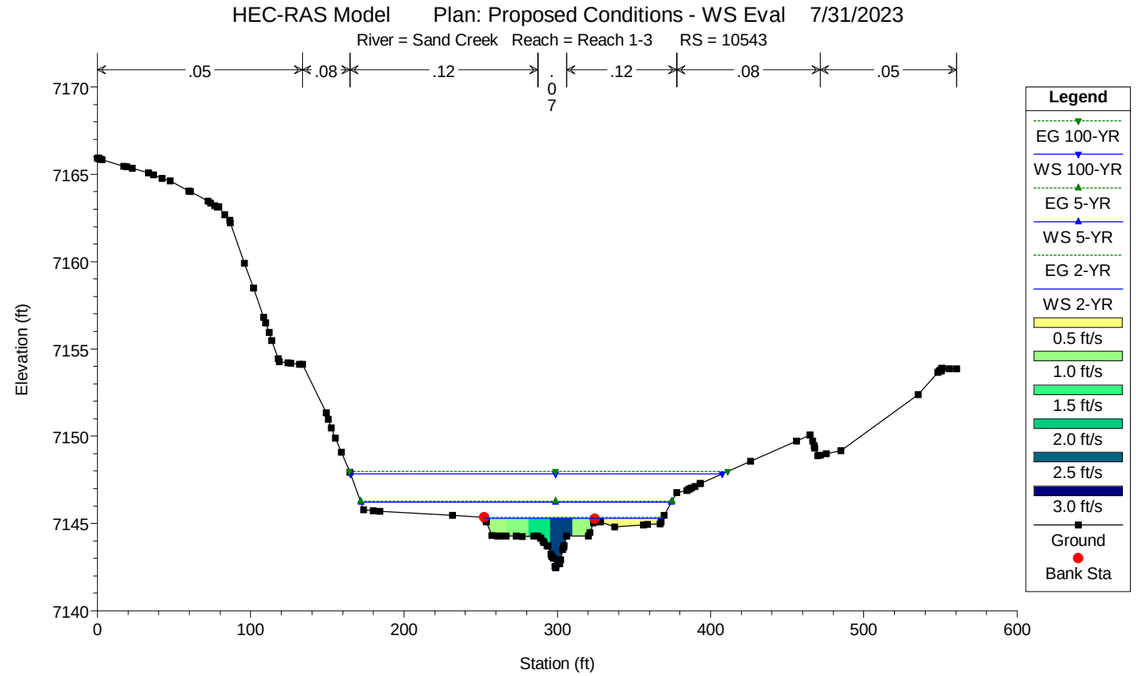


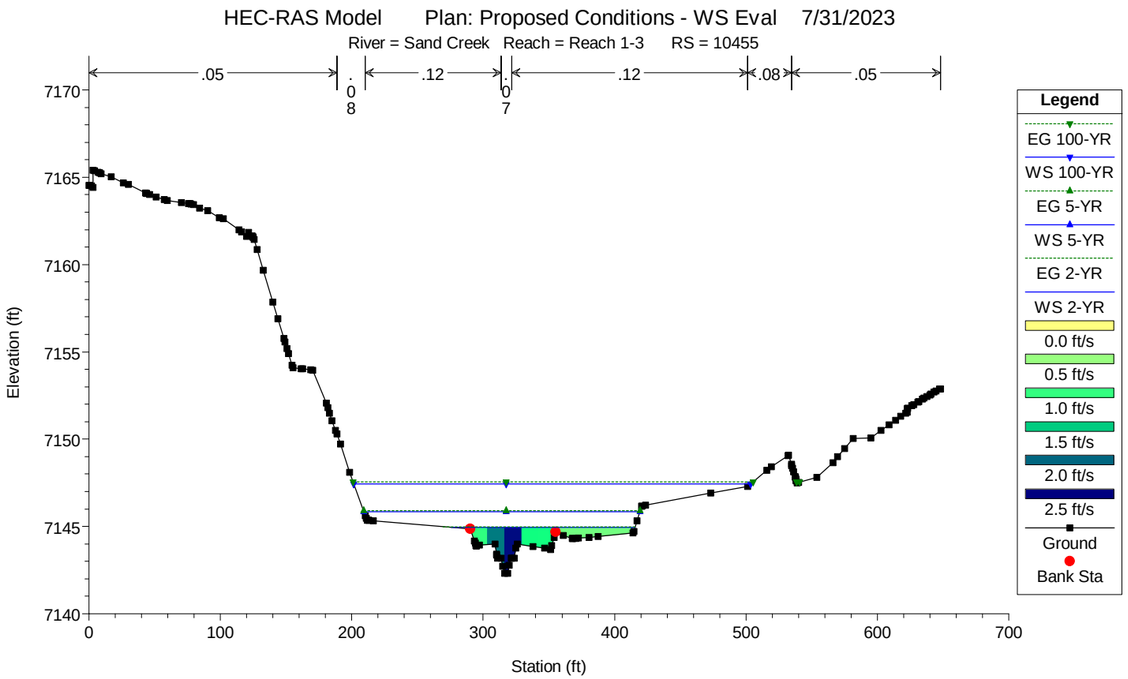


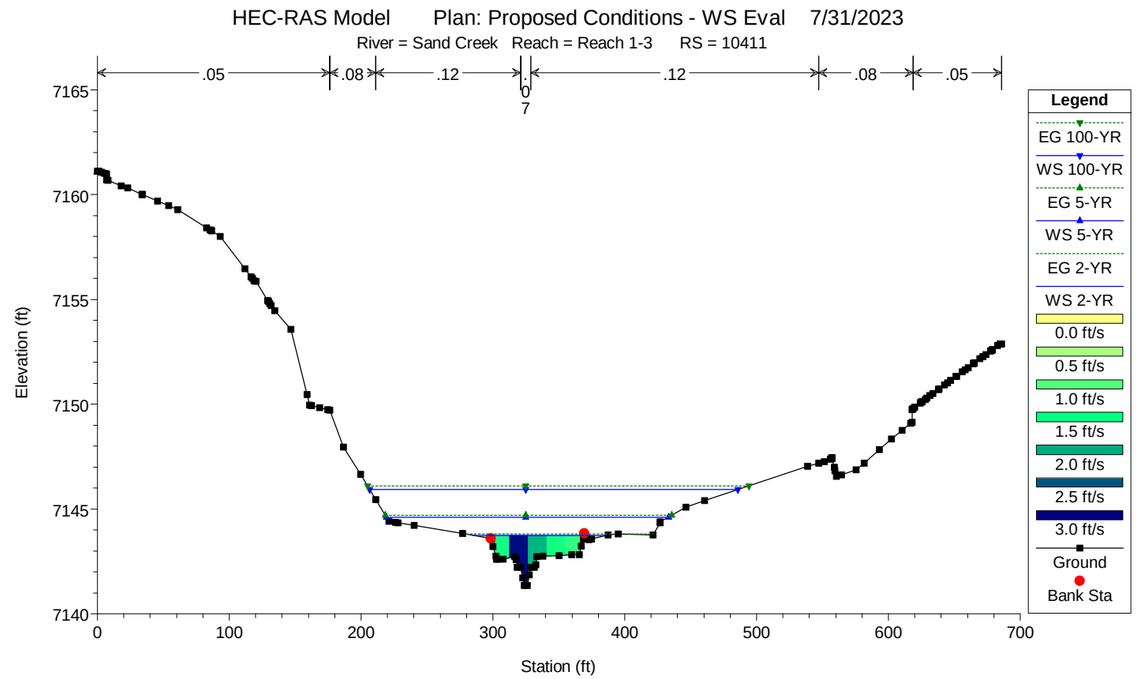


Subcritical flow analysis for Water Surface Evaluation of Naturalized Channel Design except FIS flow rate

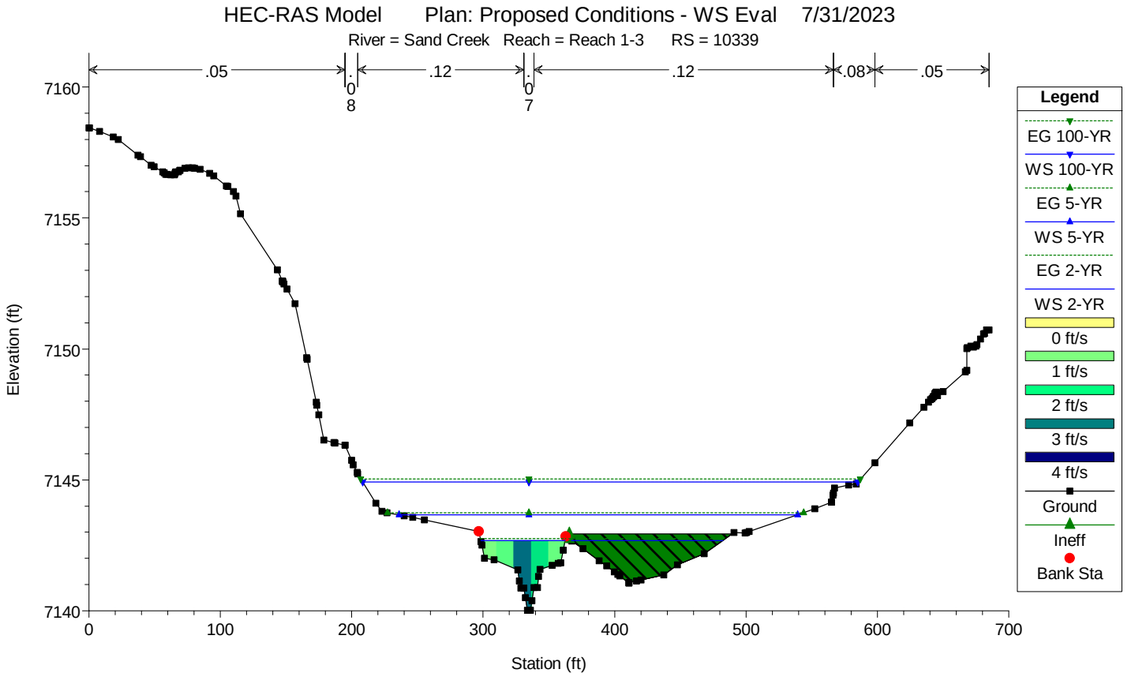


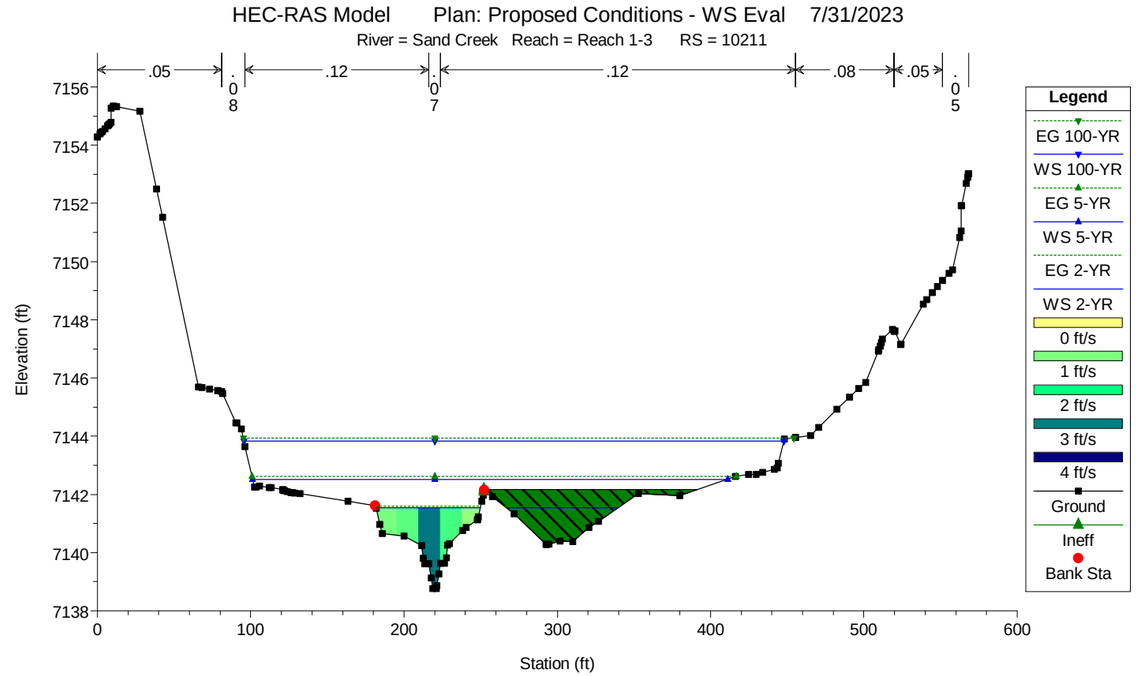


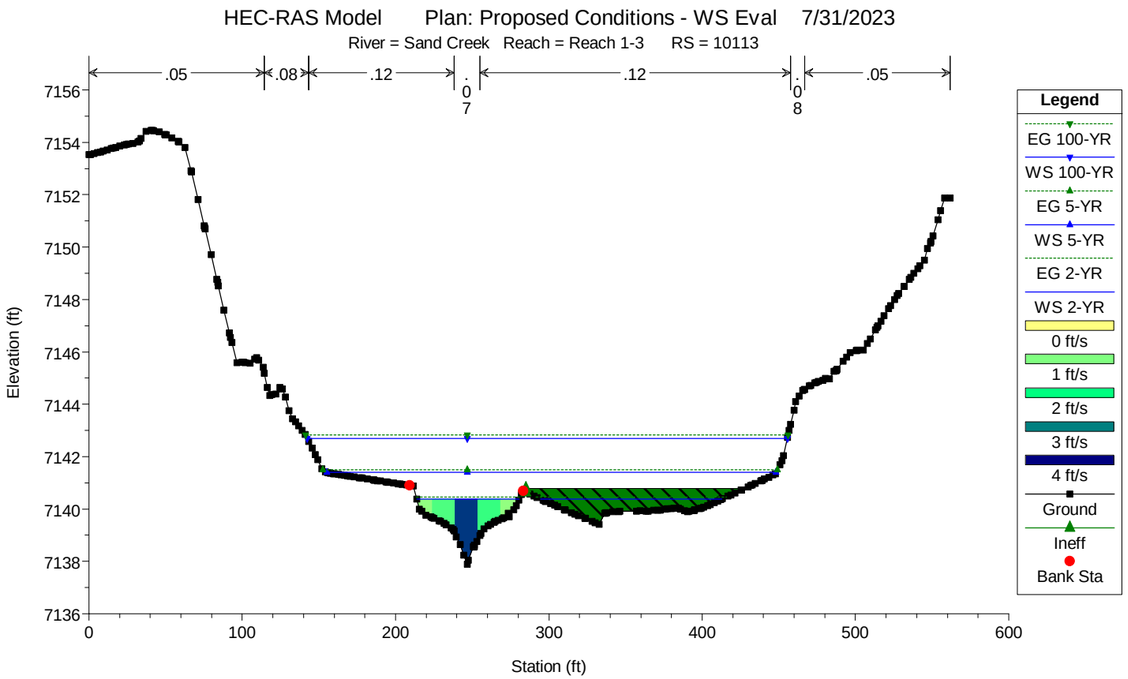


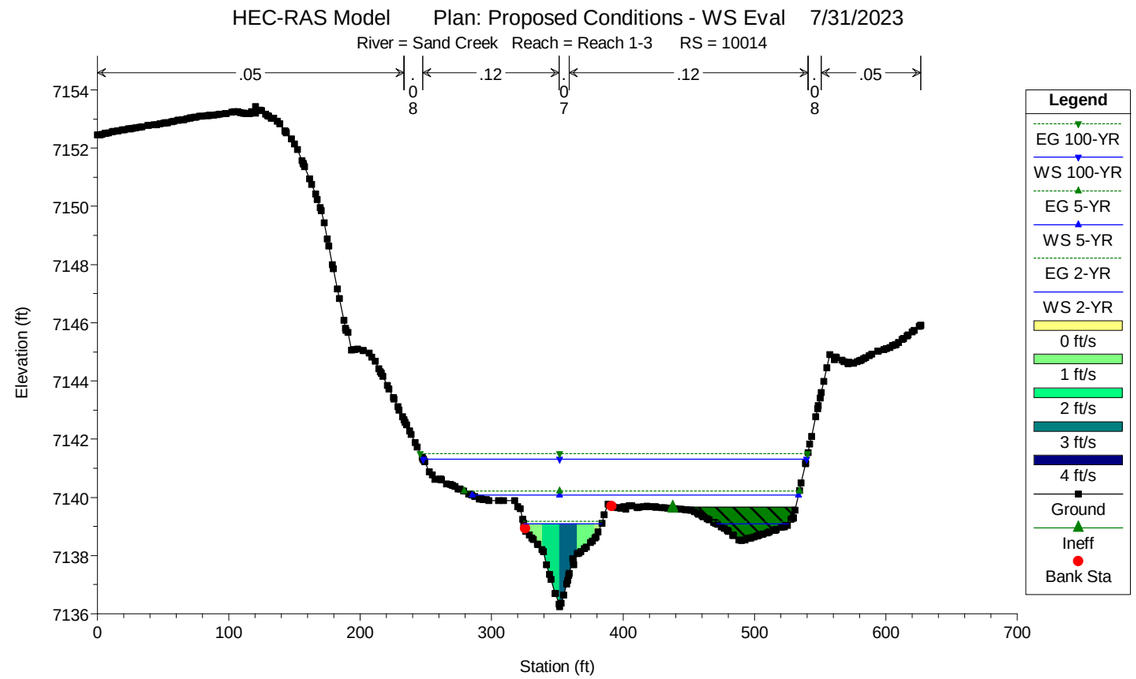


Subcritical flow analysis for Water Surface Evaluation of Naturalized Channel Design except FIS flow rate

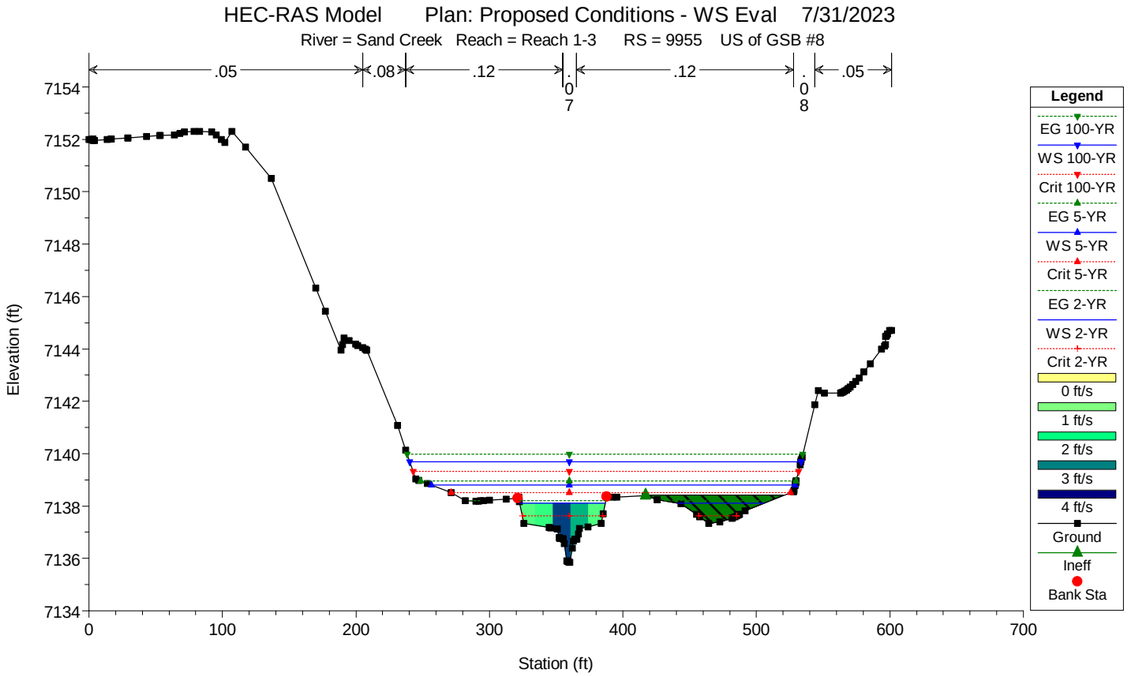


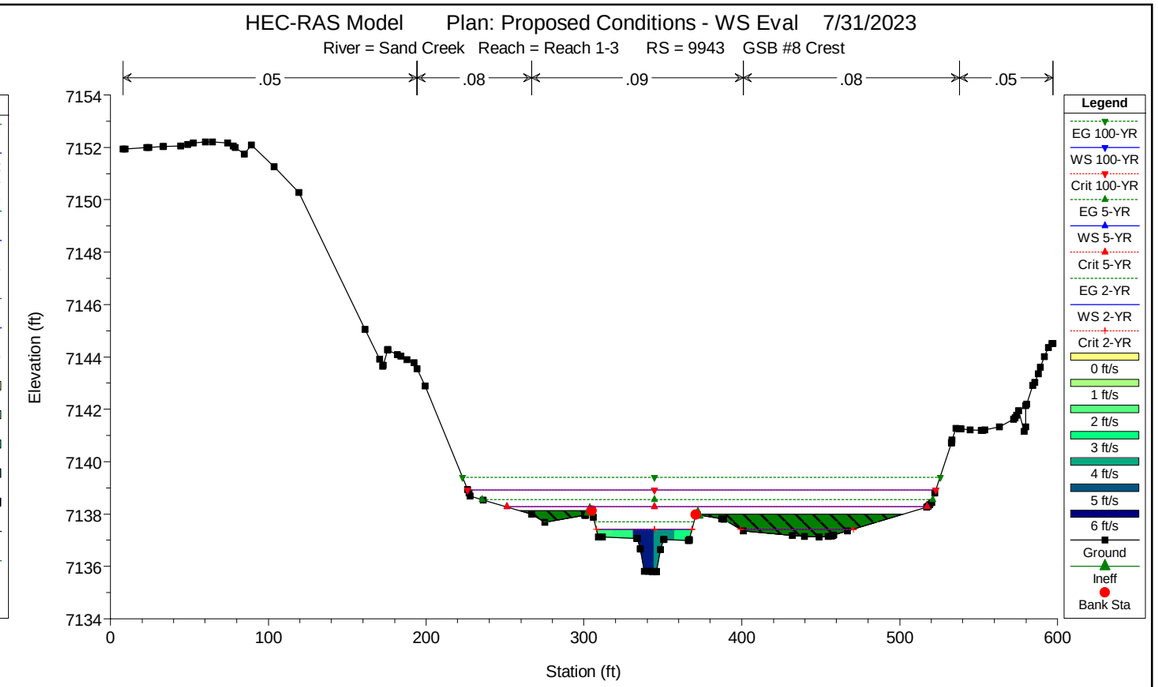


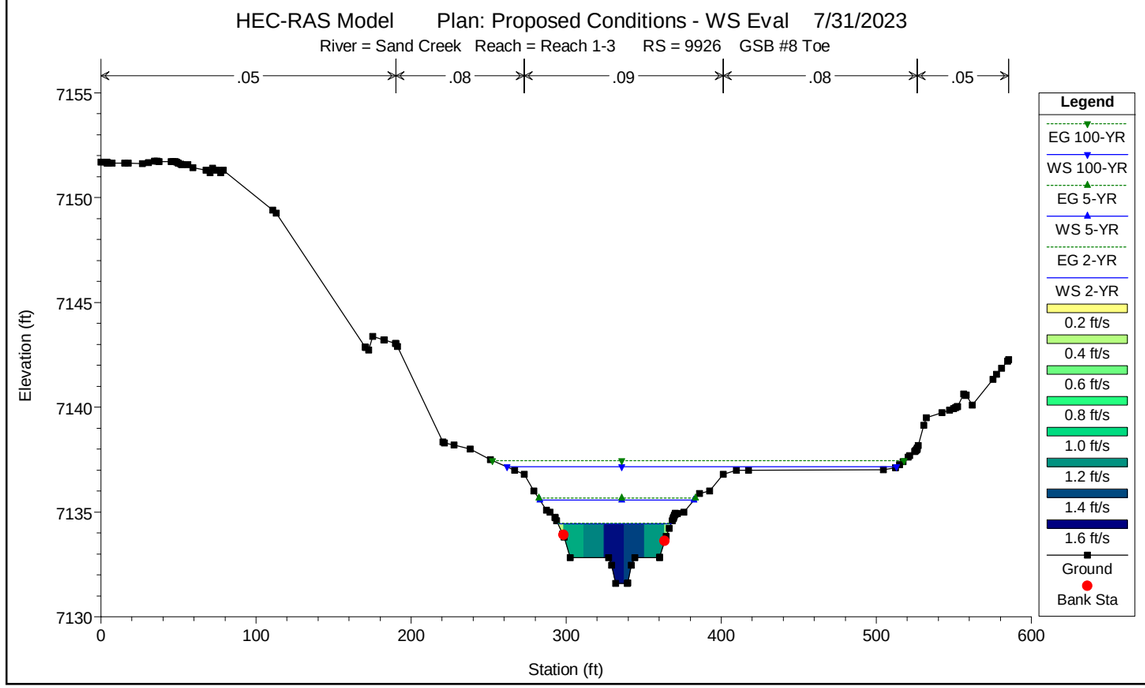


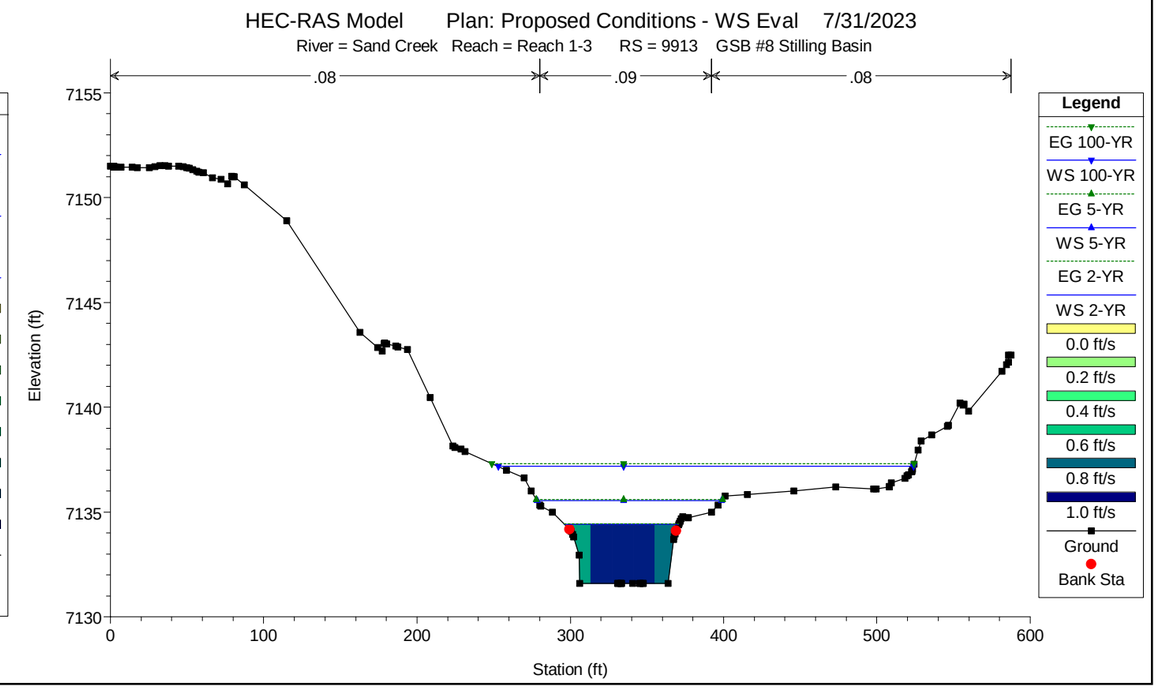


Subcritical flow analysis for Water Surface Evaluation of Naturalized Channel Design except FIS flow rate

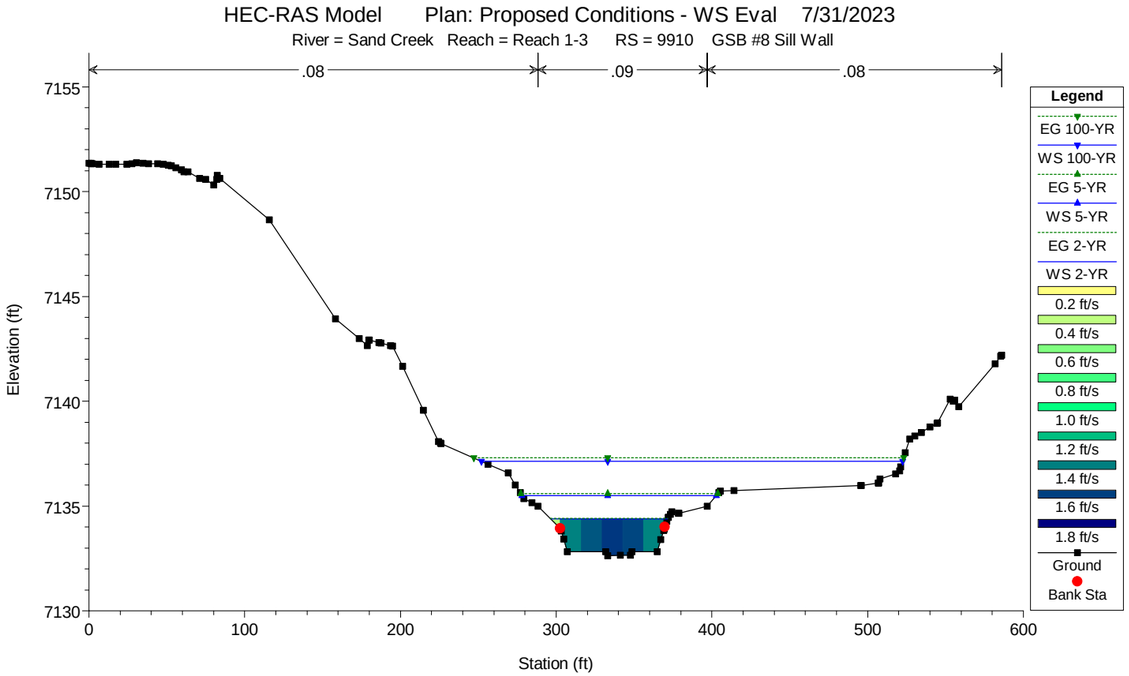


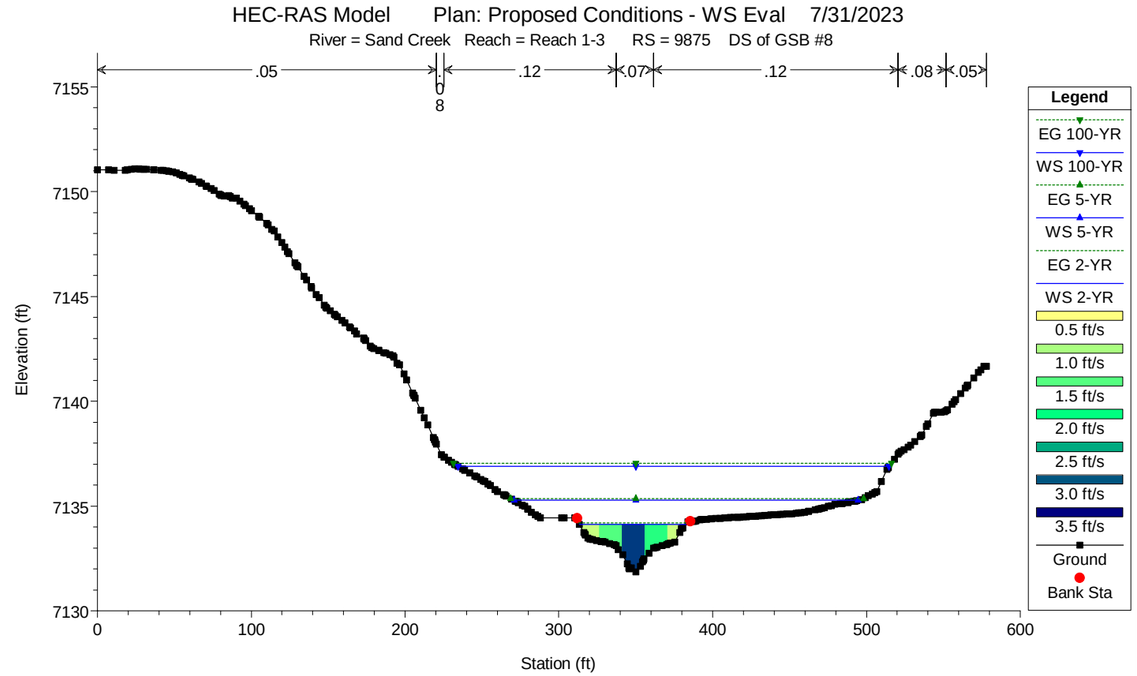


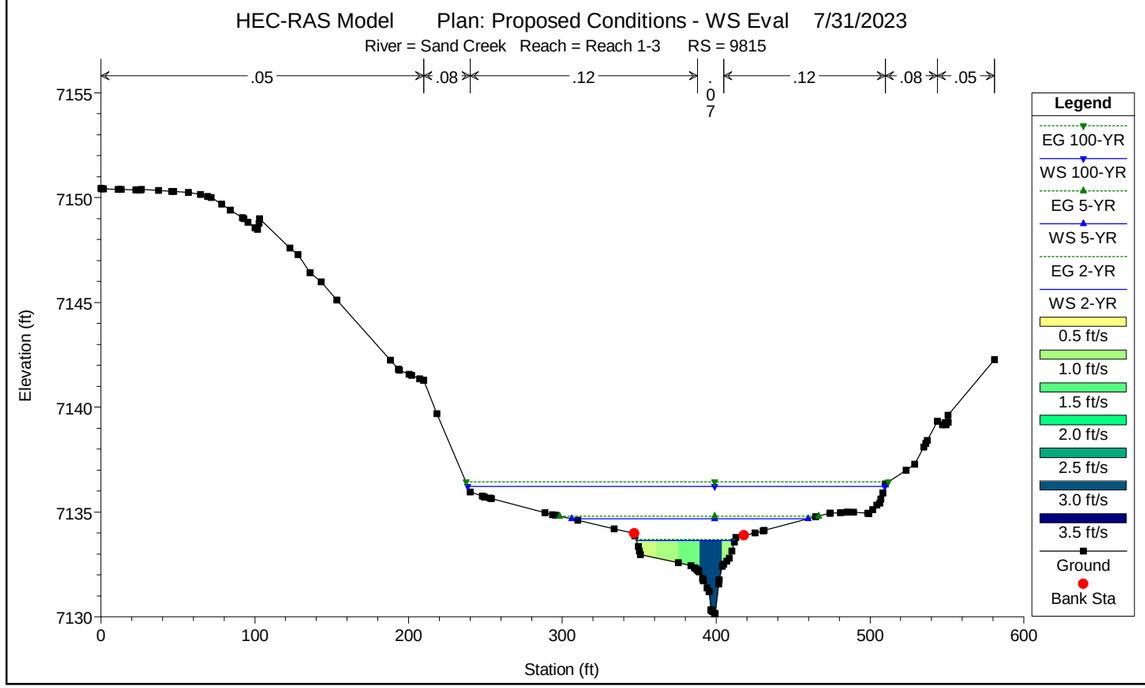


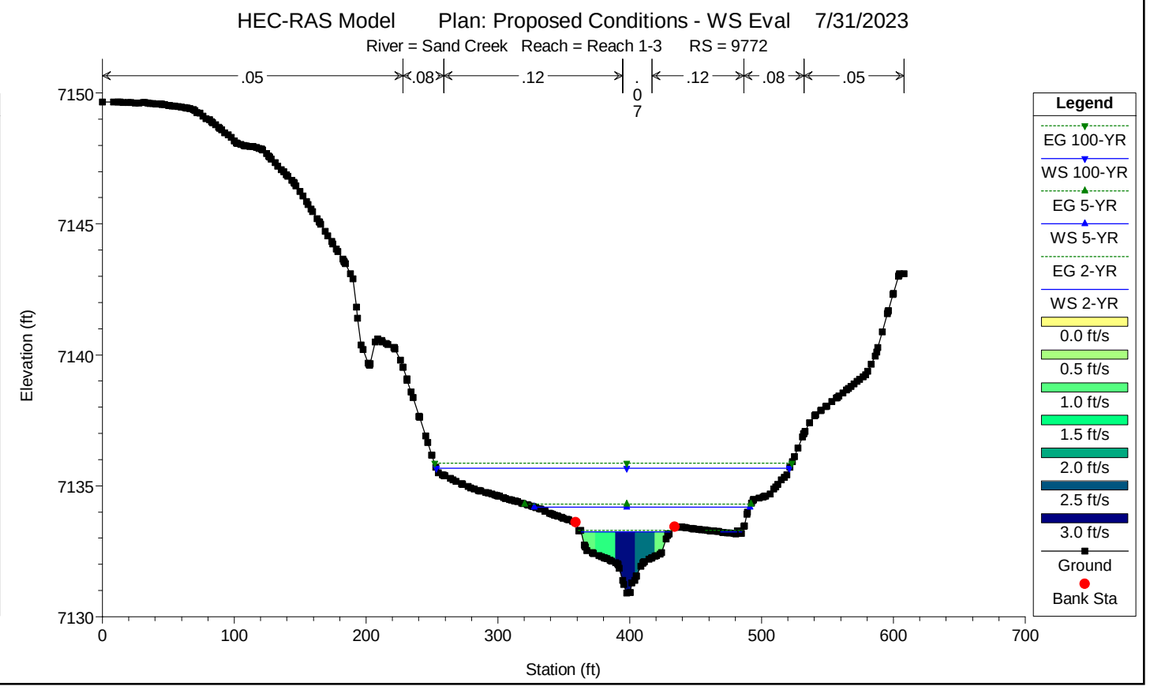


Subcritical flow analysis for Water Surface Evaluation of Naturalized Channel Design except FIS flow rate

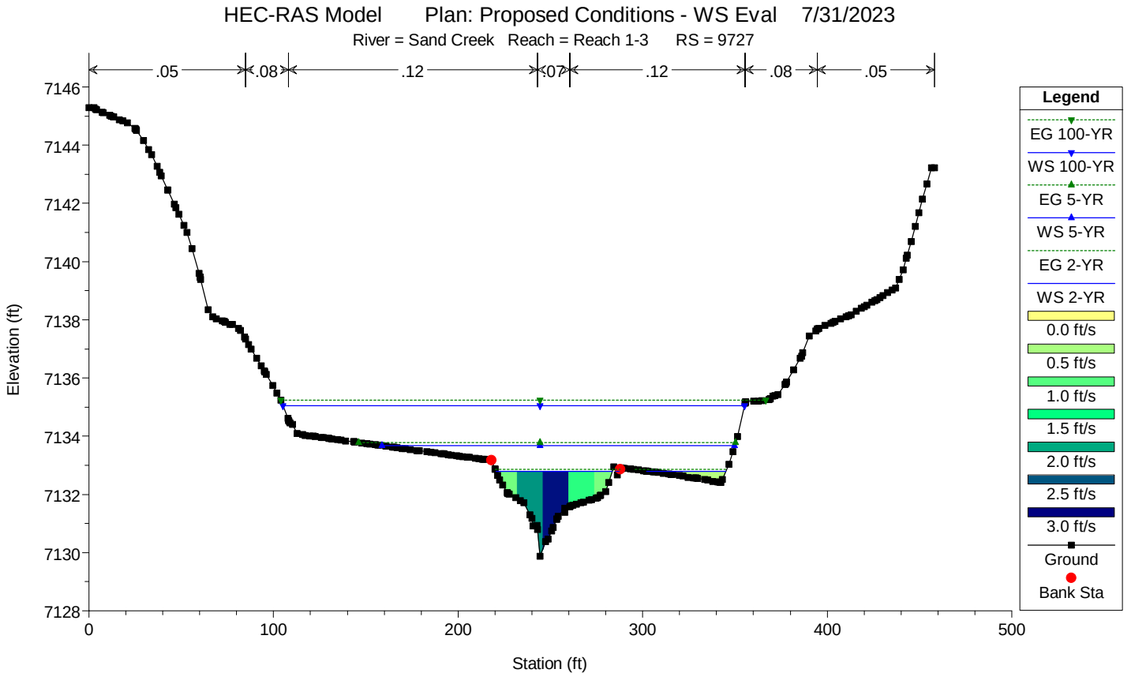


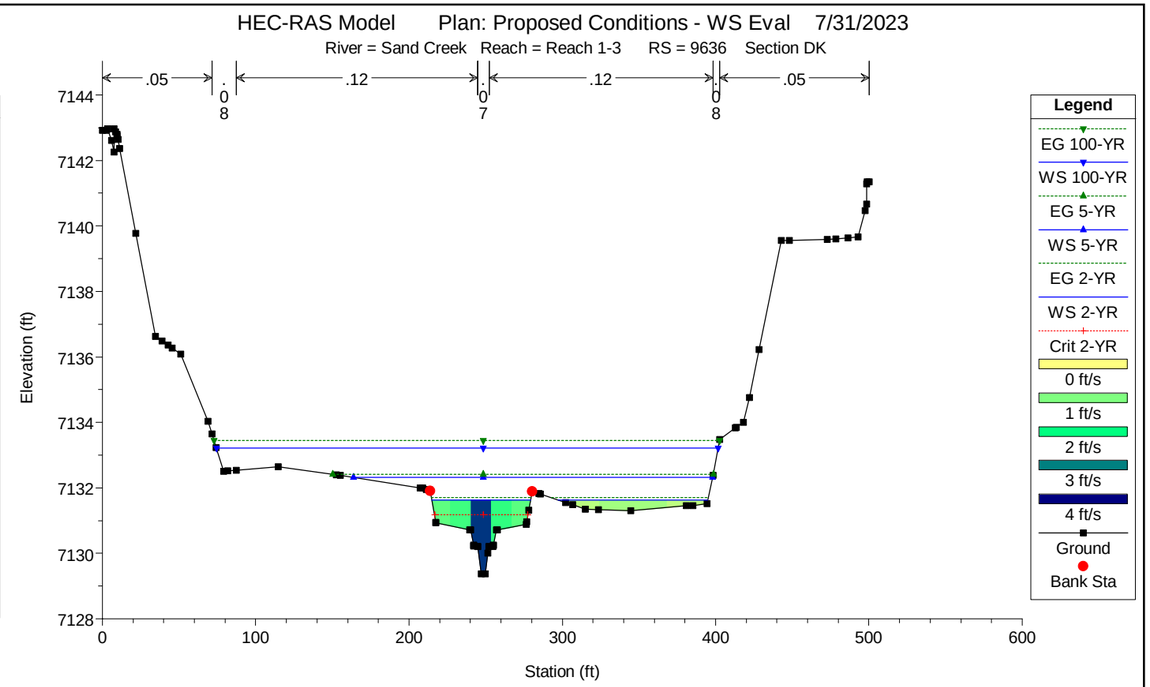


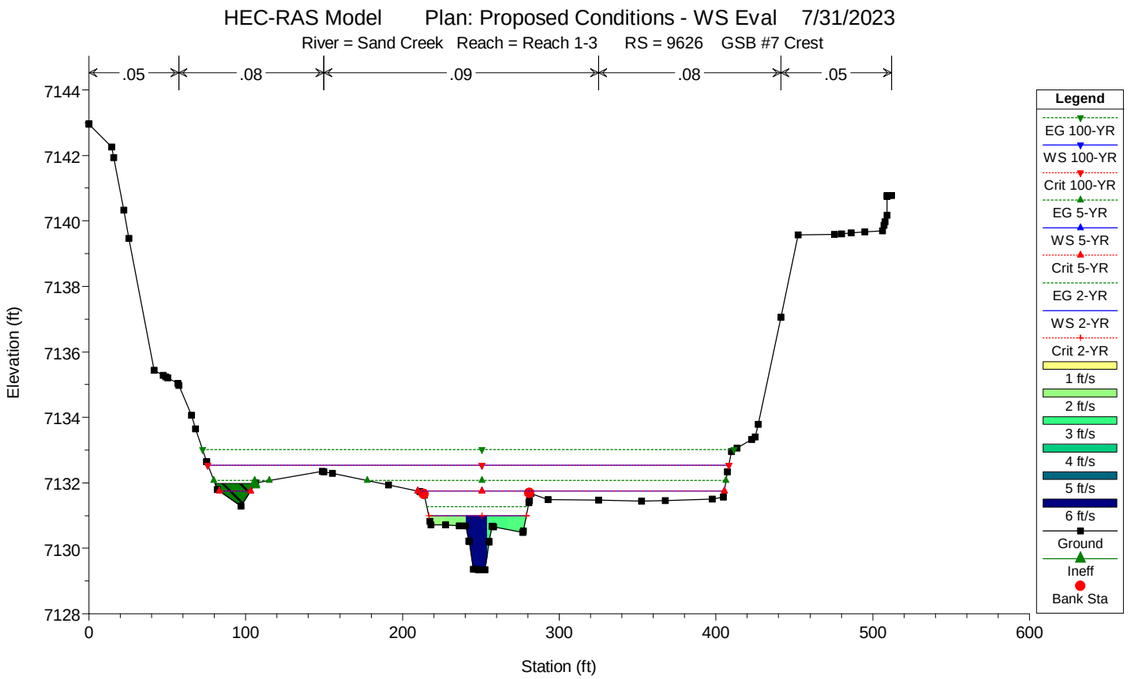


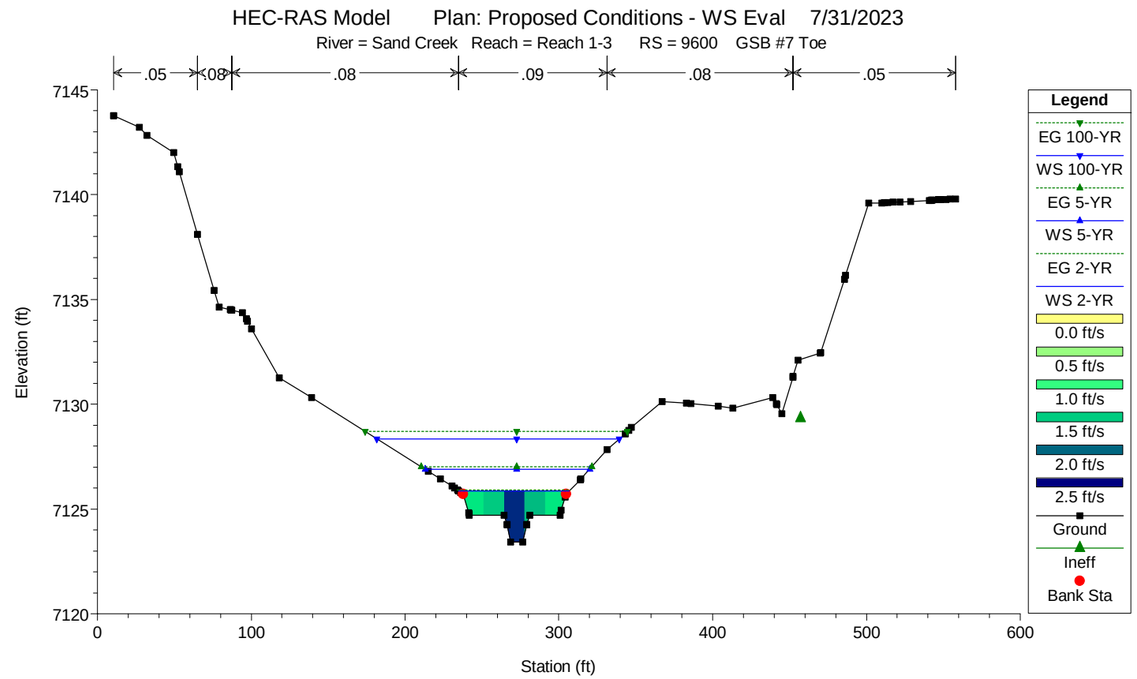


Subcritical flow analysis for Water Surface Evaluation of Naturalized Channel Design except FIS flow rate

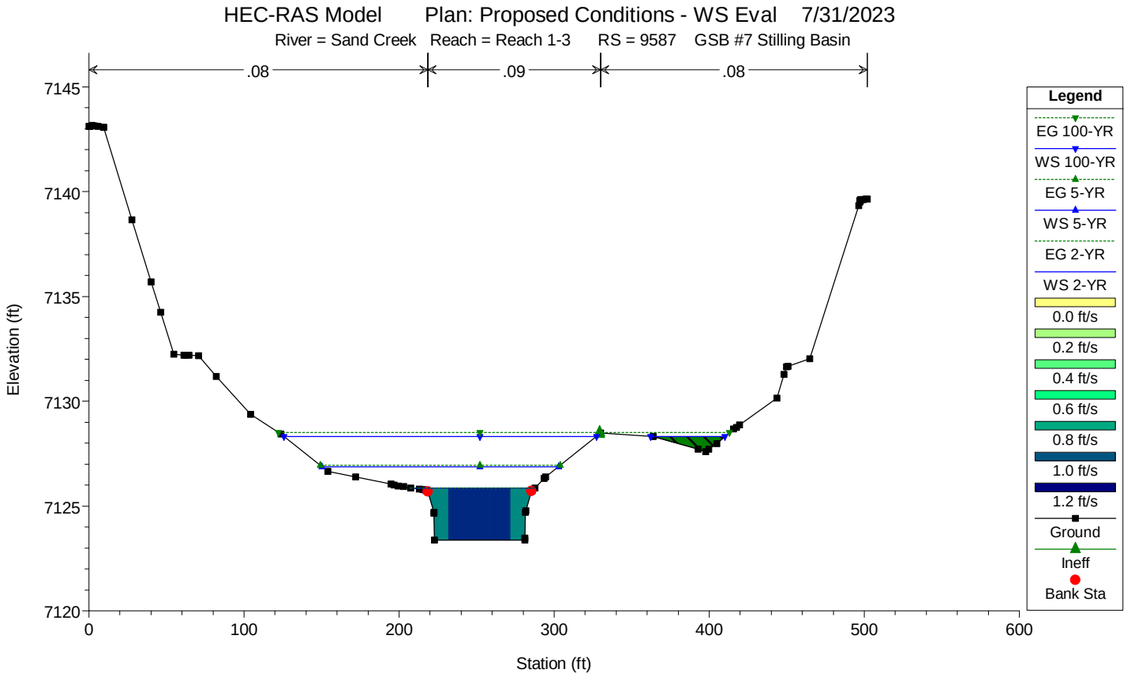


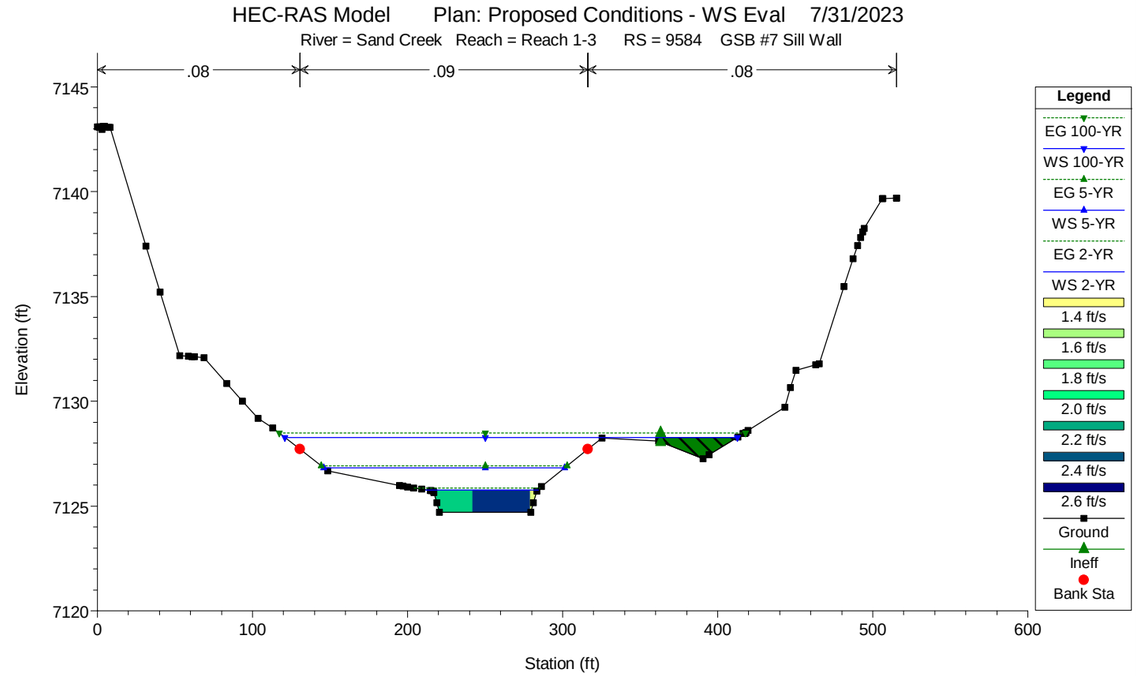


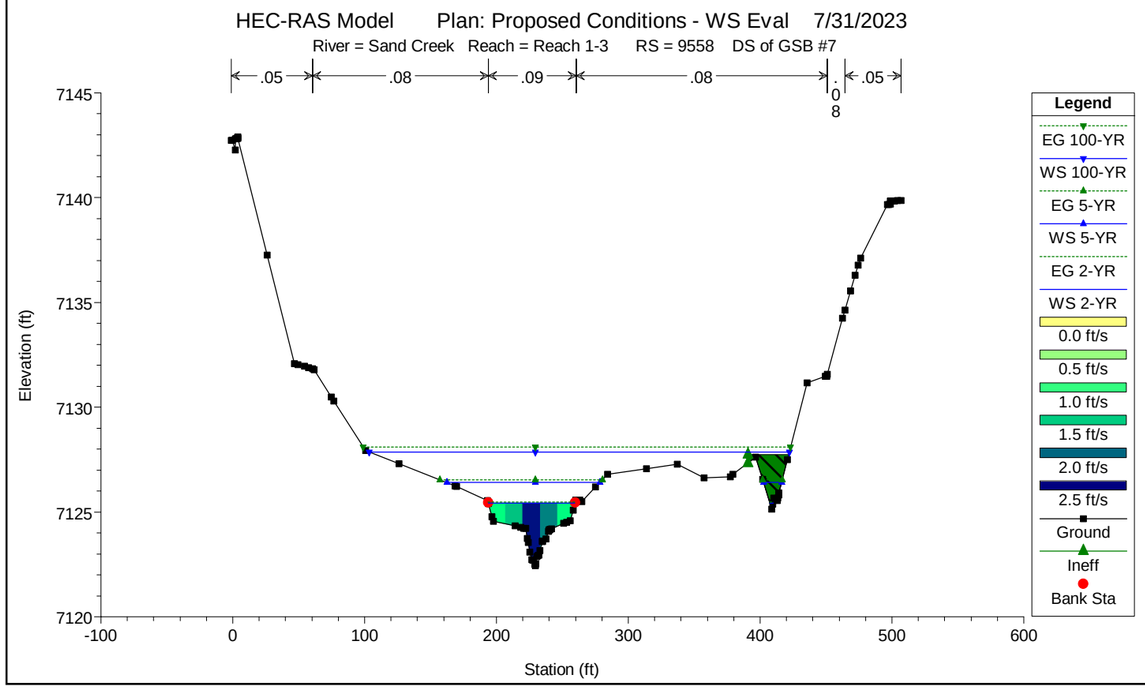


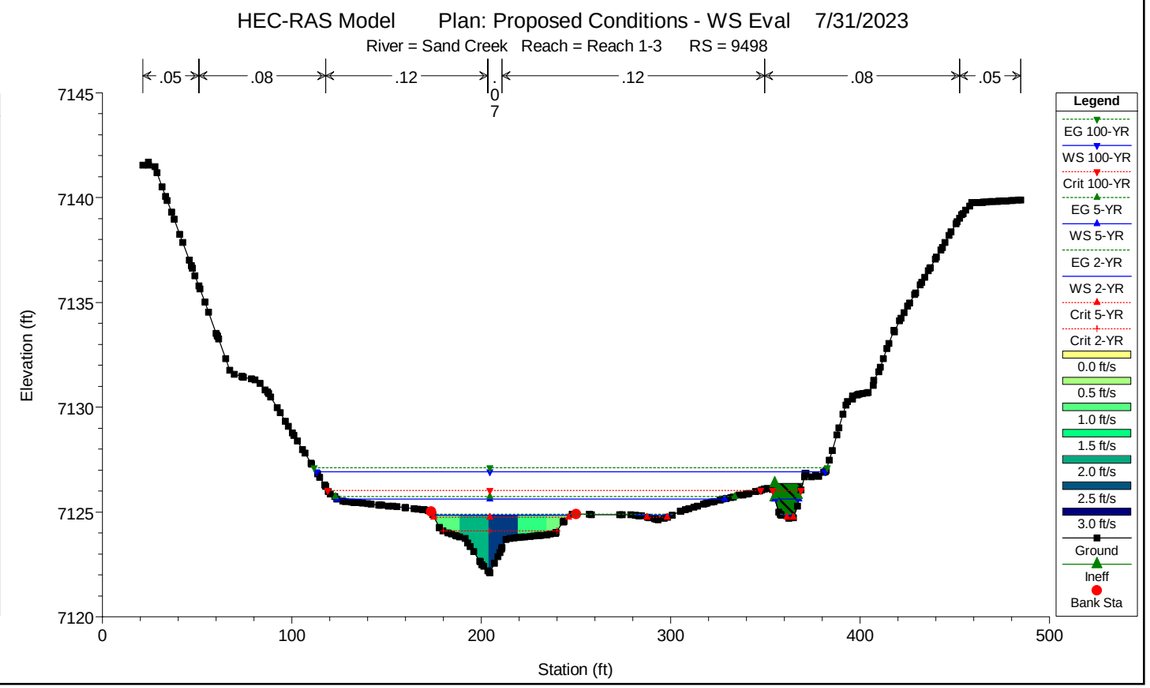


Subcritical flow analysis for Water Surface Evaluation of Naturalized Channel Design except FIS flow rate

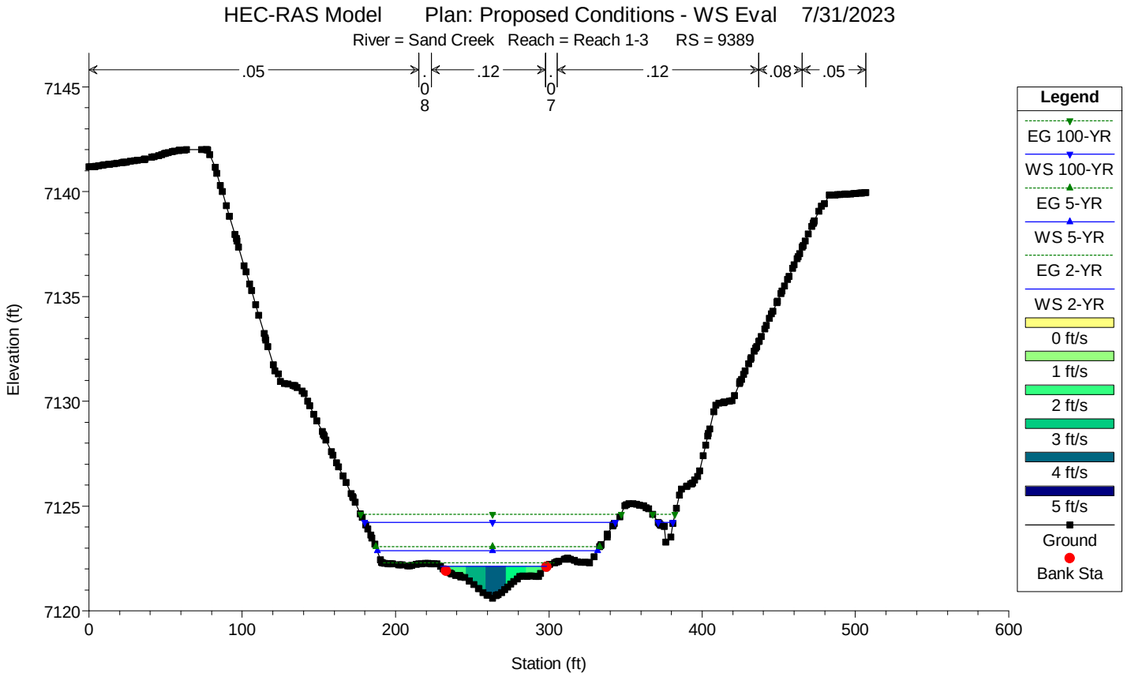


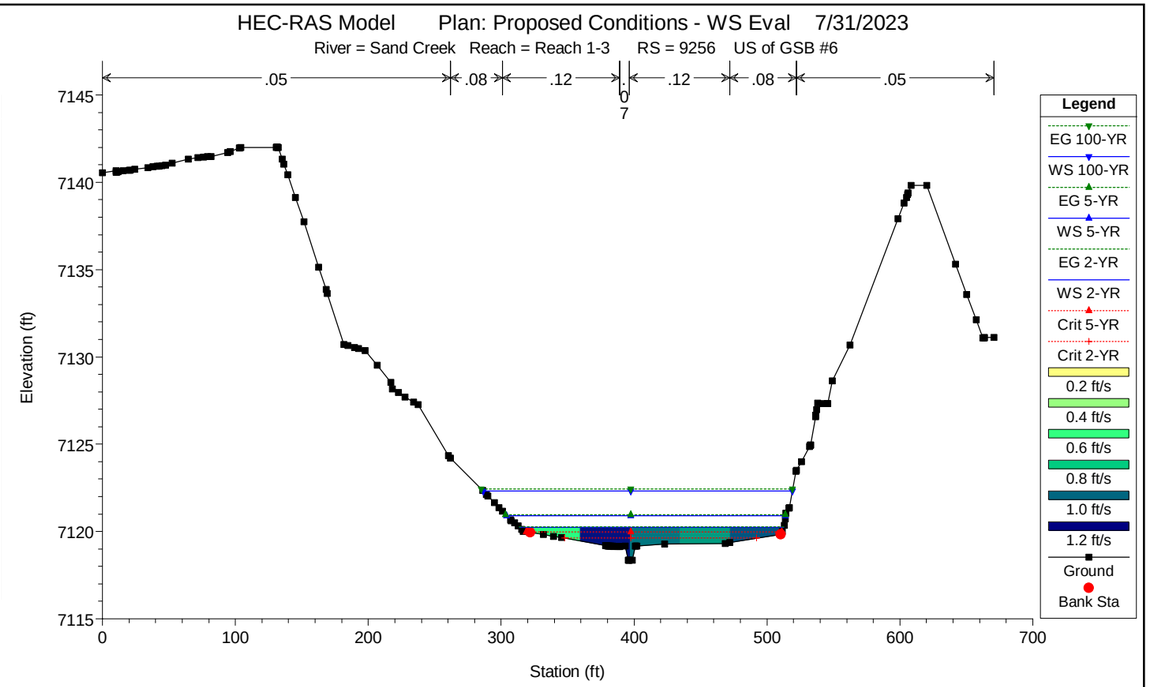


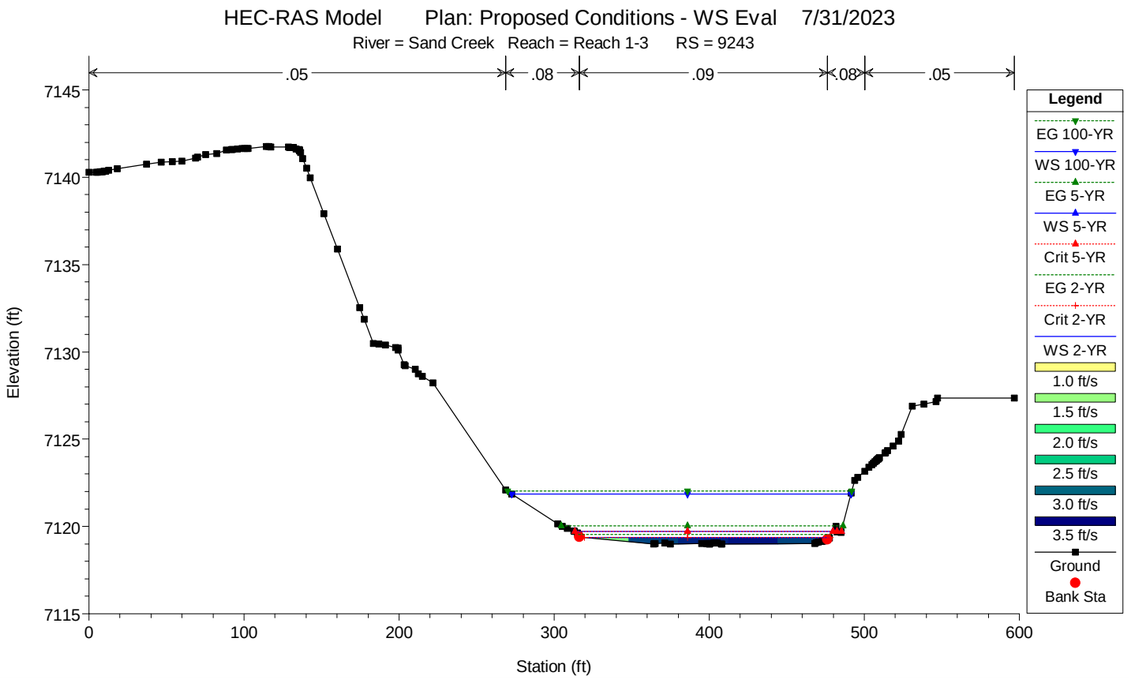


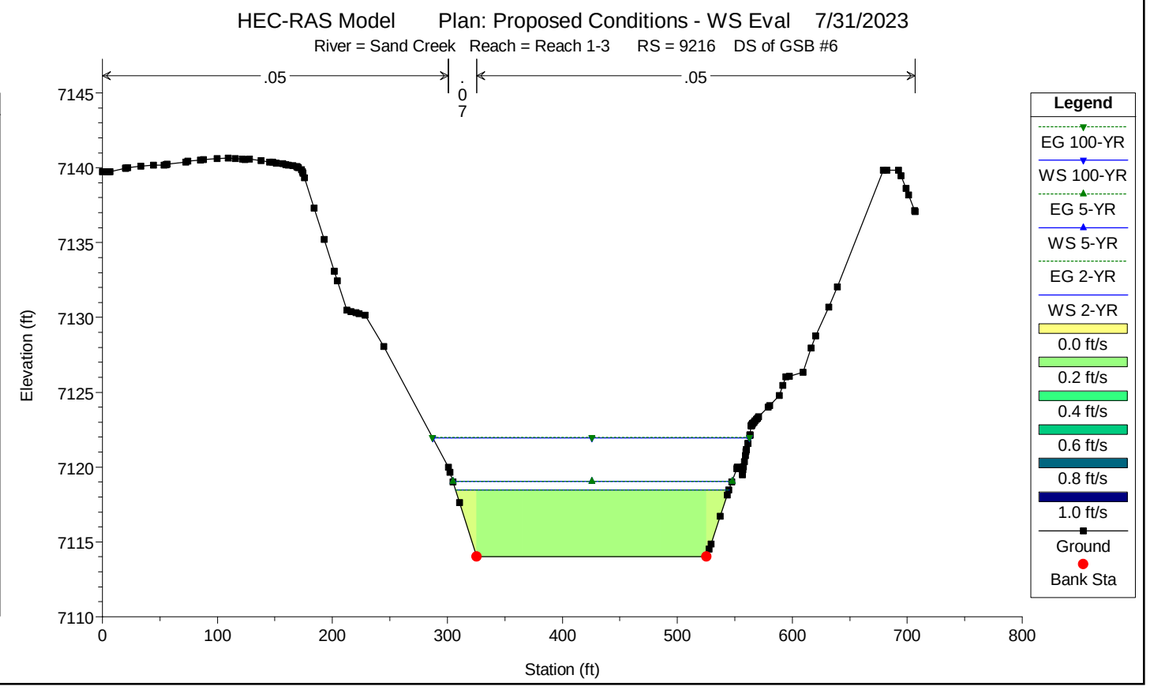


Subcritical flow analysis for Water Surface Evaluation of Naturalized Channel Design except FIS flow rate

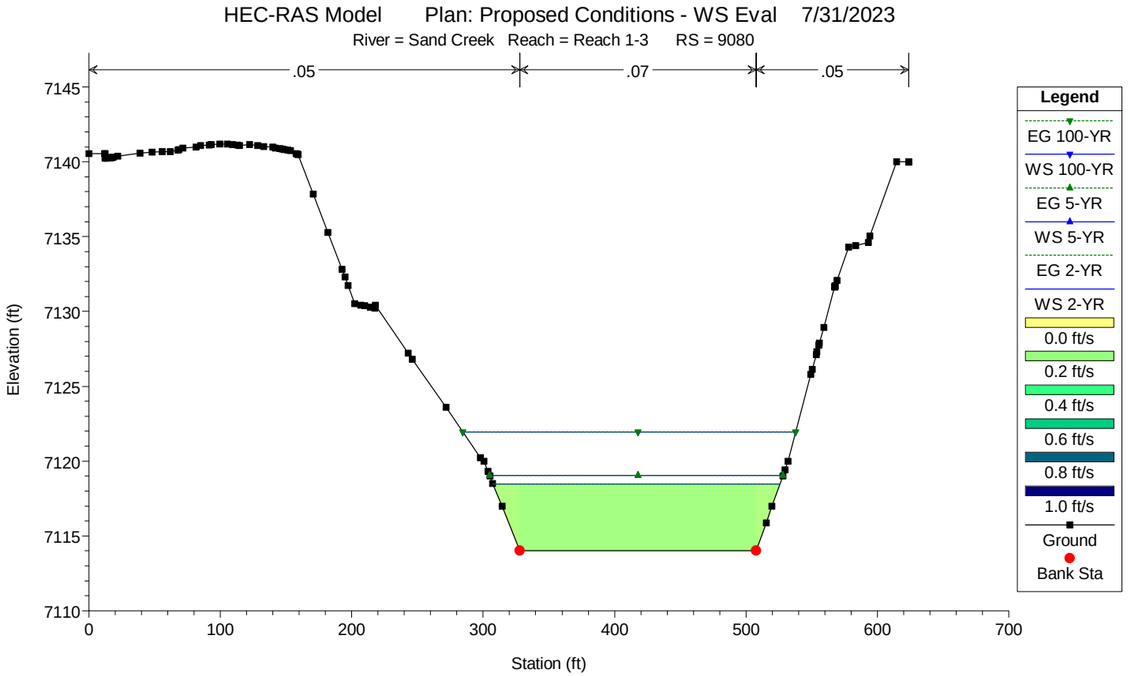


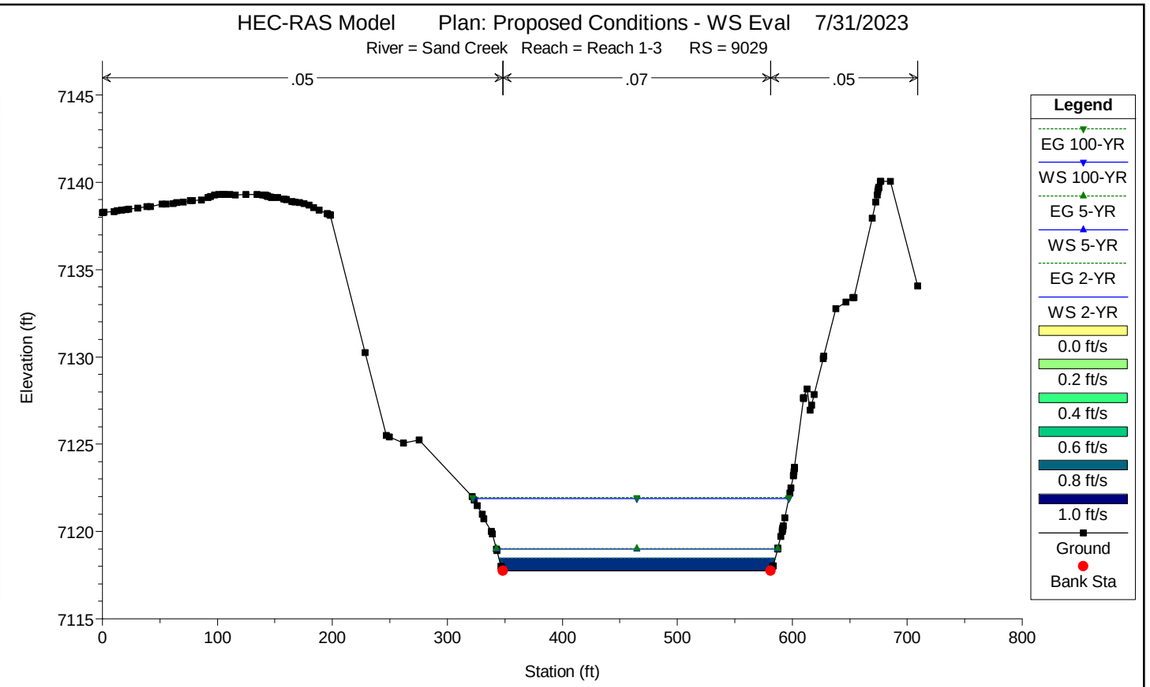


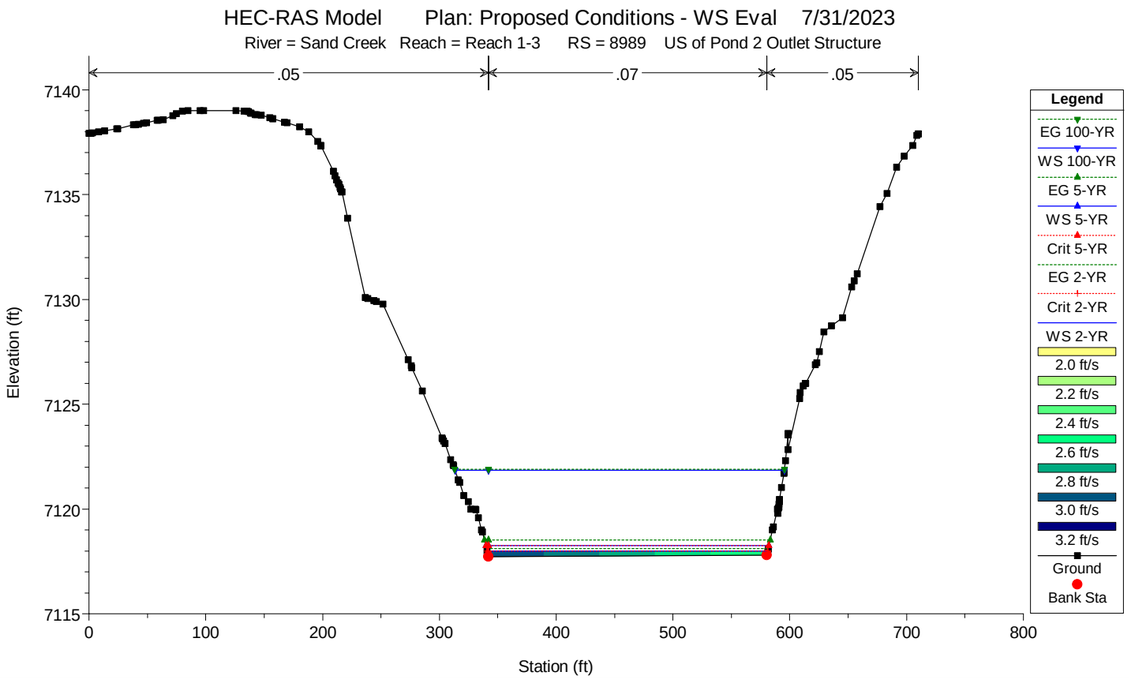


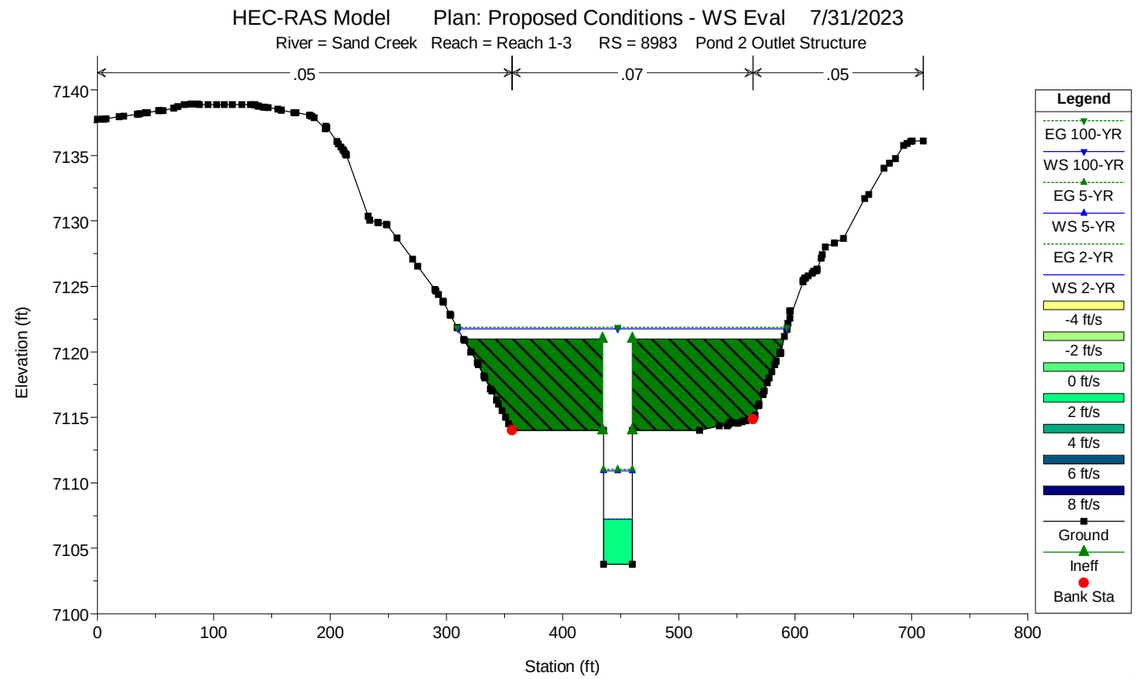


Subcritical flow analysis for Water Surface Evaluation of Naturalized Channel Design except FIS flow rate

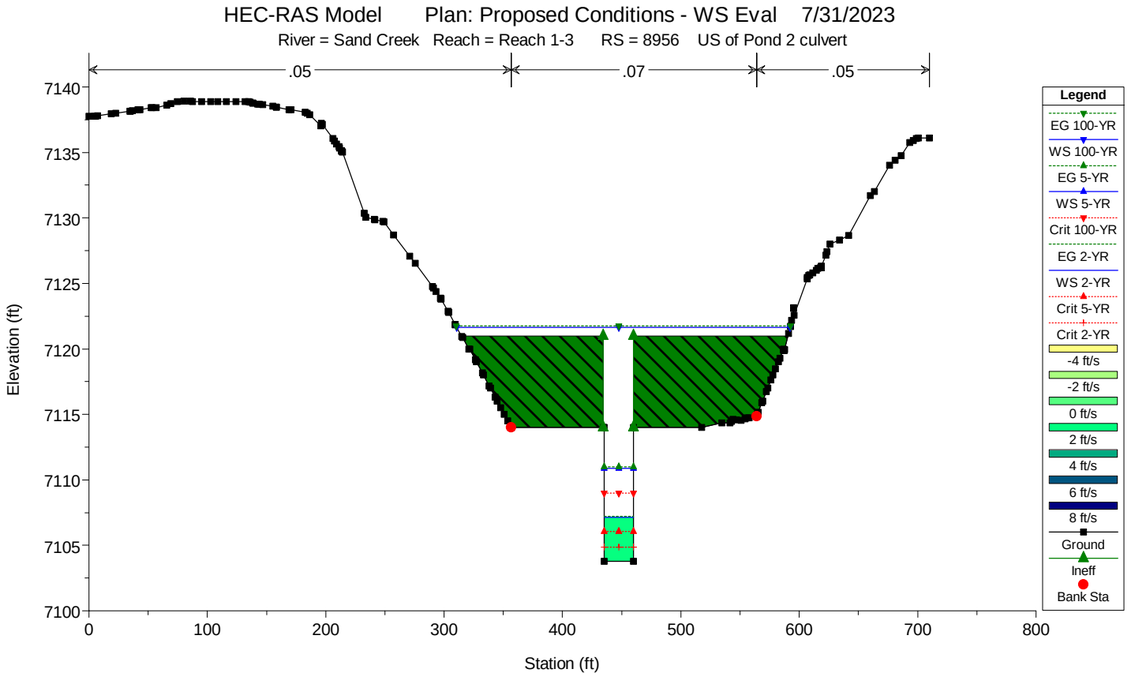


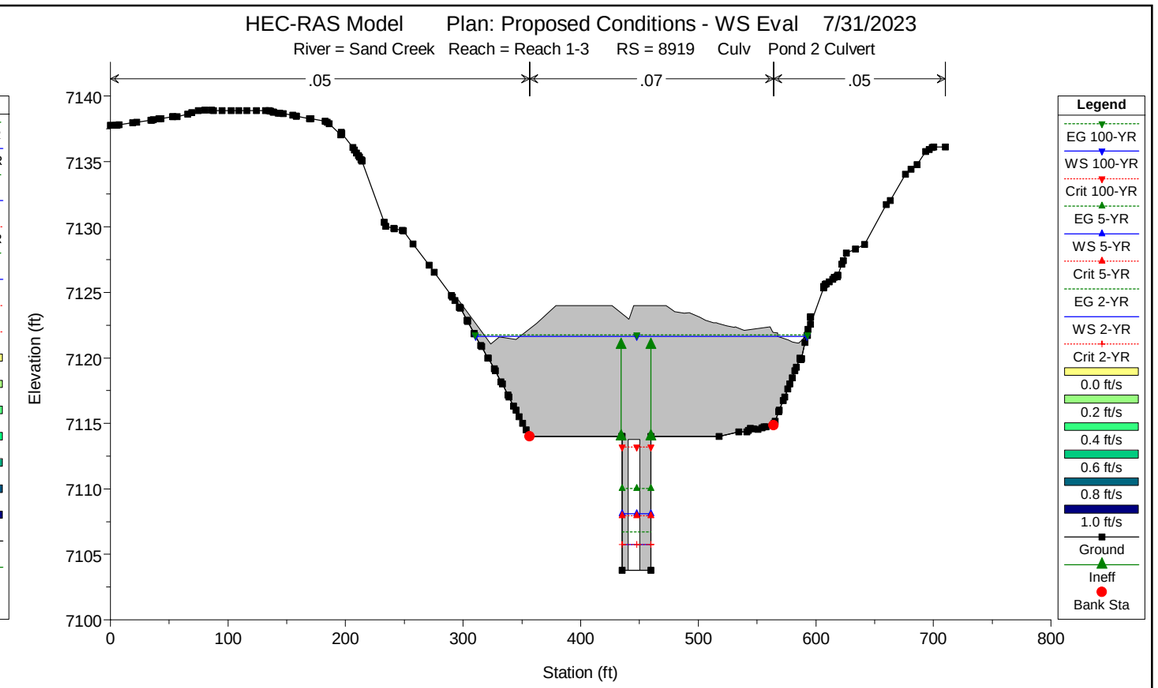


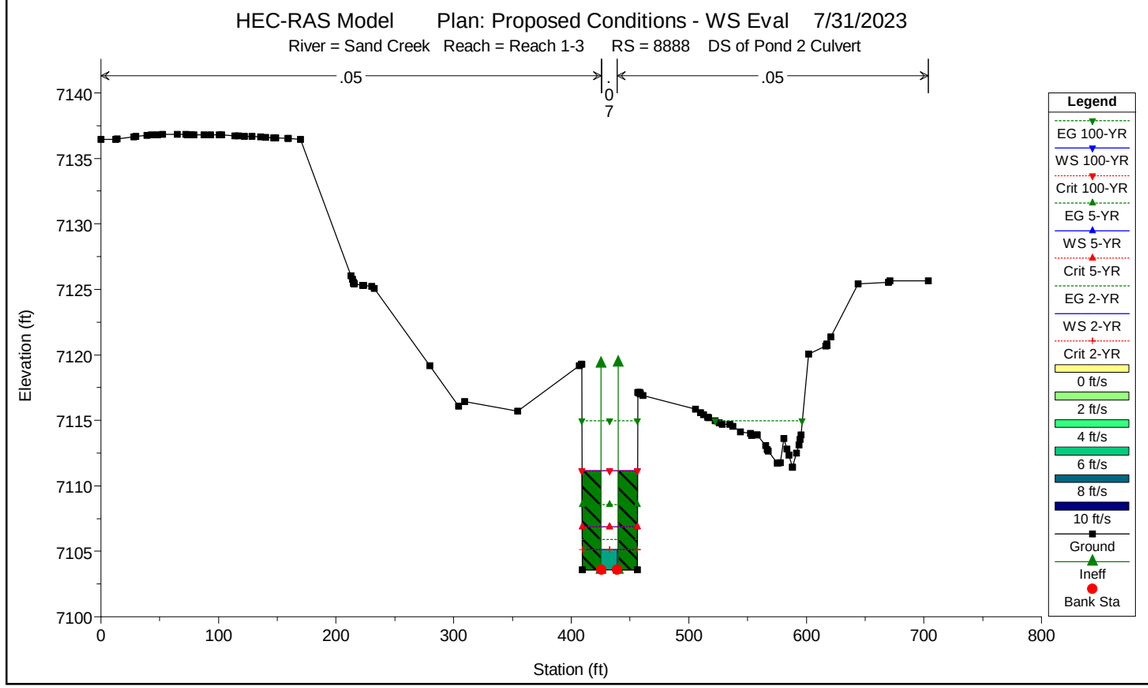


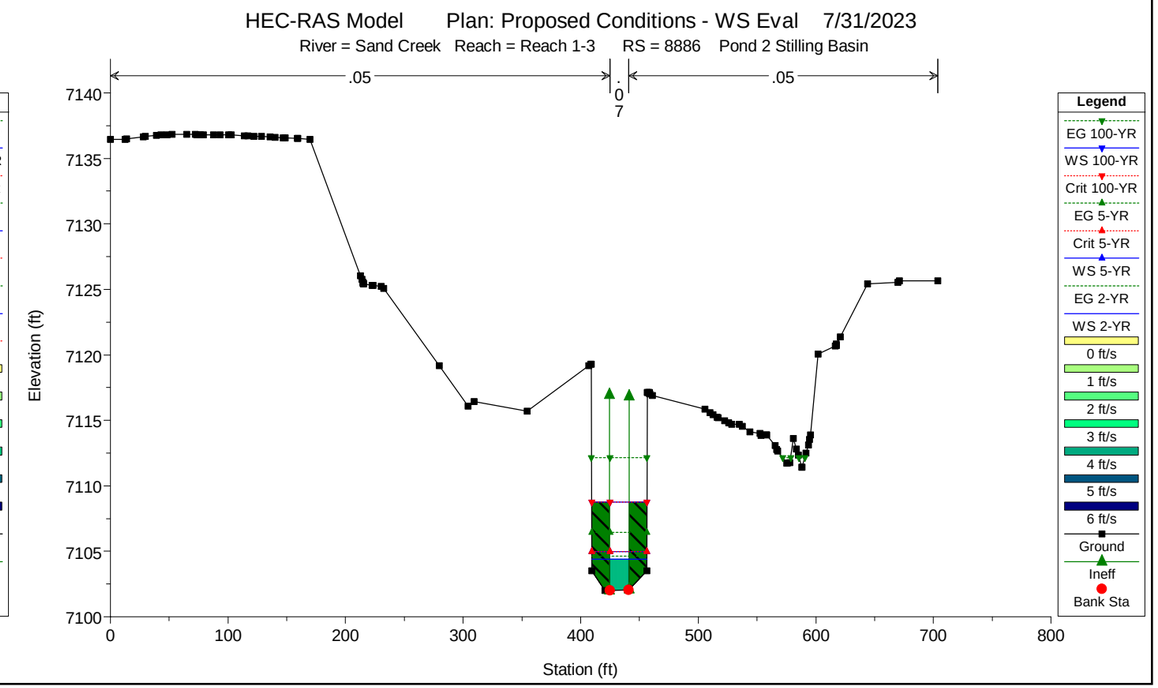


Subcritical flow analysis for Water Surface Evaluation of Naturalized Channel Design except FIS flow rate

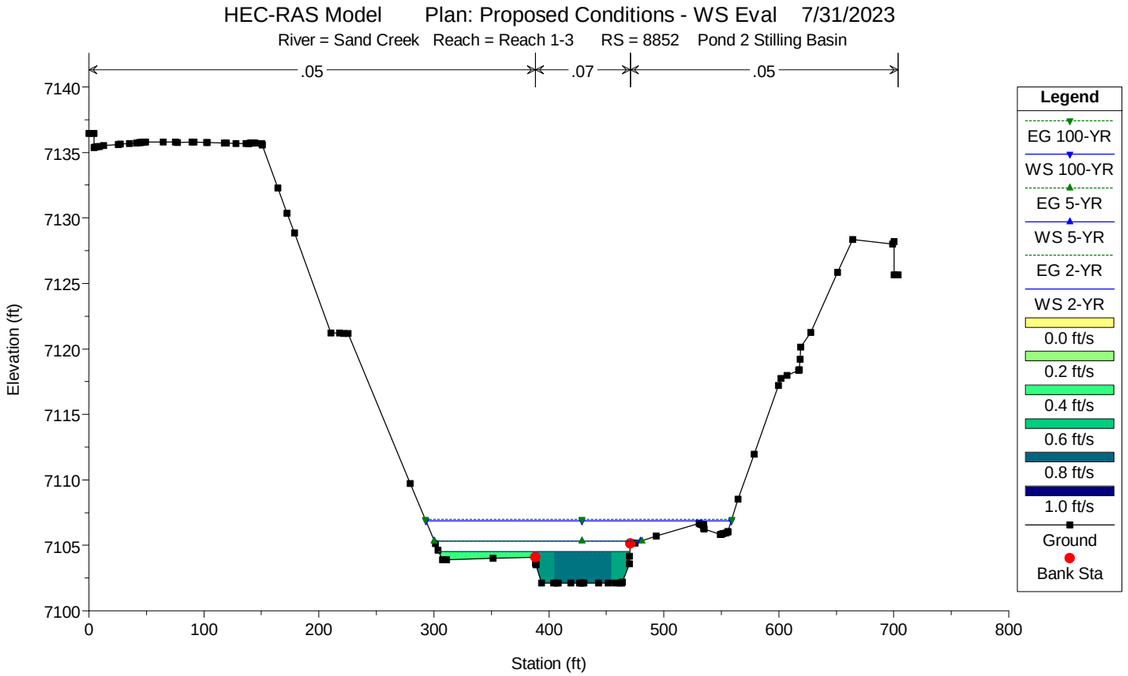


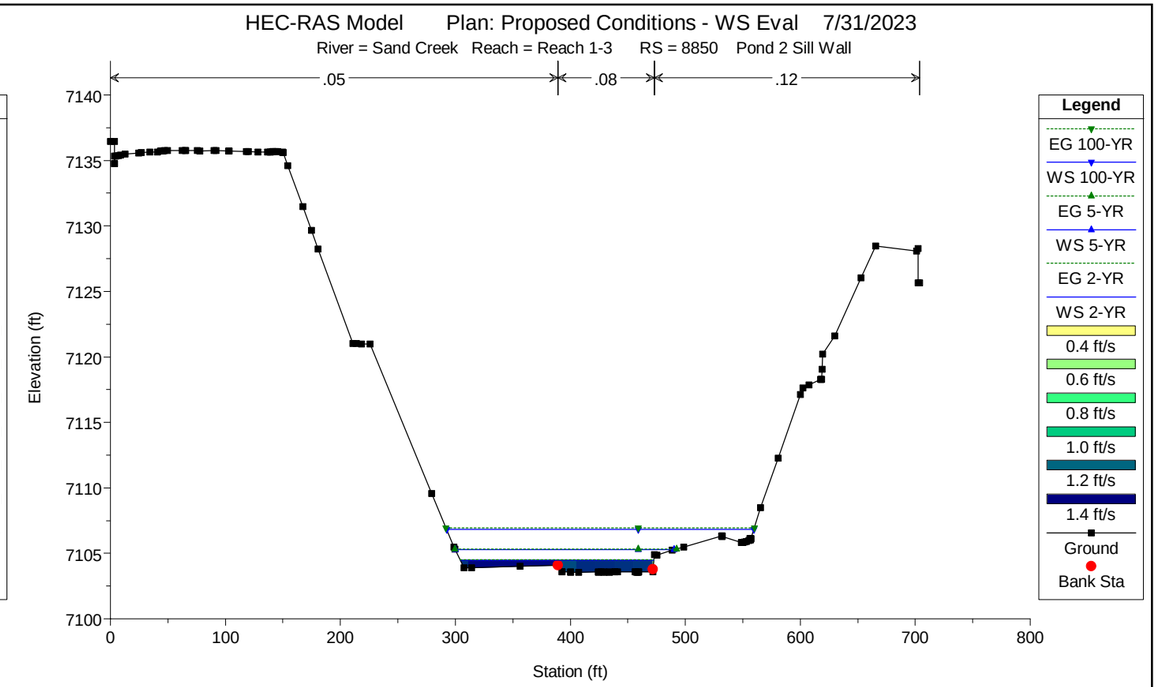


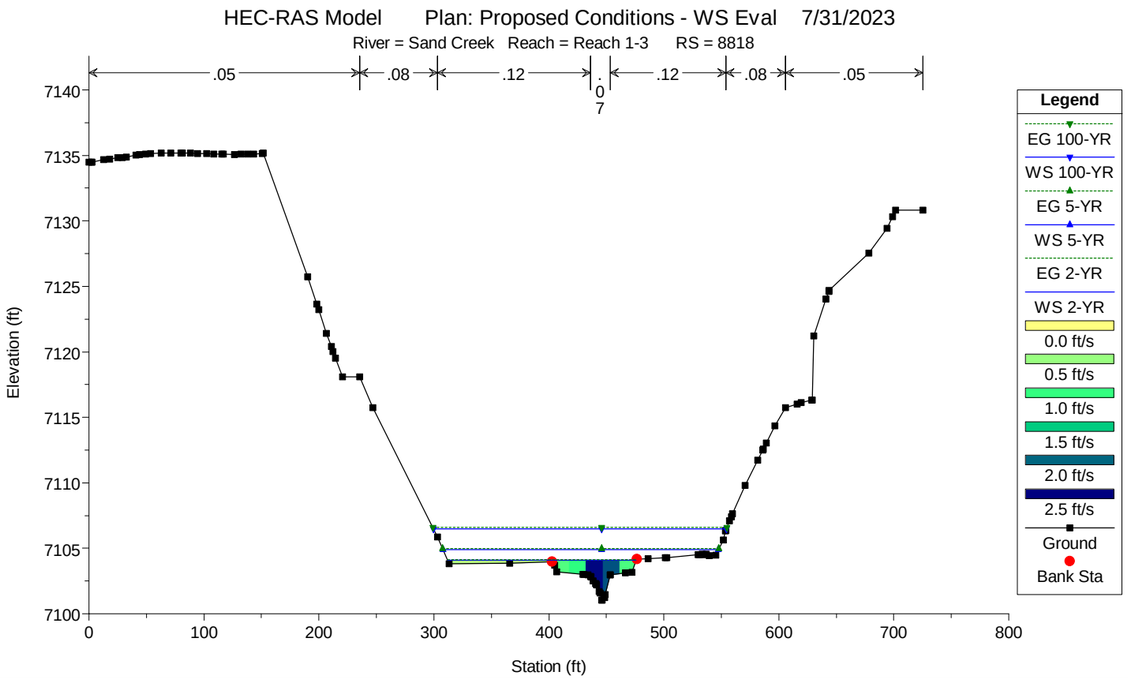


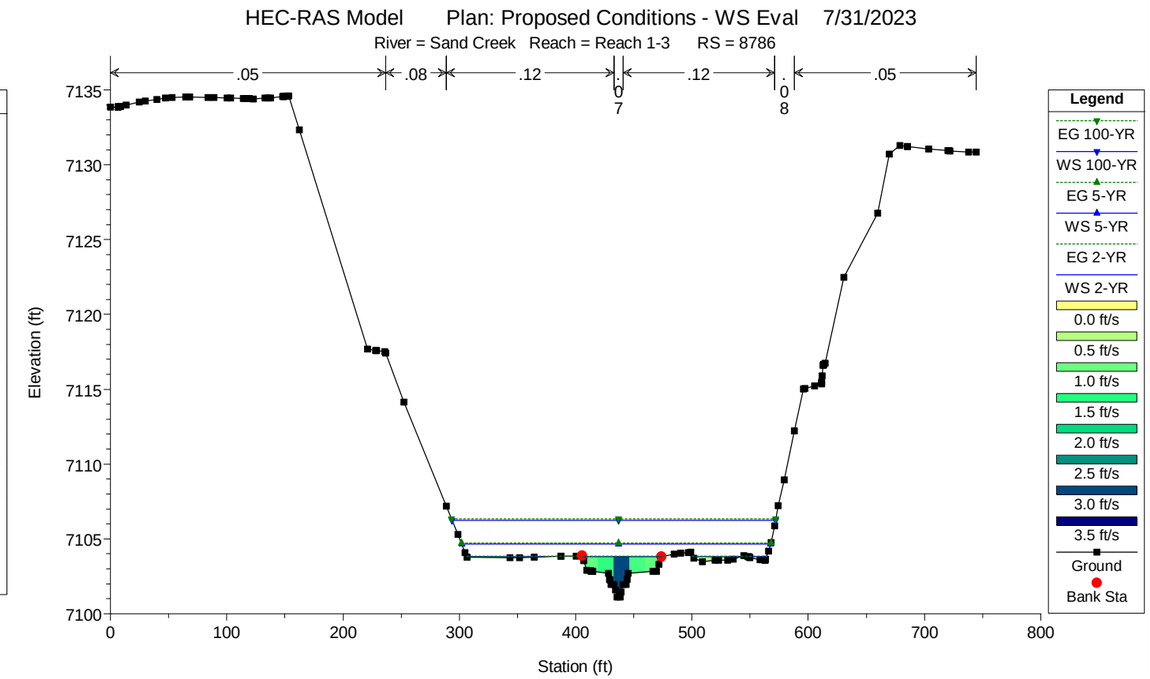


Subcritical flow analysis for Water Surface Evaluation of Naturalized Channel Design except FIS flow rate

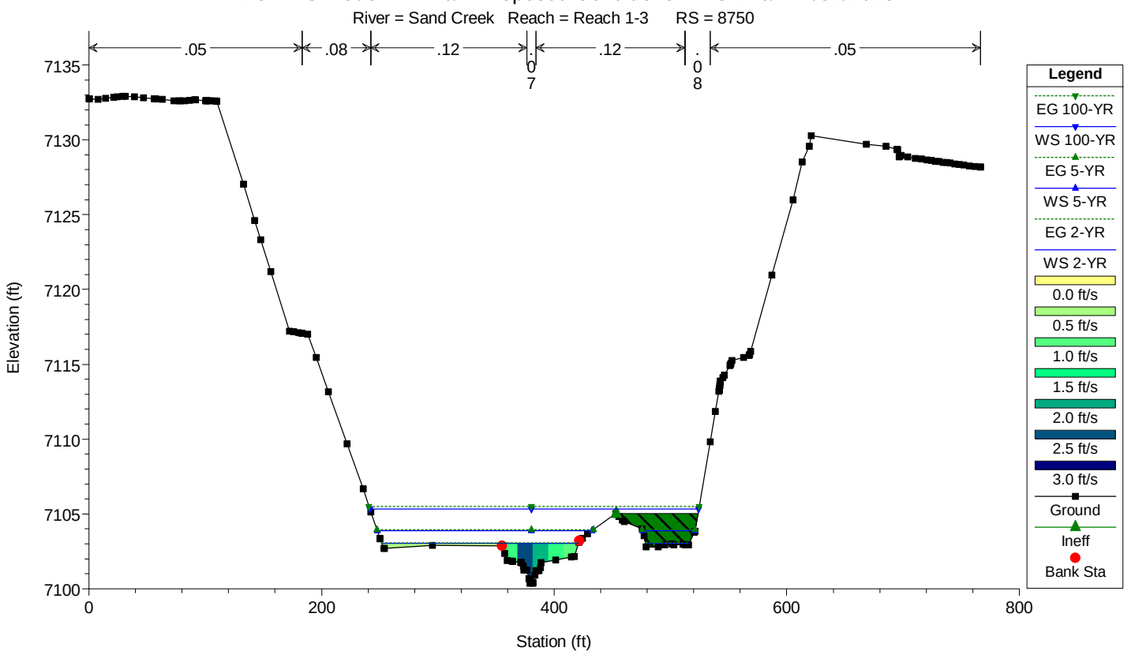


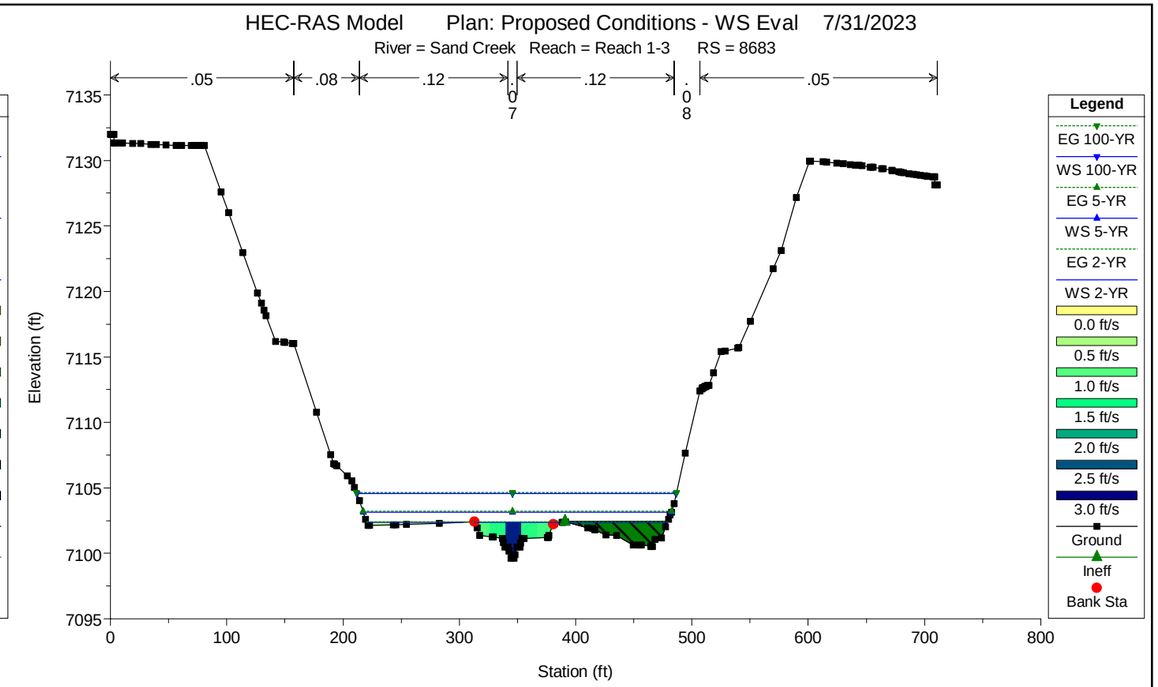


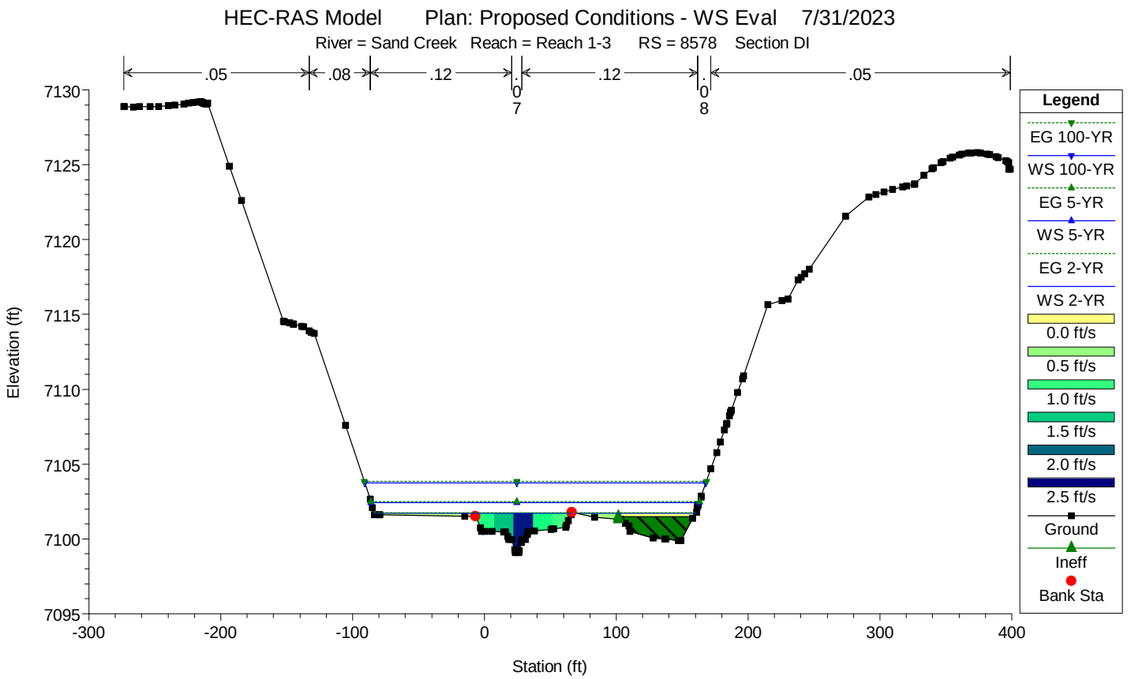


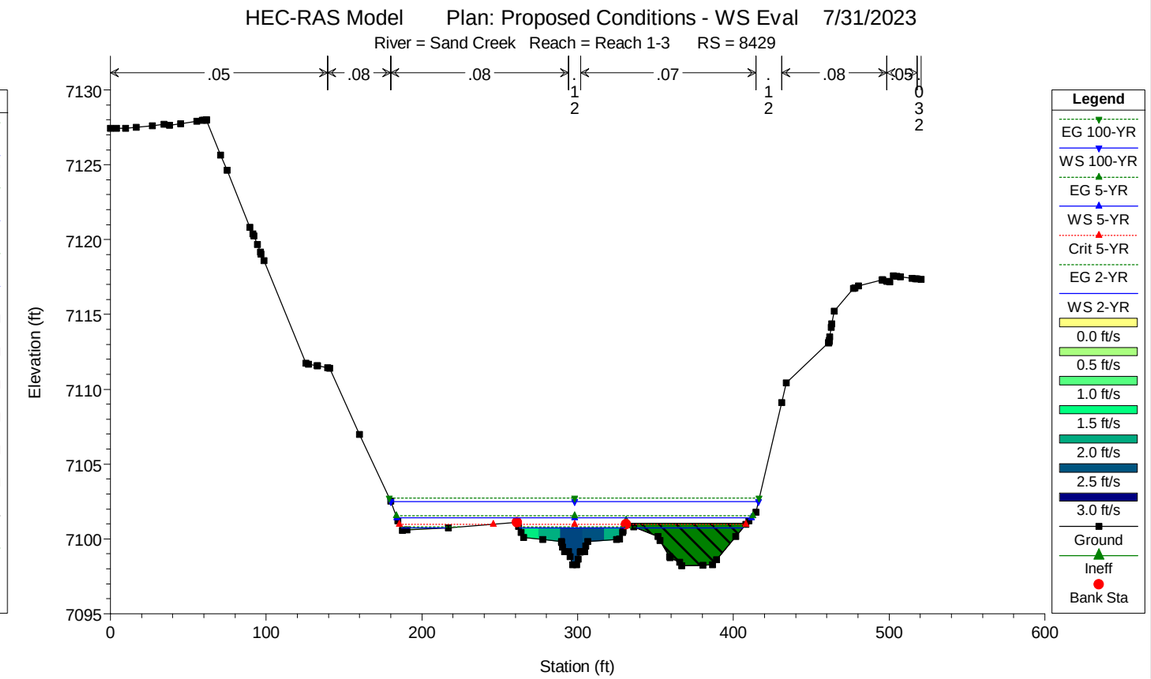


Subcritical flow analysis for Water Surface Evaluation of Naturalized Channel Design except FIS flow rate

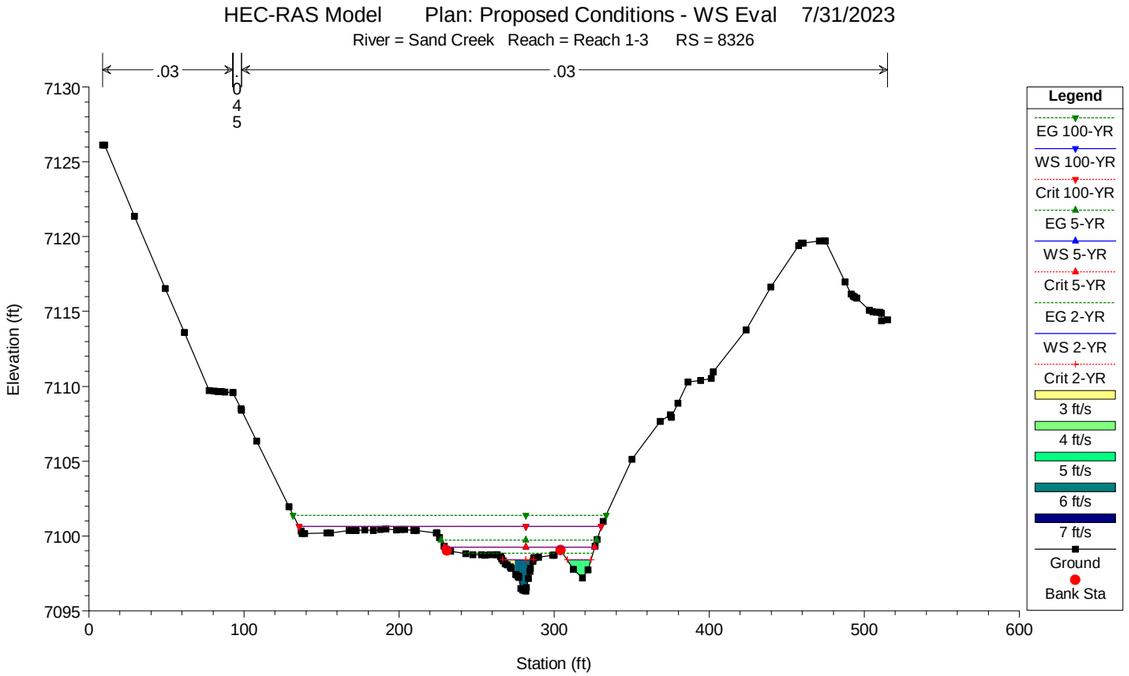


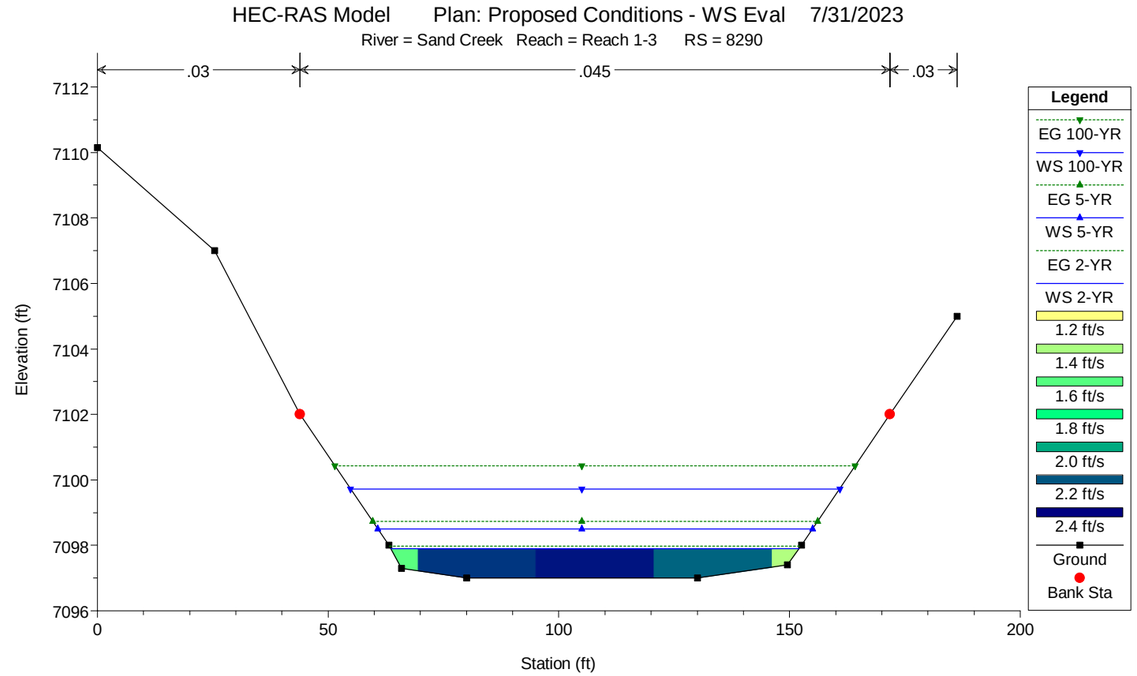


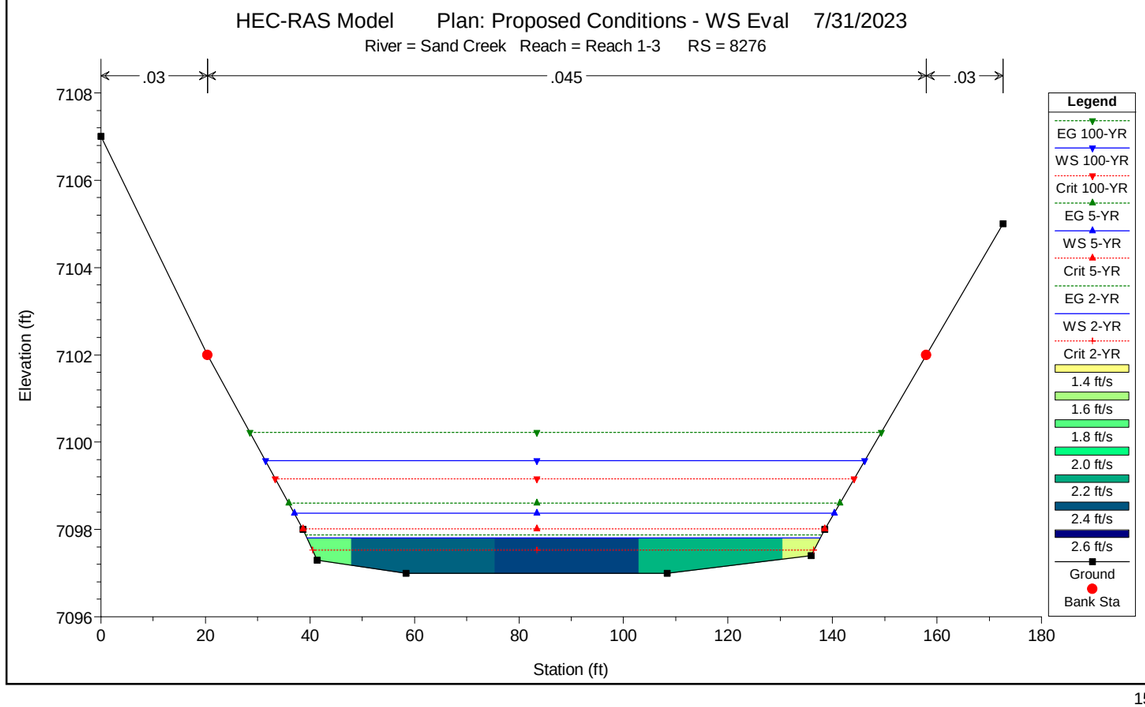


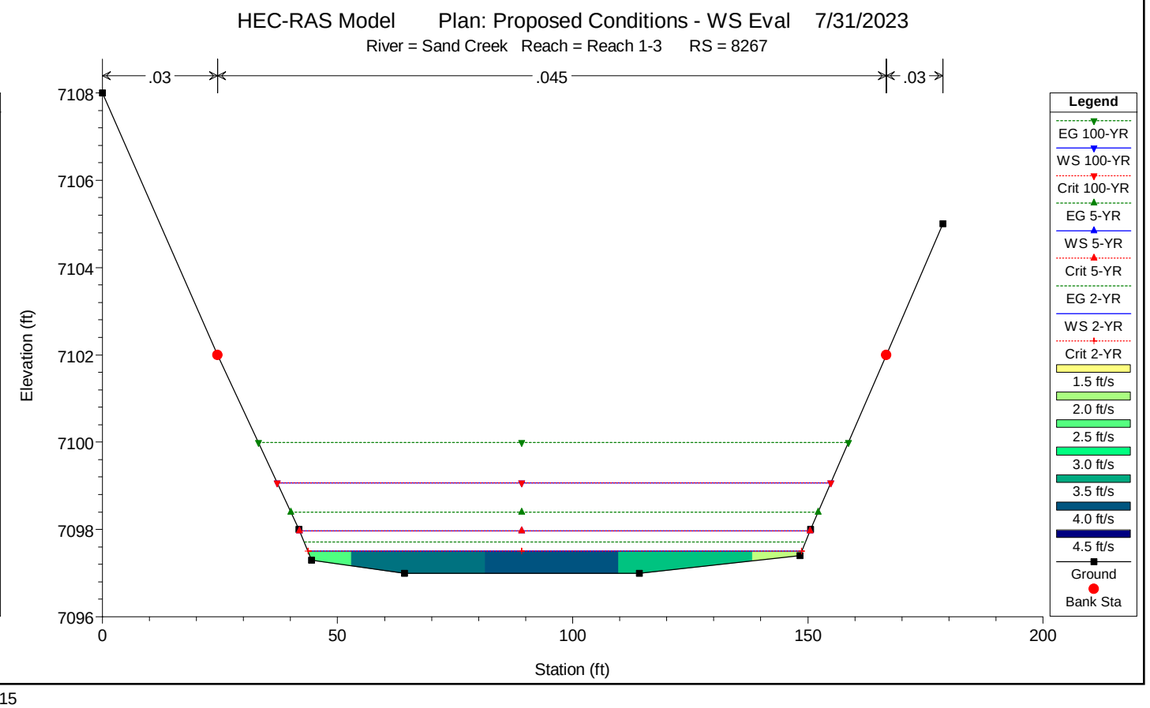


Subcritical flow analysis for Water Surface Evaluation of Naturalized Channel Design except FIS flow rate

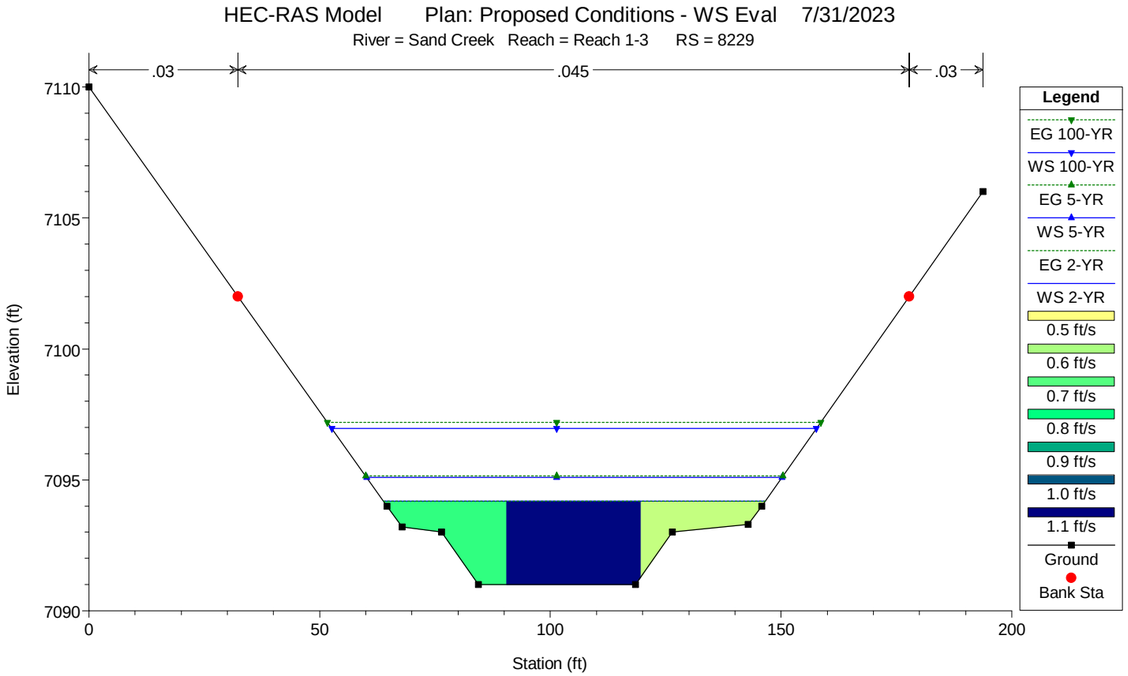


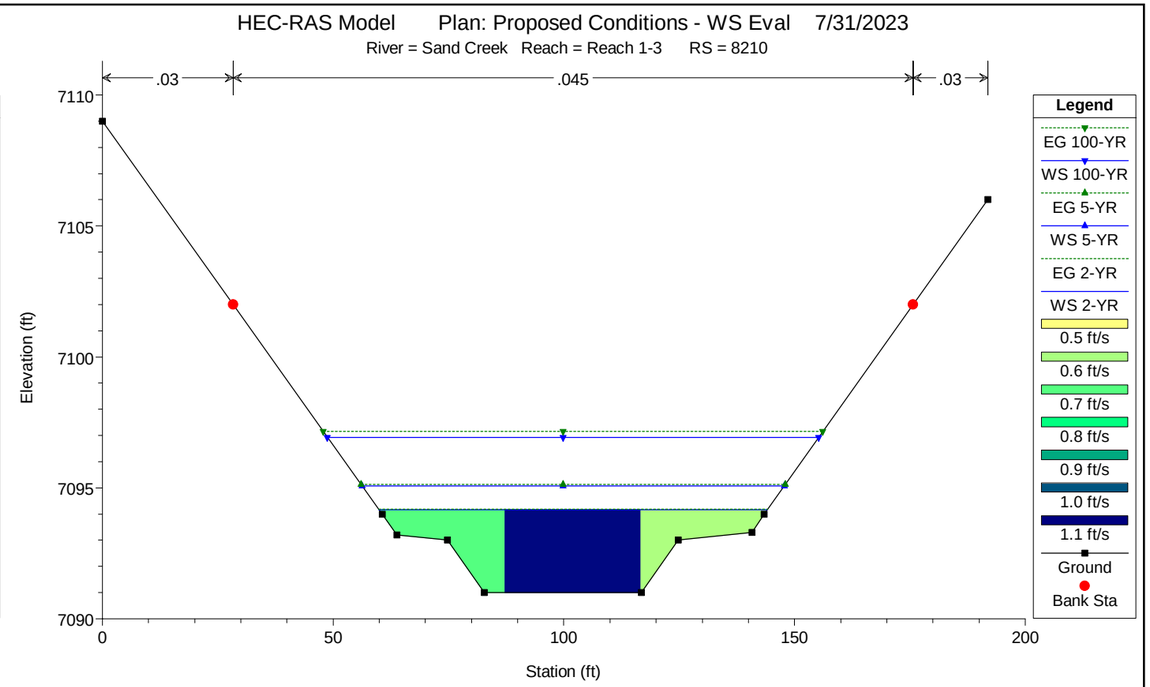


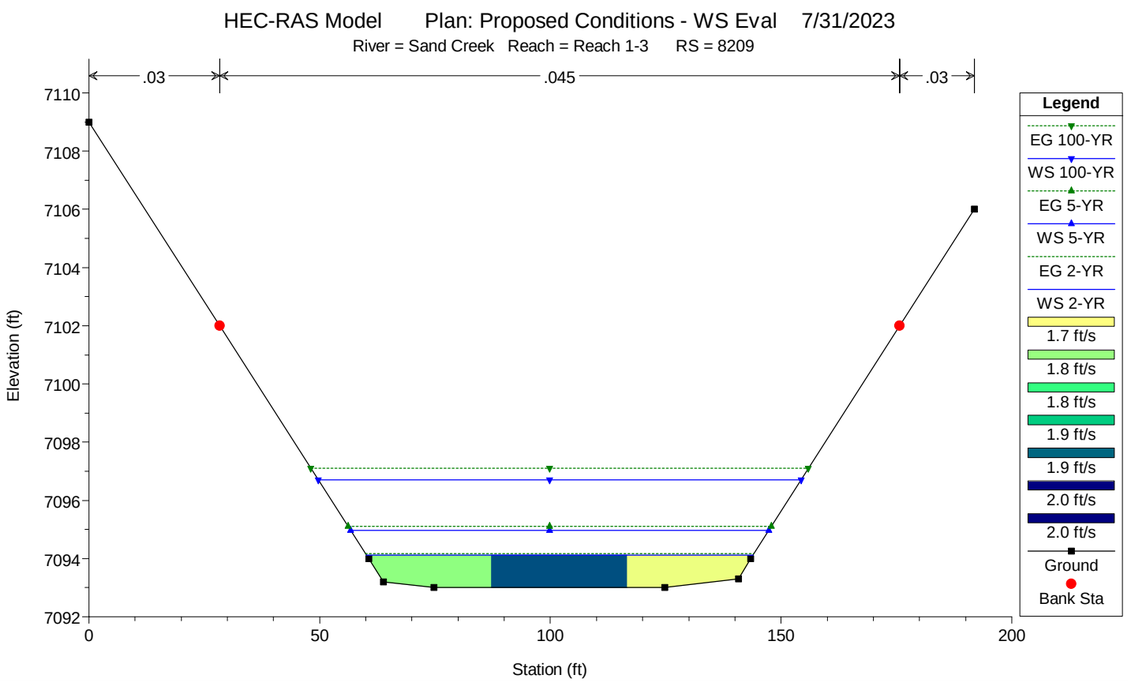


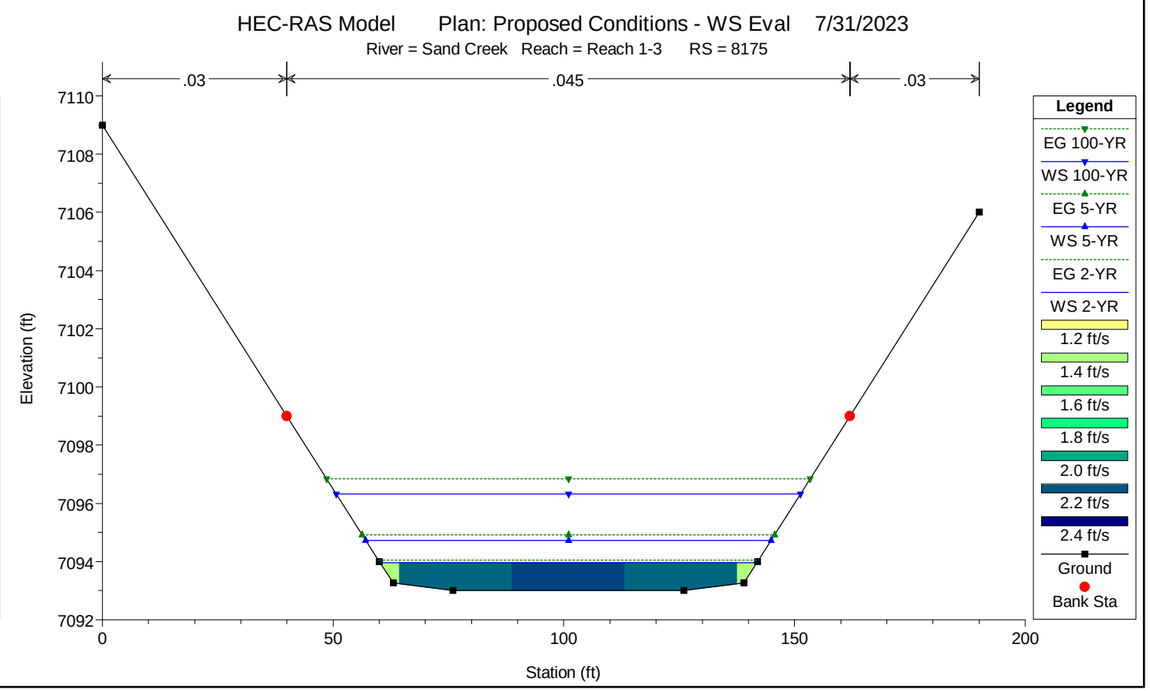


Subcritical flow analysis for Water Surface Evaluation of Naturalized Channel Design except FIS flow rate

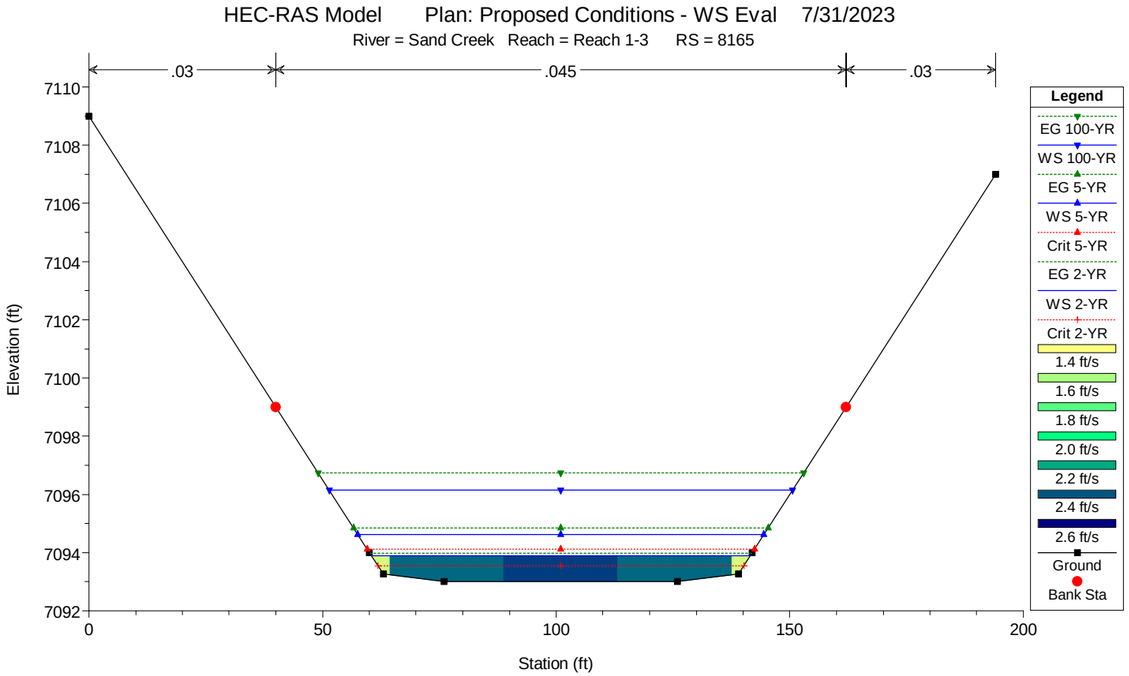


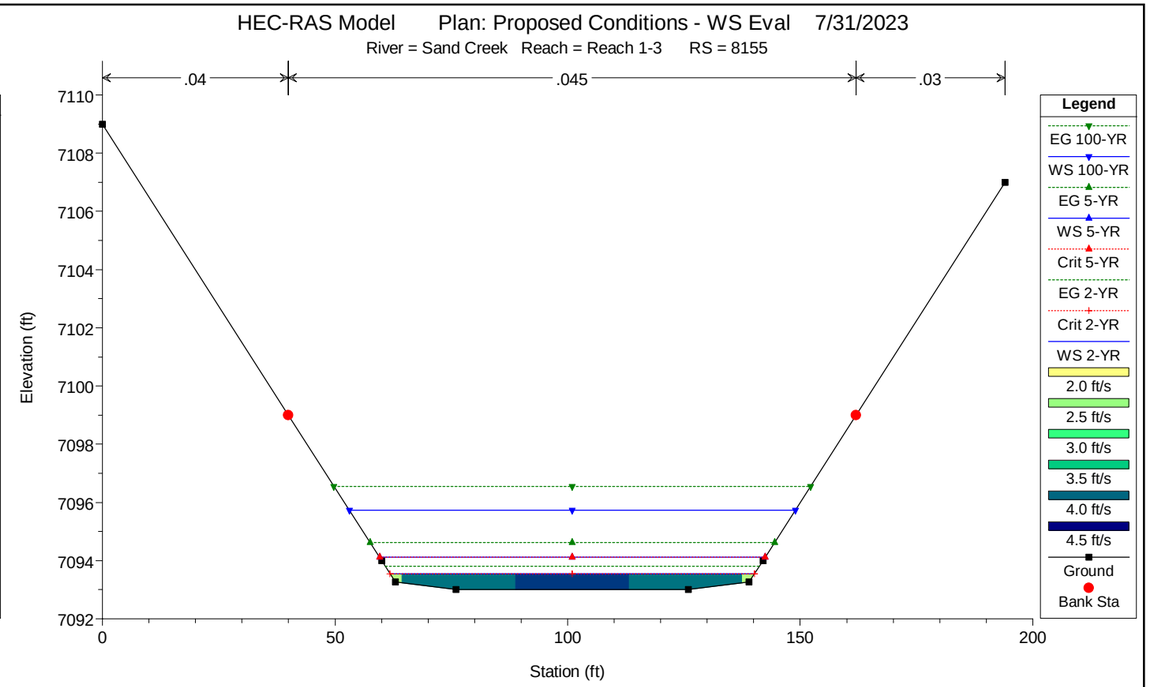


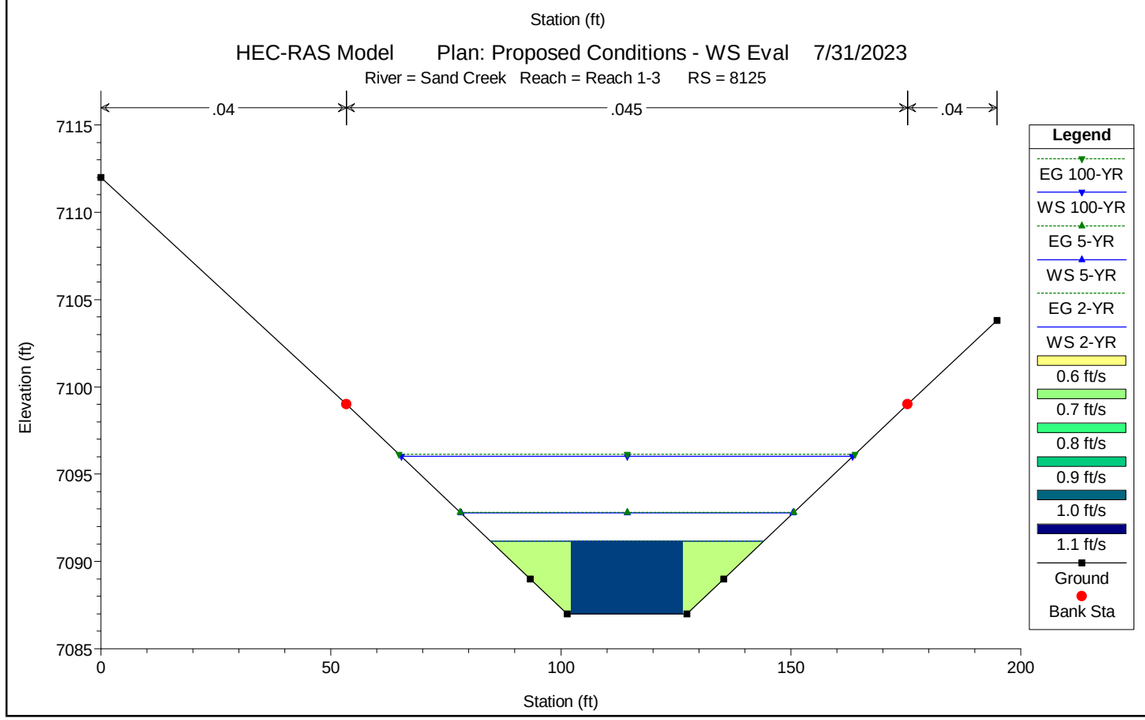


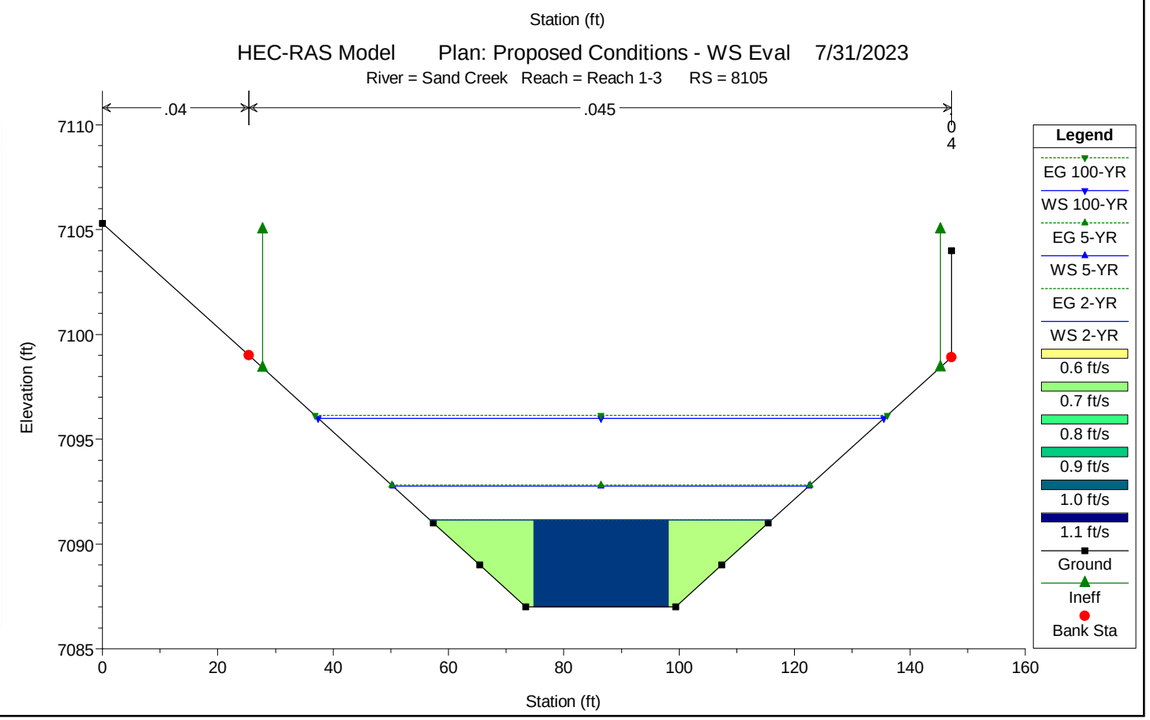


Subcritical flow analysis for Water Surface Evaluation of Naturalized Channel Design except FIS flow rate

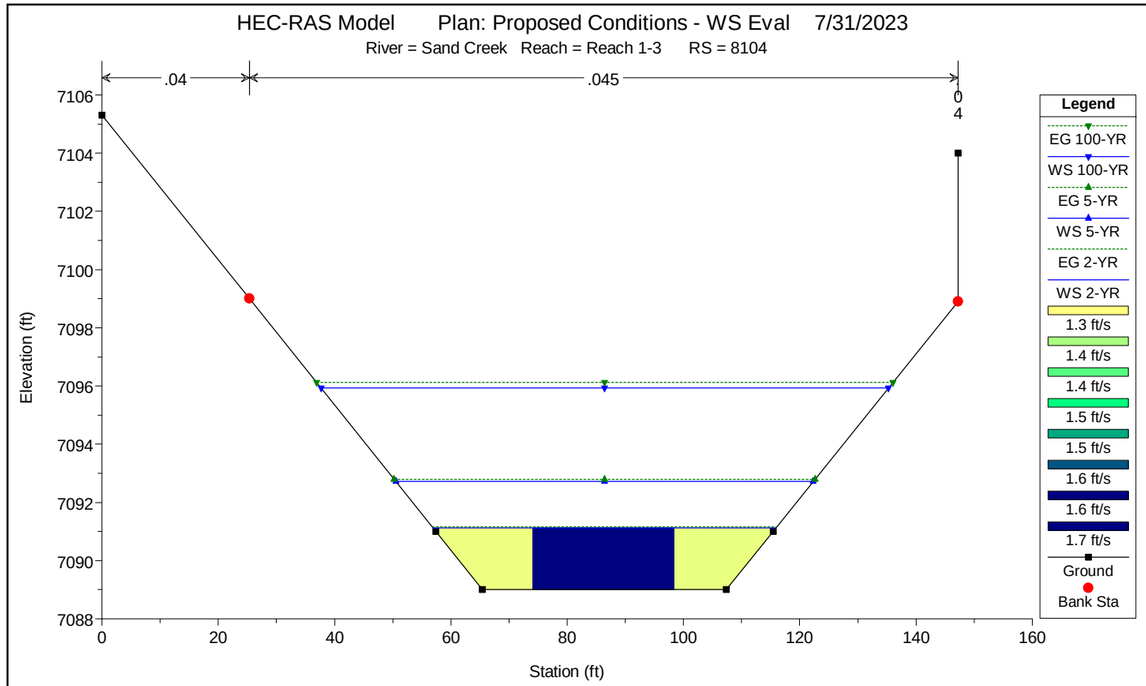


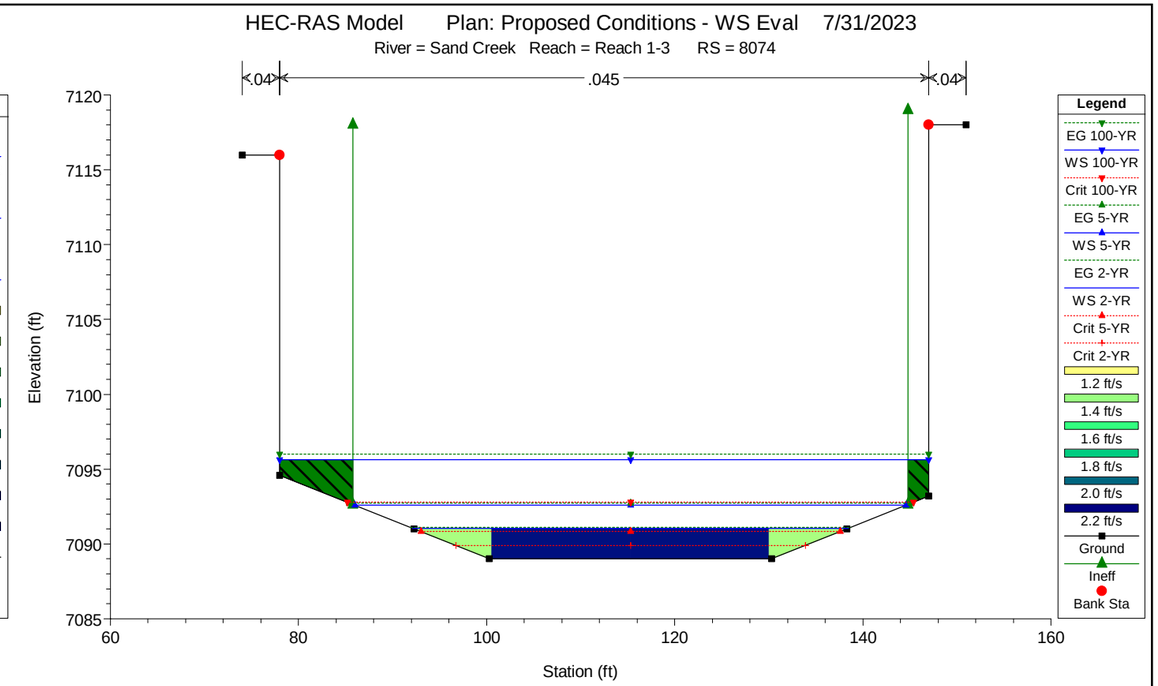


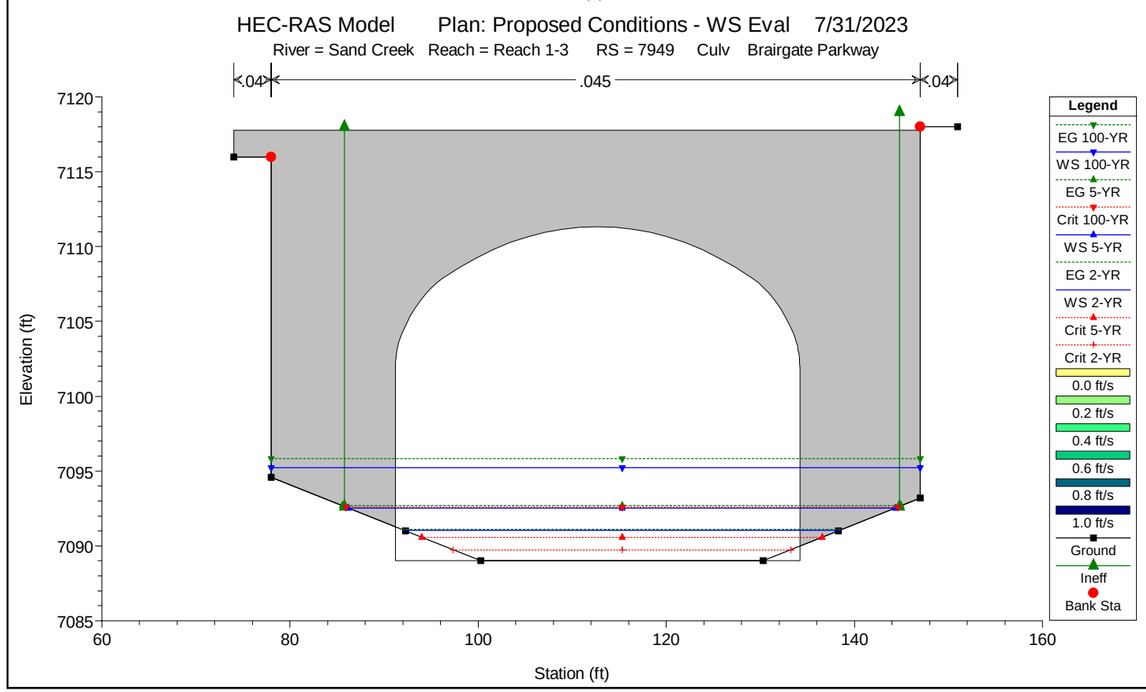


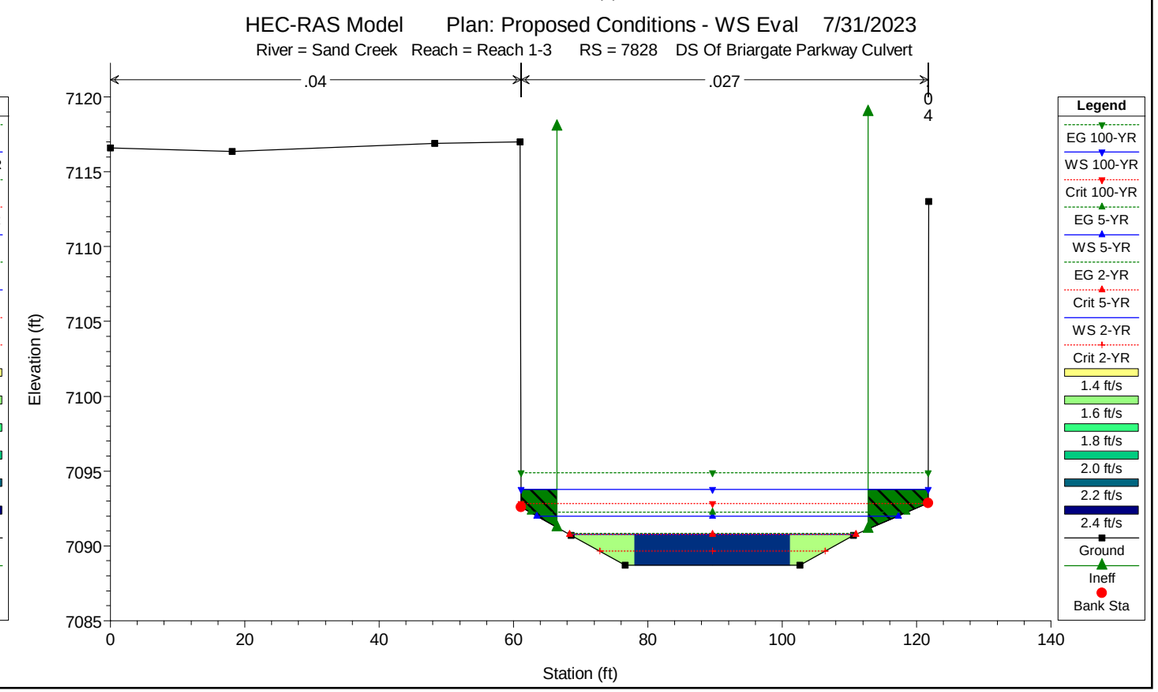


Subcritical flow analysis for Water Surface Evaluation of Naturalized Channel Design except FIS flow rate

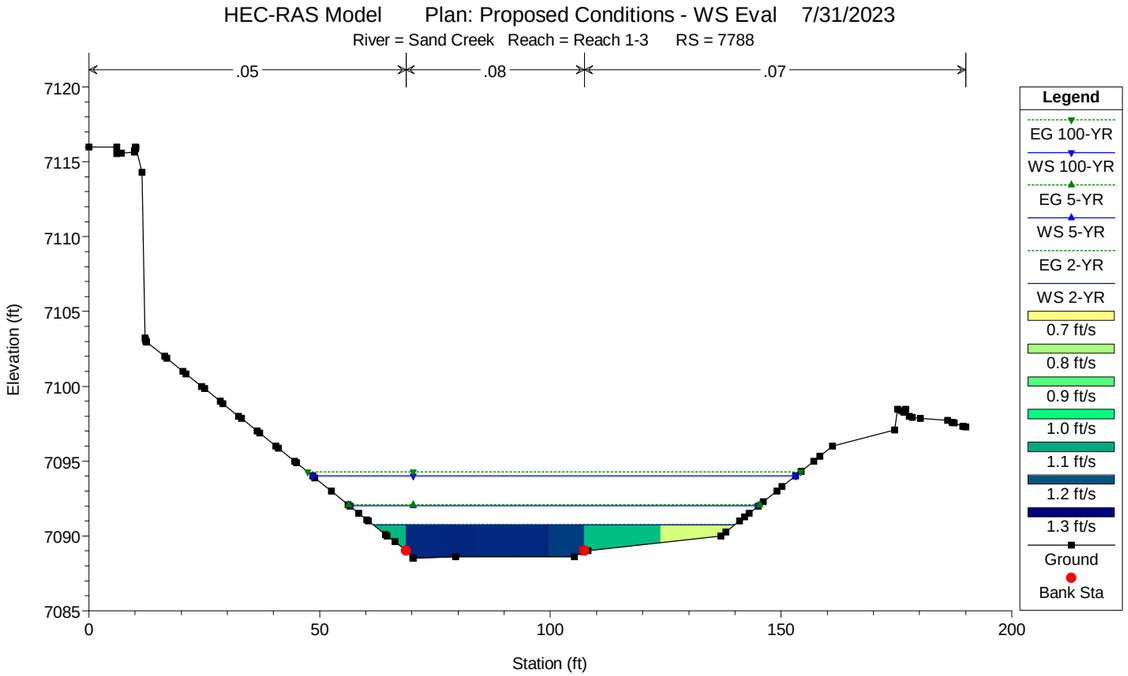


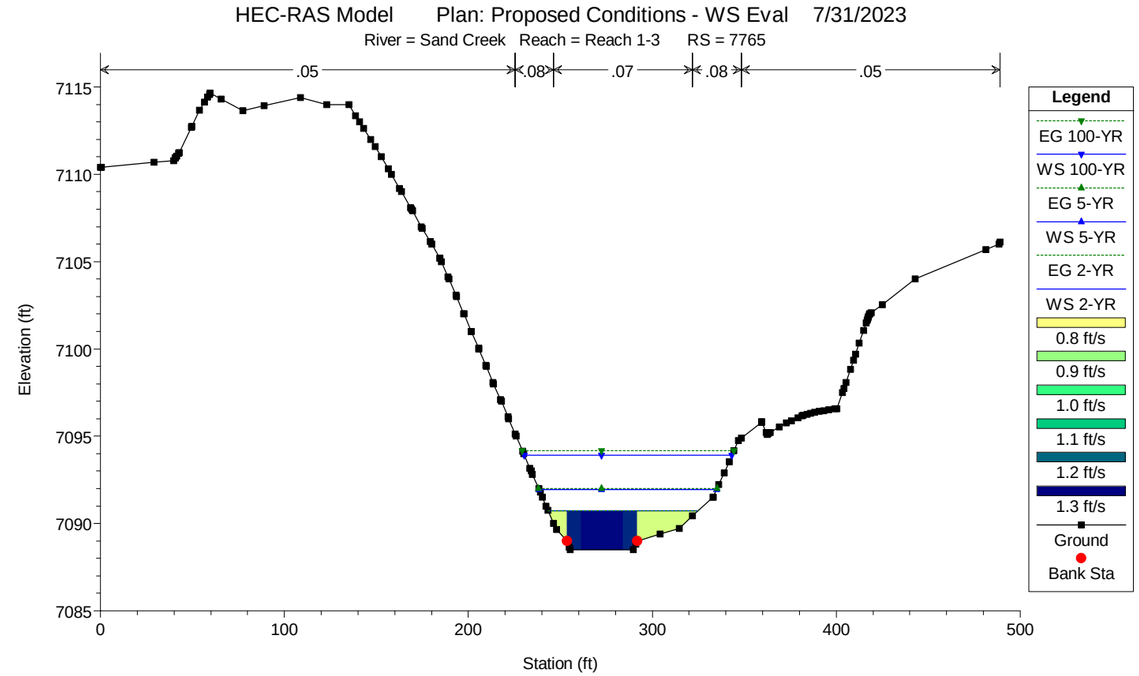


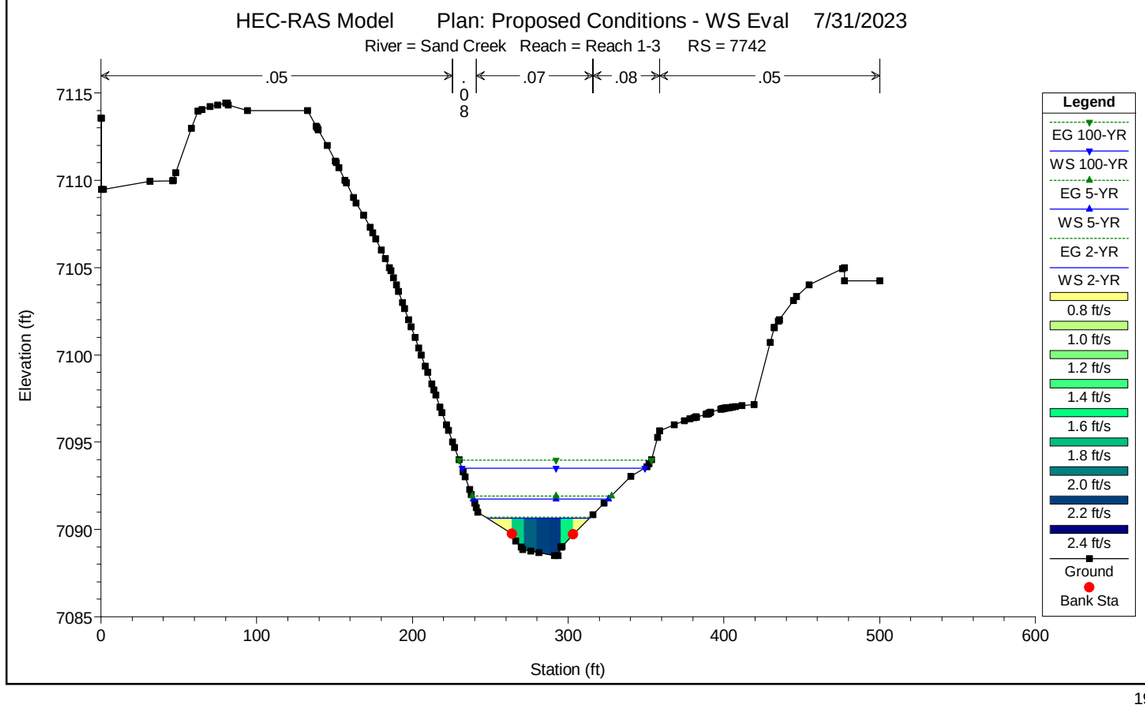


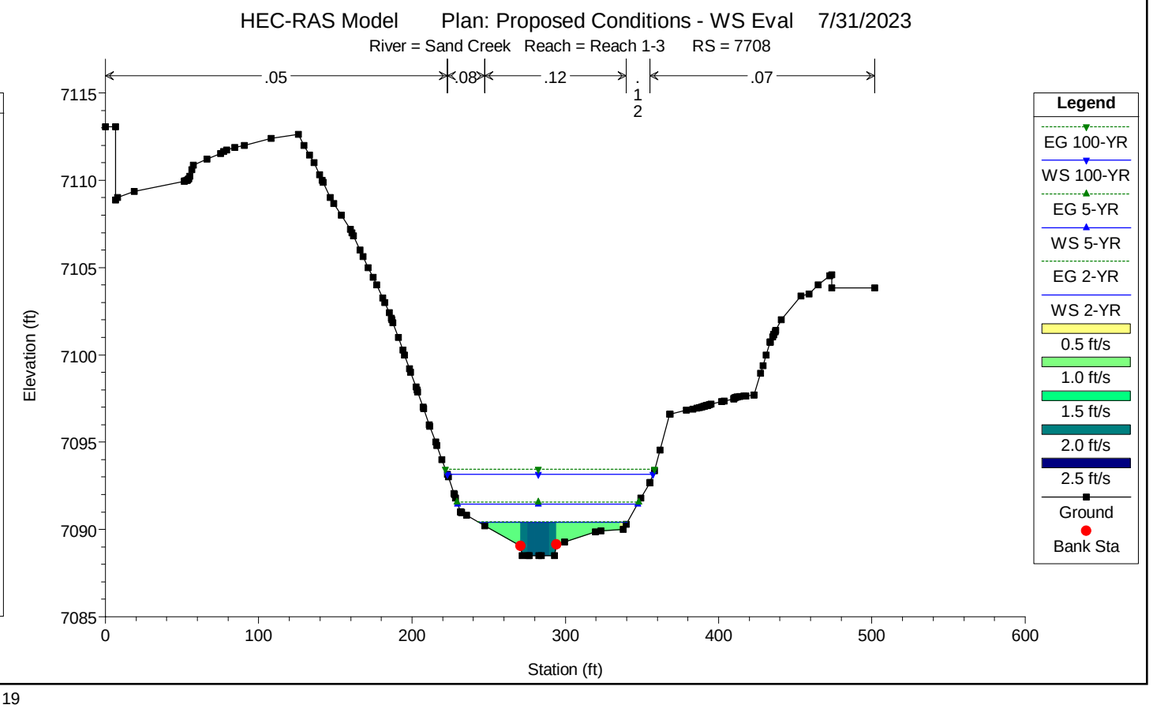


Subcritical flow analysis for Water Surface Evaluation of Naturalized Channel Design except FIS flow rate

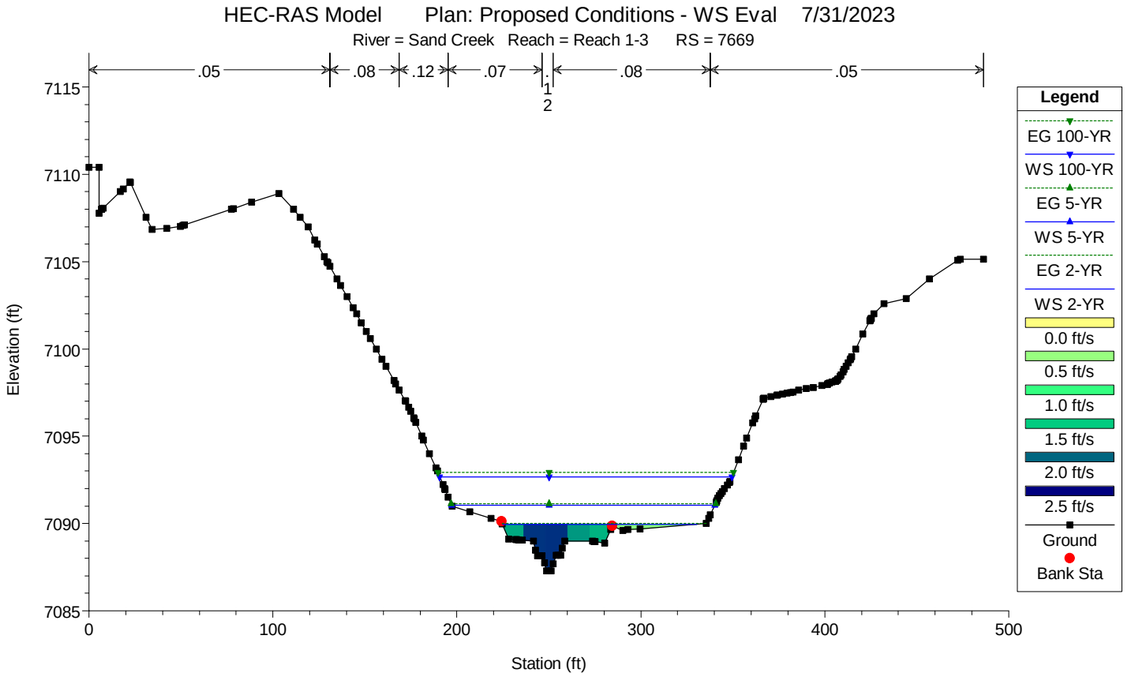


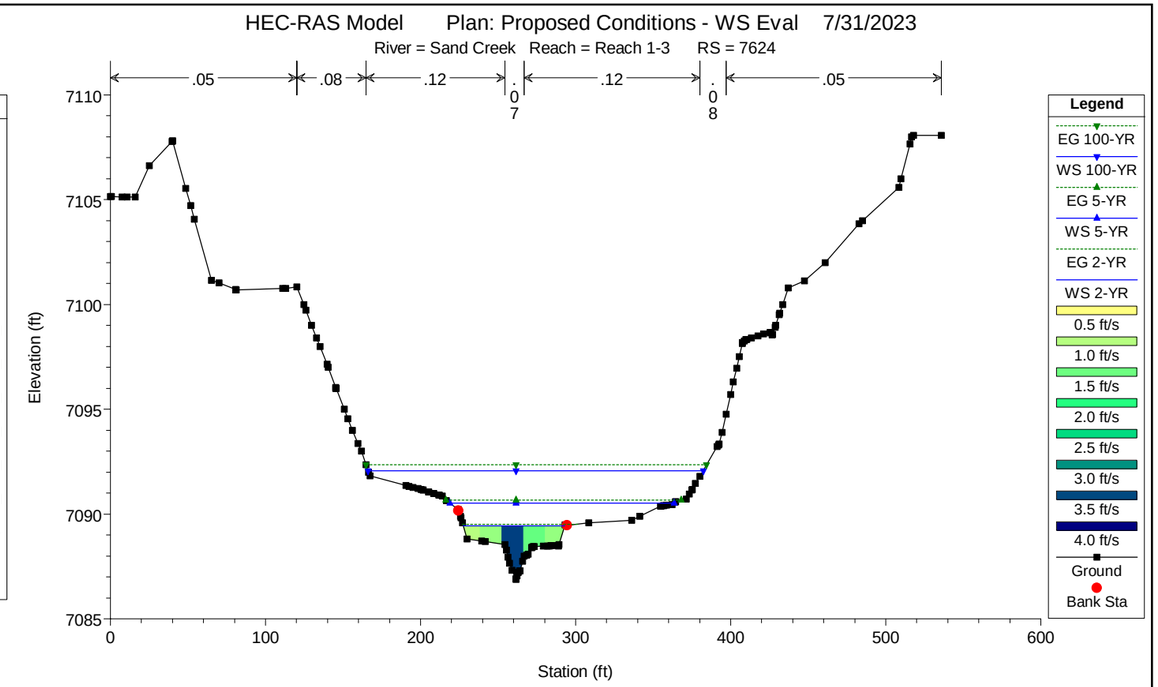


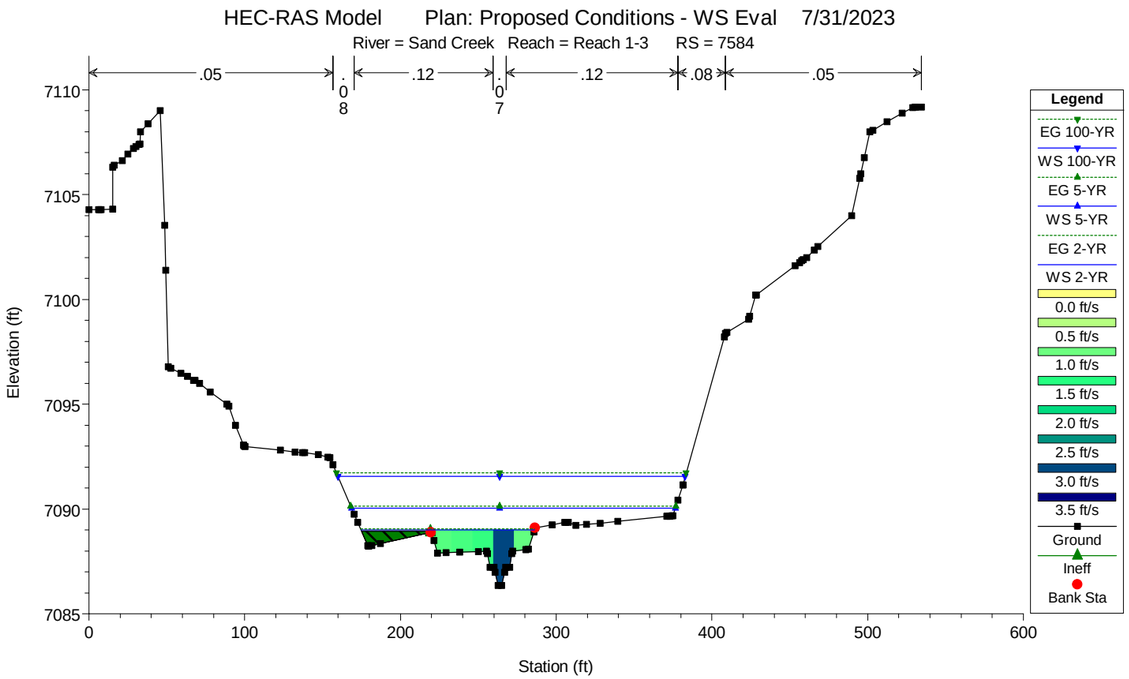


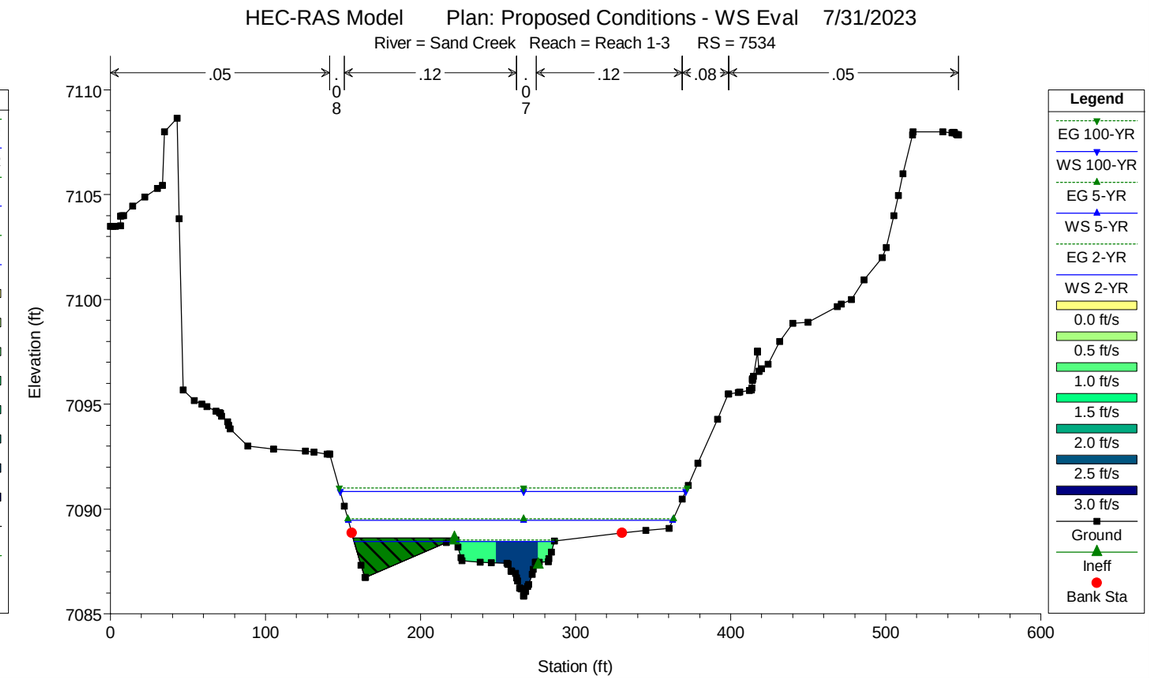


Subcritical flow analysis for Water Surface Evaluation of Naturalized Channel Design except FIS flow rate

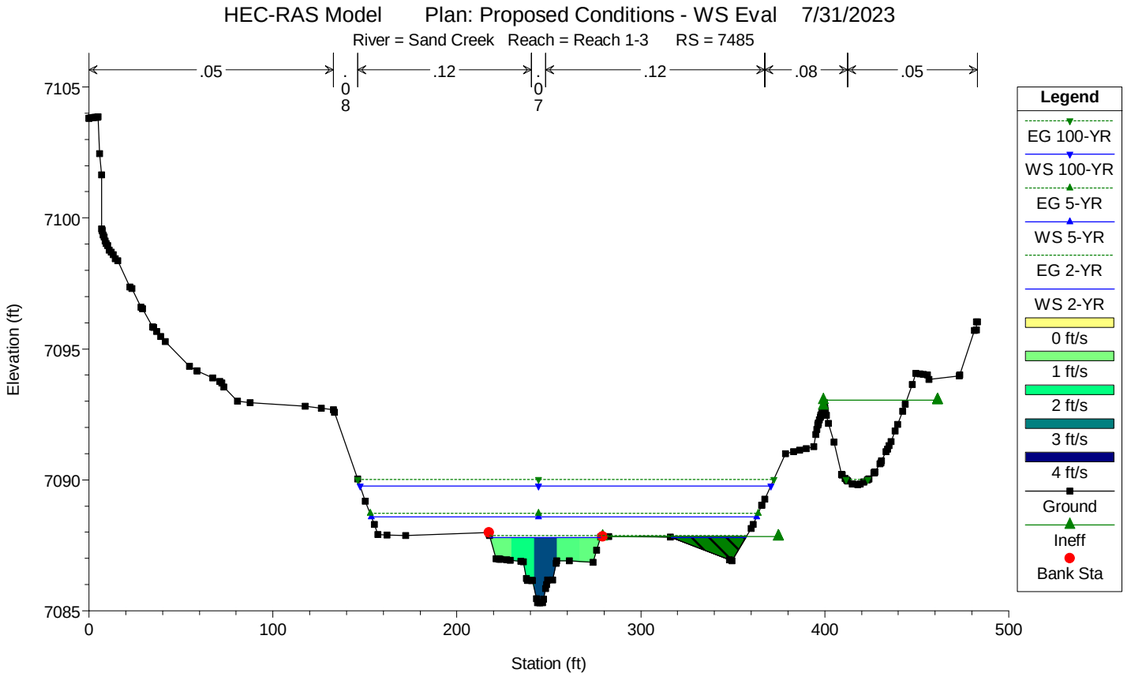


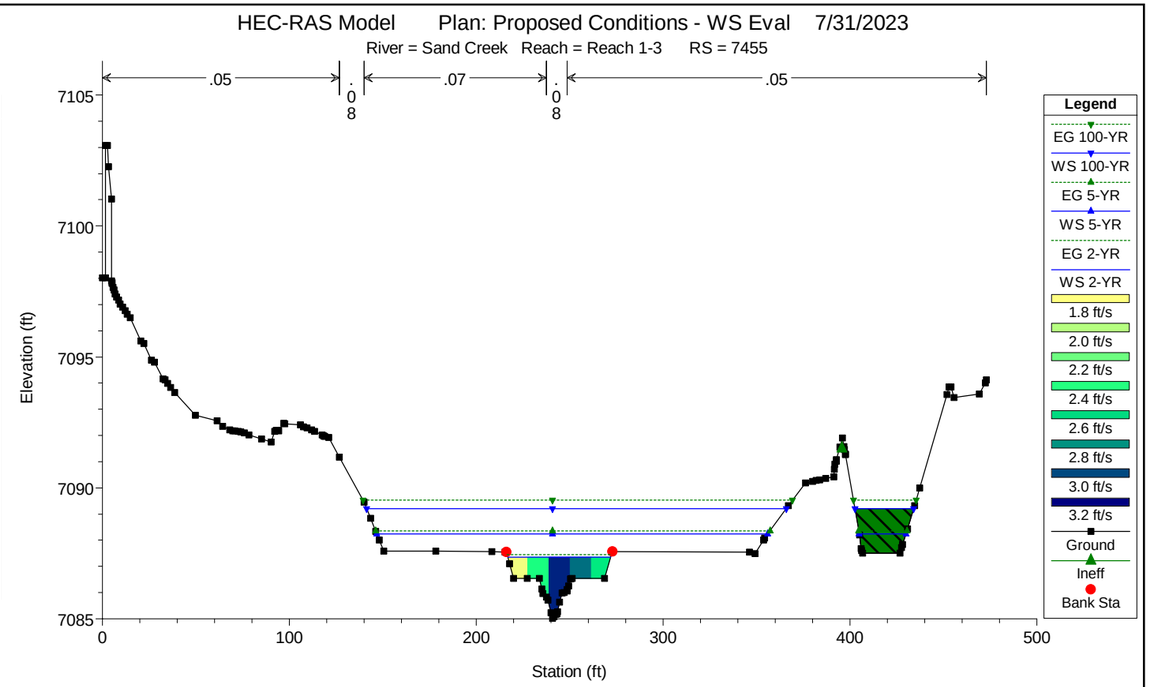


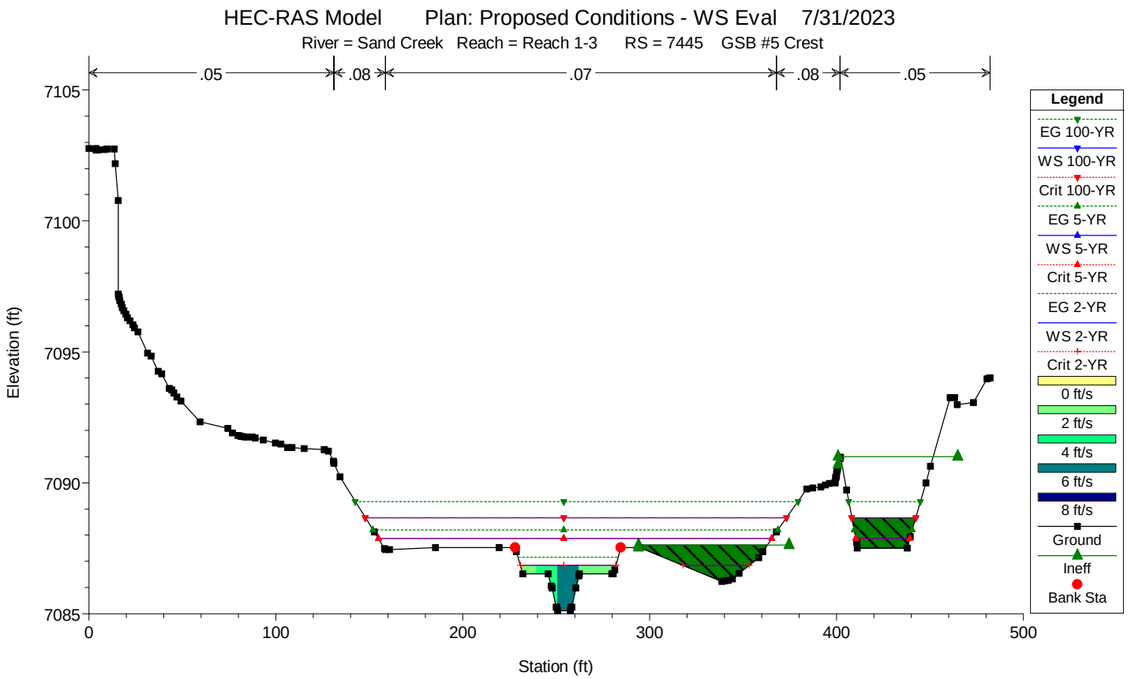


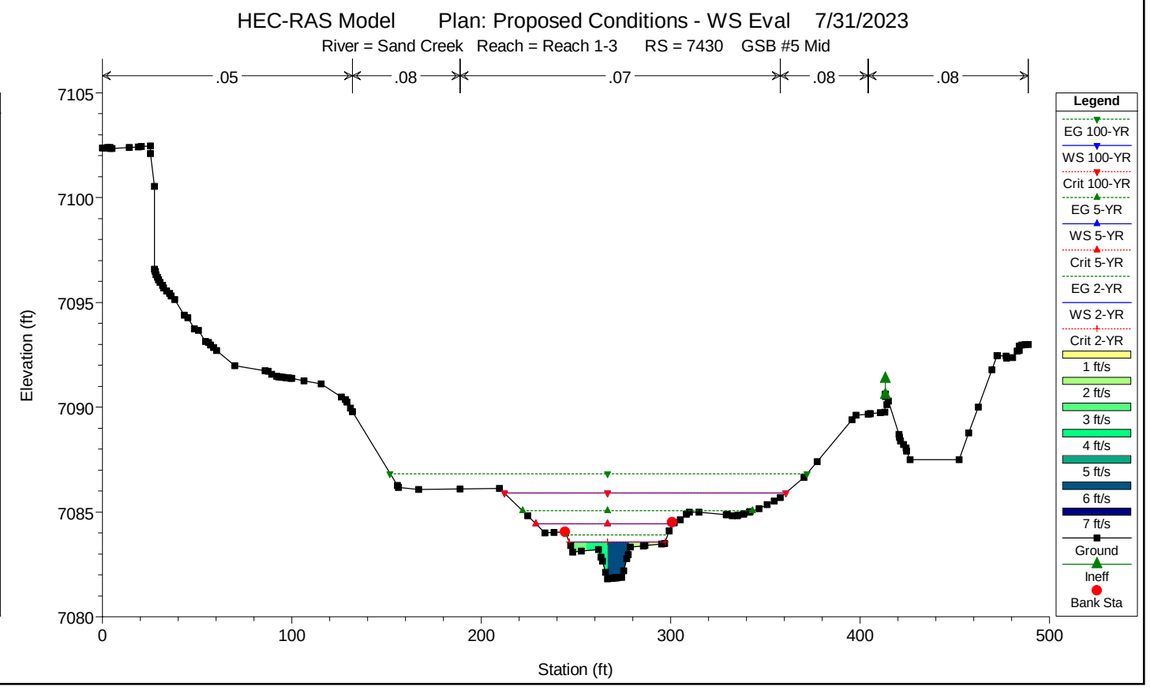


Subcritical flow analysis for Water Surface Evaluation of Naturalized Channel Design except FIS flow rate

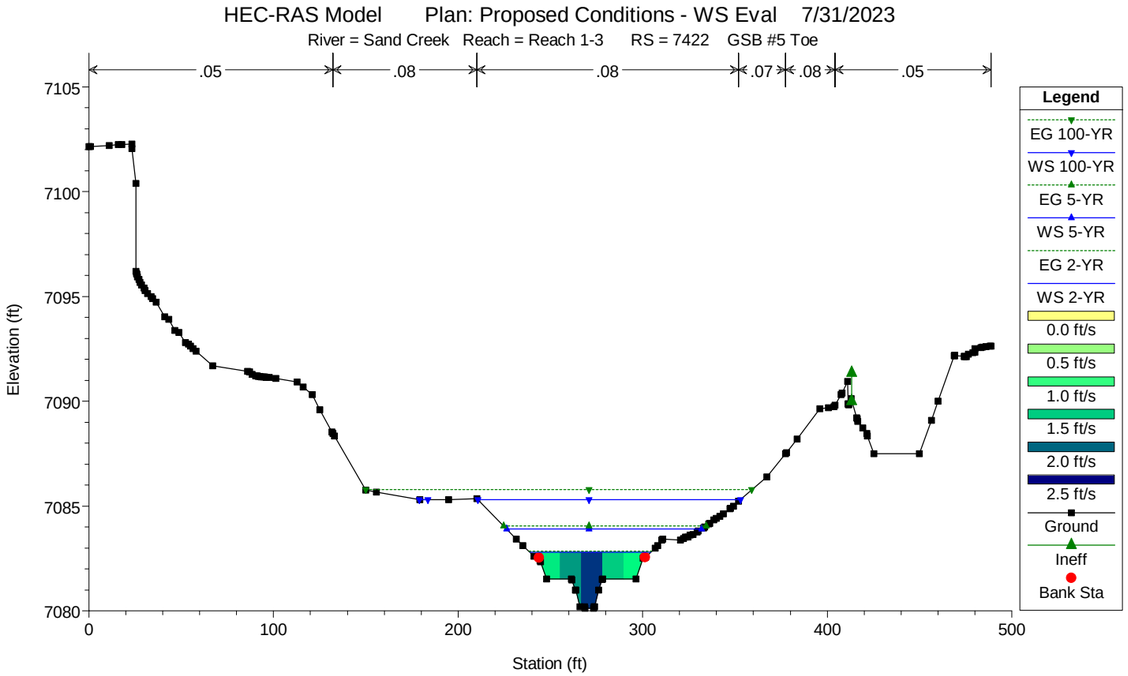


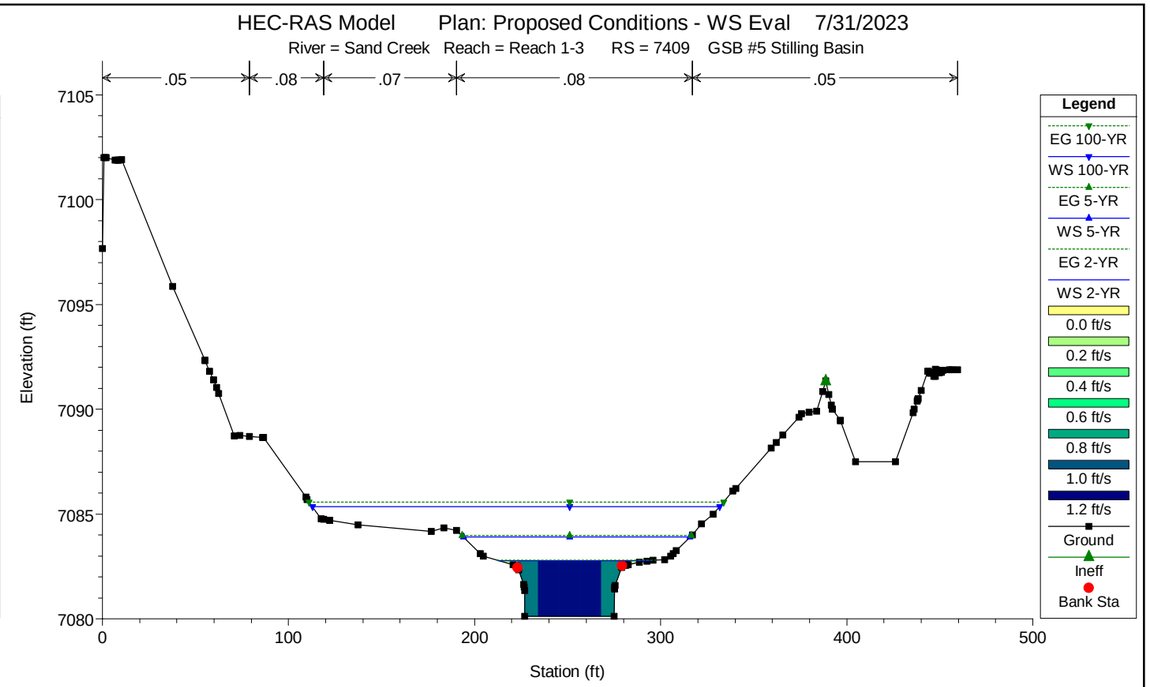


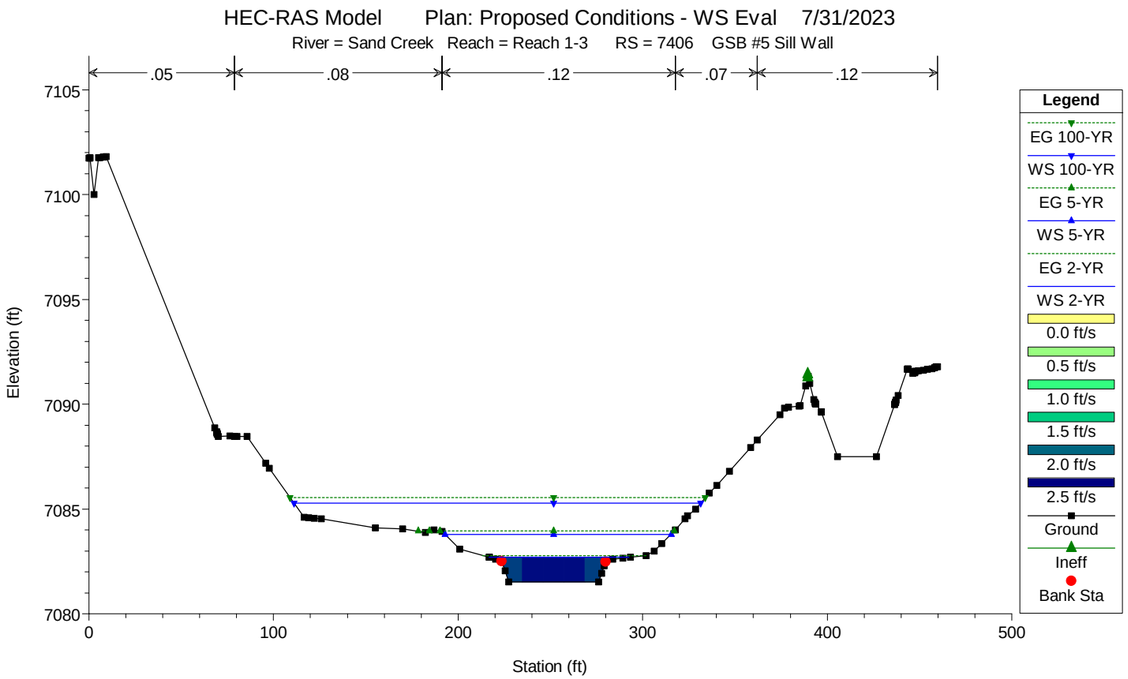


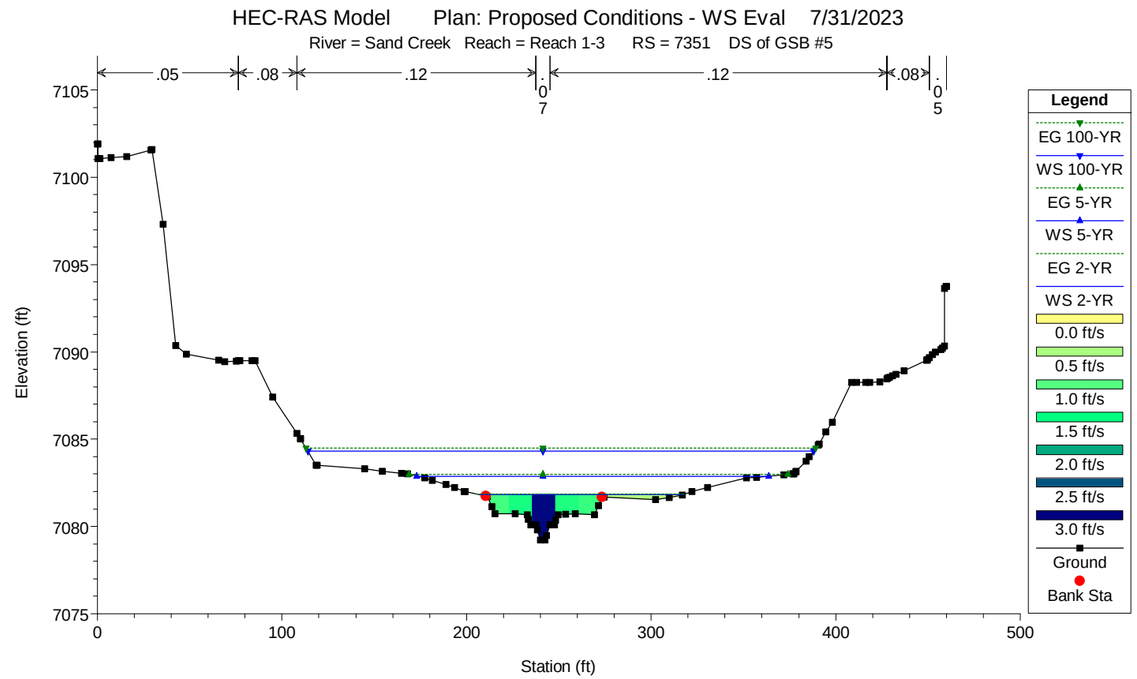


Subcritical flow analysis for Water Surface Evaluation of Naturalized Channel Design except FIS flow rate

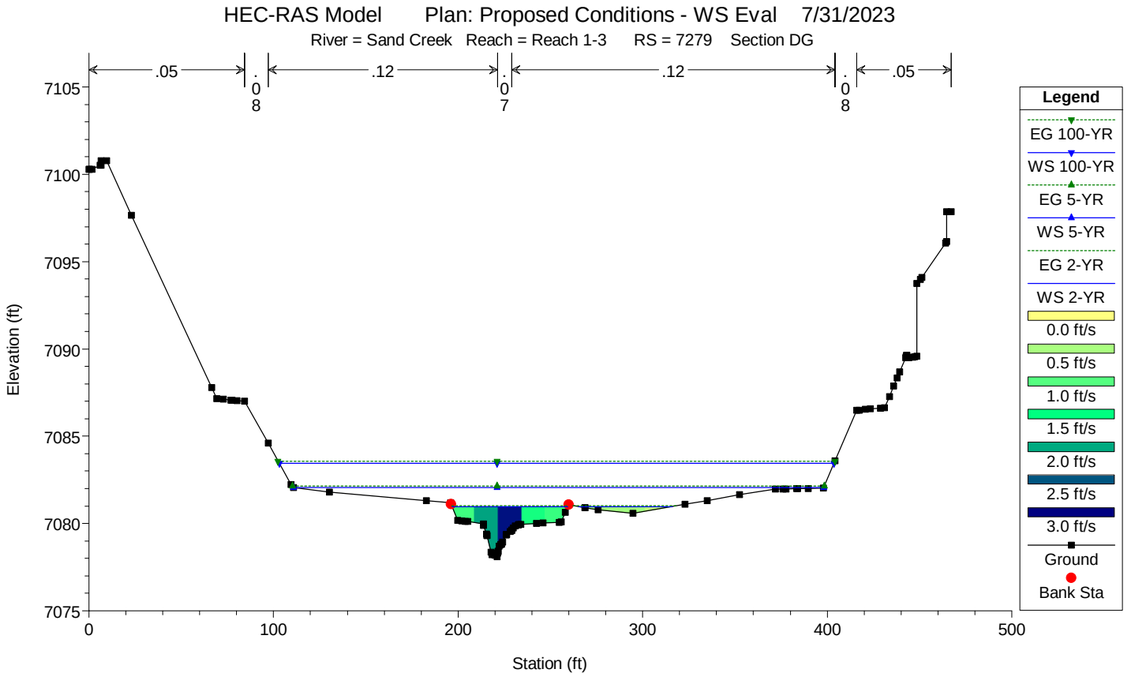


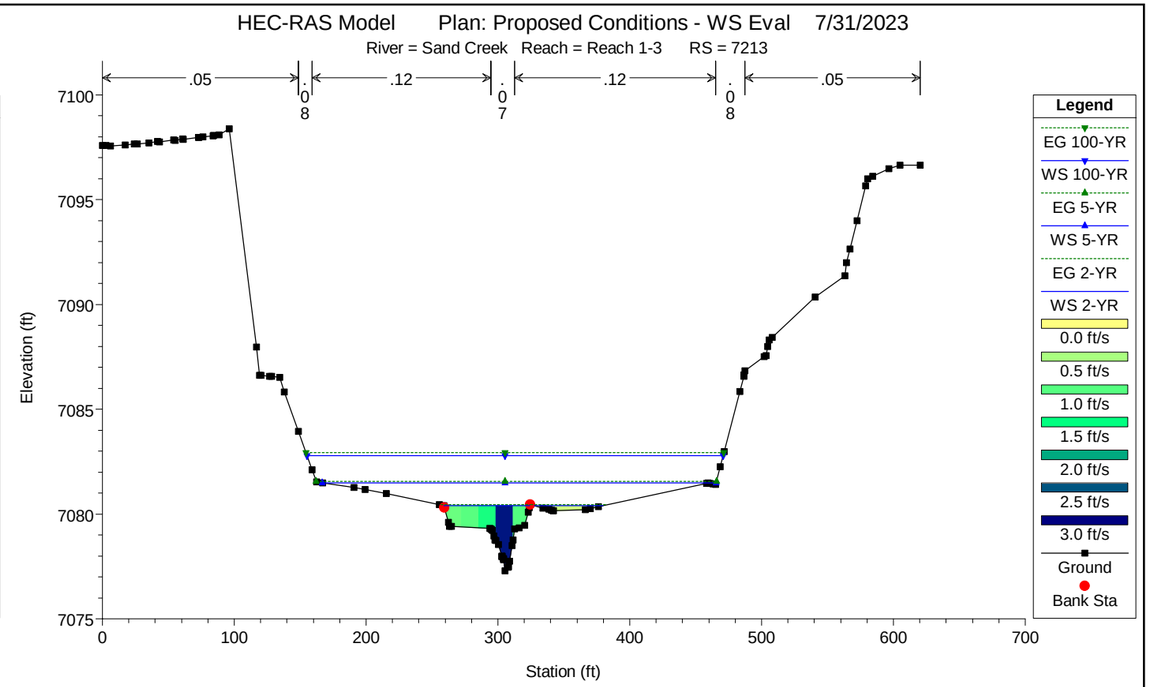


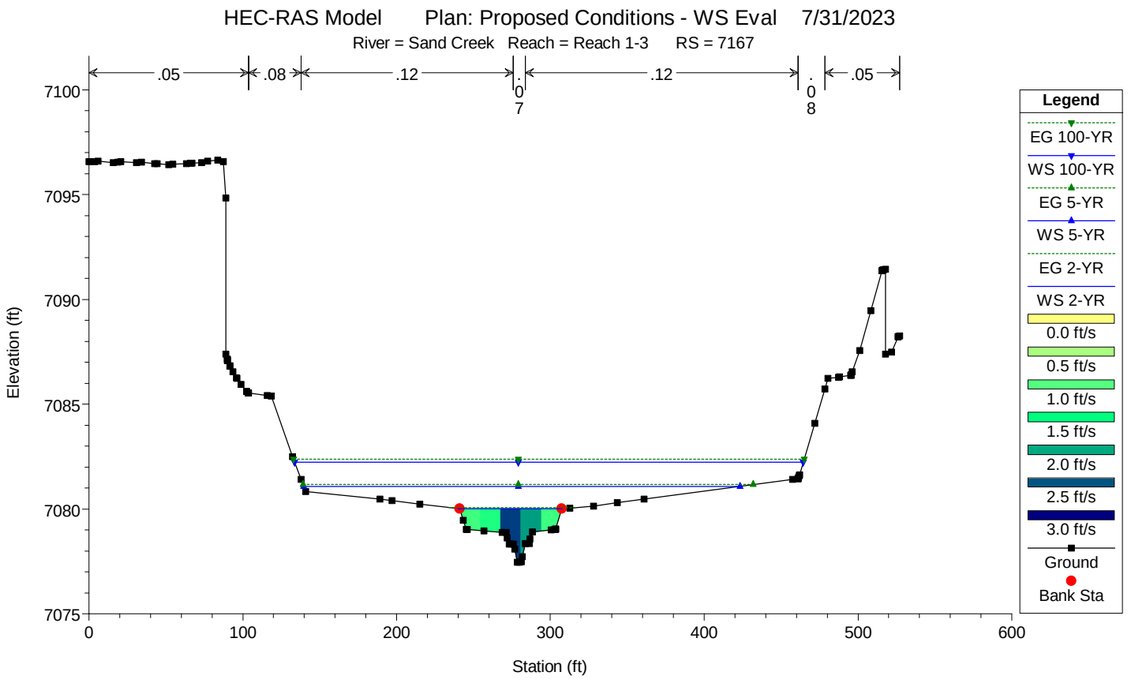


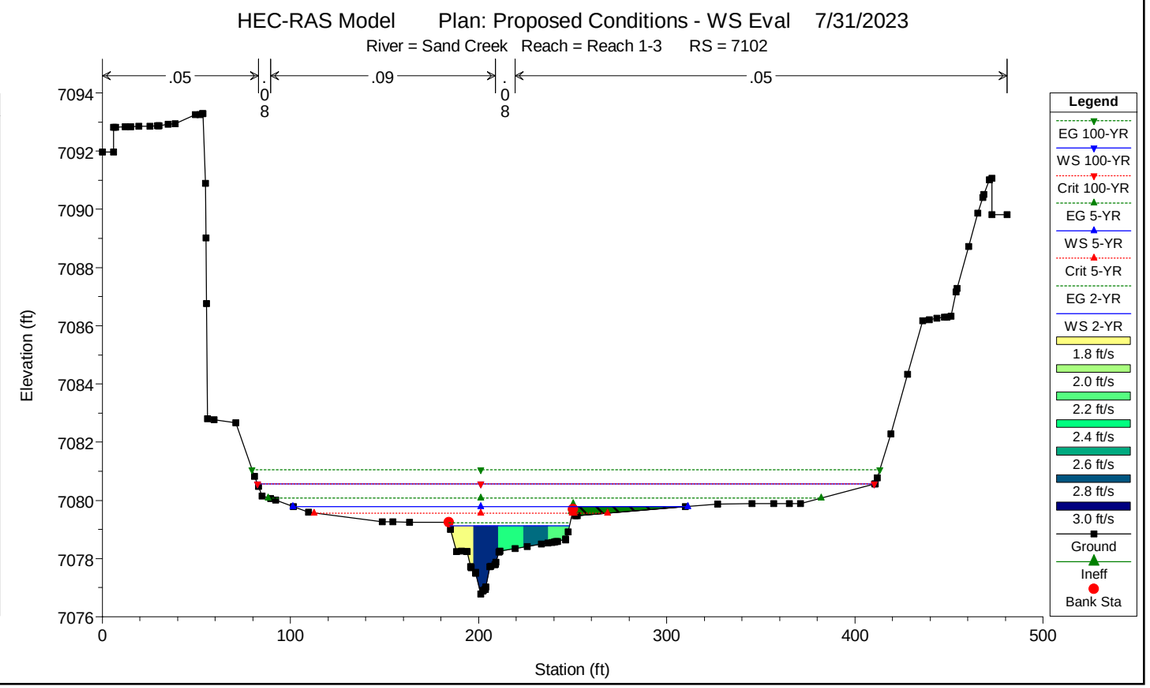


Subcritical flow analysis for Water Surface Evaluation of Naturalized Channel Design except FIS flow rate

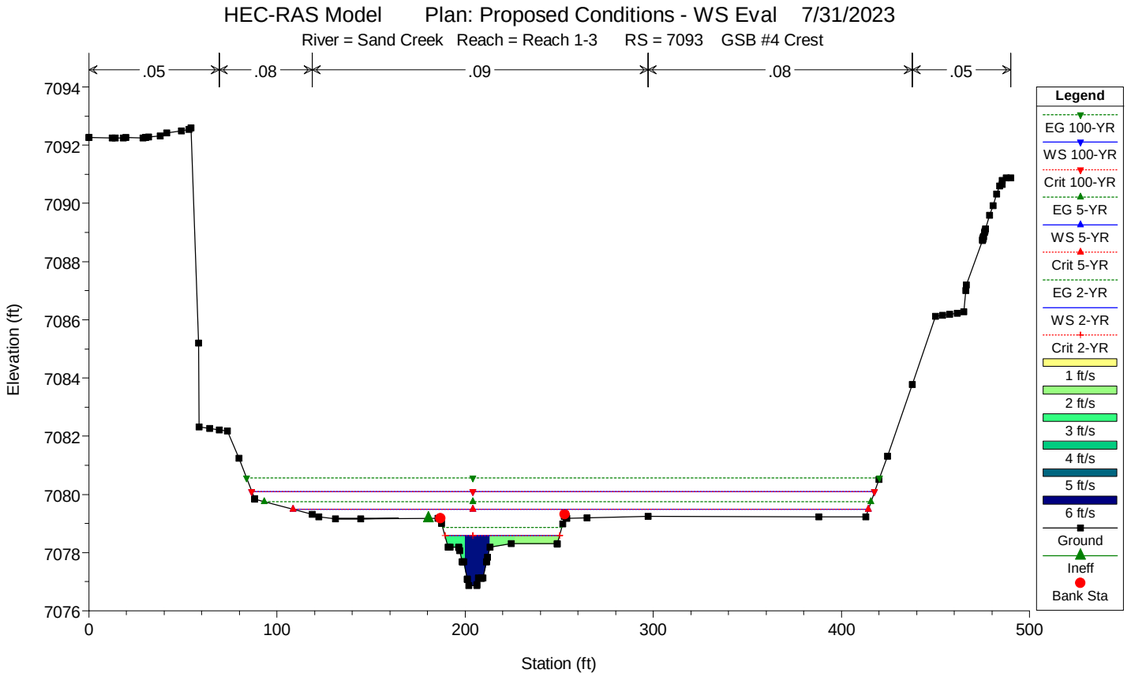


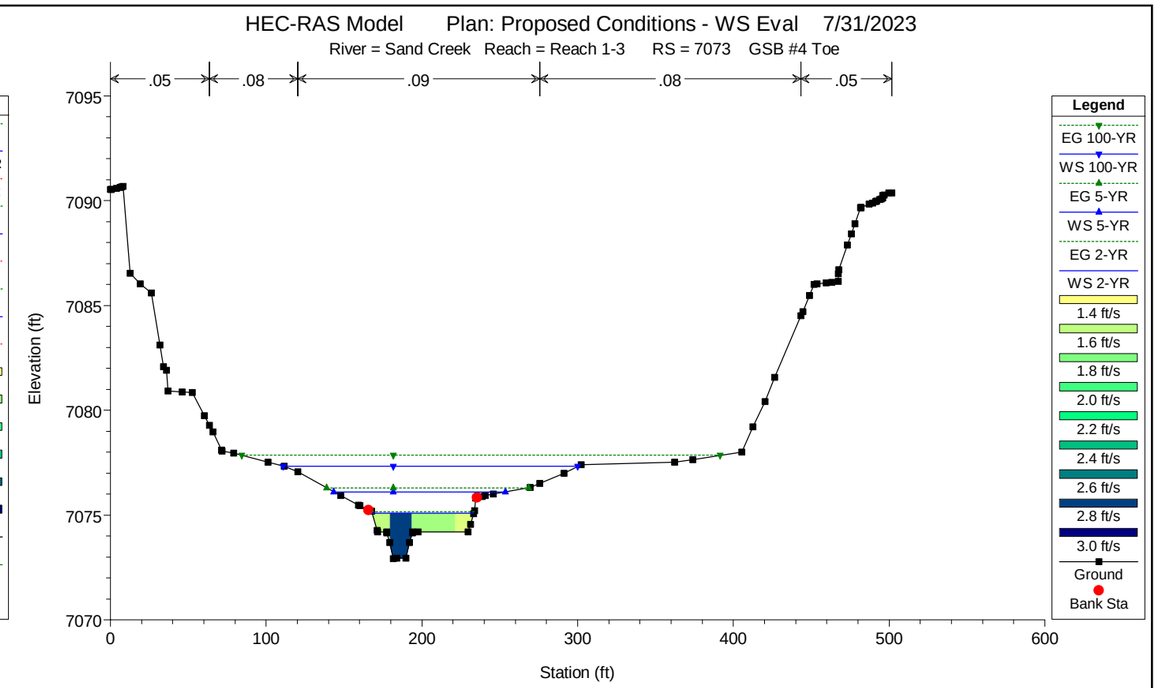


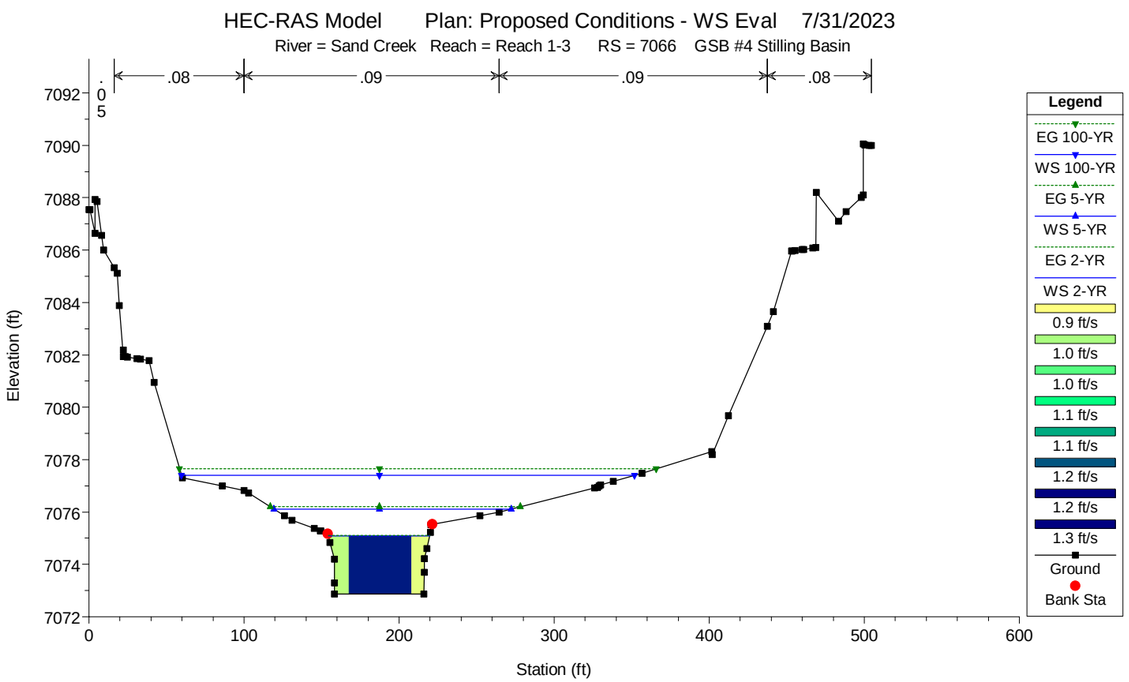


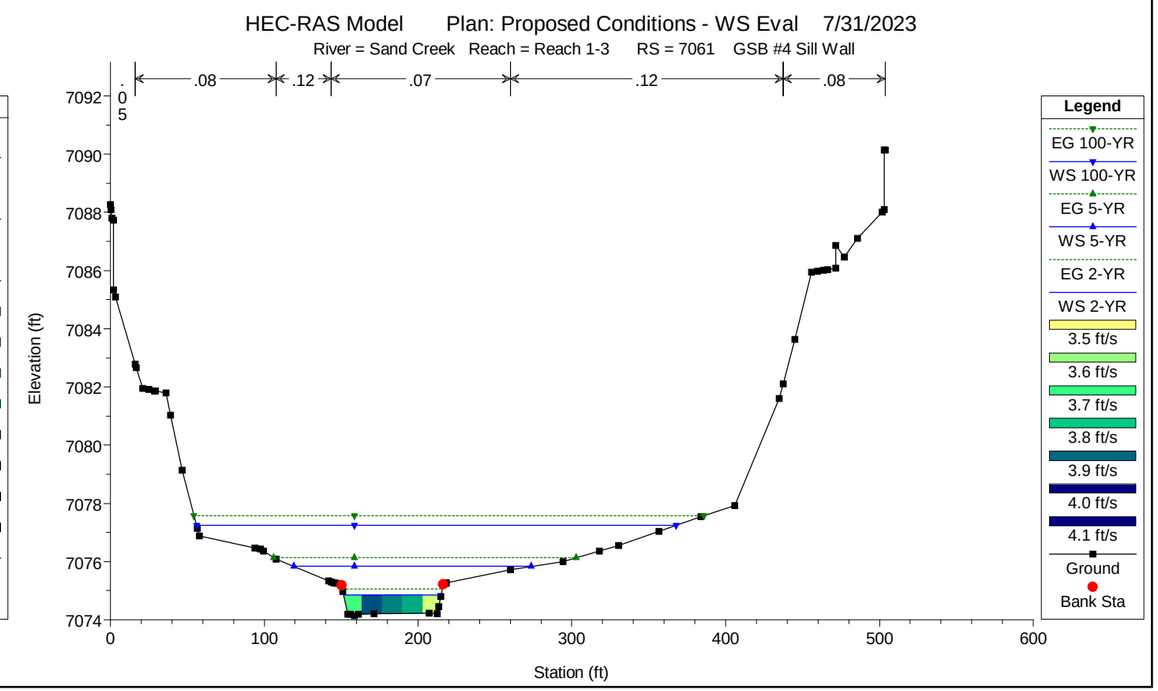


Subcritical flow analysis for Water Surface Evaluation of Naturalized Channel Design except FIS flow rate

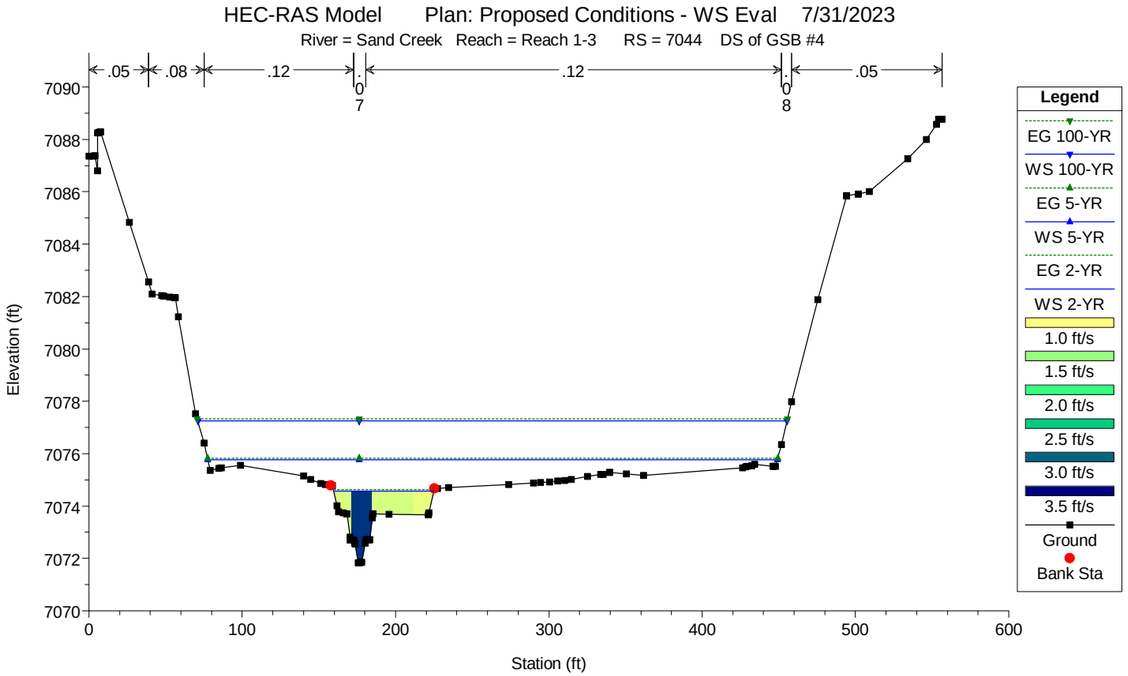


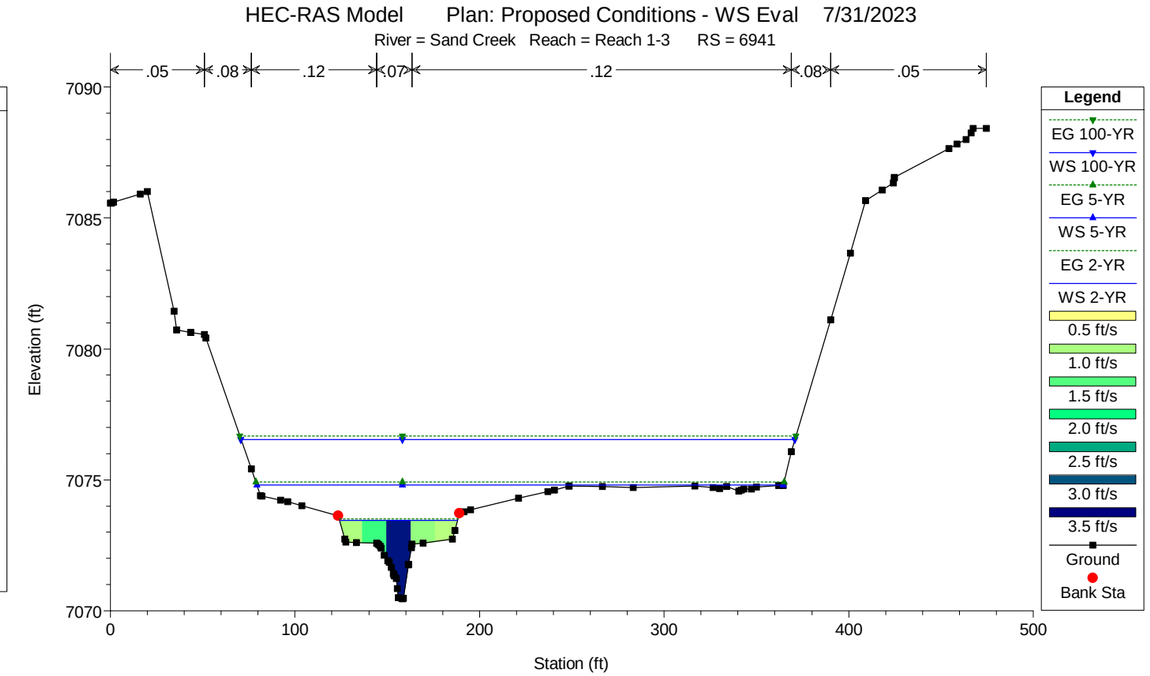


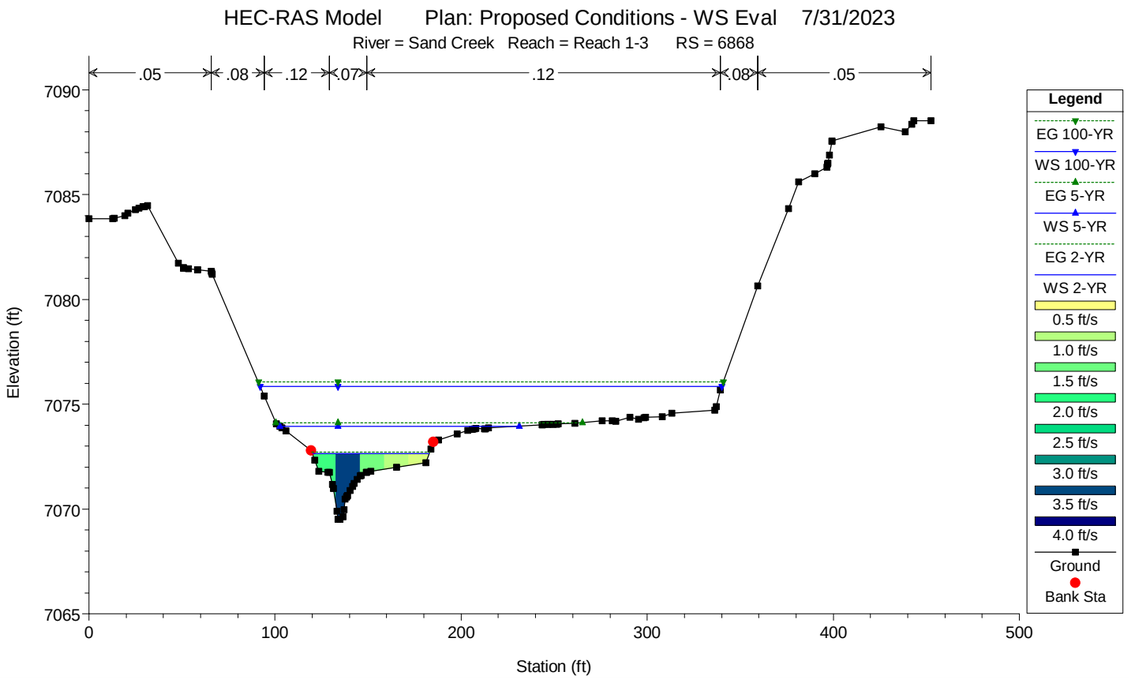


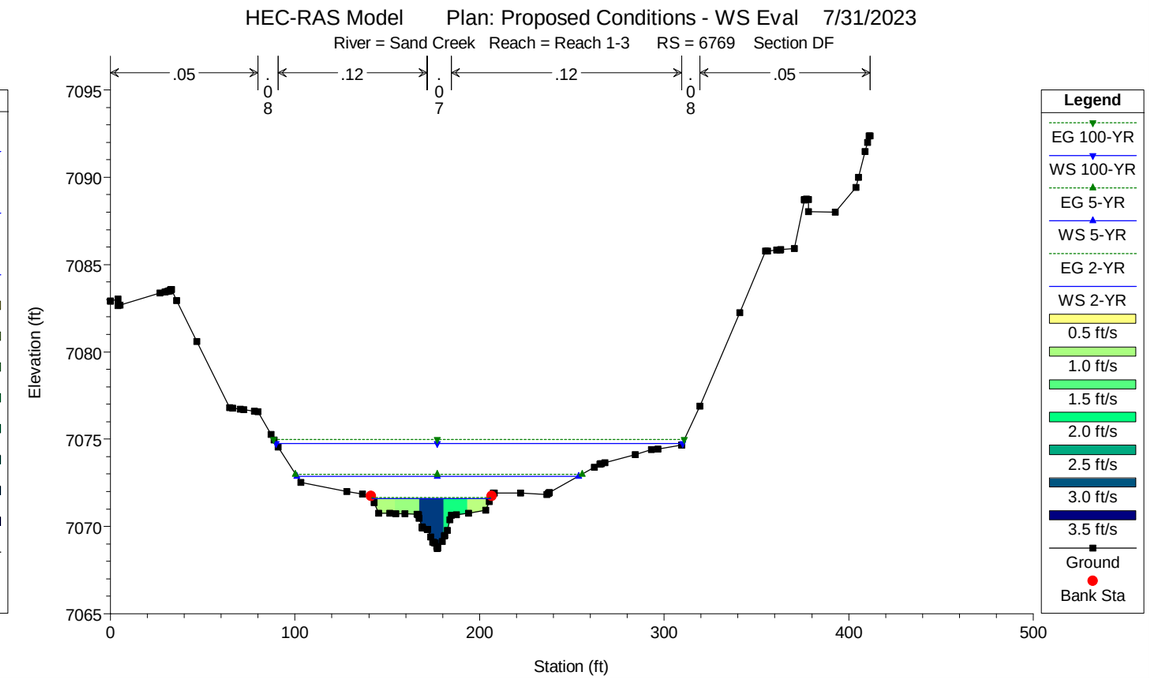


Subcritical flow analysis for Water Surface Evaluation of Naturalized Channel Design except FIS flow rate

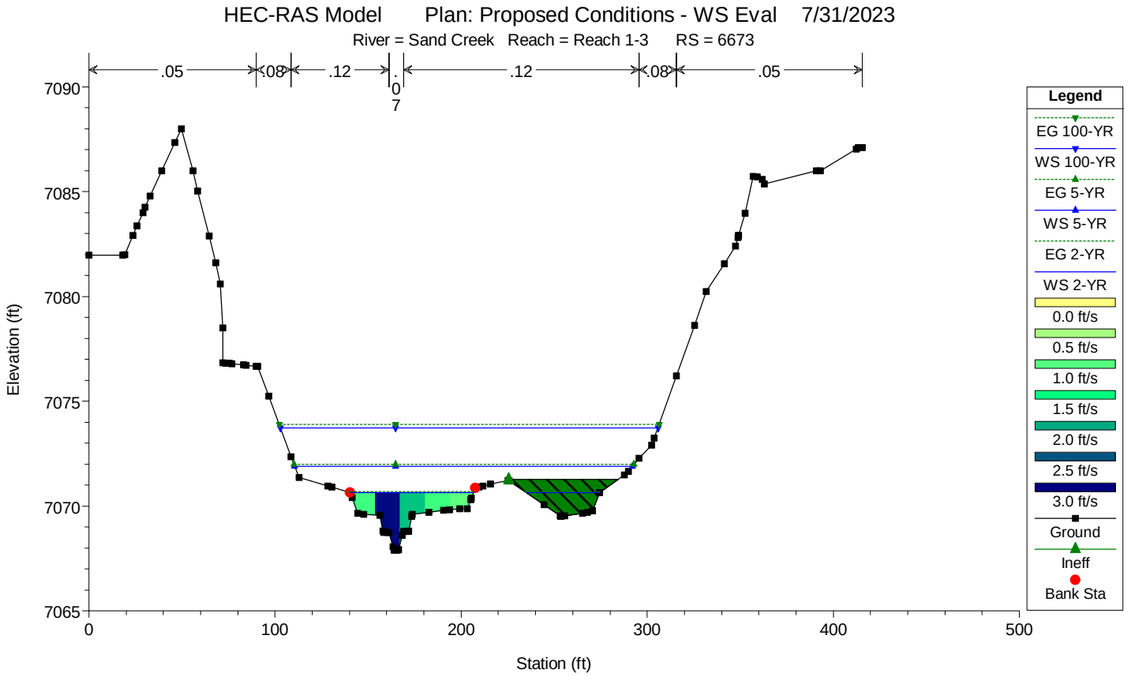


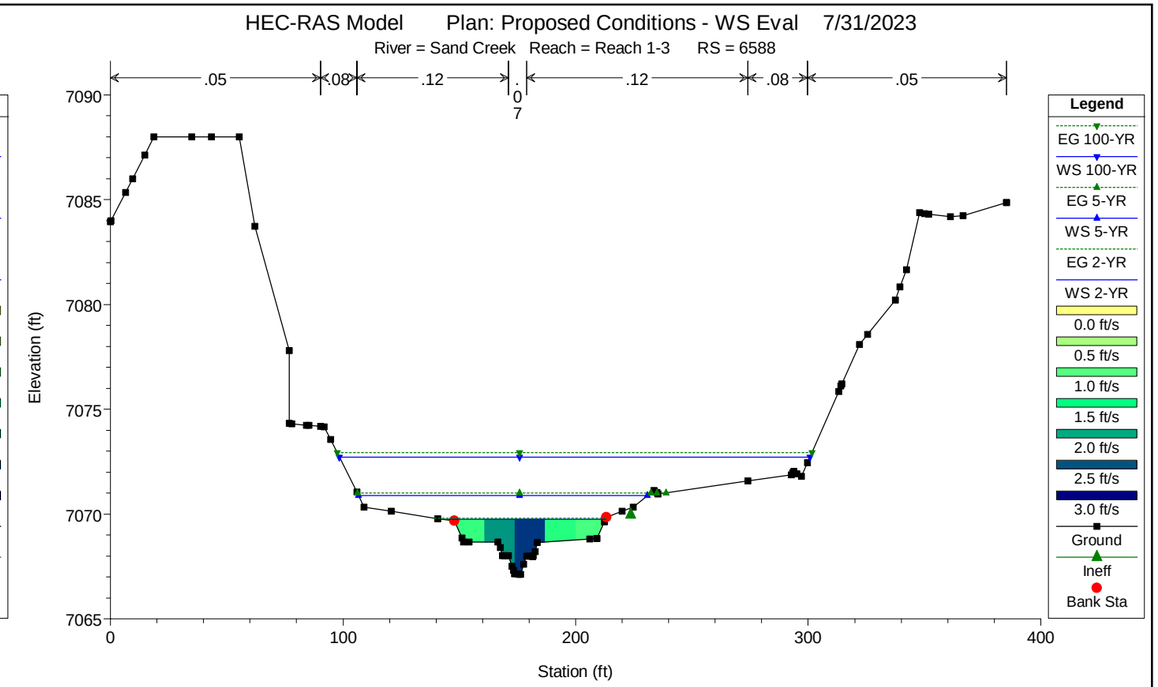


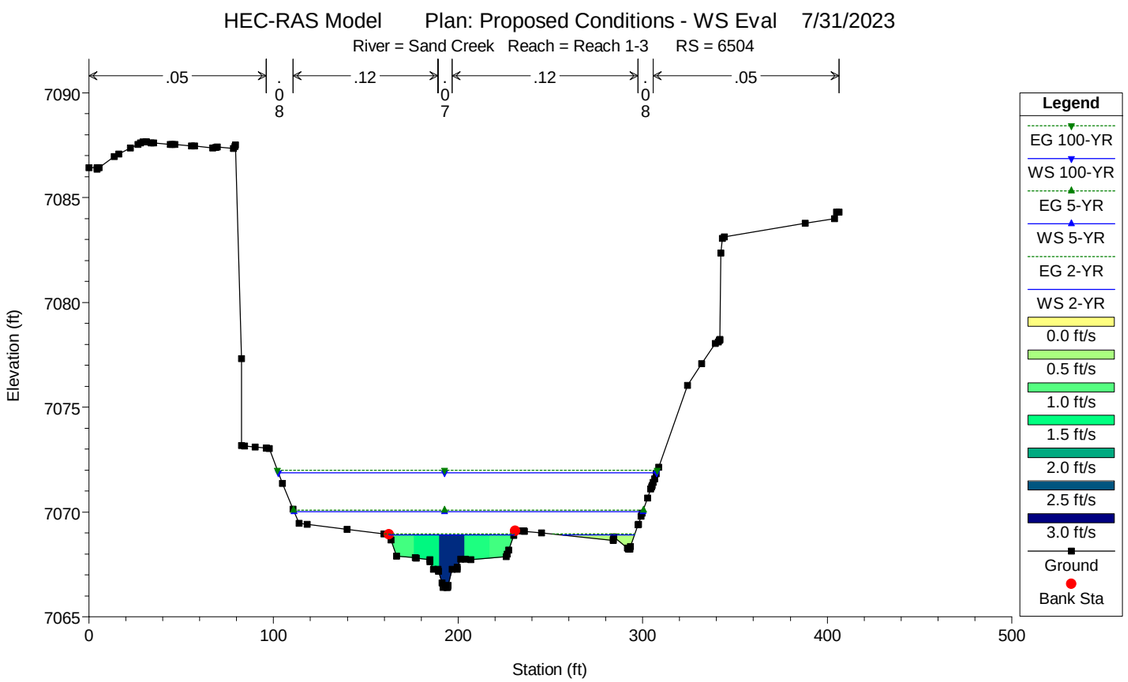


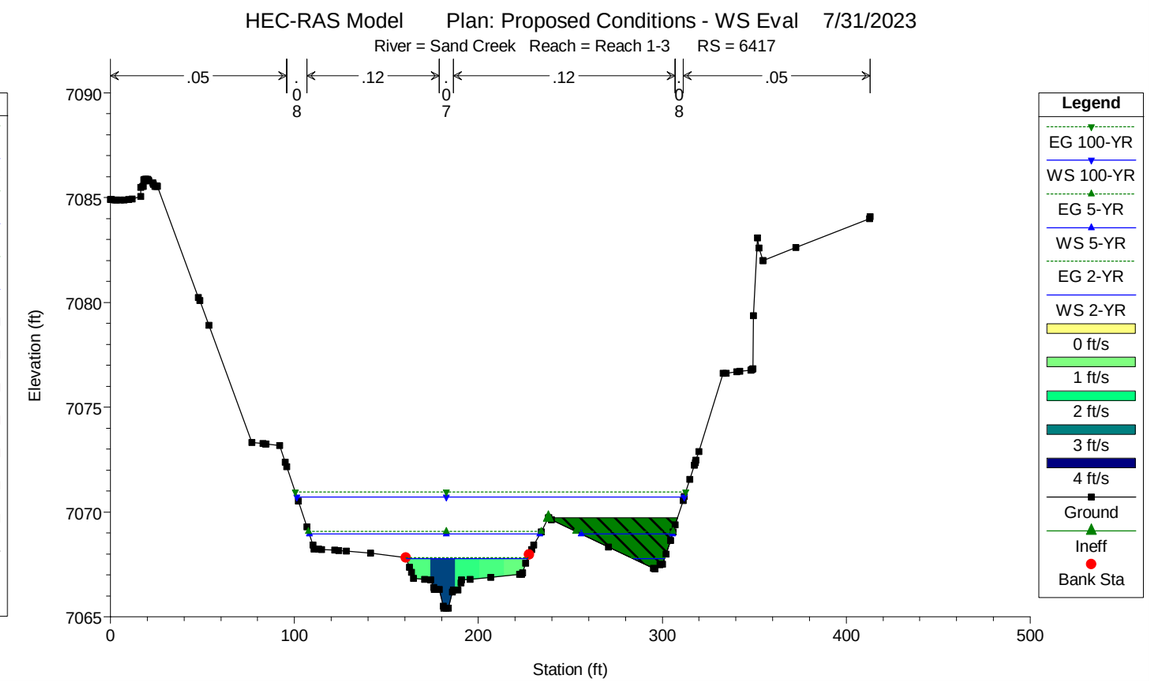


Subcritical flow analysis for Water Surface Evaluation of Naturalized Channel Design except FIS flow rate

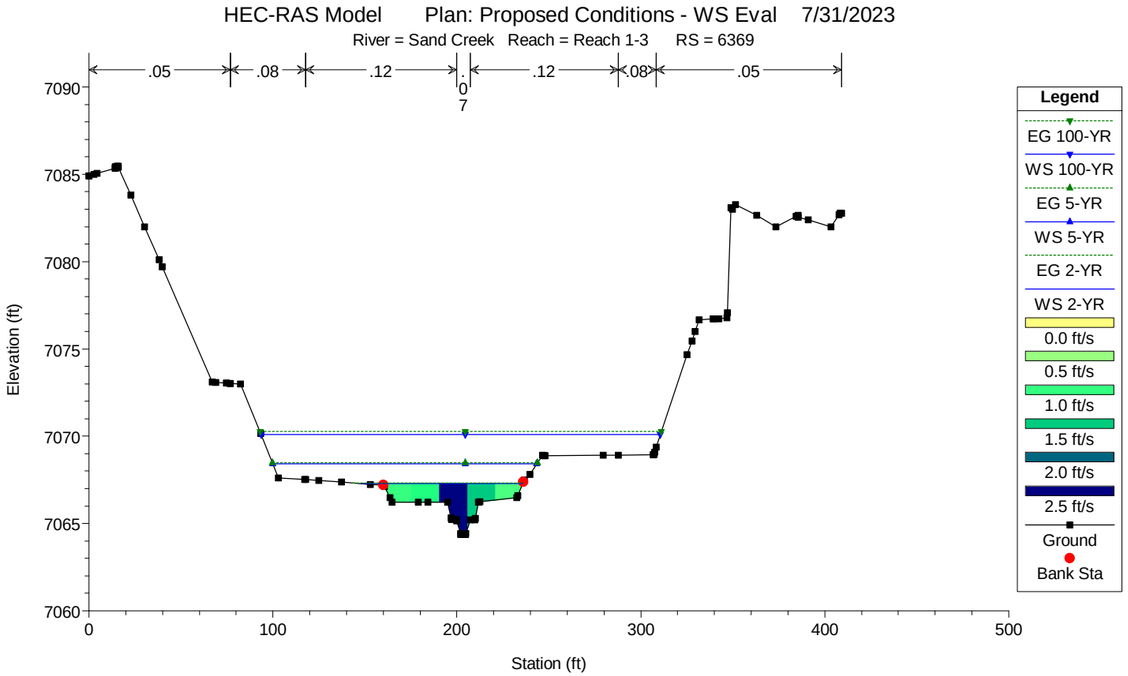


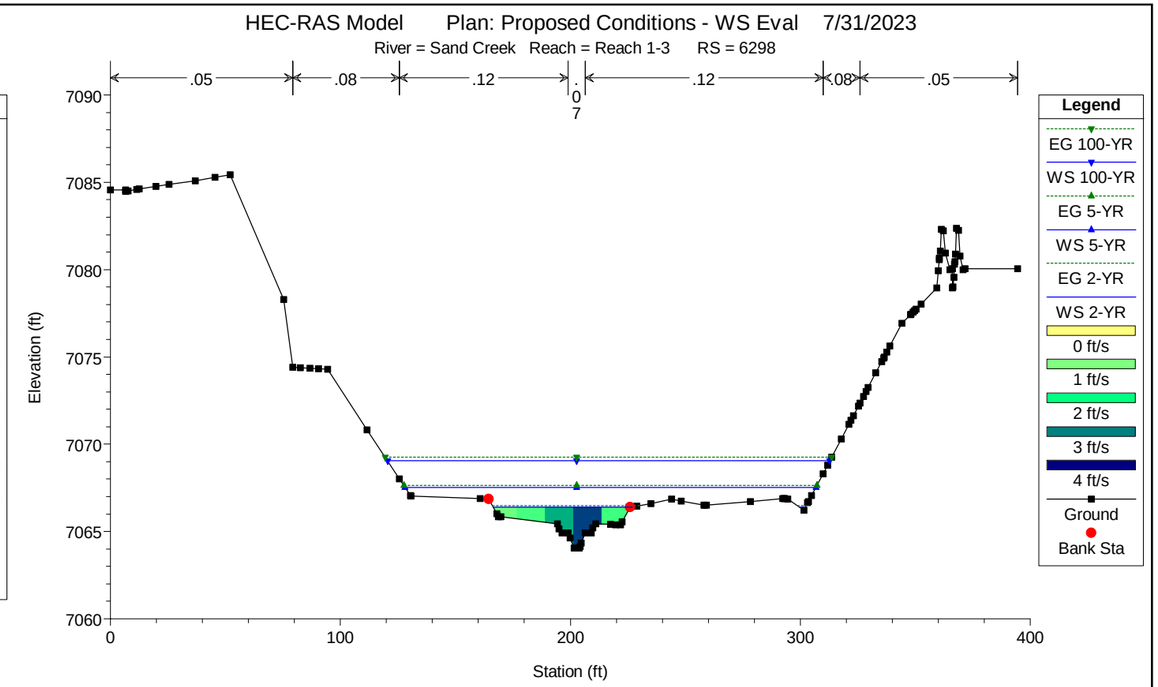


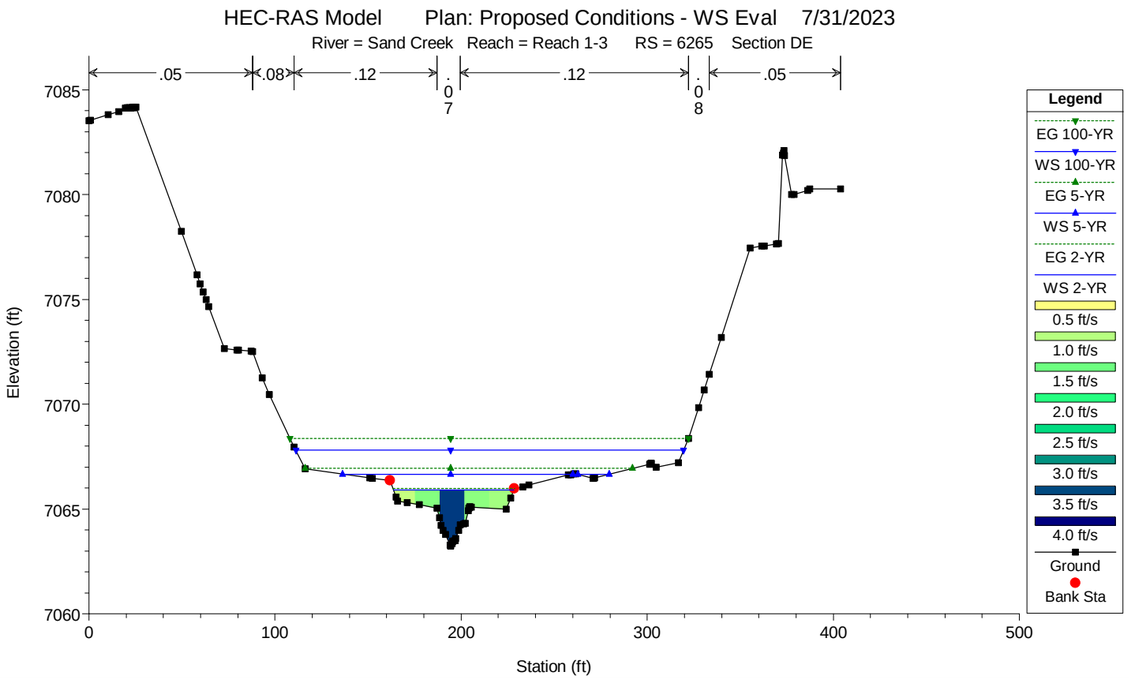


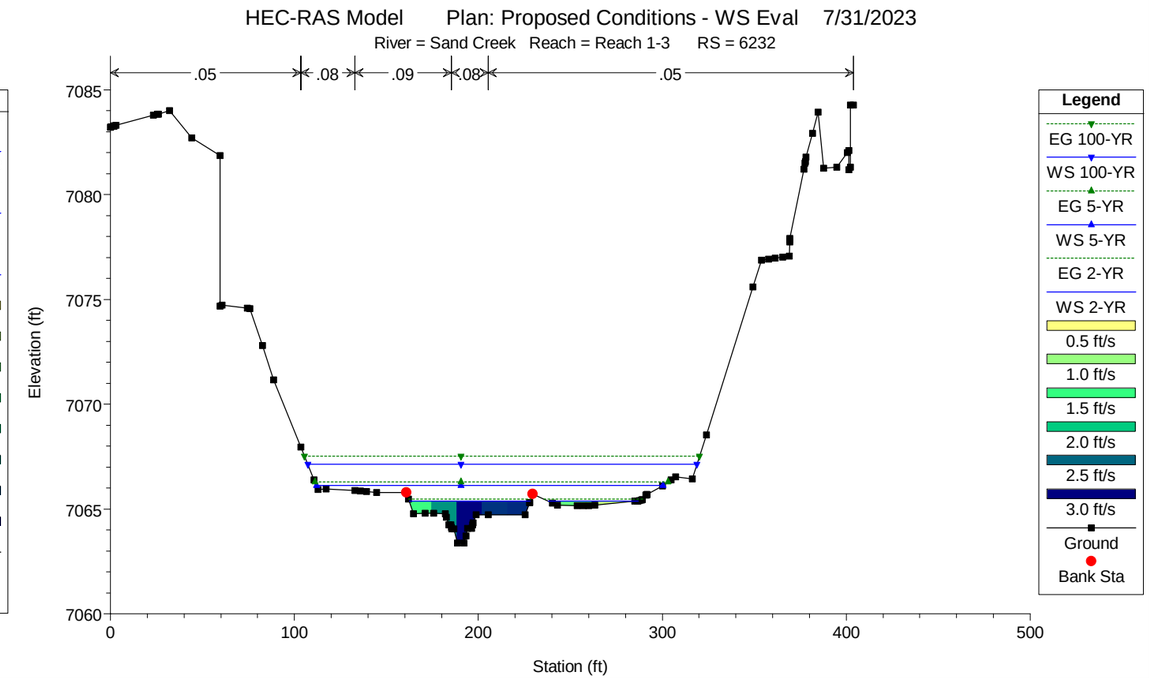


Subcritical flow analysis for Water Surface Evaluation of Naturalized Channel Design except FIS flow rate

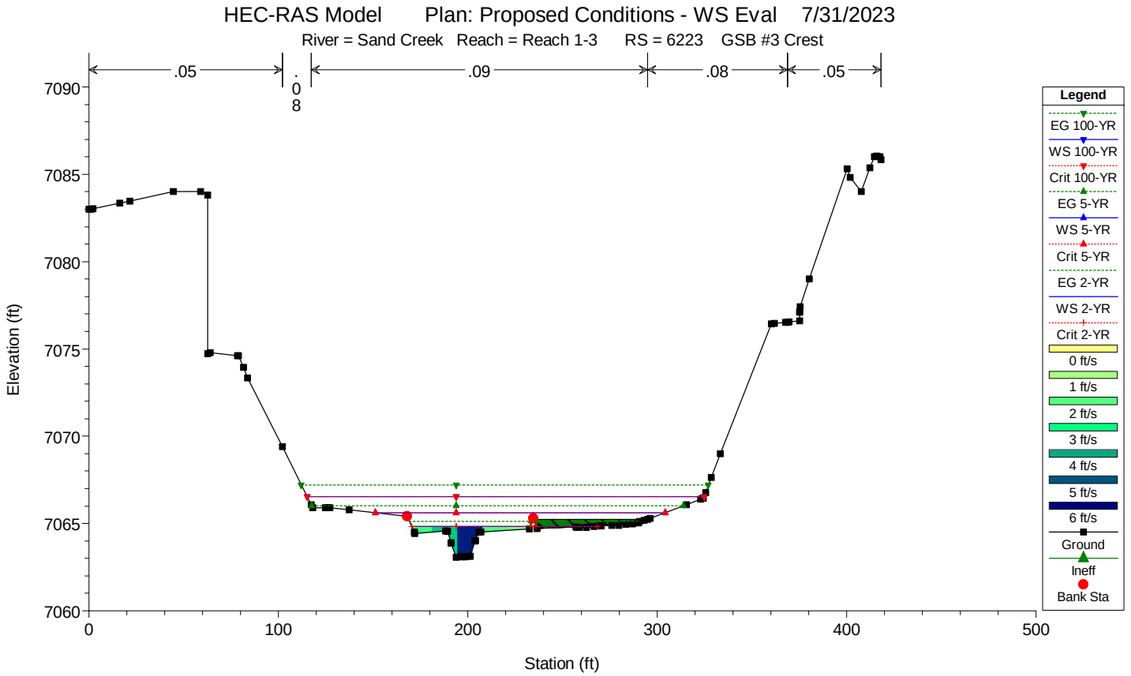


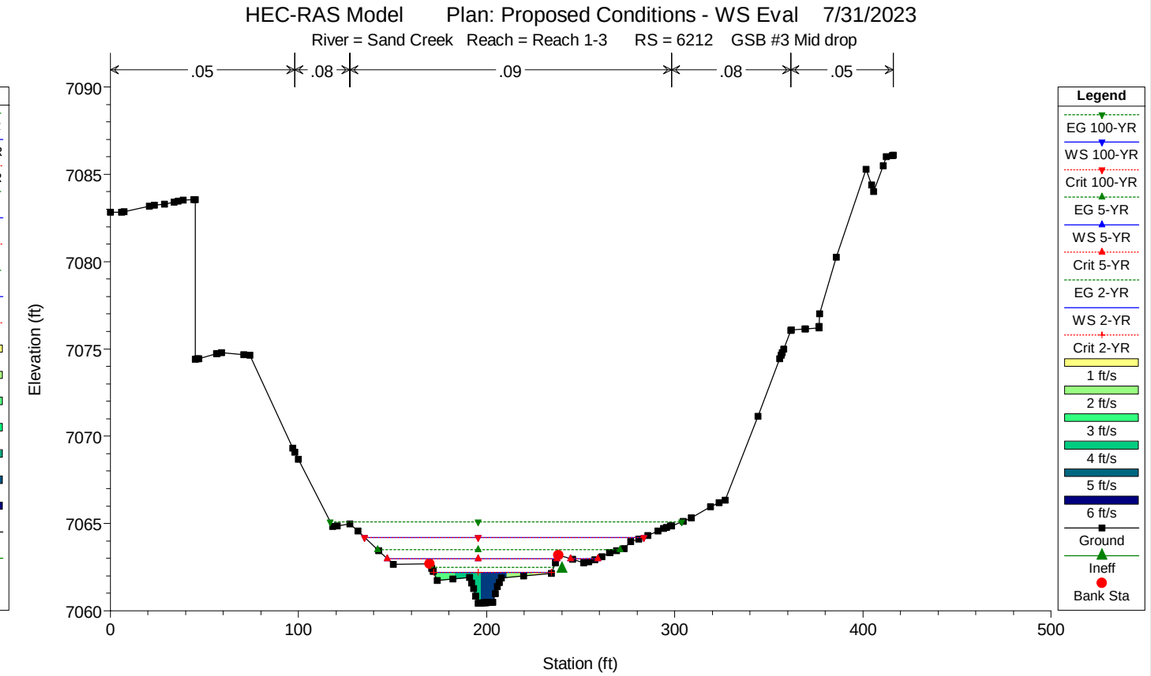


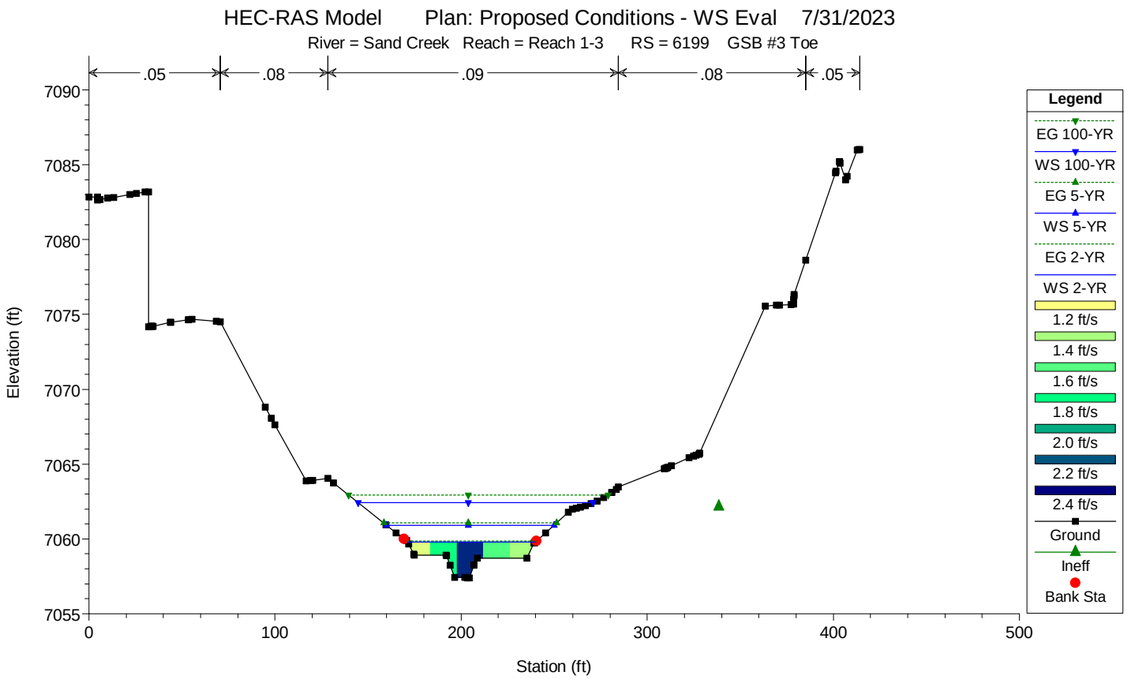


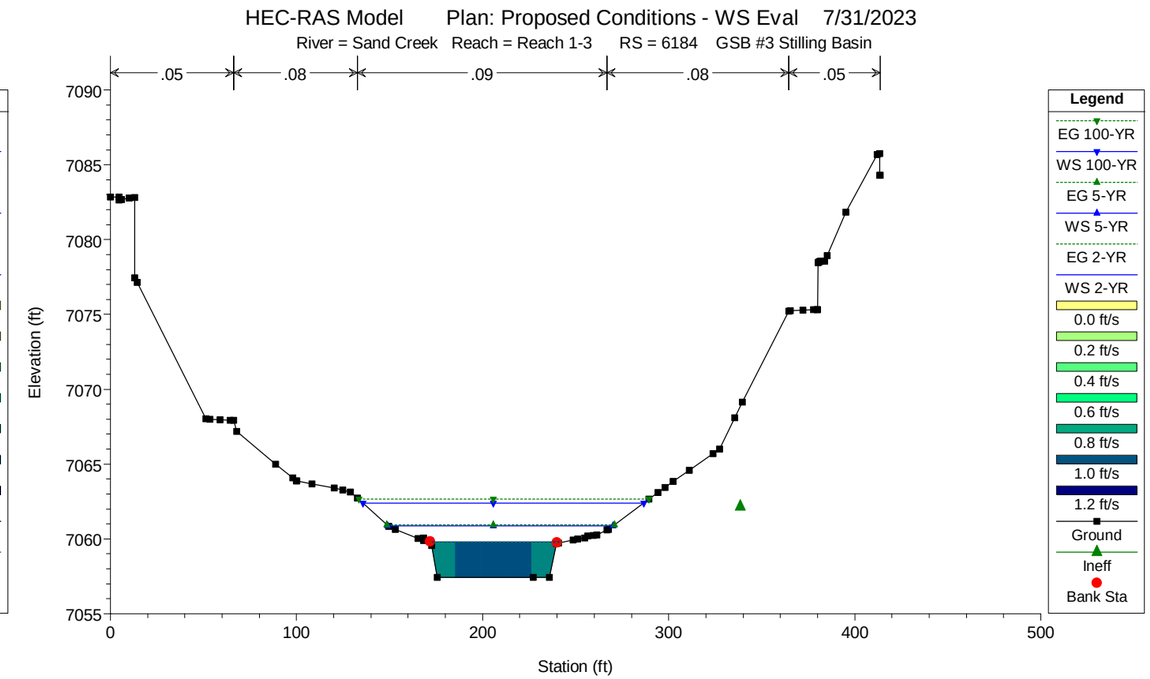


Subcritical flow analysis for Water Surface Evaluation of Naturalized Channel Design except FIS flow rate

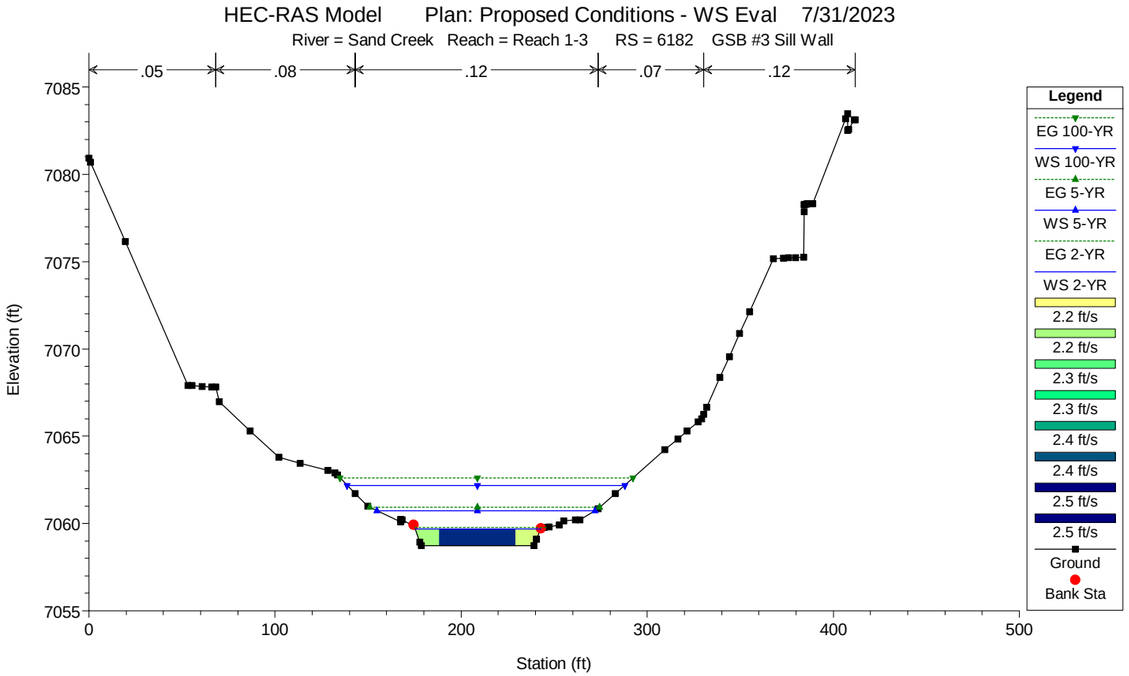


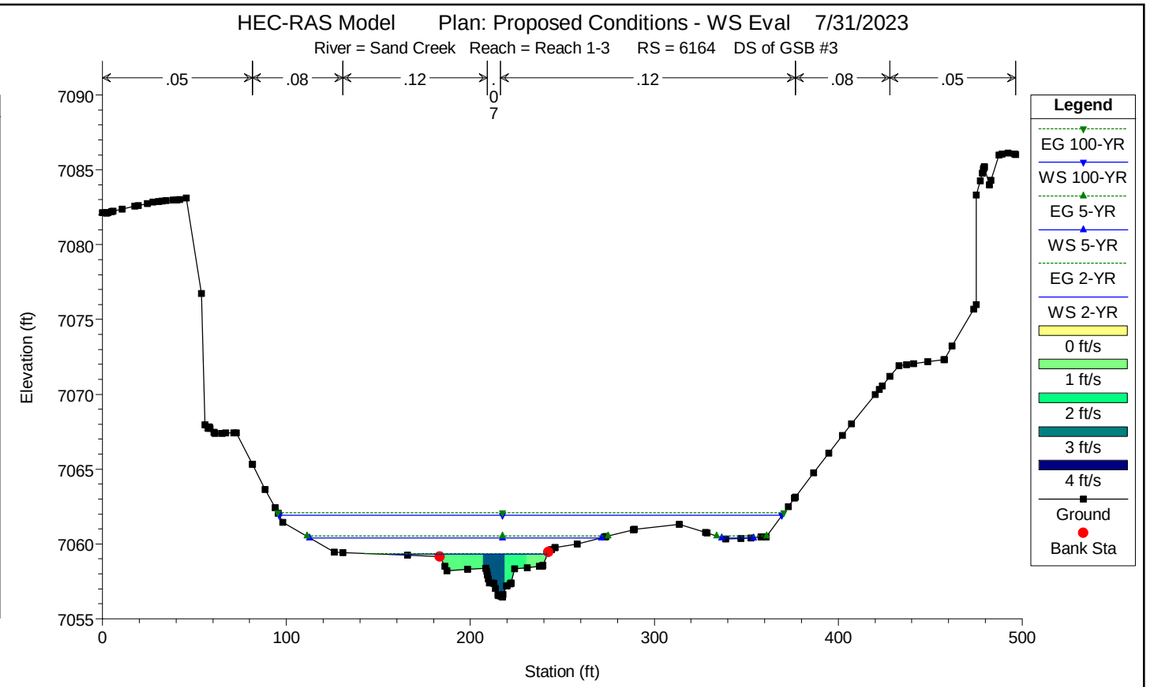


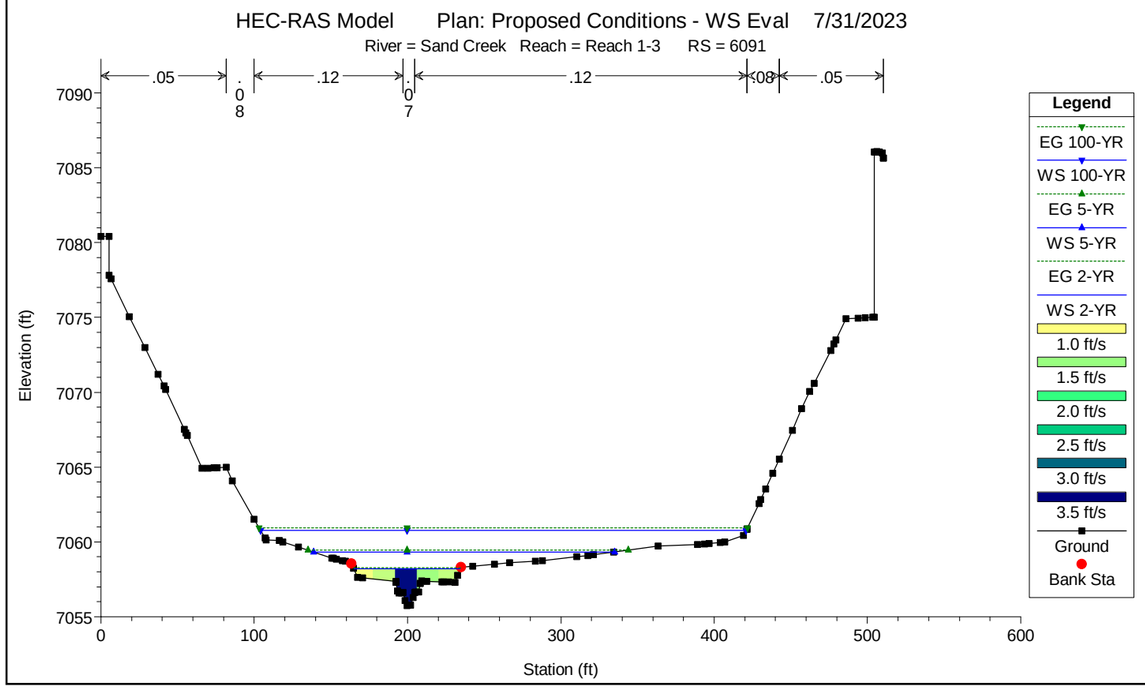


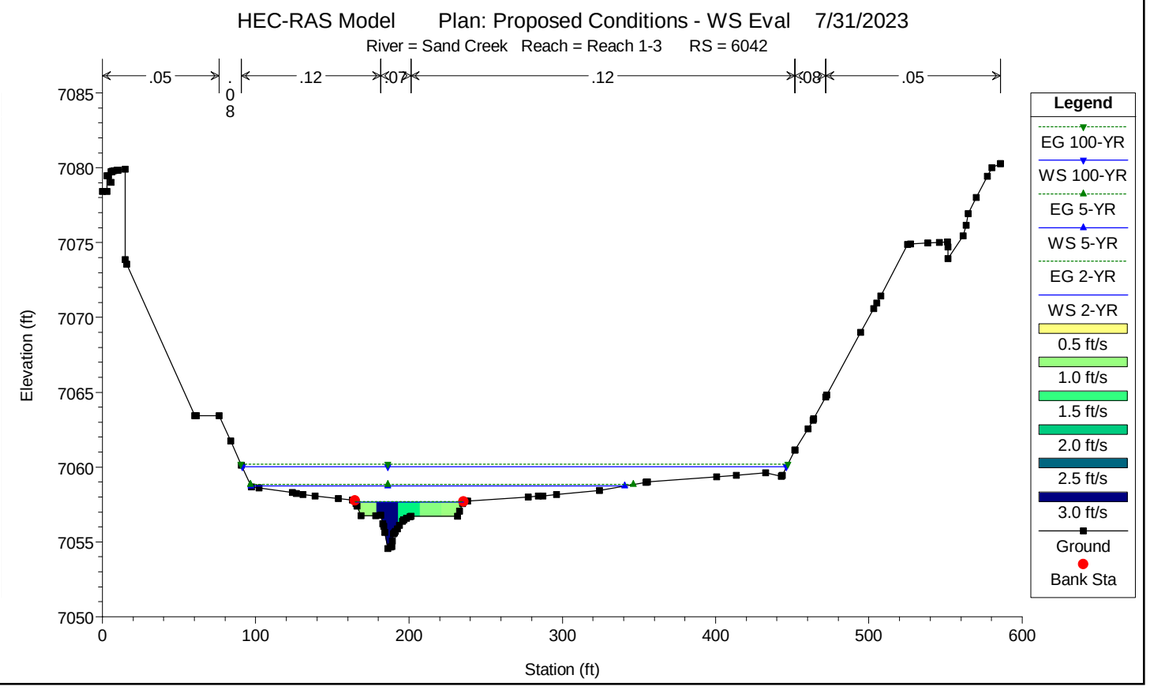


Subcritical flow analysis for Water Surface Evaluation of Naturalized Channel Design except FIS flow rate

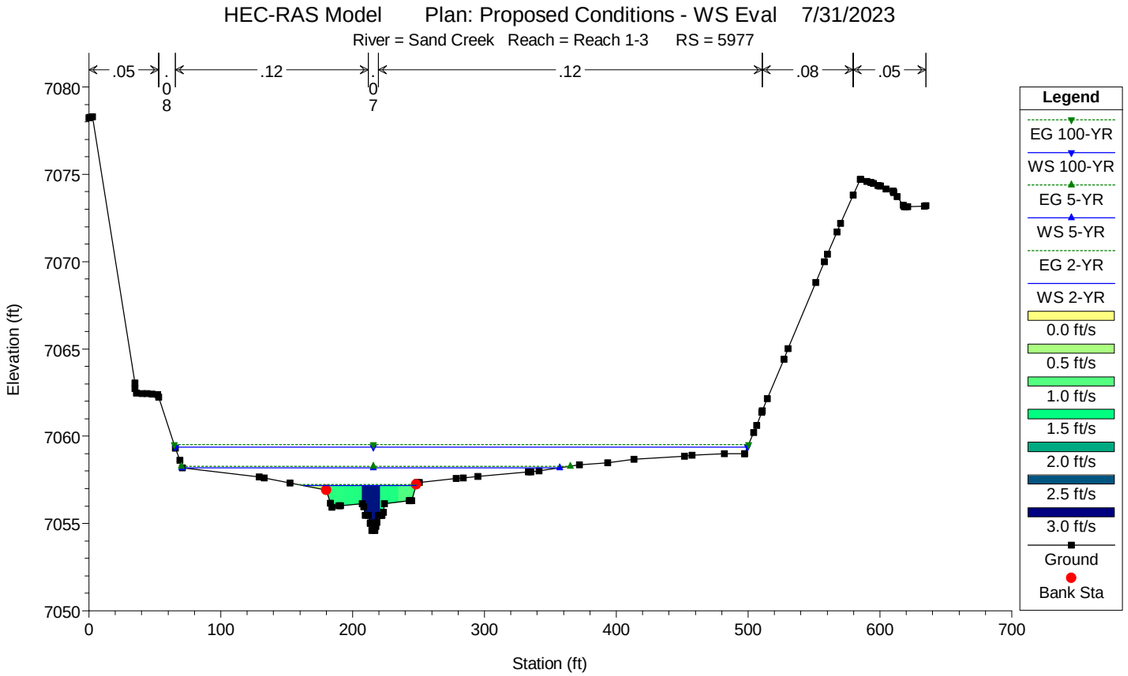


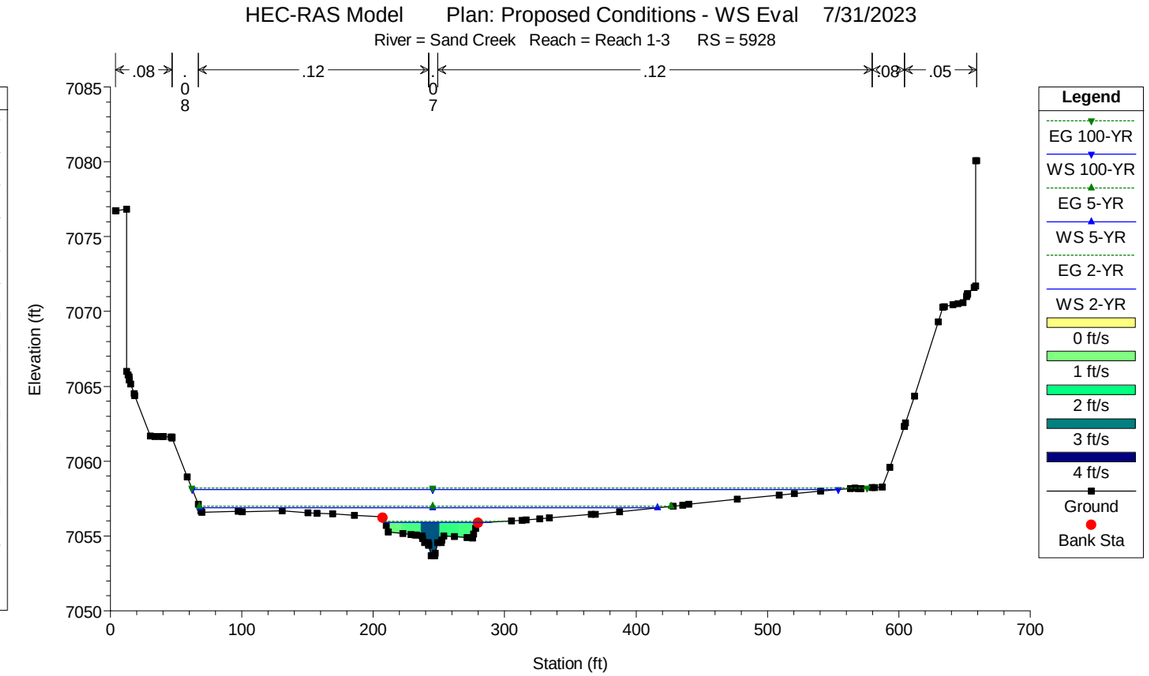


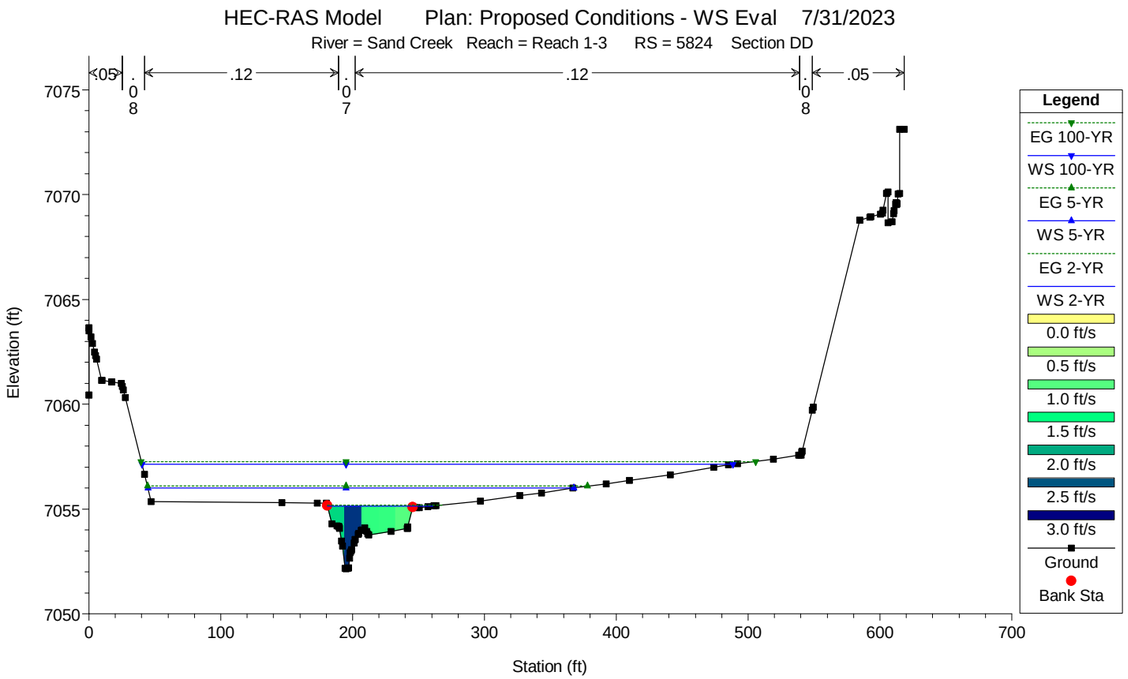


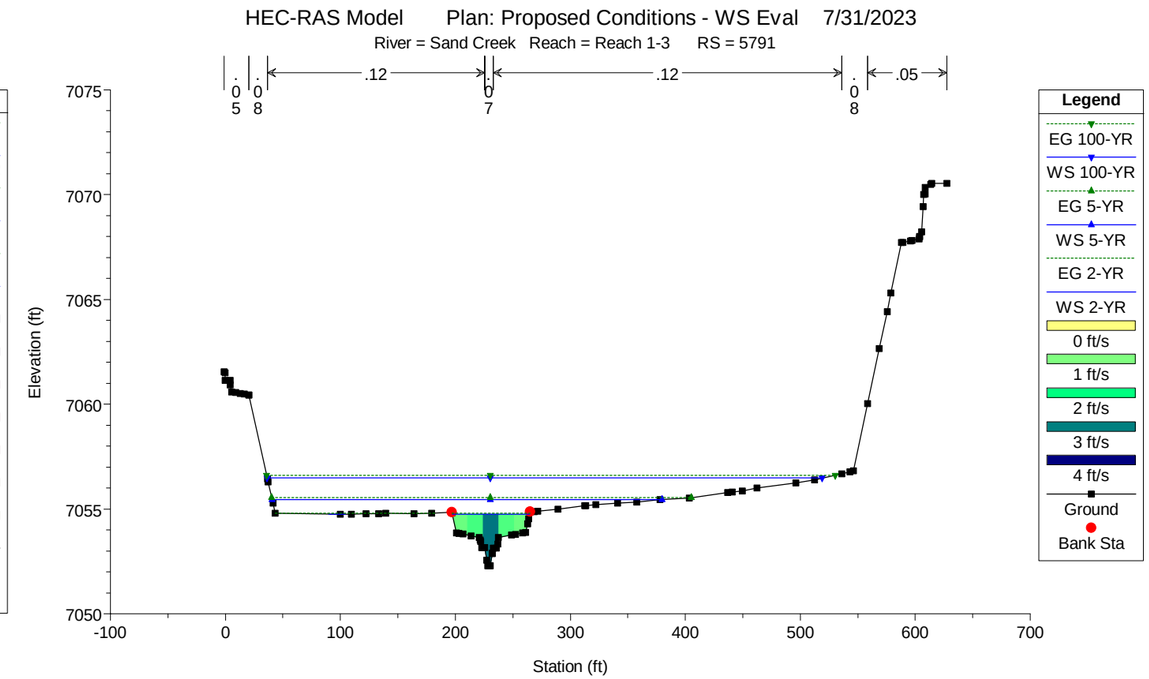


Subcritical flow analysis for Water Surface Evaluation of Naturalized Channel Design except FIS flow rate

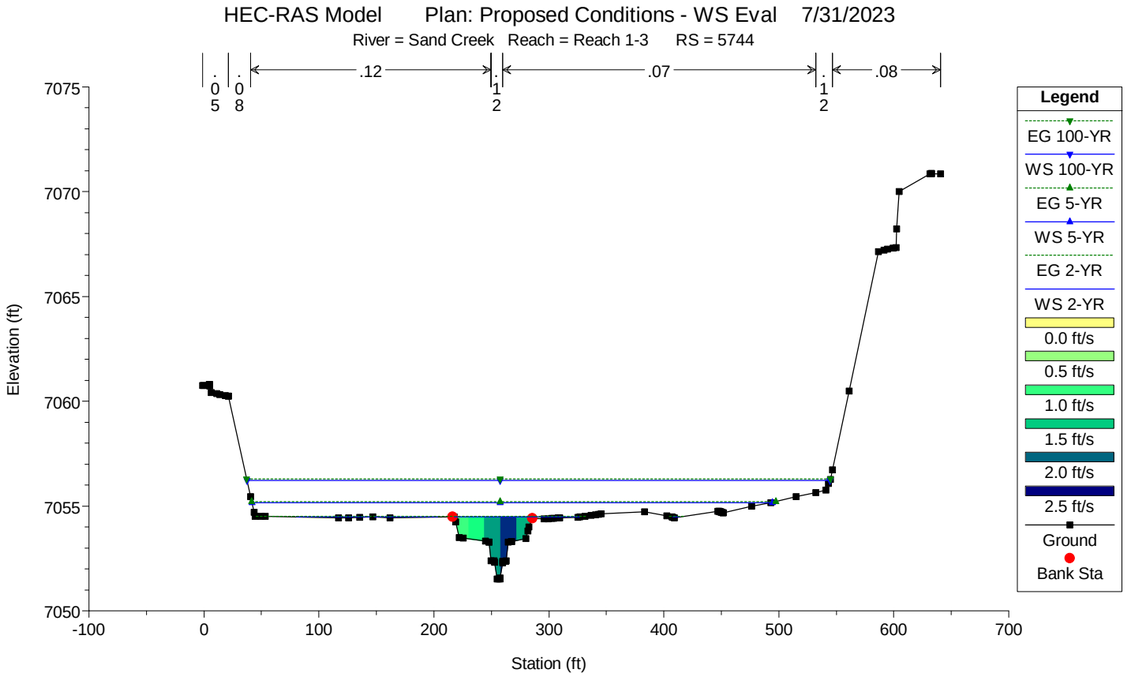


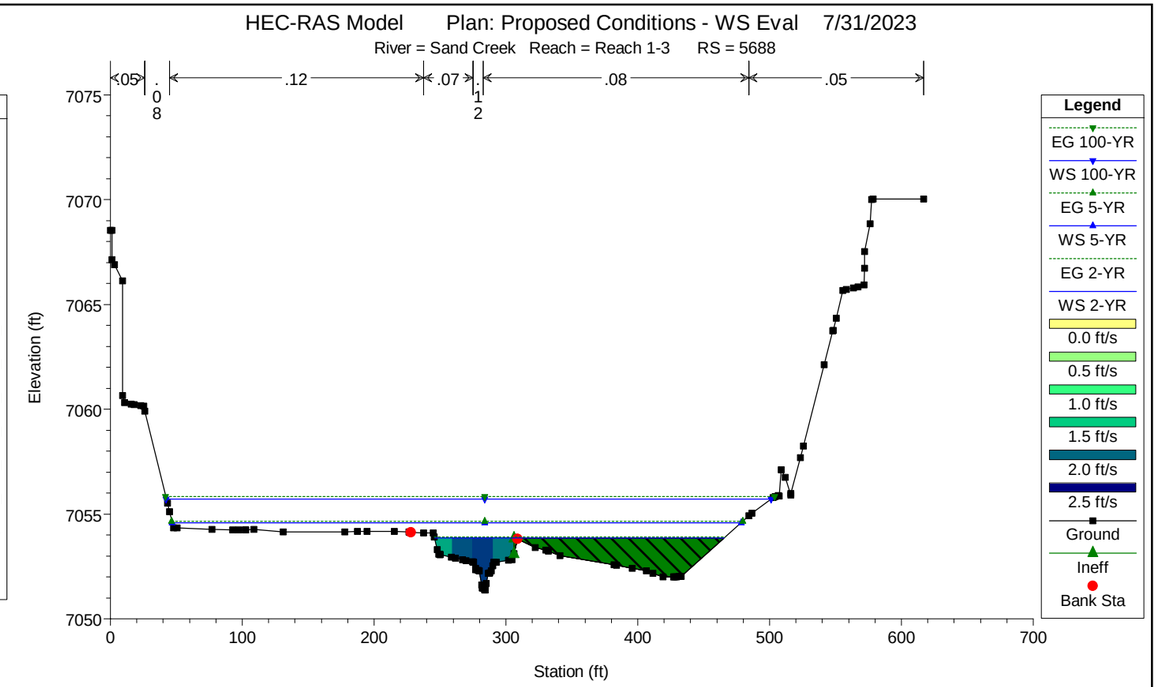


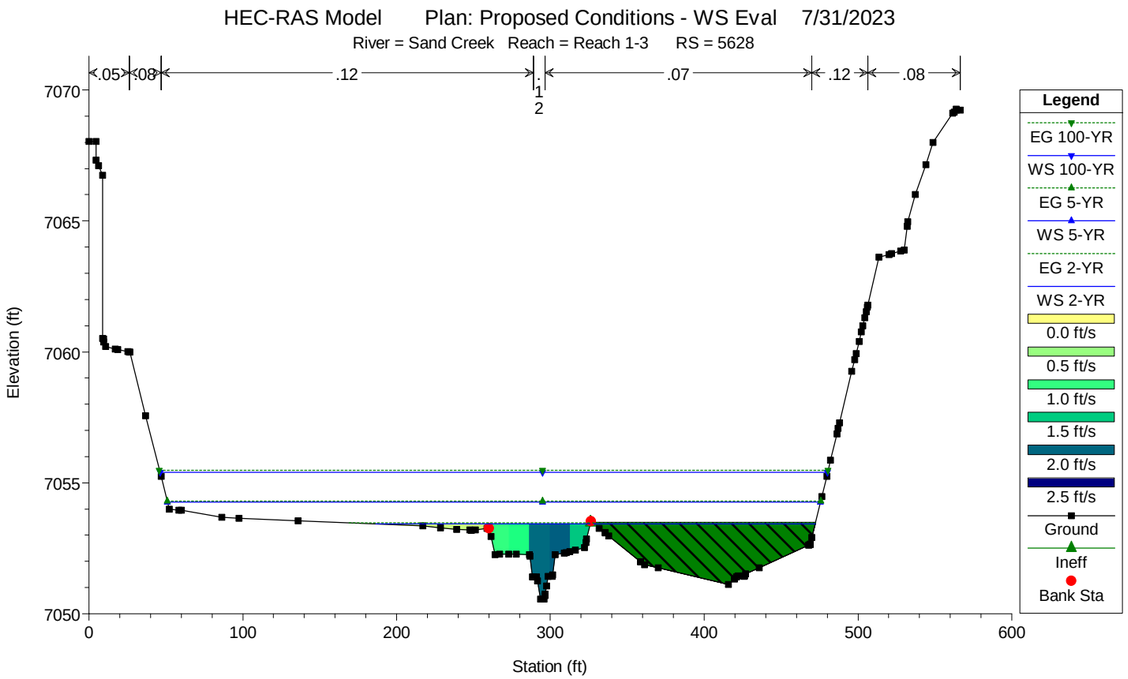


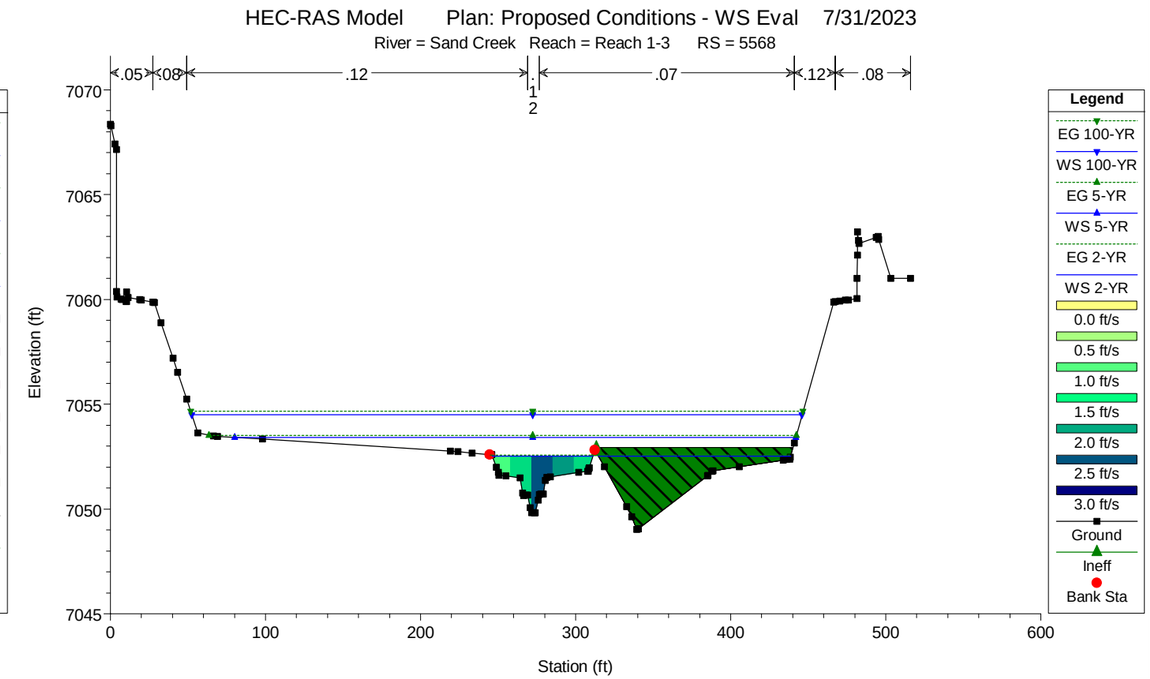


Subcritical flow analysis for Water Surface Evaluation of Naturalized Channel Design except FIS flow rate

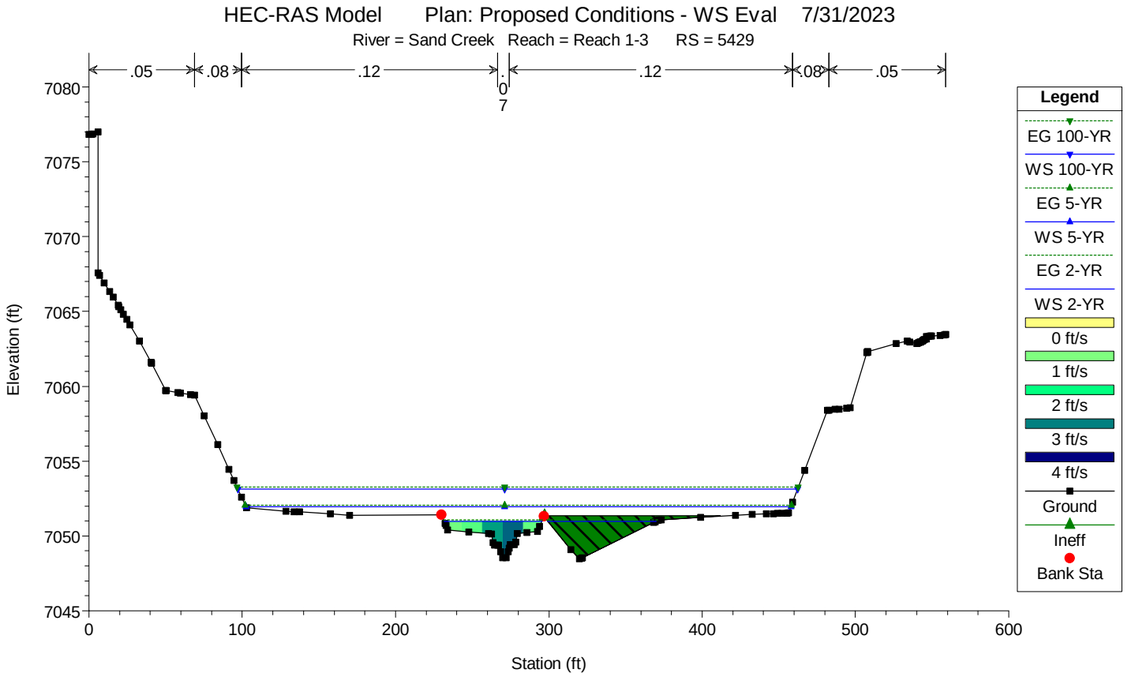


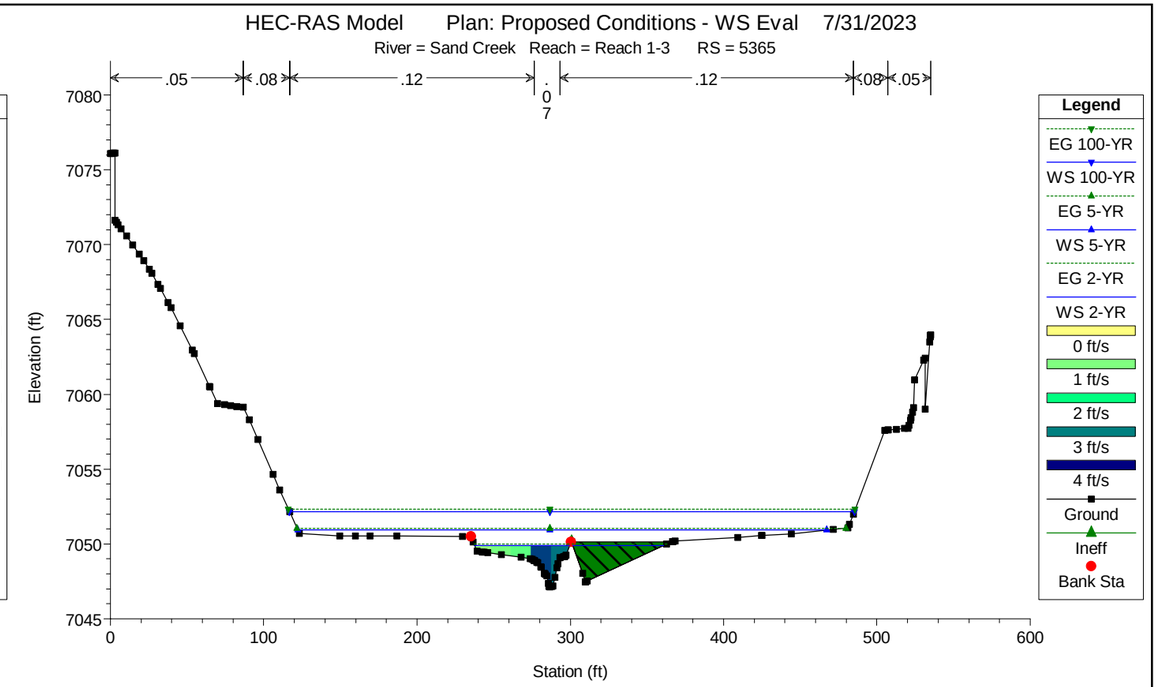


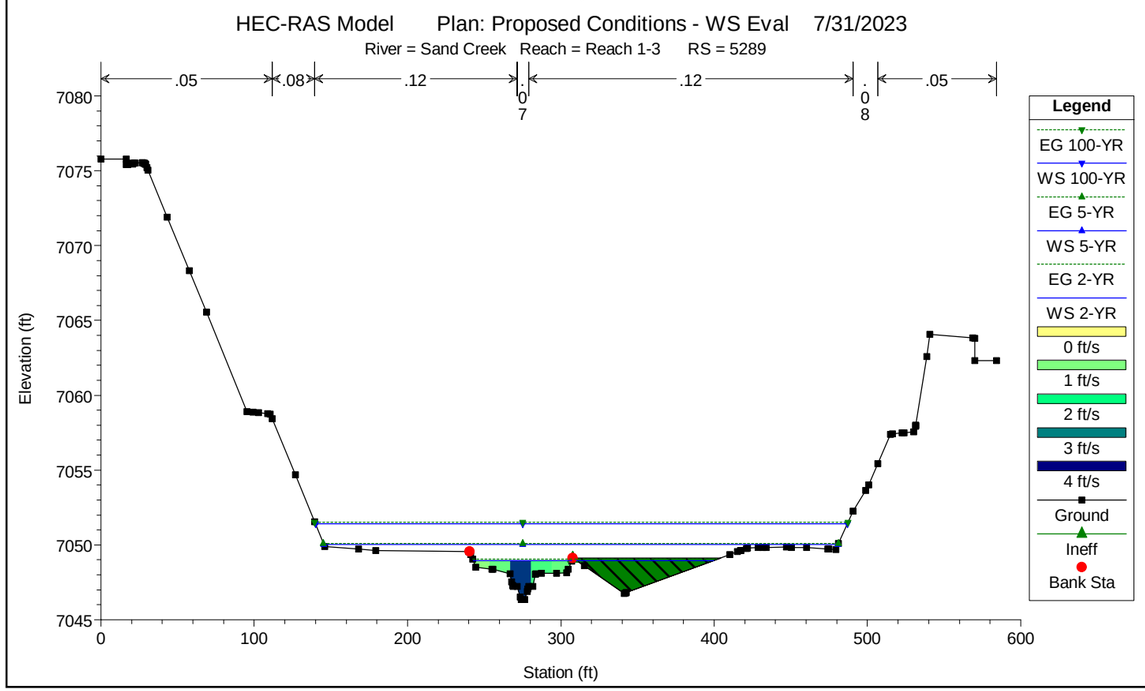


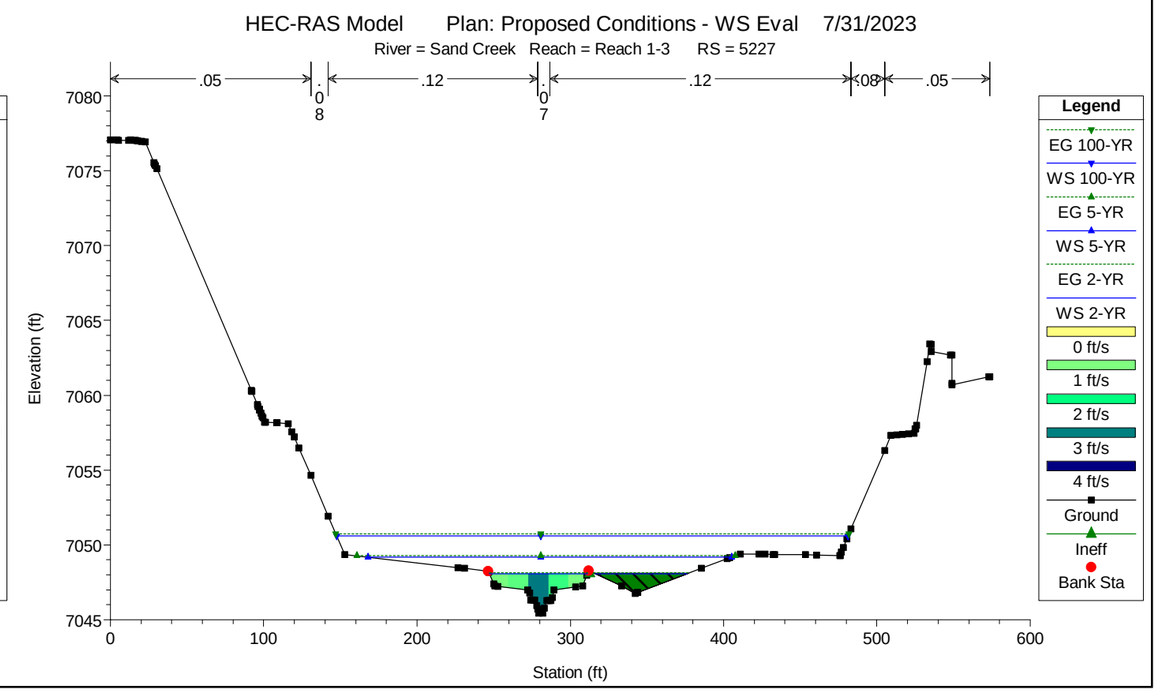


Subcritical flow analysis for Water Surface Evaluation of Naturalized Channel Design except FIS flow rate

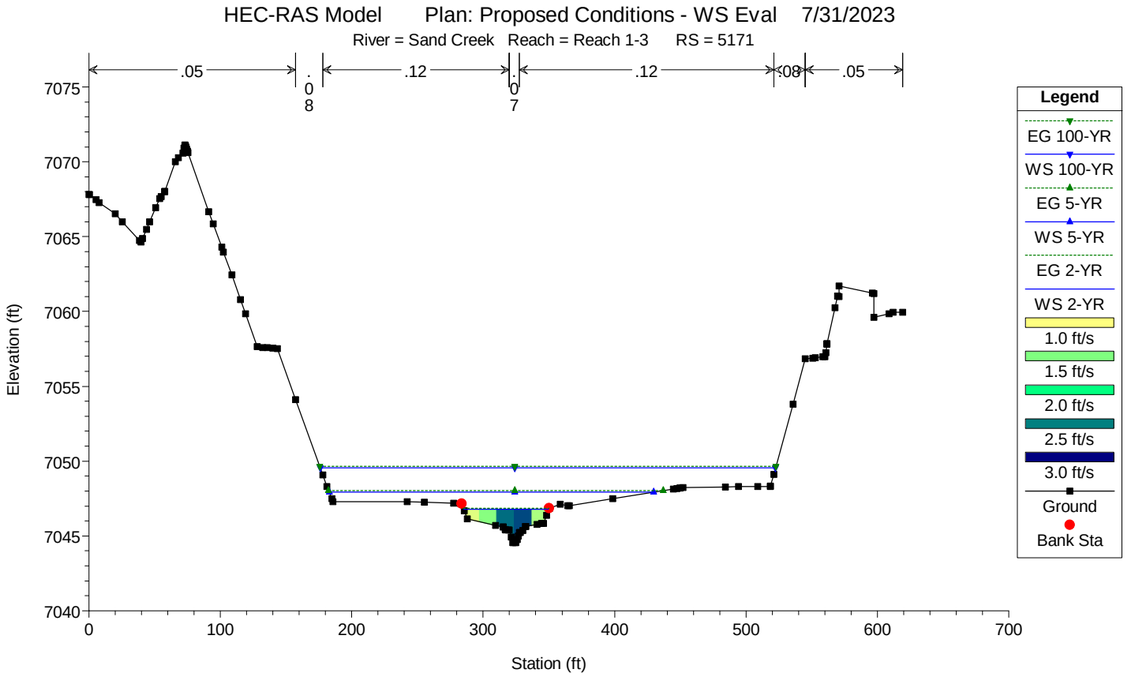


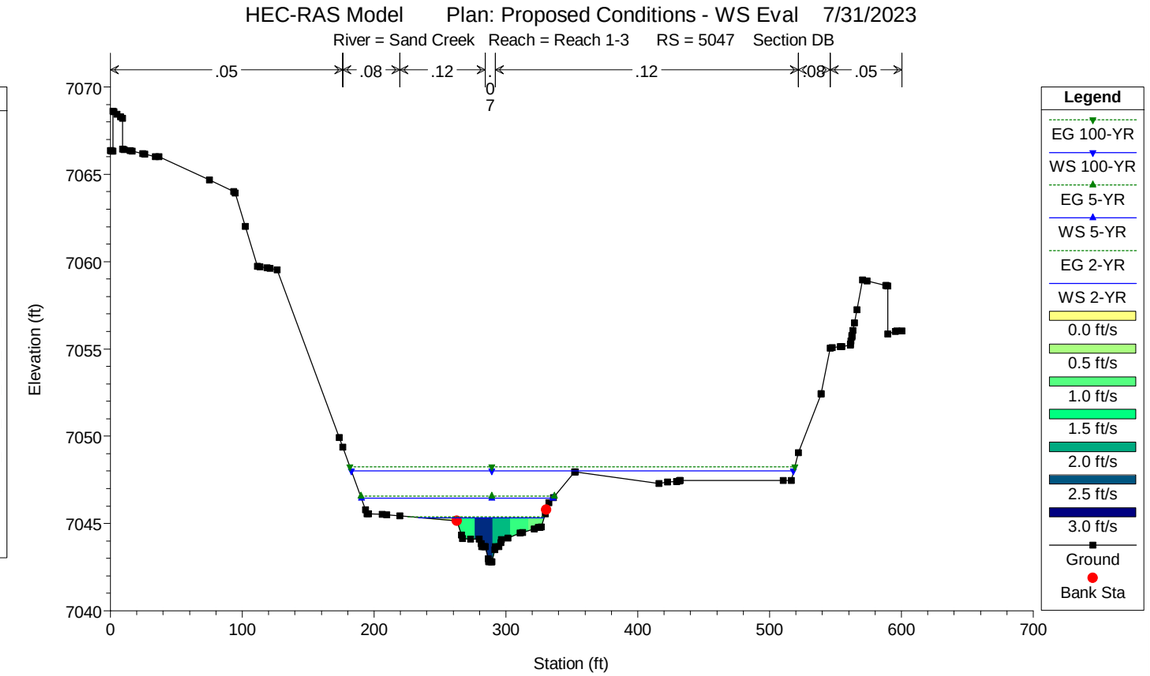


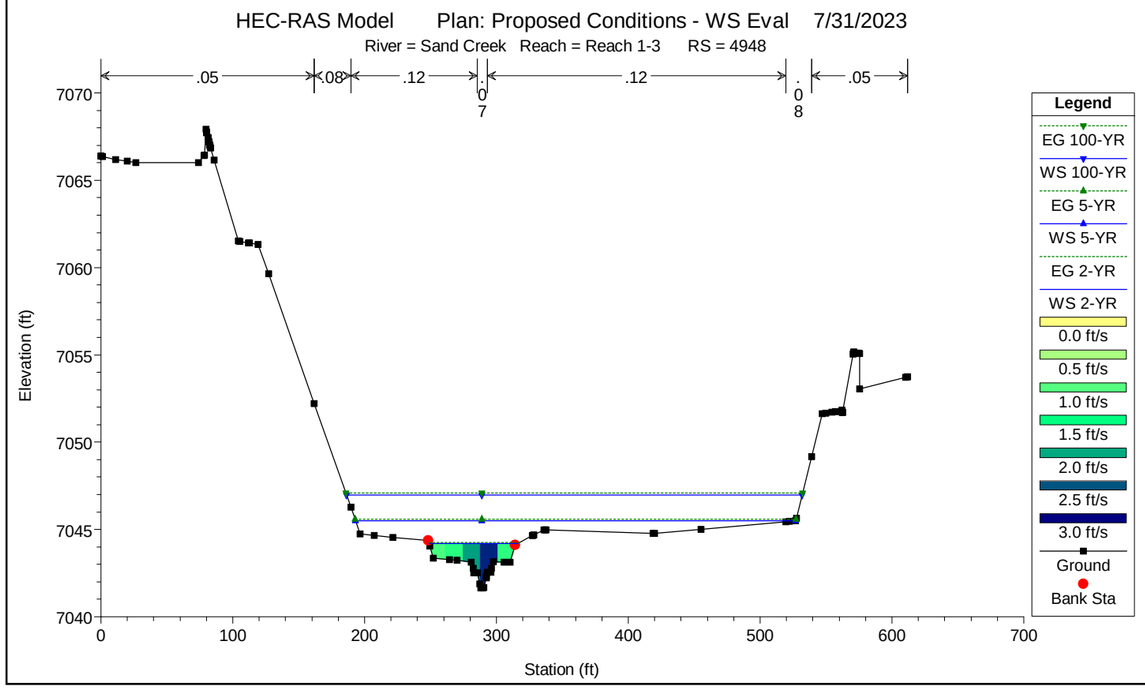


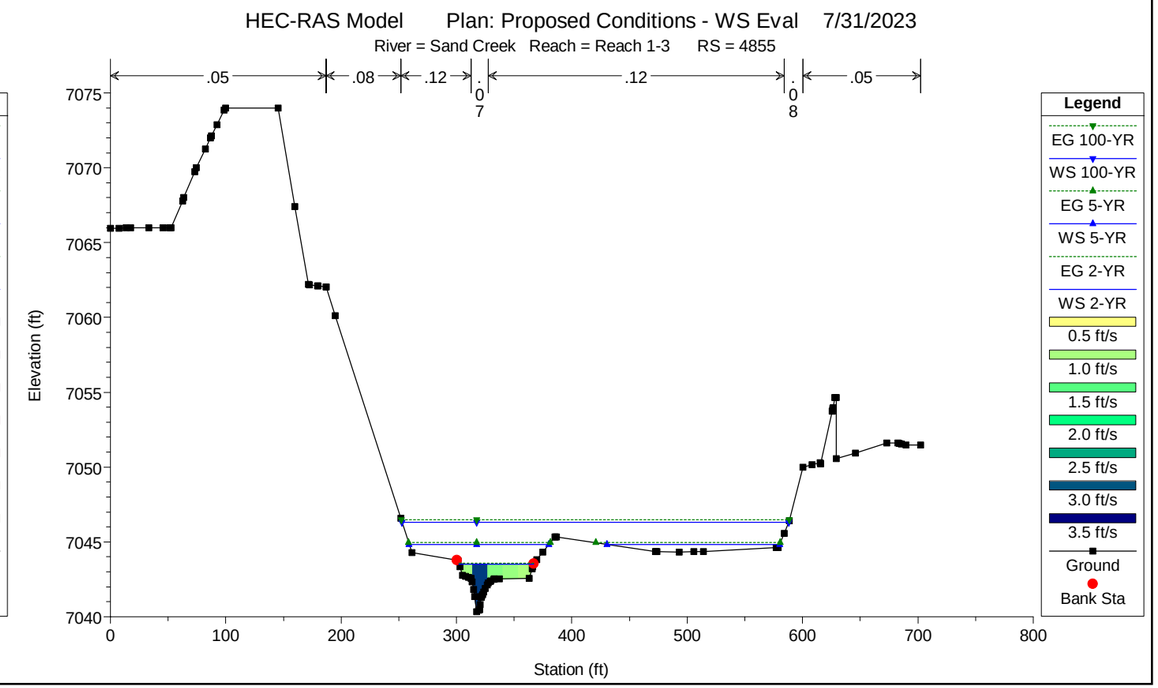


Subcritical flow analysis for Water Surface Evaluation of Naturalized Channel Design except FIS flow rate

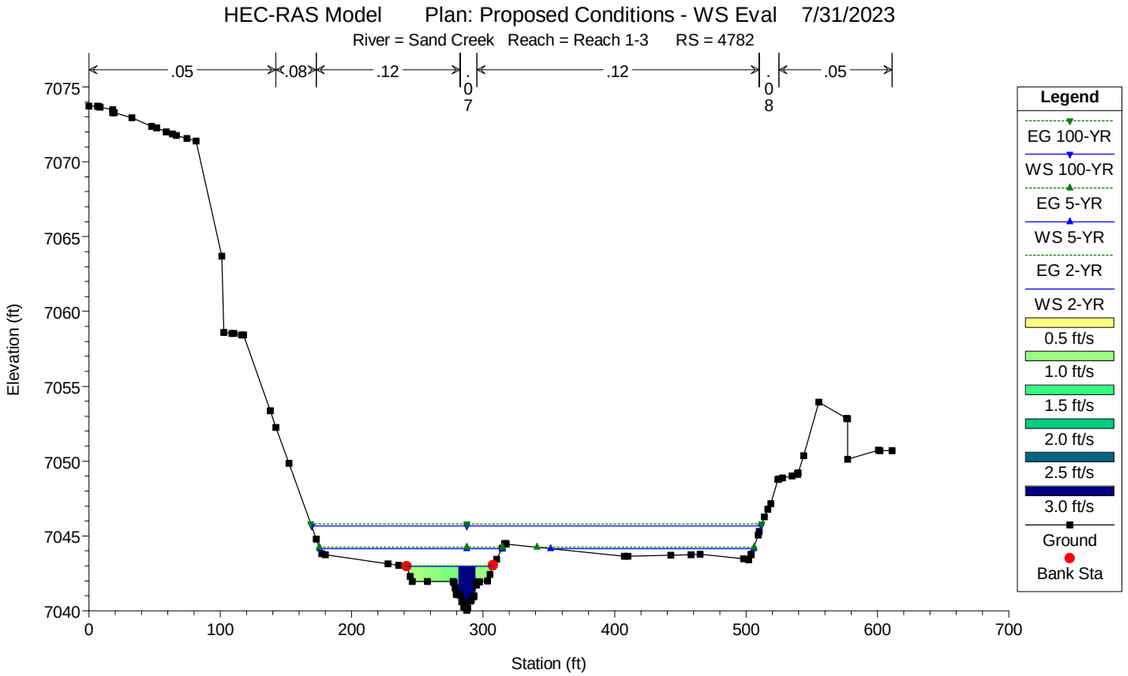


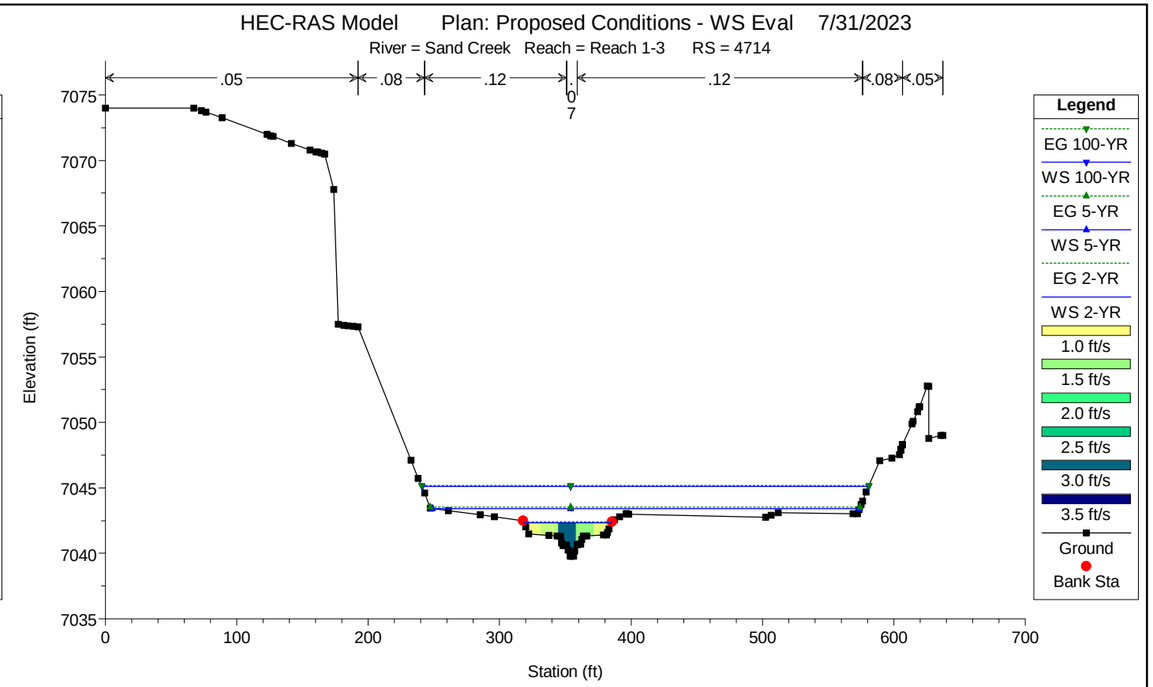


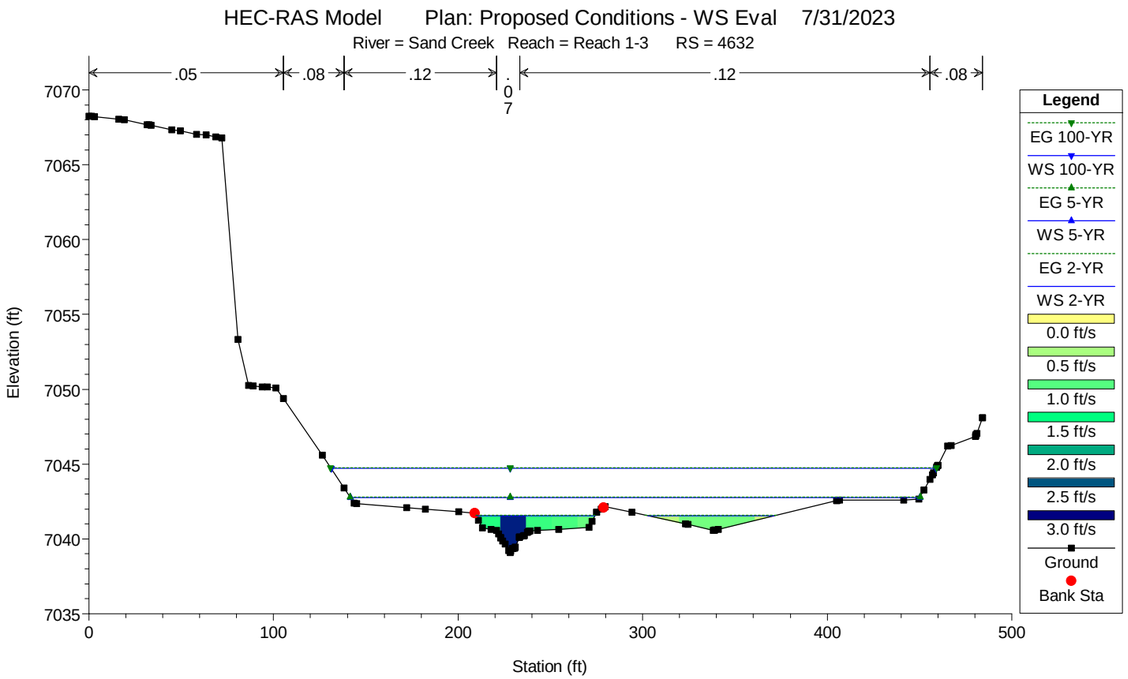


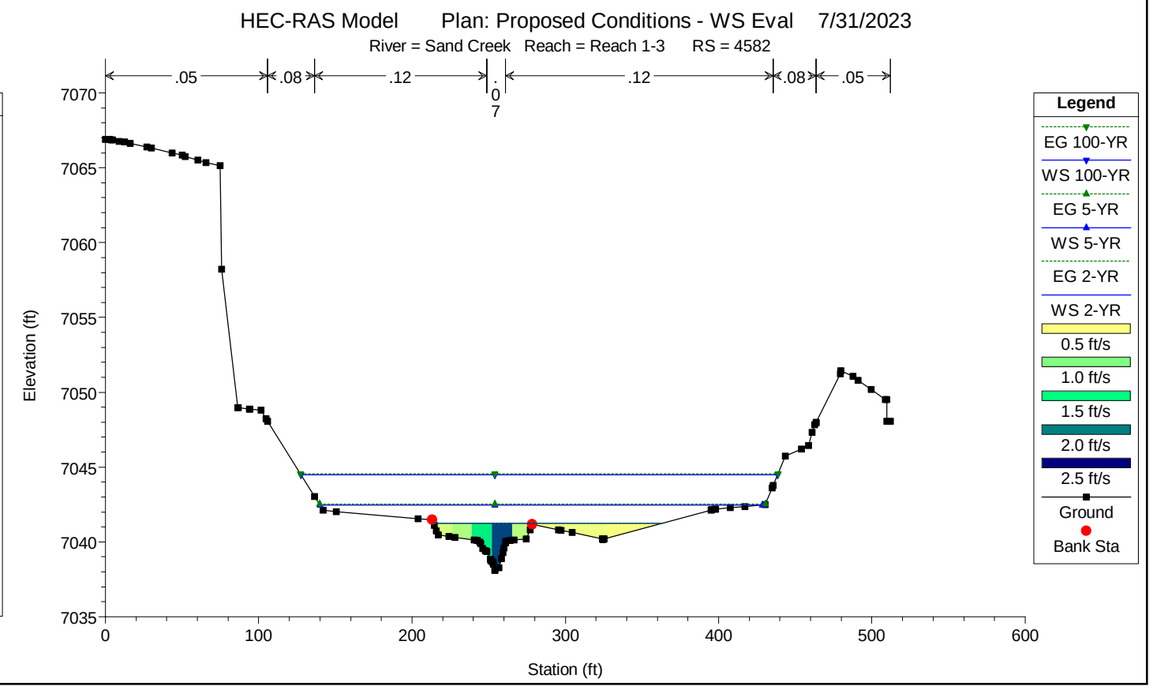


Subcritical flow analysis for Water Surface Evaluation of Naturalized Channel Design except FIS flow rate

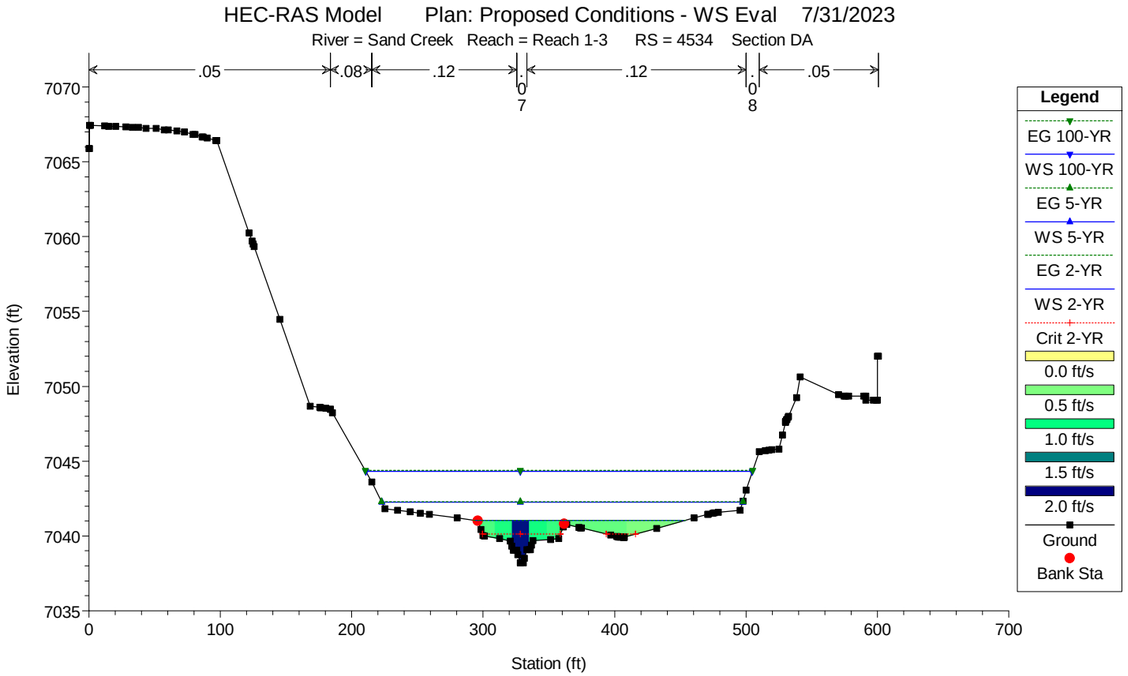


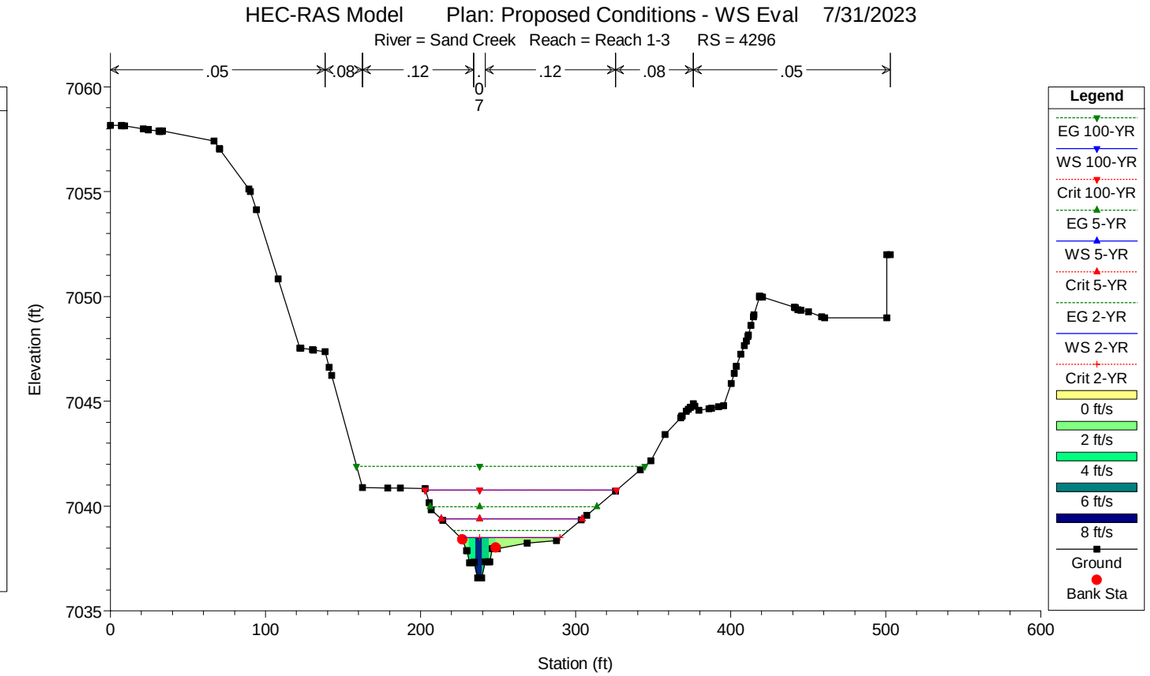


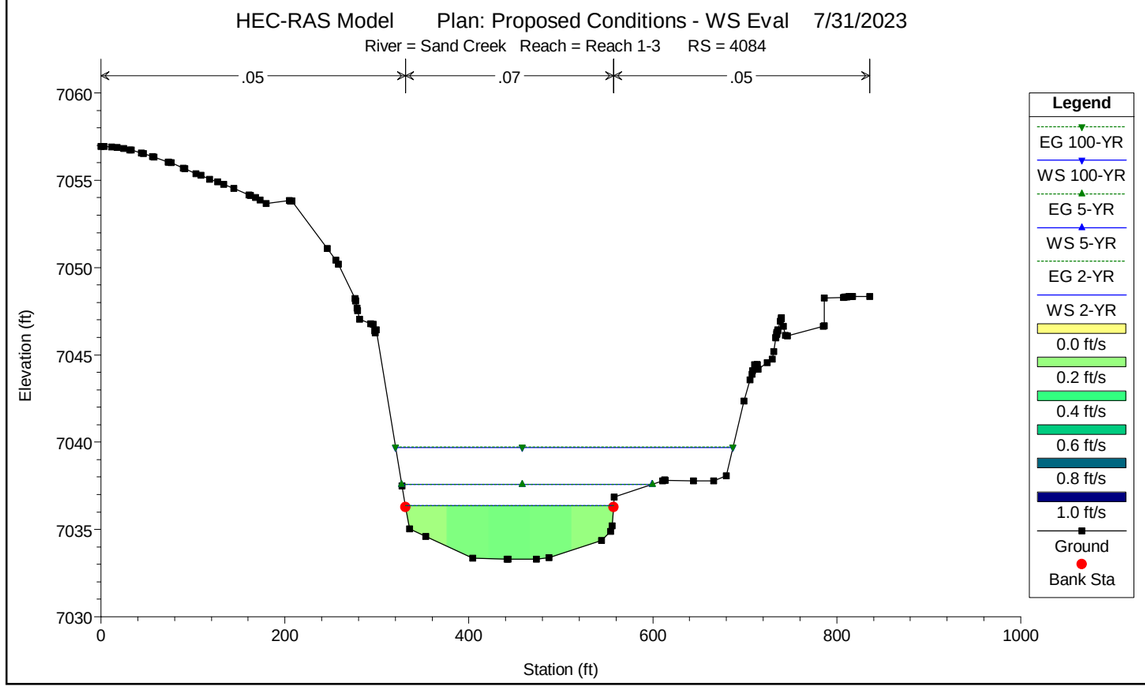


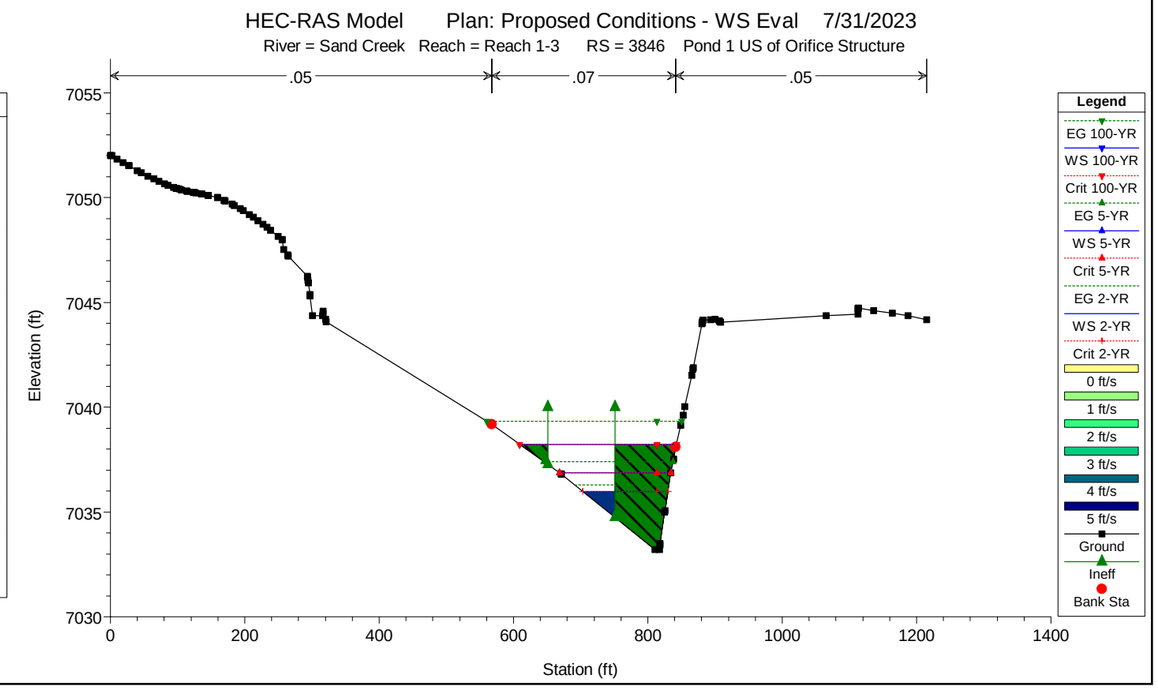


Subcritical flow analysis for Water Surface Evaluation of Naturalized Channel Design except FIS flow rate





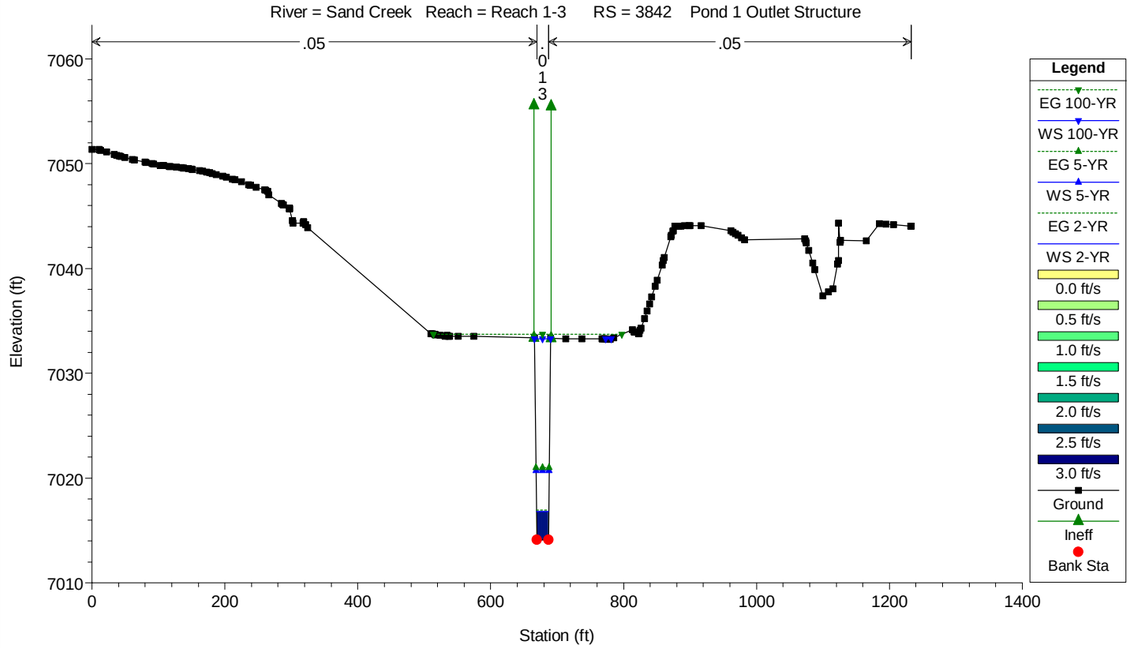




Subcritical flow analysis for Water Surface Evaluation of Naturalized Channel Design except FIS flow rate

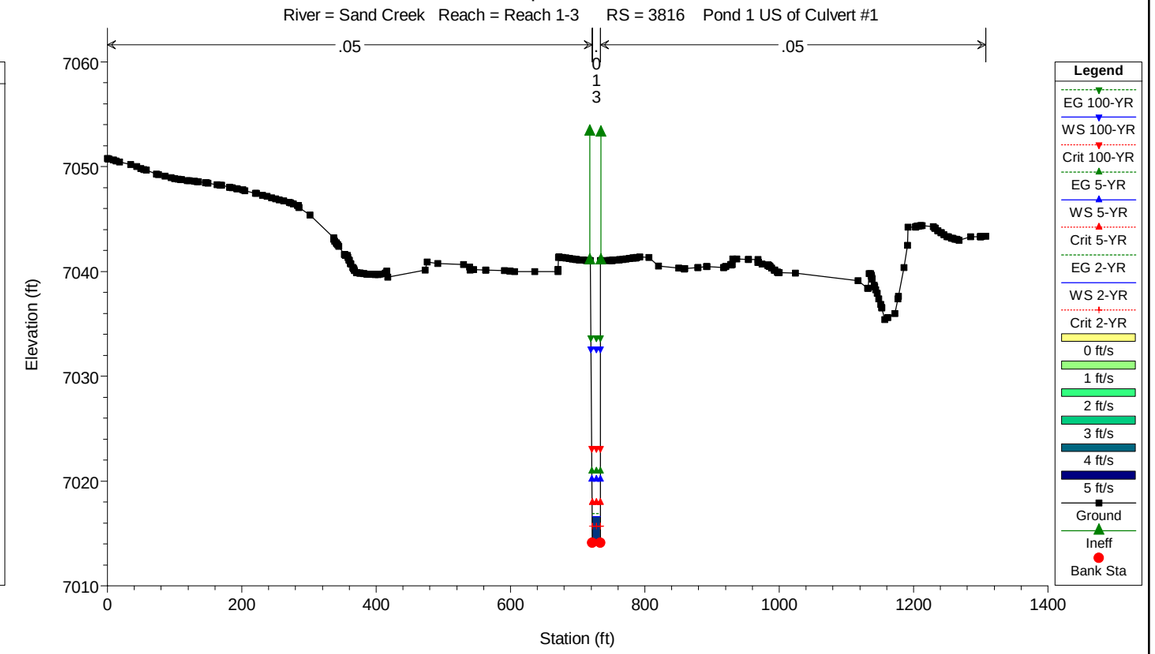
HEC-RAS Model Plan: Proposed Conditions - WS Eval 7/31/2023

River = Sand Creek Reach = Reach 1-3 RS = 3842 Pond 1 Outlet Structure



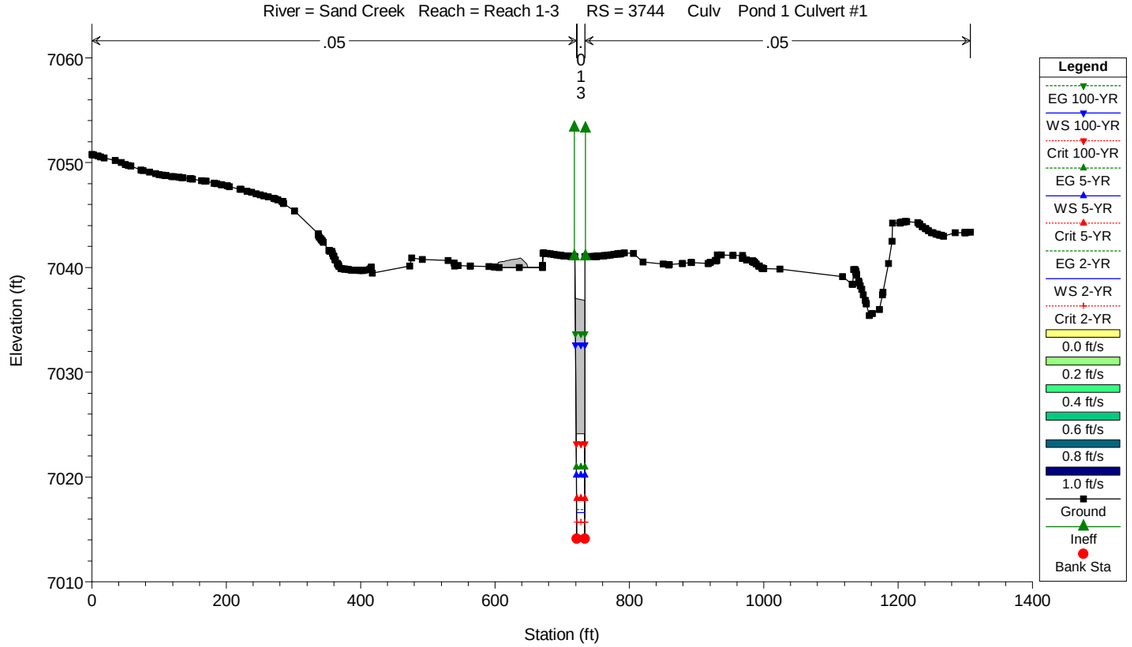
HEC-RAS Model Plan: Proposed Conditions - WS Eval 7/31/2023

River = Sand Creek Reach = Reach 1-3 RS = 3816 Pond 1 US of Culvert #1



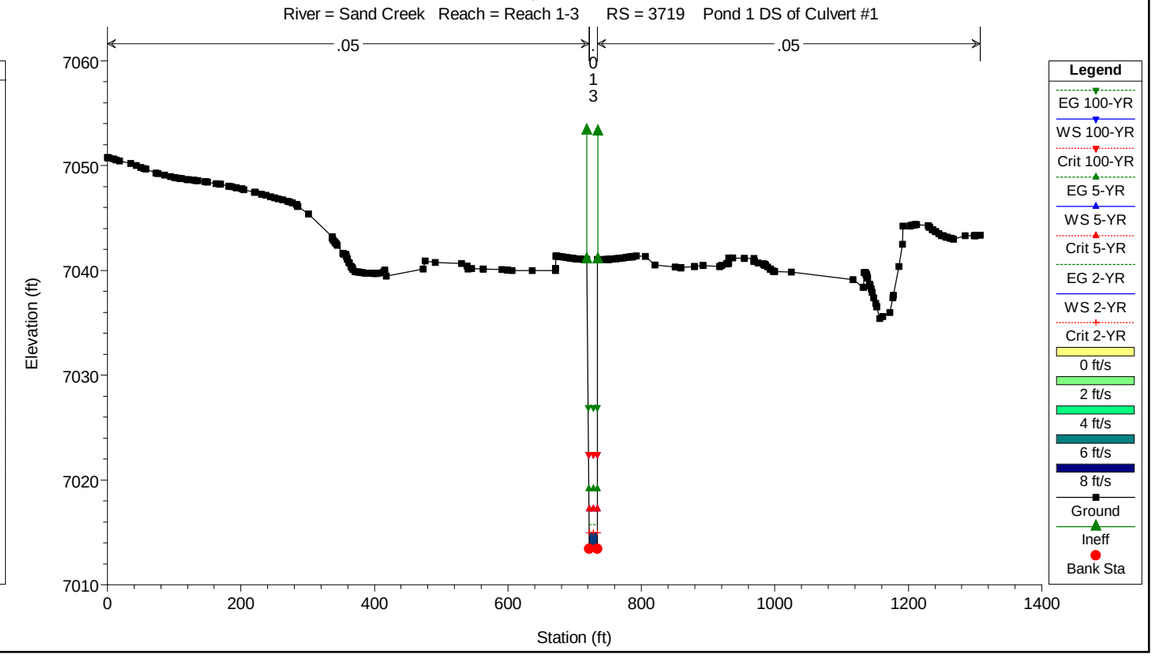
HEC-RAS Model Plan: Proposed Conditions - WS Eval 7/31/2023

River = Sand Creek Reach = Reach 1-3 RS = 3744 Culv Pond 1 Culvert #1

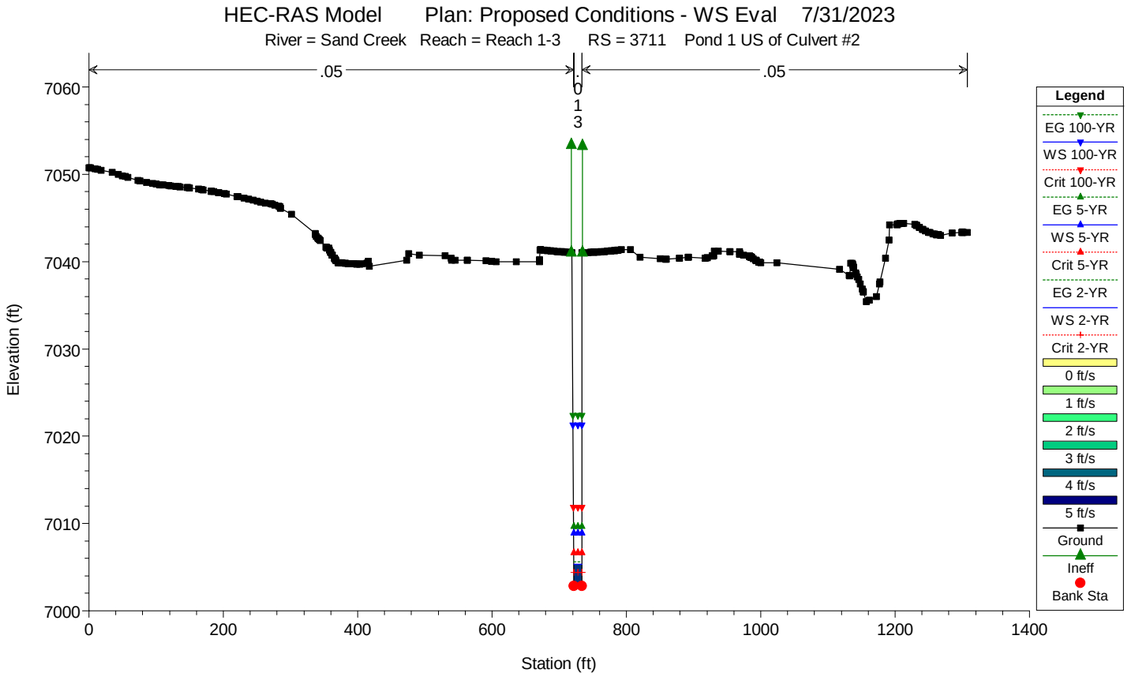


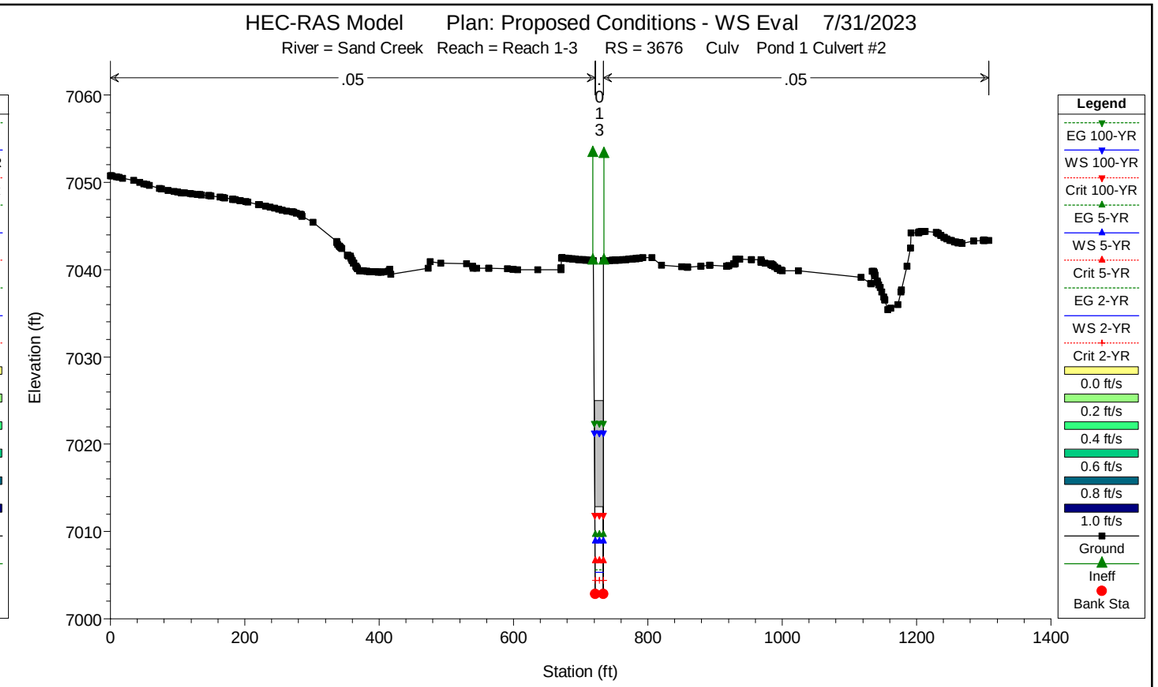
HEC-RAS Model Plan: Proposed Conditions - WS Eval 7/31/2023

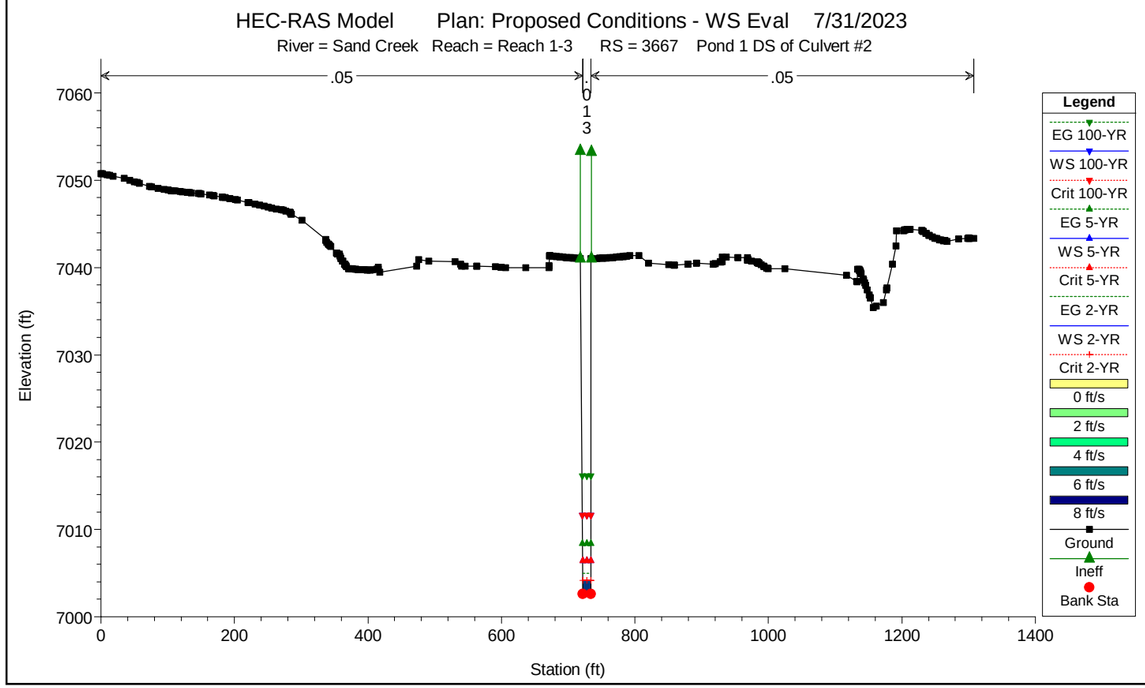
River = Sand Creek Reach = Reach 1-3 RS = 3719 Pond 1 DS of Culvert #1

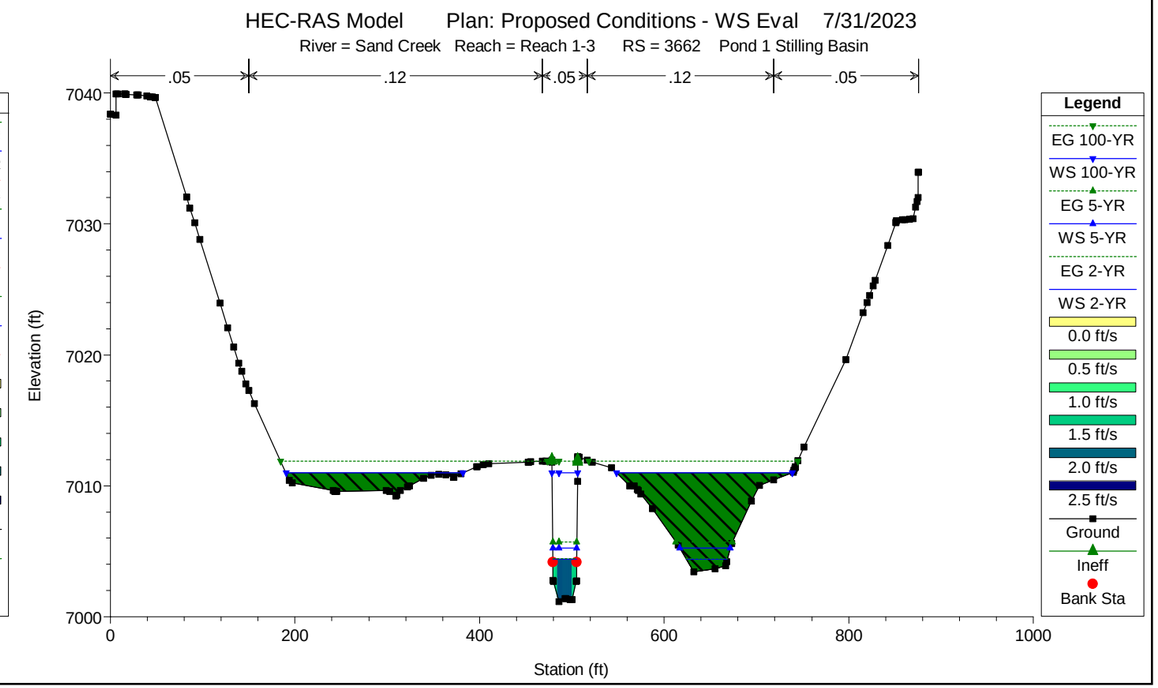


Subcritical flow analysis for Water Surface Evaluation of Naturalized Channel Design except FIS flow rate

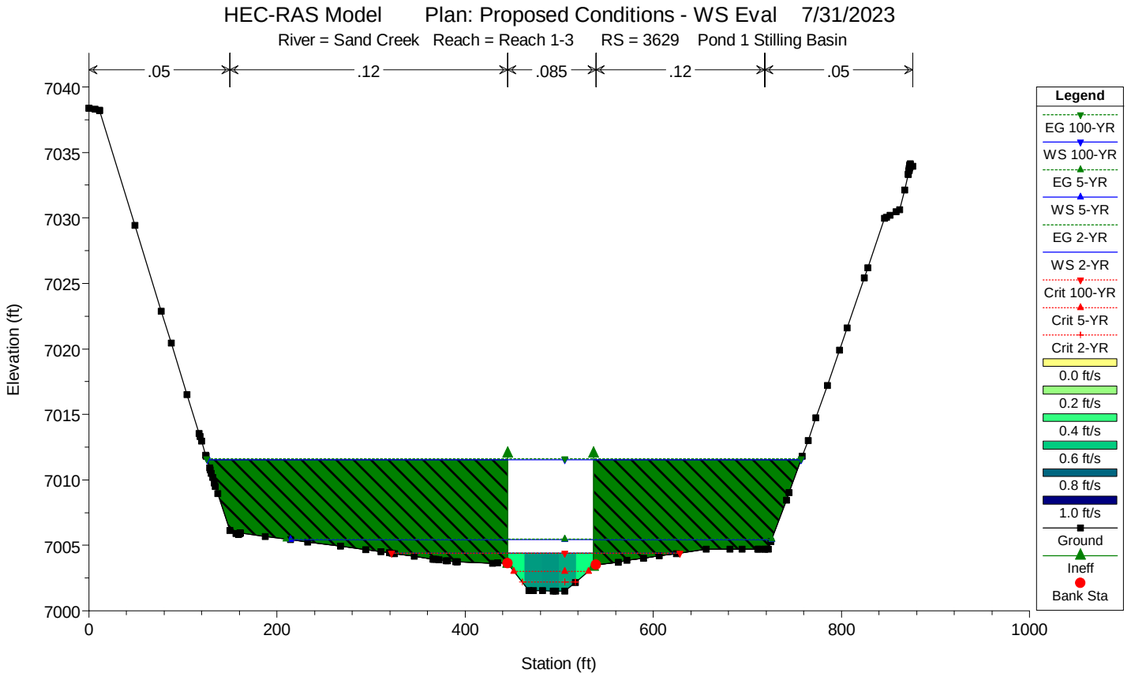


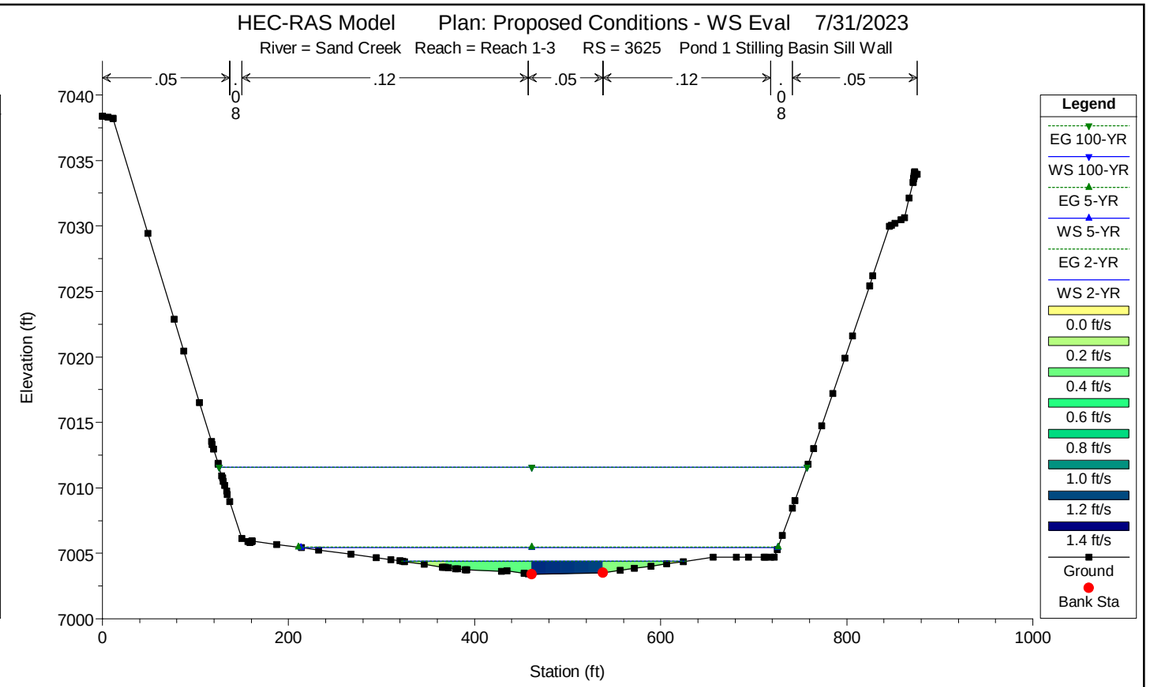


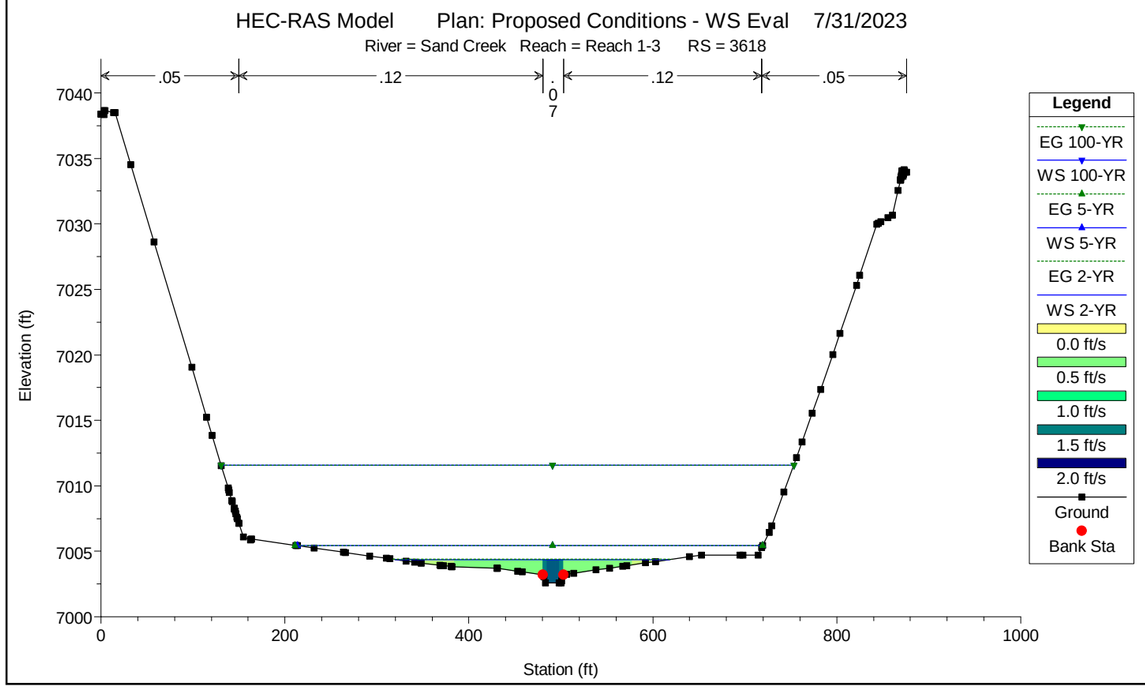


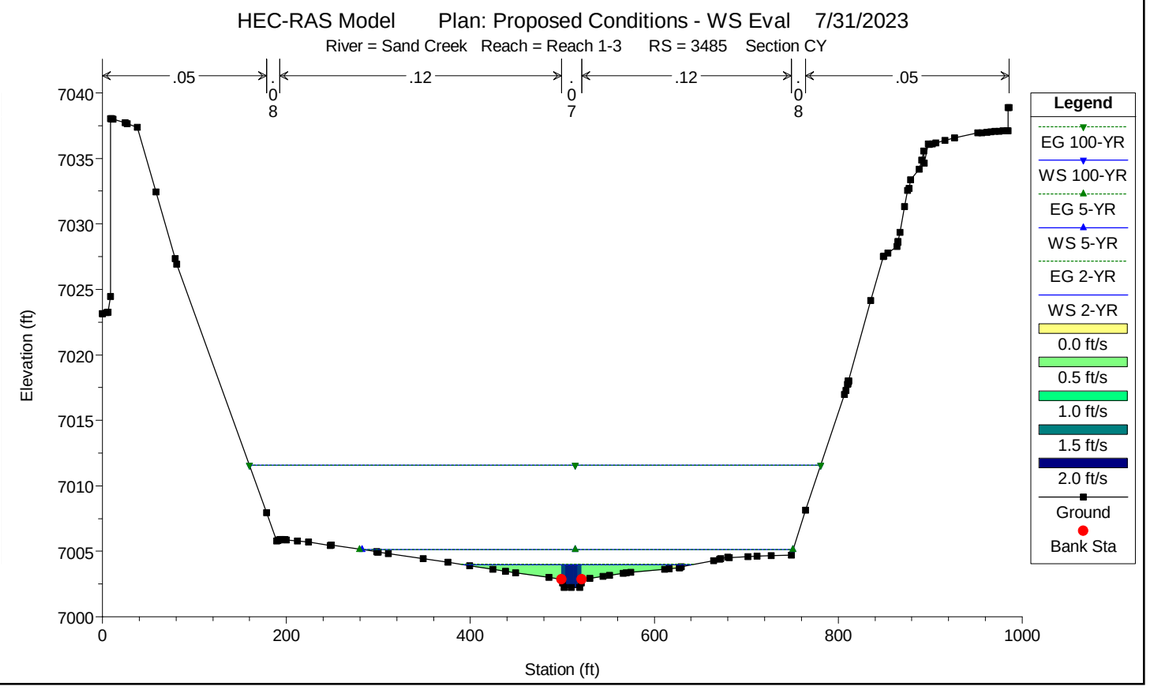


Subcritical flow analysis for Water Surface Evaluation of Naturalized Channel Design except FIS flow rate

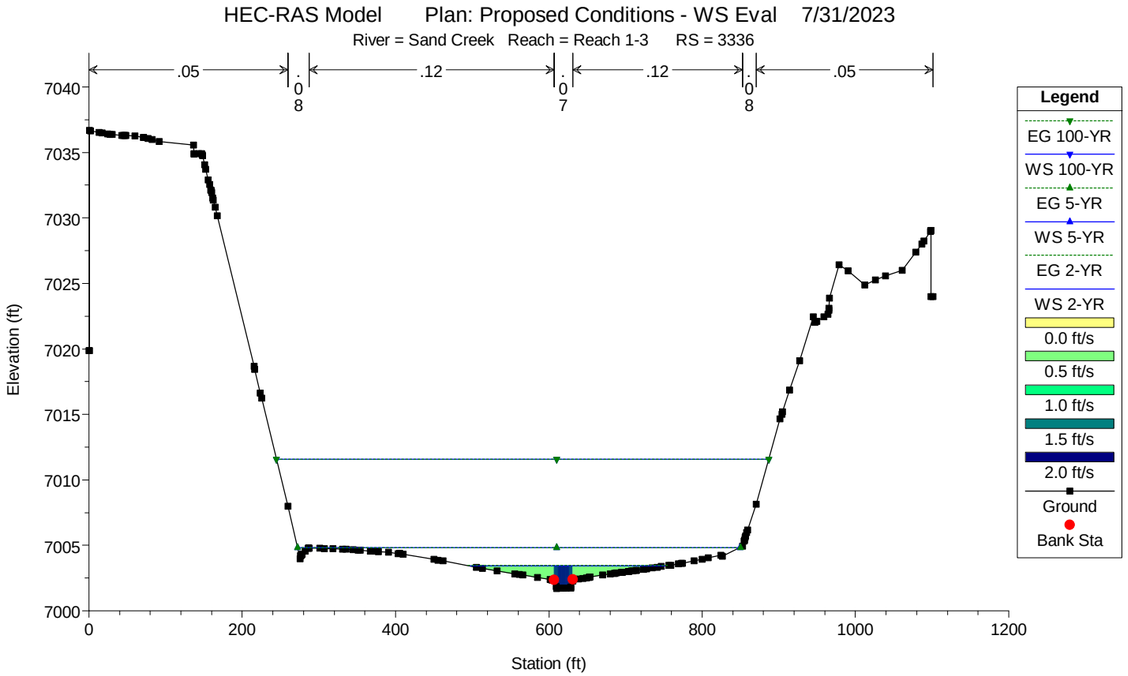


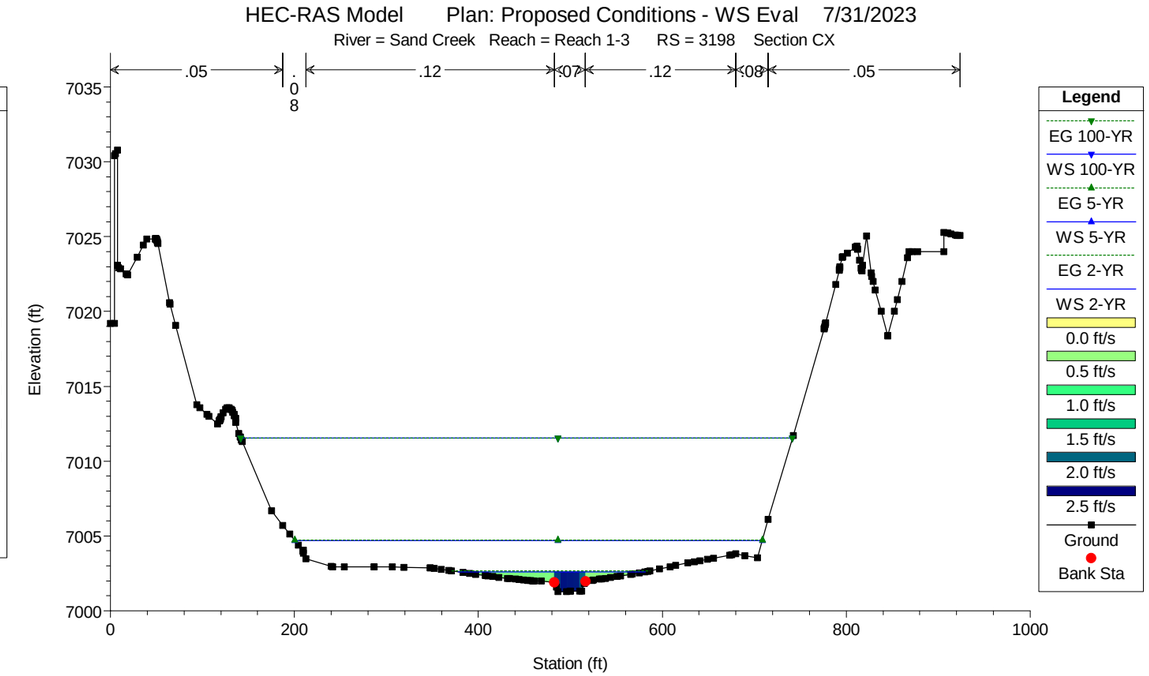


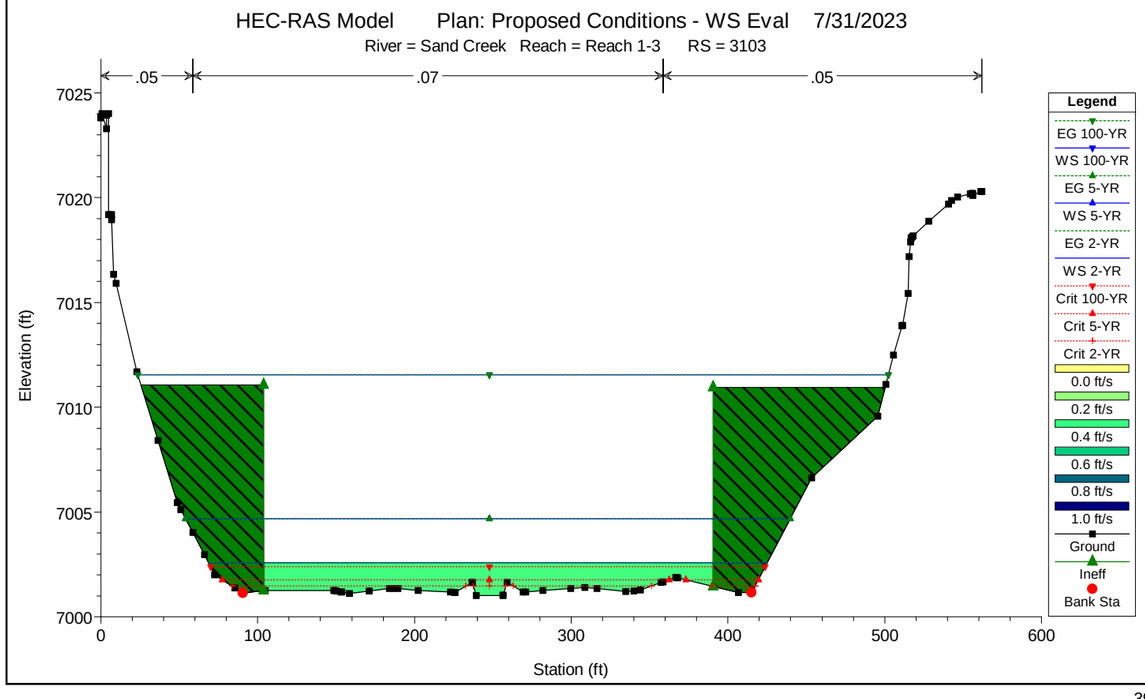


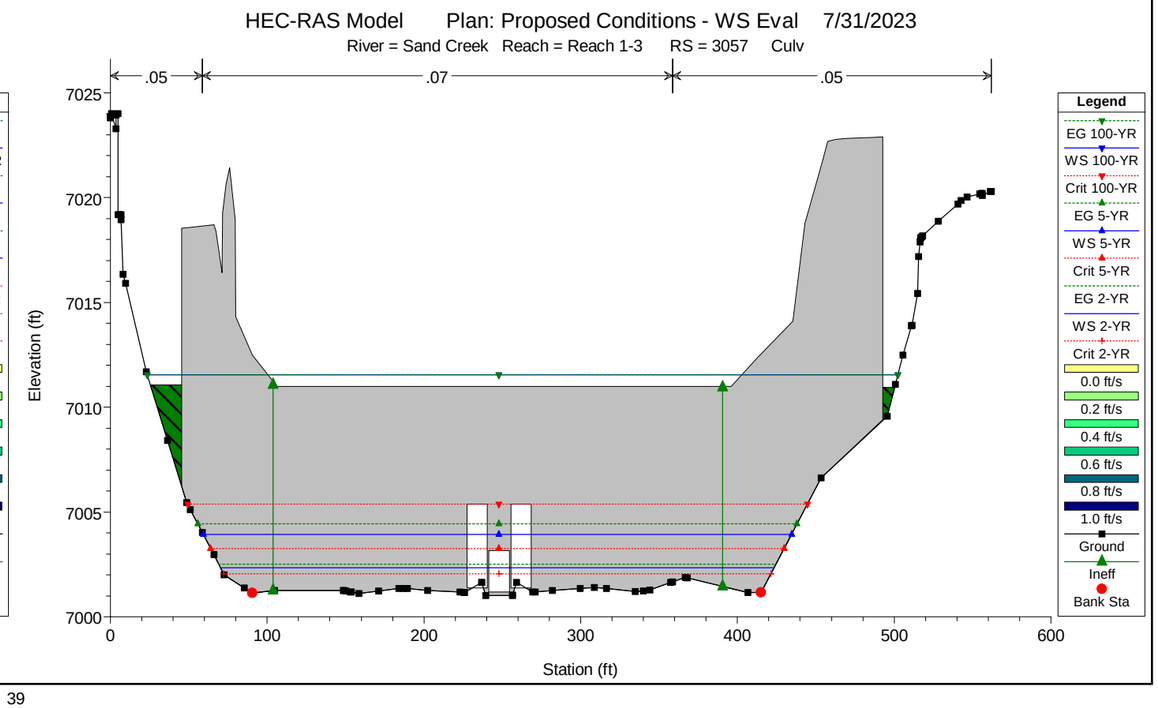


Subcritical flow analysis for Water Surface Evaluation of Naturalized Channel Design except FIS flow rate

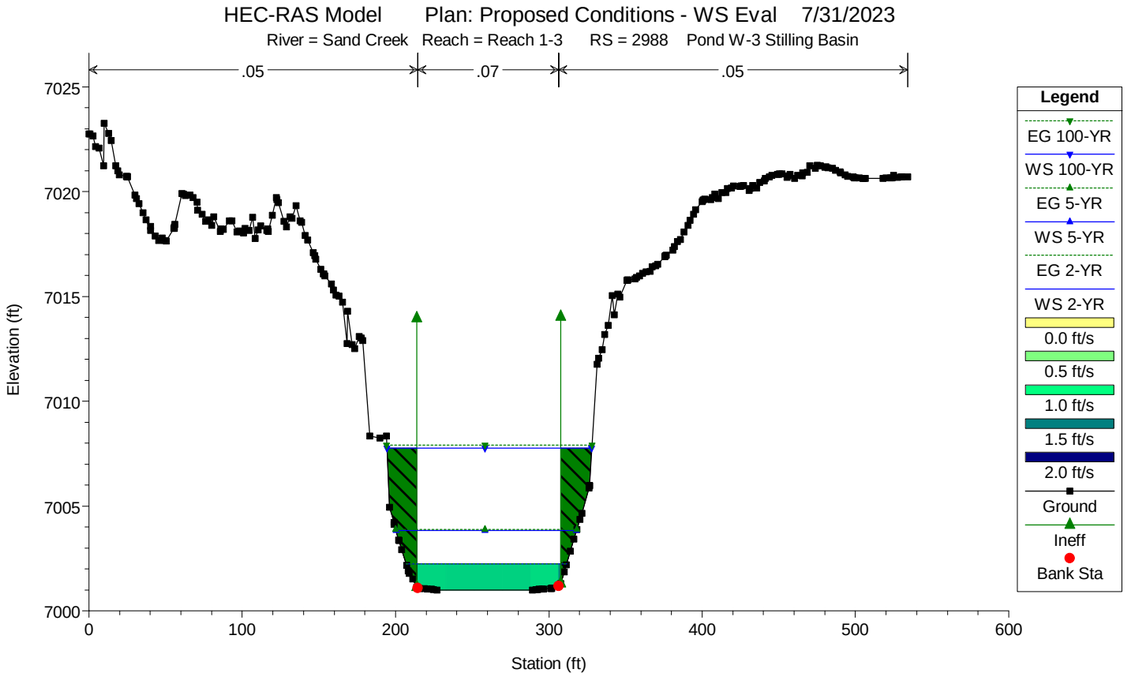


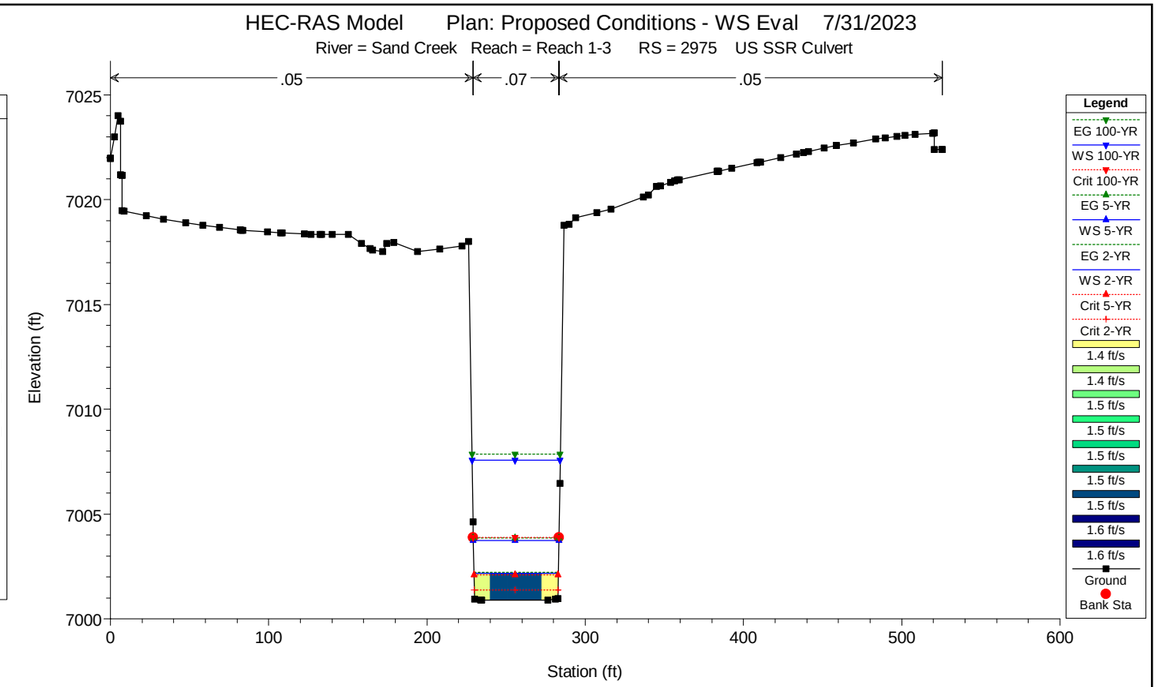


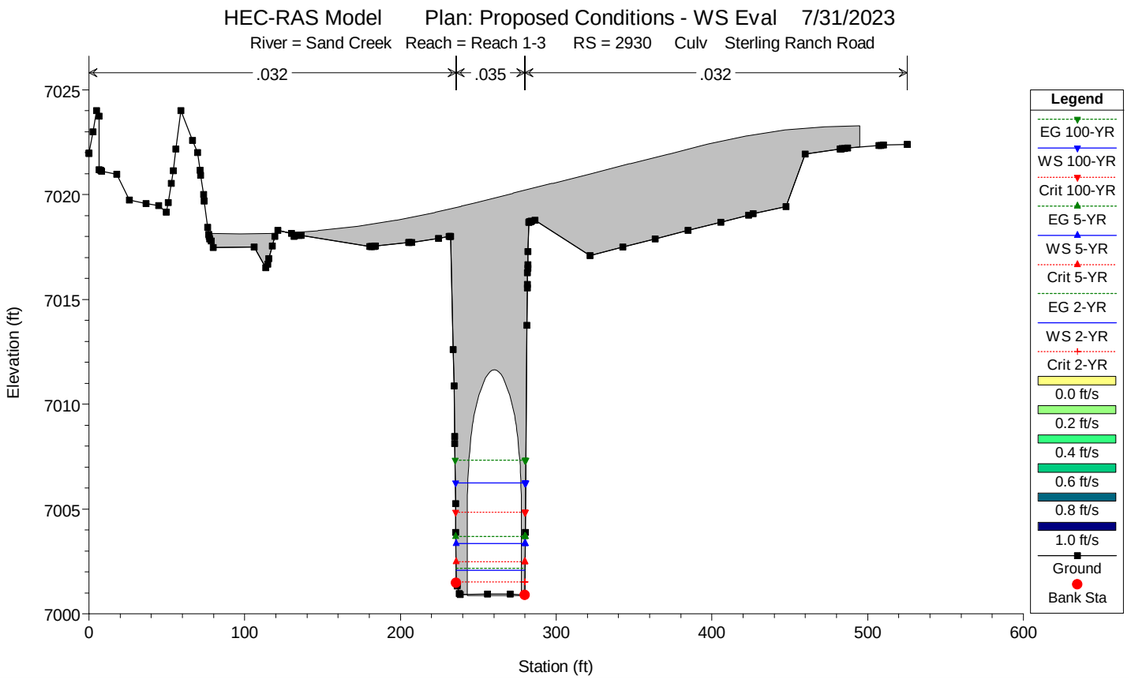


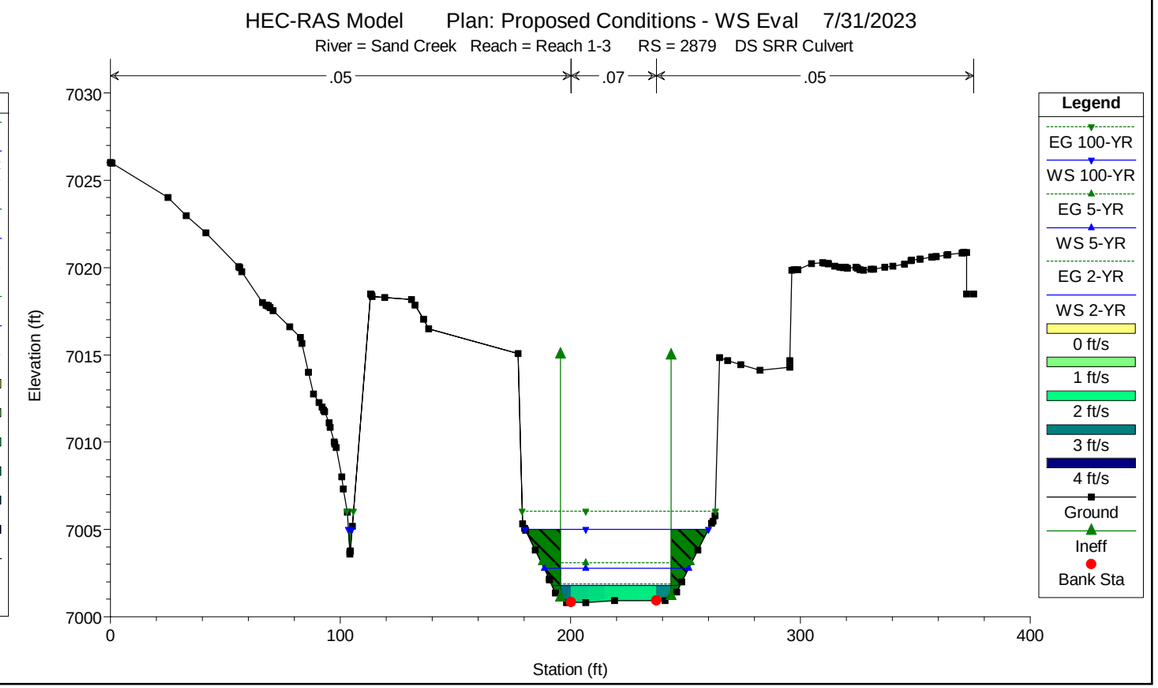


Subcritical flow analysis for Water Surface Evaluation of Naturalized Channel Design except FIS flow rate

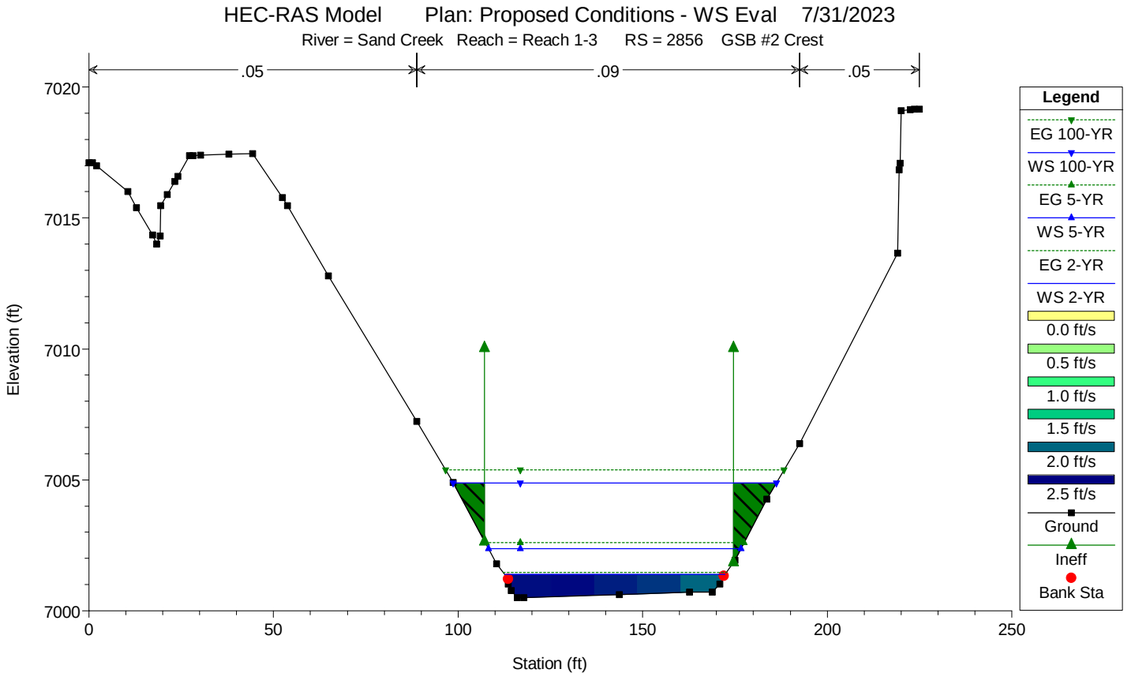


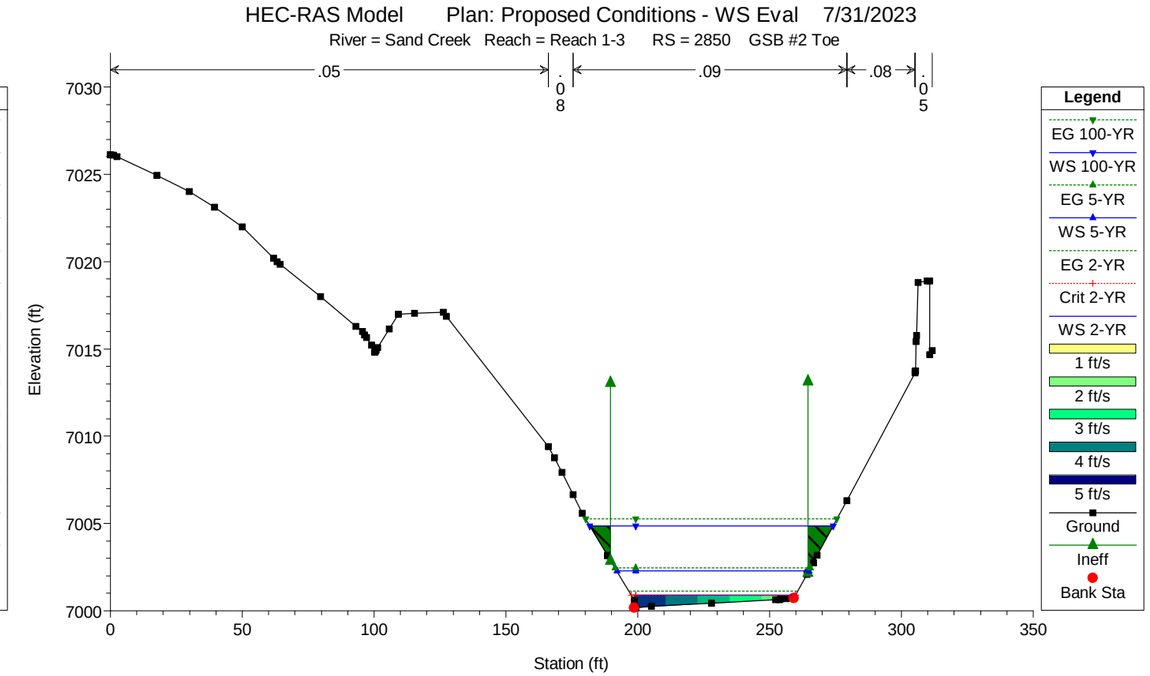


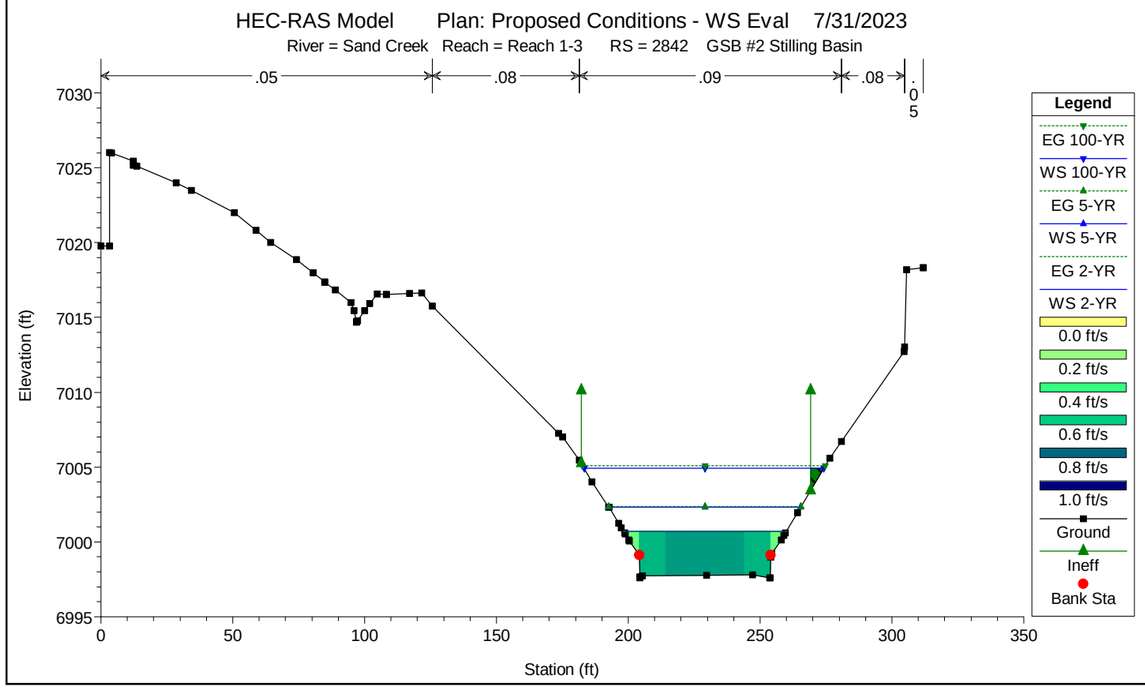


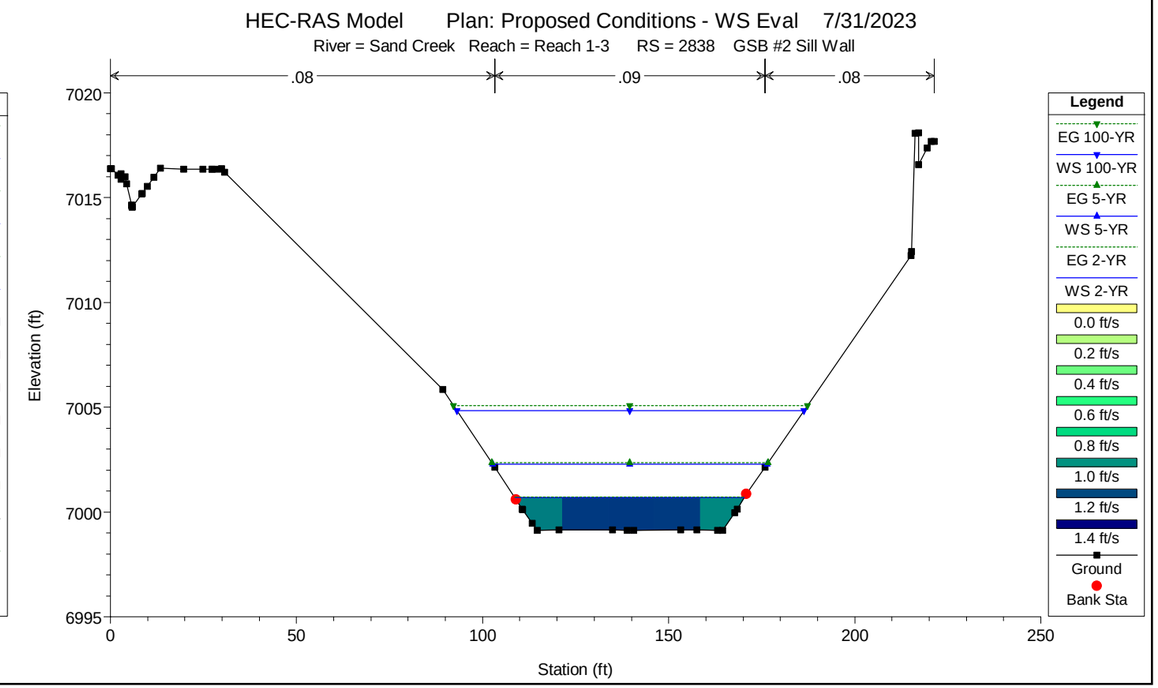


Subcritical flow analysis for Water Surface Evaluation of Naturalized Channel Design except FIS flow rate

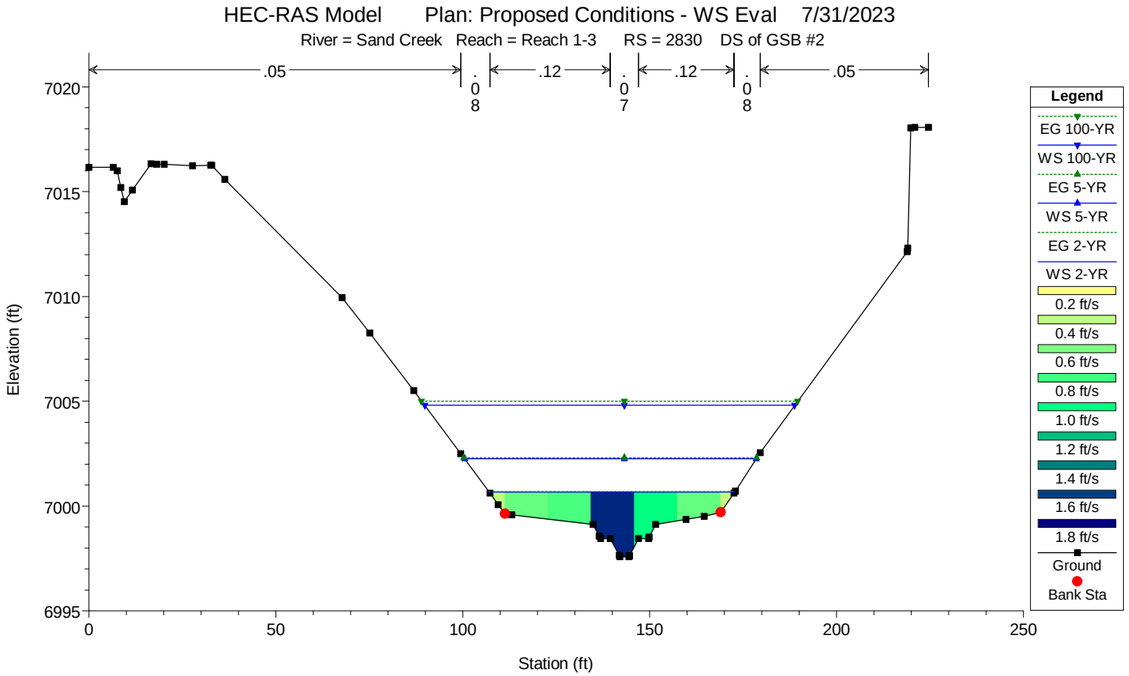


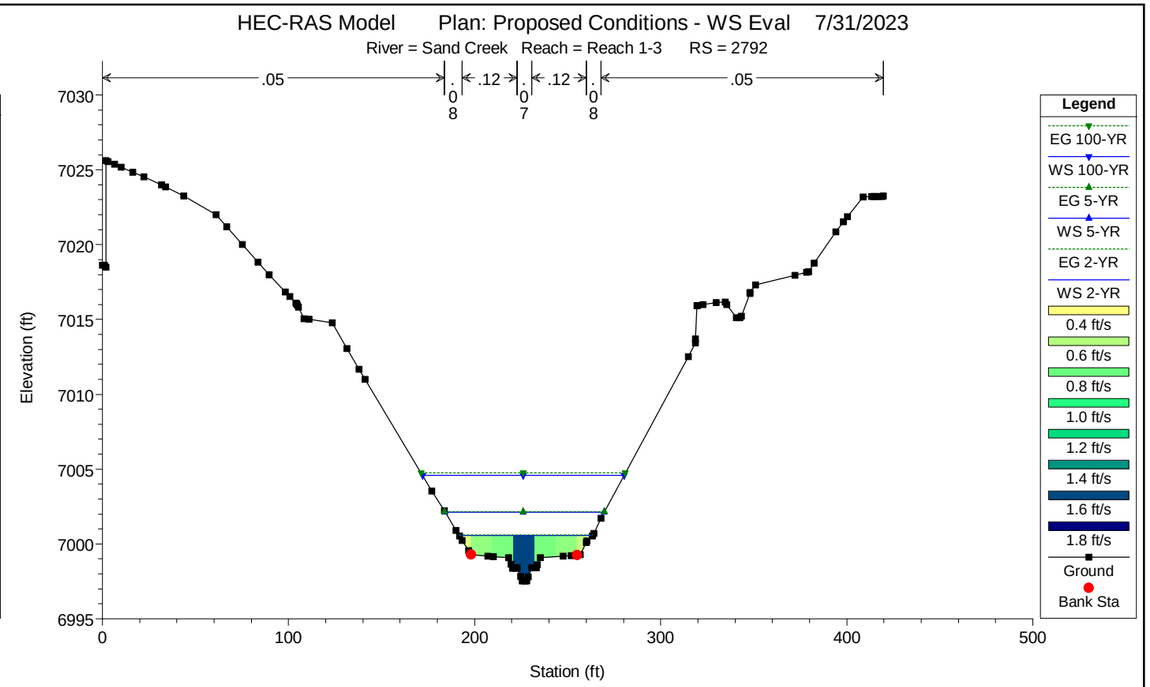


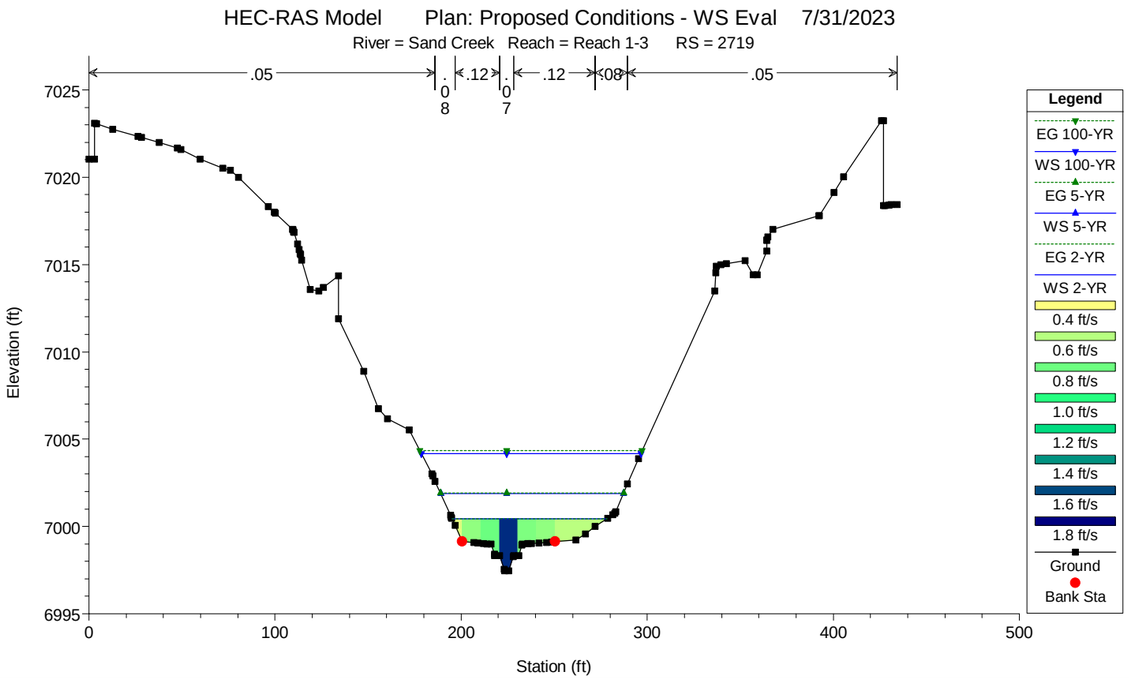


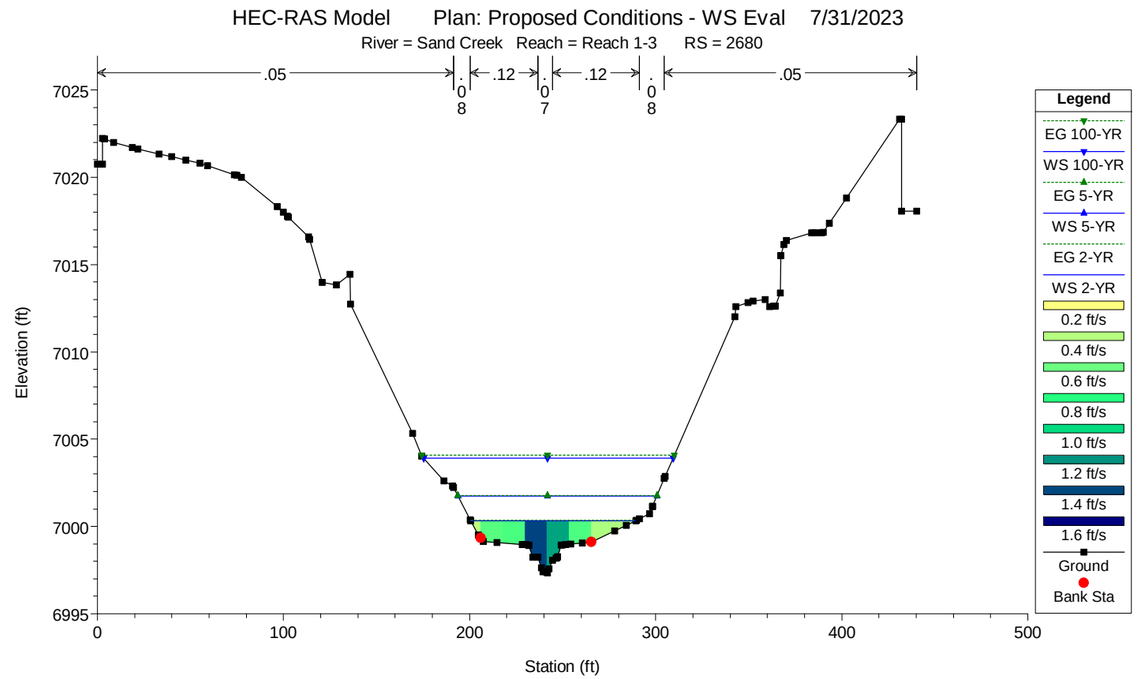


Subcritical flow analysis for Water Surface Evaluation of Naturalized Channel Design except FIS flow rate

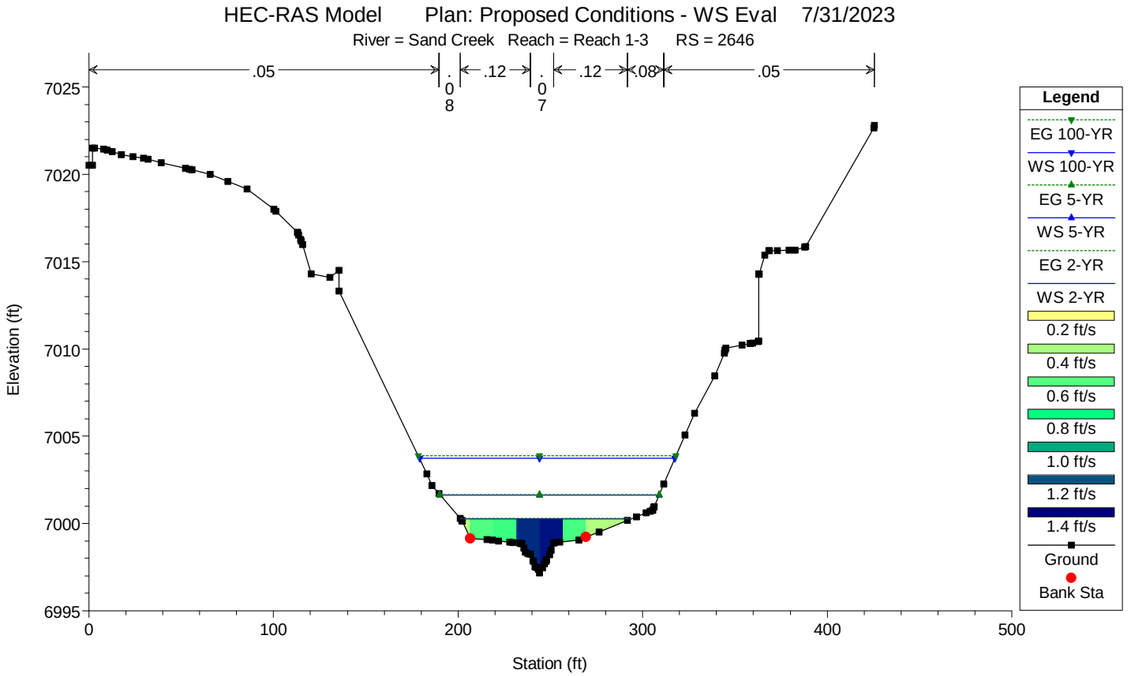


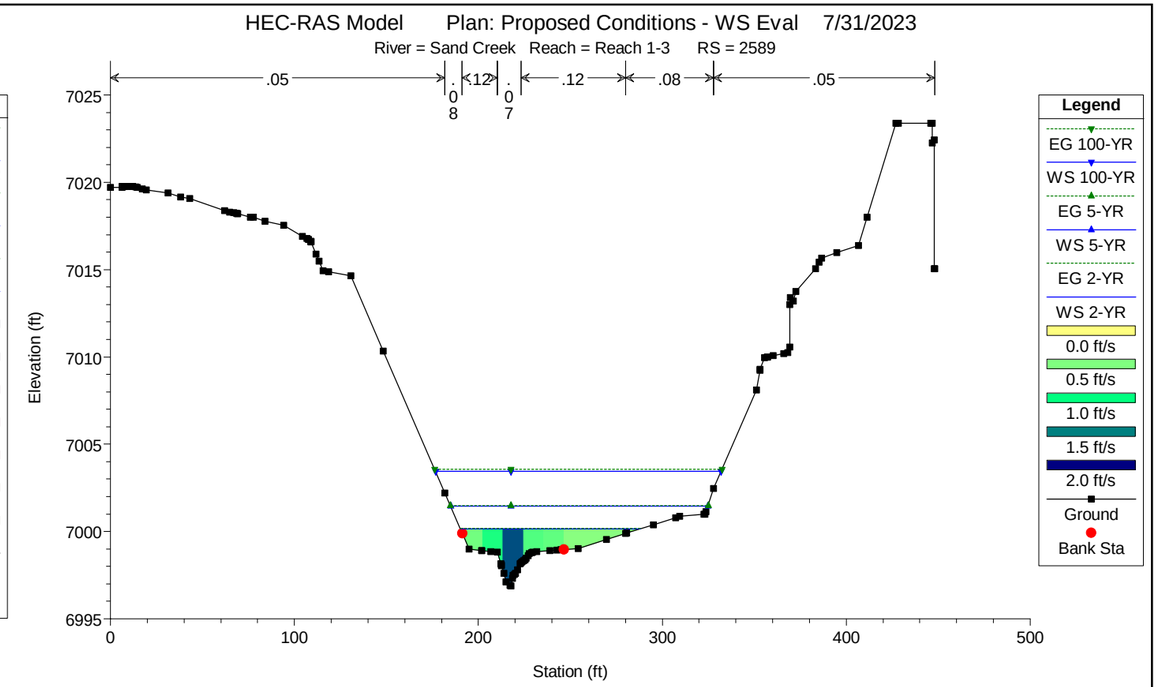


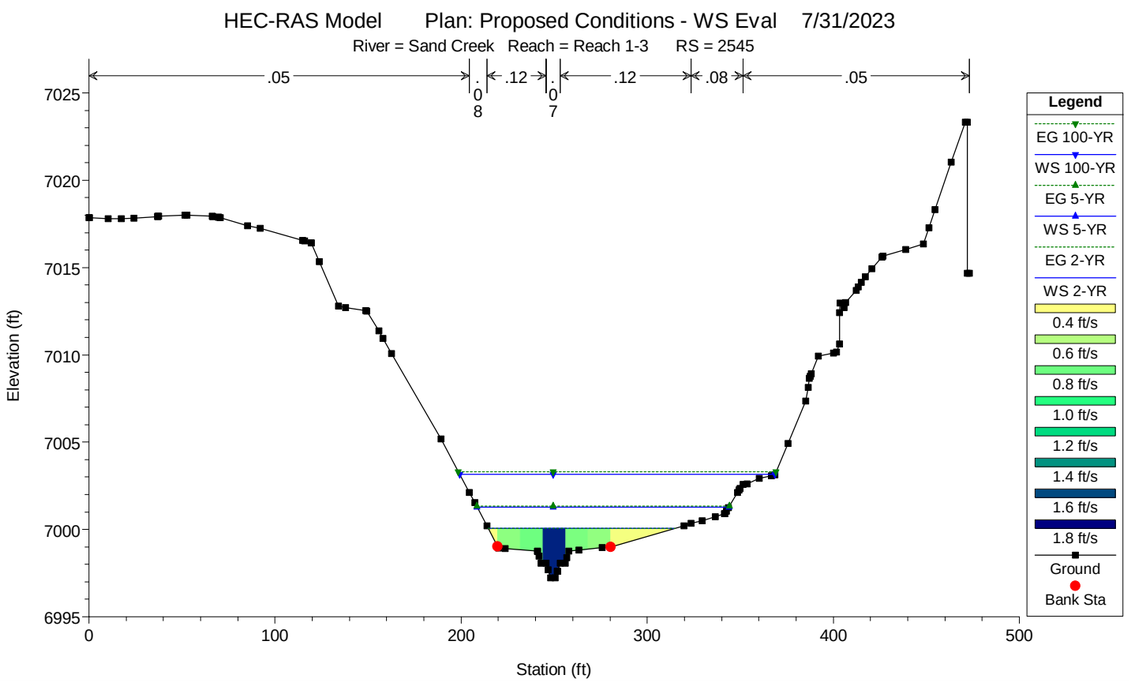


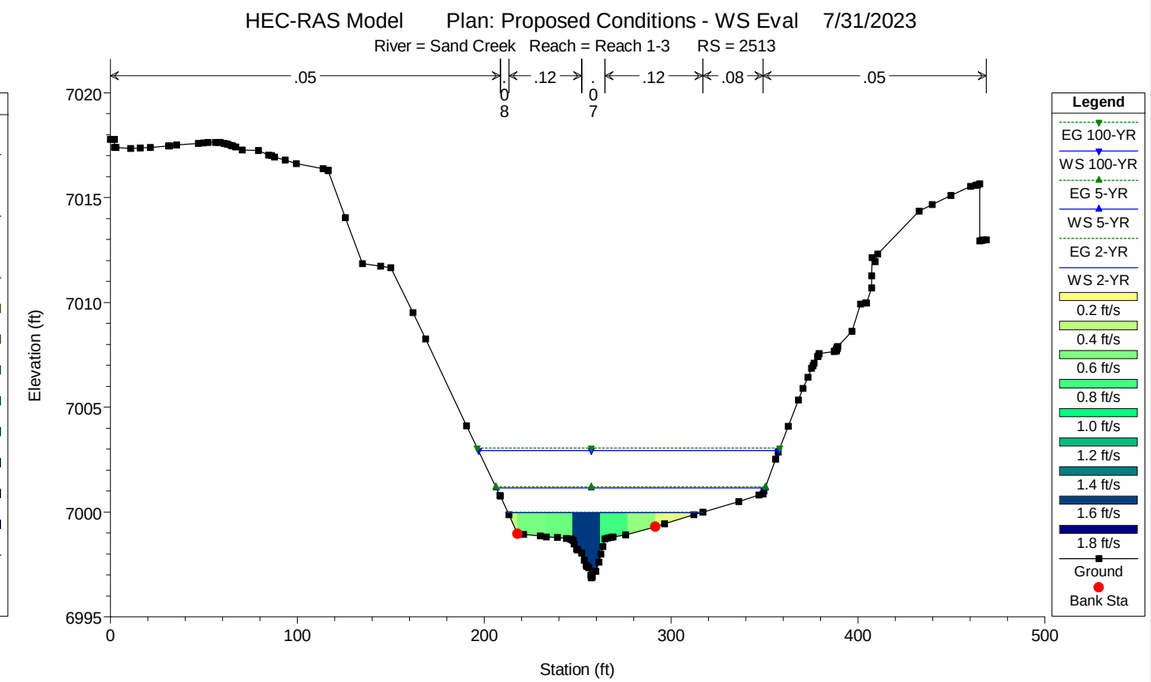


Subcritical flow analysis for Water Surface Evaluation of Naturalized Channel Design except FIS flow rate

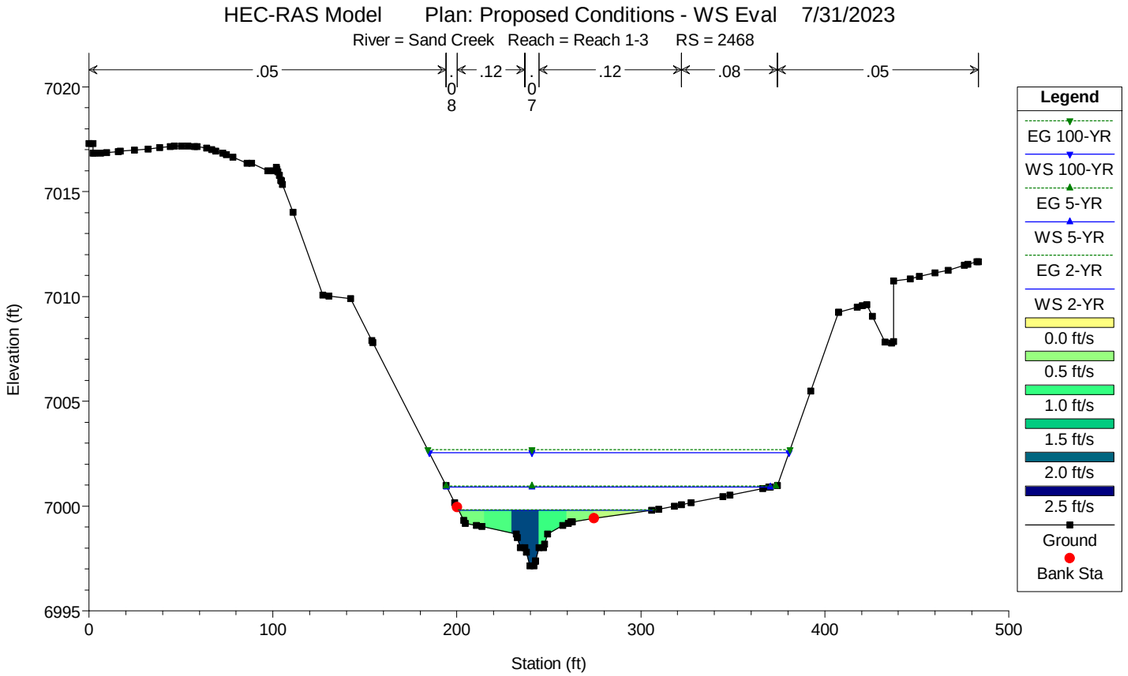


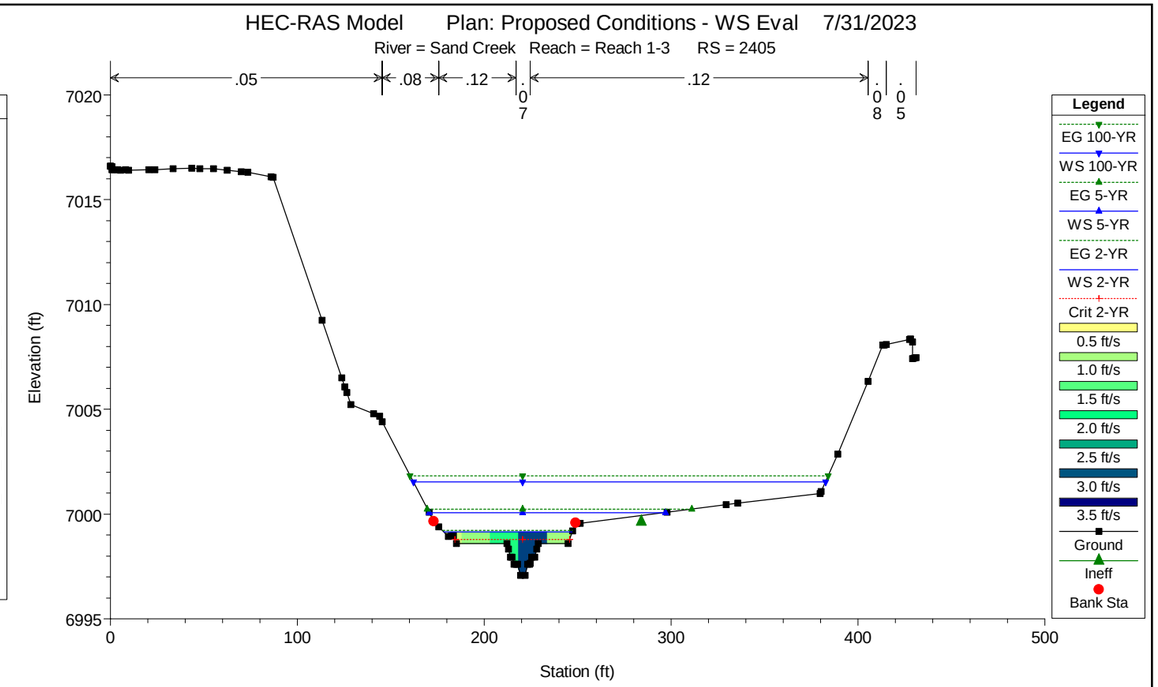


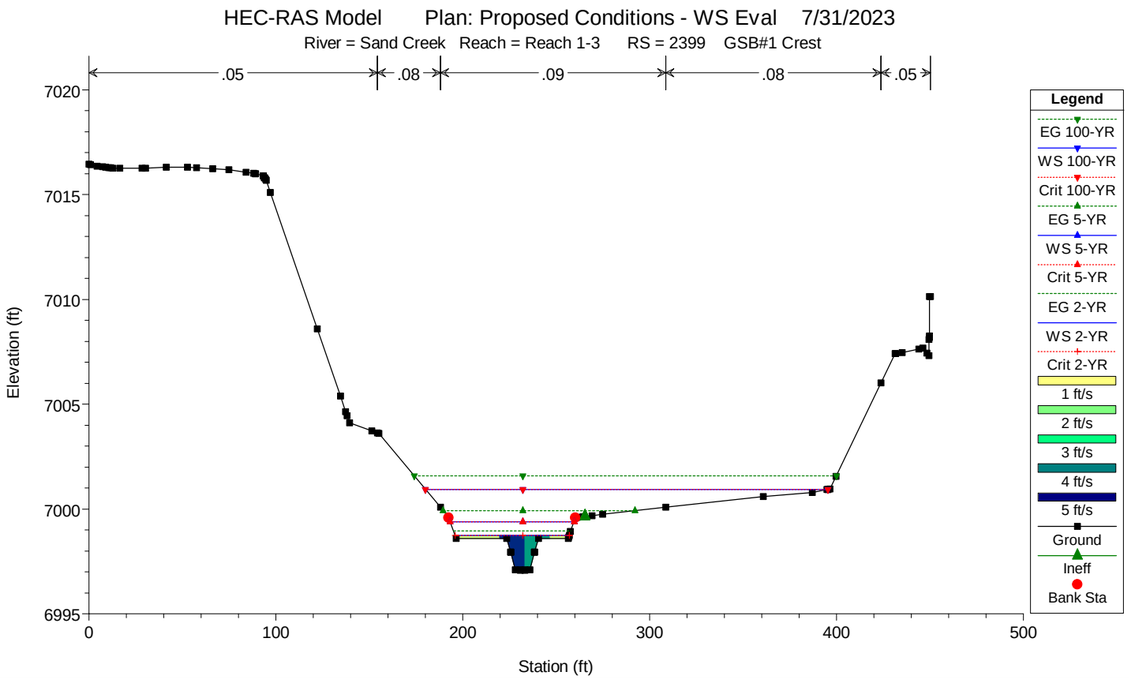


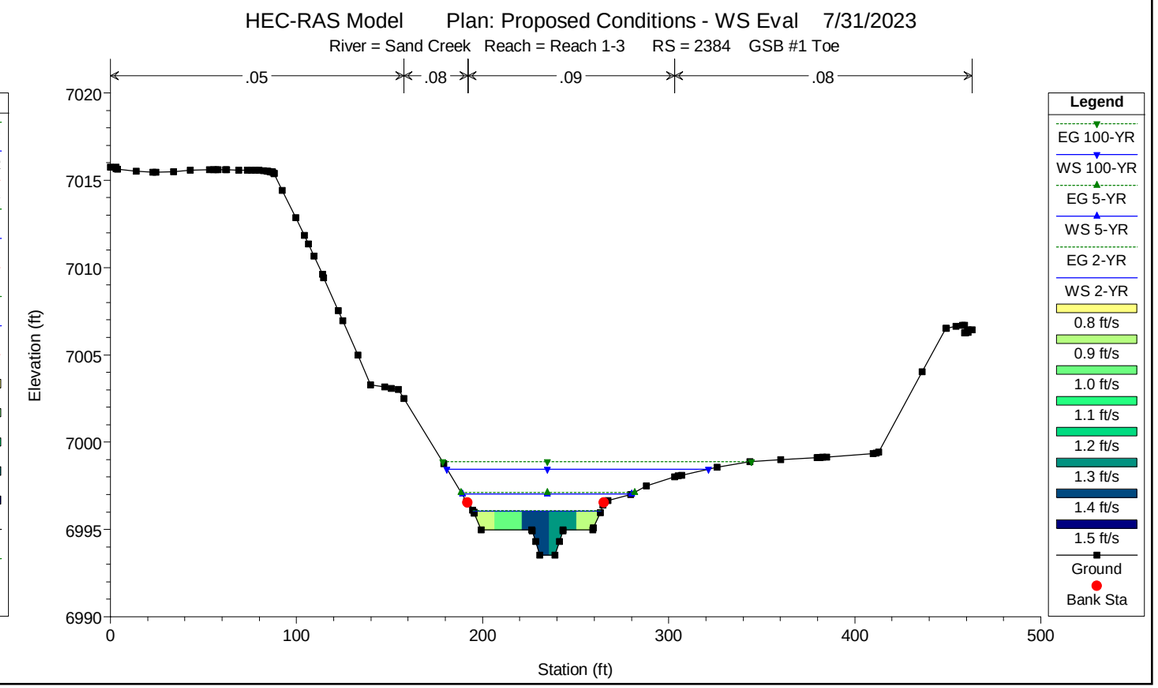


Subcritical flow analysis for Water Surface Evaluation of Naturalized Channel Design except FIS flow rate

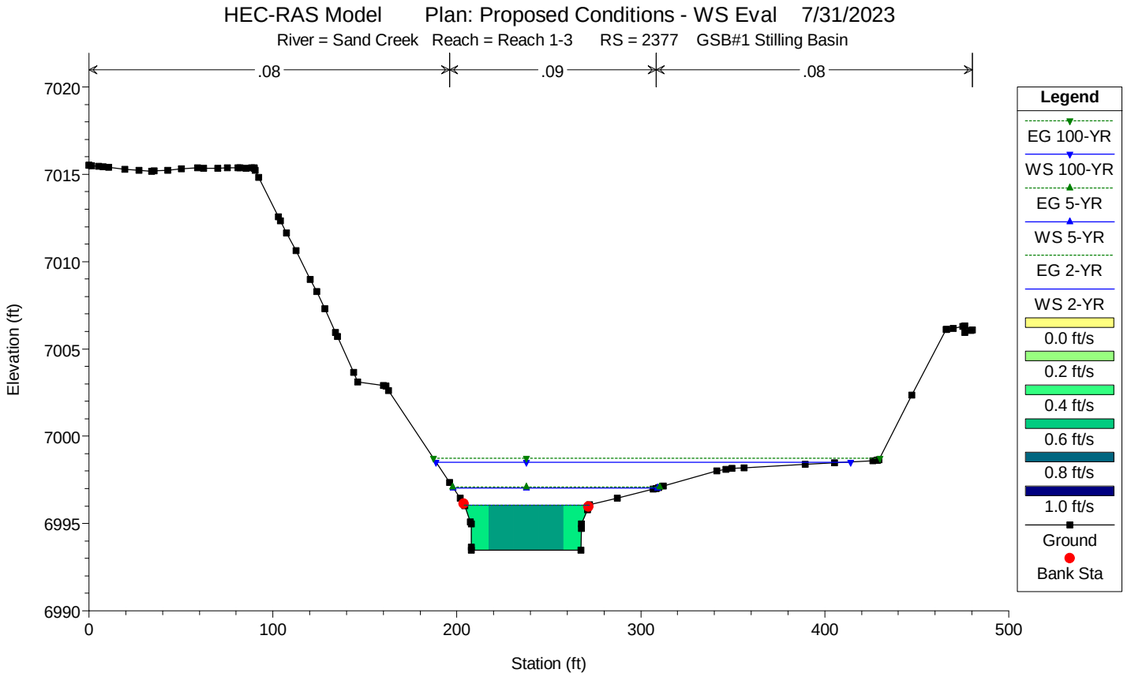


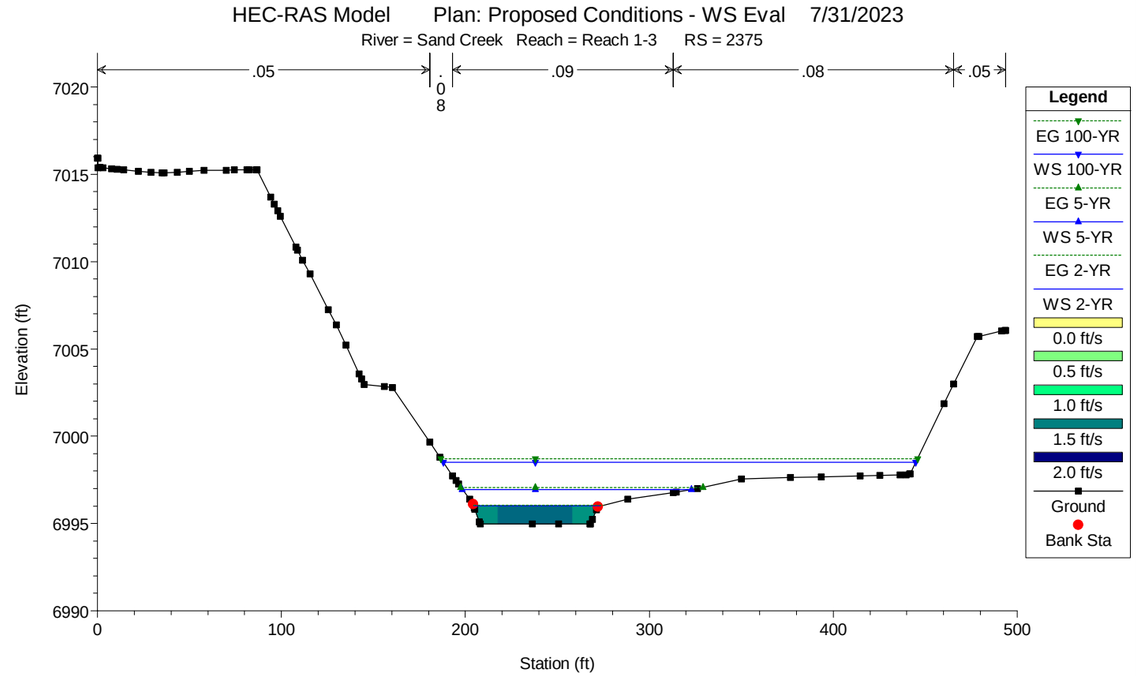


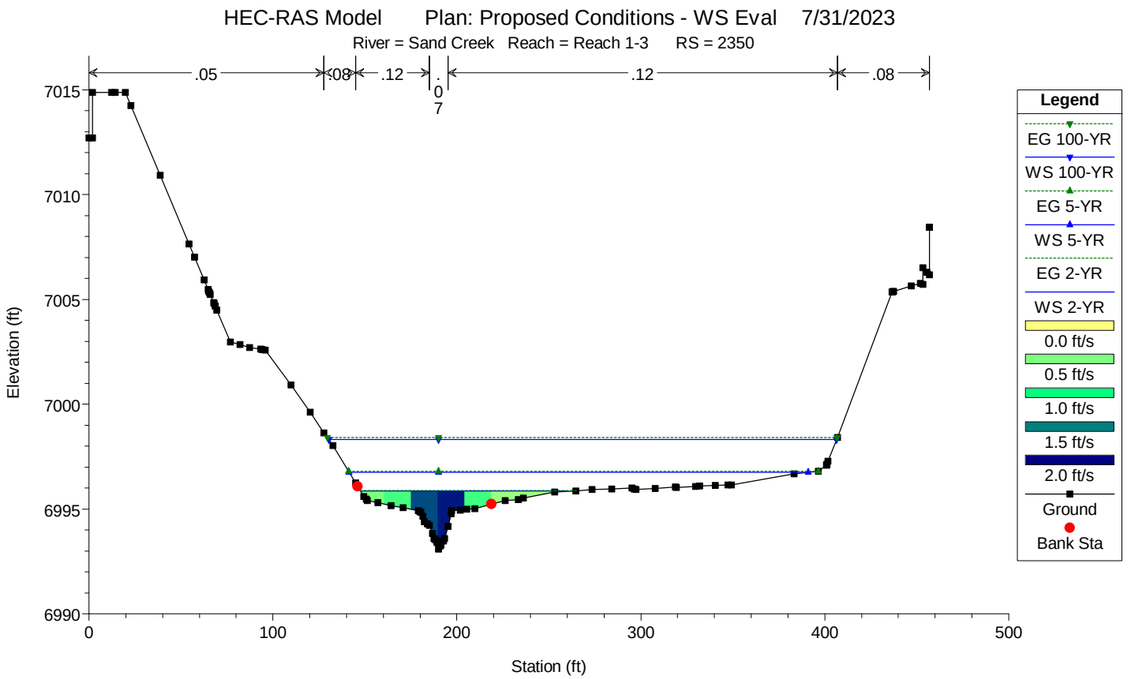


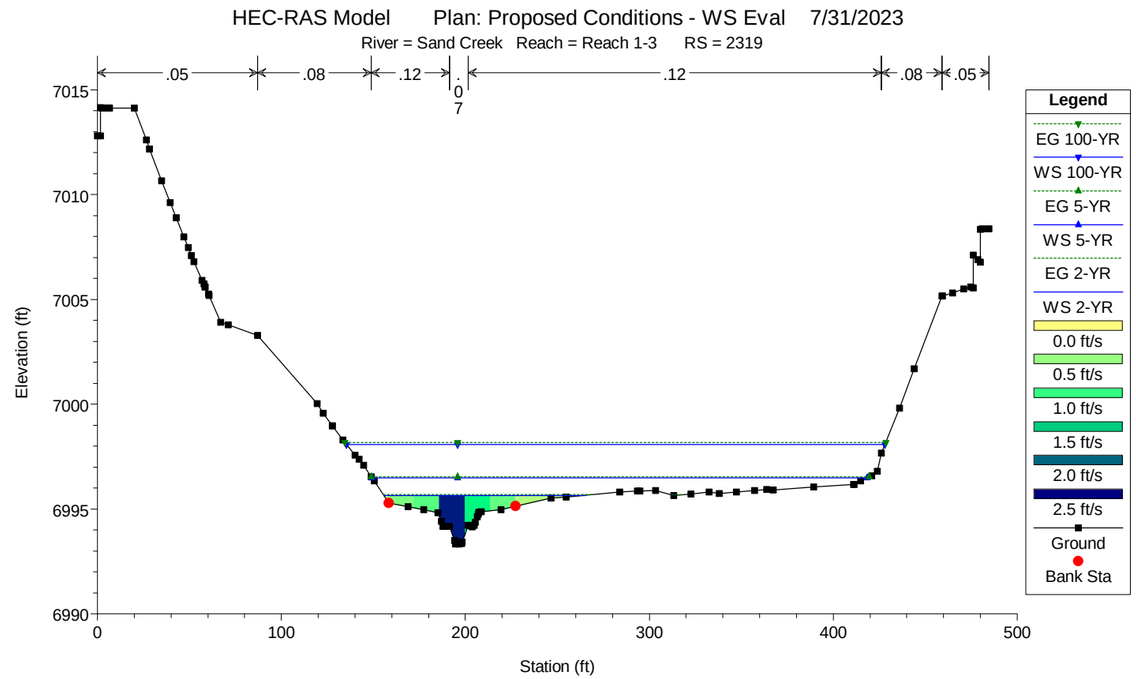


Subcritical flow analysis for Water Surface Evaluation of Naturalized Channel Design except FIS flow rate

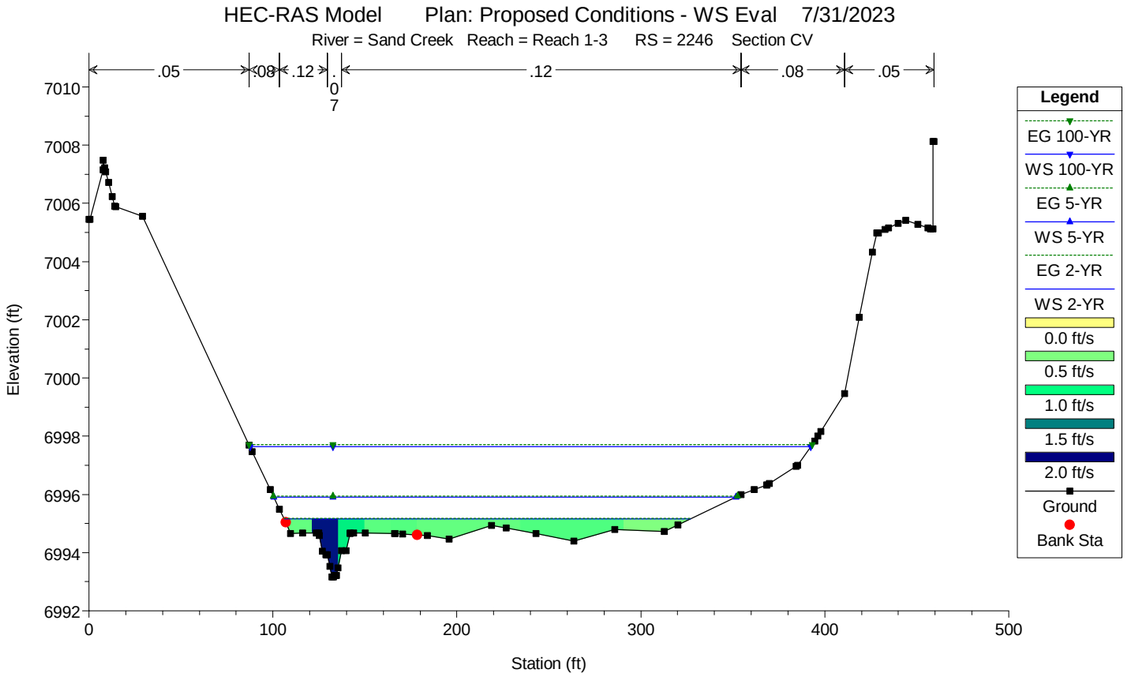


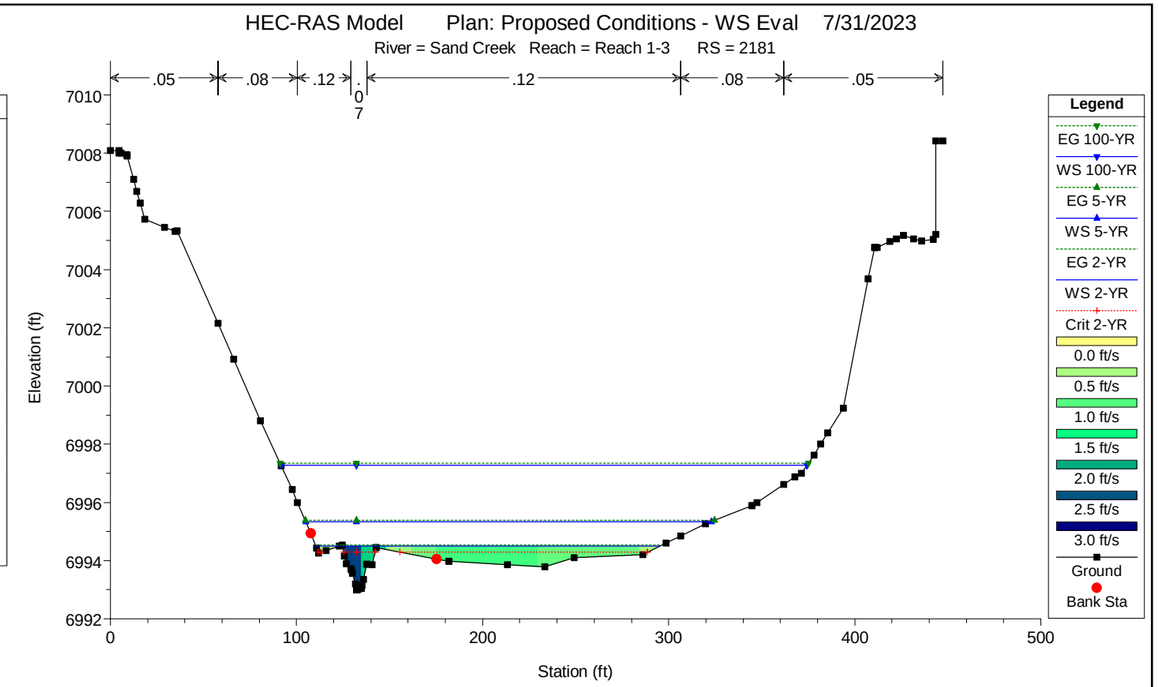


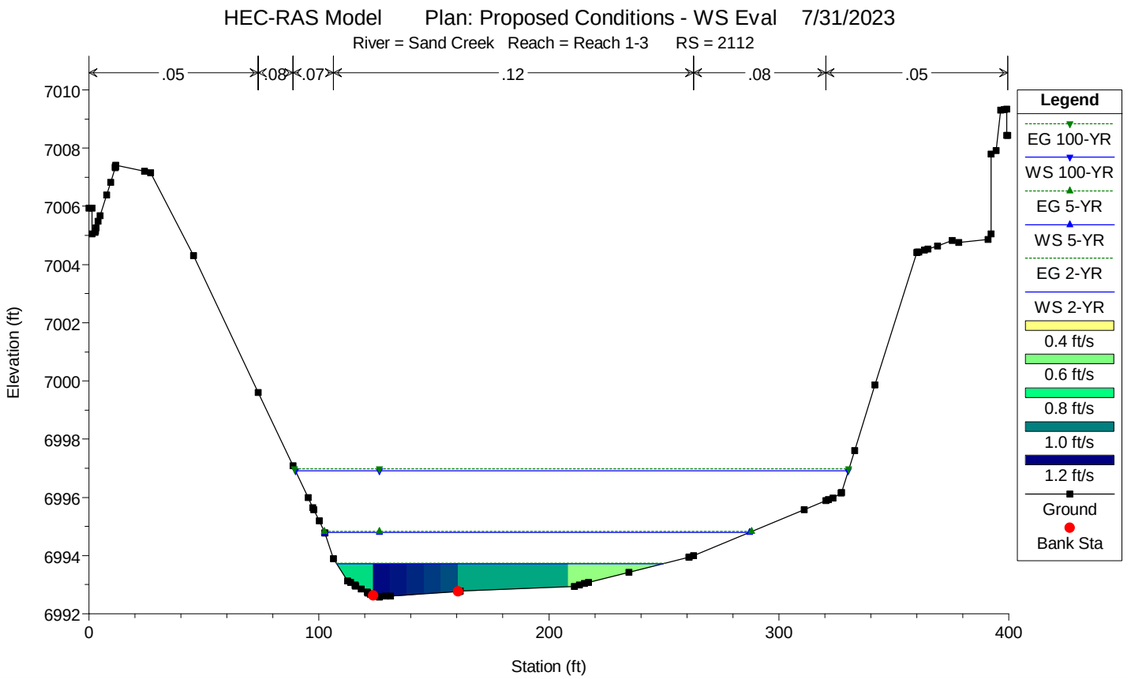


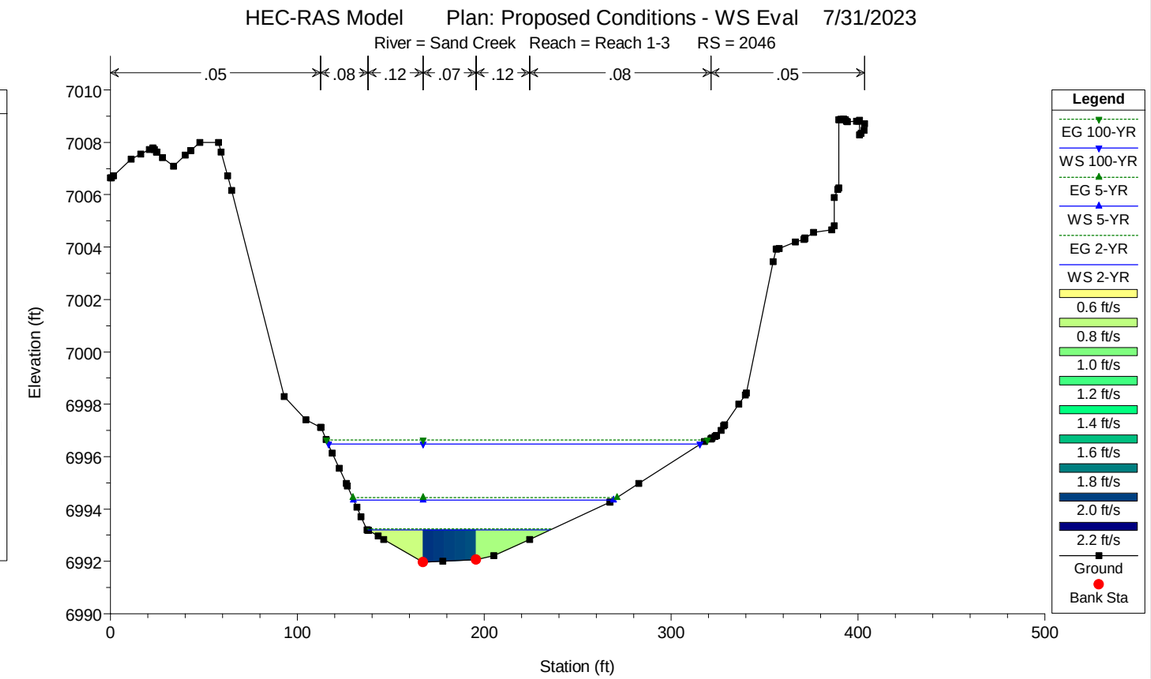


Subcritical flow analysis for Water Surface Evaluation of Naturalized Channel Design except FIS flow rate

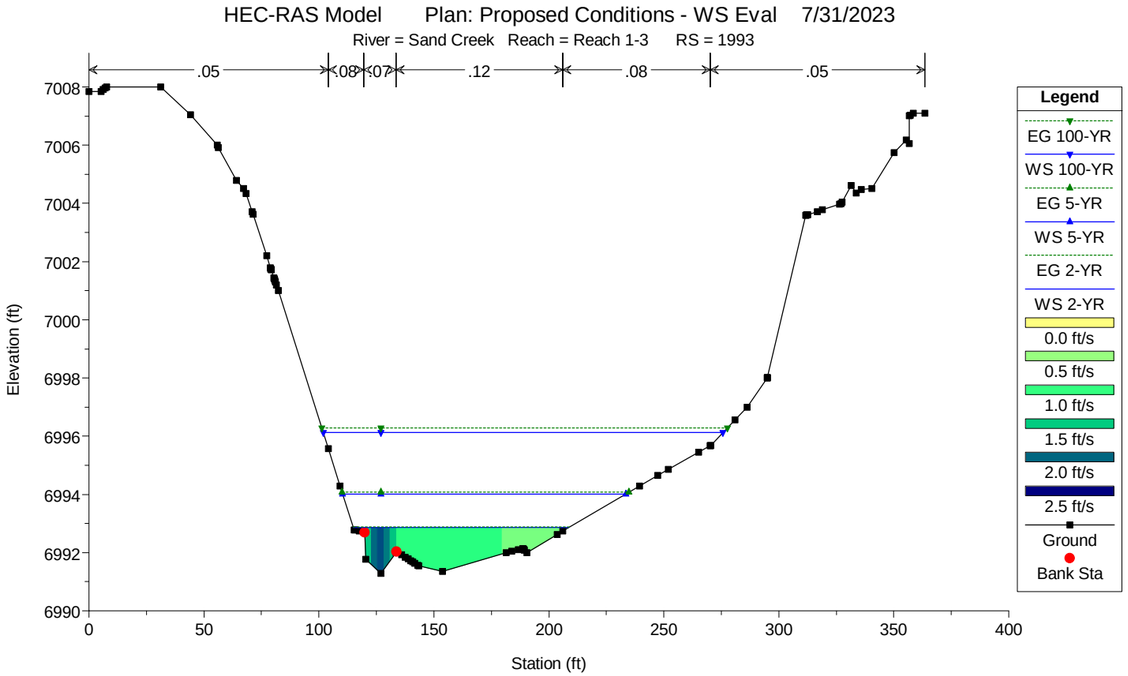


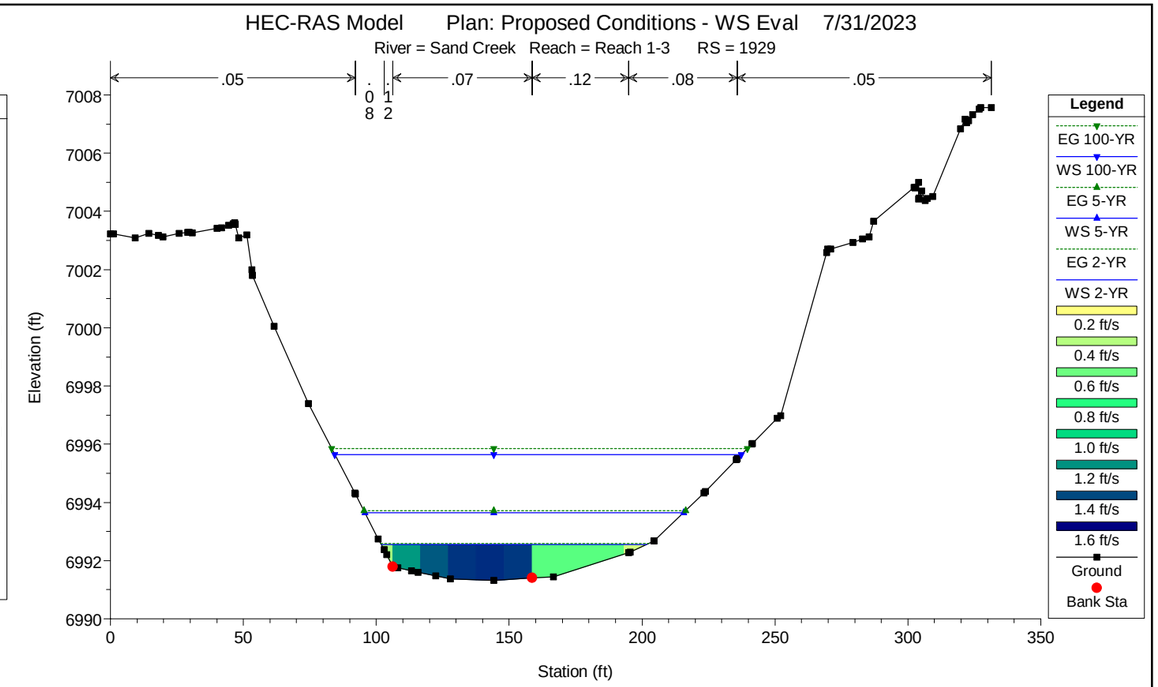


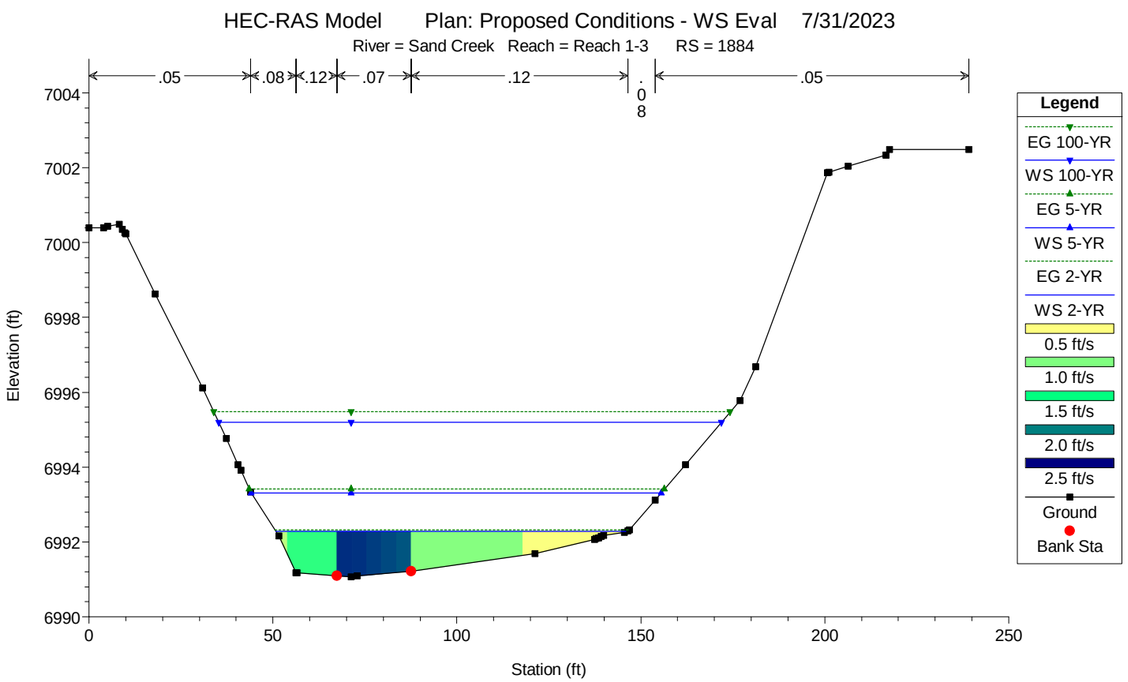


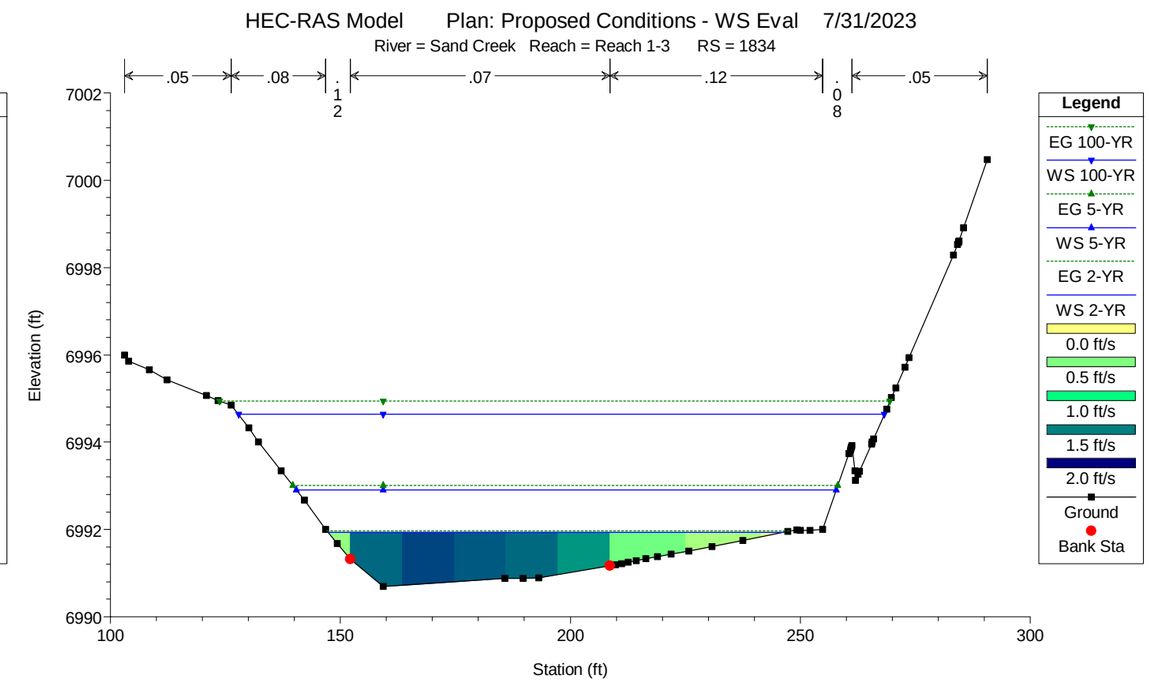


Subcritical flow analysis for Water Surface Evaluation of Naturalized Channel Design except FIS flow rate

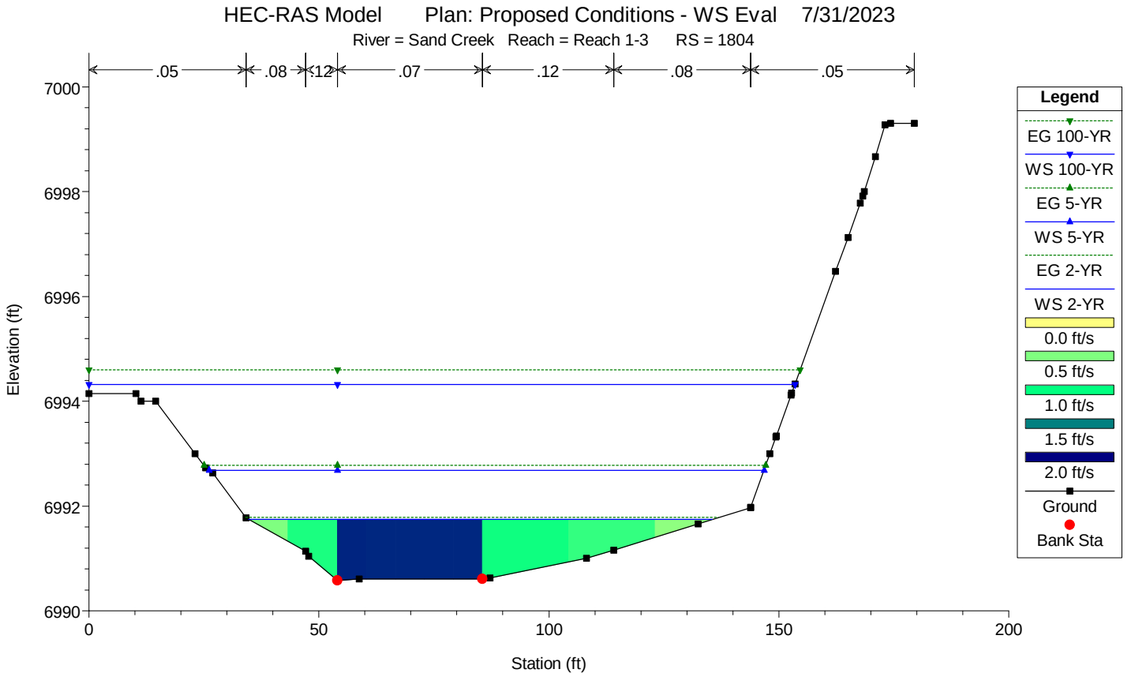


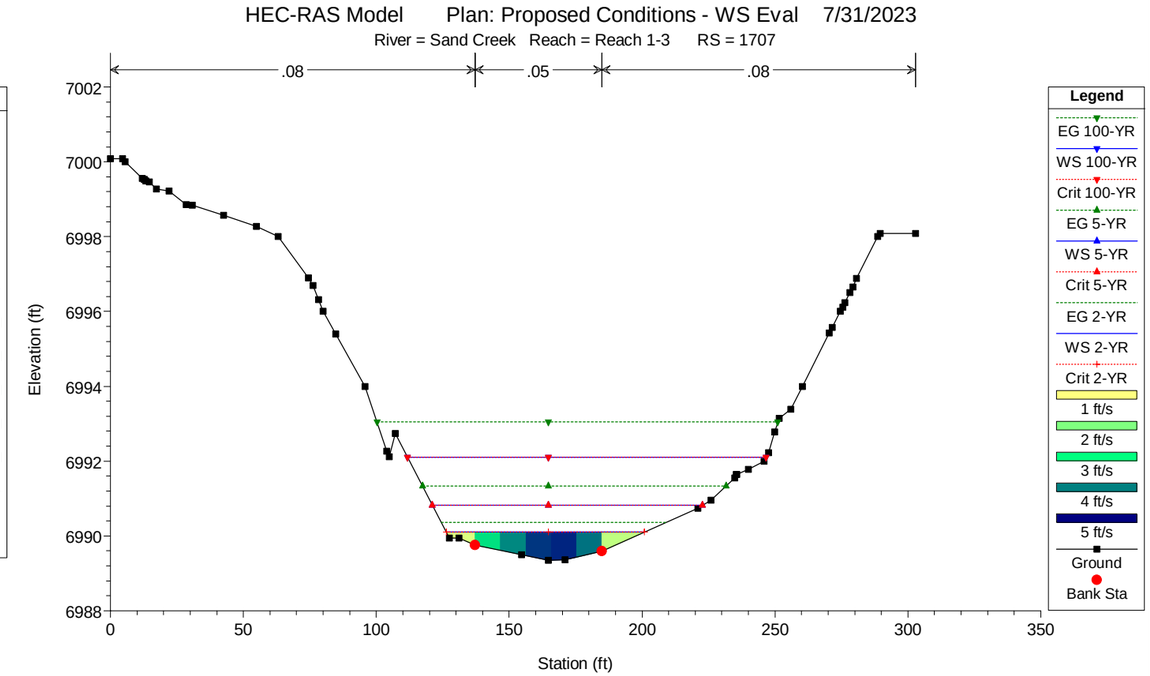


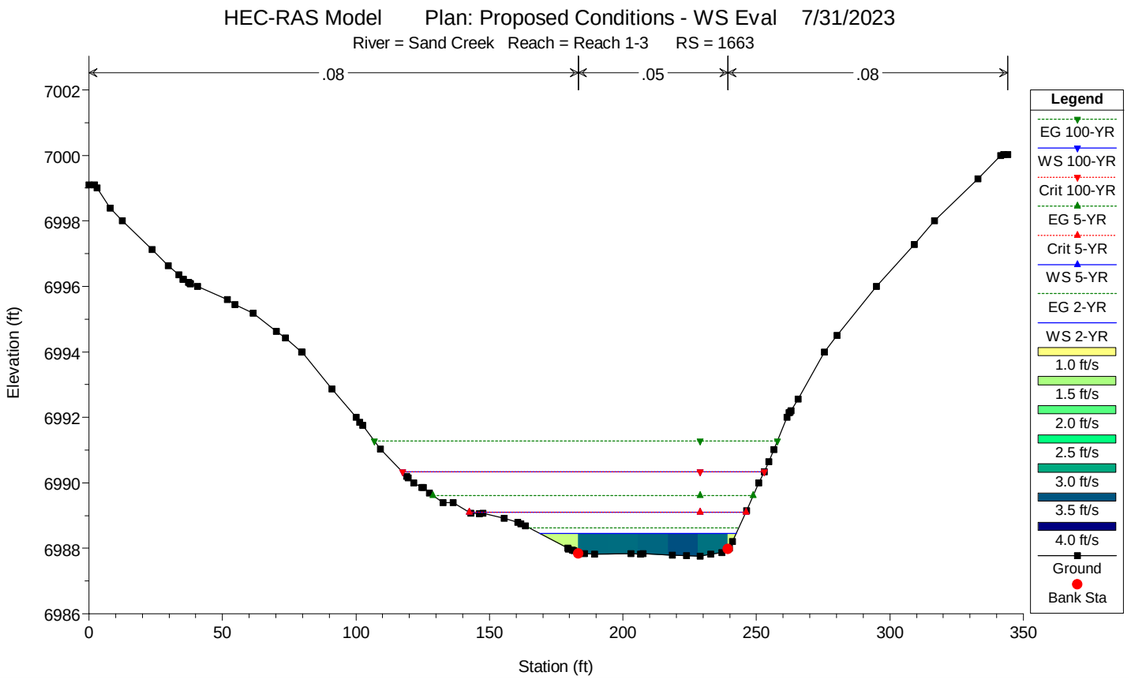


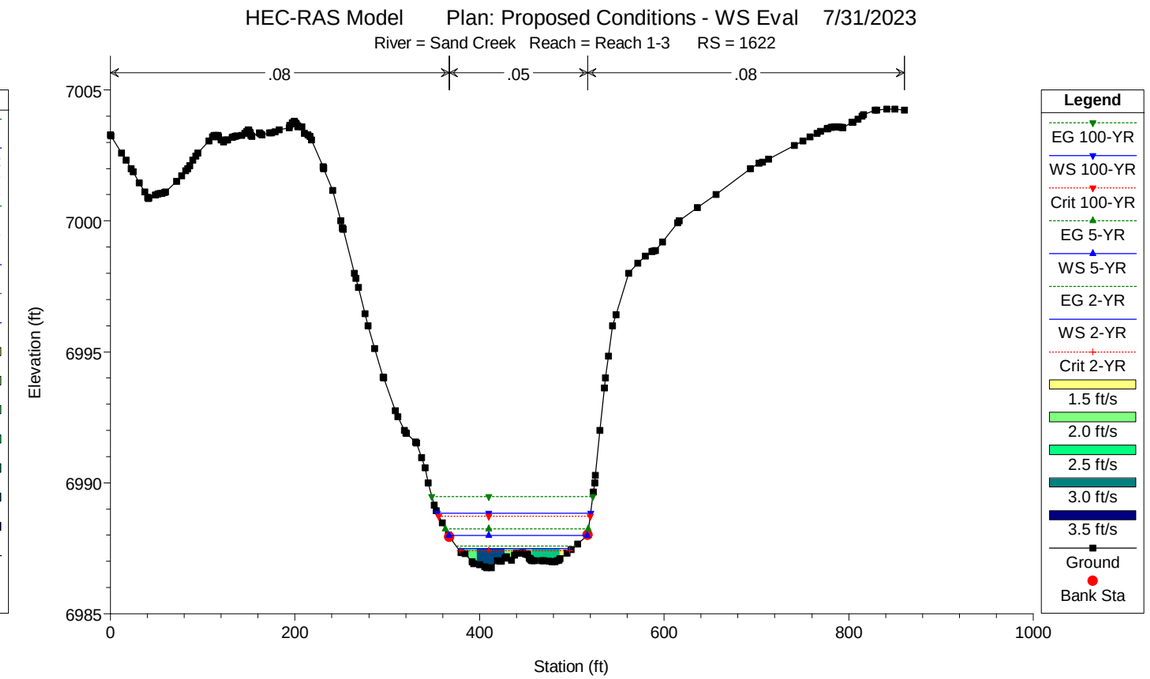


Subcritical flow analysis for Water Surface Evaluation of Naturalized Channel Design except FIS flow rate

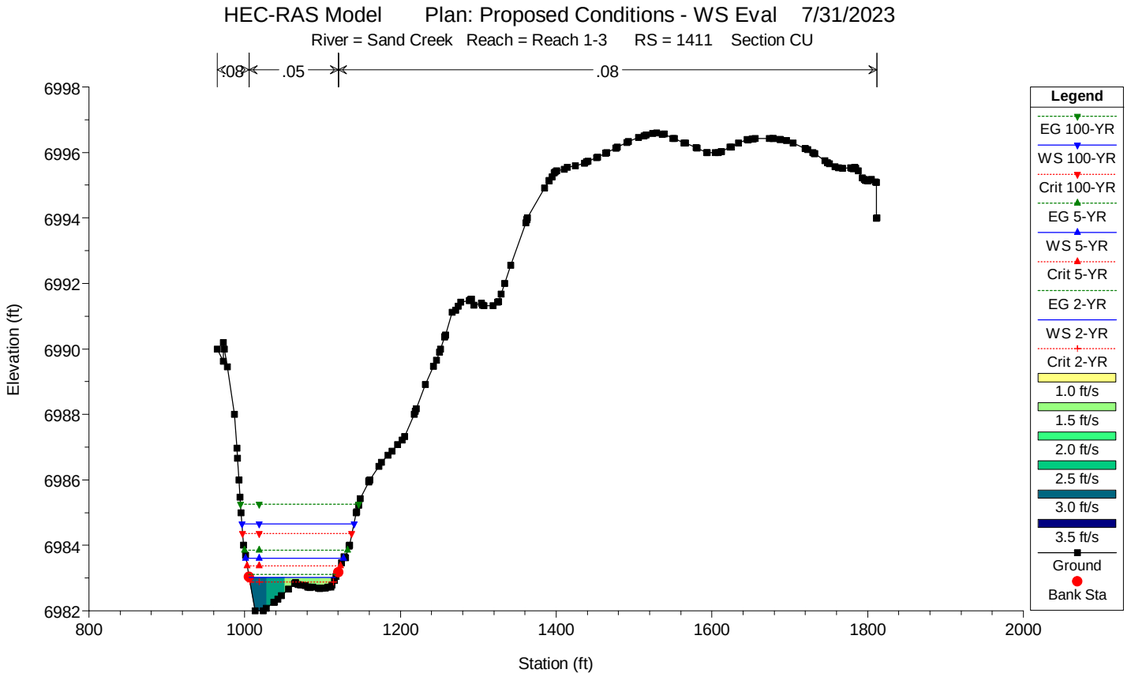








Subcritical flow analysis for Water Surface Evaluation of Naturalized Channel Design except FIS flow rate



Subcritical flow analysis for Water Surface Evaluation of Naturalized Channel Design except FIS flow rate

HEC-RAS Plan: PROP WSEL River: Sand Creek Reach: Reach 1-3

Reach	River Sta	Profile	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl
			(cfs)	(ft)	(ft)	(ft)	(ft)	(ft/ft)	(ft/s)	(sq ft)	(ft)	
Reach 1-3	12465	2-YR	154.80	7177.88	7178.86	7178.86	7179.30	0.027359	8.03	57.54	65.81	1.44
Reach 1-3	12465	5-YR	475.50	7177.88	7179.86	7179.86	7180.73	0.022174	11.59	126.71	72.72	1.46
Reach 1-3	12465	100-YR	1643.00	7177.88	7181.72	7181.72	7184.09	0.025899	19.50	264.22	74.32	1.76
Reach 1-3	12366		Culvert									
Reach 1-3	12253	2-YR	154.80	7168.00	7171.95		7171.96	0.000141	1.10	285.96	80.41	0.10
Reach 1-3	12253	5-YR	475.50	7168.00	7174.49		7174.52	0.000244	2.02	503.26	90.66	0.14
Reach 1-3	12253	100-YR	1643.00	7168.00	7177.91		7178.09	0.000671	4.44	837.30	104.45	0.25
Reach 1-3	12070	2-YR	154.80	7168.31	7171.75		7171.89	0.001880	3.53	104.46	61.98	0.34
Reach 1-3	12070	5-YR	475.50	7168.31	7174.26		7174.43	0.001444	4.52	282.47	76.58	0.33
Reach 1-3	12070	100-YR	1643.00	7168.31	7177.32		7177.84	0.002991	8.63	536.83	89.71	0.51
Reach 1-3	11880	2-YR	154.80	7165.52	7167.32	7167.32	7167.90	0.018608	9.99	64.04	61.50	1.31
Reach 1-3	11880	5-YR	475.50	7165.52	7167.80	7166.91	7170.23	0.064236	21.70	97.00	76.90	2.54
Reach 1-3	11880	100-YR	1643.00	7165.52	7170.51	7170.51	7172.02	0.021051	20.98	346.70	101.28	1.66
Reach 1-3	11569	2-YR	154.80	7159.96	7160.95		7161.00	0.014680	4.46	103.51	113.32	0.79
Reach 1-3	11569	5-YR	475.50	7159.96	7161.92		7162.04	0.012853	6.60	220.19	125.24	0.83
Reach 1-3	11569	100-YR	1643.00	7159.96	7163.91	7162.21	7164.19	0.013414	10.75	500.88	225.08	0.95
Reach 1-3	11368	2-YR	154.80	7153.99	7155.30	7155.30	7155.86	0.051313	10.07	42.79	50.27	1.55
Reach 1-3	11368	5-YR	475.50	7153.99	7156.62	7156.62	7157.63	0.041093	14.34	109.58	87.74	1.56
Reach 1-3	11368	100-YR	1643.00	7153.99	7158.94	7158.94	7160.19	0.029174	18.43	325.01	152.72	1.46
Reach 1-3	11206	2-YR	154.80	7151.03	7153.68		7153.81	0.002766	3.44	103.17	89.26	0.40
Reach 1-3	11206	5-YR	475.50	7151.03	7155.11		7155.33	0.003128	5.03	273.98	146.35	0.46
Reach 1-3	11206	100-YR	1643.00	7151.03	7157.18		7157.60	0.004511	8.07	629.35	182.82	0.59
Reach 1-3	11103	2-YR	154.80	7150.00	7151.89	7151.43	7152.17	0.018074	7.64	60.33	43.80	0.98
Reach 1-3	11103	5-YR	475.50	7150.00	7152.90	7152.87	7153.39	0.024052	11.73	174.86	130.64	1.21
Reach 1-3	11103	100-YR	1643.00	7150.00	7154.95	7154.16	7155.40	0.015822	13.57	475.13	161.39	1.08
Reach 1-3	10925	2-YR	154.80	7148.00	7149.43	7149.22	7149.65	0.012359	4.61	70.93	85.41	0.74
Reach 1-3	10925	5-YR	475.50	7148.00	7150.45		7150.81	0.010496	6.41	181.96	124.70	0.76
Reach 1-3	10925	100-YR	1643.00	7148.00	7151.98	7151.61	7152.85	0.014689	10.75	382.70	137.40	0.98
Reach 1-3	10797	2-YR	154.80	7145.39	7147.87	7147.17	7147.94	0.013807	2.08	75.15	102.78	0.33
Reach 1-3	10797	5-YR	475.50	7145.39	7148.89	7147.91	7149.04	0.017843	3.19	161.53	145.88	0.39
Reach 1-3	10797	100-YR	1643.00	7145.39	7150.46	7149.14	7150.68	0.016234	4.22	474.59	182.87	0.39
Reach 1-3	10713	2-YR	154.80	7144.30	7146.91		7146.96	0.009729	1.78	105.27	138.60	0.29
Reach 1-3	10713	5-YR	475.50	7144.30	7147.83		7147.90	0.010027	2.37	252.43	203.74	0.29
Reach 1-3	10713	100-YR	1643.00	7144.30	7149.43		7149.56	0.010517	3.39	597.38	225.73	0.31
Reach 1-3	10617	2-YR	154.80	7143.44	7145.98		7146.03	0.010474	1.79	89.18	109.92	0.29
Reach 1-3	10617	5-YR	475.50	7143.44	7146.91		7146.98	0.009928	2.34	267.04	223.15	0.28
Reach 1-3	10617	100-YR	1643.00	7143.44	7148.56		7148.67	0.008928	3.14	658.97	253.50	0.29
Reach 1-3	10543	2-YR	154.80	7142.46	7145.30		7145.35	0.007542	1.72	100.89	116.17	0.28
Reach 1-3	10543	5-YR	475.50	7142.46	7146.21		7146.28	0.008291	2.39	260.23	202.50	0.29
Reach 1-3	10543	100-YR	1643.00	7142.46	7147.84		7147.97	0.008865	3.47	618.24	242.46	0.32
Reach 1-3	10455	2-YR	154.80	7142.32	7144.95		7144.99	0.008321	1.68	109.94	140.01	0.27
Reach 1-3	10455	5-YR	475.50	7142.32	7145.84		7145.90	0.008485	2.22	280.43	210.09	0.27
Reach 1-3	10455	100-YR	1643.00	7142.32	7147.43		7147.55	0.009856	3.33	680.22	302.06	0.30
Reach 1-3	10411	2-YR	154.80	7141.35	7143.74		7143.80	0.013419	1.94	82.20	99.62	0.32
Reach 1-3	10411	5-YR	475.50	7141.35	7144.61		7144.70	0.013372	2.61	237.26	214.02	0.33
Reach 1-3	10411	100-YR	1643.00	7141.35	7145.94		7146.11	0.016651	3.96	560.22	279.42	0.38
Reach 1-3	10339	2-YR	154.80	7140.02	7142.69		7142.76	0.013445	2.11	73.26	179.77	0.35
Reach 1-3	10339	5-YR	475.50	7140.02	7143.67		7143.74	0.011375	2.57	269.61	303.29	0.31
Reach 1-3	10339	100-YR	1643.00	7140.02	7144.93		7145.03	0.011407	3.36	706.29	376.77	0.32
Reach 1-3	10211	2-YR	154.80	7138.76	7141.54		7141.60	0.010939	1.93	80.09	140.59	0.31
Reach 1-3	10211	5-YR	475.50	7138.76	7142.52		7142.62	0.012244	2.67	247.55	309.95	0.33
Reach 1-3	10211	100-YR	1643.00	7138.76	7143.83		7143.94	0.011343	3.38	695.10	352.26	0.32
Reach 1-3	10113	2-YR	154.80	7137.89	7140.38		7140.46	0.012510	2.24	69.07	185.20	0.39
Reach 1-3	10113	5-YR	475.50	7137.89	7141.40		7141.50	0.010658	2.68	252.87	293.00	0.34
Reach 1-3	10113	100-YR	1643.00	7137.89	7142.69		7142.82	0.011500	3.65	644.45	313.24	0.36
Reach 1-3	10014	2-YR	154.80	7136.24	7139.09		7139.17	0.013519	2.24	69.32	113.82	0.36
Reach 1-3	10014	5-YR	475.50	7136.24	7140.07		7140.21	0.017395	3.20	197.95	248.41	0.40

Subcritical flow analysis for Water Surface Evaluation of Naturalized Channel Design except FIS flow rate

HEC-RAS Plan: PROP WSEL River: Sand Creek Reach: Reach 1-3 (Continued)

Reach	River Sta	Profile	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl
			(cfs)	(ft)	(ft)	(ft)	(ft)	(ft/ft)	(ft/s)	(sq ft)	(ft)	
Reach 1-3	10014	100-YR	1643.00	7136.24	7141.31		7141.51	0.019171	4.35	537.80	291.66	0.43
Reach 1-3	9955	2-YR	154.80	7135.86	7138.11	7137.62	7138.20	0.019818	2.37	65.30	129.12	0.41
Reach 1-3	9955	5-YR	475.50	7135.86	7138.80	7138.52	7138.95	0.026172	3.46	194.87	272.40	0.47
Reach 1-3	9955	100-YR	1643.00	7135.86	7139.70	7139.33	7139.97	0.035552	5.14	452.15	293.02	0.57
Reach 1-3	9943	2-YR	154.80	7135.80	7137.42	7137.42	7137.71	0.138584	4.31	35.90	132.56	0.99
Reach 1-3	9943	5-YR	475.50	7135.80	7138.27	7138.27	7138.54	0.048588	4.47	136.62	266.18	0.67
Reach 1-3	9943	100-YR	1643.00	7135.80	7138.92	7138.92	7139.41	0.063551	6.62	322.72	296.66	0.82
Reach 1-3	9926	2-YR	154.80	7131.59	7134.43		7134.45	0.003128	1.34	117.35	72.82	0.18
Reach 1-3	9926	5-YR	475.50	7131.59	7135.57		7135.66	0.005068	2.38	215.02	99.43	0.25
Reach 1-3	9926	100-YR	1643.00	7131.59	7137.16		7137.45	0.010802	4.64	422.25	251.39	0.39
Reach 1-3	9913	2-YR	154.80	7131.58	7134.42		7134.43	0.000846	0.88	177.18	74.75	0.10
Reach 1-3	9913	5-YR	475.50	7131.58	7135.56		7135.60	0.002116	1.78	290.09	120.47	0.16
Reach 1-3	9913	100-YR	1643.00	7131.58	7137.18		7137.32	0.004532	3.32	636.21	270.74	0.25
Reach 1-3	9910	2-YR	154.80	7132.63	7134.39		7134.42	0.004823	1.51	103.69	75.17	0.22
Reach 1-3	9910	5-YR	475.50	7132.63	7135.50		7135.59	0.006023	2.44	217.01	124.88	0.26
Reach 1-3	9910	100-YR	1643.00	7132.63	7137.14		7137.30	0.007113	3.66	579.19	270.51	0.31
Reach 1-3	9875	2-YR	154.80	7131.85	7134.12		7134.19	0.009583	2.07	74.69	69.18	0.35
Reach 1-3	9875	5-YR	475.50	7131.85	7135.27		7135.35	0.007698	2.53	252.05	223.86	0.30
Reach 1-3	9875	100-YR	1643.00	7131.85	7136.90		7137.03	0.007915	3.52	668.90	280.44	0.32
Reach 1-3	9815	2-YR	154.80	7130.14	7133.63		7133.69	0.007322	1.94	79.80	63.90	0.31
Reach 1-3	9815	5-YR	475.50	7130.14	7134.67		7134.81	0.011143	2.97	183.80	153.71	0.36
Reach 1-3	9815	100-YR	1643.00	7130.14	7136.22		7136.44	0.013335	4.30	544.78	271.13	0.39
Reach 1-3	9772	2-YR	154.80	7130.91	7133.24		7133.31	0.010809	2.07	75.27	82.59	0.35
Reach 1-3	9772	5-YR	475.50	7130.91	7134.19		7134.30	0.011569	2.82	203.50	163.47	0.36
Reach 1-3	9772	100-YR	1643.00	7130.91	7135.66		7135.87	0.013366	4.17	533.47	267.93	0.40
Reach 1-3	9727	2-YR	154.80	7129.87	7132.79		7132.85	0.009130	1.98	84.42	108.18	0.32
Reach 1-3	9727	5-YR	475.50	7129.87	7133.68		7133.78	0.011711	2.83	212.67	190.96	0.35
Reach 1-3	9727	100-YR	1643.00	7129.87	7135.05		7135.24	0.014573	4.20	535.95	249.96	0.41
Reach 1-3	9636	2-YR	154.80	7129.38	7131.63	7131.17	7131.70	0.018998	2.22	85.86	162.06	0.39
Reach 1-3	9636	5-YR	475.50	7129.38	7132.32		7132.41	0.019725	2.88	218.41	234.23	0.40
Reach 1-3	9636	100-YR	1643.00	7129.38	7133.22		7133.44	0.029955	4.55	493.01	327.36	0.50
Reach 1-3	9626	2-YR	154.80	7129.34	7130.99	7130.99	7131.27	0.139922	4.28	36.13	62.05	0.99
Reach 1-3	9626	5-YR	475.50	7129.34	7131.75	7131.75	7132.07	0.062086	4.80	119.55	215.57	0.75
Reach 1-3	9626	100-YR	1643.00	7129.34	7132.54	7132.54	7133.01	0.058168	6.41	336.09	332.35	0.79
Reach 1-3	9600	2-YR	154.80	7123.43	7125.87		7125.91	0.007760	1.74	89.07	71.98	0.27
Reach 1-3	9600	5-YR	475.50	7123.43	7126.90		7127.02	0.009463	2.83	181.51	107.02	0.32
Reach 1-3	9600	100-YR	1643.00	7123.43	7128.34		7128.70	0.016611	5.15	371.39	157.51	0.47
Reach 1-3	9587	2-YR	154.80	7123.38	7125.85		7125.87	0.001385	1.03	150.98	78.83	0.12
Reach 1-3	9587	5-YR	475.50	7123.38	7126.88		7126.93	0.003104	1.98	274.39	152.71	0.19
Reach 1-3	9587	100-YR	1643.00	7123.38	7128.33		7128.51	0.006928	3.78	531.54	249.78	0.31
Reach 1-3	9584	2-YR	154.80	7124.71	7125.77		7125.85	0.021779	2.31	67.01	72.35	0.42
Reach 1-3	9584	5-YR	475.50	7124.71	7126.82		7126.92	0.017430	2.50	190.54	155.25	0.40
Reach 1-3	9584	100-YR	1643.00	7124.71	7128.28		7128.48	0.015176	3.65	457.37	291.77	0.41
Reach 1-3	9558	2-YR	154.80	7122.44	7125.43		7125.48	0.009207	1.85	83.73	68.20	0.29
Reach 1-3	9558	5-YR	475.50	7122.44	7126.40		7126.54	0.011459	3.01	171.99	129.86	0.35
Reach 1-3	9558	100-YR	1643.00	7122.44	7127.85		7128.09	0.013635	4.58	489.68	318.69	0.42
Reach 1-3	9498	2-YR	154.80	7122.10	7124.84	7124.09	7124.89	0.010707	1.81	87.16	98.75	0.30
Reach 1-3	9498	5-YR	475.50	7122.10	7125.63	7124.75	7125.73	0.015813	2.80	211.12	217.56	0.36
Reach 1-3	9498	100-YR	1643.00	7122.10	7126.92	7126.04	7127.11	0.018590	4.10	520.19	268.54	0.40
Reach 1-3	9389	2-YR	154.80	7120.61	7122.13		7122.28	0.091469	3.12	49.98	69.48	0.63
Reach 1-3	9389	5-YR	475.50	7120.61	7122.88		7123.05	0.043975	3.41	143.95	143.70	0.49
Reach 1-3	9389	100-YR	1643.00	7120.61	7124.23		7124.61	0.030723	4.38	355.54	173.42	0.46
Reach 1-3	9256	2-YR	154.80	7118.36	7120.25	7119.62	7120.26	0.005839	0.97	161.55	198.68	0.19
Reach 1-3	9256	5-YR	475.50	7118.36	7120.91	7119.97	7120.95	0.007834	1.63	298.13	210.03	0.23
Reach 1-3	9256	100-YR	1643.00	7118.36	7122.33		7122.44	0.009506	2.78	611.72	232.37	0.29
Reach 1-3	9243	2-YR	154.80	7119.00	7119.38	7119.38	7119.54	0.170899	3.15	49.24	158.41	0.99
Reach 1-3	9243	5-YR	475.50	7119.00	7119.72	7119.72	7120.04	0.136550	4.56	104.91	169.42	1.00

Subcritical flow analysis for Water Surface Evaluation of Naturalized Channel Design except FIS flow rate

HEC-RAS Plan: PROP WSEL River: Sand Creek Reach: Reach 1-3 (Continued)

Reach	River Sta	Profile	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl
			(cfs)	(ft)	(ft)	(ft)	(ft)	(ft/ft)	(ft/s)	(sq ft)	(ft)	
Reach 1-3	9243	100-YR	1643.00	7119.00	7121.86		7122.02	0.010082	3.28	524.94	219.00	0.35
Reach 1-3	9216	2-YR	154.80	7114.00	7118.49		7118.49	0.000004	0.16	981.43	237.93	0.01
Reach 1-3	9216	5-YR	475.50	7114.00	7119.04		7119.04	0.000026	0.45	1114.42	242.83	0.04
Reach 1-3	9216	100-YR	1643.00	7114.00	7121.95		7121.97	0.000063	0.94	1872.58	275.39	0.06
Reach 1-3	9080	2-YR	155.10	7114.00	7118.48		7118.49	0.000009	0.18	892.72	218.41	0.01
Reach 1-3	9080	5-YR	480.20	7114.00	7119.03		7119.04	0.000059	0.48	1013.89	223.12	0.04
Reach 1-3	9080	100-YR	1665.90	7114.00	7121.94		7121.95	0.000141	1.00	1704.14	253.19	0.06
Reach 1-3	9029	2-YR	155.10	7117.75	7118.47		7118.48	0.002859	0.91	170.43	240.30	0.19
Reach 1-3	9029	5-YR	480.20	7117.75	7118.98		7119.02	0.004516	1.64	293.98	244.42	0.26
Reach 1-3	9029	100-YR	1665.90	7117.75	7121.89		7121.93	0.000867	1.61	1046.08	274.53	0.14
Reach 1-3	8989	2-YR	155.10	7117.73	7118.00	7118.00	7118.12	0.122416	2.80	55.39	240.21	1.03
Reach 1-3	8989	5-YR	480.20	7117.73	7118.26	7118.26	7118.51	0.089953	4.01	119.98	242.58	1.00
Reach 1-3	8989	100-YR	1665.90	7117.73	7121.86		7121.89	0.000857	1.59	1060.85	282.01	0.14
Reach 1-3	8983	2-YR	155.10	7103.78	7107.20		7107.25	0.002002	1.83	84.59	24.77	0.17
Reach 1-3	8983	5-YR	480.20	7103.78	7110.92		7111.04	0.002176	2.71	176.93	24.84	0.18
Reach 1-3	8983	100-YR	1665.90	7103.78	7121.77		7121.88	0.004403	2.66	647.71	282.90	0.28
Reach 1-3	8956	2-YR	155.10	7103.78	7107.14	7104.85	7107.20	0.002109	1.87	83.16	24.77	0.18
Reach 1-3	8956	5-YR	480.20	7103.78	7110.86	7106.05	7110.98	0.002230	2.74	175.39	24.84	0.18
Reach 1-3	8956	100-YR	1665.90	7103.78	7121.62	7108.98	7121.75	0.005388	2.85	606.09	281.58	0.30
Reach 1-3	8919		Culvert									
Reach 1-3	8888	2-YR	155.10	7103.58	7105.14	7105.14	7105.92	0.056603	6.78	22.21	46.92	0.96
Reach 1-3	8888	5-YR	480.20	7103.58	7106.88	7106.88	7108.55	0.044095	9.89	47.17	47.00	0.96
Reach 1-3	8888	100-YR	1665.90	7103.58	7111.16	7111.16	7114.97	0.033367	14.96	108.17	47.20	0.96
Reach 1-3	8886	2-YR	155.10	7102.02	7104.39		7104.63	0.010227	3.80	39.99	46.89	0.44
Reach 1-3	8886	5-YR	480.20	7102.02	7104.96	7104.96	7106.45	0.047351	9.47	49.75	46.92	0.97
Reach 1-3	8886	100-YR	1665.90	7102.02	7108.76	7108.76	7112.15	0.035810	14.32	114.09	47.09	0.97
Reach 1-3	8852	2-YR	155.10	7102.13	7104.51		7104.52	0.000420	0.74	229.40	166.35	0.09
Reach 1-3	8852	5-YR	480.20	7102.13	7105.31		7105.34	0.001021	1.41	365.34	179.65	0.14
Reach 1-3	8852	100-YR	1665.90	7102.13	7106.88		7106.97	0.001814	2.47	718.55	265.97	0.20
Reach 1-3	8850	2-YR	155.10	7103.55	7104.49		7104.52	0.005578	1.30	116.97	168.25	0.24
Reach 1-3	8850	5-YR	480.20	7103.55	7105.27		7105.33	0.004116	1.69	255.31	190.31	0.23
Reach 1-3	8850	100-YR	1665.90	7103.55	7106.81		7106.96	0.003985	2.56	616.74	266.88	0.25
Reach 1-3	8818	2-YR	155.10	7101.03	7104.08		7104.12	0.006652	1.70	105.46	163.86	0.27
Reach 1-3	8818	5-YR	480.20	7101.03	7104.90		7104.97	0.008031	2.34	281.21	239.60	0.29
Reach 1-3	8818	100-YR	1665.90	7101.03	7106.47		7106.59	0.008386	3.28	669.44	254.59	0.31
Reach 1-3	8786	2-YR	155.10	7101.10	7103.81		7103.86	0.010258	1.85	95.06	191.55	0.30
Reach 1-3	8786	5-YR	480.20	7101.10	7104.66		7104.71	0.008389	2.16	312.09	265.75	0.27
Reach 1-3	8786	100-YR	1665.90	7101.10	7106.25		7106.33	0.007640	2.88	743.97	278.23	0.27
Reach 1-3	8750	2-YR	155.10	7100.37	7103.04		7103.08	0.009028	1.76	103.16	206.84	0.27
Reach 1-3	8750	5-YR	480.20	7100.37	7103.87		7103.94	0.010688	2.46	249.18	229.50	0.30
Reach 1-3	8750	100-YR	1665.90	7100.37	7105.34		7105.51	0.013732	3.82	566.53	282.83	0.36
Reach 1-3	8683	2-YR	155.10	7099.61	7102.35		7102.40	0.008831	1.75	97.16	241.95	0.27
Reach 1-3	8683	5-YR	480.20	7099.61	7103.14		7103.20	0.009533	2.31	293.09	264.91	0.28
Reach 1-3	8683	100-YR	1665.90	7099.61	7104.55		7104.66	0.010071	3.21	674.91	274.79	0.30
Reach 1-3	8578	2-YR	155.10	7099.09	7101.70		7101.74	0.007846	1.58	122.63	238.84	0.25
Reach 1-3	8578	5-YR	480.20	7099.09	7102.44		7102.49	0.008739	2.12	304.41	248.92	0.27
Reach 1-3	8578	100-YR	1665.90	7099.09	7103.73		7103.85	0.011606	3.28	632.37	258.85	0.32
Reach 1-3	8429	2-YR	155.10	7098.29	7100.73		7100.81	0.015293	2.28	69.88	164.15	0.40
Reach 1-3	8429	5-YR	480.20	7098.29	7101.42	7100.98	7101.55	0.015142	3.15	191.78	227.60	0.43
Reach 1-3	8429	100-YR	1665.90	7098.29	7102.50		7102.74	0.015363	4.47	441.80	235.88	0.48
Reach 1-3	8326	2-YR	155.10	7096.32	7098.41	7098.41	7098.84	0.013934	5.57	29.84	35.34	1.00
Reach 1-3	8326	5-YR	480.20	7096.32	7099.25	7099.25	7099.72	0.012631	4.98	89.61	96.87	0.95
Reach 1-3	8326	100-YR	1665.90	7096.32	7100.64	7100.64	7101.39	0.007135	7.11	258.28	195.05	0.84
Reach 1-3	8290	2-YR	155.10	7097.00	7097.90		7097.97	0.006102	2.21	70.21	88.46	0.44
Reach 1-3	8290	5-YR	480.20	7097.00	7098.50		7098.73	0.009227	3.83	125.37	94.21	0.59
Reach 1-3	8290	100-YR	1665.90	7097.00	7099.73		7100.43	0.013409	6.72	248.01	106.00	0.77

Subcritical flow analysis for Water Surface Evaluation of Naturalized Channel Design except FIS flow rate

HEC-RAS Plan: PROP WSEL River: Sand Creek Reach: Reach 1-3 (Continued)

Reach	River Sta	Profile	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl
			(cfs)	(ft)	(ft)	(ft)	(ft)	(ft/ft)	(ft/s)	(sq ft)	(ft)	
Reach 1-3	8276	2-YR	155.10	7097.00	7097.80	7097.52	7097.88	0.007642	2.27	68.41	98.16	0.48
Reach 1-3	8276	5-YR	480.20	7097.00	7098.37	7098.01	7098.60	0.010226	3.81	126.12	103.33	0.61
Reach 1-3	8276	100-YR	1665.90	7097.00	7099.57	7099.17	7100.23	0.013252	6.49	256.77	114.66	0.76
Reach 1-3	8267	2-YR	155.10	7097.00	7097.51	7097.51	7097.71	0.039749	3.62	42.84	105.00	1.00
Reach 1-3	8267	5-YR	480.20	7097.00	7097.97	7097.97	7098.39	0.031384	5.23	91.84	108.53	1.00
Reach 1-3	8267	100-YR	1665.90	7097.00	7099.06	7099.06	7099.99	0.024397	7.71	215.98	117.67	1.00
Reach 1-3	8229	2-YR	155.10	7091.00	7094.18		7094.19	0.000280	0.90	172.77	82.65	0.11
Reach 1-3	8229	5-YR	480.20	7091.00	7095.09		7095.15	0.000860	1.91	251.59	89.99	0.20
Reach 1-3	8229	100-YR	1665.90	7091.00	7096.97		7097.20	0.002066	3.83	434.60	105.07	0.33
Reach 1-3	8210	2-YR	155.10	7091.00	7094.18		7094.19	0.000278	0.89	174.33	84.22	0.11
Reach 1-3	8210	5-YR	480.20	7091.00	7095.08		7095.13	0.000856	1.89	253.61	91.50	0.20
Reach 1-3	8210	100-YR	1665.90	7091.00	7096.93		7097.16	0.002063	3.81	437.08	106.47	0.33
Reach 1-3	8209	2-YR	155.10	7093.00	7094.13		7094.18	0.002881	1.80	86.10	83.81	0.31
Reach 1-3	8209	5-YR	480.20	7093.00	7094.97		7095.11	0.003948	3.01	159.34	90.59	0.40
Reach 1-3	8209	100-YR	1665.90	7093.00	7096.70		7097.10	0.005160	5.06	329.01	104.63	0.50
Reach 1-3	8175	2-YR	155.10	7093.00	7093.97		7094.04	0.004972	2.14	72.37	81.75	0.40
Reach 1-3	8175	5-YR	480.20	7093.00	7094.73		7094.92	0.006283	3.51	136.88	87.84	0.50
Reach 1-3	8175	100-YR	1665.90	7093.00	7096.33		7096.85	0.007686	5.80	287.33	100.62	0.60
Reach 1-3	8165	2-YR	155.10	7093.00	7093.89	7093.55	7093.98	0.006634	2.34	66.16	81.14	0.46
Reach 1-3	8165	5-YR	480.20	7093.00	7094.62	7094.11	7094.84	0.007890	3.77	127.32	86.97	0.55
Reach 1-3	8165	100-YR	1665.90	7093.00	7096.15		7096.74	0.009339	6.18	269.43	99.18	0.66
Reach 1-3	8155	2-YR	155.10	7093.00	7093.55	7093.55	7093.80	0.037138	3.99	38.90	78.37	1.00
Reach 1-3	8155	5-YR	480.20	7093.00	7094.11	7094.11	7094.62	0.029657	5.72	83.90	82.88	1.00
Reach 1-3	8155	100-YR	1665.90	7093.00	7095.73		7096.56	0.015310	7.27	229.09	95.88	0.83
Reach 1-3	8125	2-YR	155.10	7087.00	7091.15		7091.16	0.000168	0.88	176.76	59.20	0.09
Reach 1-3	8125	5-YR	480.20	7087.00	7092.77		7092.82	0.000437	1.70	283.30	72.17	0.15
Reach 1-3	8125	100-YR	1665.90	7087.00	7096.01		7096.15	0.000824	2.98	559.05	98.09	0.22
Reach 1-3	8105	2-YR	155.10	7087.00	7091.15		7091.16	0.000169	0.88	176.52	59.17	0.09
Reach 1-3	8105	5-YR	480.20	7087.00	7092.76		7092.81	0.000440	1.70	282.67	72.14	0.15
Reach 1-3	8105	100-YR	1665.90	7087.00	7095.99		7096.13	0.000831	2.99	557.65	98.07	0.22
Reach 1-3	8104	2-YR	155.10	7089.00	7091.12		7091.15	0.000882	1.45	106.94	58.95	0.19
Reach 1-3	8104	5-YR	480.20	7089.00	7092.72		7092.80	0.001141	2.27	211.33	71.77	0.23
Reach 1-3	8104	100-YR	1665.90	7089.00	7095.93		7096.12	0.001317	3.44	483.77	97.59	0.27
Reach 1-3	8074	2-YR	155.10	7089.00	7091.05	7089.90	7091.11	0.001831	1.99	78.10	46.36	0.27
Reach 1-3	8074	5-YR	480.20	7089.00	7092.59	7090.82	7092.73	0.002247	3.02	159.18	58.61	0.32
Reach 1-3	8074	100-YR	1665.90	7089.00	7095.64	7092.79	7096.01	0.002200	4.92	338.82	69.00	0.36
Reach 1-3	7949		Culvert									
Reach 1-3	7828	2-YR	146.52	7088.70	7090.77	7089.65	7090.84	0.000724	2.06	71.01	42.66	0.28
Reach 1-3	7828	5-YR	512.38	7088.70	7092.00	7090.77	7092.25	0.001424	4.03	126.99	53.82	0.43
Reach 1-3	7828	100-YR	1763.93	7088.70	7093.78	7092.84	7094.88	0.003189	8.43	209.35	60.61	0.70
Reach 1-3	7788	2-YR	146.52	7088.52	7090.75		7090.77	0.001648	1.25	127.14	78.45	0.15
Reach 1-3	7788	5-YR	512.38	7088.52	7092.00		7092.08	0.003168	2.35	231.51	88.50	0.23
Reach 1-3	7788	100-YR	1763.93	7088.52	7094.02		7094.29	0.005890	4.38	426.53	104.75	0.33
Reach 1-3	7765	2-YR	146.52	7088.50	7090.72		7090.74	0.001285	1.28	130.26	81.51	0.15
Reach 1-3	7765	5-YR	512.38	7088.50	7091.94		7092.02	0.002603	2.45	239.81	96.53	0.23
Reach 1-3	7765	100-YR	1763.93	7088.50	7093.90		7094.17	0.005015	4.60	445.50	112.82	0.35
Reach 1-3	7742	2-YR	146.52	7088.50	7090.63		7090.69	0.004401	2.02	79.36	65.03	0.27
Reach 1-3	7742	5-YR	512.38	7088.50	7091.74		7091.91	0.007069	3.57	166.03	86.97	0.37
Reach 1-3	7742	100-YR	1763.93	7088.50	7093.52		7093.98	0.010974	6.15	344.86	117.47	0.50
Reach 1-3	7708	2-YR	146.52	7088.50	7090.40		7090.45	0.012364	2.08	94.10	96.63	0.27
Reach 1-3	7708	5-YR	512.38	7088.50	7091.46		7091.56	0.014868	3.07	209.19	117.45	0.32
Reach 1-3	7708	100-YR	1763.93	7088.50	7093.16		7093.44	0.020165	4.84	423.95	134.20	0.40
Reach 1-3	7669	2-YR	146.52	7087.30	7089.96		7090.02	0.009665	2.01	78.80	105.60	0.32
Reach 1-3	7669	5-YR	512.38	7087.30	7091.04		7091.14	0.007692	2.76	215.15	142.99	0.32
Reach 1-3	7669	100-YR	1763.93	7087.30	7092.68		7092.92	0.008756	4.26	462.14	158.93	0.38
Reach 1-3	7624	2-YR	146.52	7086.89	7089.44		7089.52	0.013314	2.14	68.38	65.48	0.37
Reach 1-3	7624	5-YR	512.38	7086.89	7090.52		7090.66	0.016063	3.18	191.43	144.70	0.39

Subcritical flow analysis for Water Surface Evaluation of Naturalized Channel Design except FIS flow rate

HEC-RAS Plan: PROP WSEL River: Sand Creek Reach: Reach 1-3 (Continued)

Reach	River Sta	Profile	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl
			(cfs)	(ft)	(ft)	(ft)	(ft)	(ft/ft)	(ft/s)	(sq ft)	(ft)	
Reach 1-3	7624	100-YR	1763.93	7086.89	7092.08		7092.35	0.019266	4.80	476.18	216.16	0.45
Reach 1-3	7584	2-YR	146.52	7086.36	7089.00		7089.05	0.010119	1.84	82.51	111.31	0.30
Reach 1-3	7584	5-YR	512.38	7086.36	7090.04		7090.13	0.010701	2.58	261.19	207.95	0.30
Reach 1-3	7584	100-YR	1763.93	7086.36	7091.55		7091.72	0.012703	3.80	586.44	222.93	0.35
Reach 1-3	7534	2-YR	146.52	7085.85	7088.45		7088.51	0.011368	2.01	72.74	125.00	0.33
Reach 1-3	7534	5-YR	512.38	7085.85	7089.45		7089.52	0.014099	2.20	241.93	209.26	0.34
Reach 1-3	7534	100-YR	1763.93	7085.85	7090.84		7091.01	0.016093	3.42	542.94	222.89	0.37
Reach 1-3	7485	2-YR	146.52	7085.30	7087.81		7087.88	0.014770	2.18	67.14	100.56	0.36
Reach 1-3	7485	5-YR	512.38	7085.30	7088.59		7088.72	0.019760	3.20	219.00	209.43	0.41
Reach 1-3	7485	100-YR	1763.93	7085.30	7089.75		7090.02	0.026994	4.90	470.27	223.09	0.50
Reach 1-3	7455	2-YR	146.52	7085.01	7087.35		7087.46	0.013005	2.69	54.50	55.05	0.48
Reach 1-3	7455	5-YR	512.38	7085.01	7088.24		7088.37	0.008120	3.20	204.99	234.20	0.41
Reach 1-3	7455	100-YR	1763.93	7085.01	7089.21		7089.52	0.011719	5.11	415.54	256.13	0.54
Reach 1-3	7445	2-YR	146.52	7085.12	7086.85	7086.85	7087.16	0.082062	4.49	32.66	86.31	0.99
Reach 1-3	7445	5-YR	512.38	7085.12	7087.87	7087.87	7088.20	0.029739	4.91	134.96	239.60	0.69
Reach 1-3	7445	100-YR	1763.93	7085.12	7088.67	7088.67	7089.29	0.039514	7.44	308.93	259.72	0.85
Reach 1-3	7430	2-YR	146.52	7081.82	7083.58	7083.58	7083.91	0.090885	4.63	31.63	50.84	1.04
Reach 1-3	7430	5-YR	512.38	7081.82	7084.44	7084.44	7085.06	0.058497	6.36	83.89	71.89	0.95
Reach 1-3	7430	100-YR	1763.93	7081.82	7085.91	7085.91	7086.83	0.039417	8.41	254.35	148.64	0.88
Reach 1-3	7422	2-YR	146.52	7080.12	7082.79		7082.84	0.005401	1.74	85.03	65.39	0.25
Reach 1-3	7422	5-YR	512.38	7080.12	7083.90		7084.05	0.008570	3.20	178.22	105.60	0.35
Reach 1-3	7422	100-YR	1763.93	7080.12	7085.30		7085.78	0.016952	6.02	352.54	146.99	0.53
Reach 1-3	7409	2-YR	146.52	7080.12	7082.78		7082.80	0.001129	1.08	137.92	82.59	0.12
Reach 1-3	7409	5-YR	512.38	7080.12	7083.90		7083.97	0.003051	2.30	257.94	121.52	0.22
Reach 1-3	7409	100-YR	1763.93	7080.12	7085.35		7085.57	0.006696	4.29	522.06	218.75	0.34
Reach 1-3	7406	2-YR	146.52	7081.53	7082.70		7082.78	0.031863	2.35	63.57	75.76	0.39
Reach 1-3	7406	5-YR	512.38	7081.53	7083.80		7083.94	0.025058	3.31	181.47	122.62	0.39
Reach 1-3	7406	100-YR	1763.93	7081.53	7085.29		7085.54	0.024098	4.58	462.07	220.42	0.42
Reach 1-3	7351	2-YR	146.52	7079.22	7081.82		7081.87	0.009928	1.82	87.14	110.22	0.29
Reach 1-3	7351	5-YR	512.38	7079.22	7082.88		7082.98	0.011959	2.76	242.94	190.60	0.32
Reach 1-3	7351	100-YR	1763.93	7079.22	7084.32		7084.49	0.014590	4.06	602.72	273.94	0.37
Reach 1-3	7279	2-YR	146.52	7078.10	7080.97		7081.03	0.013635	1.93	83.68	113.61	0.32
Reach 1-3	7279	5-YR	512.38	7078.10	7082.06		7082.13	0.011545	2.57	286.07	287.33	0.30
Reach 1-3	7279	100-YR	1763.93	7078.10	7083.45		7083.57	0.011469	3.46	694.45	300.55	0.32
Reach 1-3	7213	2-YR	146.52	7077.30	7080.40		7080.45	0.006290	1.76	90.31	117.26	0.27
Reach 1-3	7213	5-YR	512.38	7077.30	7081.50		7081.57	0.007088	2.47	313.74	298.97	0.28
Reach 1-3	7213	100-YR	1763.93	7077.30	7082.79		7082.92	0.009450	3.64	714.57	315.67	0.34
Reach 1-3	7167	2-YR	146.52	7077.47	7080.02		7080.08	0.010656	1.84	79.69	67.93	0.30
Reach 1-3	7167	5-YR	512.38	7077.47	7081.08		7081.16	0.011300	2.63	278.20	283.49	0.31
Reach 1-3	7167	100-YR	1763.93	7077.47	7082.23		7082.38	0.015164	3.89	646.32	330.64	0.37
Reach 1-3	7102	2-YR	146.52	7076.78	7079.13		7079.22	0.016175	2.50	58.54	63.53	0.46
Reach 1-3	7102	5-YR	512.38	7076.78	7079.79	7079.57	7080.08	0.025696	4.55	136.27	210.07	0.65
Reach 1-3	7102	100-YR	1763.93	7076.78	7080.57	7080.57	7081.05	0.031052	6.69	364.85	327.93	0.77
Reach 1-3	7093	2-YR	146.52	7076.86	7078.59	7078.59	7078.86	0.141923	4.24	34.59	60.99	0.99
Reach 1-3	7093	5-YR	512.38	7076.86	7079.48	7079.48	7079.74	0.047787	4.48	154.91	305.87	0.67
Reach 1-3	7093	100-YR	1763.93	7076.86	7080.09	7080.09	7080.57	0.065753	6.68	351.20	331.01	0.83
Reach 1-3	7073	2-YR	146.52	7072.92	7075.09		7075.16	0.014543	2.08	70.40	65.29	0.35
Reach 1-3	7073	5-YR	512.38	7072.92	7076.10		7076.30	0.018670	3.56	152.20	110.31	0.44
Reach 1-3	7073	100-YR	1763.93	7072.92	7077.34		7077.85	0.030312	6.24	340.57	189.36	0.61
Reach 1-3	7066	2-YR	146.52	7072.86	7075.10		7075.11	0.001822	1.10	132.86	65.32	0.14
Reach 1-3	7066	5-YR	512.38	7072.86	7076.12		7076.20	0.005297	2.43	235.60	153.21	0.25
Reach 1-3	7066	100-YR	1763.93	7072.86	7077.40		7077.65	0.011350	4.51	517.48	292.31	0.38
Reach 1-3	7061	2-YR	146.52	7074.14	7074.84		7075.07	0.061517	3.79	38.70	63.32	0.85
Reach 1-3	7061	5-YR	512.38	7074.14	7075.83		7076.13	0.025435	4.55	130.07	154.48	0.64
Reach 1-3	7061	100-YR	1763.93	7074.14	7077.24		7077.58	0.015980	5.54	471.95	311.67	0.57
Reach 1-3	7044	2-YR	146.52	7071.83	7074.57		7074.63	0.011669	1.99	73.53	65.56	0.33
Reach 1-3	7044	5-YR	512.38	7071.83	7075.76		7075.82	0.008586	2.36	335.79	371.43	0.28

Subcritical flow analysis for Water Surface Evaluation of Naturalized Channel Design except FIS flow rate

HEC-RAS Plan: PROP WSEL River: Sand Creek Reach: Reach 1-3 (Continued)

Reach	River Sta	Profile	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl
			(cfs)	(ft)	(ft)	(ft)	(ft)	(ft/ft)	(ft/s)	(sq ft)	(ft)	
Reach 1-3	7044	100-YR	1763.93	7071.83	7077.25		7077.33	0.006643	2.77	900.17	384.48	0.25
Reach 1-3	6941	2-YR	146.52	7070.47	7073.44		7073.51	0.010173	2.11	69.40	63.80	0.36
Reach 1-3	6941	5-YR	512.38	7070.47	7074.80		7074.92	0.009497	2.91	232.83	285.22	0.33
Reach 1-3	6941	100-YR	1763.93	7070.47	7076.54		7076.67	0.007441	3.51	741.48	300.23	0.30
Reach 1-3	6868	2-YR	146.52	7069.50	7072.63		7072.72	0.011818	2.31	63.32	62.60	0.41
Reach 1-3	6868	5-YR	512.38	7069.50	7073.95		7074.12	0.012833	3.33	170.03	128.74	0.39
Reach 1-3	6868	100-YR	1763.93	7069.50	7075.85		7076.06	0.010709	4.26	592.36	247.98	0.37
Reach 1-3	6769	2-YR	146.52	7068.73	7071.60		7071.66	0.009530	2.02	72.36	64.18	0.34
Reach 1-3	6769	5-YR	512.38	7068.73	7072.88		7072.99	0.010004	2.84	223.11	152.79	0.32
Reach 1-3	6769	100-YR	1763.93	7068.73	7074.76		7074.97	0.011545	4.23	565.49	220.35	0.36
Reach 1-3	6673	2-YR	146.52	7067.90	7070.63		7070.69	0.010553	1.91	76.65	105.51	0.31
Reach 1-3	6673	5-YR	512.38	7067.90	7071.90		7072.00	0.010332	2.67	242.32	181.58	0.30
Reach 1-3	6673	100-YR	1763.93	7067.90	7073.73		7073.89	0.010296	3.70	596.02	202.86	0.32
Reach 1-3	6588	2-YR	146.52	7067.13	7069.74		7069.80	0.010543	1.86	78.83	70.24	0.30
Reach 1-3	6588	5-YR	512.38	7067.13	7070.88		7071.00	0.013791	2.98	198.56	124.26	0.34
Reach 1-3	6588	100-YR	1763.93	7067.13	7072.70		7072.92	0.014208	4.27	519.06	202.19	0.37
Reach 1-3	6504	2-YR	146.52	7066.40	7068.90		7068.95	0.009951	1.75	89.70	106.84	0.28
Reach 1-3	6504	5-YR	512.38	7066.40	7070.02		7070.08	0.008760	2.32	279.58	188.98	0.27
Reach 1-3	6504	100-YR	1763.93	7066.40	7071.86		7071.99	0.008654	3.30	642.85	204.76	0.29
Reach 1-3	6417	2-YR	146.52	7065.42	7067.76		7067.83	0.016527	2.13	68.72	82.32	0.37
Reach 1-3	6417	5-YR	512.38	7065.42	7068.94		7069.07	0.015522	3.03	195.56	174.94	0.36
Reach 1-3	6417	100-YR	1763.93	7065.42	7070.71		7070.95	0.016587	4.46	499.67	210.51	0.39
Reach 1-3	6369	2-YR	146.52	7064.37	7067.28		7067.32	0.007479	1.59	92.38	87.75	0.26
Reach 1-3	6369	5-YR	512.38	7064.37	7068.41		7068.49	0.009367	2.45	239.34	143.46	0.28
Reach 1-3	6369	100-YR	1763.93	7064.37	7070.08		7070.26	0.011666	3.75	562.76	216.98	0.33
Reach 1-3	6298	2-YR	146.52	7064.05	7066.40		7066.49	0.019941	2.40	61.27	62.92	0.42
Reach 1-3	6298	5-YR	512.38	7064.05	7067.53		7067.65	0.015888	3.04	218.97	178.62	0.37
Reach 1-3	6298	100-YR	1763.93	7064.05	7069.04		7069.27	0.017872	4.42	500.14	192.30	0.41
Reach 1-3	6265	2-YR	146.52	7063.23	7065.90		7065.98	0.012685	2.20	66.66	64.40	0.38
Reach 1-3	6265	5-YR	512.38	7063.23	7066.66		7066.94	0.031828	4.26	133.23	140.83	0.57
Reach 1-3	6265	100-YR	1763.93	7063.23	7067.80		7068.37	0.048278	6.79	349.59	208.24	0.70
Reach 1-3	6232	2-YR	146.52	7063.38	7065.39		7065.48	0.018407	2.57	60.97	114.61	0.50
Reach 1-3	6232	5-YR	512.38	7063.38	7066.13		7066.28	0.014018	3.34	170.05	188.56	0.48
Reach 1-3	6232	100-YR	1763.93	7063.38	7067.15		7067.52	0.016648	5.13	377.05	211.63	0.57
Reach 1-3	6223	2-YR	146.52	7063.07	7064.84	7064.84	7065.11	0.140119	4.17	35.11	94.97	0.98
Reach 1-3	6223	5-YR	512.38	7063.07	7065.62	7065.62	7066.01	0.074076	5.27	112.56	153.07	0.82
Reach 1-3	6223	100-YR	1763.93	7063.07	7066.54	7066.54	7067.21	0.071568	7.44	290.07	209.48	0.88
Reach 1-3	6212	2-YR	146.52	7060.43	7062.21	7062.21	7062.49	0.142503	4.19	34.93	62.76	0.99
Reach 1-3	6212	5-YR	512.38	7060.43	7062.98	7062.98	7063.49	0.091328	5.80	93.90	104.76	0.91
Reach 1-3	6212	100-YR	1763.93	7060.43	7064.21	7064.21	7065.09	0.073523	8.13	252.69	148.43	0.91
Reach 1-3	6199	2-YR	146.52	7057.41	7059.80		7059.85	0.009719	1.81	81.09	68.66	0.29
Reach 1-3	6199	5-YR	512.38	7057.41	7060.91		7061.06	0.012343	3.13	169.63	90.04	0.37
Reach 1-3	6199	100-YR	1763.93	7057.41	7062.42		7062.94	0.022635	5.97	329.39	126.19	0.54
Reach 1-3	6184	2-YR	146.52	7057.42	7059.78		7059.80	0.001222	0.97	151.17	70.51	0.11
Reach 1-3	6184	5-YR	512.38	7057.42	7060.88		7060.95	0.003521	2.15	260.90	120.90	0.21
Reach 1-3	6184	100-YR	1763.93	7057.42	7062.40		7062.66	0.008839	4.38	467.58	150.79	0.35
Reach 1-3	6182	2-YR	146.52	7058.72	7059.70		7059.78	0.039798	2.34	62.61	67.63	0.43
Reach 1-3	6182	5-YR	512.38	7058.72	7060.74		7060.92	0.033327	3.53	160.56	117.46	0.44
Reach 1-3	6182	100-YR	1763.93	7058.72	7062.19		7062.61	0.040940	5.65	355.02	149.07	0.54
Reach 1-3	6164	2-YR	146.52	7056.45	7059.30		7059.37	0.013759	2.07	72.57	85.40	0.33
Reach 1-3	6164	5-YR	512.38	7056.45	7060.42		7060.52	0.013539	2.89	219.26	176.25	0.34
Reach 1-3	6164	100-YR	1763.93	7056.45	7061.91		7062.09	0.015021	4.11	576.25	273.15	0.37
Reach 1-3	6091	2-YR	146.52	7055.75	7058.22		7058.29	0.016189	2.13	68.78	69.42	0.38
Reach 1-3	6091	5-YR	512.38	7055.75	7059.34		7059.46	0.015959	2.99	214.80	196.48	0.37
Reach 1-3	6091	100-YR	1763.93	7055.75	7060.76		7060.94	0.016746	4.14	604.76	316.82	0.39
Reach 1-3	6042	2-YR	146.52	7054.55	7057.65		7057.71	0.008888	1.87	78.38	70.35	0.31
Reach 1-3	6042	5-YR	512.38	7054.55	7058.74		7058.84	0.009928	2.73	256.23	243.81	0.33

Subcritical flow analysis for Water Surface Evaluation of Naturalized Channel Design except FIS flow rate

HEC-RAS Plan: PROP WSEL River: Sand Creek Reach: Reach 1-3 (Continued)

Reach	River Sta	Profile	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl
			(cfs)	(ft)	(ft)	(ft)	(ft)	(ft/ft)	(ft/s)	(sq ft)	(ft)	
Reach 1-3	6042	100-YR	1763.93	7054.55	7060.03		7060.20	0.013370	4.14	652.68	355.12	0.39
Reach 1-3	5977	2-YR	146.52	7054.61	7057.17		7057.22	0.010109	1.78	84.07	85.55	0.29
Reach 1-3	5977	5-YR	512.38	7054.61	7058.19		7058.29	0.012640	2.74	261.69	286.49	0.32
Reach 1-3	5977	100-YR	1763.93	7054.61	7059.38		7059.52	0.015243	3.88	699.58	434.08	0.37
Reach 1-3	5928	2-YR	146.52	7053.68	7055.92		7055.98	0.017666	2.08	70.75	81.05	0.37
Reach 1-3	5928	5-YR	512.38	7053.68	7056.89		7056.99	0.015844	2.79	266.81	348.40	0.35
Reach 1-3	5928	100-YR	1763.93	7053.68	7058.10		7058.21	0.014074	3.50	772.35	491.39	0.35
Reach 1-3	5824	2-YR	146.52	7052.15	7055.14		7055.19	0.007316	1.73	85.57	79.90	0.27
Reach 1-3	5824	5-YR	512.38	7052.15	7056.01		7056.09	0.010321	2.63	296.73	323.29	0.31
Reach 1-3	5824	100-YR	1763.93	7052.15	7057.13		7057.27	0.013562	3.83	732.70	448.42	0.37
Reach 1-3	5791	2-YR	146.52	7052.28	7054.75		7054.81	0.012414	1.92	76.55	81.65	0.32
Reach 1-3	5791	5-YR	512.38	7052.28	7055.45		7055.55	0.017810	2.90	259.32	339.38	0.38
Reach 1-3	5791	100-YR	1763.93	7052.28	7056.47		7056.62	0.019094	3.89	690.90	482.61	0.41
Reach 1-3	5744	2-YR	146.52	7051.51	7054.48		7054.52	0.007781	1.66	92.54	233.38	0.26
Reach 1-3	5744	5-YR	512.38	7051.51	7055.16		7055.21	0.007409	2.10	364.26	452.43	0.27
Reach 1-3	5744	100-YR	1763.93	7051.51	7056.23		7056.30	0.006325	2.57	883.21	507.03	0.26
Reach 1-3	5688	2-YR	143.88	7051.38	7053.85		7053.92	0.010674	2.04	72.18	219.55	0.34
Reach 1-3	5688	5-YR	533.15	7051.38	7054.59		7054.66	0.009243	2.49	317.84	431.68	0.35
Reach 1-3	5688	100-YR	1880.40	7051.38	7055.72		7055.83	0.007735	3.18	822.11	458.82	0.34
Reach 1-3	5628	2-YR	143.88	7050.55	7053.43		7053.47	0.007004	1.63	95.74	283.41	0.25
Reach 1-3	5628	5-YR	533.15	7050.55	7054.26		7054.30	0.005290	1.94	410.09	424.62	0.23
Reach 1-3	5628	100-YR	1880.40	7050.55	7055.39		7055.48	0.006138	2.77	895.01	434.10	0.27
Reach 1-3	5568	2-YR	143.88	7049.82	7052.52		7052.58	0.011823	1.96	73.32	188.81	0.33
Reach 1-3	5568	5-YR	533.15	7049.82	7053.42		7053.52	0.012765	2.94	260.34	361.74	0.37
Reach 1-3	5568	100-YR	1880.40	7049.82	7054.50		7054.66	0.011904	3.81	681.72	393.58	0.38
Reach 1-3	5429	2-YR	143.88	7048.55	7050.99		7051.07	0.018607	2.32	62.07	134.51	0.41
Reach 1-3	5429	5-YR	533.15	7048.55	7051.97		7052.06	0.016378	2.91	281.80	355.57	0.37
Reach 1-3	5429	100-YR	1880.40	7048.55	7053.13		7053.27	0.016209	3.79	700.18	365.08	0.38
Reach 1-3	5365	2-YR	143.88	7047.14	7049.90		7049.99	0.015298	2.49	57.89	121.22	0.45
Reach 1-3	5365	5-YR	533.15	7047.14	7050.92		7051.05	0.015205	3.21	262.20	345.08	0.41
Reach 1-3	5365	100-YR	1880.40	7047.14	7052.17		7052.31	0.014111	4.03	712.62	368.51	0.40
Reach 1-3	5289	2-YR	143.88	7046.36	7048.96		7049.04	0.015877	2.24	64.33	153.89	0.39
Reach 1-3	5289	5-YR	533.15	7046.36	7050.01		7050.11	0.014882	2.89	275.77	335.37	0.36
Reach 1-3	5289	100-YR	1880.40	7046.36	7051.40		7051.52	0.012189	3.51	748.92	347.04	0.34
Reach 1-3	5227	2-YR	143.88	7045.43	7048.08		7048.13	0.011378	1.94	74.27	123.93	0.32
Reach 1-3	5227	5-YR	533.15	7045.43	7049.19		7049.28	0.011649	2.70	268.44	237.12	0.32
Reach 1-3	5227	100-YR	1880.40	7045.43	7050.60		7050.74	0.012567	3.74	720.28	333.56	0.34
Reach 1-3	5171	2-YR	143.88	7044.55	7046.77		7046.84	0.015446	2.06	69.74	64.62	0.35
Reach 1-3	5171	5-YR	533.15	7044.55	7047.92		7048.02	0.014425	2.89	252.19	246.82	0.35
Reach 1-3	5171	100-YR	1880.40	7044.55	7049.54		7049.66	0.010232	3.41	778.64	346.44	0.31
Reach 1-3	5047	2-YR	143.88	7042.80	7045.34		7045.39	0.010939	1.85	80.05	95.18	0.30
Reach 1-3	5047	5-YR	533.15	7042.80	7046.46		7046.55	0.011726	2.68	230.54	145.30	0.31
Reach 1-3	5047	100-YR	1880.40	7042.80	7048.00		7048.24	0.016421	4.33	553.64	335.30	0.39
Reach 1-3	4948	2-YR	143.88	7041.66	7044.21		7044.26	0.011460	1.90	76.00	67.48	0.31
Reach 1-3	4948	5-YR	533.15	7041.66	7045.51		7045.58	0.008576	2.41	326.60	333.85	0.27
Reach 1-3	4948	100-YR	1880.40	7041.66	7046.98		7047.08	0.008479	3.17	826.25	345.56	0.28
Reach 1-3	4855	2-YR	143.88	7040.34	7043.52		7043.58	0.008364	1.89	75.99	64.64	0.31
Reach 1-3	4855	5-YR	533.15	7040.34	7044.84		7044.95	0.009627	2.83	256.25	270.78	0.32
Reach 1-3	4855	100-YR	1880.40	7040.34	7046.31		7046.46	0.010626	3.88	727.94	335.12	0.34
Reach 1-3	4782	2-YR	143.88	7040.04	7042.96		7043.01	0.007205	1.77	81.18	65.33	0.28
Reach 1-3	4782	5-YR	533.15	7040.04	7044.17		7044.26	0.009236	2.72	278.87	292.98	0.31
Reach 1-3	4782	100-YR	1880.40	7040.04	7045.67		7045.79	0.009302	3.58	777.28	342.27	0.32
Reach 1-3	4714	2-YR	143.88	7039.78	7042.35		7042.40	0.011228	1.88	76.46	66.65	0.31
Reach 1-3	4714	5-YR	533.15	7039.78	7043.42		7043.52	0.013338	2.84	273.95	325.07	0.34
Reach 1-3	4714	100-YR	1880.40	7039.78	7045.09		7045.19	0.008301	3.13	831.48	339.83	0.28
Reach 1-3	4632	2-YR	143.88	7039.10	7041.54		7041.58	0.009561	1.76	100.53	132.58	0.30
Reach 1-3	4632	5-YR	533.15	7039.10	7042.75		7042.80	0.007079	2.15	364.25	308.57	0.26

Subcritical flow analysis for Water Surface Evaluation of Naturalized Channel Design except FIS flow rate

HEC-RAS Plan: PROP WSEL River: Sand Creek Reach: Reach 1-3 (Continued)

Reach	River Sta	Profile	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl
			(cfs)	(ft)	(ft)	(ft)	(ft)	(ft/ft)	(ft/s)	(sq ft)	(ft)	
Reach 1-3	4632	100-YR	1880.40	7039.10	7044.71		7044.77	0.004570	2.52	985.54	327.64	0.22
Reach 1-3	4582	2-YR	143.88	7038.10	7041.23		7041.26	0.004531	1.45	127.05	148.65	0.23
Reach 1-3	4582	5-YR	533.15	7038.10	7042.47		7042.51	0.004873	2.01	390.28	288.74	0.23
Reach 1-3	4582	100-YR	1880.40	7038.10	7044.50		7044.56	0.003927	2.53	1001.18	310.85	0.21
Reach 1-3	4534	2-YR	143.88	7038.20	7041.04	7040.13	7041.06	0.003809	1.20	150.72	159.79	0.18
Reach 1-3	4534	5-YR	533.15	7038.20	7042.27		7042.30	0.003695	1.66	440.49	274.75	0.18
Reach 1-3	4534	100-YR	1880.40	7038.20	7044.32		7044.38	0.003592	2.32	1023.24	294.18	0.19
Reach 1-3	4296	2-YR	133.68	7036.56	7038.49	7038.49	7038.83	0.057088	4.89	36.03	64.04	0.81
Reach 1-3	4296	5-YR	512.29	7036.56	7039.38	7039.38	7039.96	0.072814	7.32	104.93	91.10	0.91
Reach 1-3	4296	100-YR	1848.80	7036.56	7040.77	7040.77	7041.91	0.093130	11.18	255.92	123.41	1.07
Reach 1-3	4084	2-YR	133.68	7033.29	7036.36		7036.36	0.000036	0.24	566.22	226.36	0.03
Reach 1-3	4084	5-YR	512.29	7033.29	7037.58		7037.58	0.000142	0.61	858.49	272.31	0.06
Reach 1-3	4084	100-YR	1848.80	7033.29	7039.70		7039.72	0.000316	1.22	1601.49	366.71	0.09
Reach 1-3	3846	2-YR	133.68	7033.20	7035.98	7035.98	7036.30	0.086669	4.53	29.51	126.87	1.02
Reach 1-3	3846	5-YR	512.29	7033.20	7036.87	7036.87	7037.40	0.070822	5.86	87.35	166.03	1.01
Reach 1-3	3846	100-YR	1848.80	7033.20	7038.22	7038.22	7039.33	0.055822	8.45	218.78	233.23	1.01
Reach 1-3	3842	2-YR	133.68	7014.12	7016.81		7016.94	0.000171	2.89	47.59	18.21	0.31
Reach 1-3	3842	5-YR	512.29	7014.12	7020.69		7021.01	0.000127	4.52	121.23	19.69	0.31
Reach 1-3	3842	100-YR	1848.80	7014.12	7033.27		7033.74	0.000046	5.55	398.87	32.43	0.22
Reach 1-3	3816	2-YR	133.68	7014.12	7016.60	7015.69	7016.91	0.000460	4.49	30.17	12.34	0.50
Reach 1-3	3816	5-YR	512.29	7014.12	7020.20	7017.94	7020.96	0.000340	7.02	75.42	12.83	0.50
Reach 1-3	3816	100-YR	1848.80	7014.12	7032.62	7023.12	7033.68	0.000108	8.29	245.21	14.51	0.34
Reach 1-3	3744		Culvert									
Reach 1-3	3719	2-YR	133.68	7013.40	7014.97	7014.97	7015.75	0.002127	7.11	18.96	12.21	1.00
Reach 1-3	3719	5-YR	512.29	7013.40	7017.23	7017.23	7019.16	0.001592	11.15	46.86	12.51	1.01
Reach 1-3	3719	100-YR	1848.80	7013.40	7022.42	7022.42	7026.93	0.001186	17.05	113.59	13.19	1.00
Reach 1-3	3711	2-YR	133.68	7002.83	7005.31	7004.39	7005.62	0.000461	4.49	30.04	12.24	0.50
Reach 1-3	3711	5-YR	512.29	7002.83	7008.90	7006.66	7009.67	0.000341	7.02	74.66	12.58	0.50
Reach 1-3	3711	100-YR	1848.80	7002.83	7021.32	7011.84	7022.39	0.000108	8.31	238.25	13.77	0.34
Reach 1-3	3676		Culvert									
Reach 1-3	3667	2-YR	133.68	7002.61	7004.18	7004.18	7004.96	0.002121	7.10	18.93	12.15	1.00
Reach 1-3	3667	5-YR	512.29	7002.61	7006.44	7006.44	7008.37	0.001591	11.15	46.61	12.36	1.01
Reach 1-3	3667	100-YR	1848.80	7002.61	7011.61	7011.61	7016.15	0.001194	17.09	111.90	12.86	1.00
Reach 1-3	3662	2-YR	133.68	7001.15	7004.40		7004.45	0.001185	1.88	71.24	70.35	0.20
Reach 1-3	3662	5-YR	512.29	7001.15	7005.24		7005.71	0.007146	5.51	93.18	80.94	0.51
Reach 1-3	3662	100-YR	1848.80	7001.15	7011.00		7011.90	0.003823	7.62	248.10	410.48	0.44
Reach 1-3	3629	2-YR	133.68	7001.51	7004.41	7002.20	7004.42	0.000424	0.63	211.69	306.80	0.07
Reach 1-3	3629	5-YR	512.29	7001.51	7005.43	7003.02	7005.47	0.001853	1.68	304.59	511.88	0.16
Reach 1-3	3629	100-YR	1848.80	7001.51	7011.53	7004.41	7011.60	0.000759	2.15	859.68	631.48	0.12
Reach 1-3	3625	2-YR	133.68	7003.41	7004.39		7004.41	0.001930	1.25	188.59	303.87	0.23
Reach 1-3	3625	5-YR	512.29	7003.41	7005.44		7005.46	0.001374	1.74	637.40	512.42	0.22
Reach 1-3	3625	100-YR	1848.80	7003.41	7011.58		7011.58	0.000056	0.90	4322.15	631.90	0.06
Reach 1-3	3618	2-YR	133.68	7002.58	7004.38		7004.40	0.002747	1.59	199.35	299.14	0.21
Reach 1-3	3618	5-YR	512.29	7002.58	7005.43		7005.45	0.002256	1.98	645.91	505.72	0.21
Reach 1-3	3618	100-YR	1848.80	7002.58	7011.58		7011.58	0.000079	0.81	4276.24	622.48	0.05
Reach 1-3	3485	2-YR	133.68	7002.22	7003.97		7004.00	0.003744	1.82	164.41	247.64	0.25
Reach 1-3	3485	5-YR	512.29	7002.22	7005.12		7005.15	0.002746	2.21	581.63	468.44	0.23
Reach 1-3	3485	100-YR	1848.80	7002.22	7011.57		7011.57	0.000075	0.81	4338.81	620.77	0.05
Reach 1-3	3336	2-YR	133.68	7001.71	7003.43		7003.45	0.003805	1.80	163.19	254.68	0.25
Reach 1-3	3336	5-YR	512.29	7001.71	7004.82		7004.84	0.001765	1.86	712.10	576.97	0.19
Reach 1-3	3336	100-YR	1848.80	7001.71	7011.56		7011.56	0.000054	0.71	4833.77	642.31	0.04
Reach 1-3	3198	2-YR	133.68	7001.27	7002.61		7002.67	0.008949	2.29	104.61	203.58	0.37
Reach 1-3	3198	5-YR	512.29	7001.27	7004.71		7004.71	0.000513	1.06	1004.50	508.40	0.10
Reach 1-3	3198	100-YR	1848.80	7001.27	7011.55		7011.56	0.000044	0.65	4824.91	600.00	0.04
Reach 1-3	3103	2-YR	133.68	7001.02	7002.58	7001.46	7002.58	0.000208	0.37	362.56	356.62	0.06
Reach 1-3	3103	5-YR	512.29	7001.02	7004.68	7001.77	7004.69	0.000115	0.53	965.38	385.86	0.05

Subcritical flow analysis for Water Surface Evaluation of Naturalized Channel Design except FIS flow rate

HEC-RAS Plan: PROP WSEL River: Sand Creek Reach: Reach 1-3 (Continued)

Reach	River Sta	Profile	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl
			(cfs)	(ft)	(ft)	(ft)	(ft)	(ft/ft)	(ft/s)	(sq ft)	(ft)	
Reach 1-3	3103	100-YR	1848.80	7001.02	7011.54	7002.40	7011.55	0.000041	0.62	3040.07	478.81	0.04
Reach 1-3	3057		Culvert									
Reach 1-3	2988	2-YR	133.68	7001.00	7002.23		7002.25	0.002344	1.17	113.74	104.61	0.19
Reach 1-3	2988	5-YR	512.29	7001.00	7003.83		7003.89	0.002075	1.93	264.05	117.77	0.20
Reach 1-3	2988	100-YR	1848.80	7001.00	7007.77		7007.90	0.001458	2.89	633.79	133.68	0.20
Reach 1-3	2975	2-YR	101.60	7000.89	7002.18	7001.38	7002.22	0.003758	1.50	67.94	53.21	0.23
Reach 1-3	2975	5-YR	398.70	7000.89	7003.74	7002.10	7003.85	0.004294	2.63	151.65	53.97	0.28
Reach 1-3	2975	100-YR	1562.40	7000.89	7007.56	7003.89	7007.86	0.003776	4.36	361.07	55.68	0.30
Reach 1-3	2930		Culvert									
Reach 1-3	2879	2-YR	101.60	7000.82	7001.79		7001.88	0.012749	2.23	42.52	55.63	0.41
Reach 1-3	2879	5-YR	398.70	7000.82	7002.77		7003.10	0.016163	4.11	89.76	62.82	0.53
Reach 1-3	2879	100-YR	1562.40	7000.82	7005.01		7006.05	0.017864	7.28	197.46	81.38	0.63
Reach 1-3	2856	2-YR	101.60	7000.50	7001.39		7001.47	0.029128	2.32	43.93	59.73	0.47
Reach 1-3	2856	5-YR	398.70	7000.50	7002.38		7002.60	0.025422	3.80	107.48	68.53	0.51
Reach 1-3	2856	100-YR	1562.40	7000.50	7004.88		7005.38	0.017949	5.78	275.95	87.53	0.49
Reach 1-3	2850	2-YR	101.60	7000.17	7000.90	7000.90	7001.12	0.153404	3.77	27.11	62.22	1.00
Reach 1-3	2850	5-YR	398.70	7000.17	7002.28		7002.46	0.019308	3.43	120.55	72.85	0.45
Reach 1-3	2850	100-YR	1562.40	7000.17	7004.86		7005.26	0.013472	5.16	313.05	92.30	0.43
Reach 1-3	2842	2-YR	101.60	6997.59	7000.70		7000.71	0.000426	0.67	156.06	61.73	0.07
Reach 1-3	2842	5-YR	398.70	6997.59	7002.32		7002.36	0.001369	1.62	264.58	72.77	0.13
Reach 1-3	2842	100-YR	1562.40	6997.59	7004.91		7005.10	0.003837	3.66	473.30	90.85	0.24
Reach 1-3	2838	2-YR	101.60	6999.13	7000.69		7000.71	0.003233	1.18	86.44	61.60	0.17
Reach 1-3	2838	5-YR	398.70	6999.13	7002.28		7002.35	0.003828	2.11	194.22	73.73	0.22
Reach 1-3	2838	100-YR	1562.40	6999.13	7004.83		7005.08	0.006351	4.10	407.36	93.30	0.31
Reach 1-3	2830	2-YR	101.60	6997.58	7000.66		7000.68	0.002521	1.08	96.79	65.67	0.15
Reach 1-3	2830	5-YR	398.70	6997.58	7002.25		7002.31	0.004100	1.99	210.86	77.94	0.20
Reach 1-3	2830	100-YR	1562.40	6997.58	7004.80		7005.00	0.007086	3.75	436.23	98.96	0.28
Reach 1-3	2792	2-YR	101.60	6997.53	7000.58		7000.59	0.002137	1.00	106.26	71.66	0.14
Reach 1-3	2792	5-YR	398.70	6997.53	7002.11		7002.16	0.003613	1.87	226.84	85.47	0.18
Reach 1-3	2792	100-YR	1562.40	6997.53	7004.58		7004.75	0.006239	3.49	465.45	108.18	0.26
Reach 1-3	2719	2-YR	101.60	6997.47	7000.43		7000.44	0.002207	1.03	110.89	83.05	0.14
Reach 1-3	2719	5-YR	398.70	6997.47	7001.88		7001.92	0.003485	1.83	244.07	98.15	0.18
Reach 1-3	2719	100-YR	1562.40	6997.47	7004.17		7004.33	0.006237	3.43	491.61	117.95	0.26
Reach 1-3	2680	2-YR	101.60	6997.33	7000.34		7000.35	0.002230	1.00	112.11	88.75	0.14
Reach 1-3	2680	5-YR	398.70	6997.33	7001.74		7001.78	0.003561	1.78	251.74	106.87	0.18
Reach 1-3	2680	100-YR	1562.40	6997.33	7003.92		7004.07	0.006404	3.34	514.85	134.20	0.26
Reach 1-3	2646	2-YR	101.60	6997.18	7000.27		7000.28	0.002031	1.00	111.56	92.29	0.14
Reach 1-3	2646	5-YR	398.70	6997.18	7001.62		7001.66	0.003224	1.75	258.75	118.66	0.18
Reach 1-3	2646	100-YR	1562.40	6997.18	7003.73		7003.87	0.005667	3.23	531.21	138.31	0.25
Reach 1-3	2589	2-YR	101.60	6996.89	7000.15		7000.17	0.001966	1.04	113.46	97.65	0.15
Reach 1-3	2589	5-YR	398.70	6996.89	7001.45		7001.49	0.003143	1.77	270.94	139.84	0.19
Reach 1-3	2589	100-YR	1562.40	6996.89	7003.45		7003.57	0.005248	3.12	565.34	155.27	0.25
Reach 1-3	2545	2-YR	101.60	6997.22	7000.05		7000.07	0.002796	1.05	108.60	99.60	0.15
Reach 1-3	2545	5-YR	398.70	6997.22	7001.29		7001.33	0.004256	1.81	258.67	135.31	0.19
Reach 1-3	2545	100-YR	1562.40	6997.22	7003.17		7003.31	0.007505	3.32	535.49	169.35	0.27
Reach 1-3	2513	2-YR	101.60	6996.86	6999.97		6999.99	0.002317	1.00	109.44	103.63	0.15
Reach 1-3	2513	5-YR	398.70	6996.86	7001.16		7001.20	0.003827	1.74	261.23	144.07	0.19
Reach 1-3	2513	100-YR	1562.40	6996.86	7002.92		7003.06	0.006992	3.20	530.10	160.68	0.27
Reach 1-3	2468	2-YR	101.60	6997.15	6999.80		6999.83	0.005871	1.33	81.44	105.57	0.23
Reach 1-3	2468	5-YR	398.70	6997.15	7000.91		7000.97	0.006735	1.98	238.69	175.99	0.24
Reach 1-3	2468	100-YR	1562.40	6997.15	7002.55		7002.68	0.008912	3.16	545.02	195.51	0.29
Reach 1-3	2405	2-YR	101.60	6997.08	6999.15	6998.79	6999.21	0.018374	2.02	50.28	68.72	0.42
Reach 1-3	2405	5-YR	398.70	6997.08	7000.07		7000.23	0.025979	3.27	132.18	126.50	0.46
Reach 1-3	2405	100-YR	1562.40	6997.08	7001.54		7001.83	0.027859	4.91	407.89	220.56	0.50
Reach 1-3	2399	2-YR	101.60	6997.08	6998.73	6998.73	6998.96	0.157073	3.77	26.93	61.00	1.00
Reach 1-3	2399	5-YR	398.70	6997.08	6999.39	6999.39	6999.91	0.118376	5.79	68.87	66.27	1.00

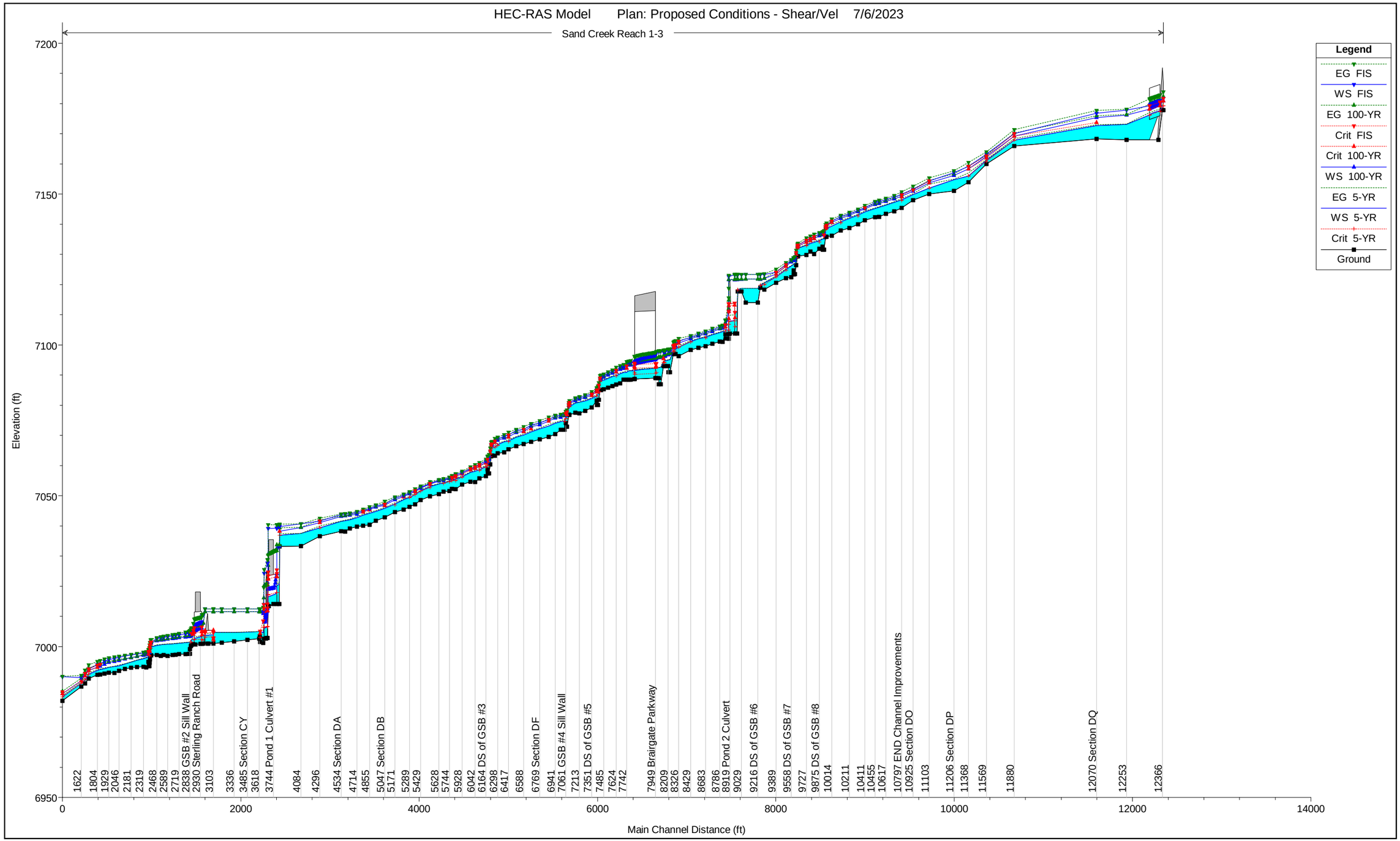
Subcritical flow analysis for Water Surface Evaluation of Naturalized Channel Design except FIS flow rate

HEC-RAS Plan: PROP WSEL River: Sand Creek Reach: Reach 1-3 (Continued)

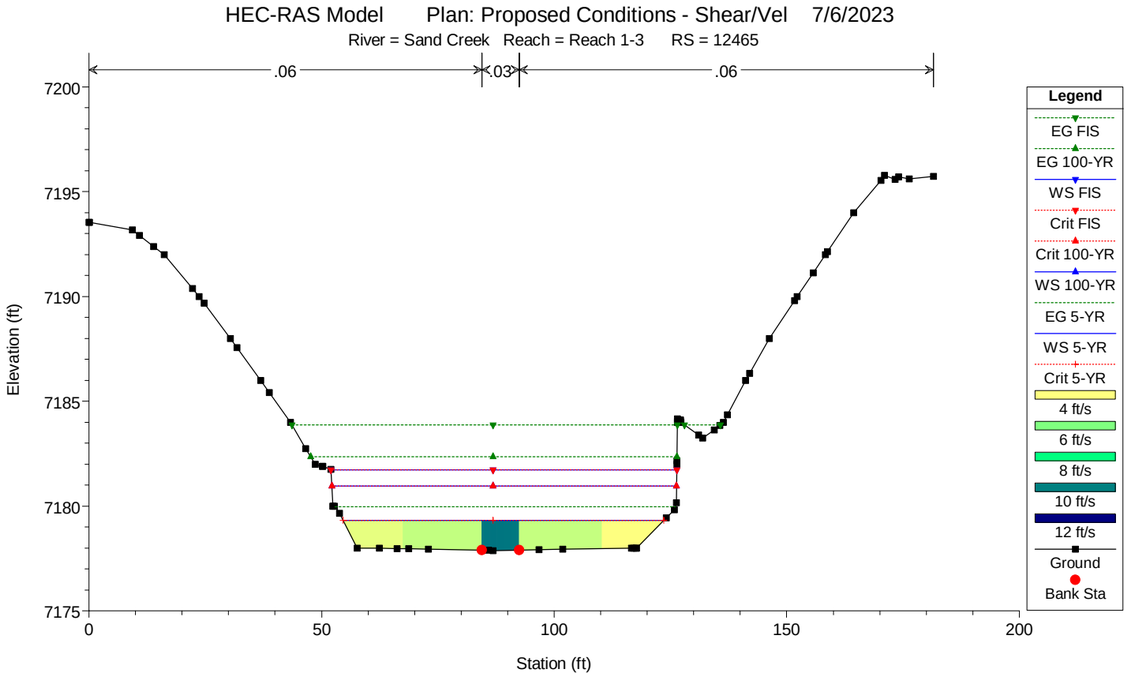
Reach	River Sta	Profile	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl
			(cfs)	(ft)	(ft)	(ft)	(ft)	(ft/ft)	(ft/s)	(sq ft)	(ft)	
Reach 1-3	2399	100-YR	1562.40	6997.08	7000.94	7000.94	7001.58	0.053268	7.07	272.63	215.43	0.78
Reach 1-3	2384	2-YR	101.60	6993.53	6996.04		6996.07	0.003727	1.17	86.74	68.52	0.18
Reach 1-3	2384	5-YR	398.70	6993.53	6997.03		6997.13	0.008439	2.51	161.85	91.07	0.30
Reach 1-3	2384	100-YR	1562.40	6993.53	6998.46		6998.88	0.019723	5.39	322.24	140.49	0.50
Reach 1-3	2377	2-YR	101.60	6993.46	6996.05		6996.05	0.000508	0.64	159.06	67.88	0.07
Reach 1-3	2377	5-YR	398.70	6993.46	6997.04		6997.08	0.002298	1.71	247.56	111.07	0.17
Reach 1-3	2377	100-YR	1562.40	6993.46	6998.52		6998.74	0.007754	4.02	465.70	225.29	0.32
Reach 1-3	2375	2-YR	101.60	6994.97	6996.01		6996.05	0.008856	1.53	66.32	69.02	0.27
Reach 1-3	2375	5-YR	398.70	6994.97	6996.95		6997.07	0.012637	2.85	154.49	124.68	0.36
Reach 1-3	2375	100-YR	1562.40	6994.97	6998.50		6998.71	0.012752	4.26	466.06	256.83	0.40
Reach 1-3	2350	2-YR	101.60	6993.08	6995.85		6995.88	0.005419	1.37	81.87	111.65	0.24
Reach 1-3	2350	5-YR	398.70	6993.08	6996.74		6996.79	0.007887	2.11	262.43	249.41	0.27
Reach 1-3	2350	100-YR	1562.40	6993.08	6998.31		6998.40	0.008225	2.99	679.98	275.96	0.29
Reach 1-3	2319	2-YR	101.60	6993.33	6995.65		6995.68	0.007141	1.49	74.55	109.82	0.27
Reach 1-3	2319	5-YR	398.70	6993.33	6996.48		6996.54	0.009302	2.21	259.81	269.06	0.29
Reach 1-3	2319	100-YR	1562.40	6993.33	6998.09		6998.17	0.007782	2.88	711.85	292.63	0.28
Reach 1-3	2246	2-YR	101.60	6993.16	6995.16		6995.17	0.007113	1.18	118.41	220.87	0.25
Reach 1-3	2246	5-YR	398.70	6993.16	6995.90		6995.94	0.008017	1.70	294.42	251.16	0.25
Reach 1-3	2246	100-YR	1562.40	6993.16	6997.64		6997.70	0.005965	2.31	785.85	304.98	0.23
Reach 1-3	2181	2-YR	101.60	6992.99	6994.50	6994.29	6994.53	0.017569	1.69	83.40	183.24	0.47
Reach 1-3	2181	5-YR	398.70	6992.99	6995.34		6995.38	0.010600	1.80	252.50	218.08	0.29
Reach 1-3	2181	100-YR	1562.40	6992.99	6997.28		6997.35	0.005867	2.30	746.00	282.66	0.23
Reach 1-3	2112	2-YR	101.60	6992.58	6993.72		6993.73	0.007951	1.14	107.66	141.87	0.20
Reach 1-3	2112	5-YR	398.70	6992.58	6994.80		6994.83	0.006054	1.59	286.88	184.90	0.19
Reach 1-3	2112	100-YR	1562.40	6992.58	6996.91		6996.98	0.004779	2.24	749.57	240.41	0.19
Reach 1-3	2046	2-YR	101.60	6991.97	6993.20		6993.24	0.007146	2.00	76.05	97.26	0.32
Reach 1-3	2046	5-YR	398.70	6991.97	6994.35		6994.43	0.006182	2.93	212.73	139.16	0.34
Reach 1-3	2046	100-YR	1562.40	6991.97	6996.47		6996.63	0.005768	4.36	571.71	198.77	0.36
Reach 1-3	1993	2-YR	101.60	6991.29	6992.86		6992.88	0.006104	1.85	90.03	93.62	0.29
Reach 1-3	1993	5-YR	398.70	6991.29	6994.01		6994.08	0.006859	3.03	214.80	123.02	0.35
Reach 1-3	1993	100-YR	1562.40	6991.29	6996.12		6996.28	0.007331	4.79	531.93	173.75	0.40
Reach 1-3	1929	2-YR	101.60	6991.32	6992.56		6992.58	0.003750	1.40	90.09	99.99	0.23
Reach 1-3	1929	5-YR	398.70	6991.32	6993.65		6993.72	0.004631	2.45	210.40	119.88	0.29
Reach 1-3	1929	100-YR	1562.40	6991.32	6995.65		6995.85	0.006060	4.30	483.46	152.96	0.37
Reach 1-3	1884	2-YR	101.60	6991.07	6992.28		6992.32	0.009504	2.26	73.26	95.07	0.37
Reach 1-3	1884	5-YR	398.70	6991.07	6993.31		6993.42	0.010028	3.57	180.42	111.41	0.43
Reach 1-3	1884	100-YR	1562.40	6991.07	6995.20		6995.48	0.011617	5.82	414.50	136.61	0.51
Reach 1-3	1834	2-YR	101.60	6990.69	6991.93		6991.97	0.005448	1.61	74.46	98.97	0.28
Reach 1-3	1834	5-YR	398.70	6990.69	6992.91		6993.01	0.006705	2.77	184.18	117.49	0.34
Reach 1-3	1834	100-YR	1562.40	6990.69	6994.64		6994.94	0.009824	5.07	407.50	140.41	0.46
Reach 1-3	1804	2-YR	101.60	6990.58	6991.74		6991.78	0.006411	1.85	77.25	100.74	0.31
Reach 1-3	1804	5-YR	398.70	6990.58	6992.68		6992.78	0.007731	3.04	183.90	120.67	0.37
Reach 1-3	1804	100-YR	1562.40	6990.58	6994.32		6994.60	0.010736	5.28	402.00	153.49	0.48
Reach 1-3	1707	2-YR	128.60	6989.35	6990.10	6990.10	6990.36	0.040207	4.21	34.67	74.60	0.96
Reach 1-3	1707	5-YR	480.40	6989.35	6990.82	6990.82	6991.33	0.031184	6.28	97.81	101.55	0.97
Reach 1-3	1707	100-YR	1585.20	6989.35	6992.10	6992.10	6993.04	0.025470	8.96	249.51	134.94	0.98
Reach 1-3	1663	2-YR	128.60	6987.76	6988.46		6988.63	0.023713	3.40	41.21	73.65	0.75
Reach 1-3	1663	5-YR	480.40	6987.76	6989.10	6989.10	6989.61	0.029082	6.00	96.27	103.68	0.93
Reach 1-3	1663	100-YR	1585.20	6987.76	6990.34	6990.34	6991.27	0.024638	8.64	245.98	135.45	0.96
Reach 1-3	1622	2-YR	128.60	6986.76	6987.48	6987.40	6987.59	0.026847	2.63	48.93	123.35	0.74
Reach 1-3	1622	5-YR	480.40	6986.76	6987.98		6988.24	0.025942	4.08	117.64	150.00	0.81
Reach 1-3	1622	100-YR	1585.20	6986.76	6988.84	6988.72	6989.47	0.023672	6.38	254.11	166.17	0.88
Reach 1-3	1411	2-YR	128.60	6982.00	6983.02	6982.88	6983.11	0.017101	2.39	53.76	111.26	0.61
Reach 1-3	1411	5-YR	480.40	6982.00	6983.60	6983.37	6983.85	0.017080	3.99	122.22	125.23	0.69
Reach 1-3	1411	100-YR	1585.20	6982.00	6984.65	6984.36	6985.26	0.017064	6.35	266.12	143.77	0.77

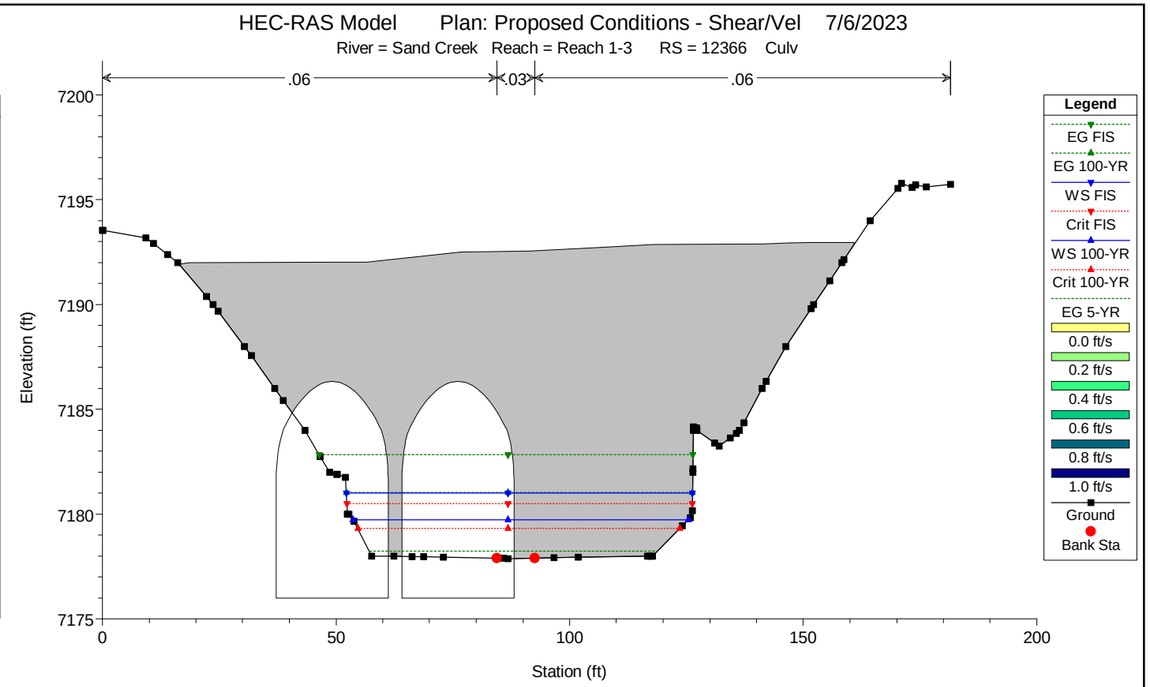
Shear and Velocity HEC-RAS Analysis

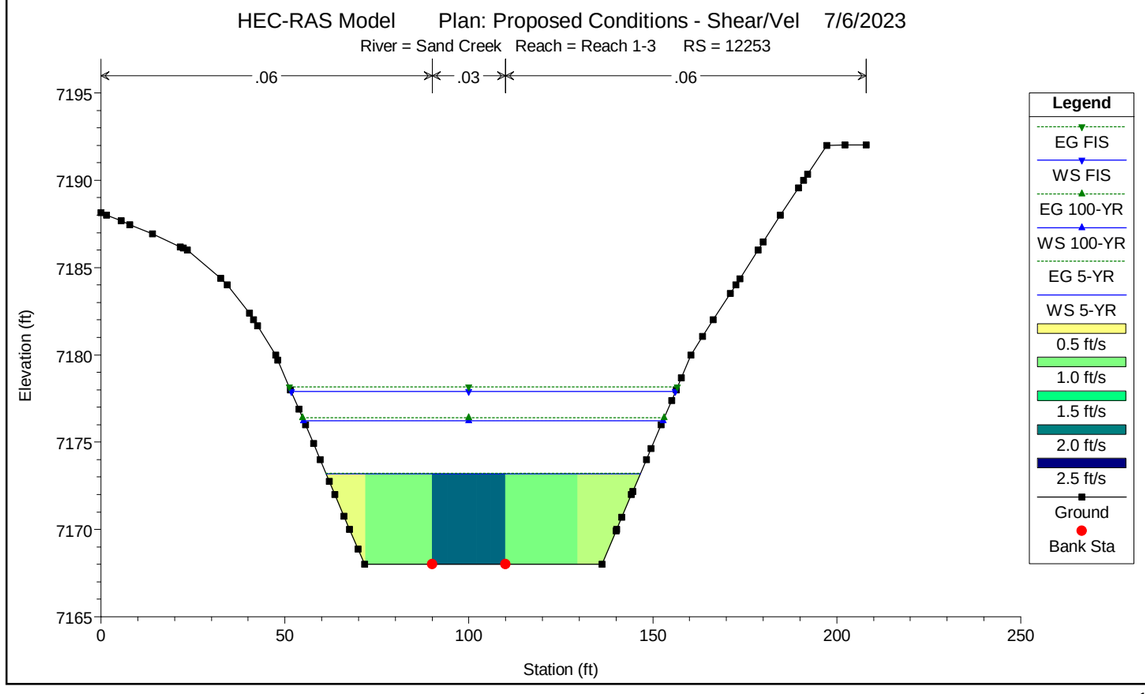
Sub-critical flow analysis for
Shear/Velocity evaluation of
Naturalized Channel Design

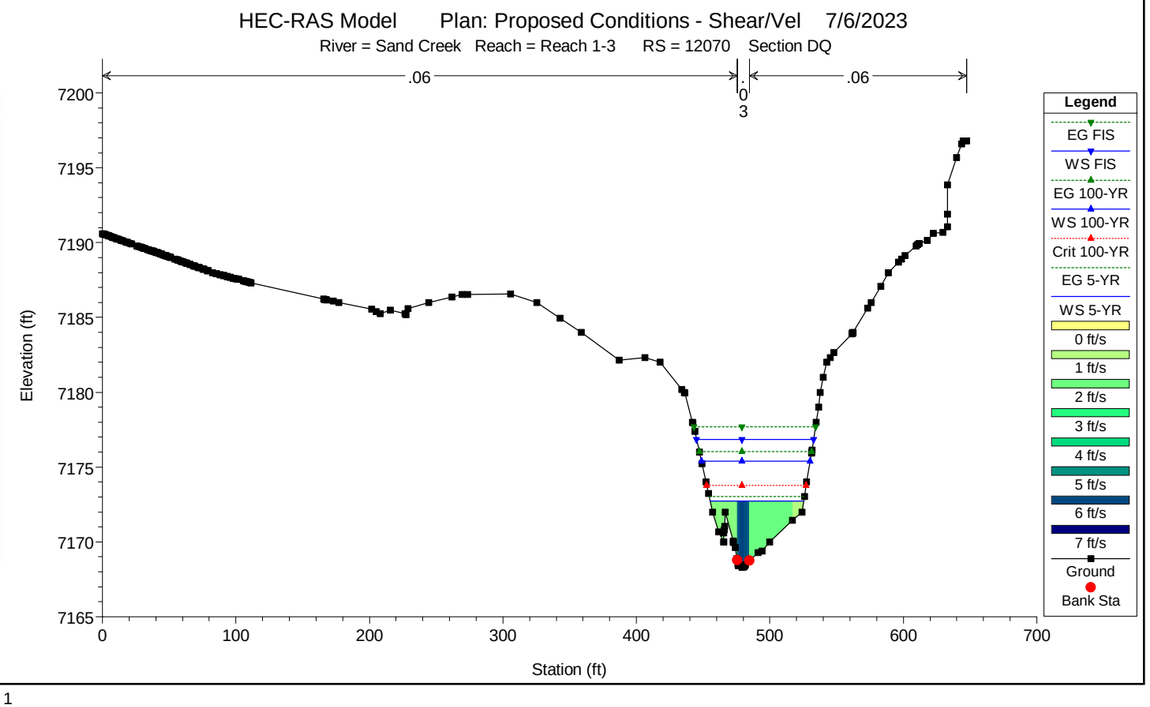


Sub-critical flow analysis for Shear/Velocity evaluation of Naturalized Channel Design

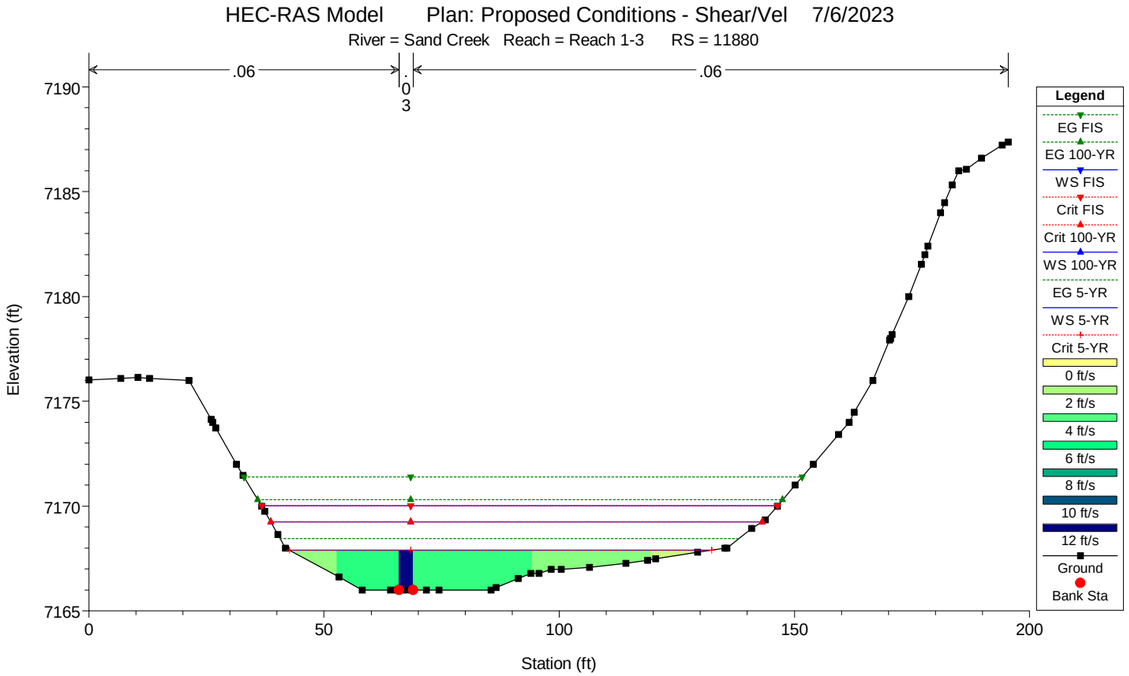


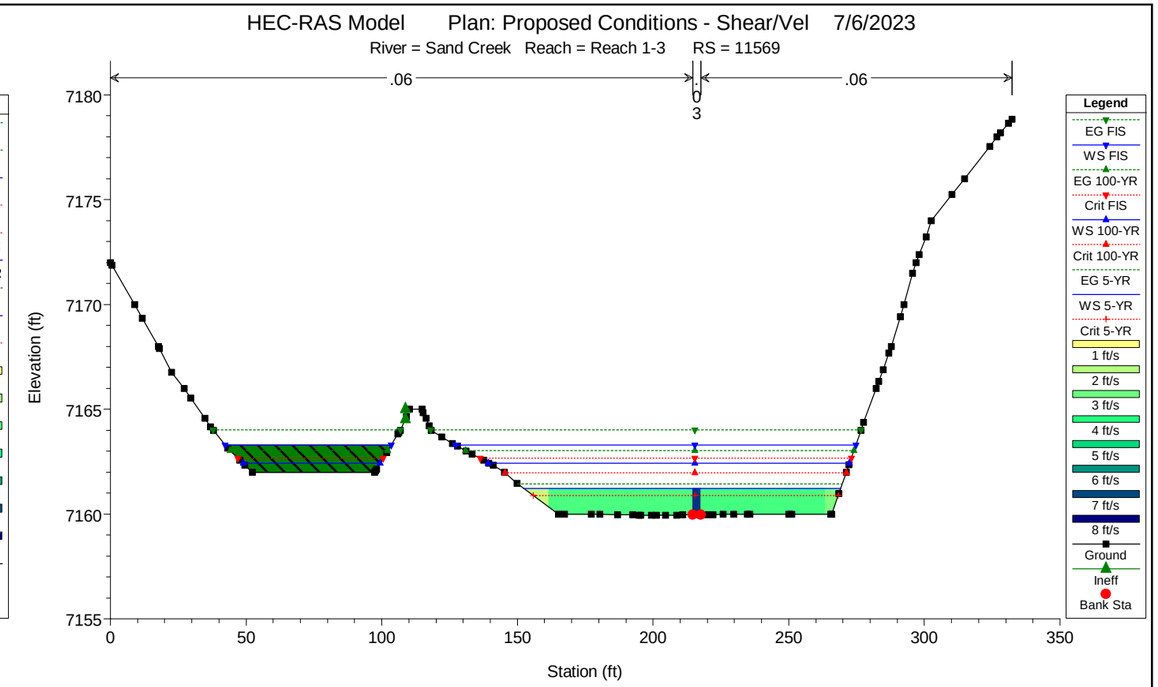


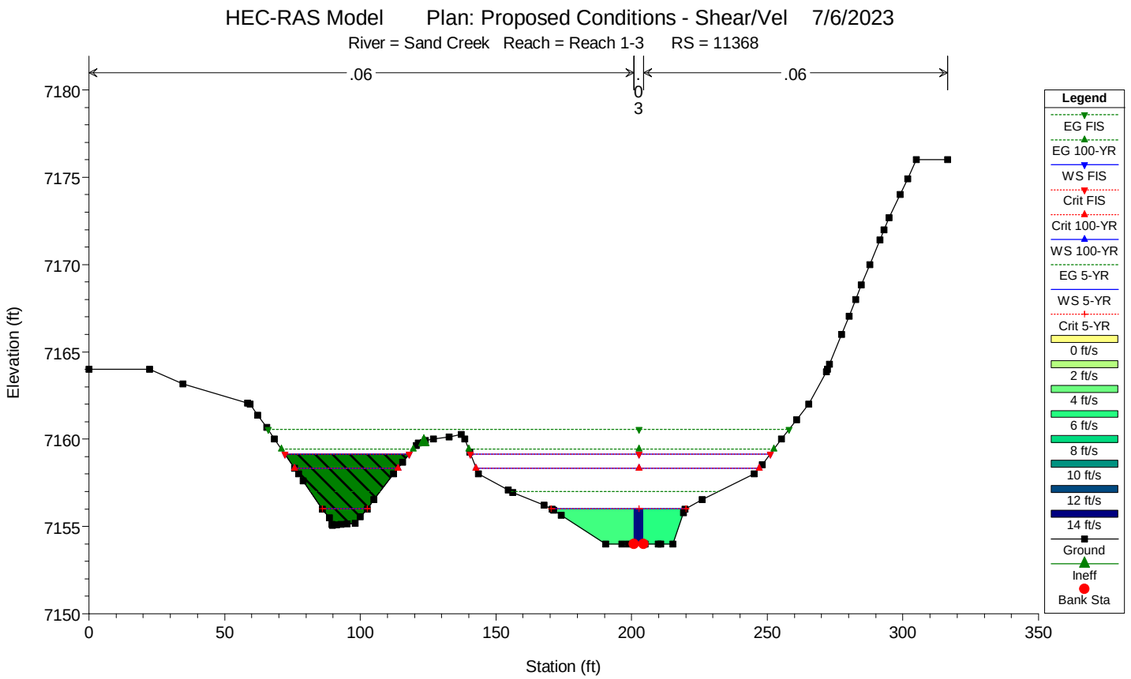


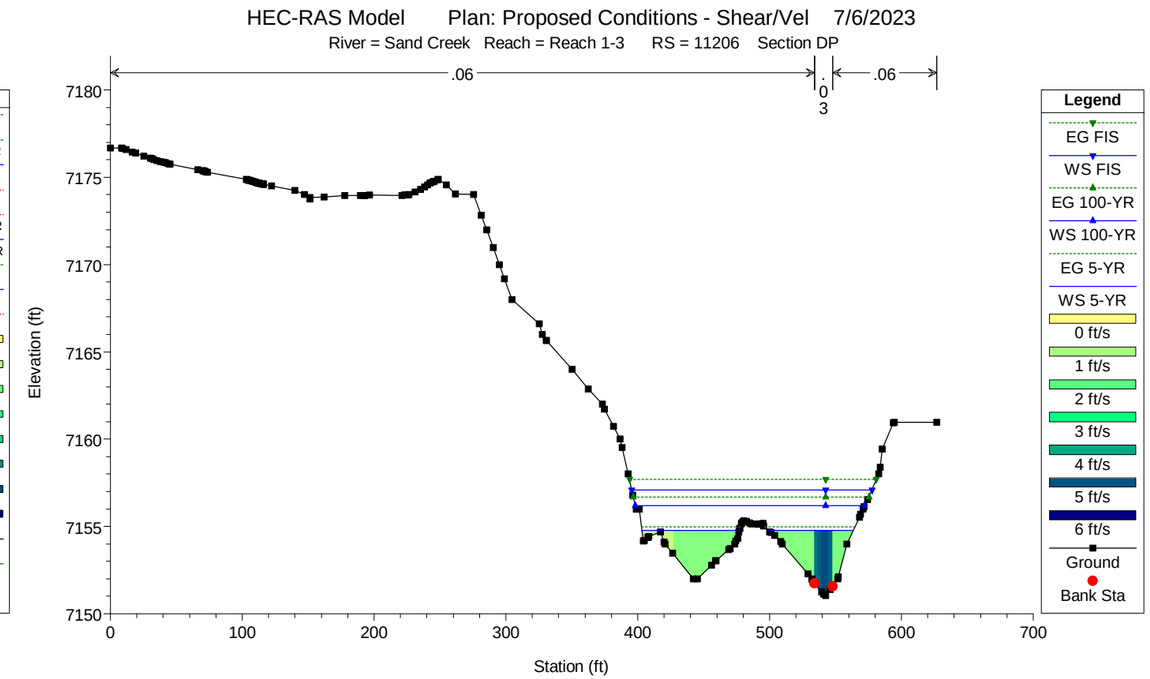


Sub-critical flow analysis for
Shear/Velocity evaluation of
Naturalized Channel Design

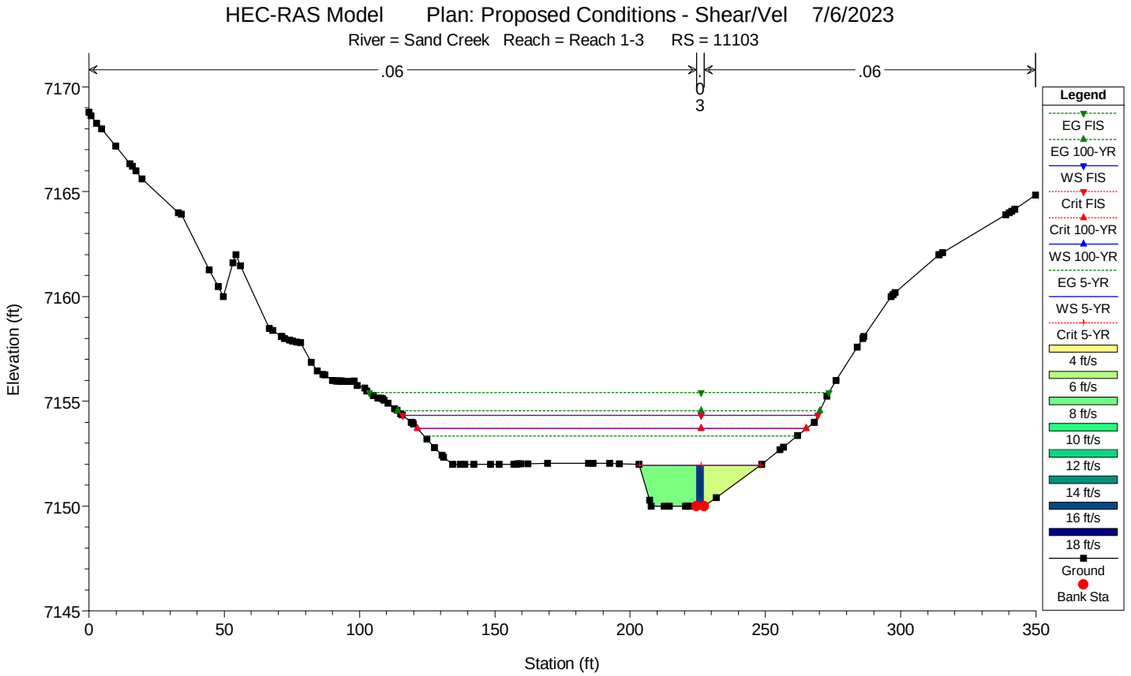


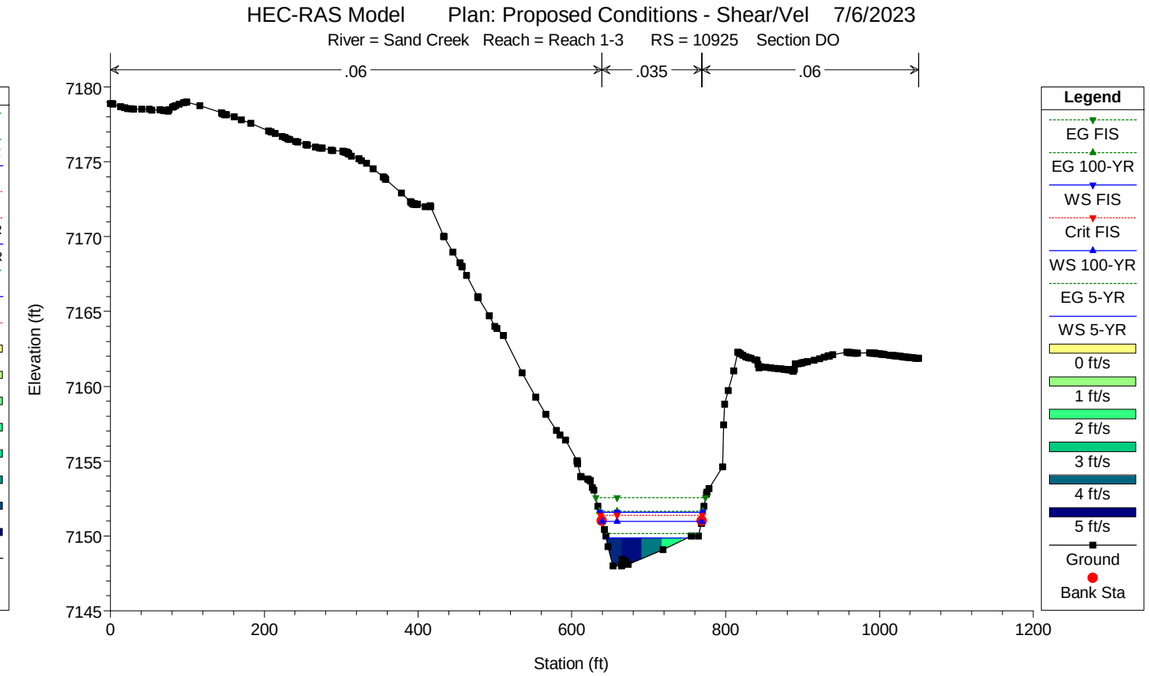


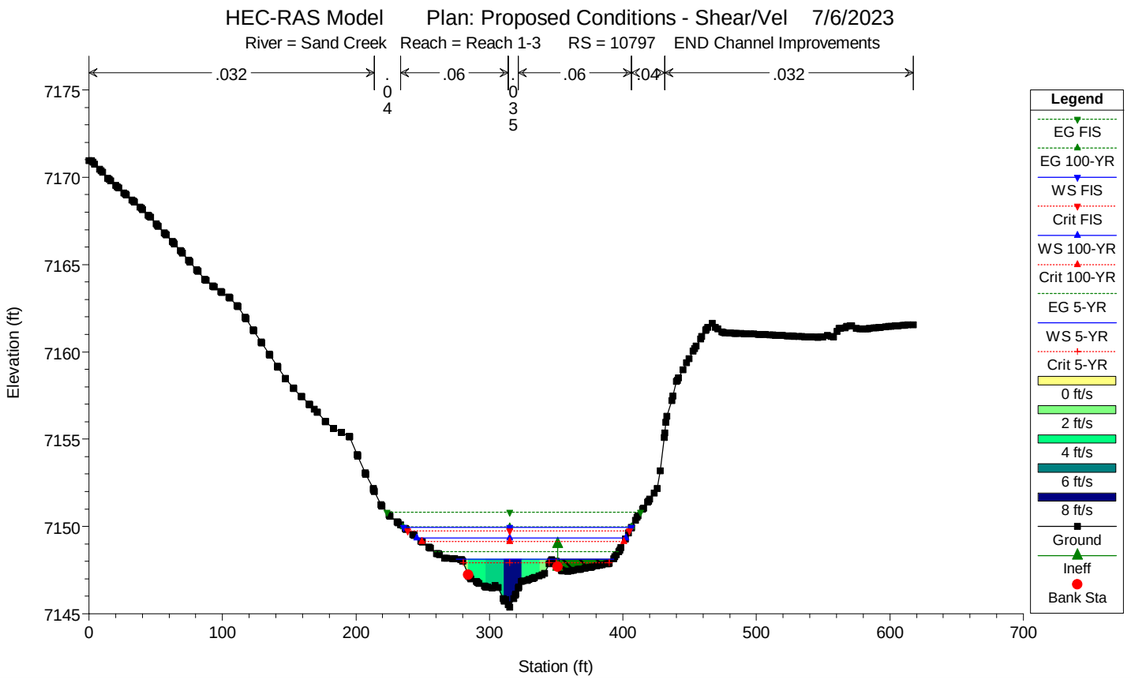


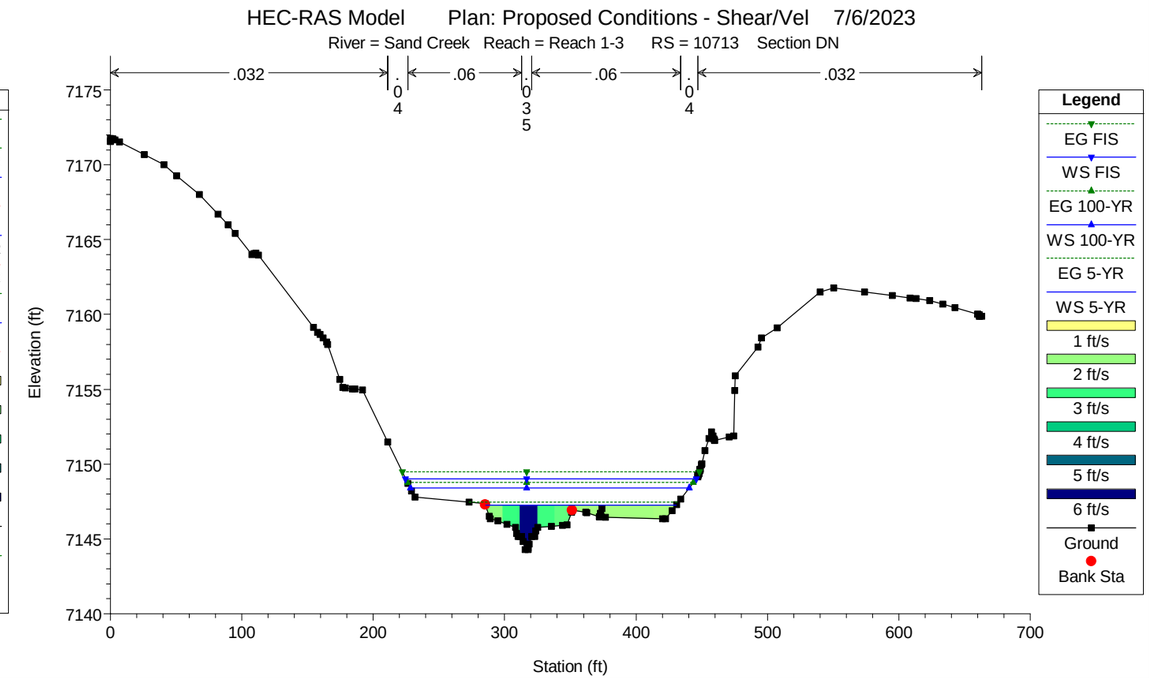


Sub-critical flow analysis for Shear/Velocity evaluation of Naturalized Channel Design

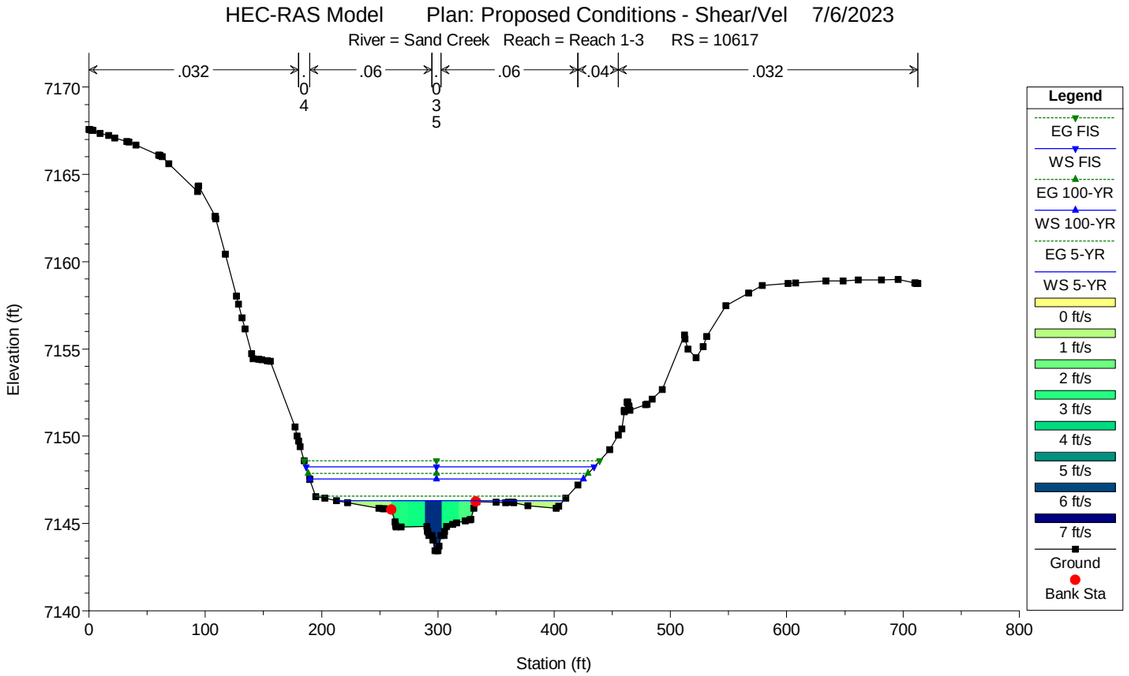


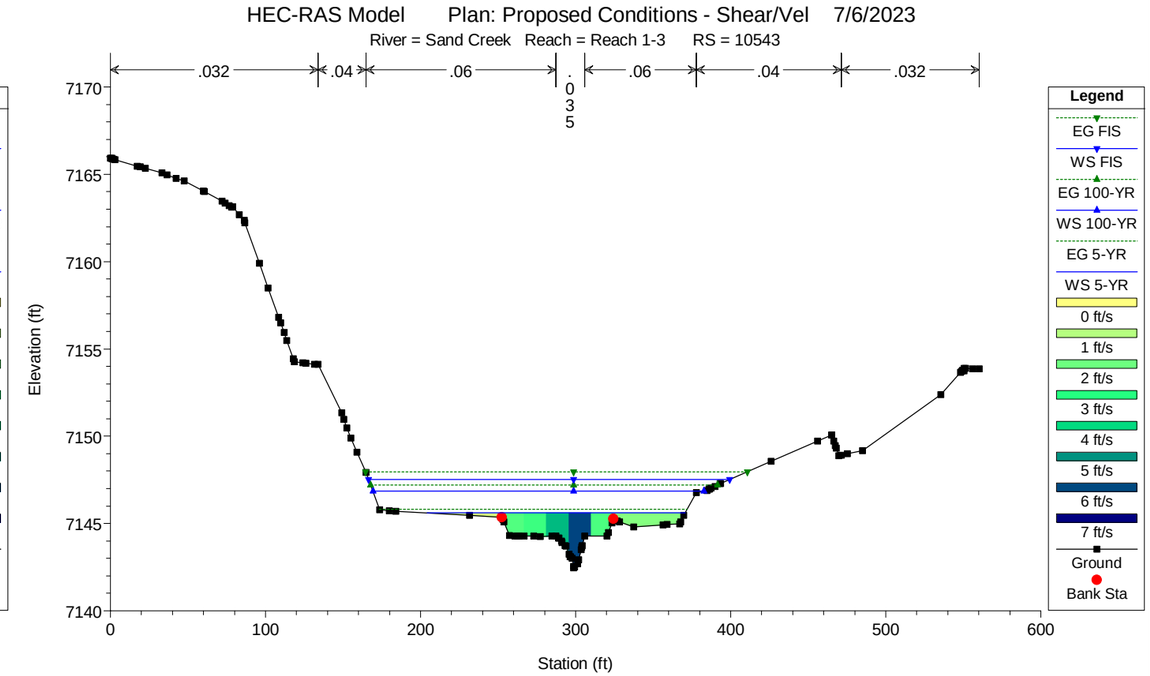


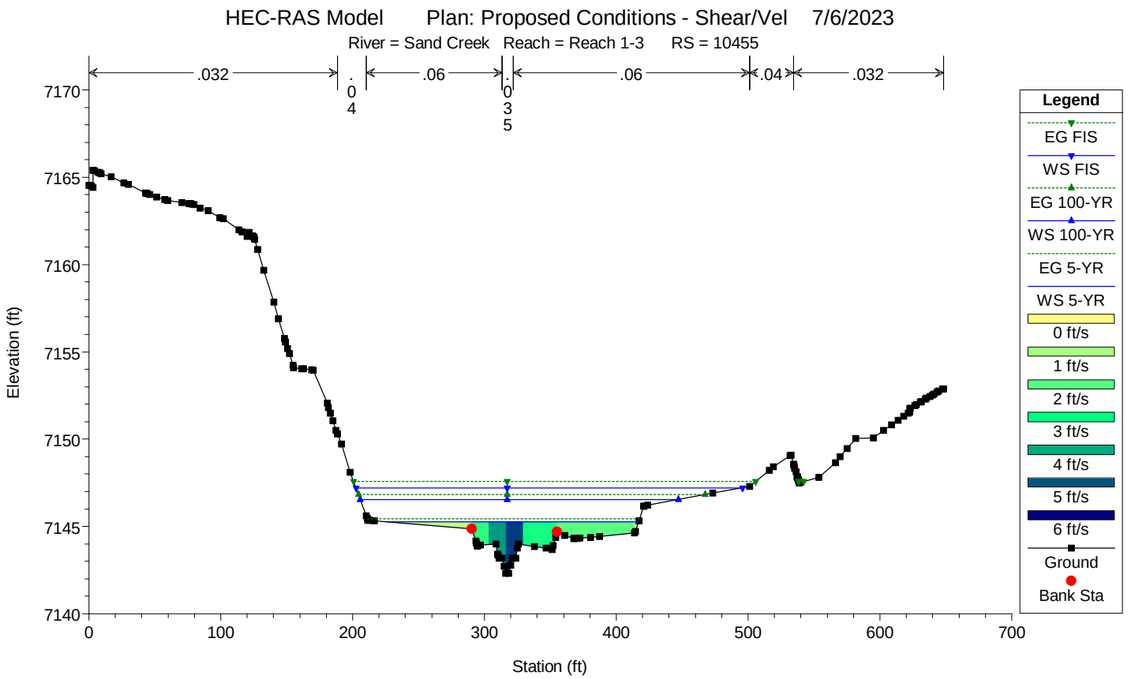


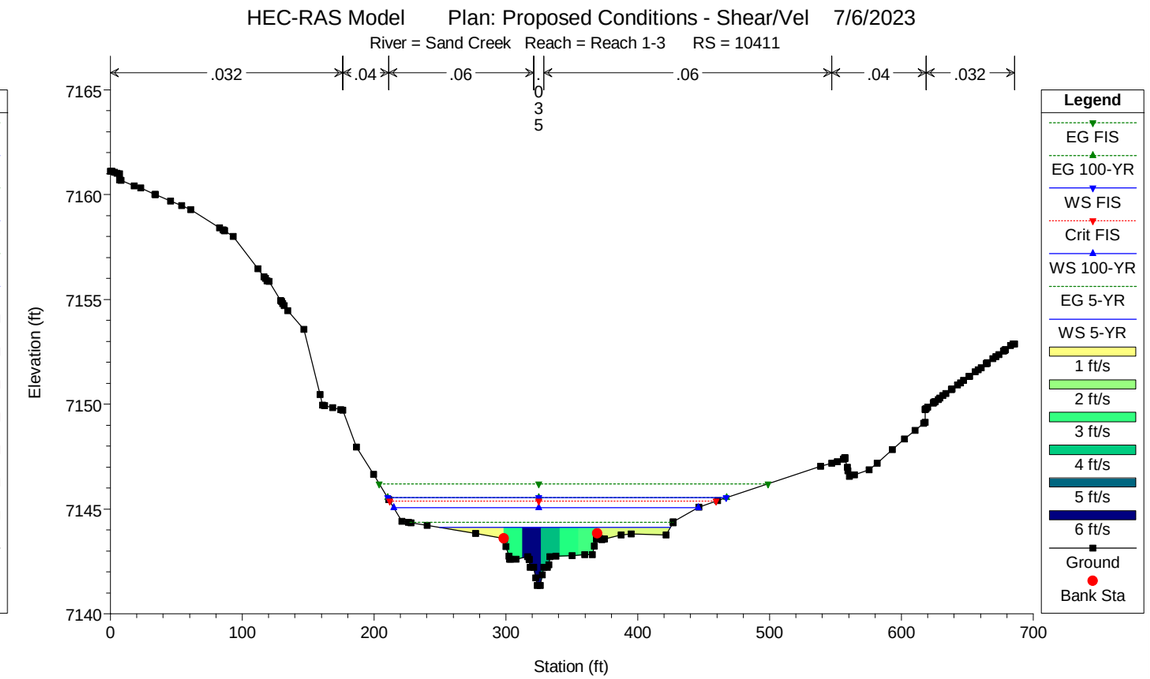


Sub-critical flow analysis for
Shear/Velocity evaluation of
Naturalized Channel Design

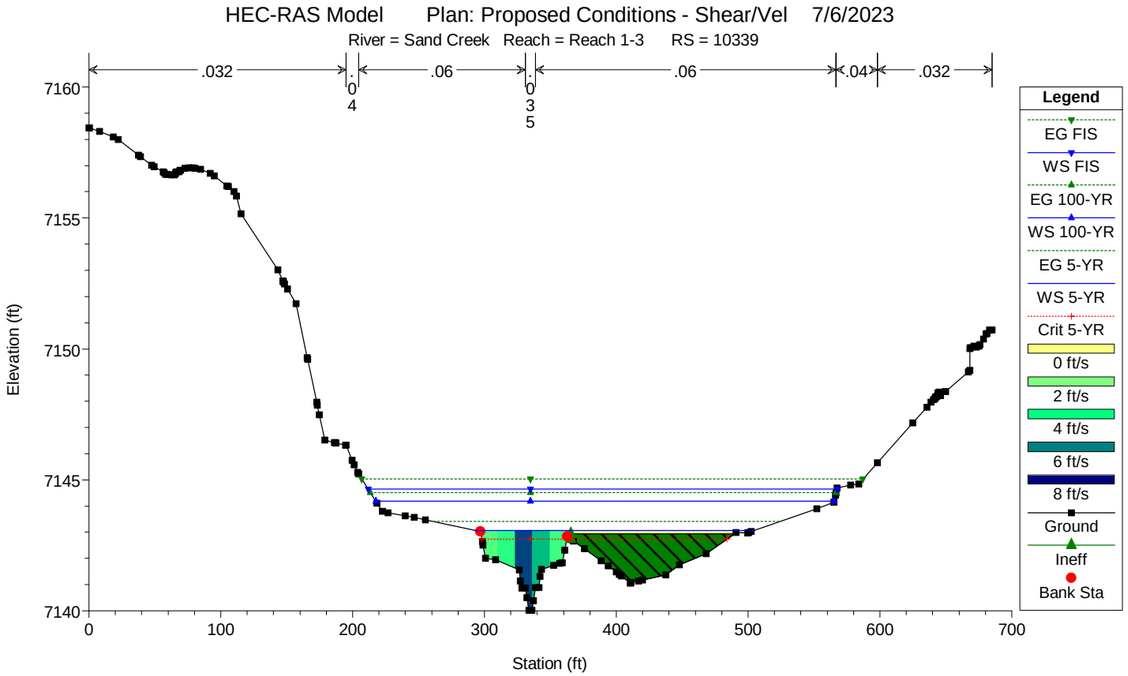


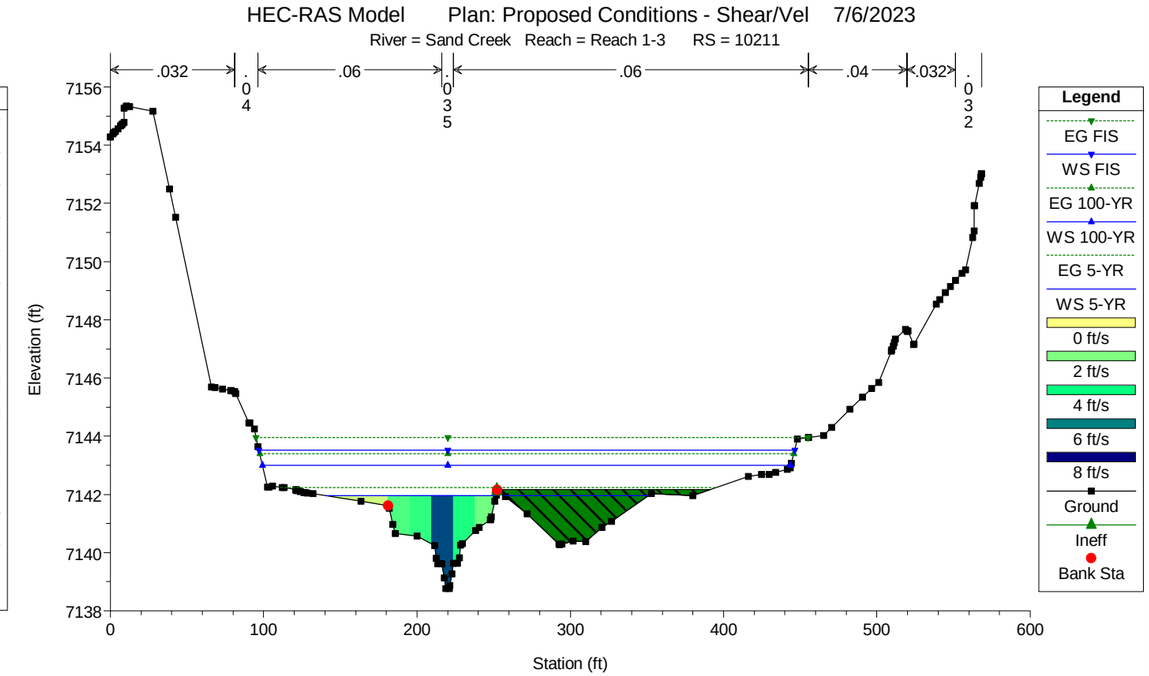


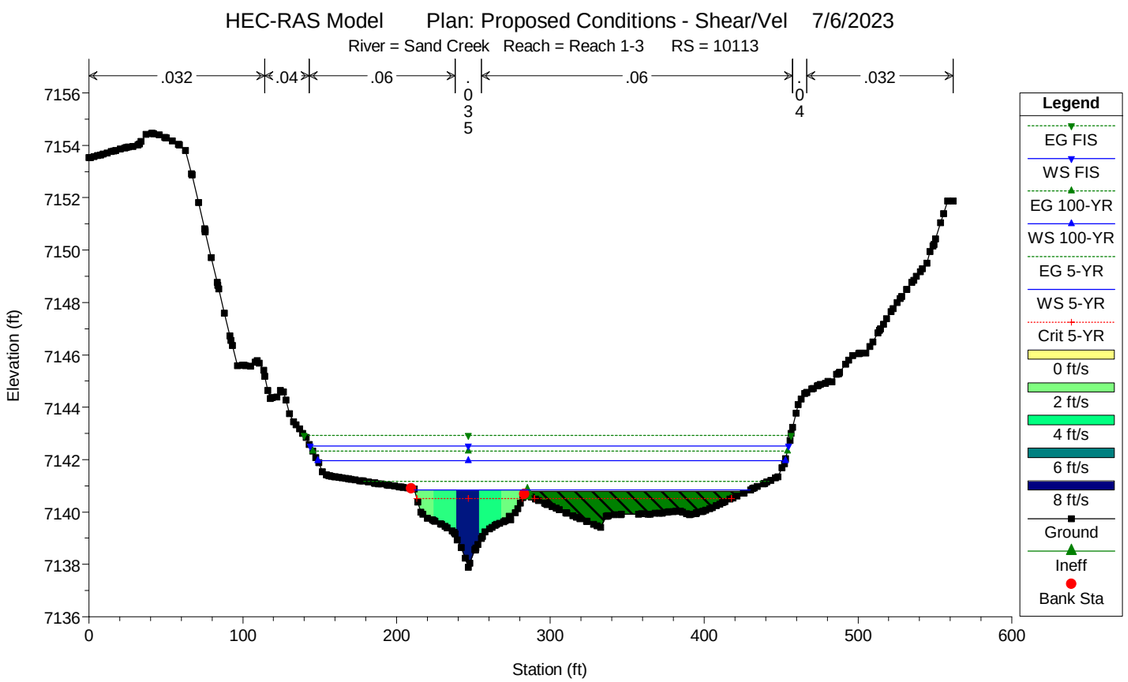


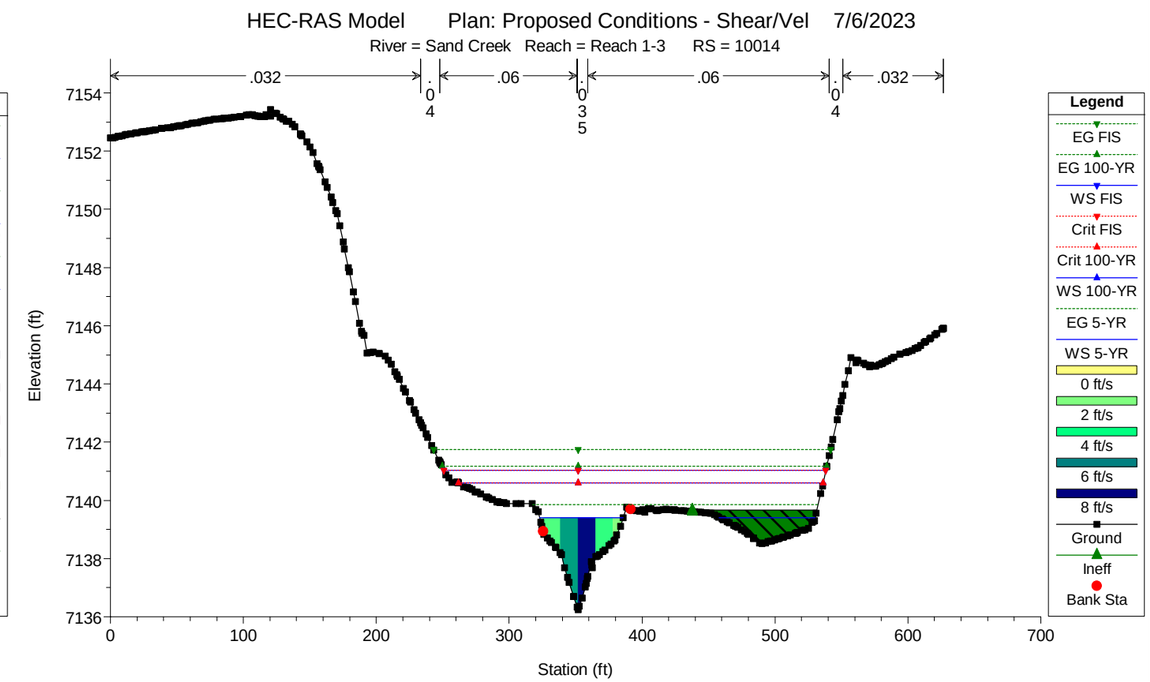


Sub-critical flow analysis for Shear/Velocity evaluation of Naturalized Channel Design

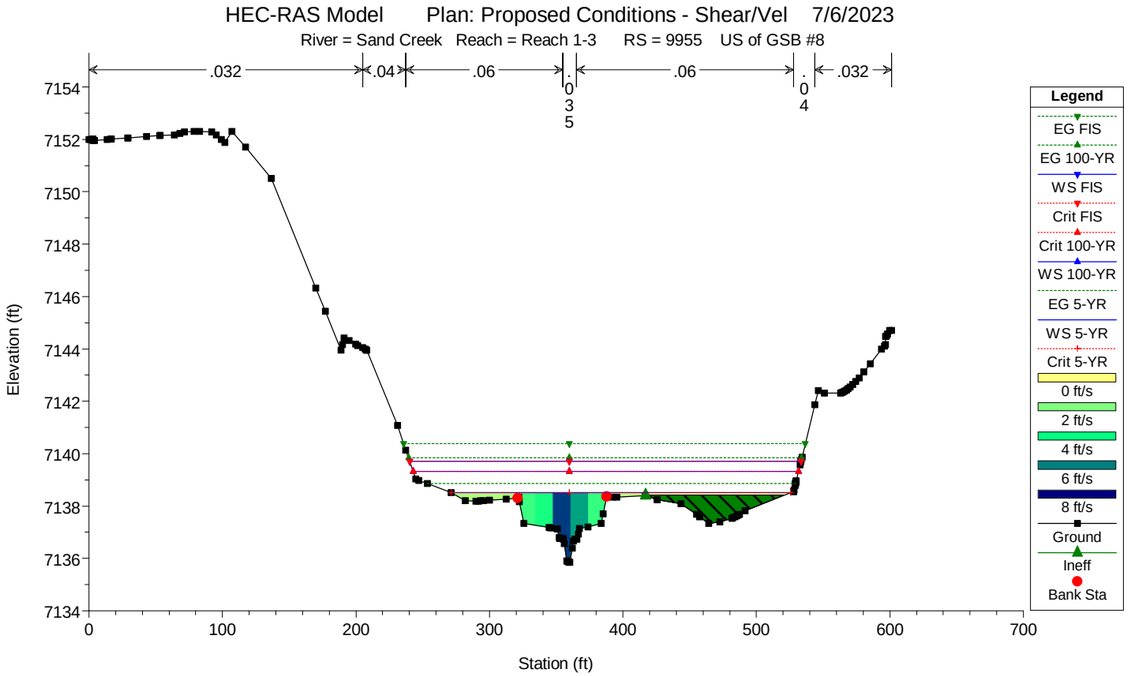


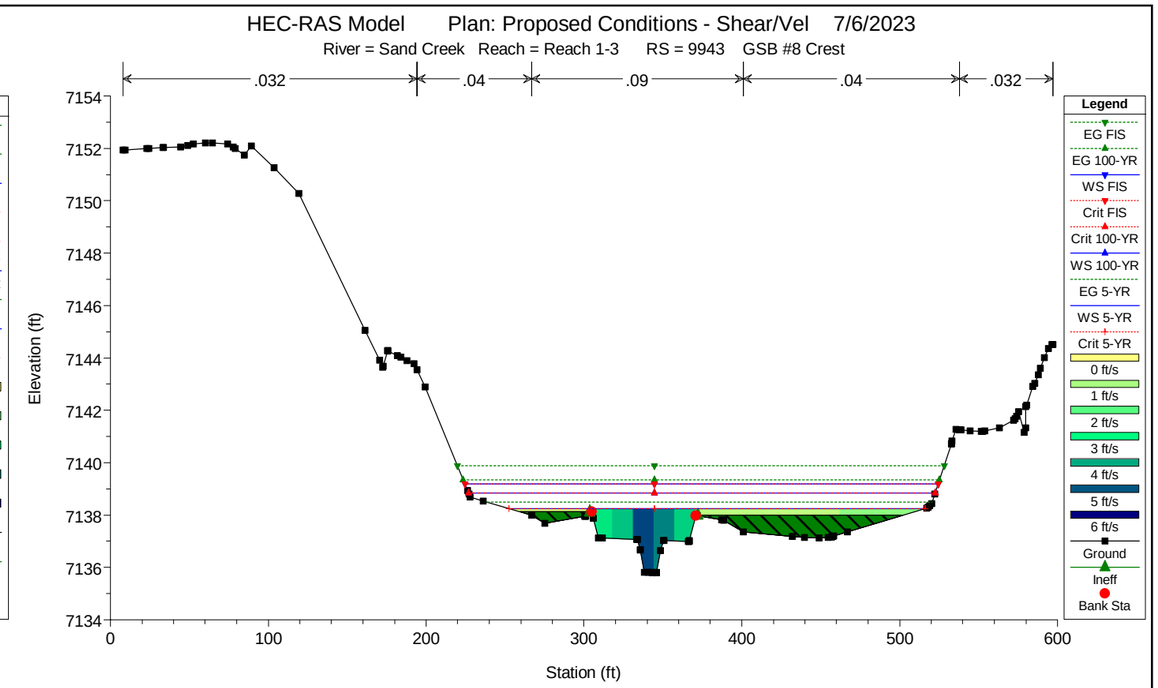


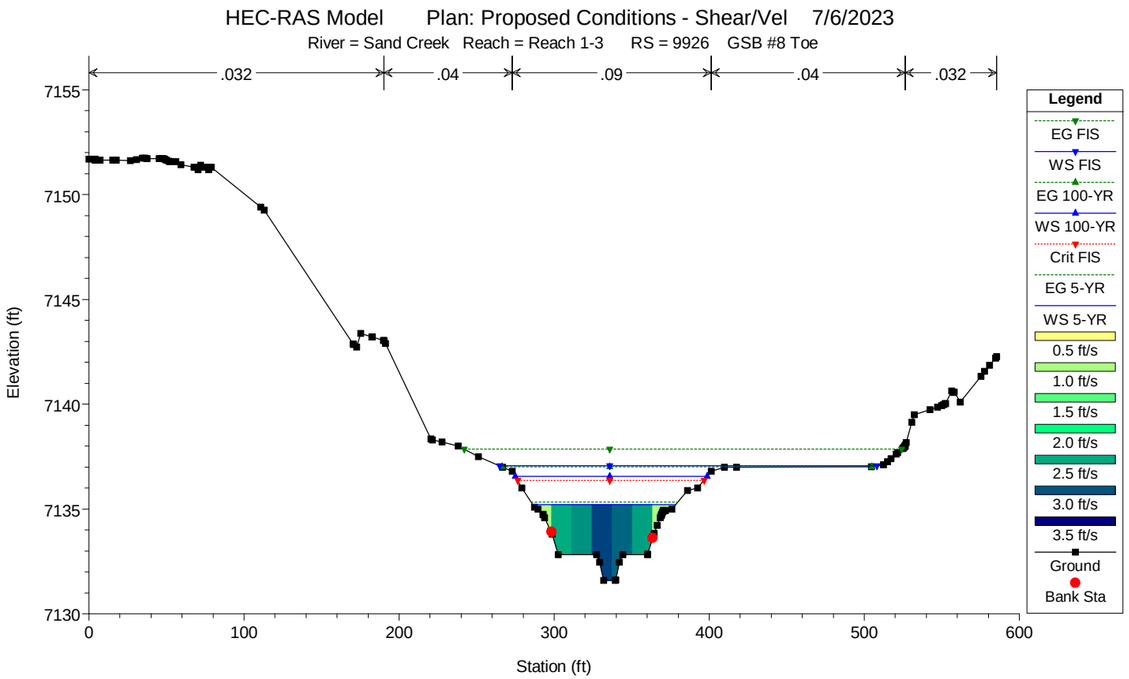


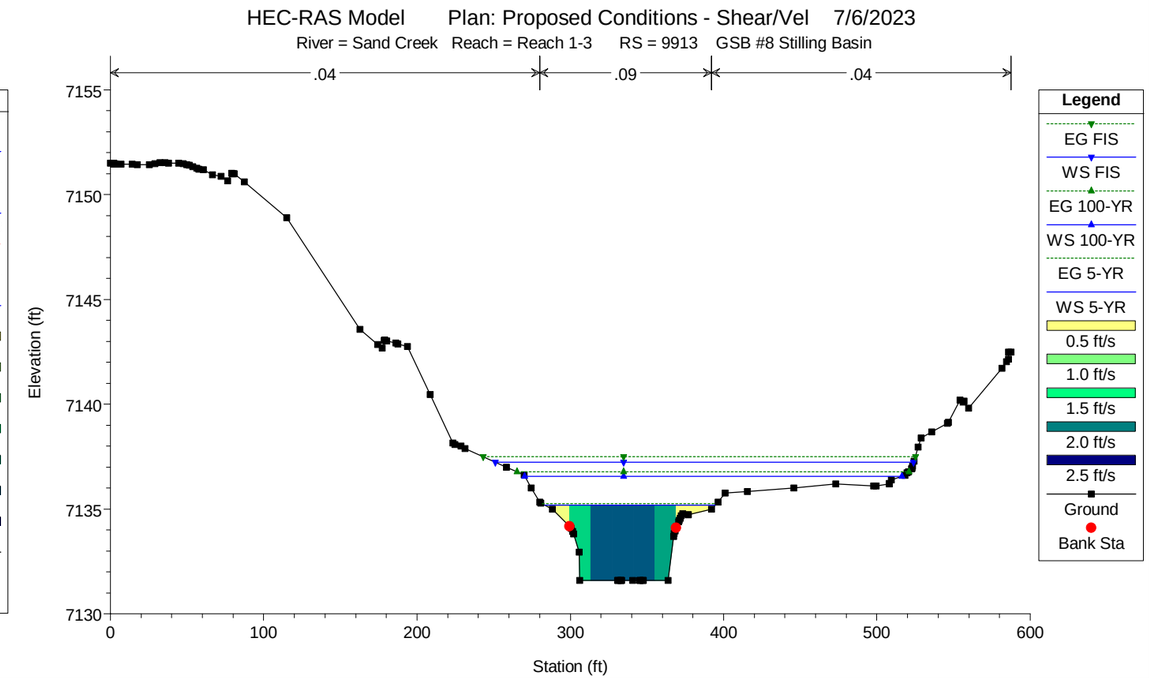


Sub-critical flow analysis for
Shear/Velocity evaluation of
Naturalized Channel Design

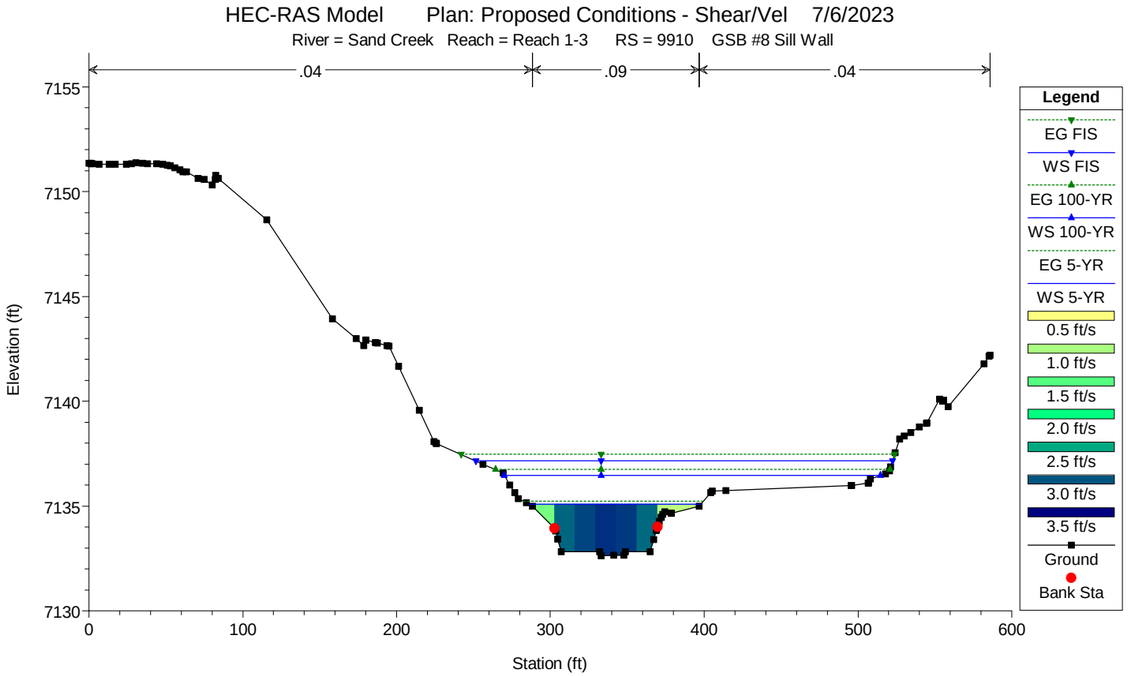


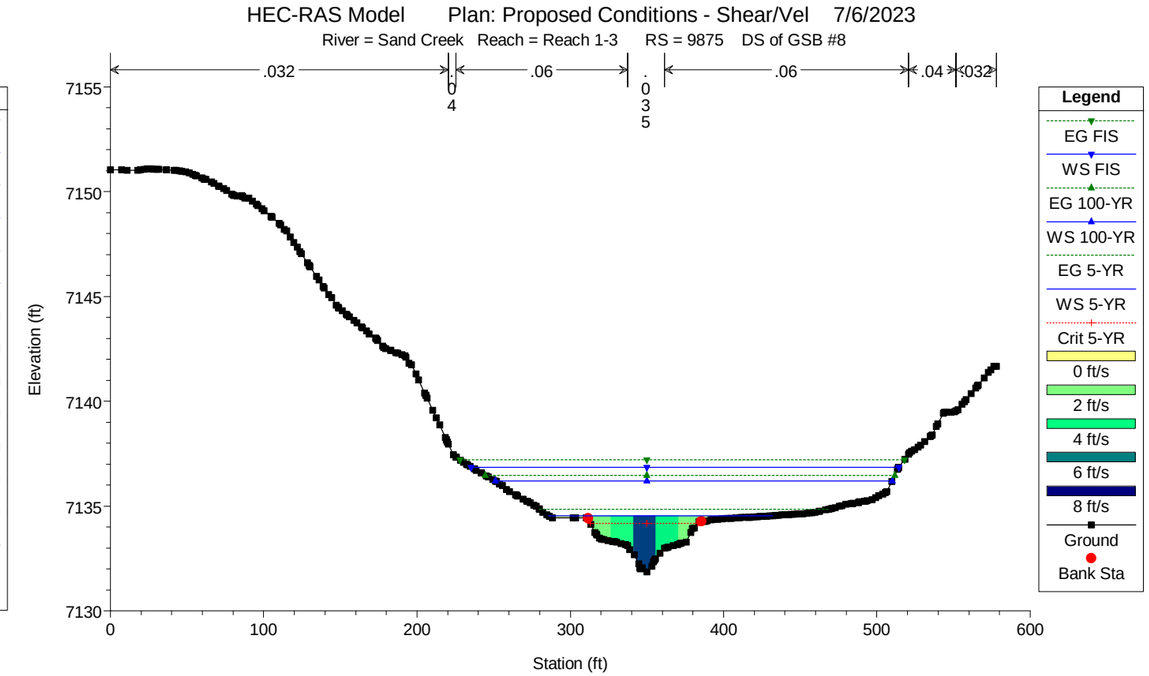


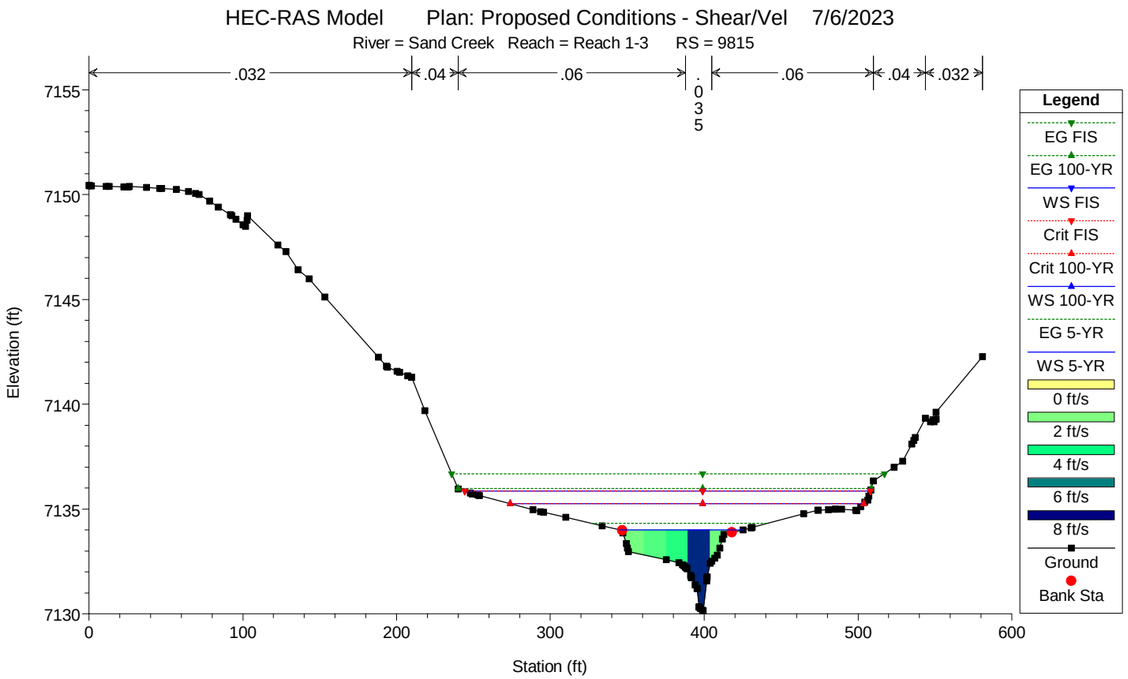


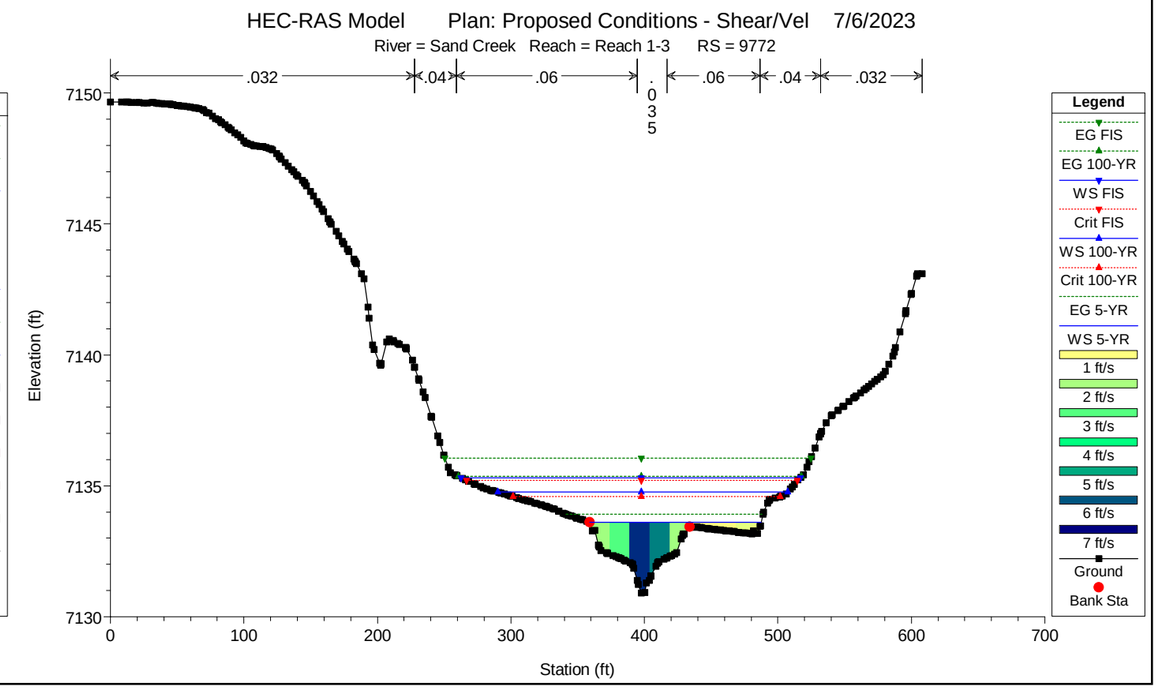


Sub-critical flow analysis for
Shear/Velocity evaluation of
Naturalized Channel Design

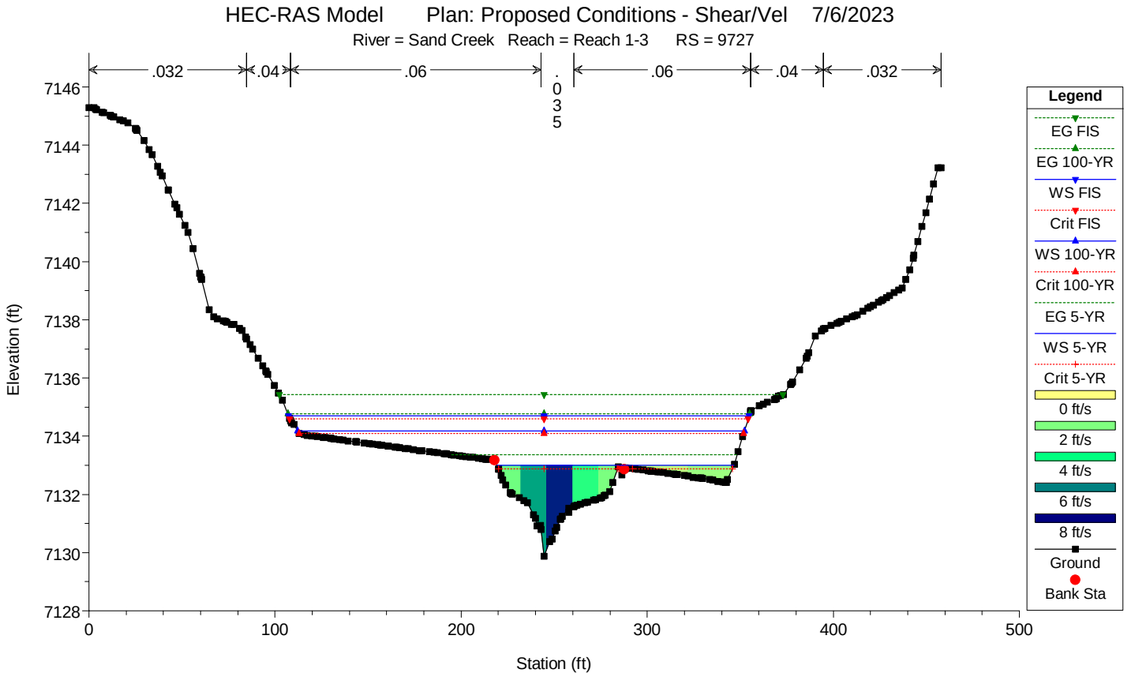


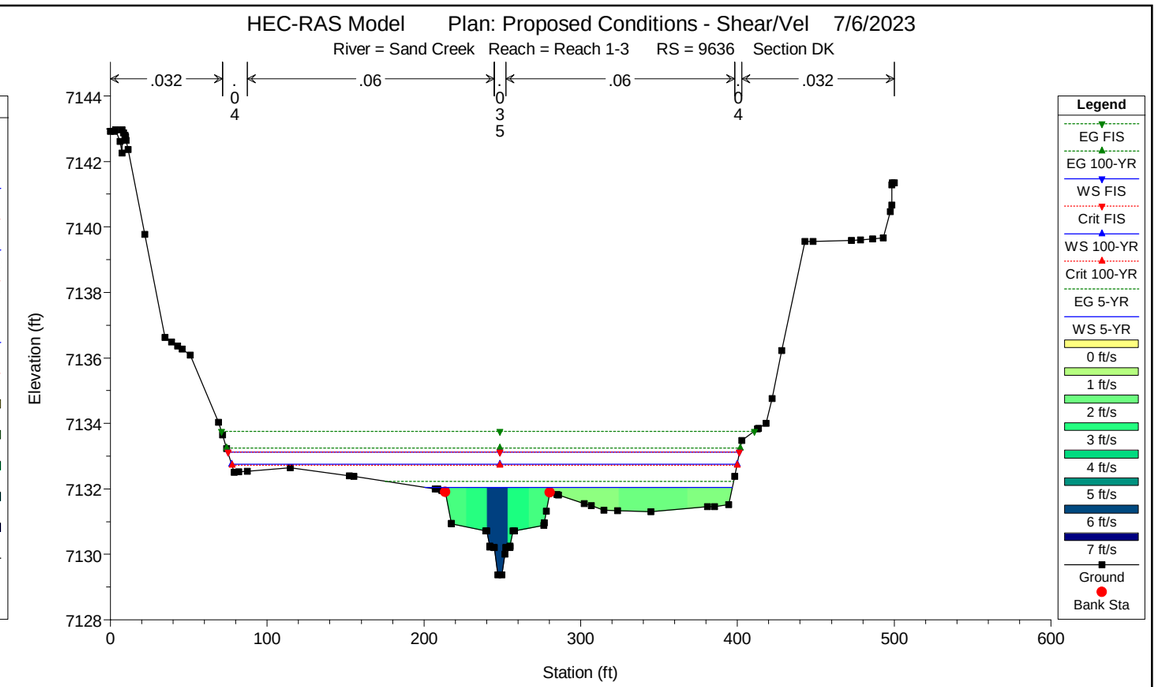


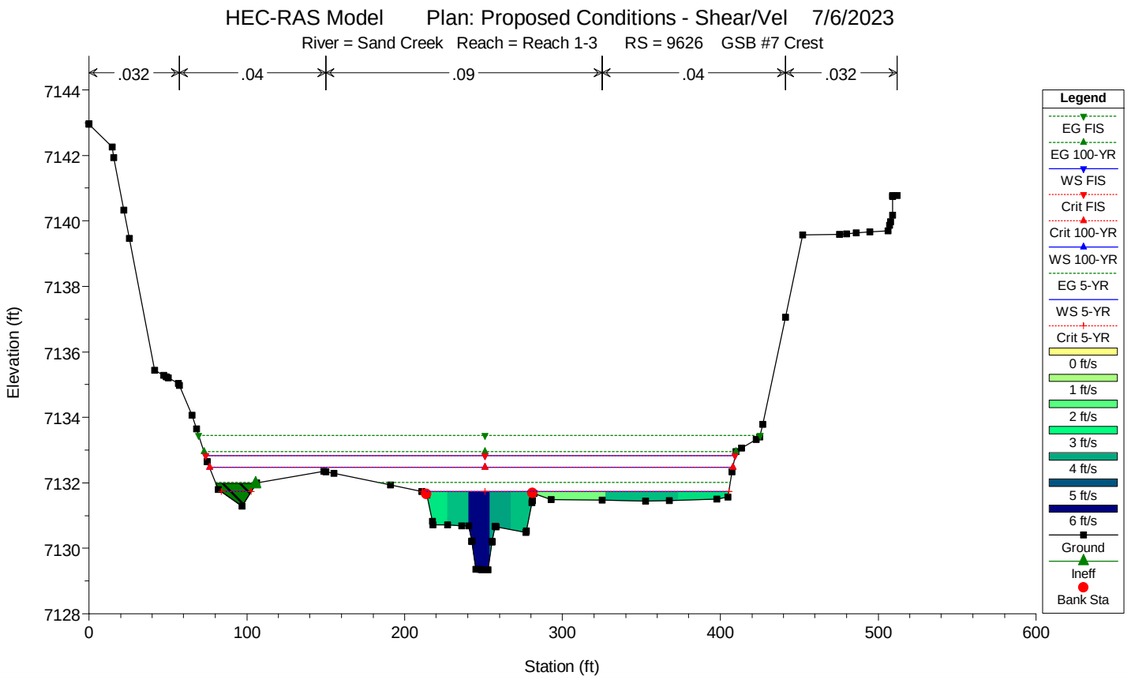


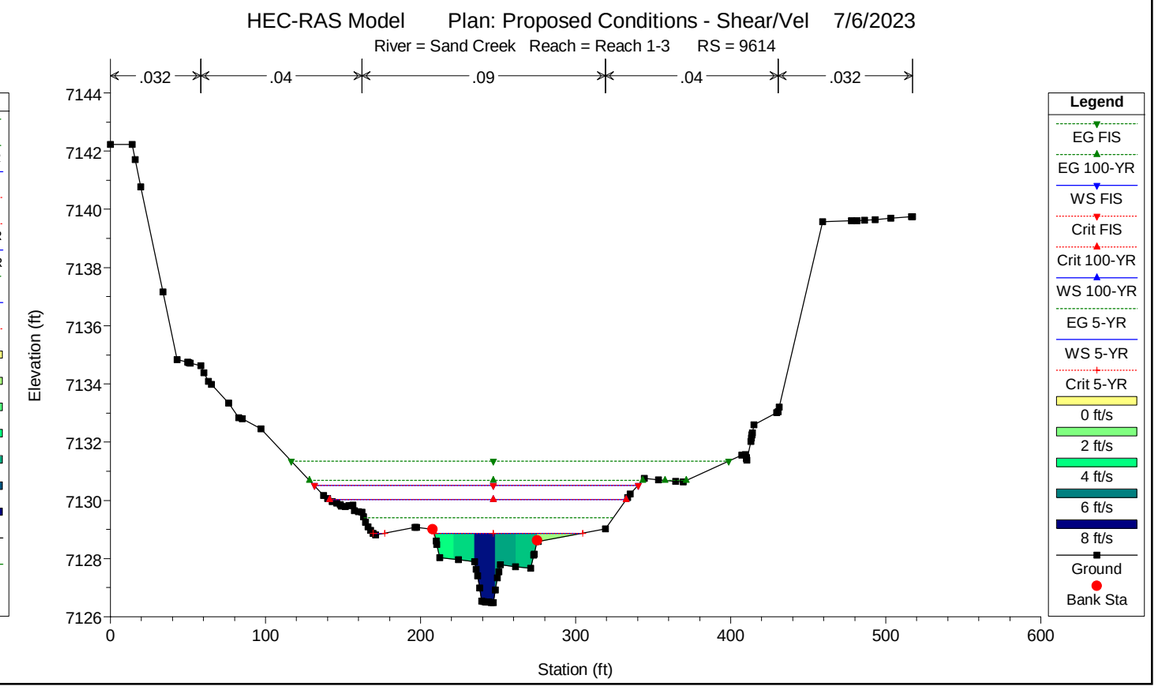


Sub-critical flow analysis for Shear/Velocity evaluation of Naturalized Channel Design

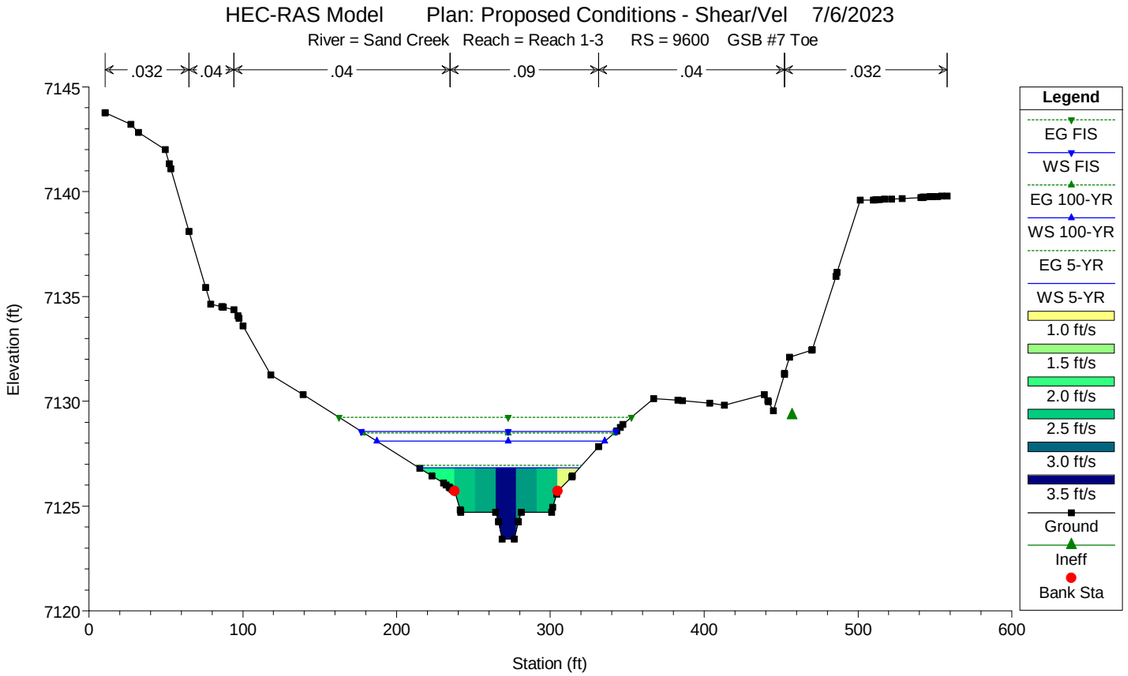


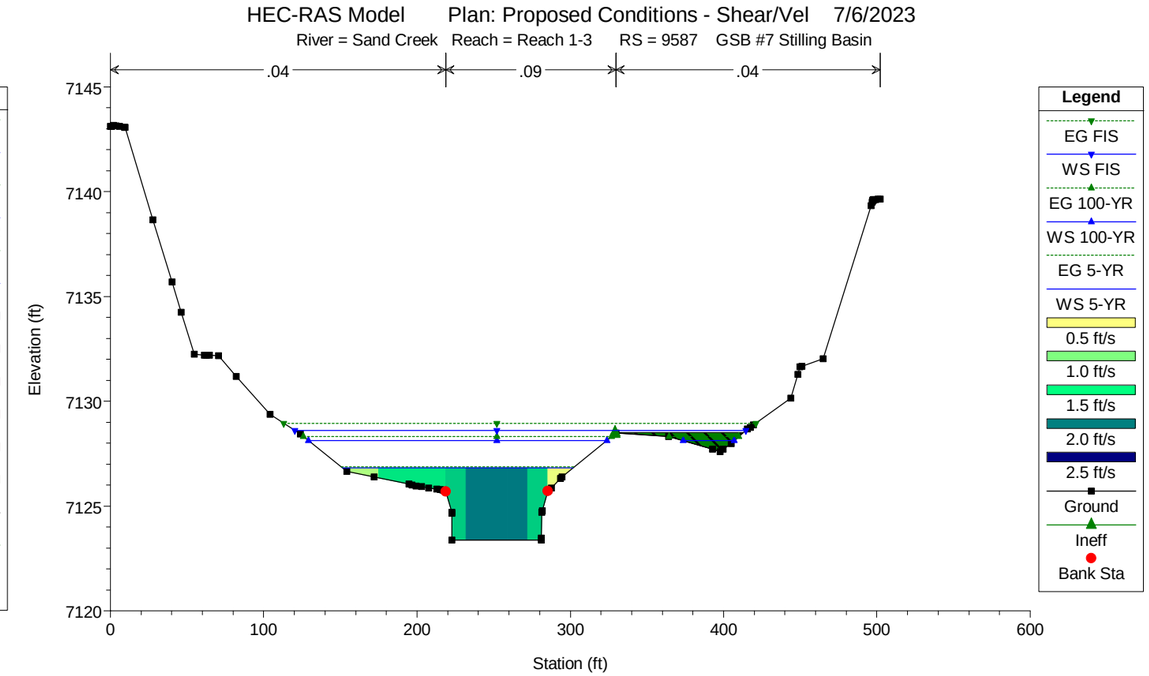


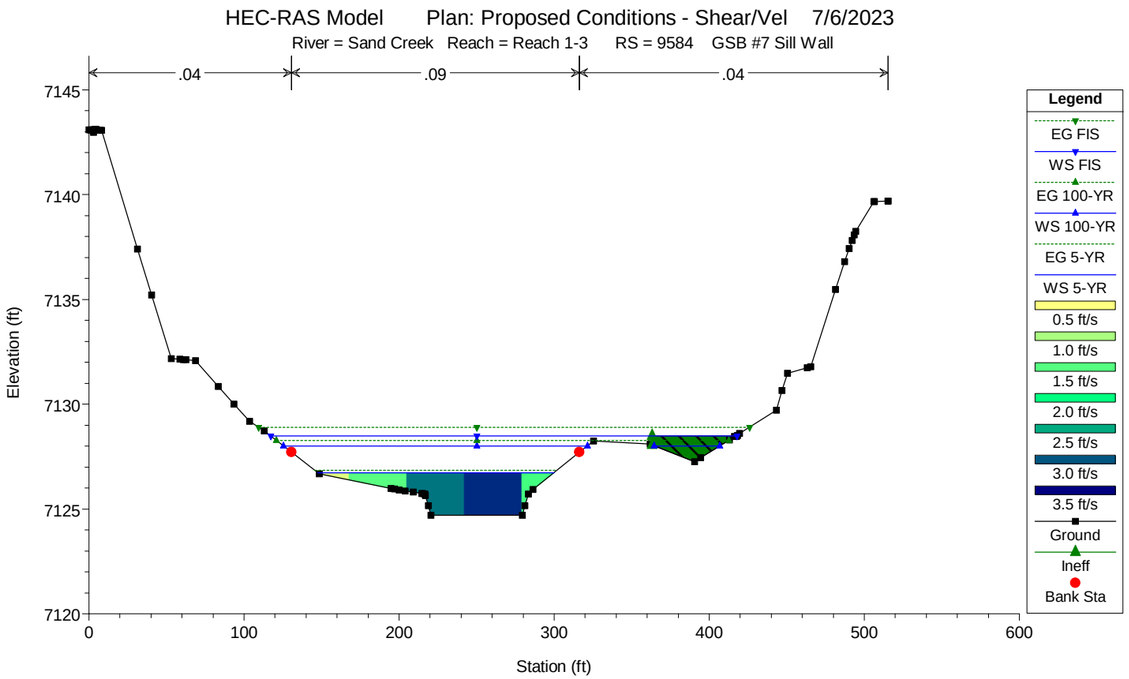


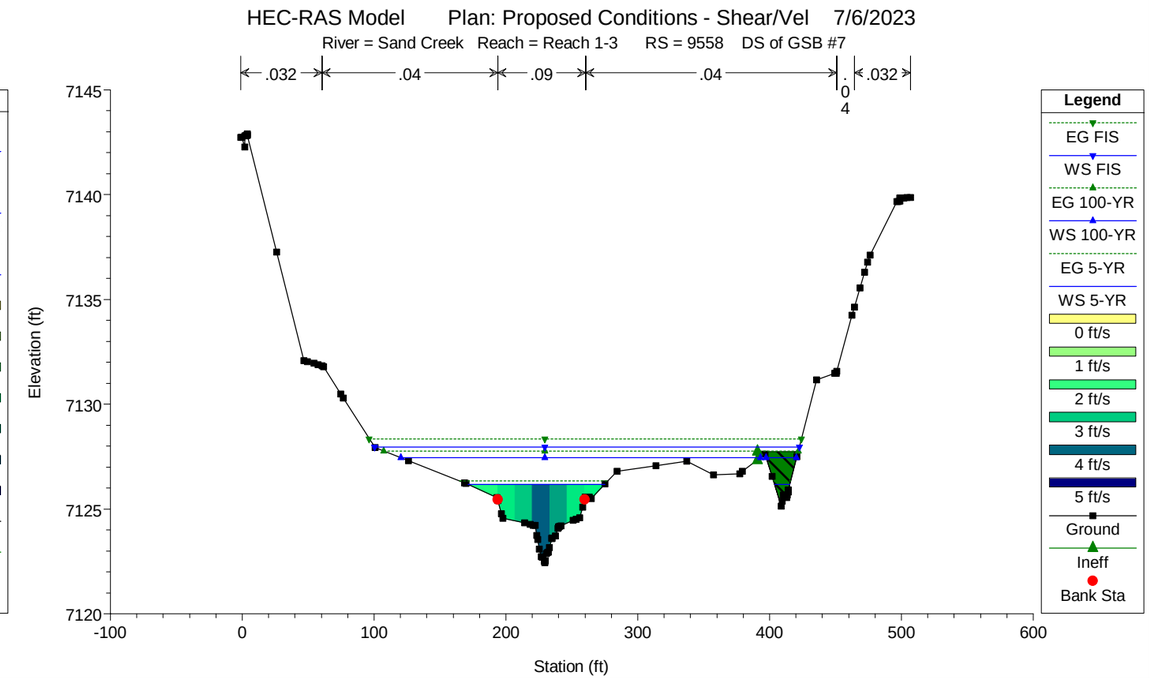


Sub-critical flow analysis for Shear/Velocity evaluation of Naturalized Channel Design

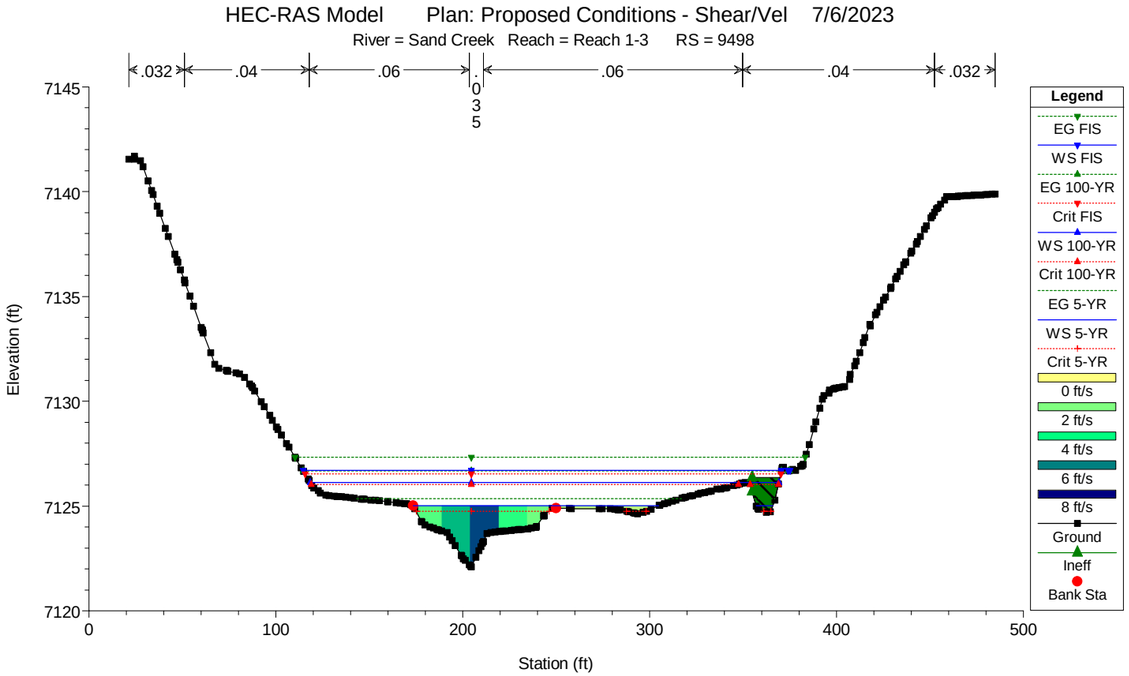


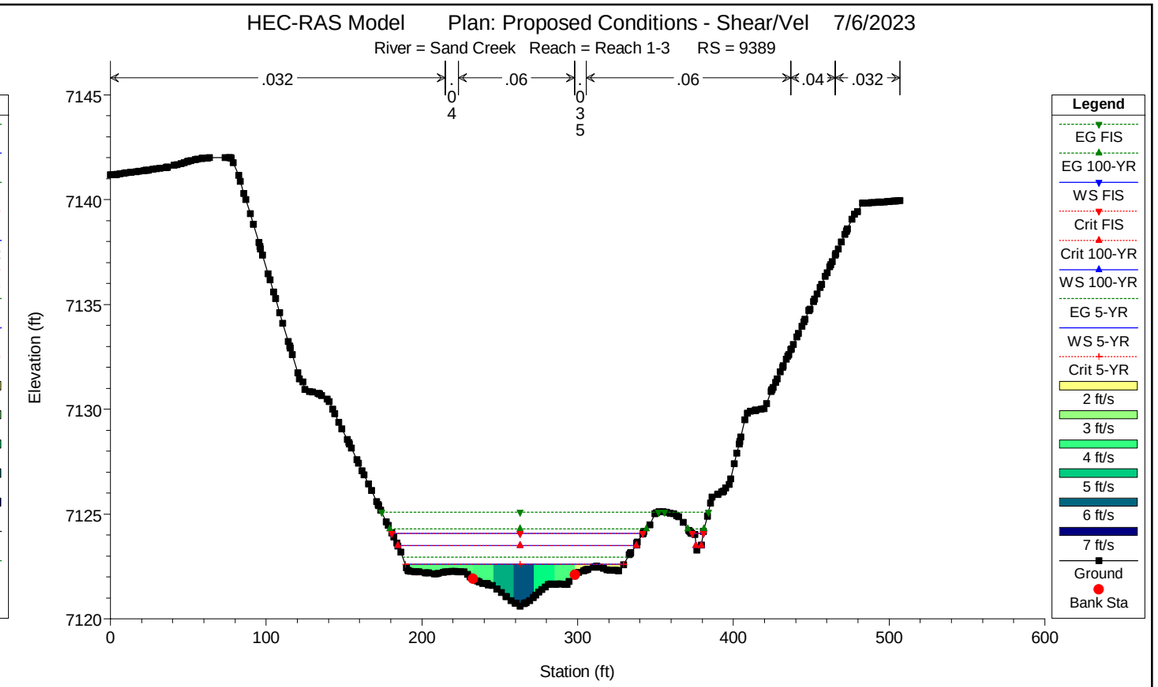


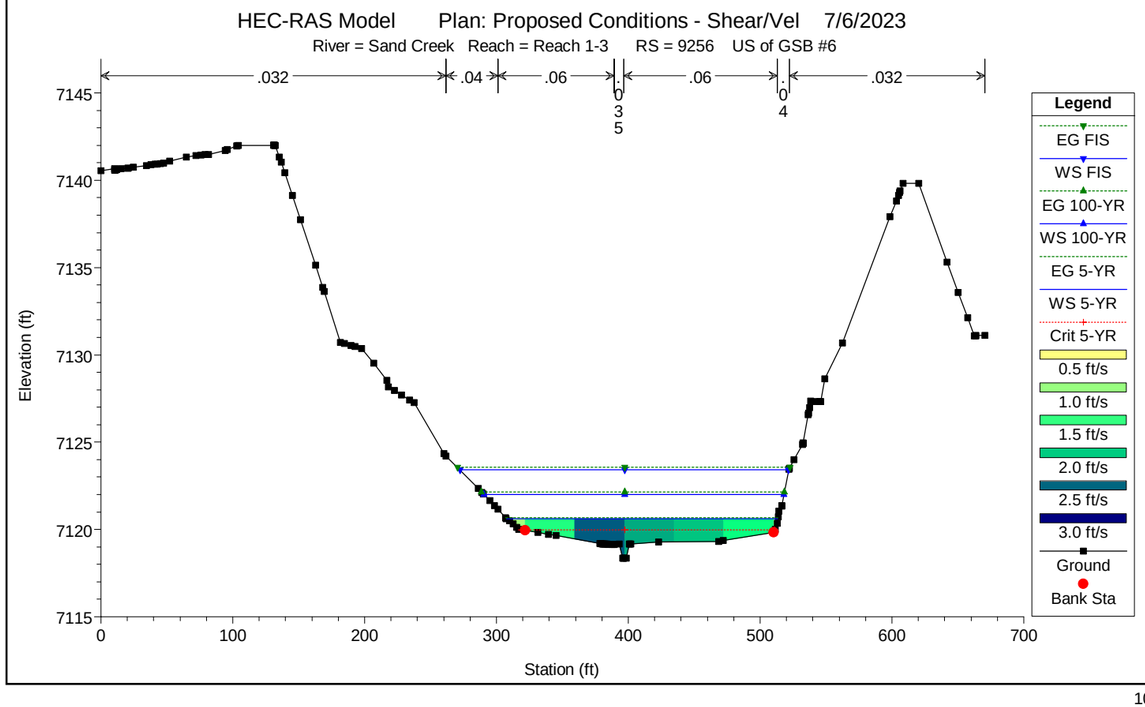


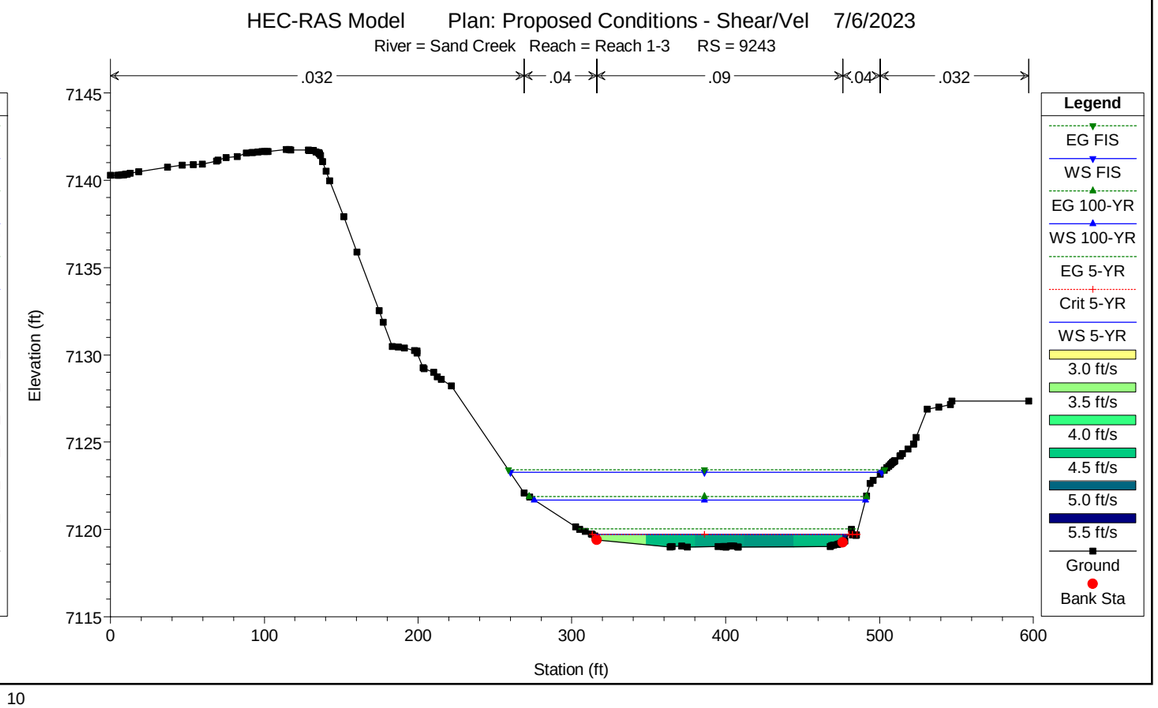


Sub-critical flow analysis for
Shear/Velocity evaluation of
Naturalized Channel Design





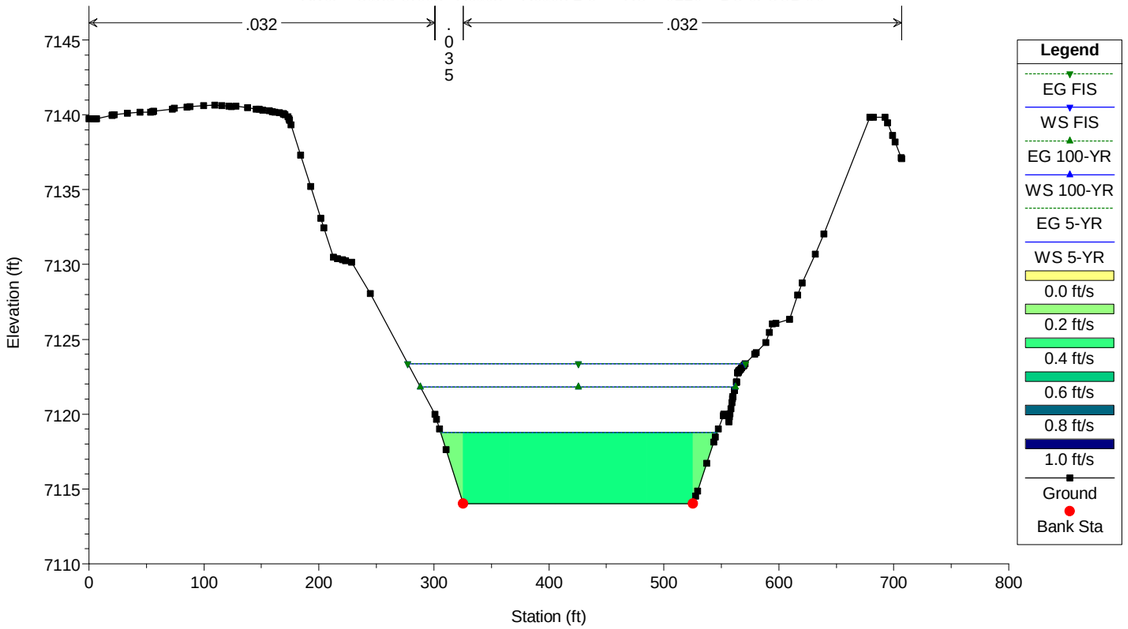




Sub-critical flow analysis for Shear/Velocity evaluation of Naturalized Channel Design

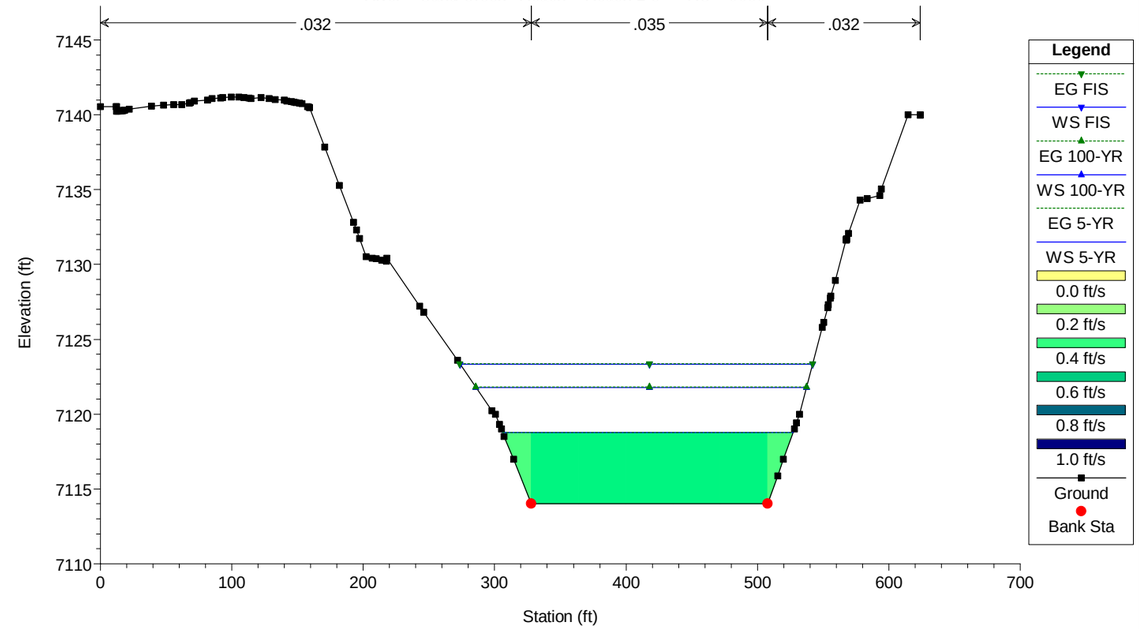
HEC-RAS Model Plan: Proposed Conditions - Shear/Vel 7/6/2023

River = Sand Creek Reach = Reach 1-3 RS = 9216 DS of GSB #6



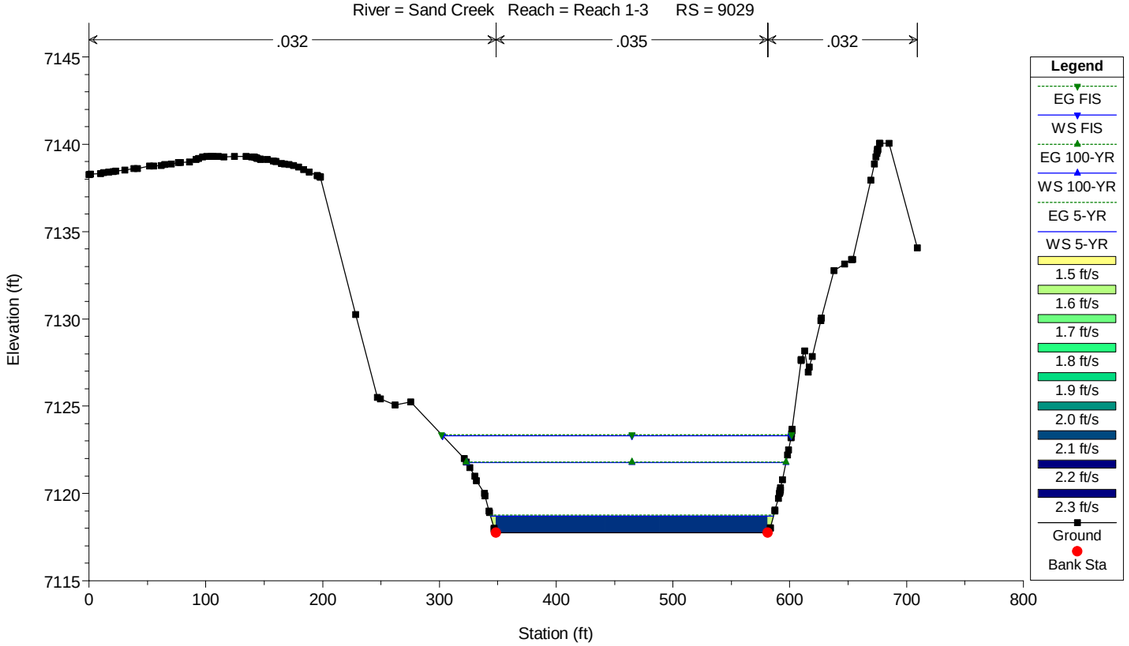
HEC-RAS Model Plan: Proposed Conditions - Shear/Vel 7/6/2023

River = Sand Creek Reach = Reach 1-3 RS = 9080



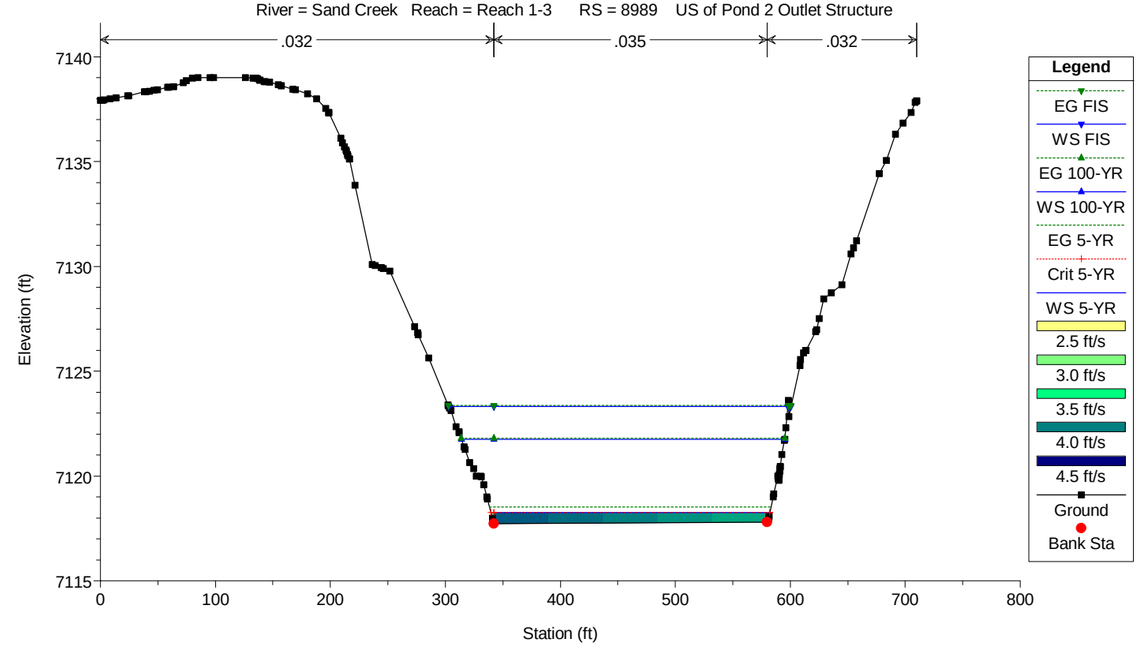
HEC-RAS Model Plan: Proposed Conditions - Shear/Vel 7/6/2023

River = Sand Creek Reach = Reach 1-3 RS = 9029

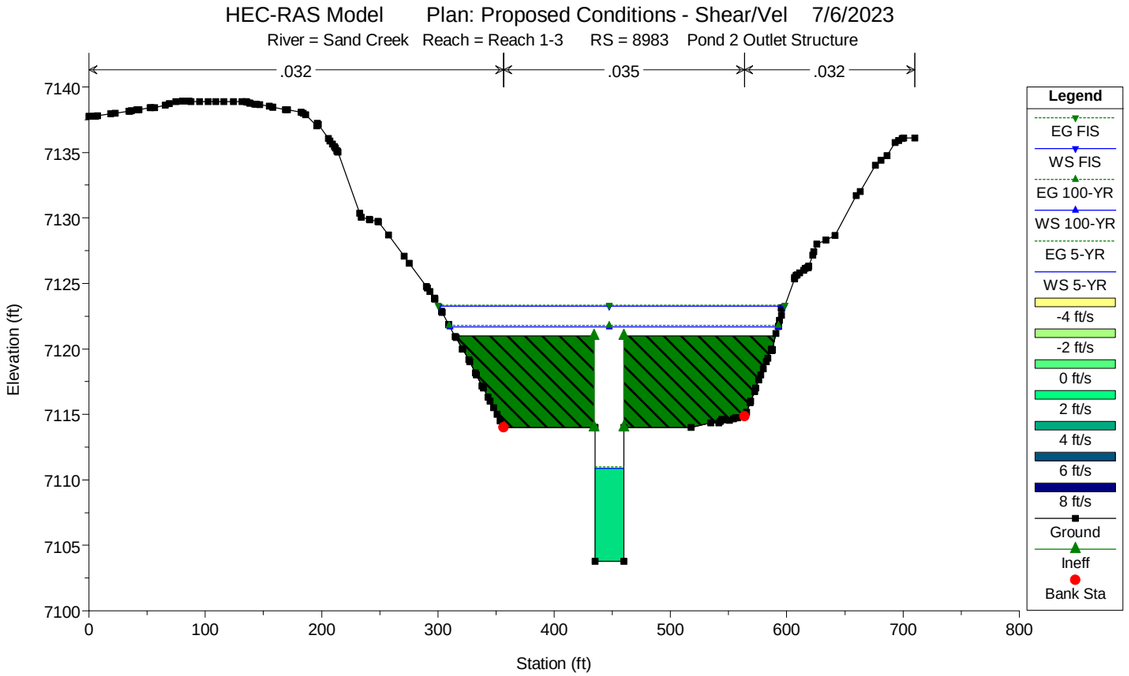


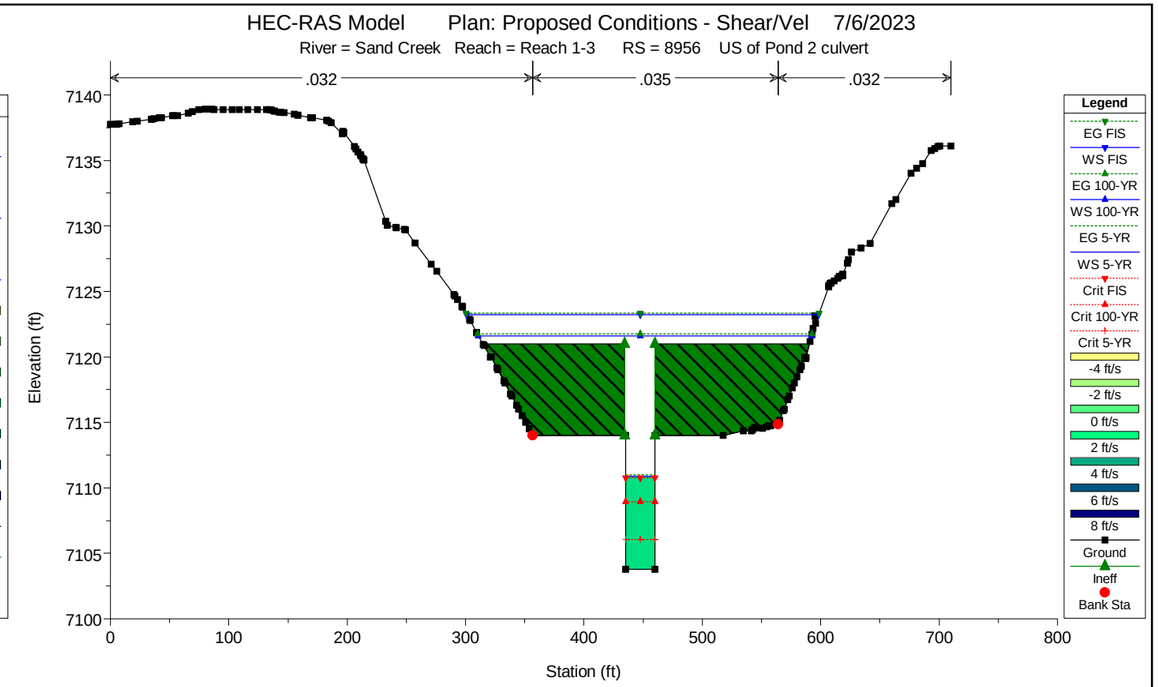
HEC-RAS Model Plan: Proposed Conditions - Shear/Vel 7/6/2023

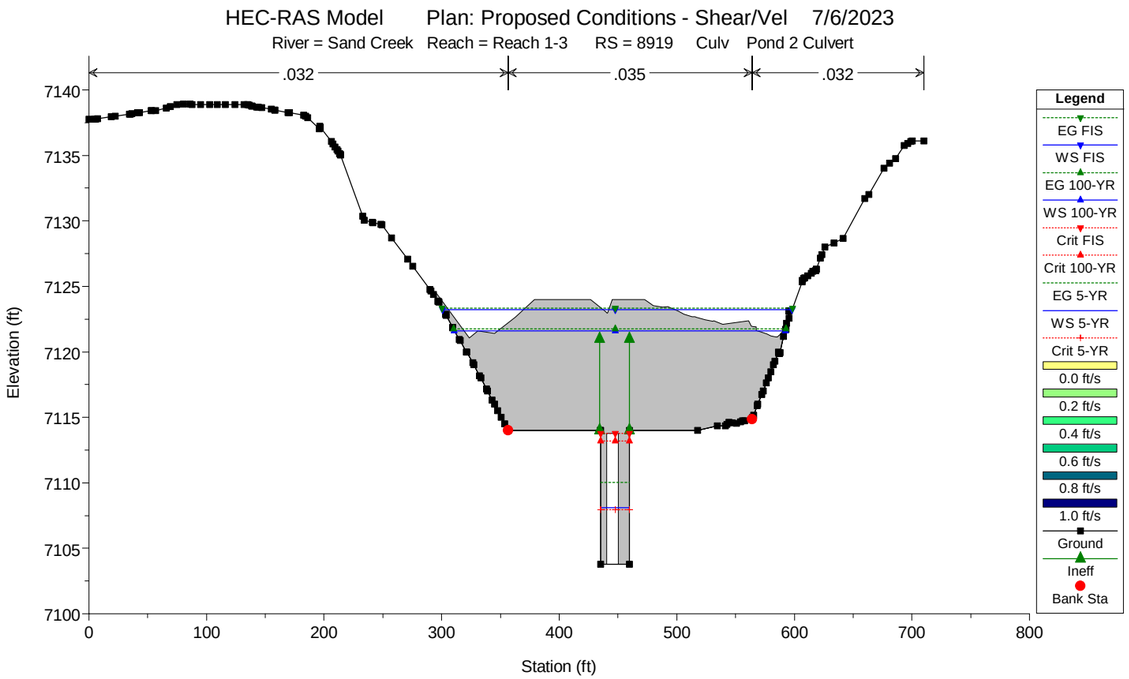
River = Sand Creek Reach = Reach 1-3 RS = 8989 US of Pond 2 Outlet Structure

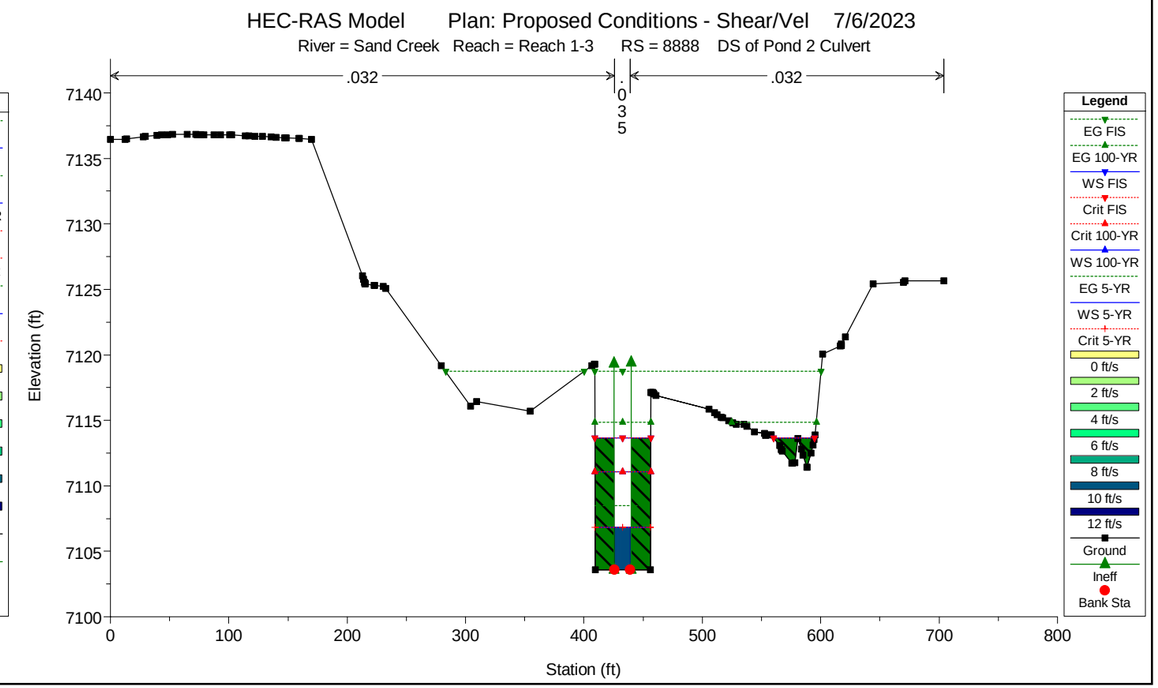


Sub-critical flow analysis for
Shear/Velocity evaluation of
Naturalized Channel Design





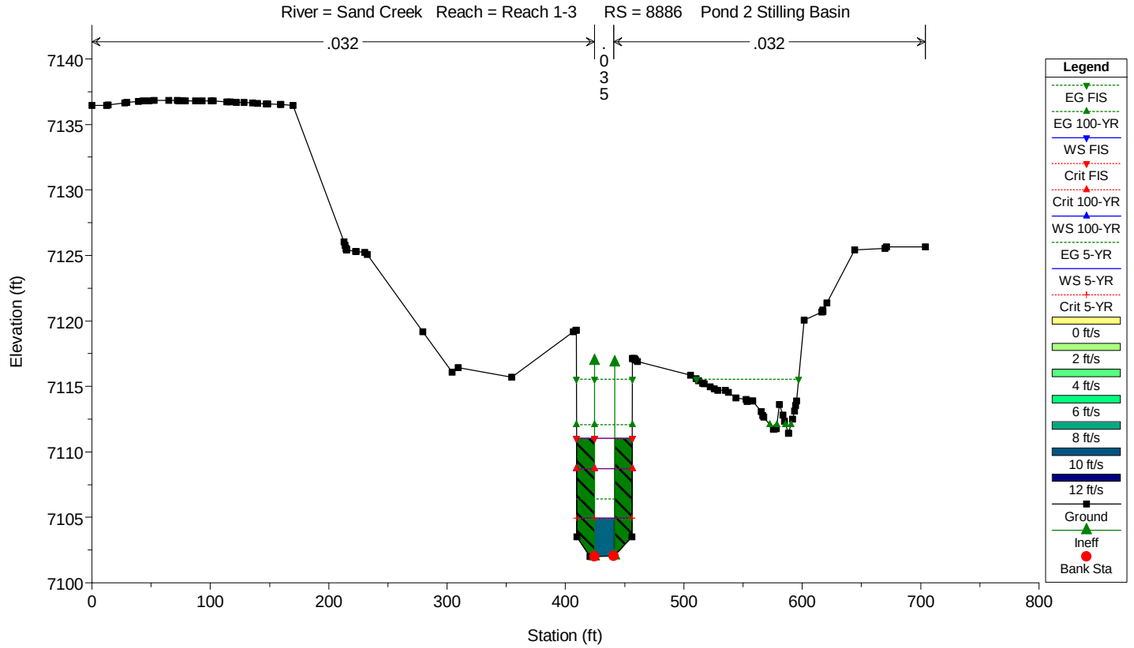




Sub-critical flow analysis for
Shear/Velocity evaluation of
Naturalized Channel Design

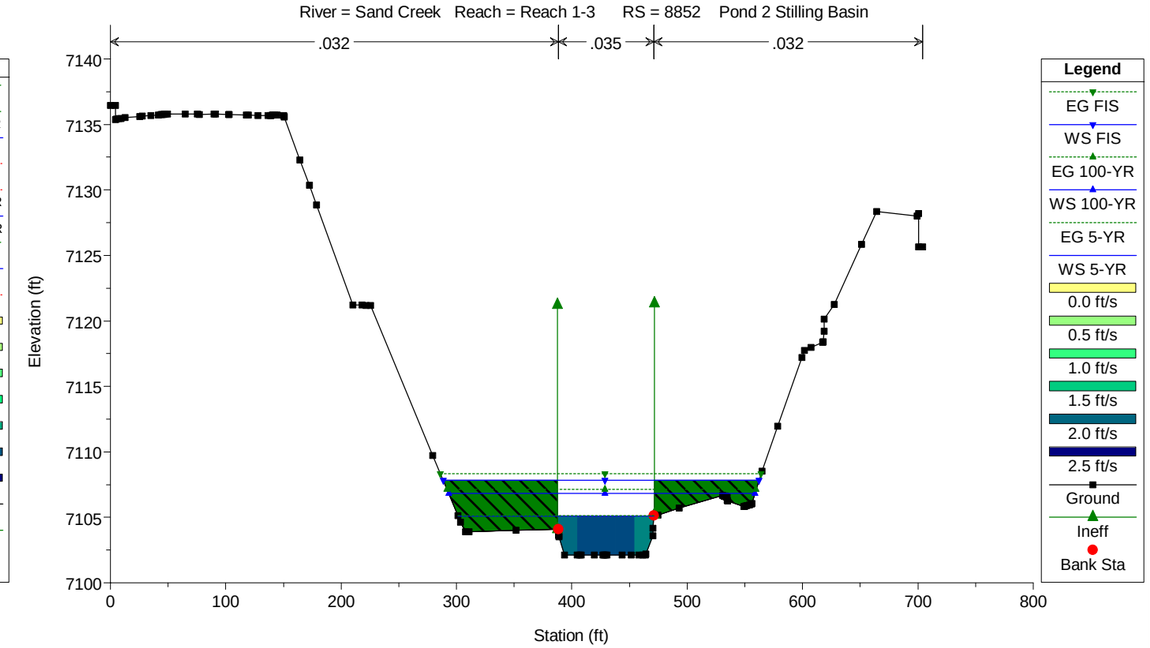
HEC-RAS Model Plan: Proposed Conditions - Shear/Vel 7/6/2023

River = Sand Creek Reach = Reach 1-3 RS = 8886 Pond 2 Stilling Basin



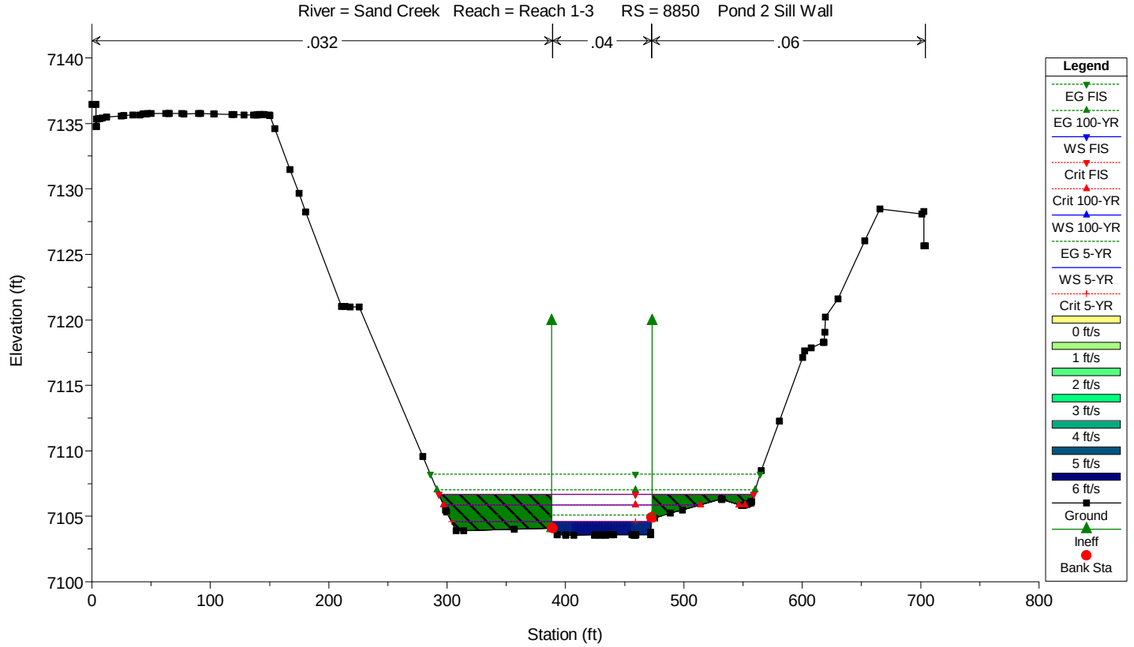
HEC-RAS Model Plan: Proposed Conditions - Shear/Vel 7/6/2023

River = Sand Creek Reach = Reach 1-3 RS = 8852 Pond 2 Stilling Basin



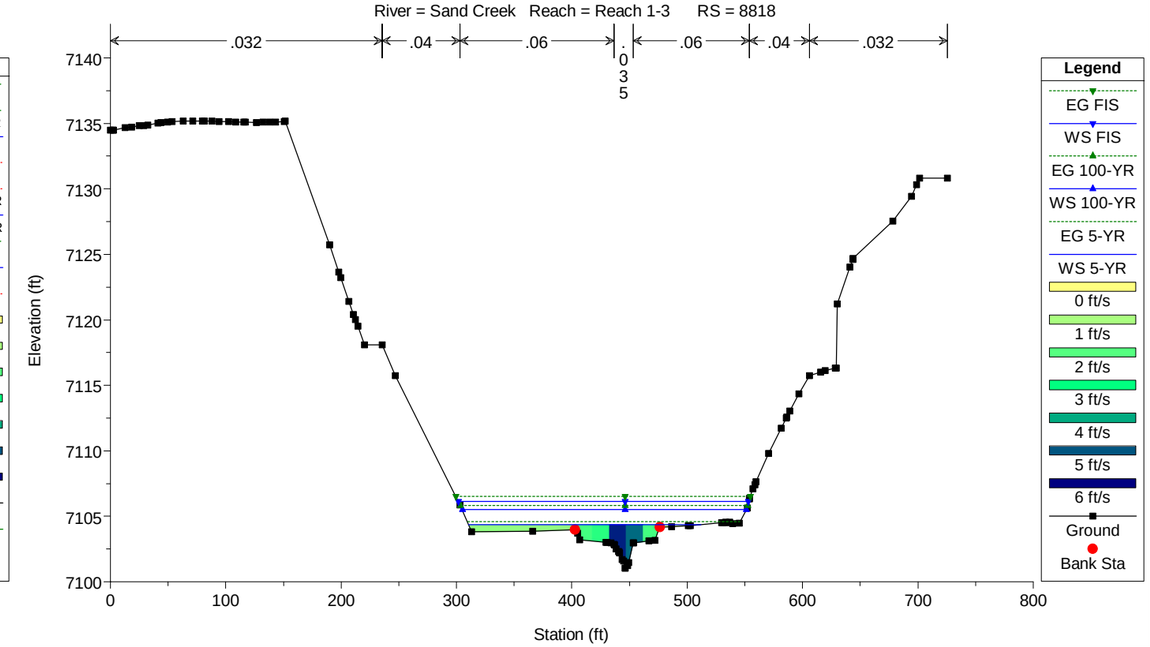
HEC-RAS Model Plan: Proposed Conditions - Shear/Vel 7/6/2023

River = Sand Creek Reach = Reach 1-3 RS = 8850 Pond 2 Sill Wall

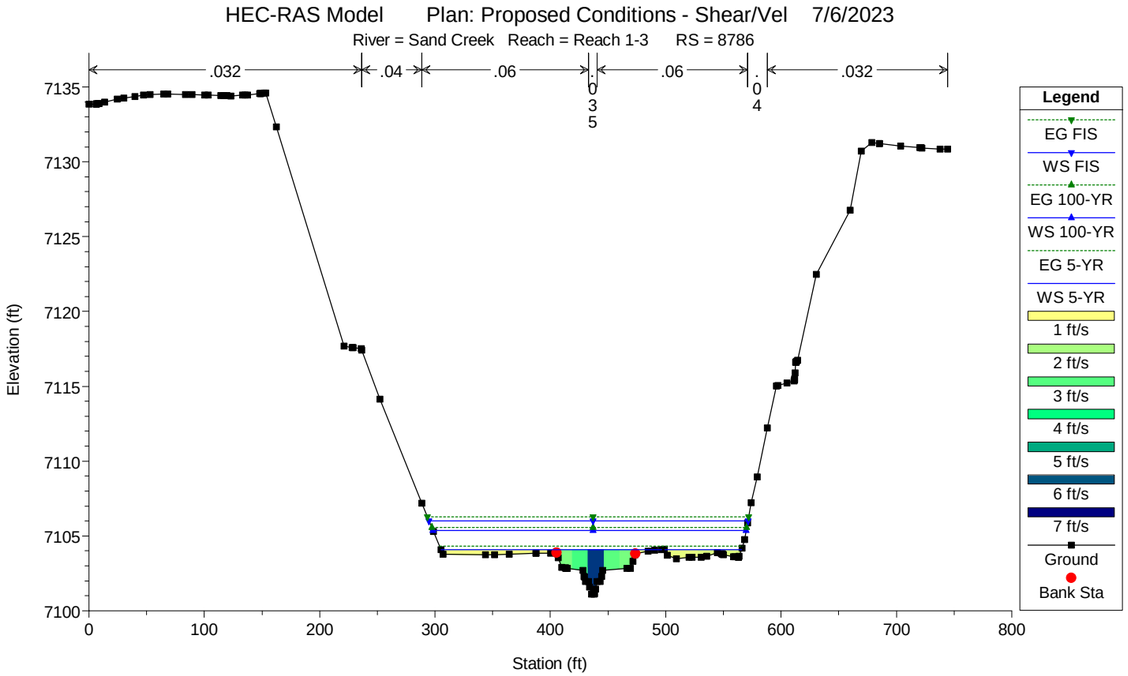


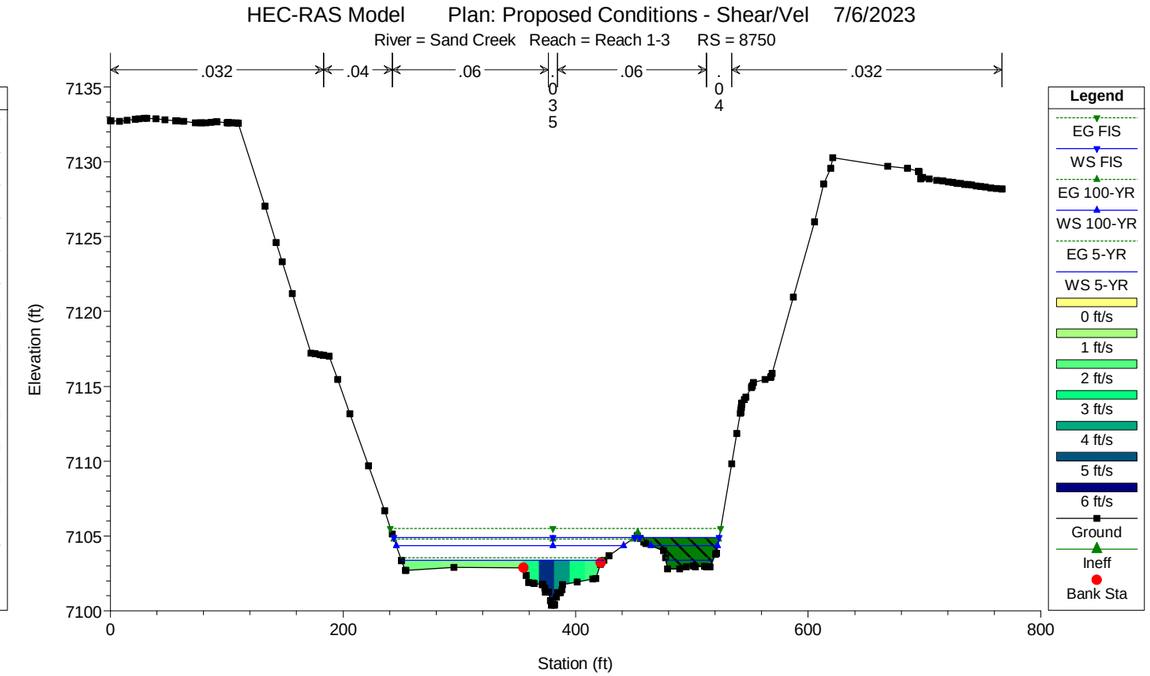
HEC-RAS Model Plan: Proposed Conditions - Shear/Vel 7/6/2023

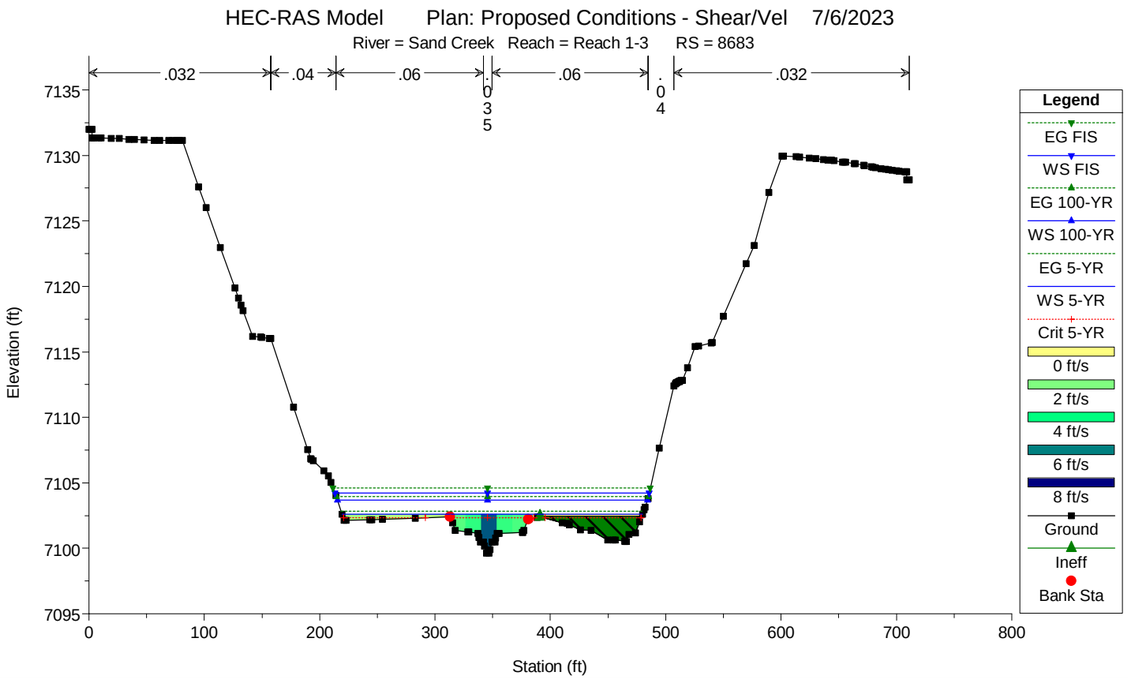
River = Sand Creek Reach = Reach 1-3 RS = 8818

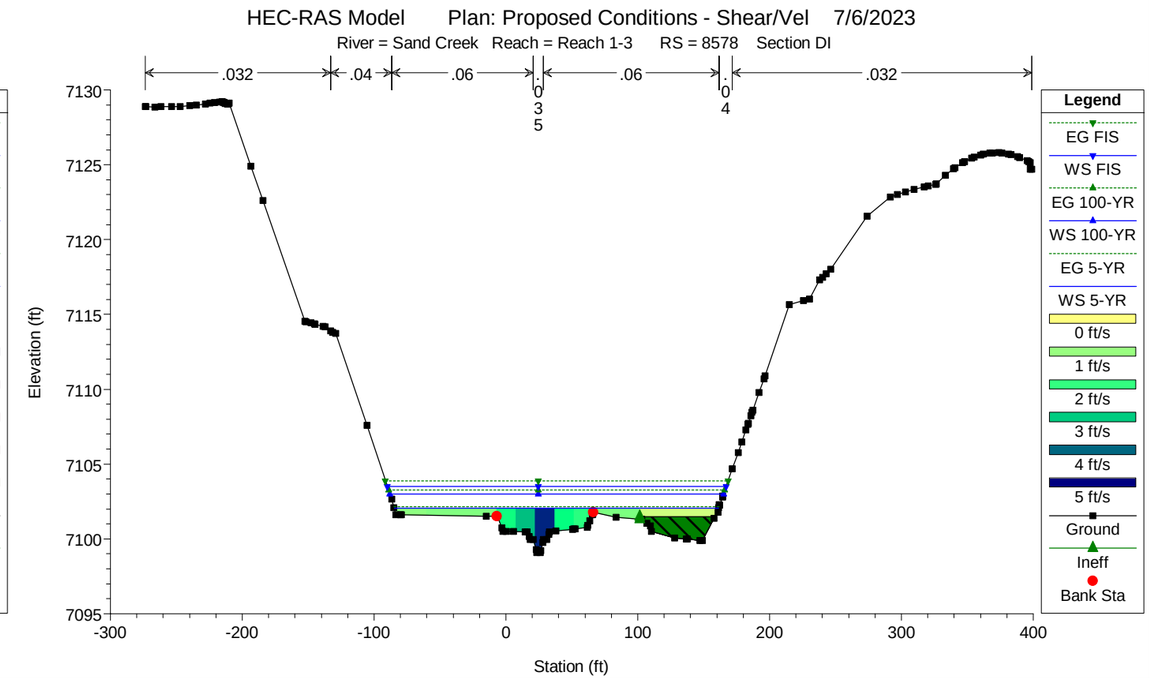


Sub-critical flow analysis for
Shear/Velocity evaluation of
Naturalized Channel Design

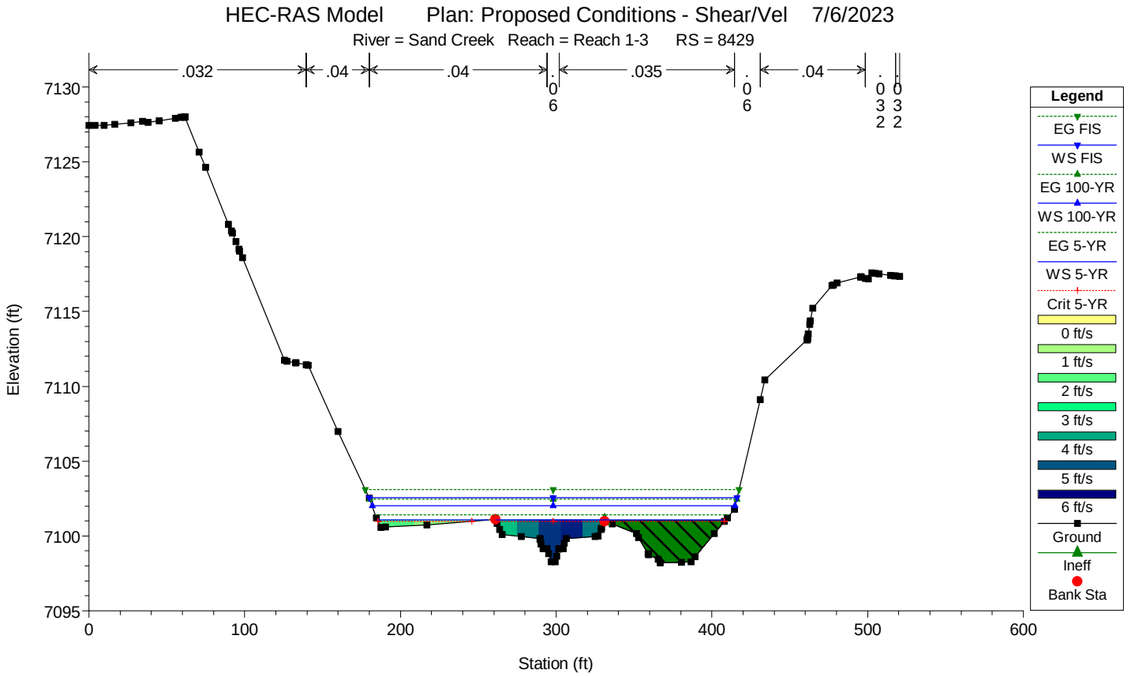


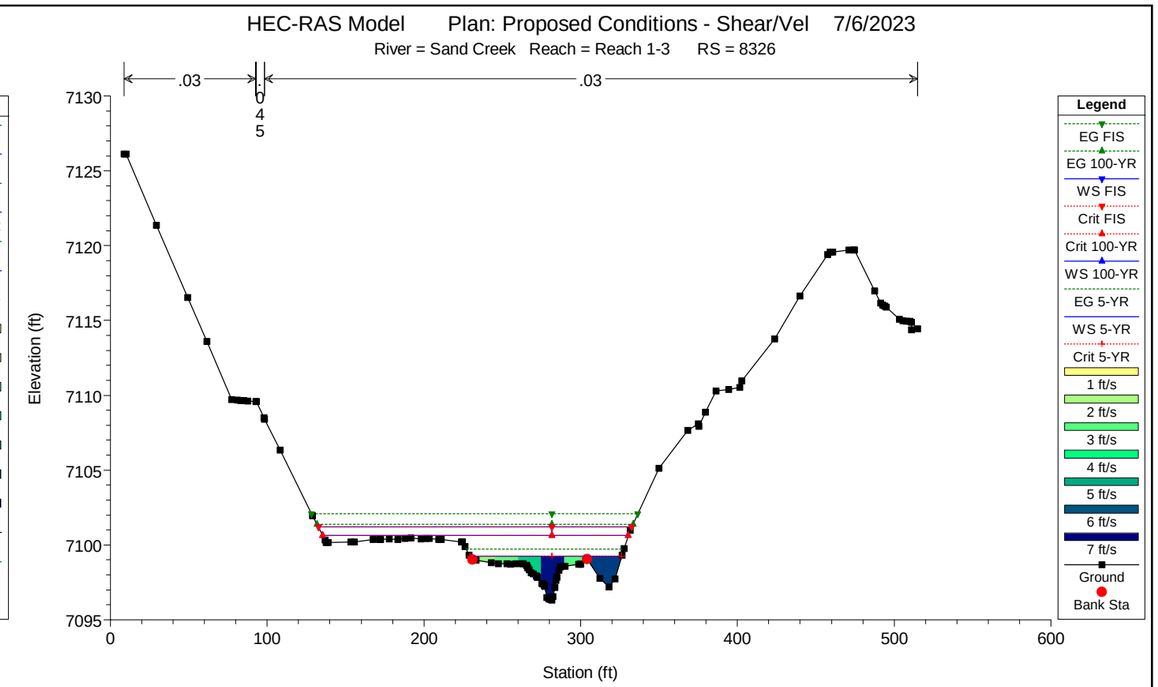


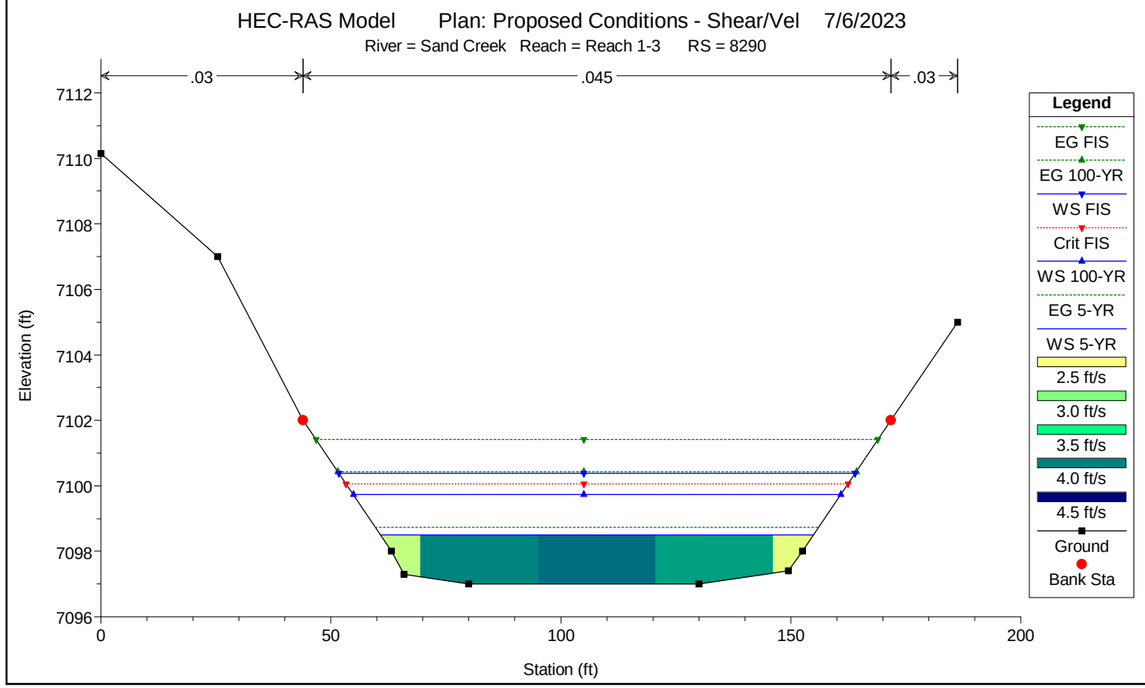


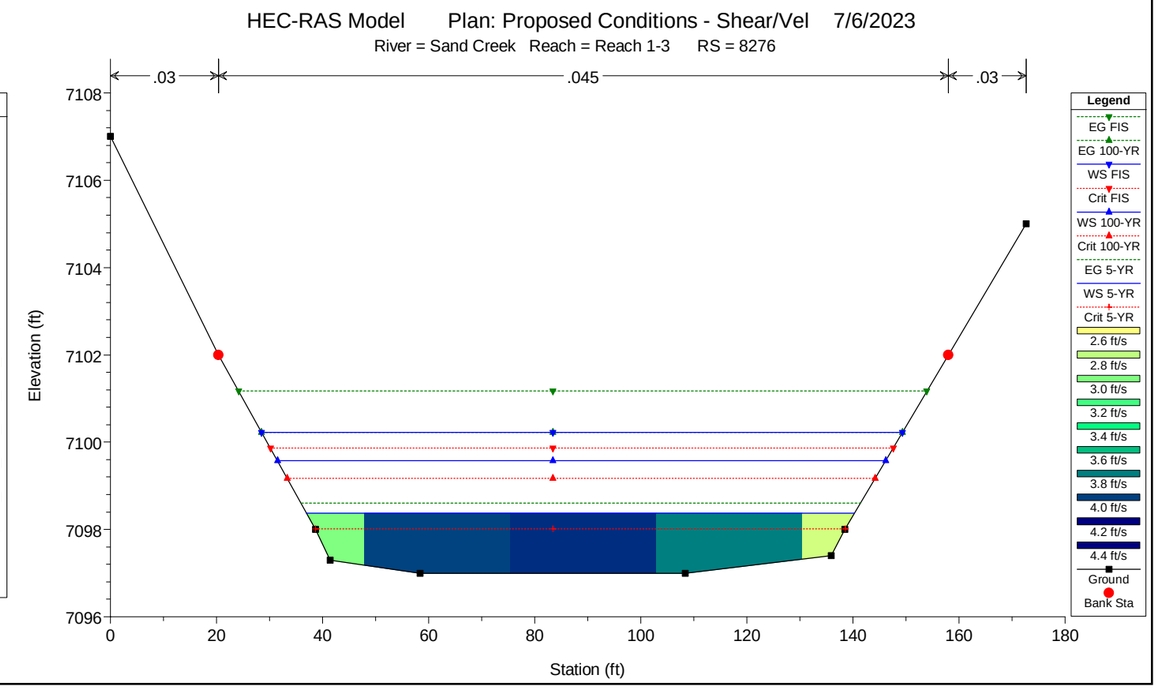


Sub-critical flow analysis for
Shear/Velocity evaluation of
Naturalized Channel Design



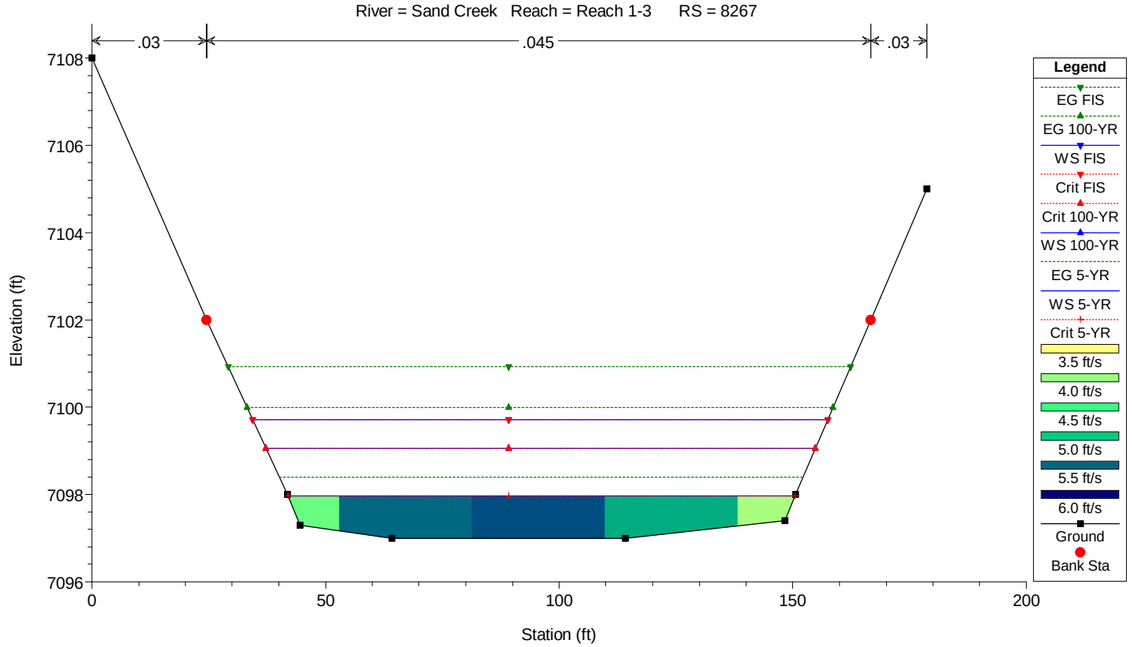




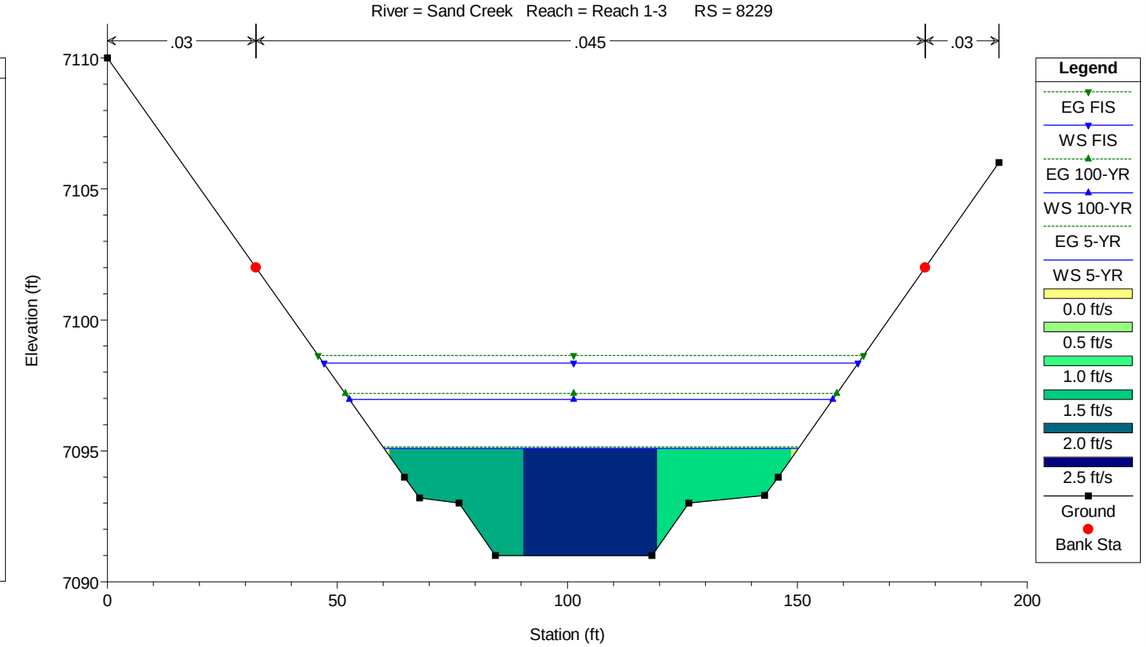


Sub-critical flow analysis for
Shear/Velocity evaluation of
Naturalized Channel Design

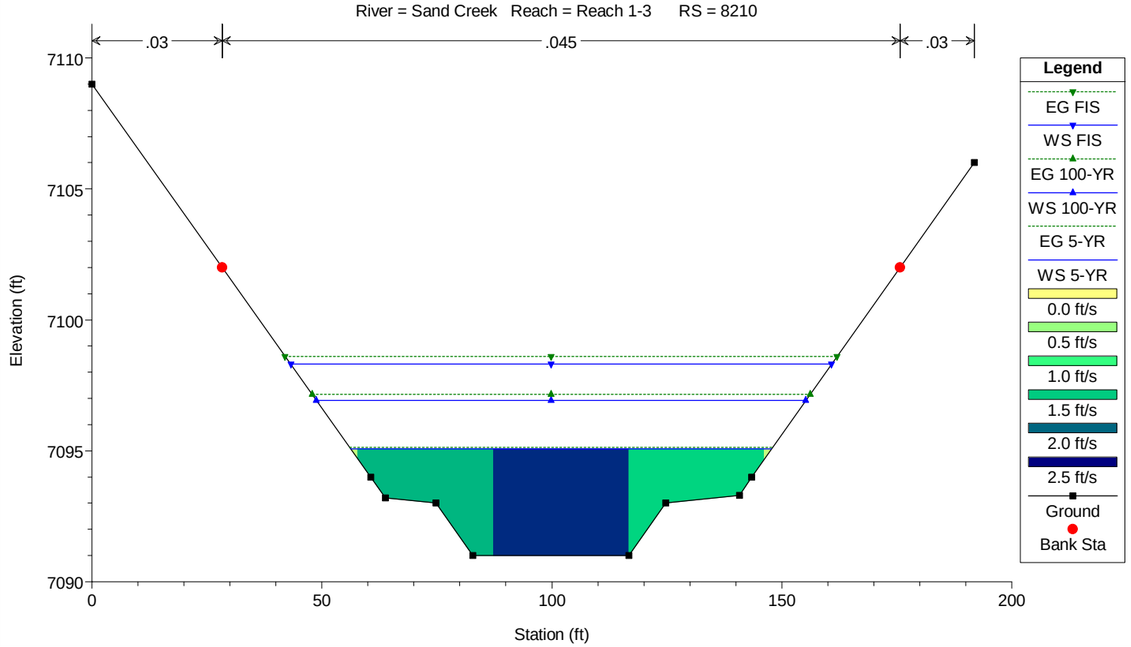
HEC-RAS Model Plan: Proposed Conditions - Shear/Vel 7/6/2023
River = Sand Creek Reach = Reach 1-3 RS = 8267



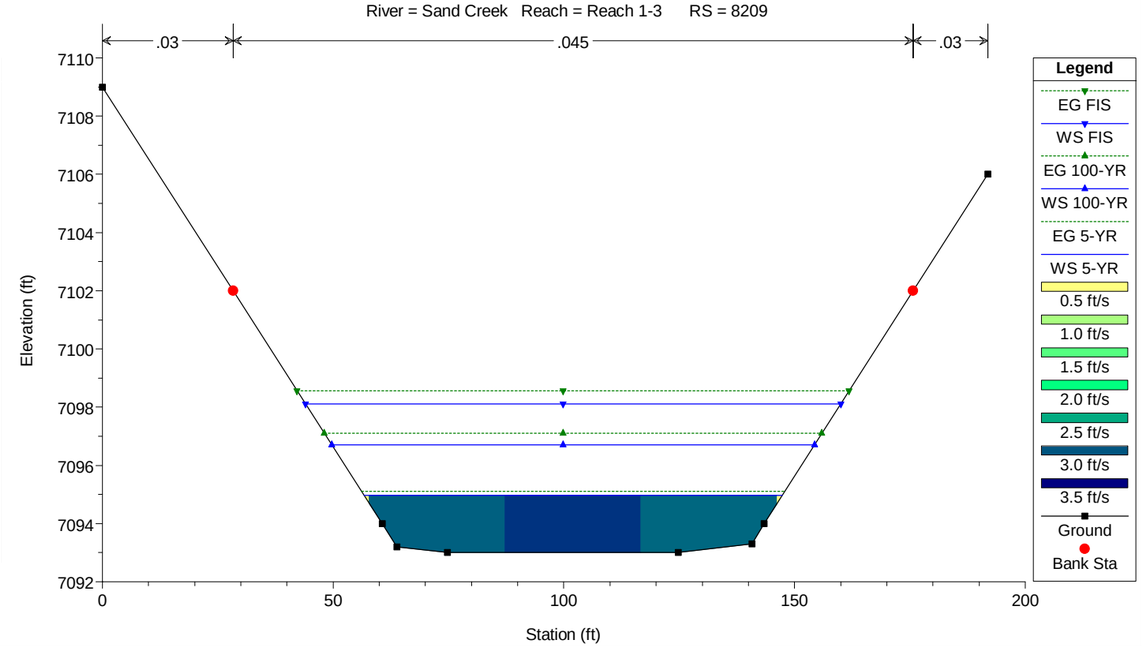
HEC-RAS Model Plan: Proposed Conditions - Shear/Vel 7/6/2023
River = Sand Creek Reach = Reach 1-3 RS = 8229



HEC-RAS Model Plan: Proposed Conditions - Shear/Vel 7/6/2023
River = Sand Creek Reach = Reach 1-3 RS = 8210

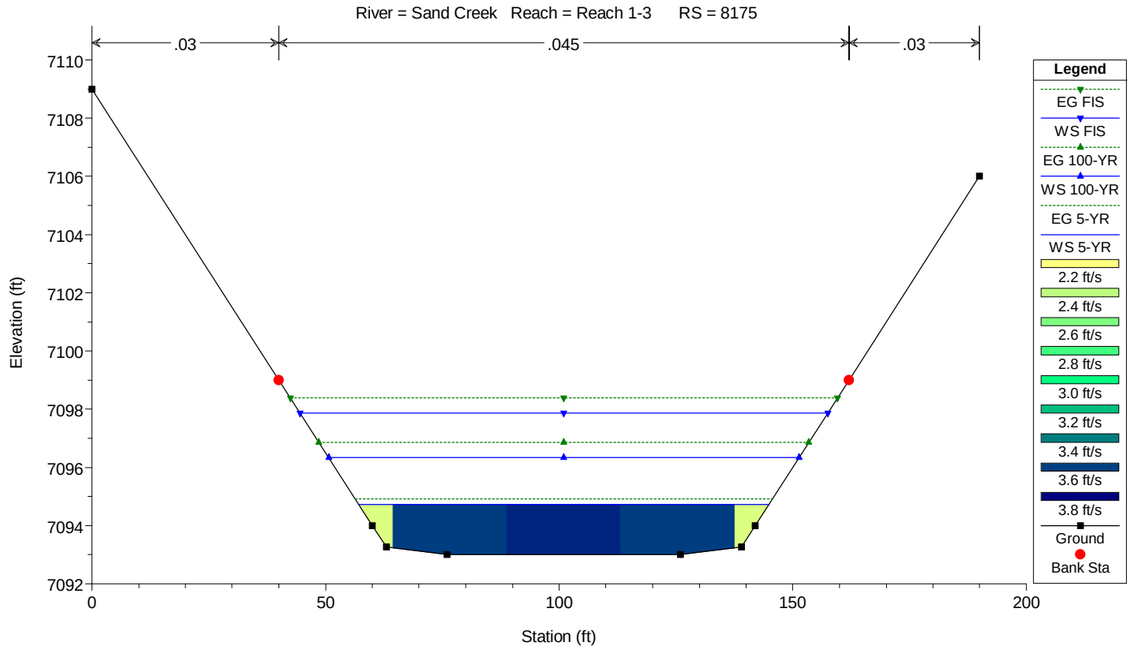


HEC-RAS Model Plan: Proposed Conditions - Shear/Vel 7/6/2023
River = Sand Creek Reach = Reach 1-3 RS = 8209

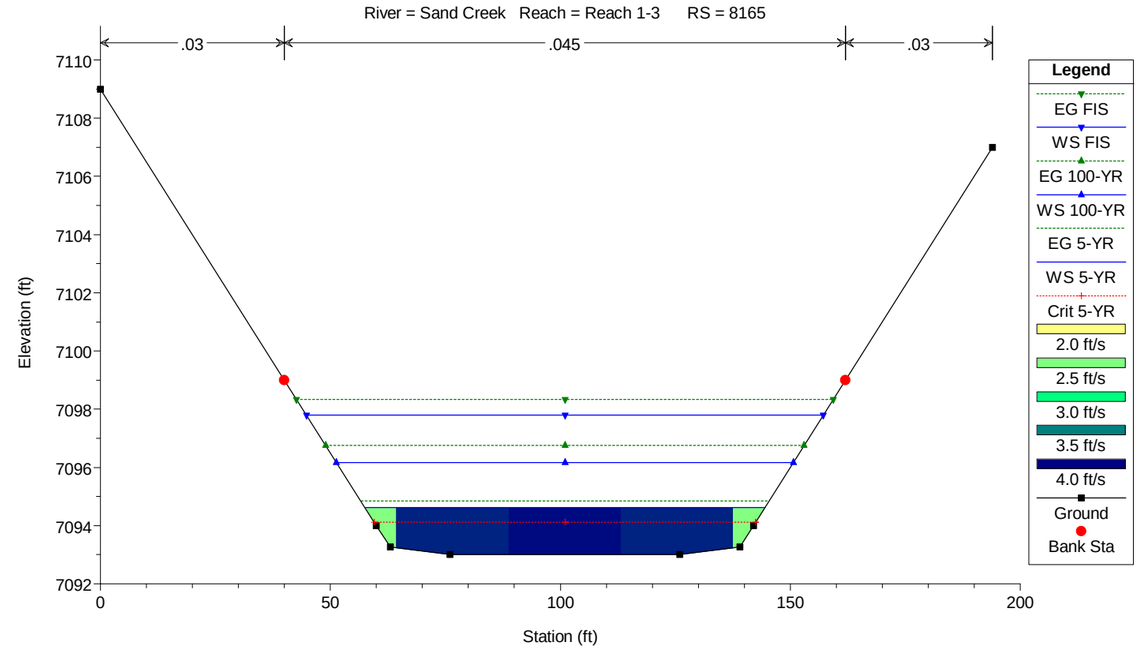


Sub-critical flow analysis for
Shear/Velocity evaluation of
Naturalized Channel Design

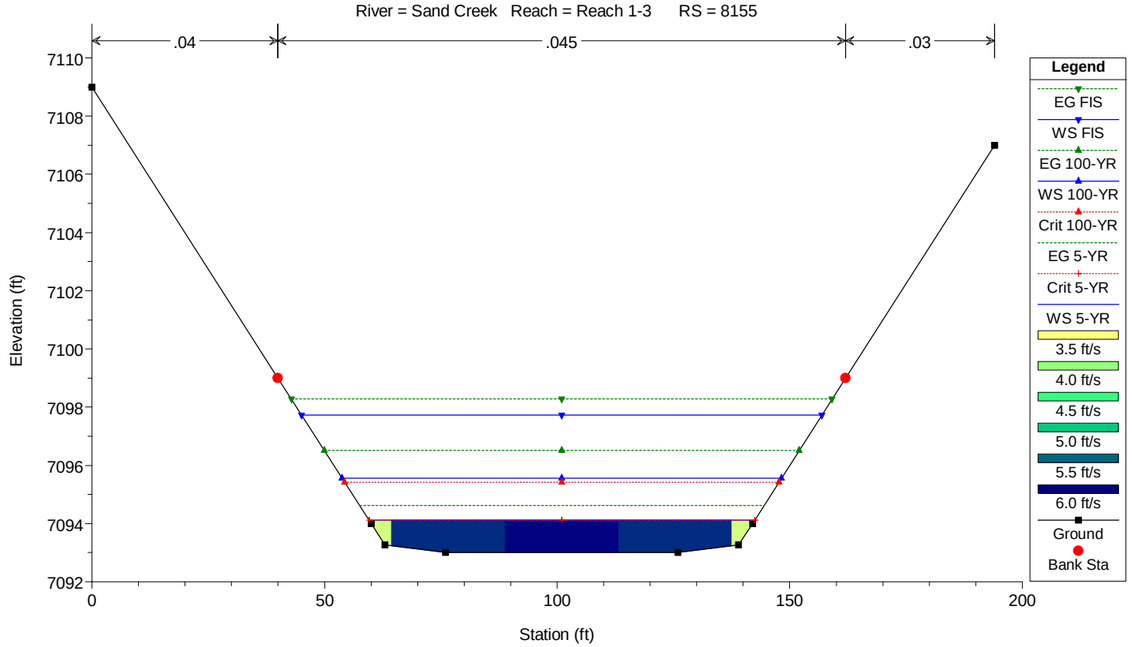
HEC-RAS Model Plan: Proposed Conditions - Shear/Vel 7/6/2023
River = Sand Creek Reach = Reach 1-3 RS = 8175



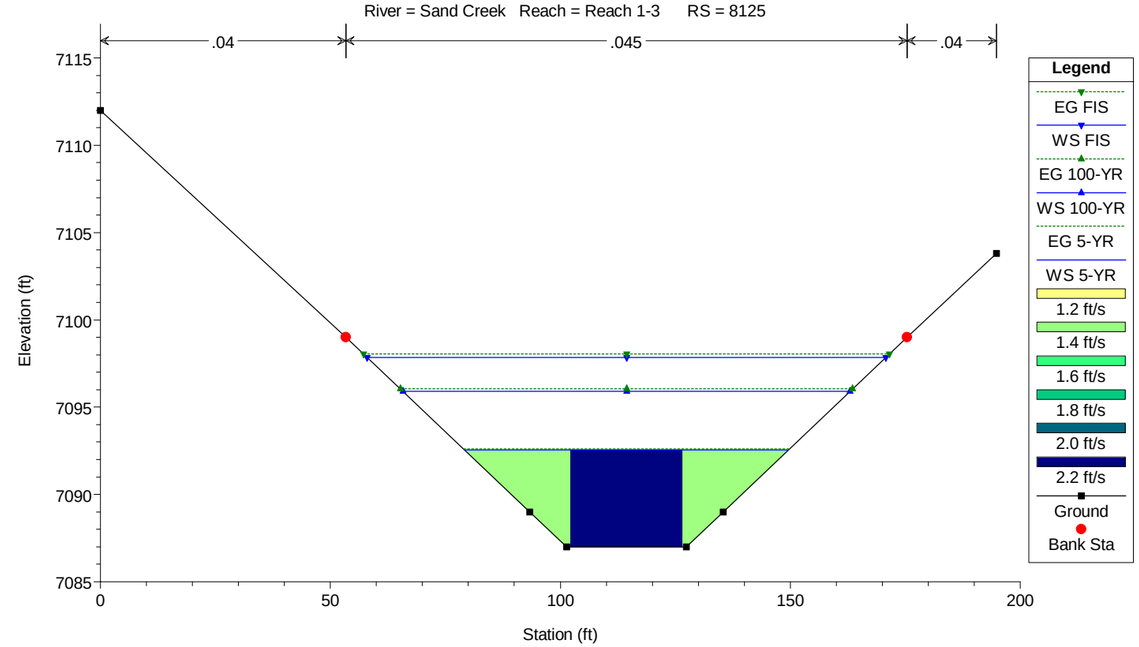
HEC-RAS Model Plan: Proposed Conditions - Shear/Vel 7/6/2023
River = Sand Creek Reach = Reach 1-3 RS = 8165



HEC-RAS Model Plan: Proposed Conditions - Shear/Vel 7/6/2023
River = Sand Creek Reach = Reach 1-3 RS = 8155



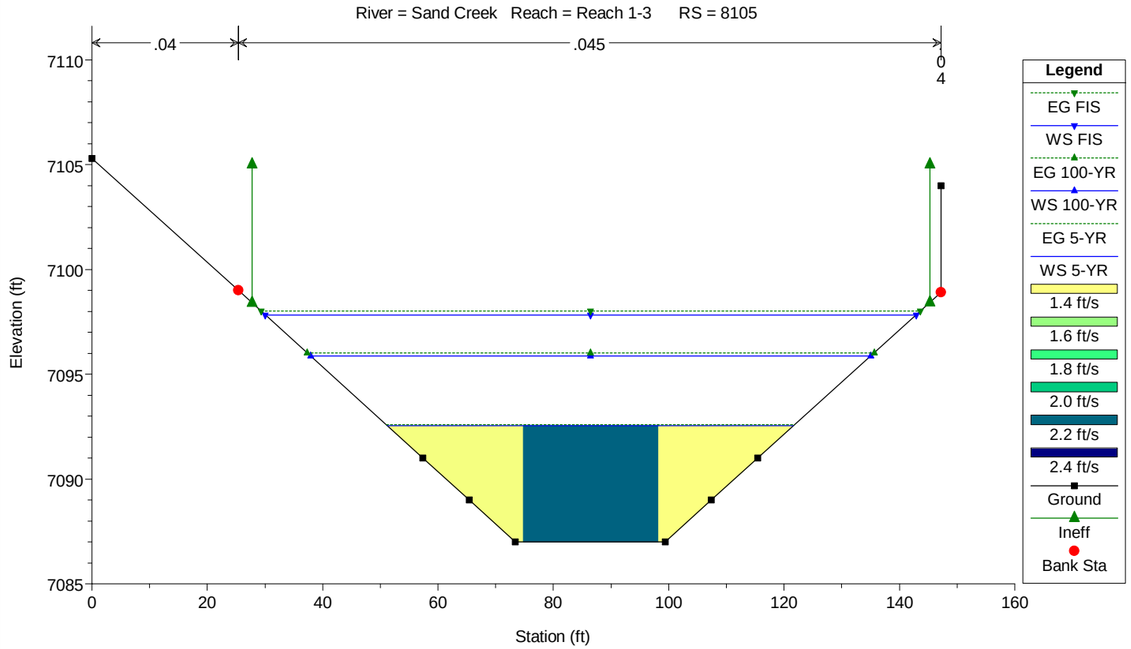
HEC-RAS Model Plan: Proposed Conditions - Shear/Vel 7/6/2023
River = Sand Creek Reach = Reach 1-3 RS = 8125



Sub-critical flow analysis for Shear/Velocity evaluation of Naturalized Channel Design

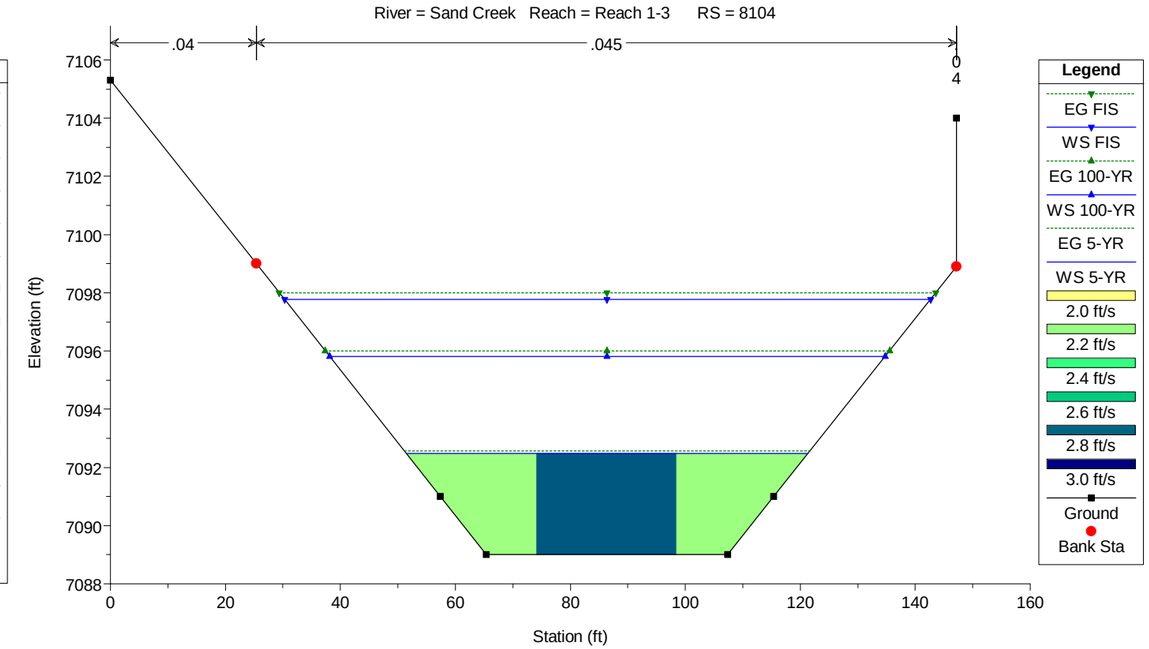
HEC-RAS Model Plan: Proposed Conditions - Shear/Vel 7/6/2023

River = Sand Creek Reach = Reach 1-3 RS = 8105



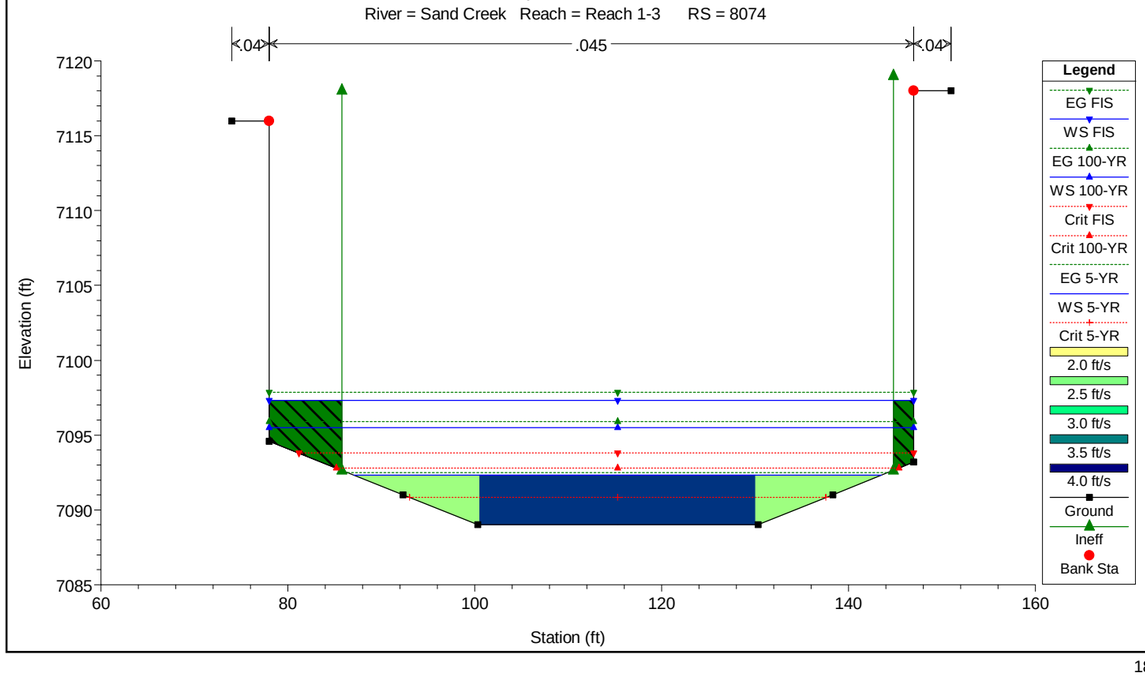
HEC-RAS Model Plan: Proposed Conditions - Shear/Vel 7/6/2023

River = Sand Creek Reach = Reach 1-3 RS = 8104



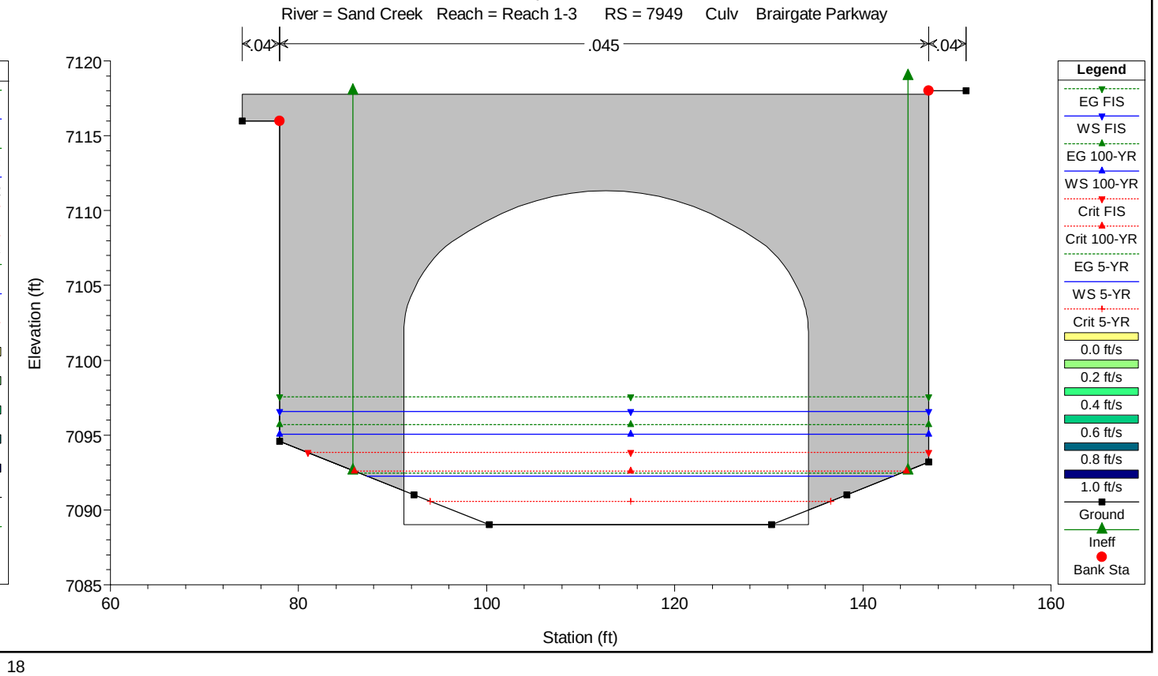
HEC-RAS Model Plan: Proposed Conditions - Shear/Vel 7/6/2023

River = Sand Creek Reach = Reach 1-3 RS = 8074

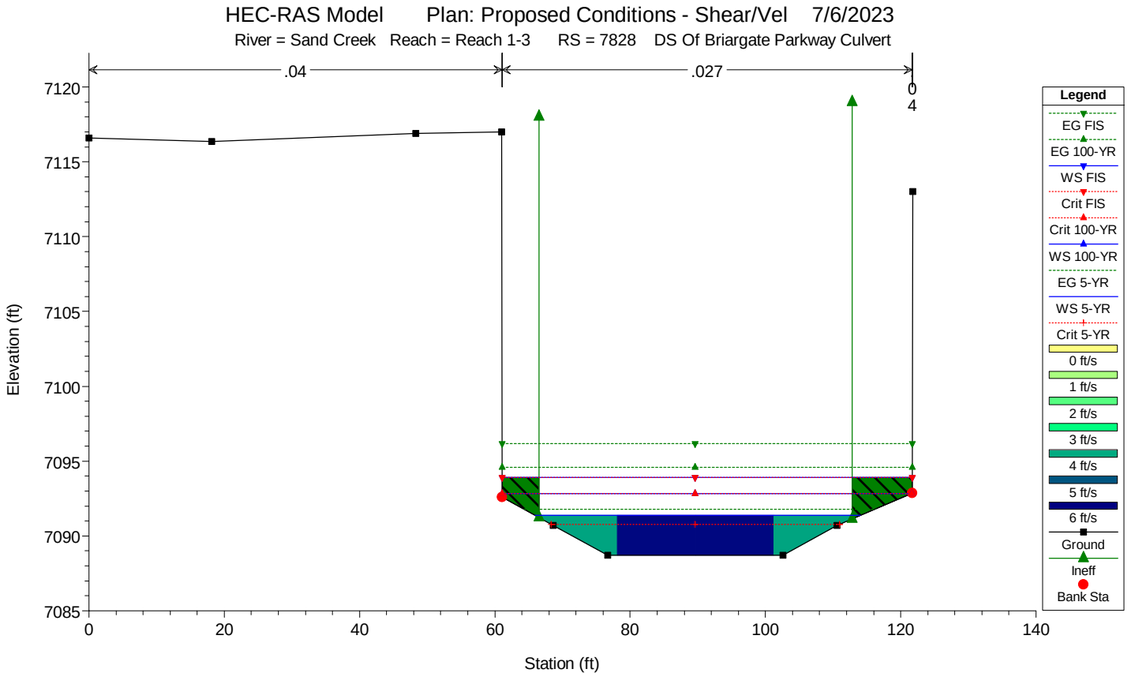


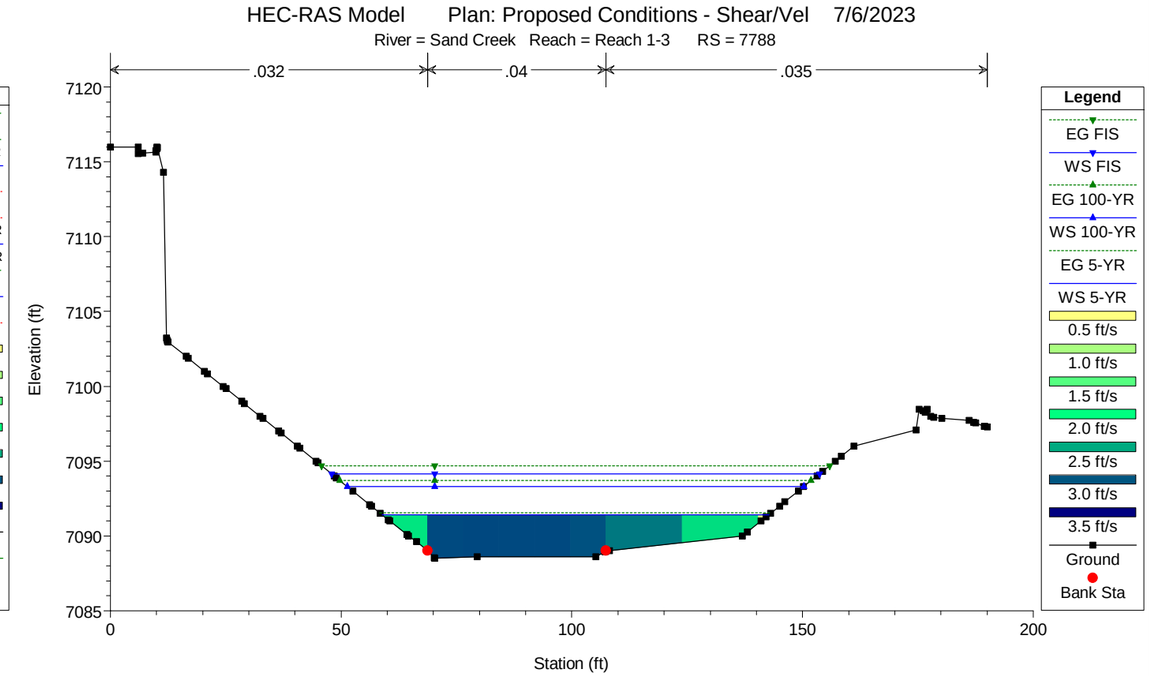
HEC-RAS Model Plan: Proposed Conditions - Shear/Vel 7/6/2023

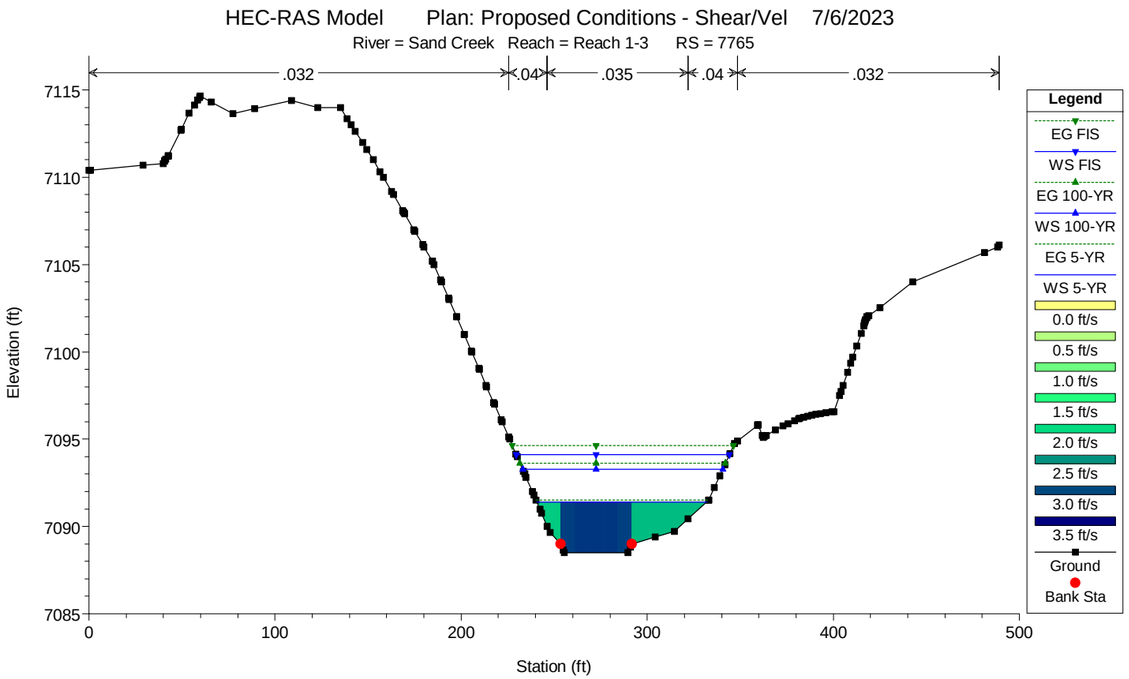
River = Sand Creek Reach = Reach 1-3 RS = 7949 Culv Brairgate Parkway

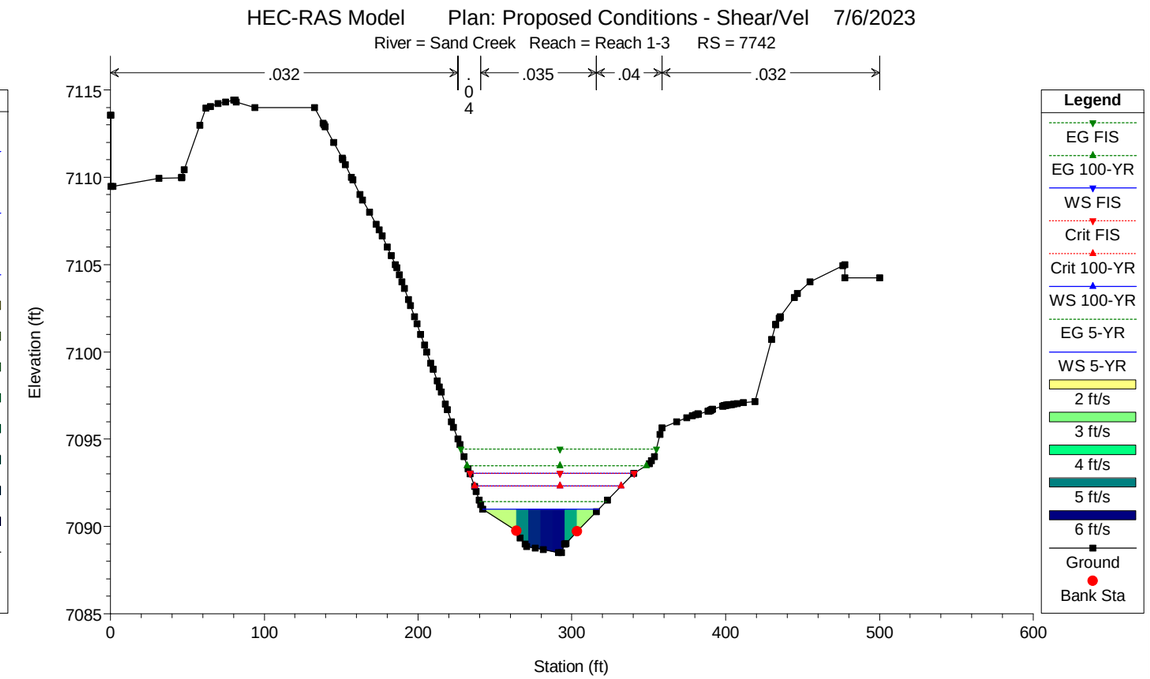


Sub-critical flow analysis for
Shear/Velocity evaluation of
Naturalized Channel Design

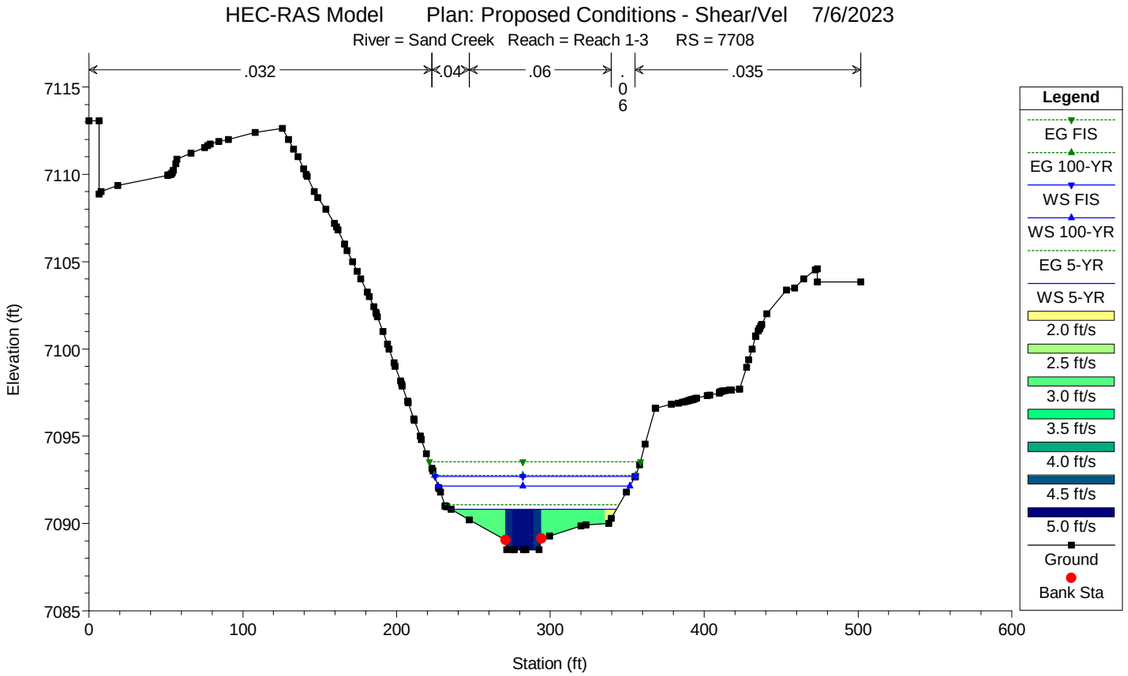


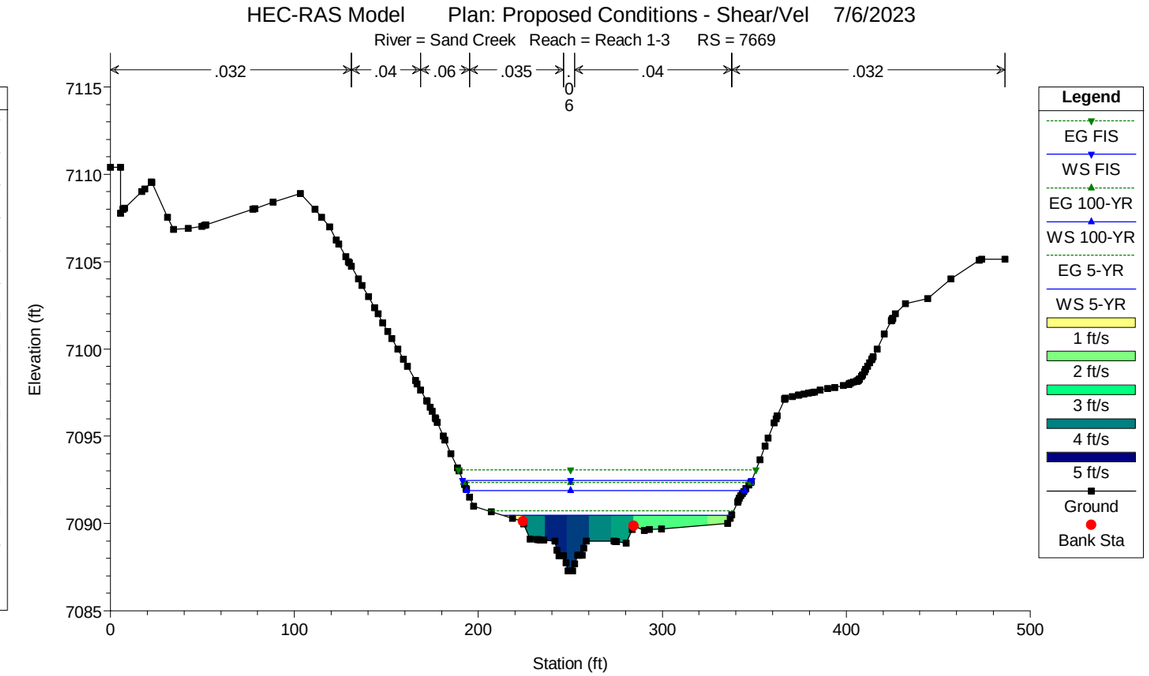


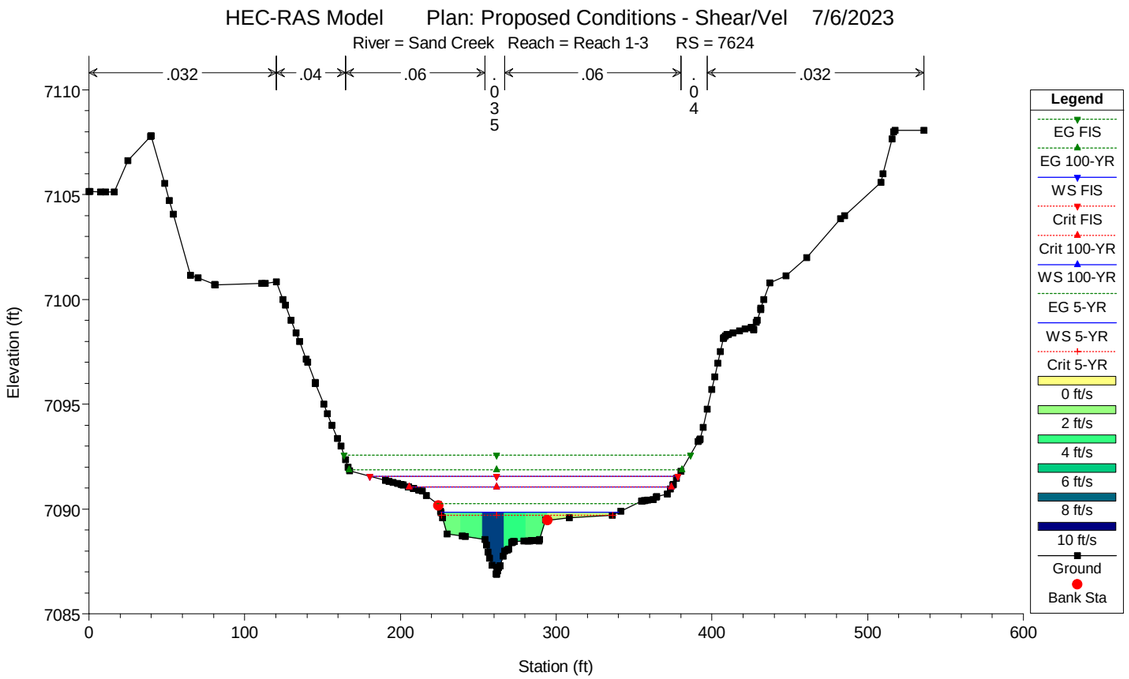


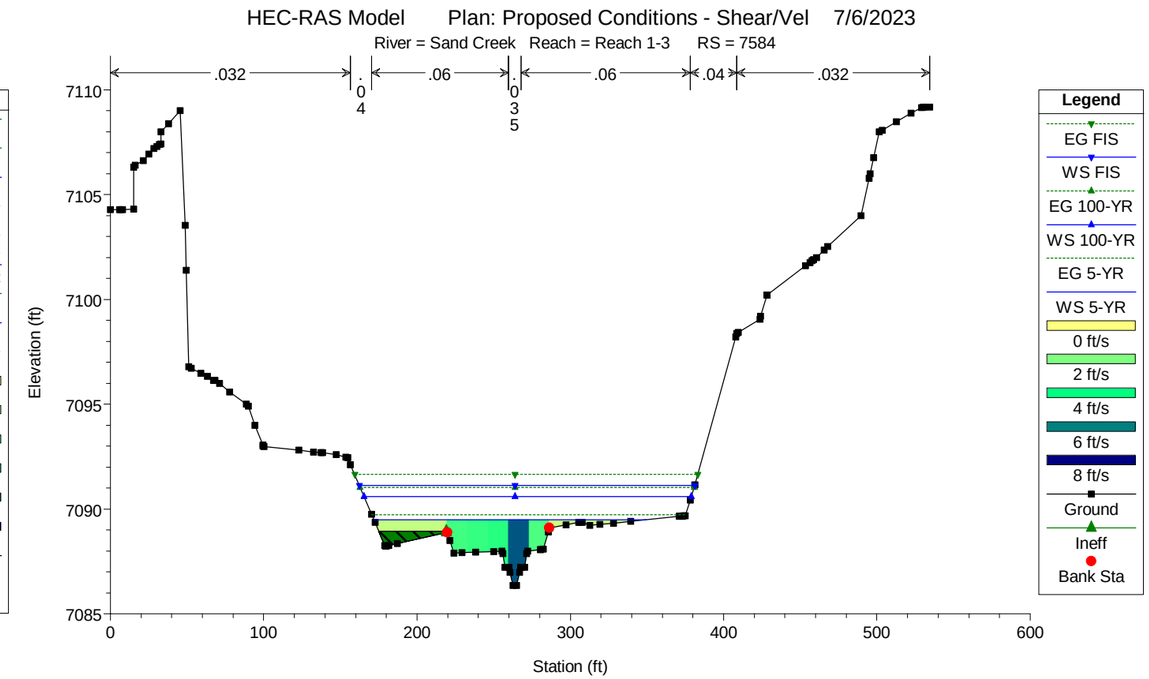


Sub-critical flow analysis for Shear/Velocity evaluation of Naturalized Channel Design

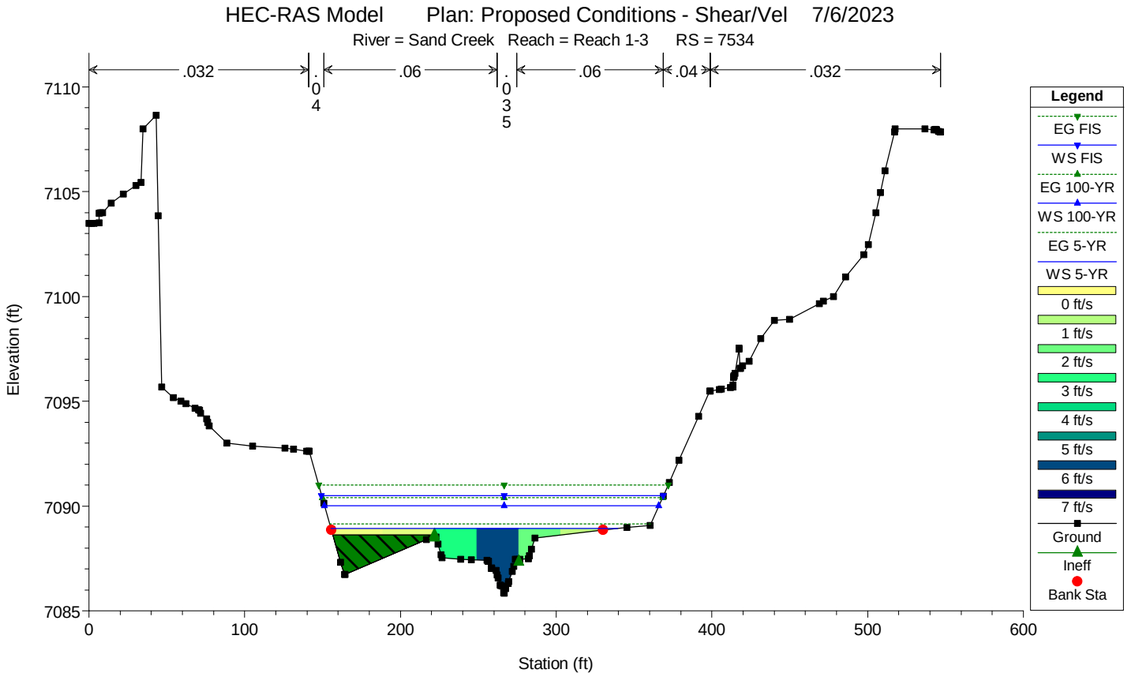


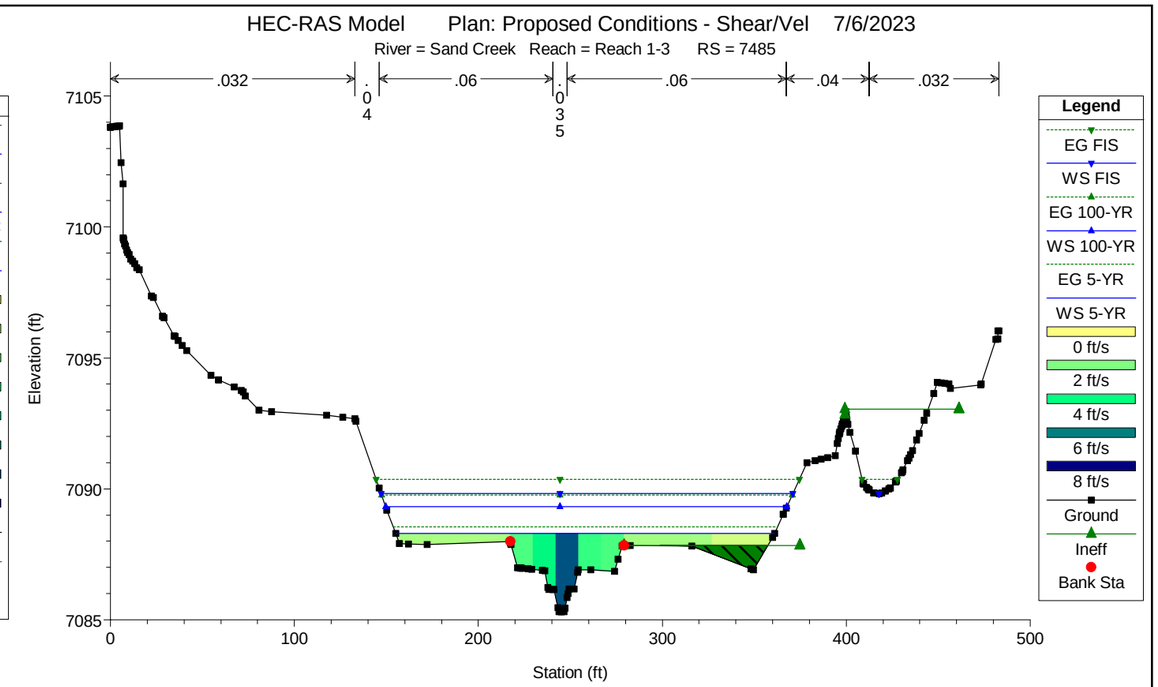


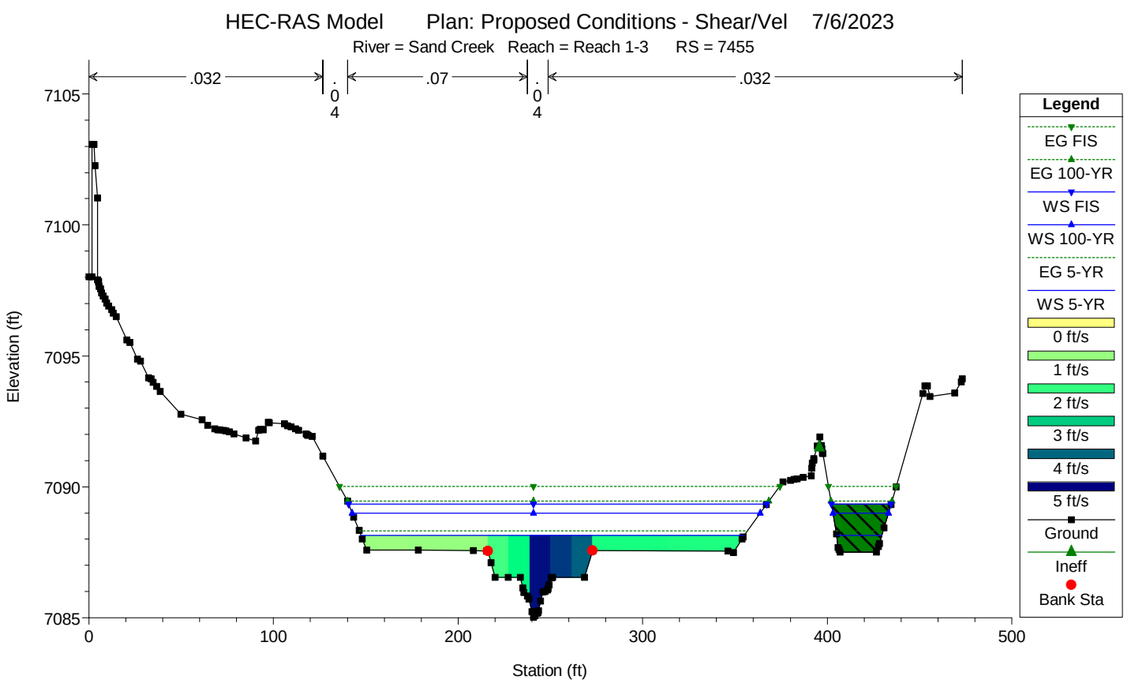


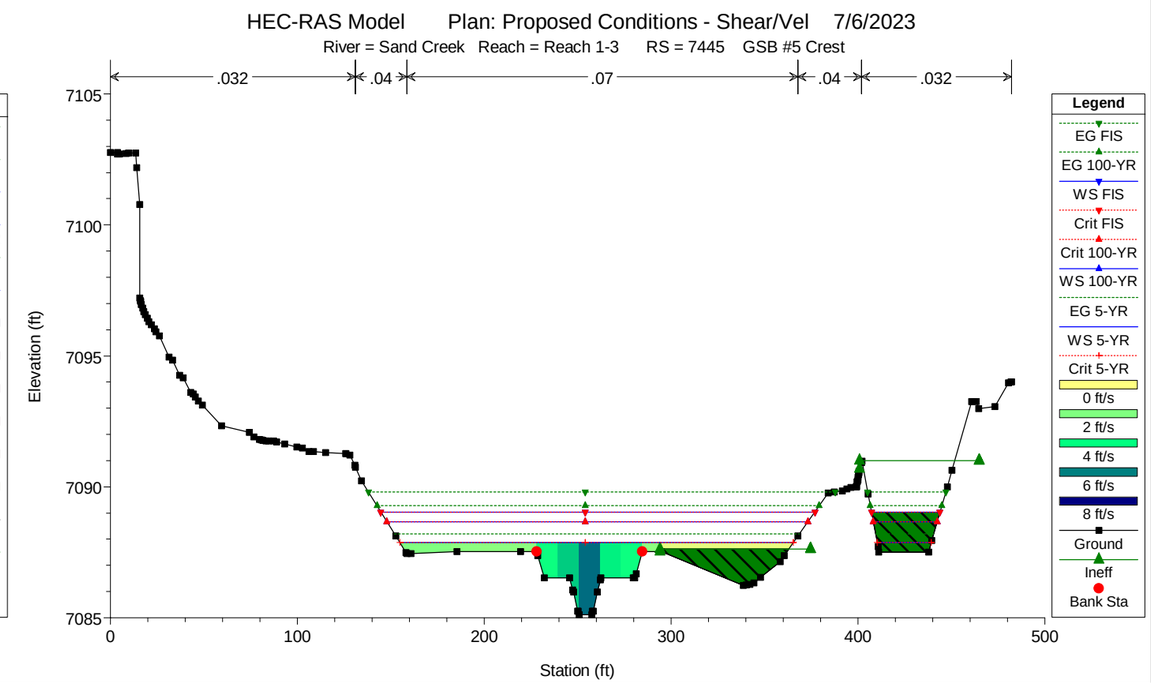


Sub-critical flow analysis for Shear/Velocity evaluation of Naturalized Channel Design

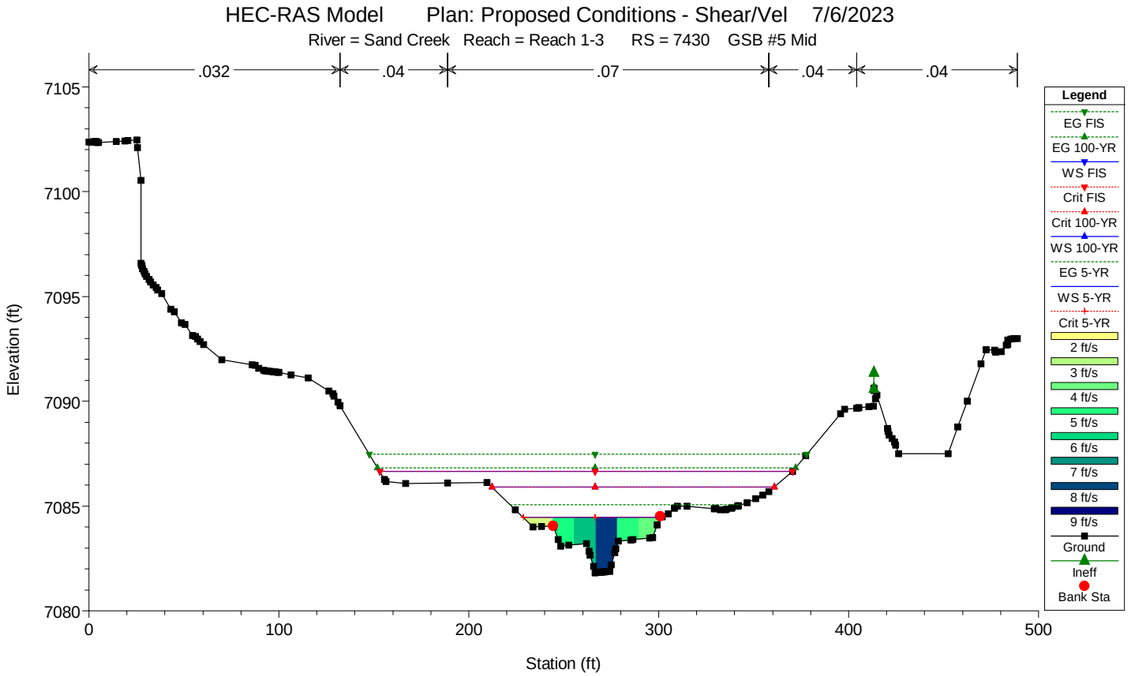


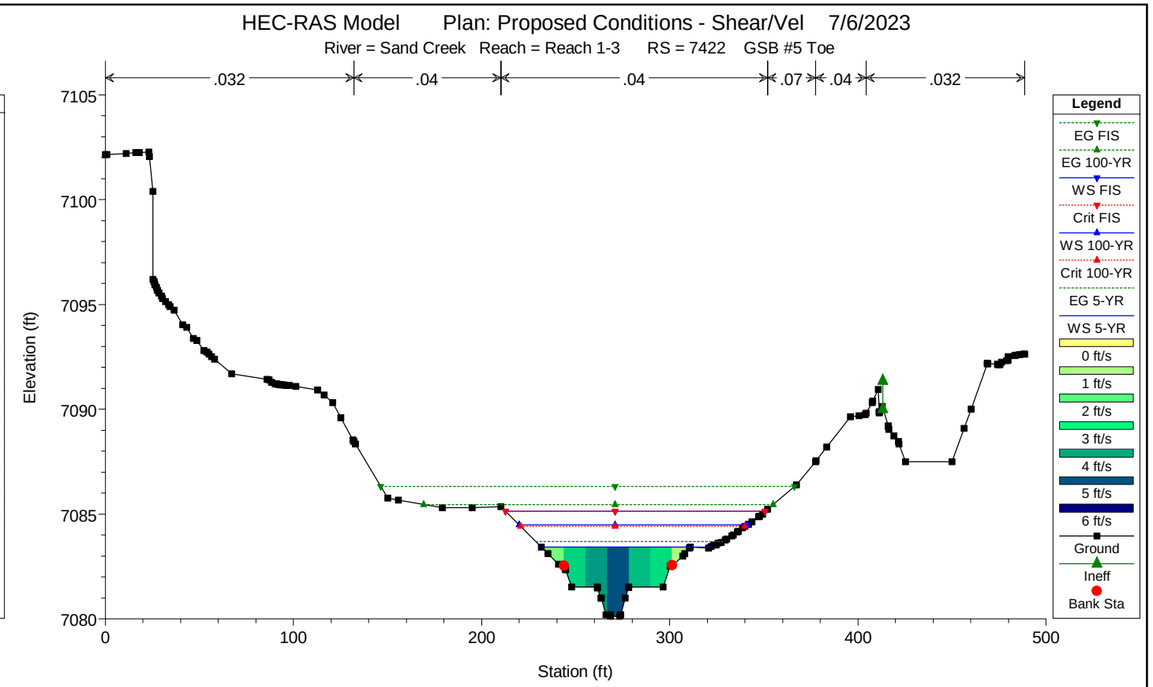


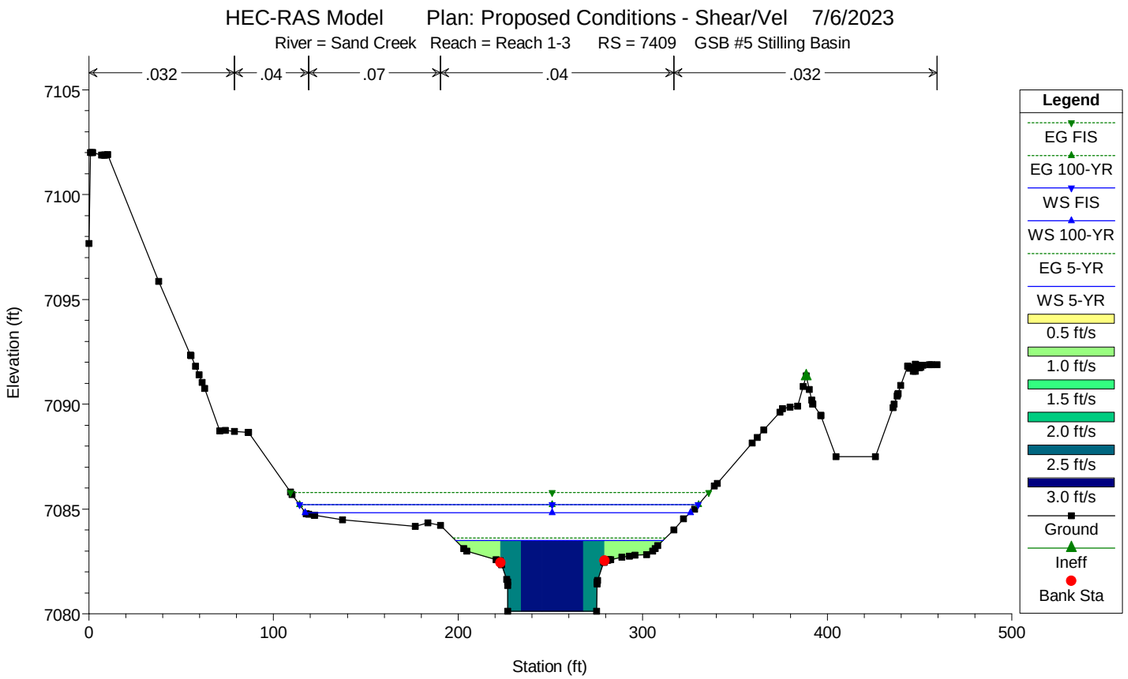


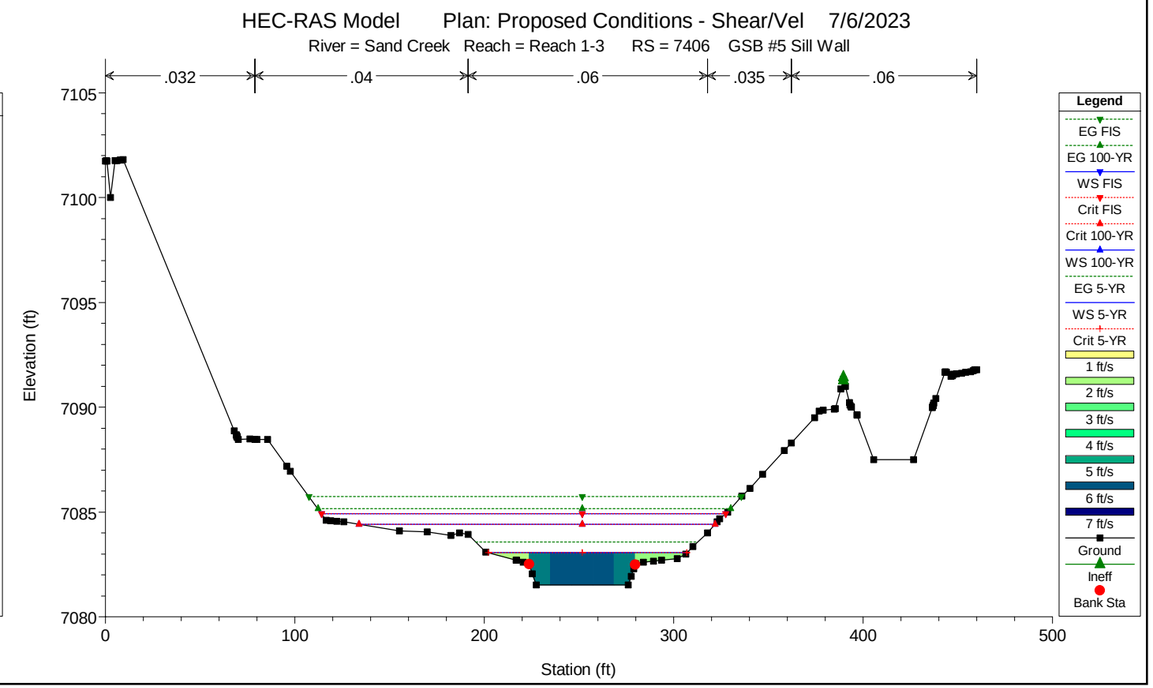


Sub-critical flow analysis for
Shear/Velocity evaluation of
Naturalized Channel Design

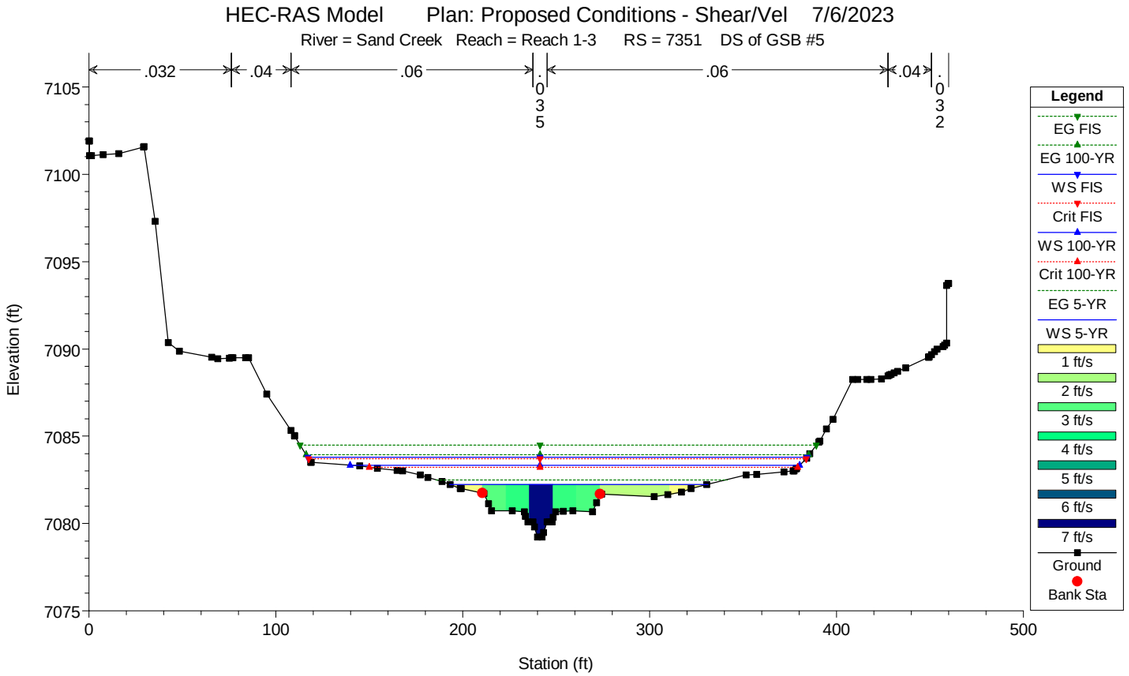


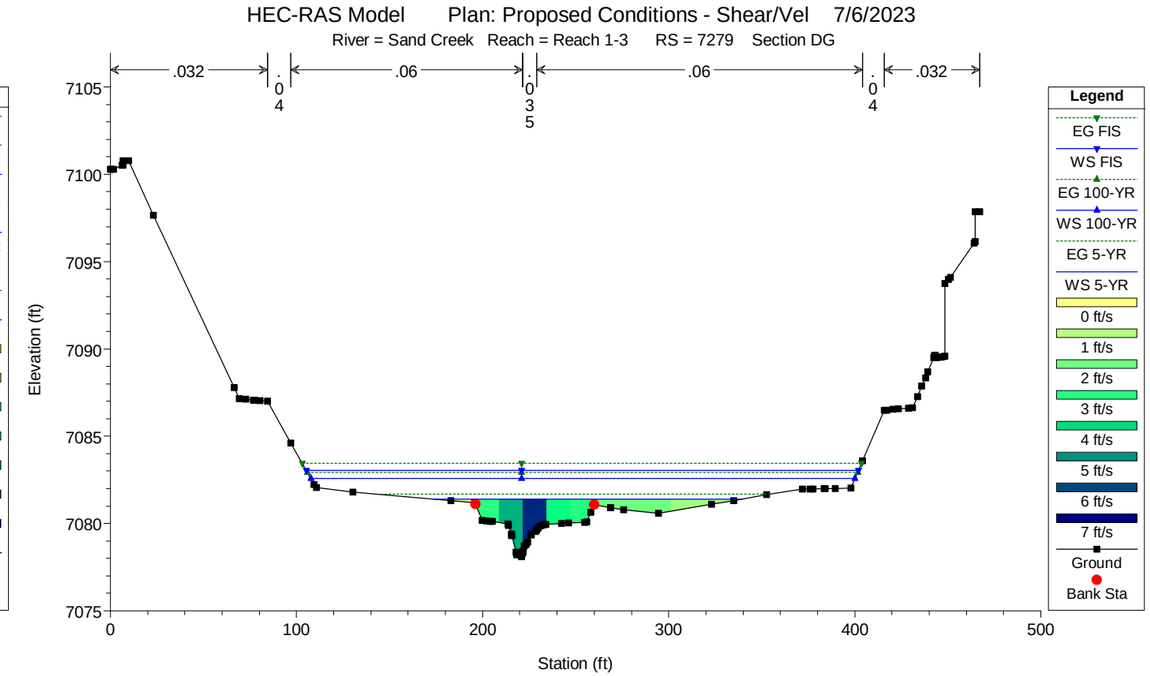


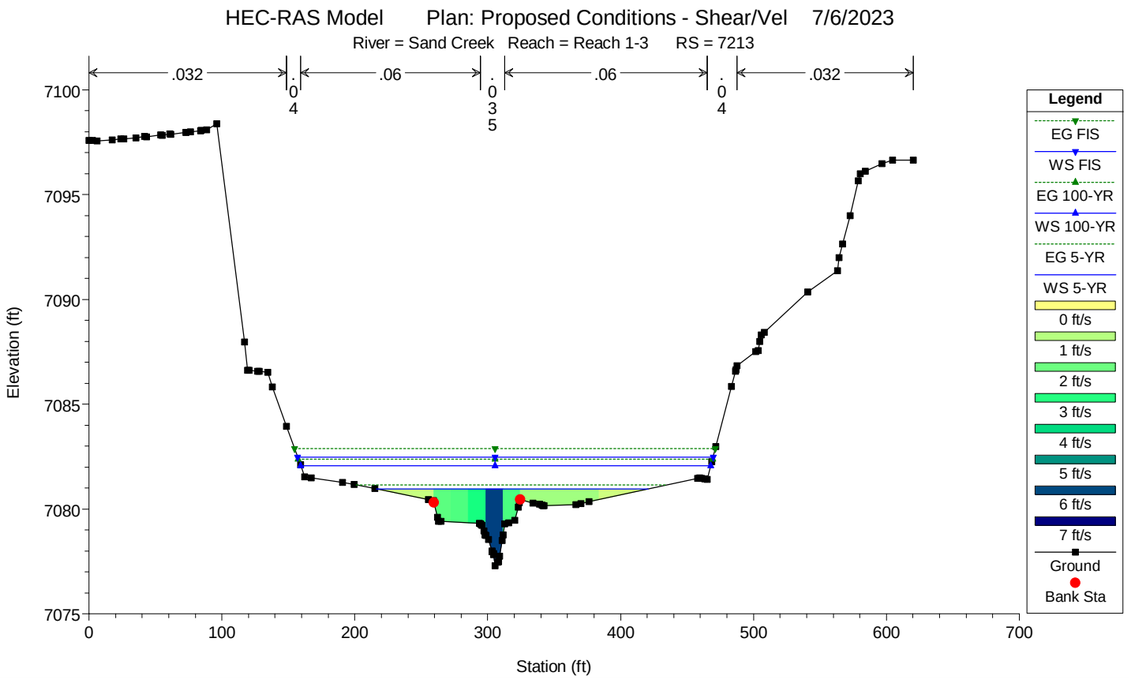


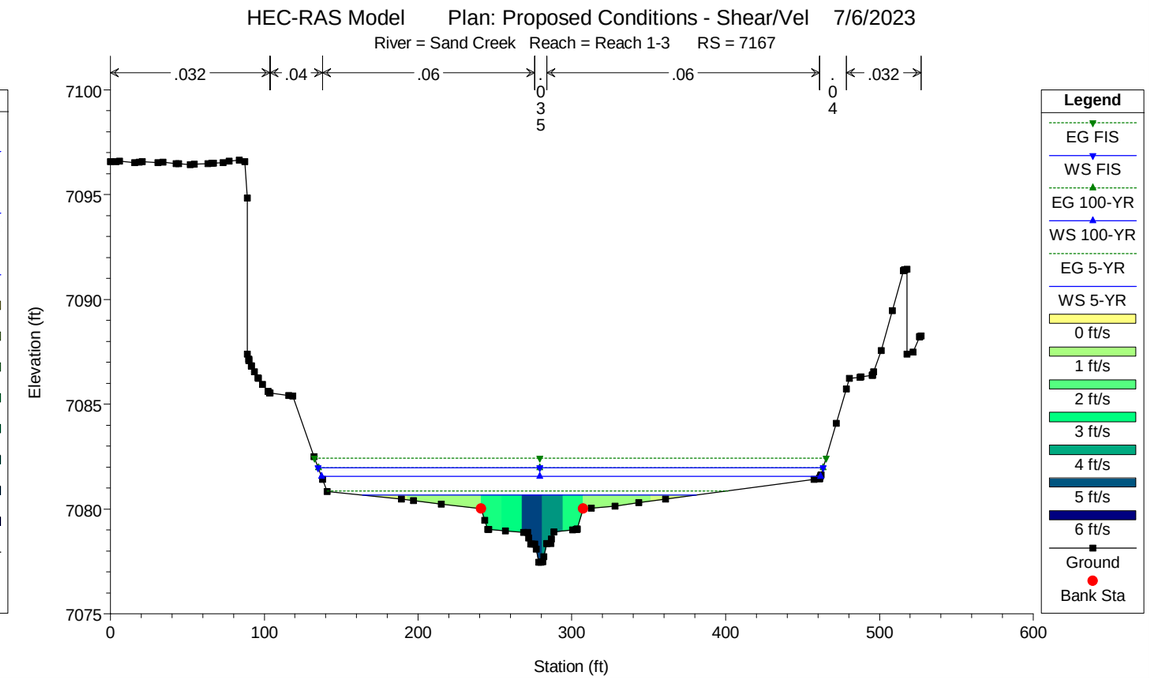


Sub-critical flow analysis for
Shear/Velocity evaluation of
Naturalized Channel Design

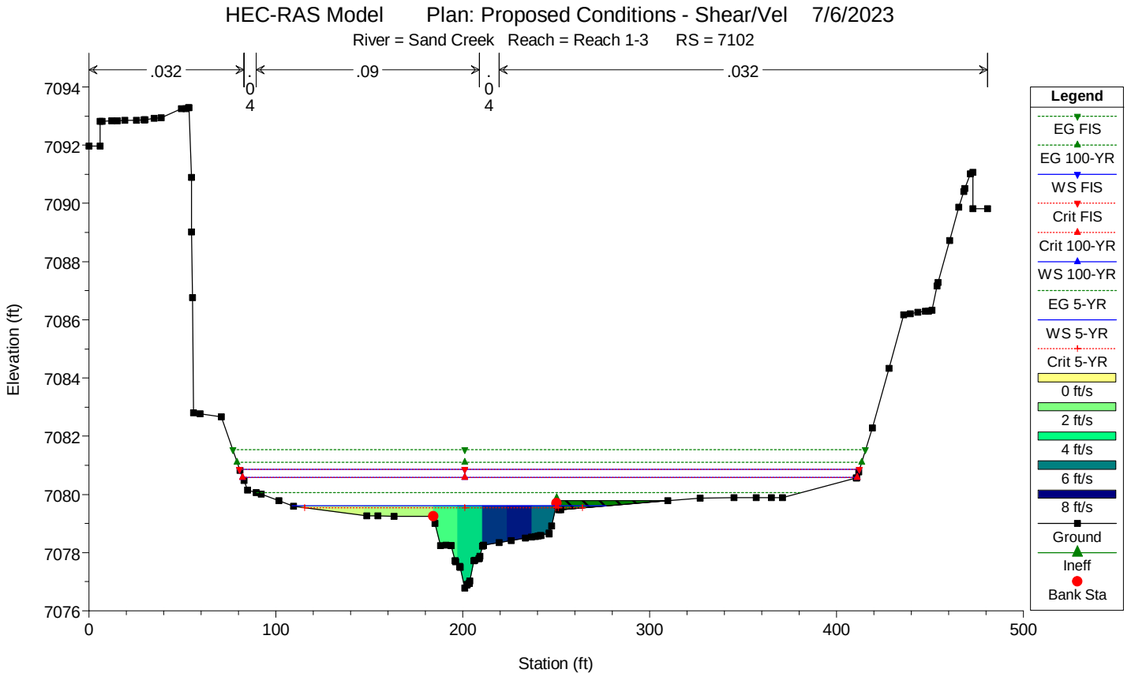


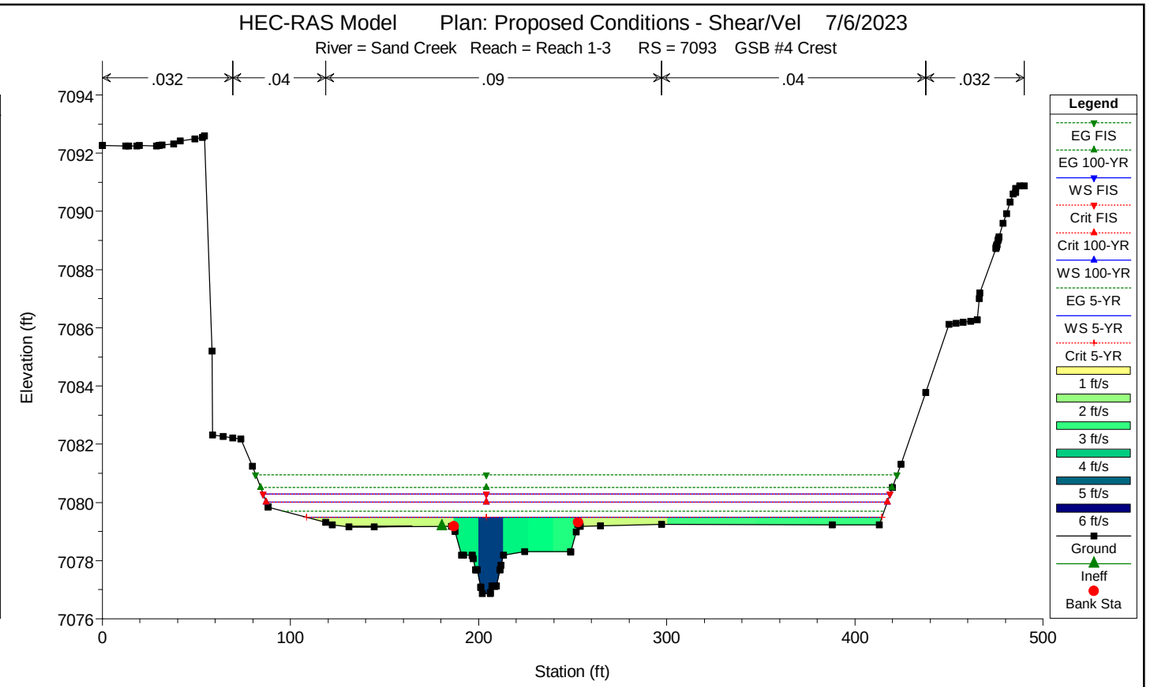


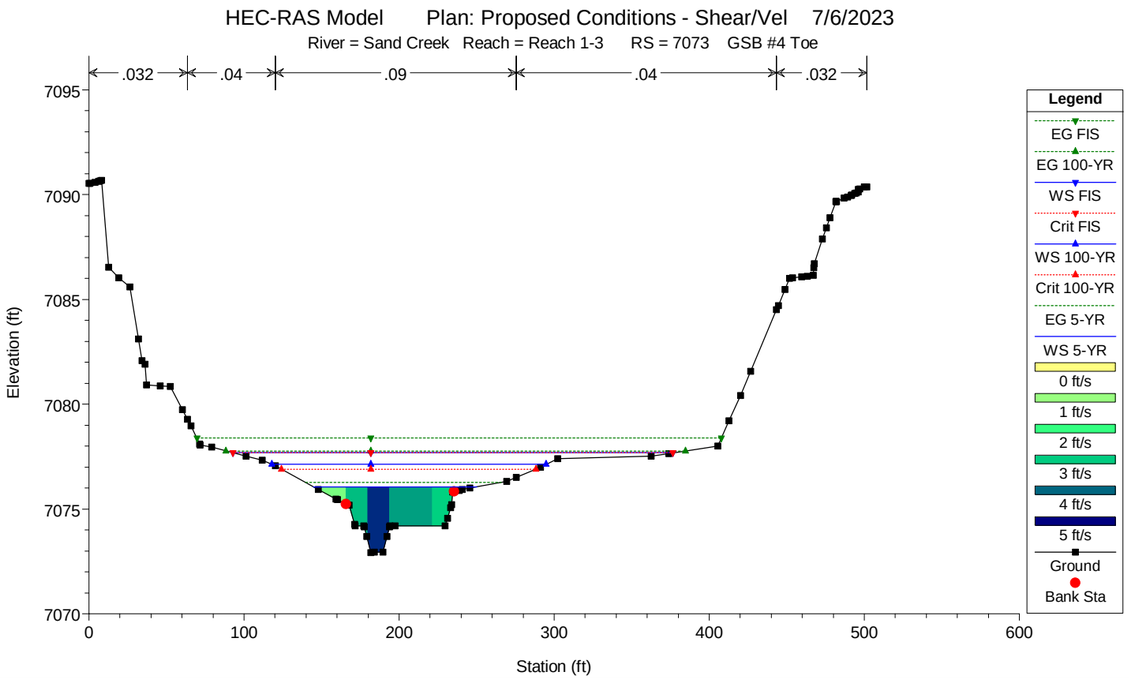


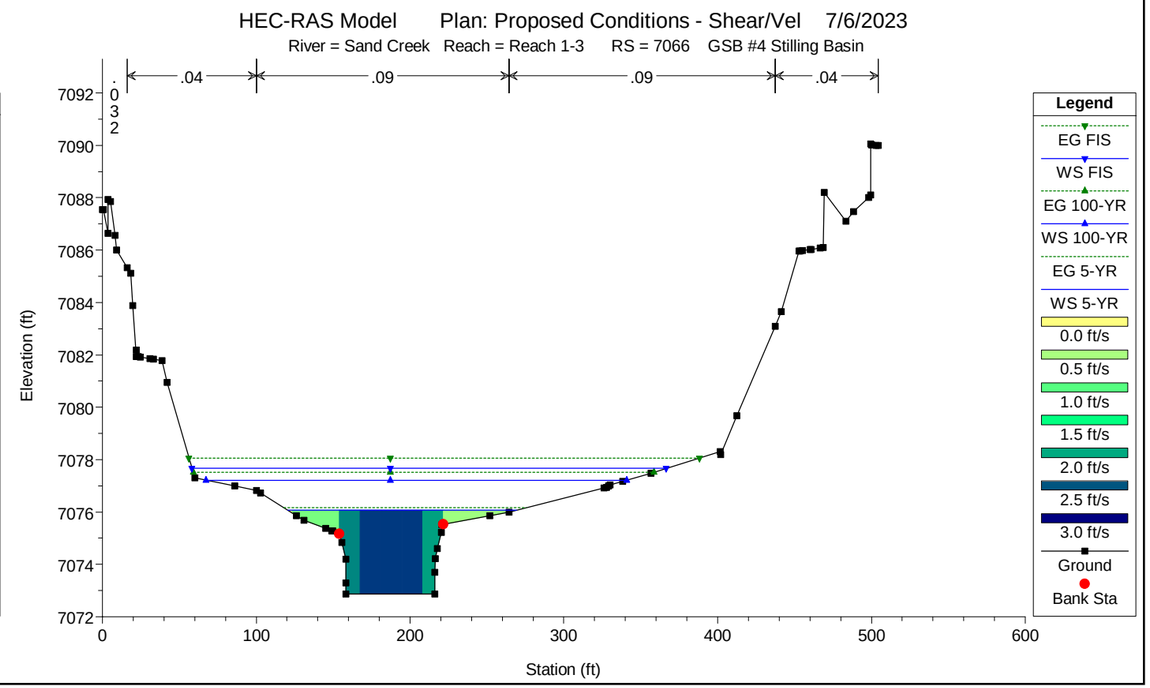


Sub-critical flow analysis for
Shear/Velocity evaluation of
Naturalized Channel Design

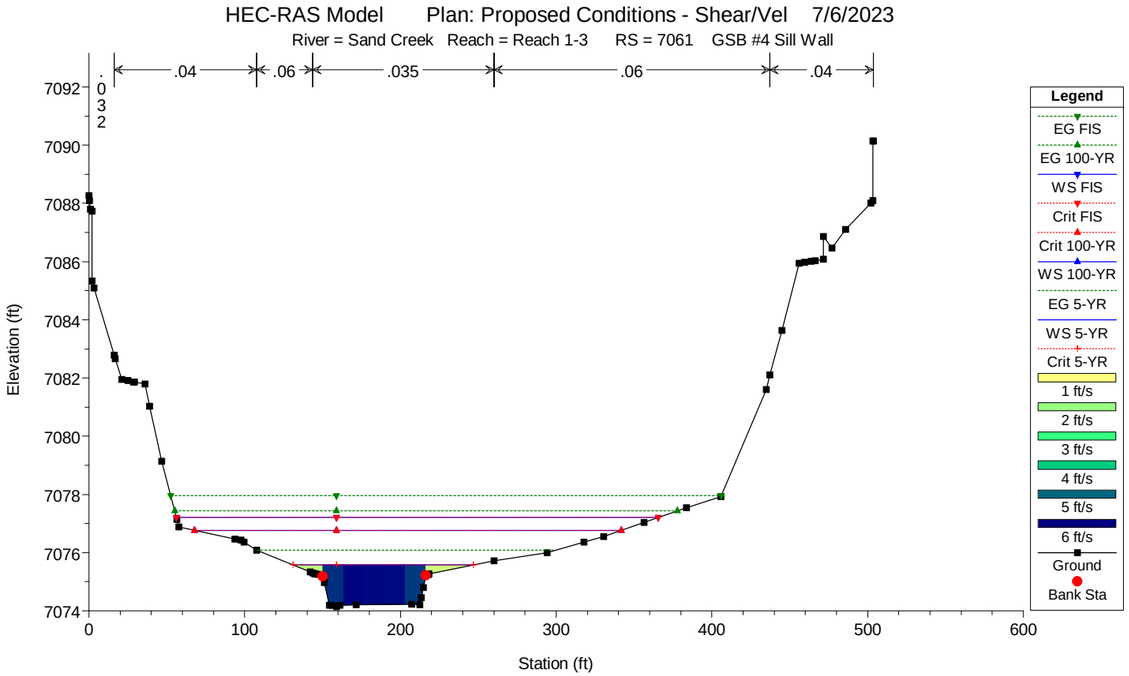


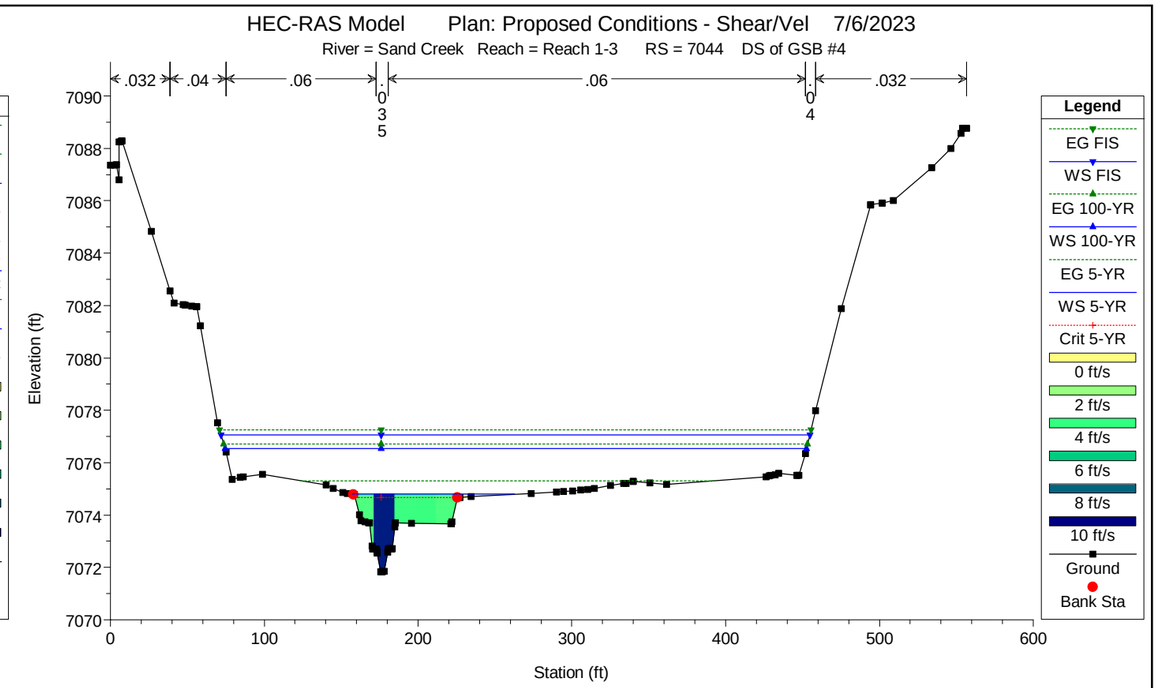


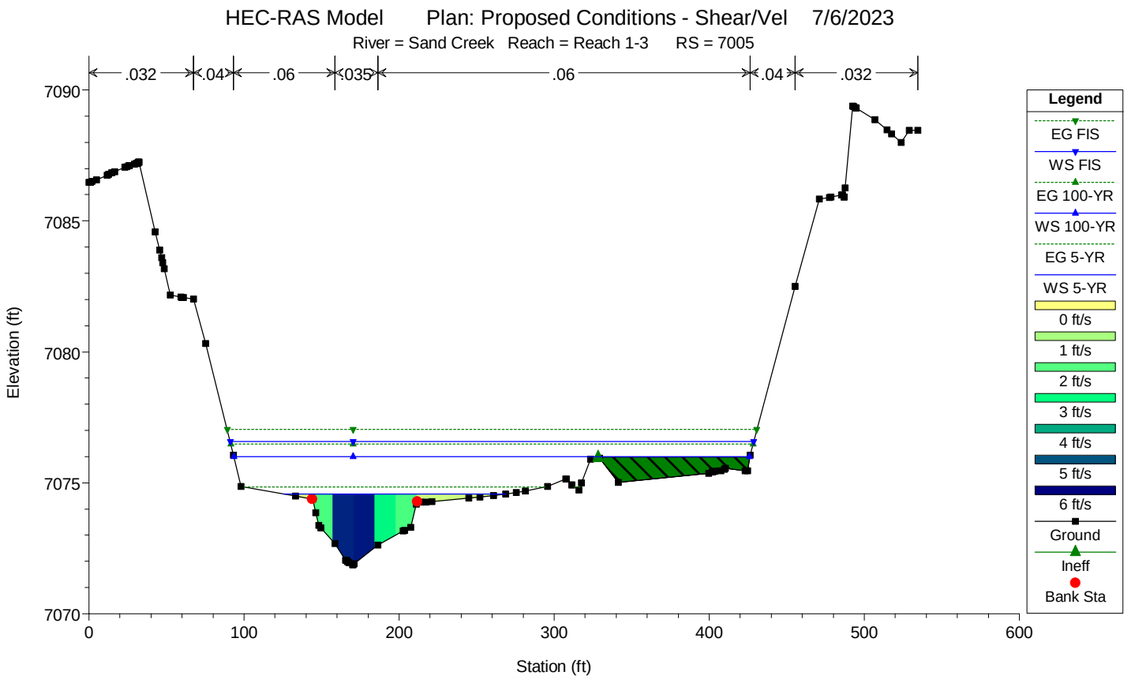


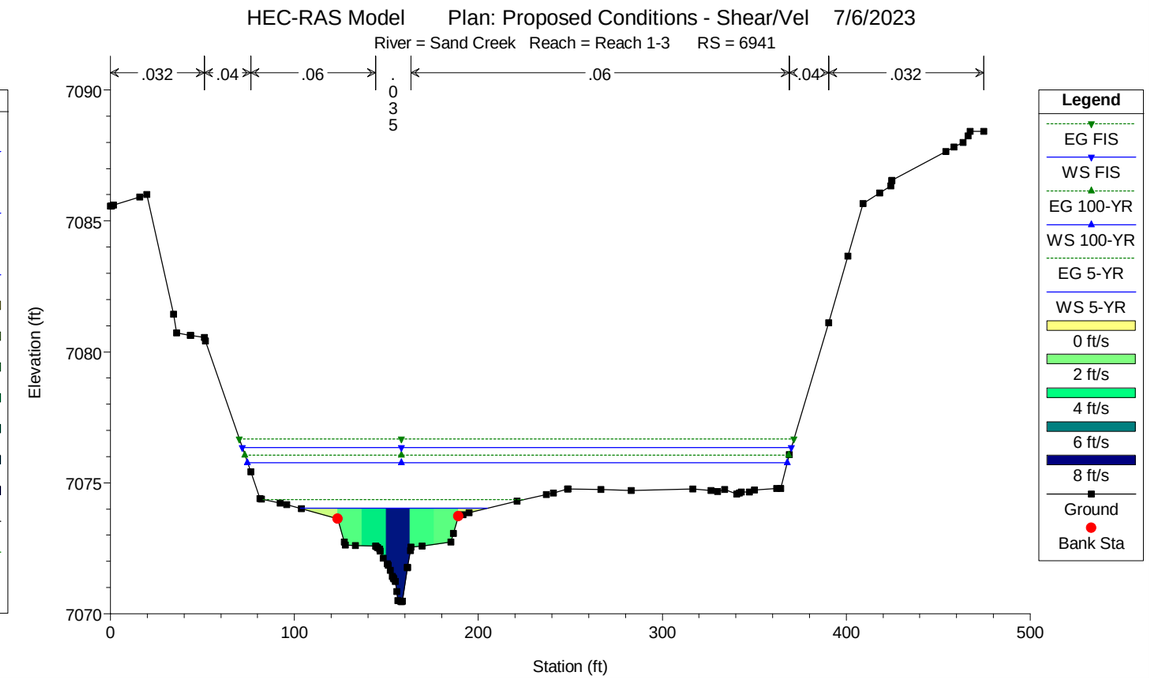


Sub-critical flow analysis for Shear/Velocity evaluation of Naturalized Channel Design

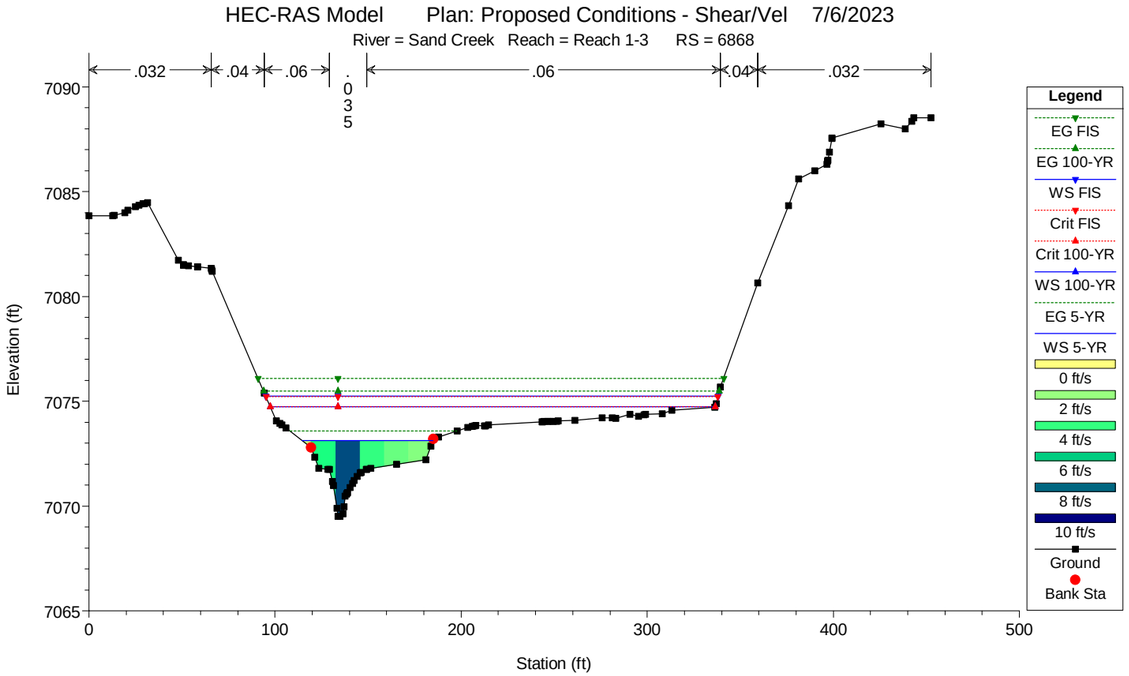


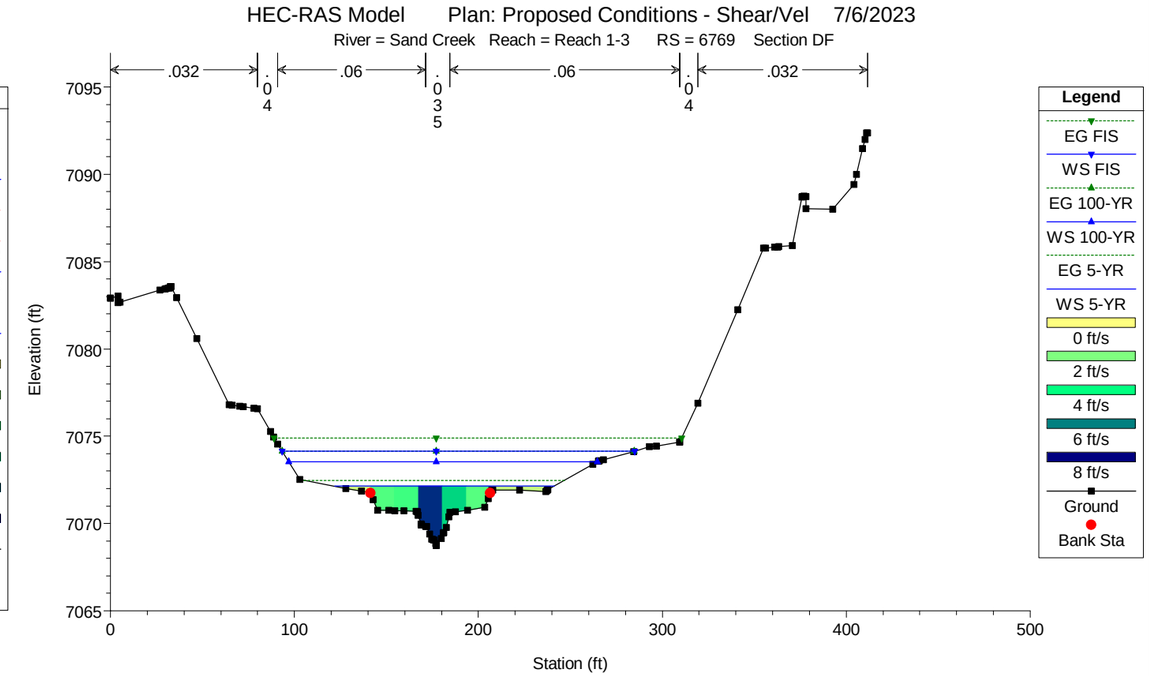


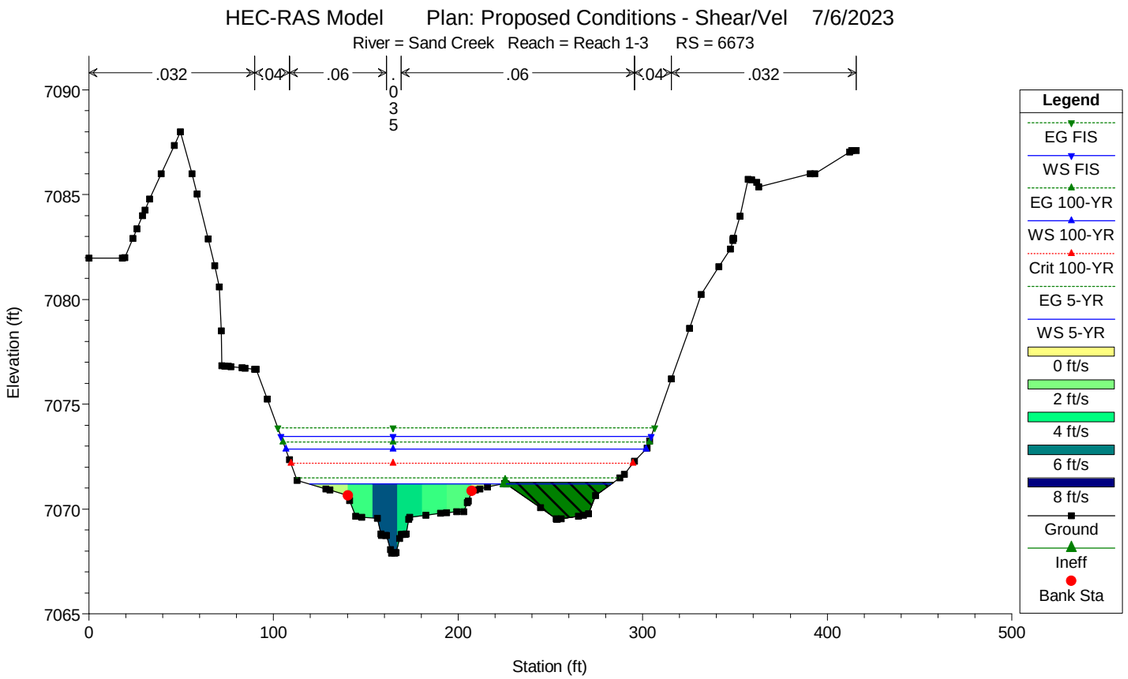


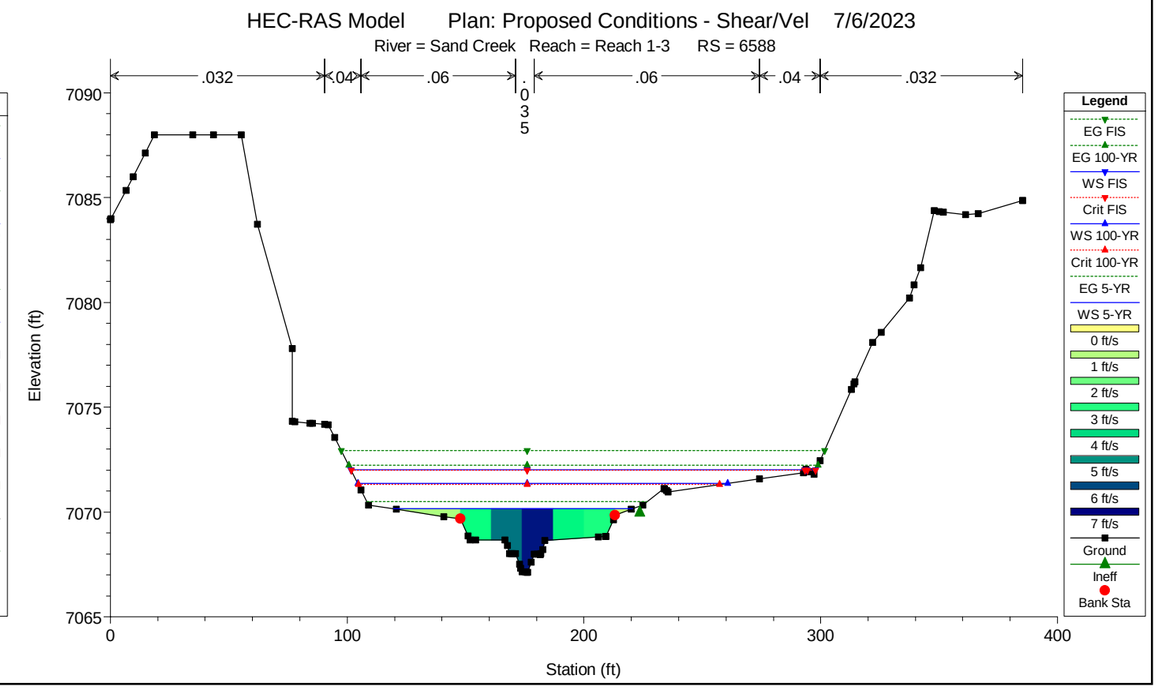


Sub-critical flow analysis for
Shear/Velocity evaluation of
Naturalized Channel Design

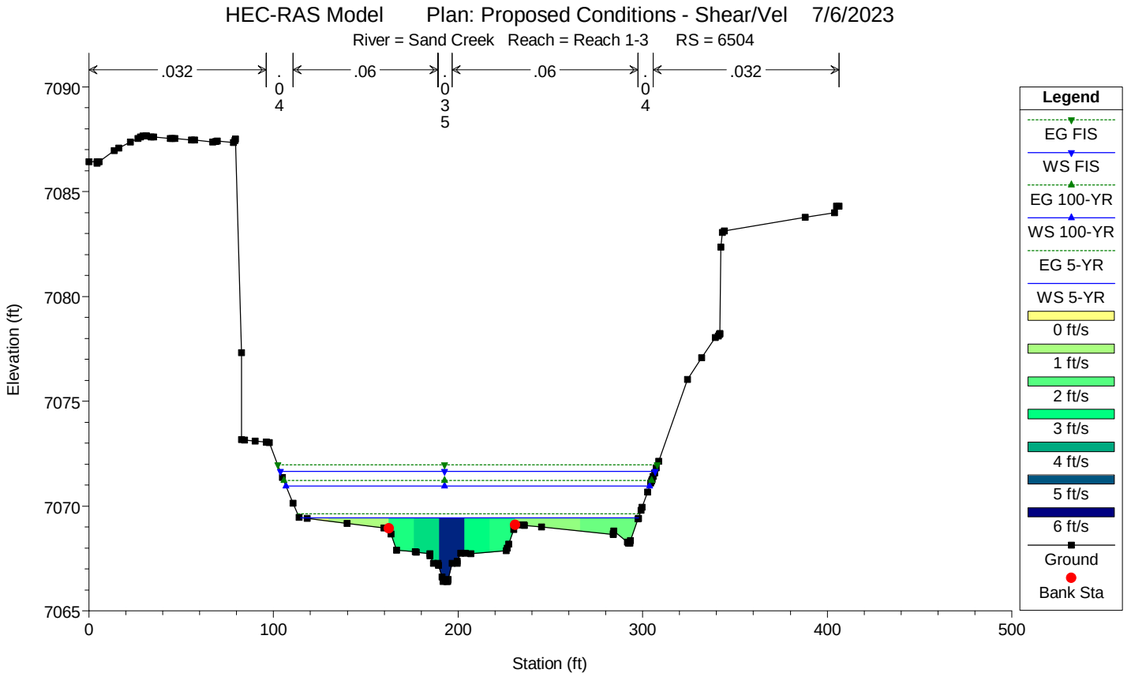


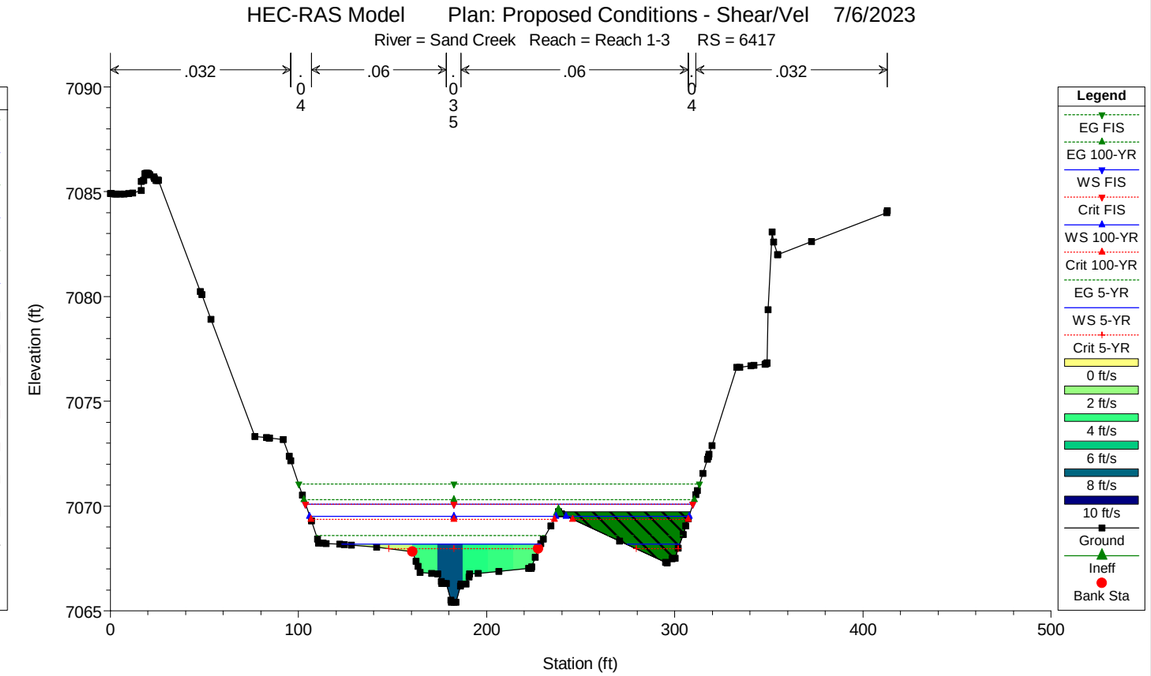


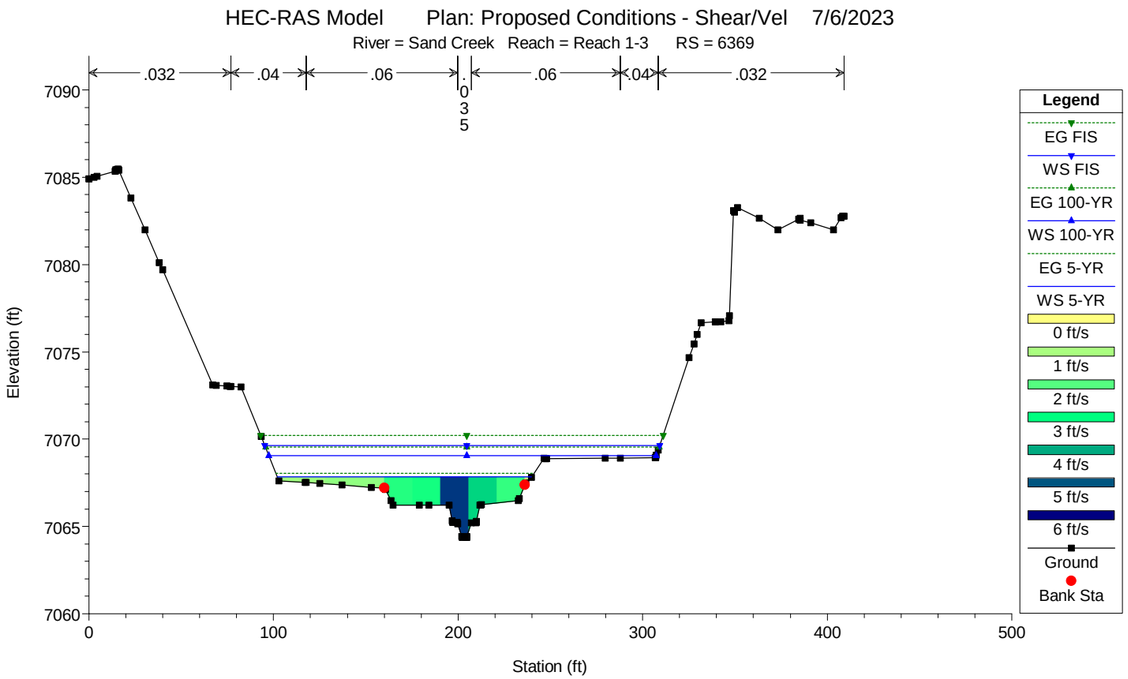


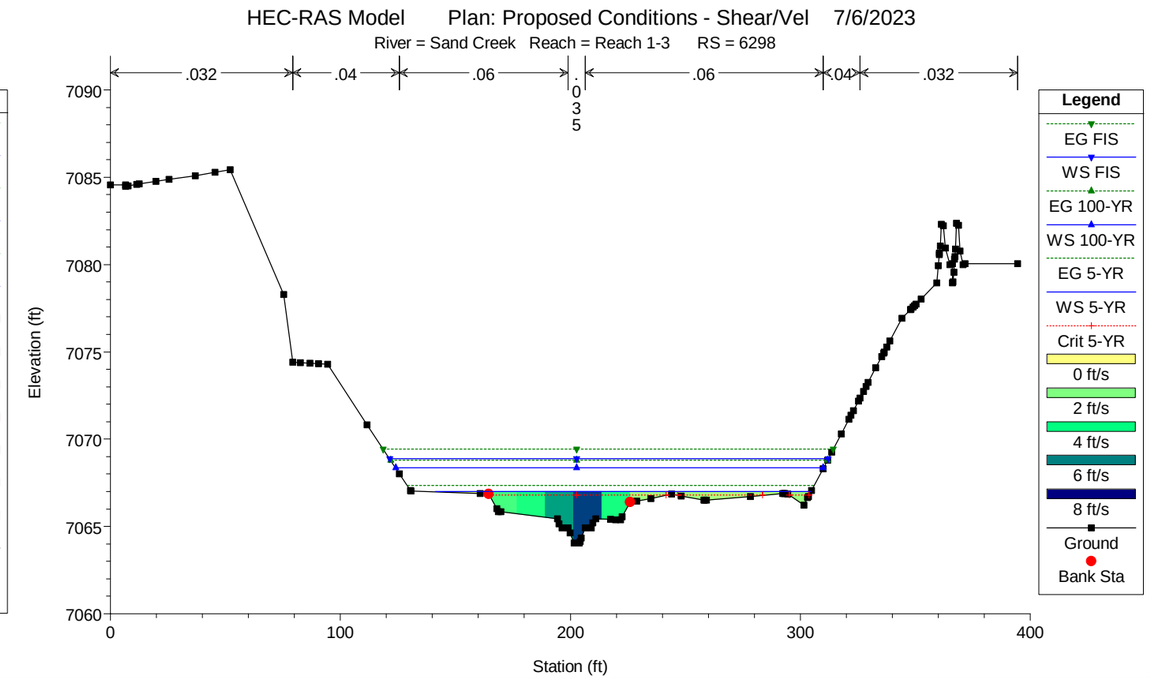


Sub-critical flow analysis for
Shear/Velocity evaluation of
Naturalized Channel Design

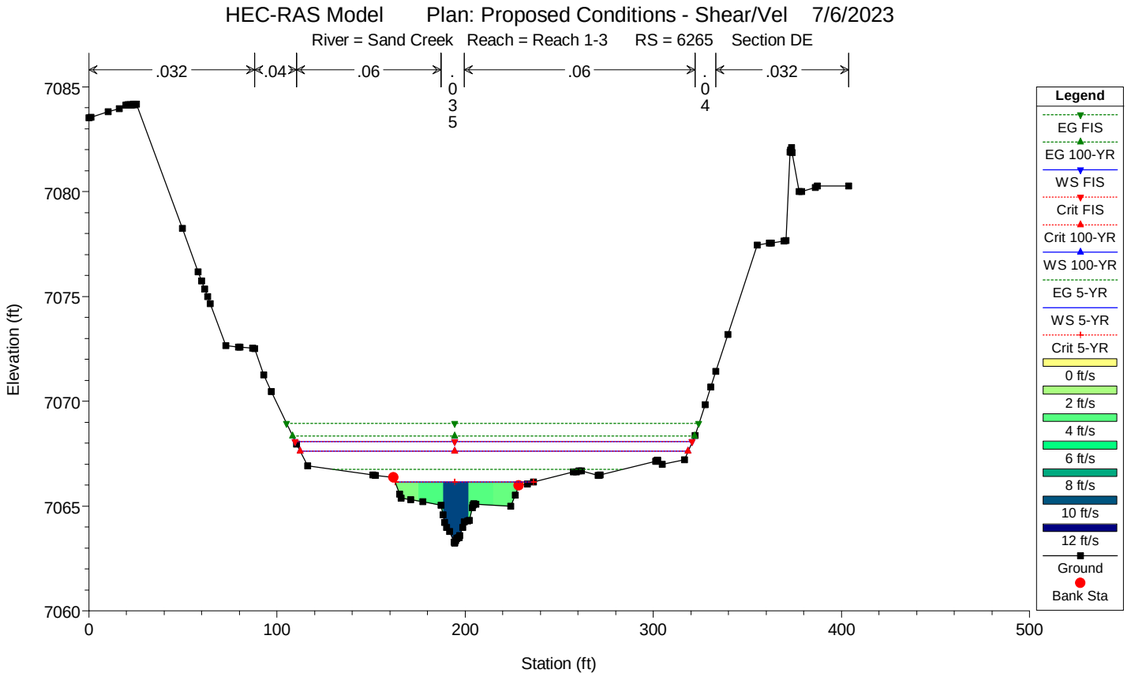


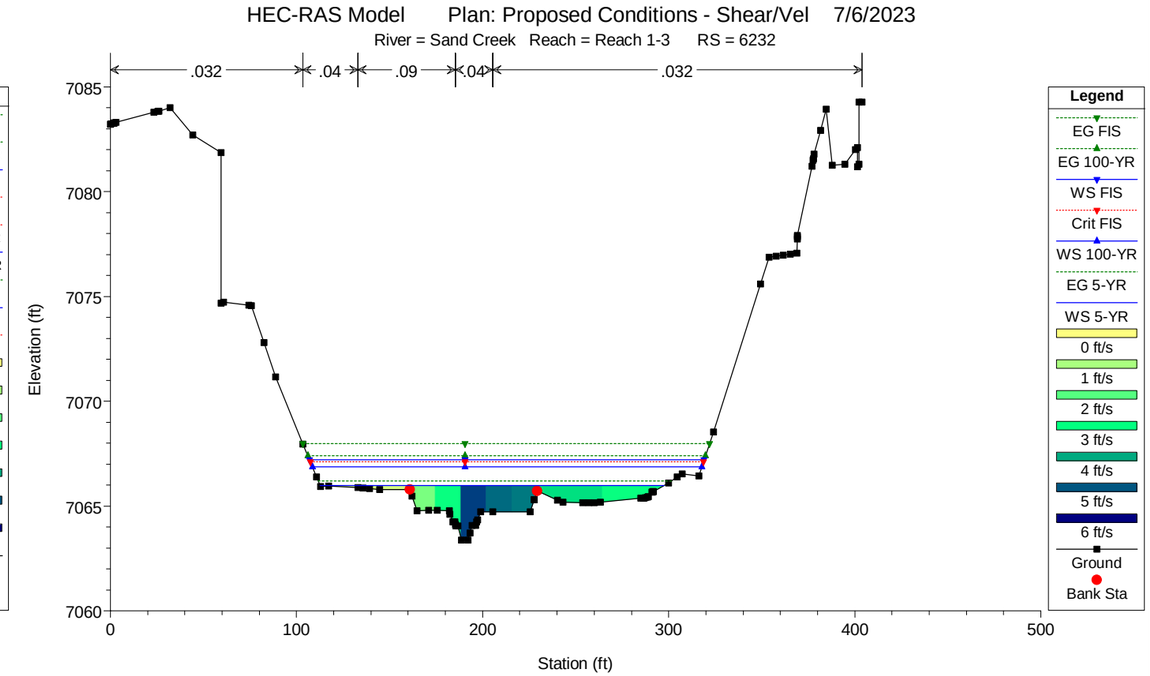


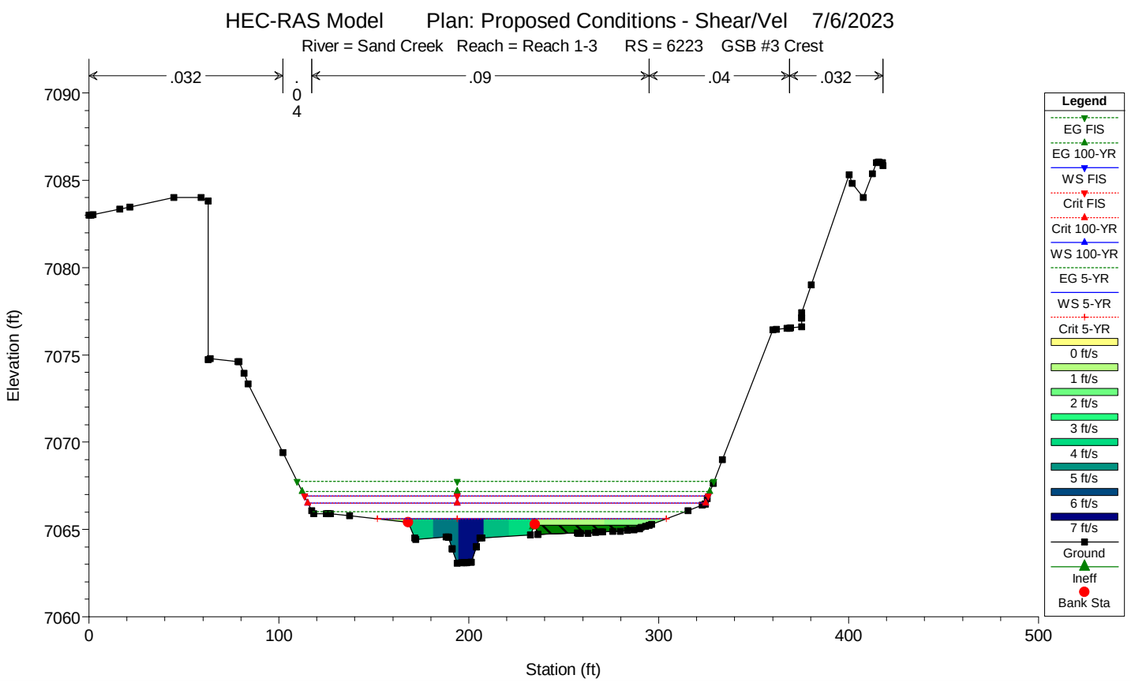


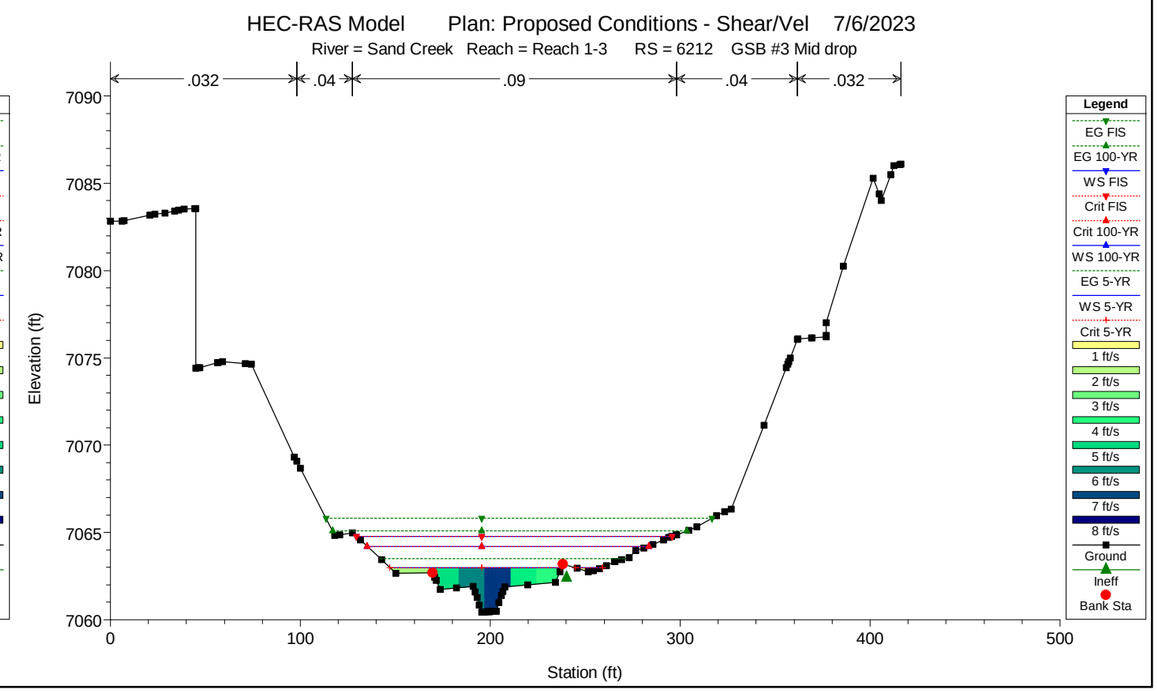


Sub-critical flow analysis for
Shear/Velocity evaluation of
Naturalized Channel Design

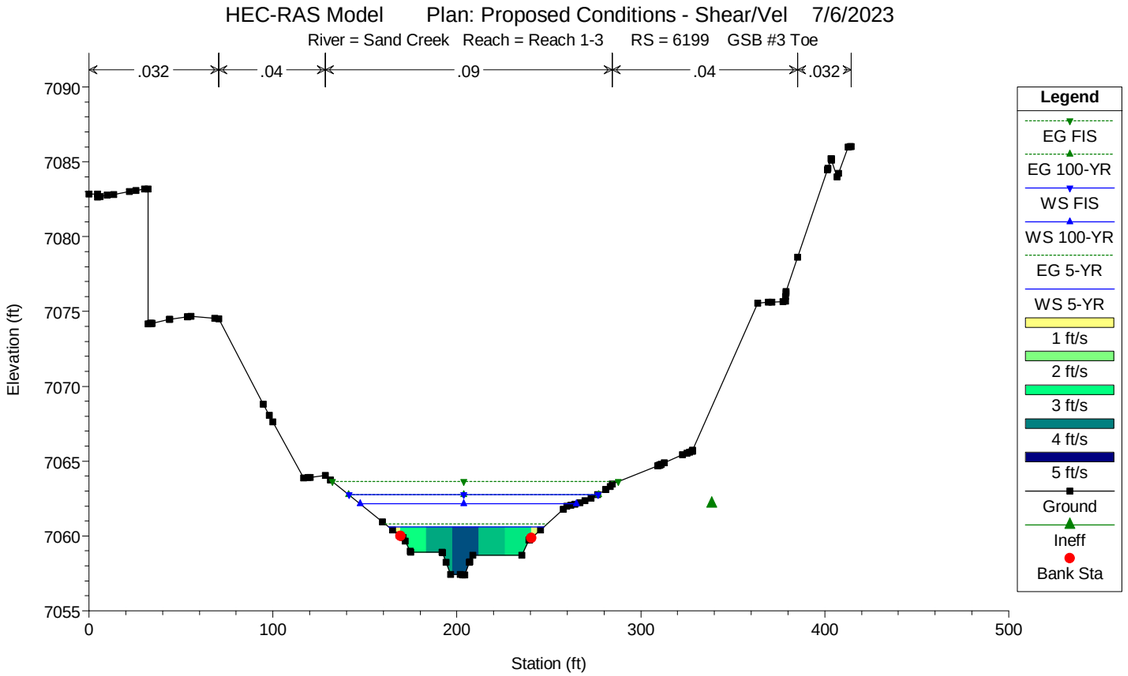


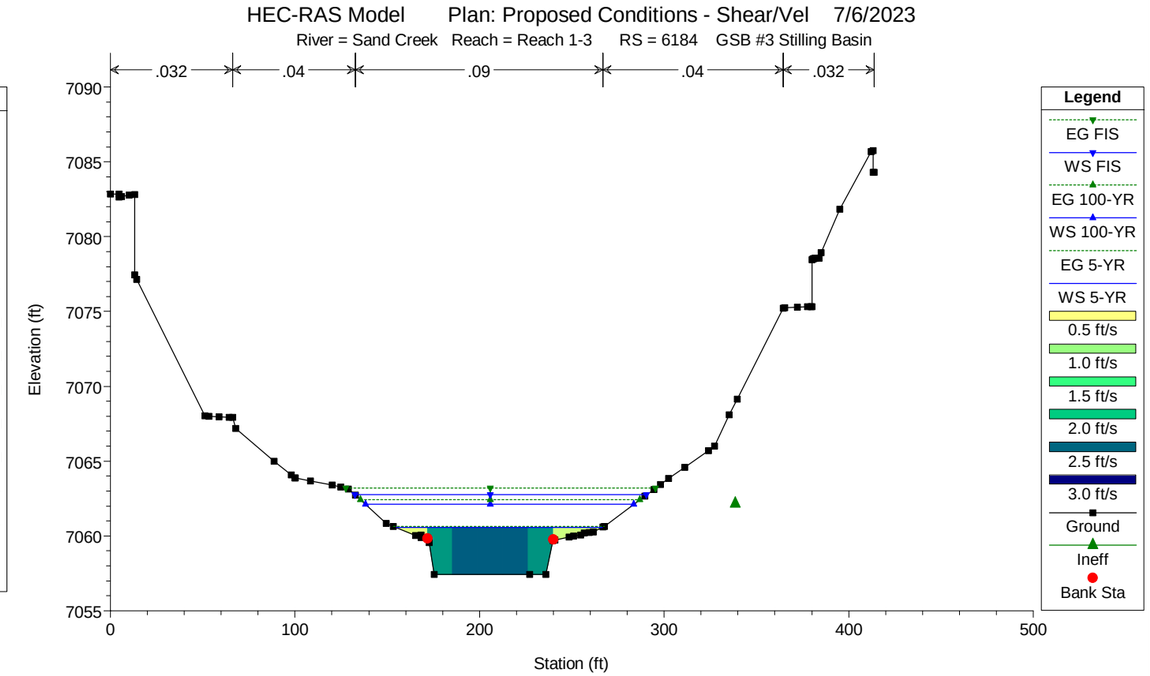


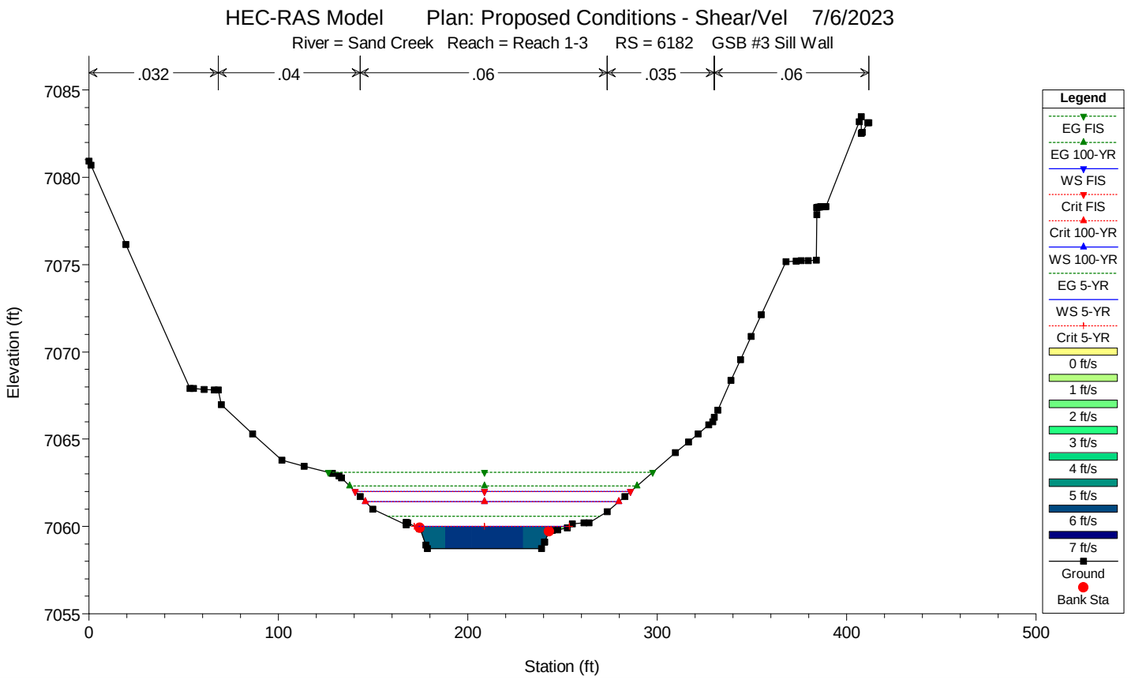


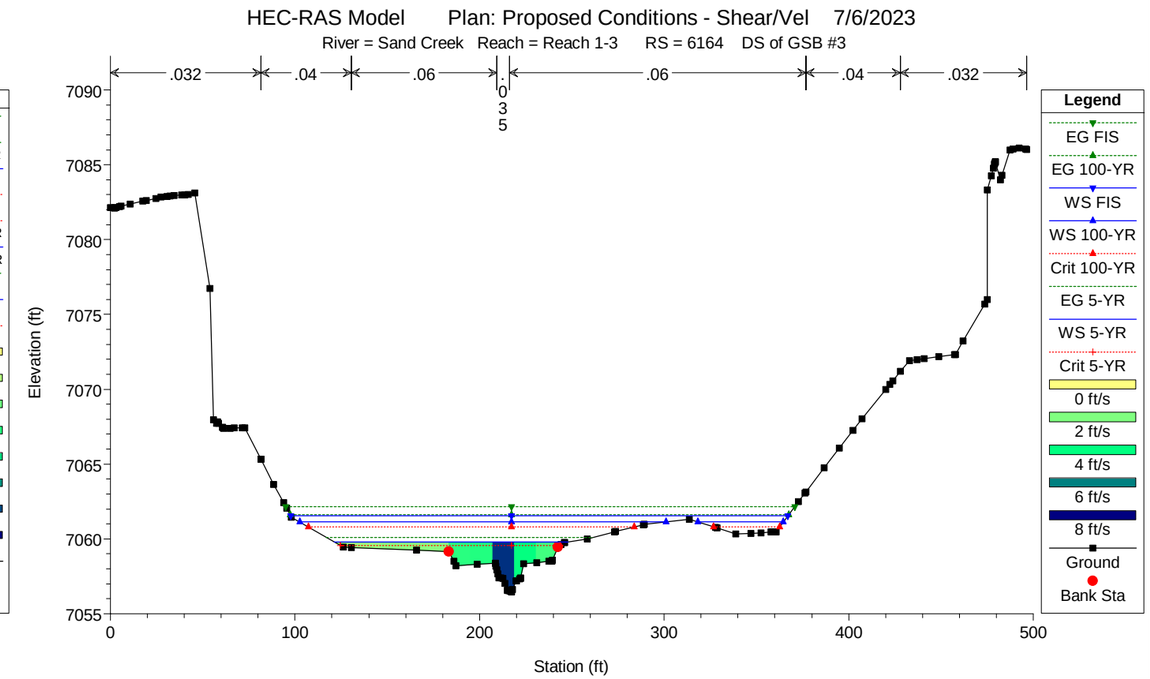


Sub-critical flow analysis for
Shear/Velocity evaluation of
Naturalized Channel Design

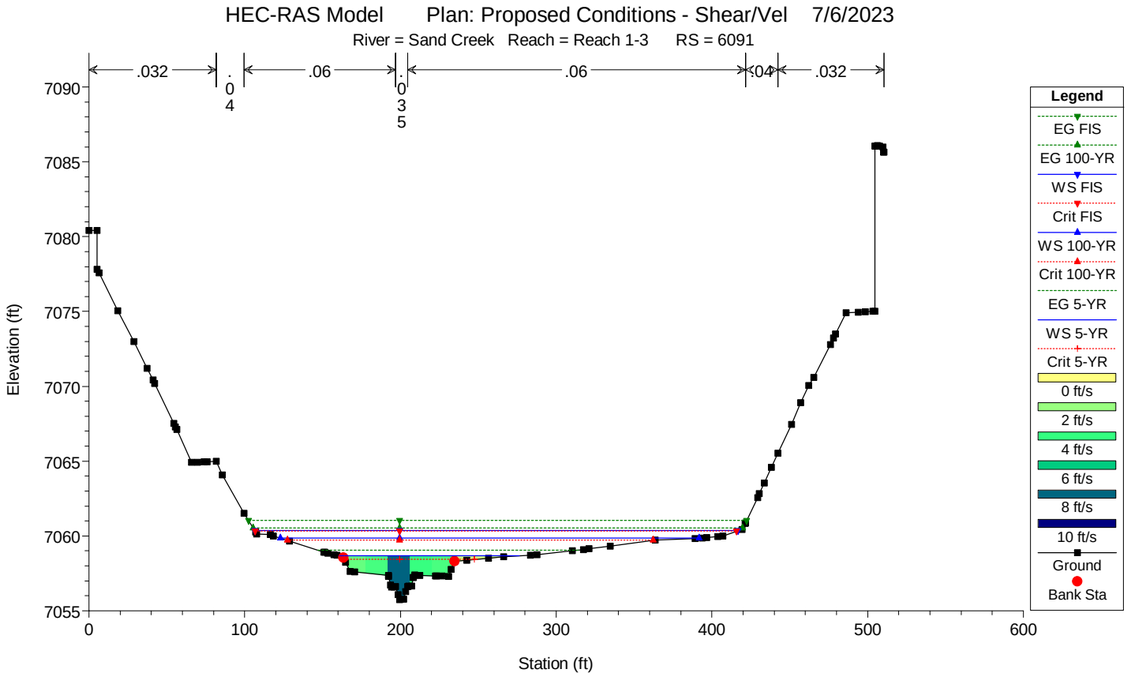


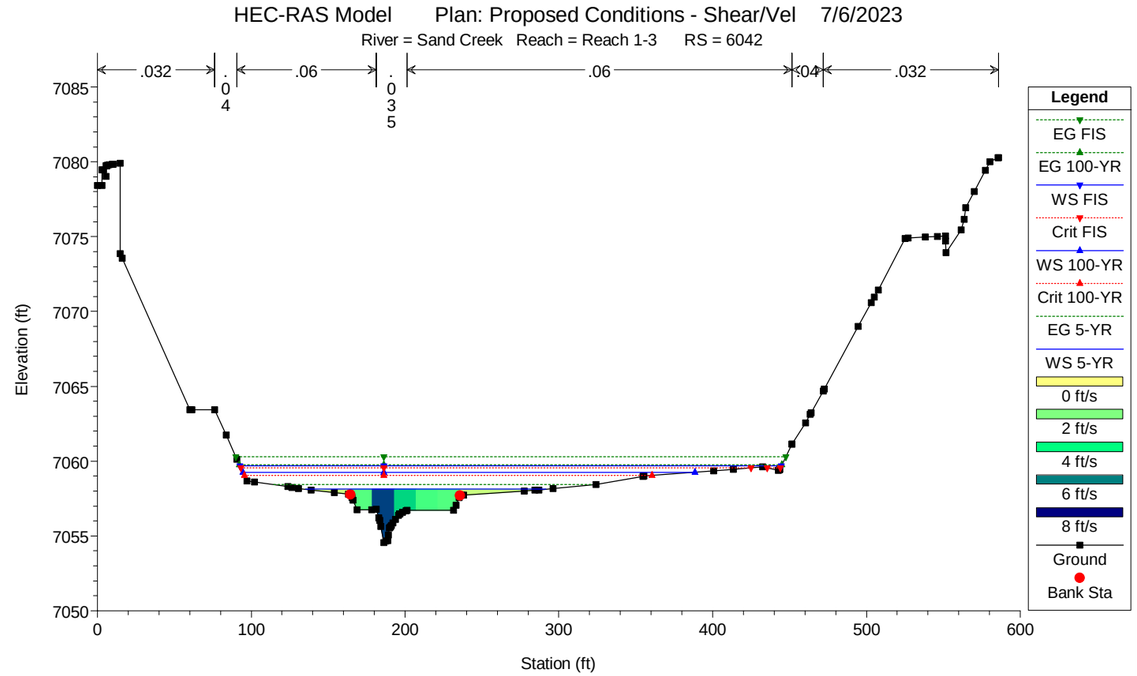


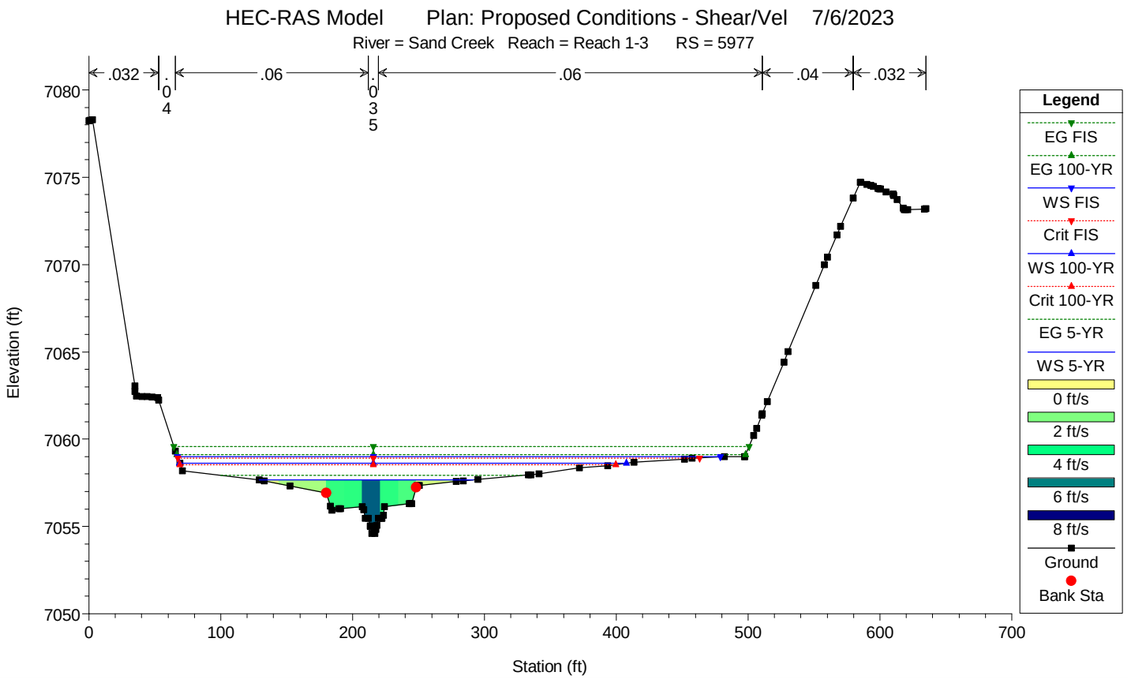


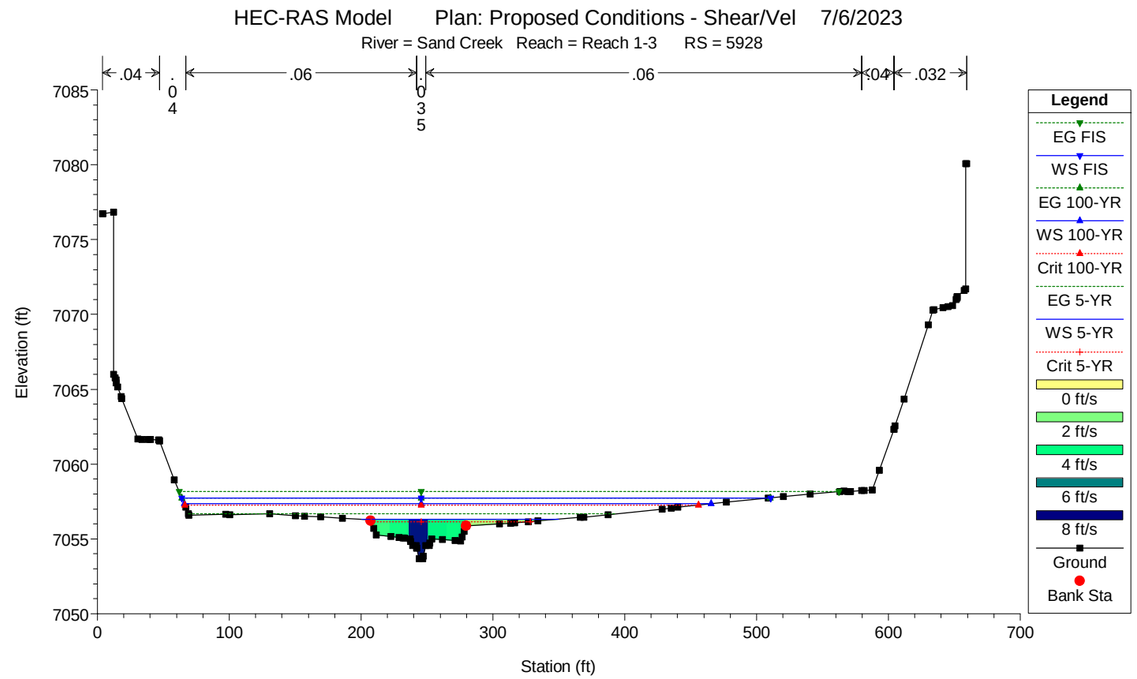


Sub-critical flow analysis for Shear/Velocity evaluation of Naturalized Channel Design

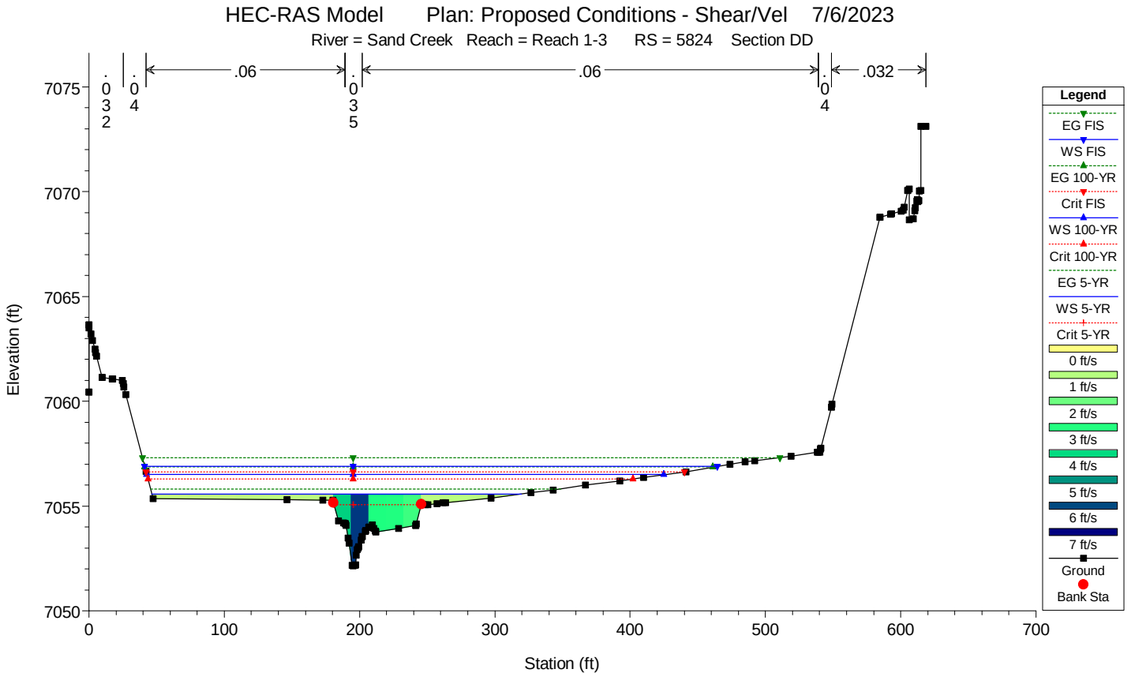


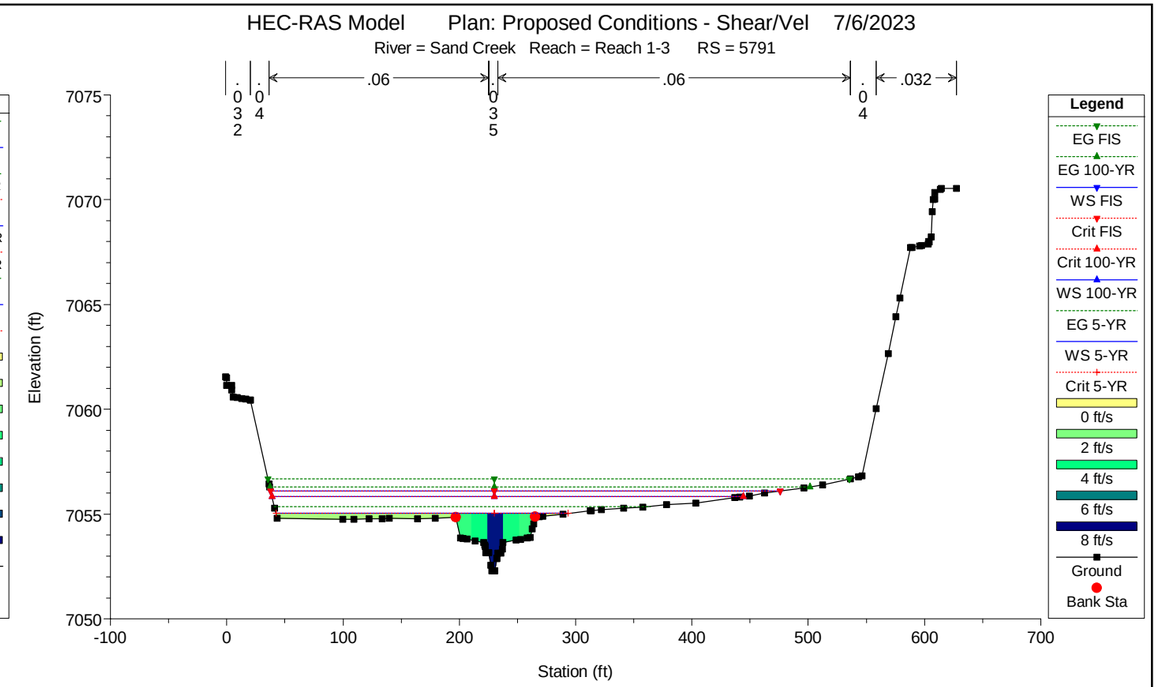


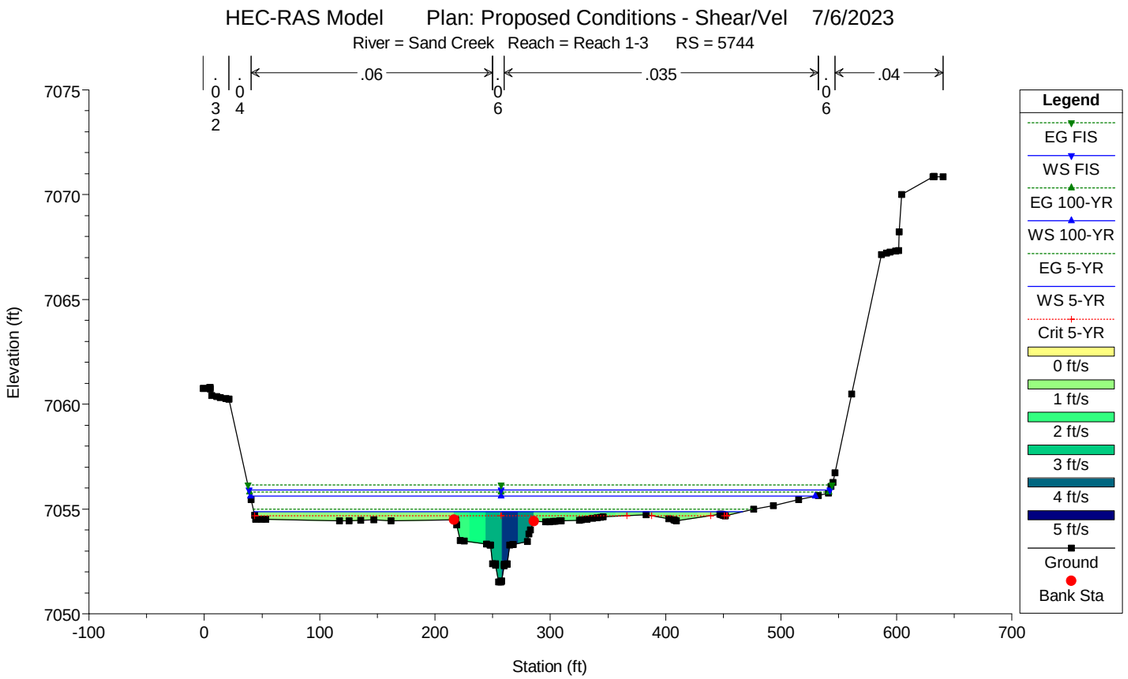


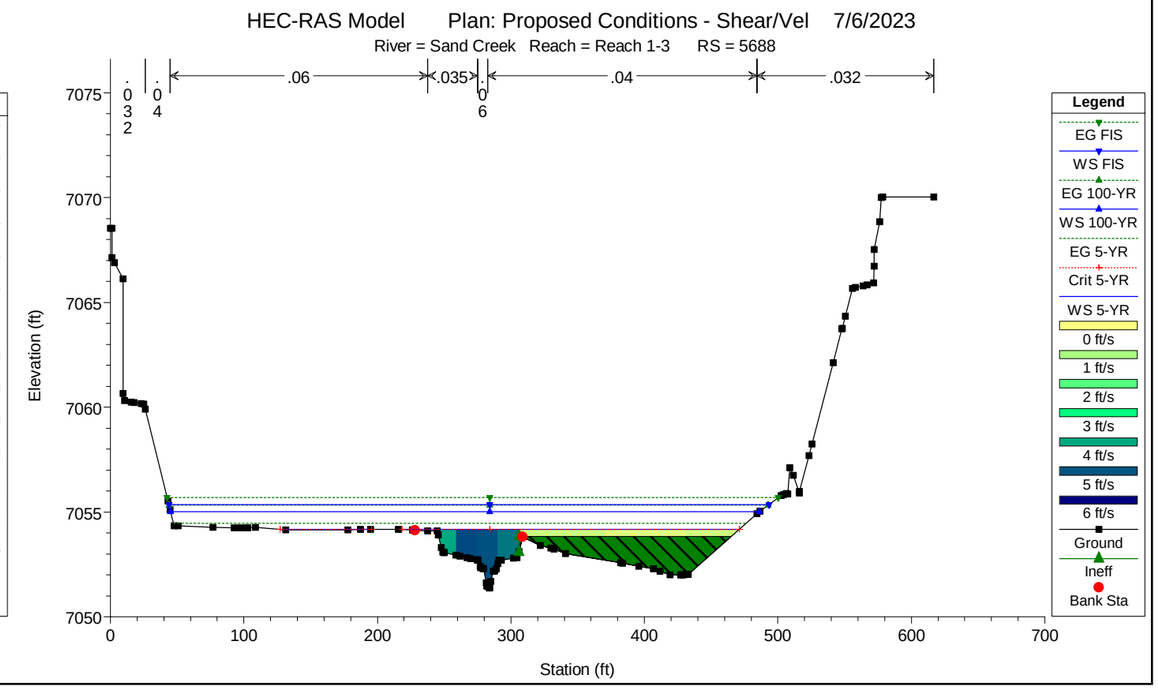


Sub-critical flow analysis for
Shear/Velocity evaluation of
Naturalized Channel Design

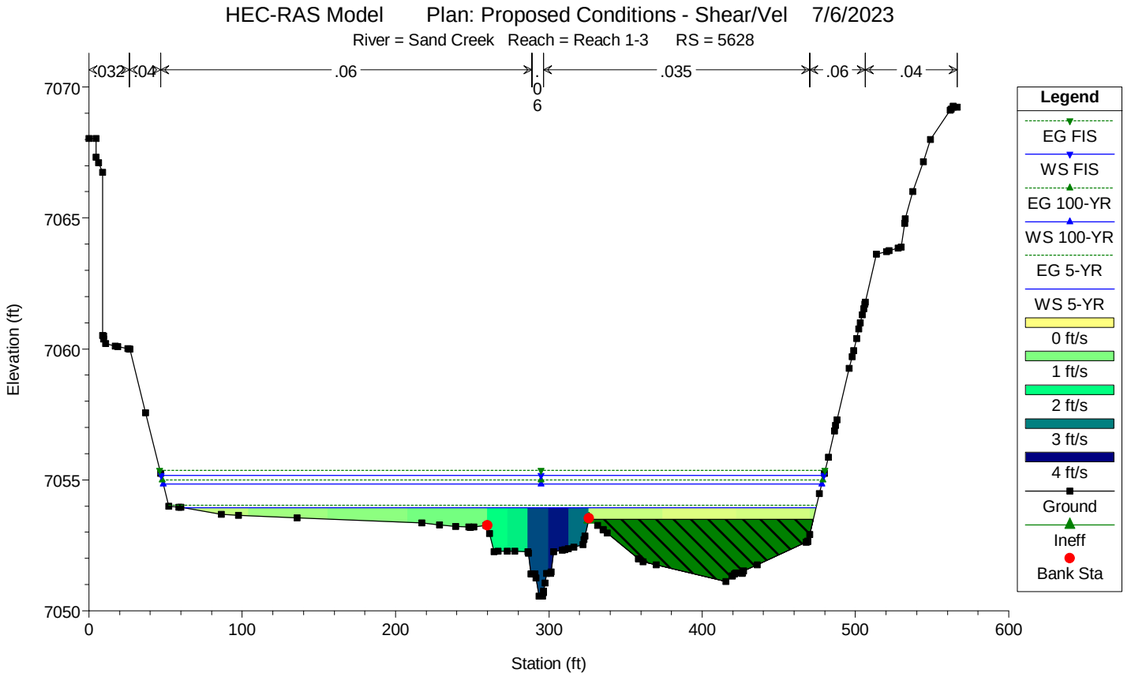


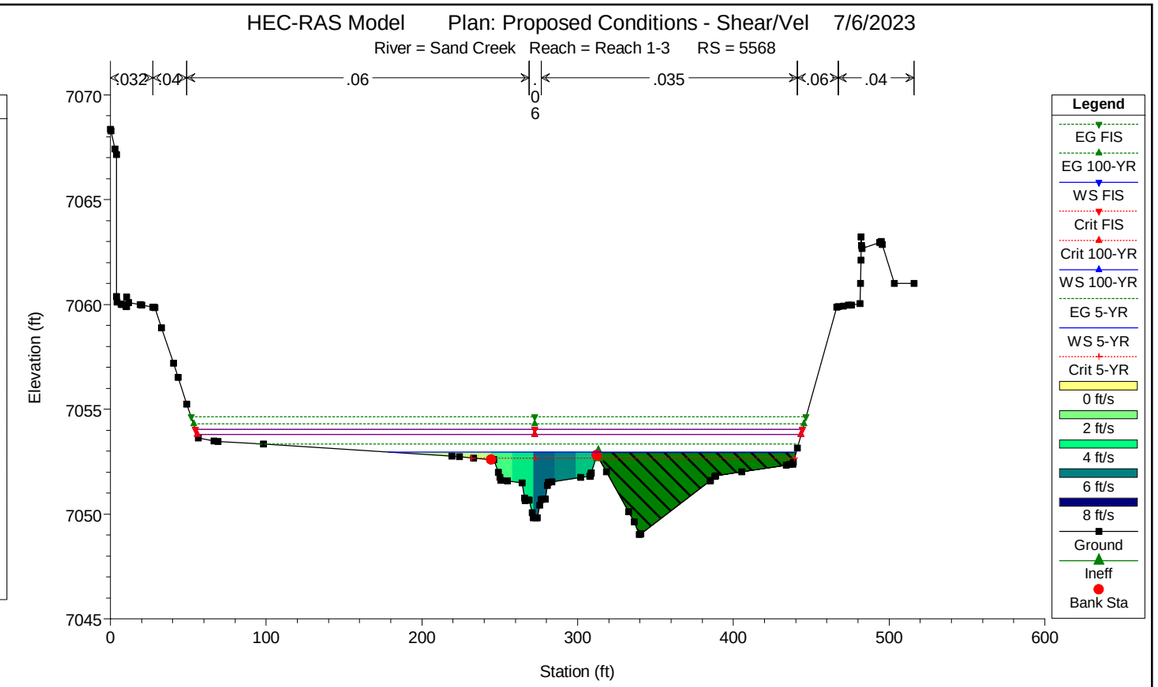


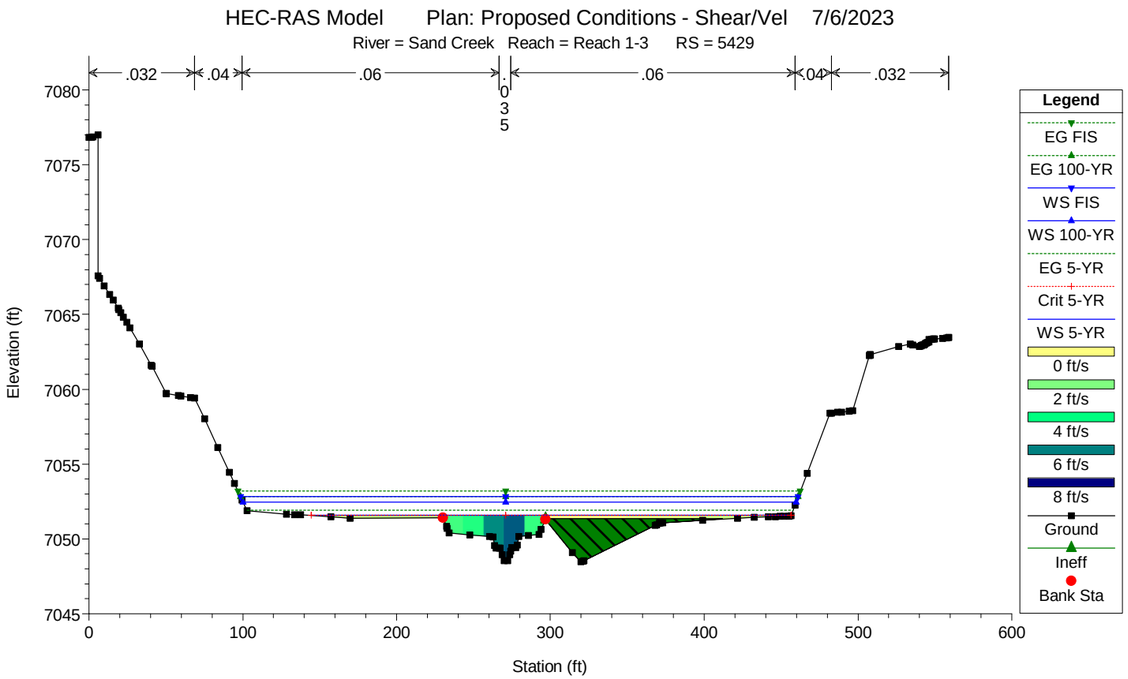


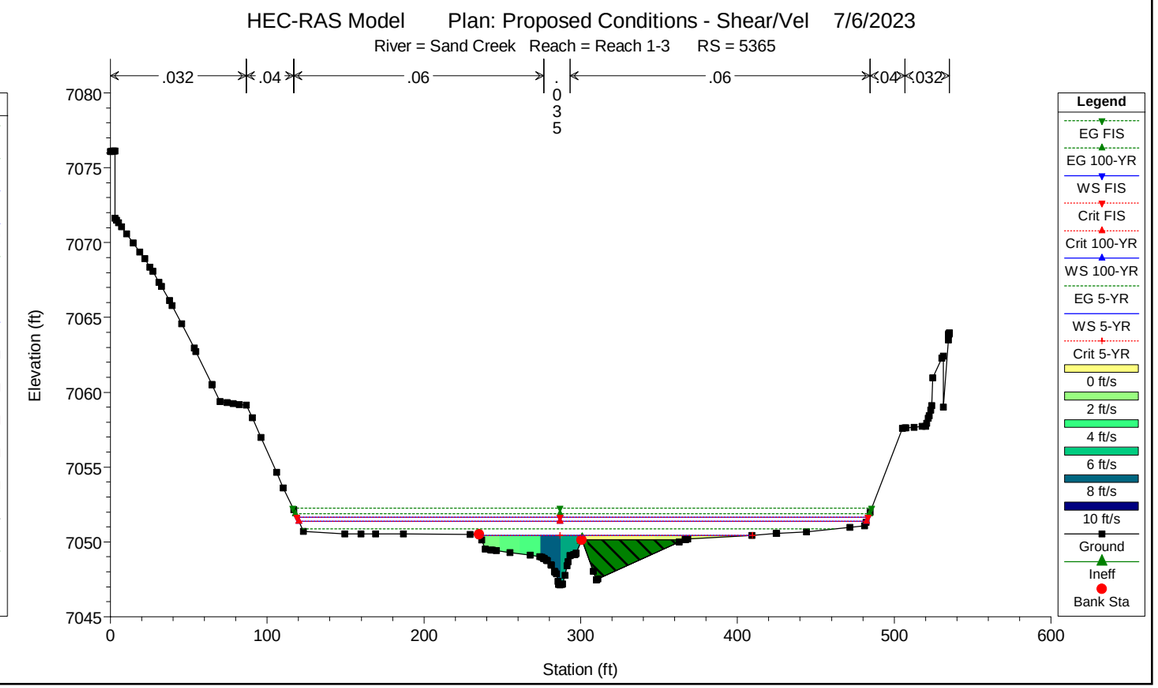


Sub-critical flow analysis for
Shear/Velocity evaluation of
Naturalized Channel Design

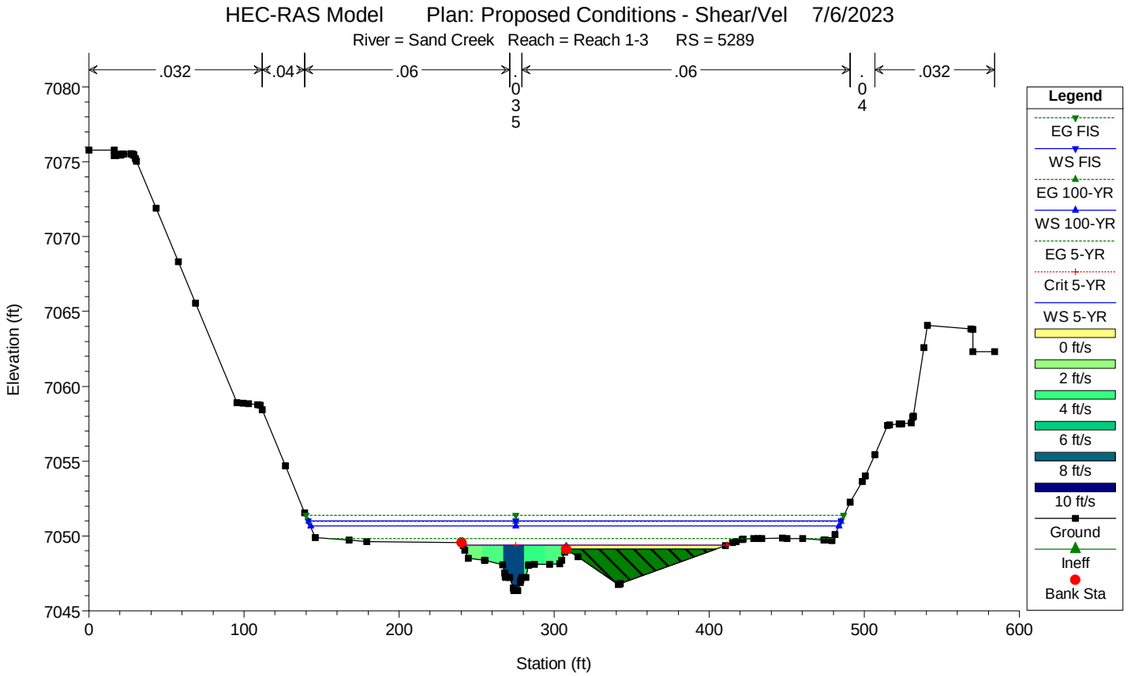


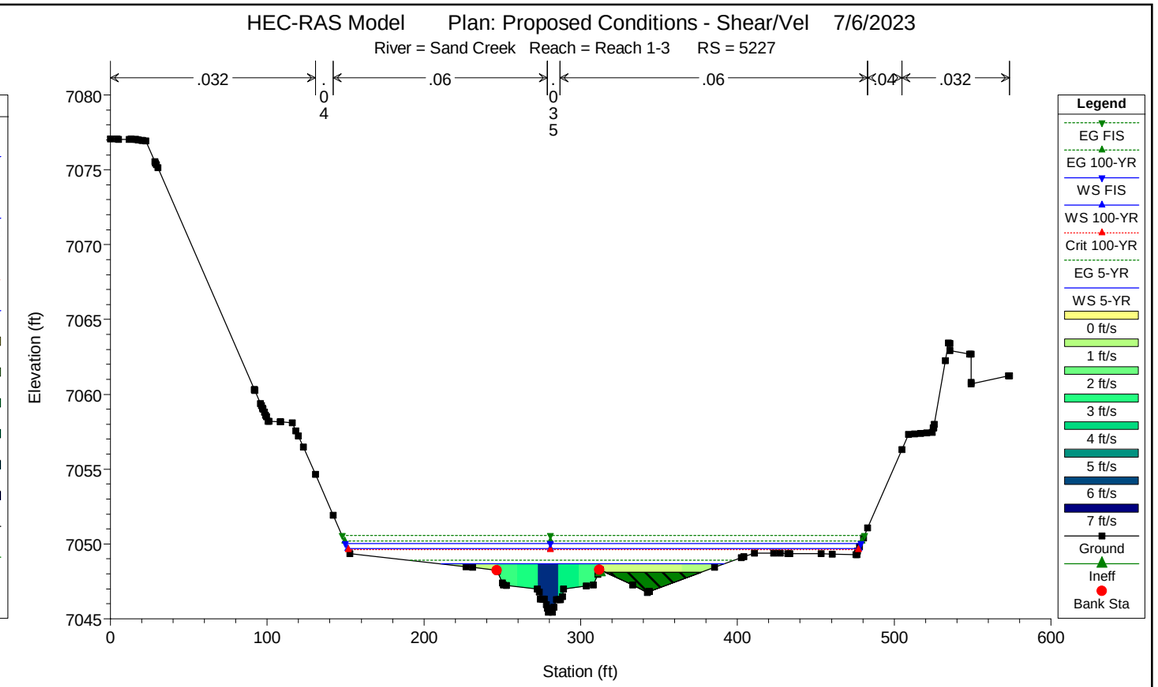


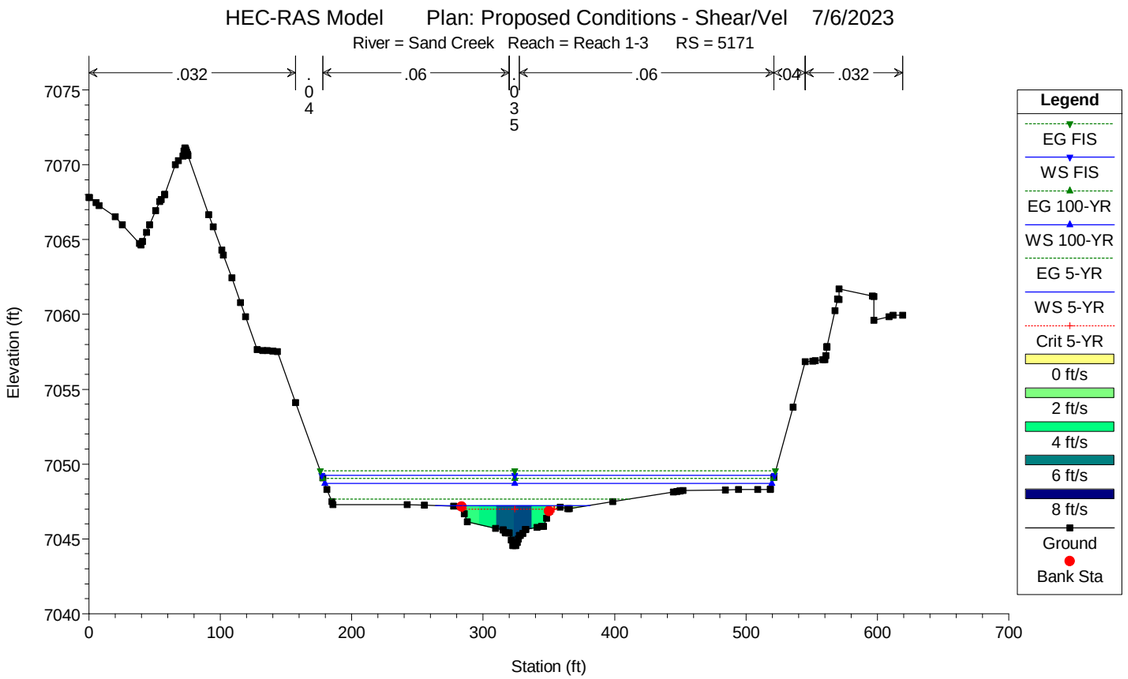


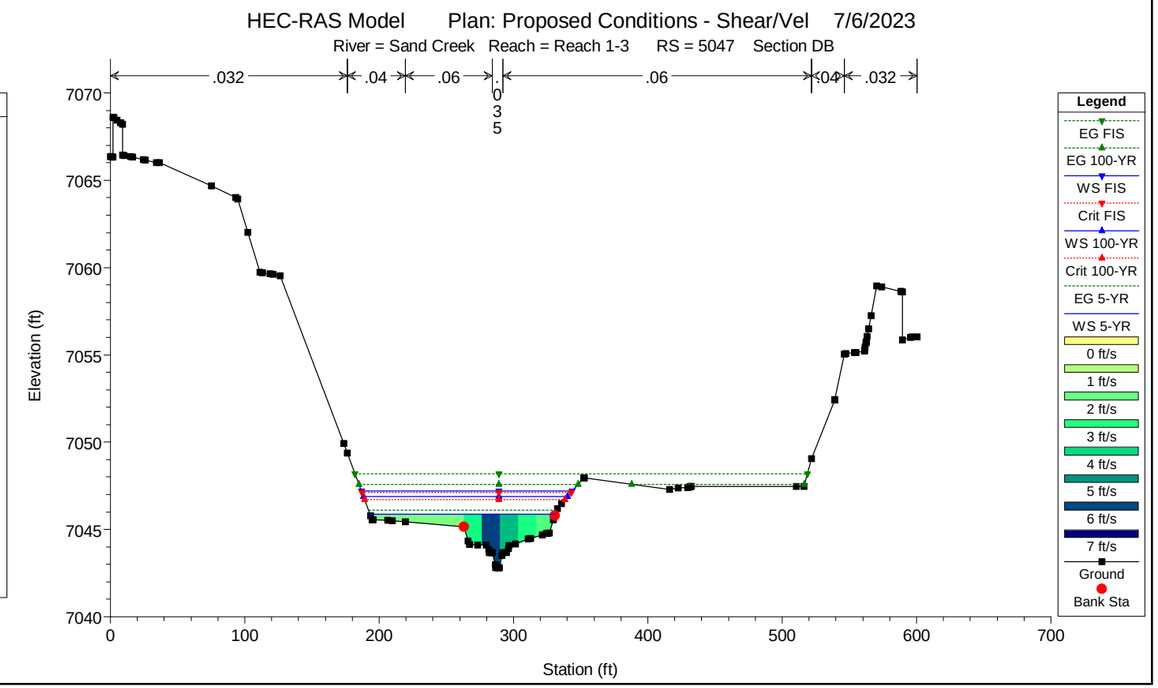


Sub-critical flow analysis for Shear/Velocity evaluation of Naturalized Channel Design

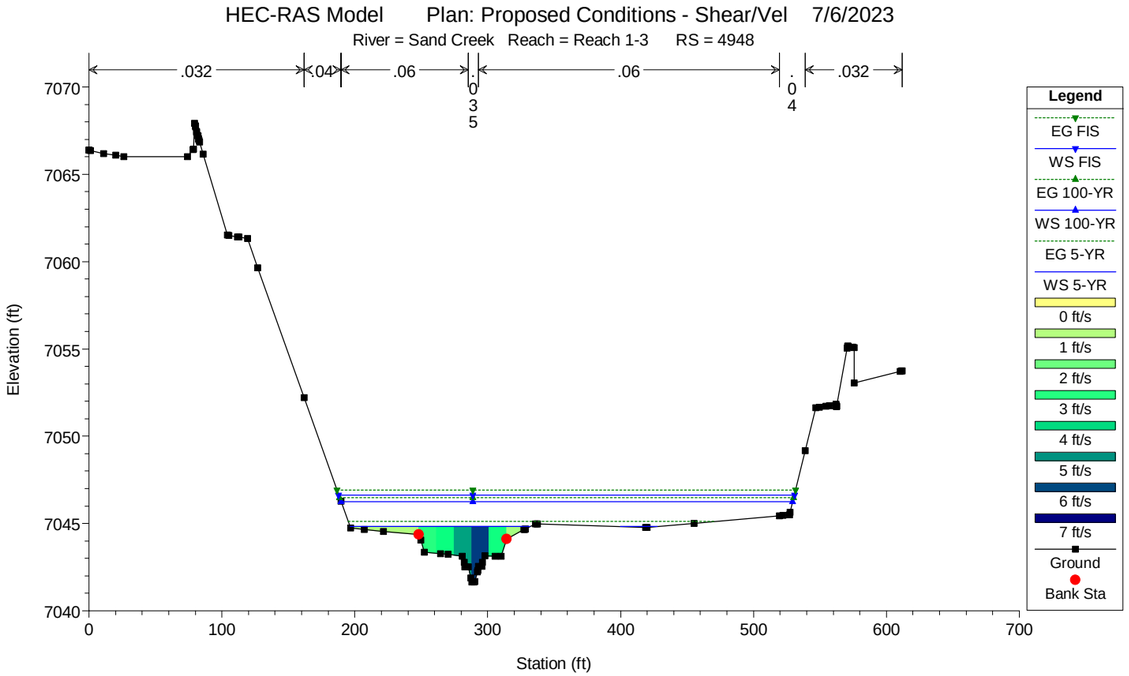


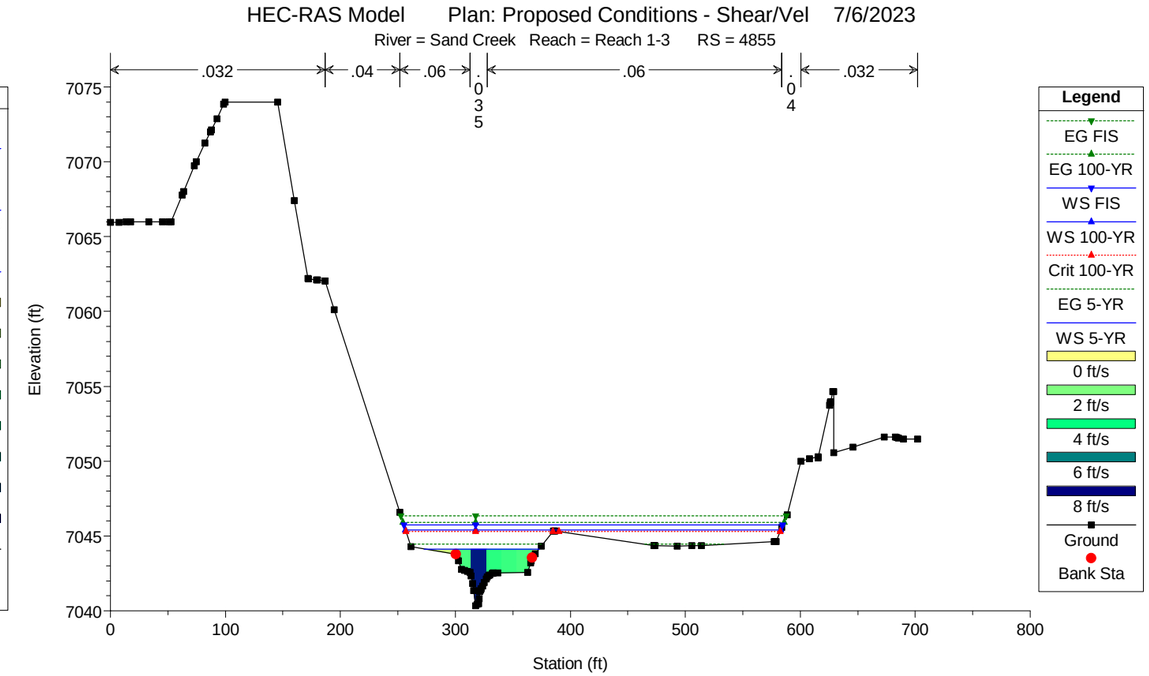


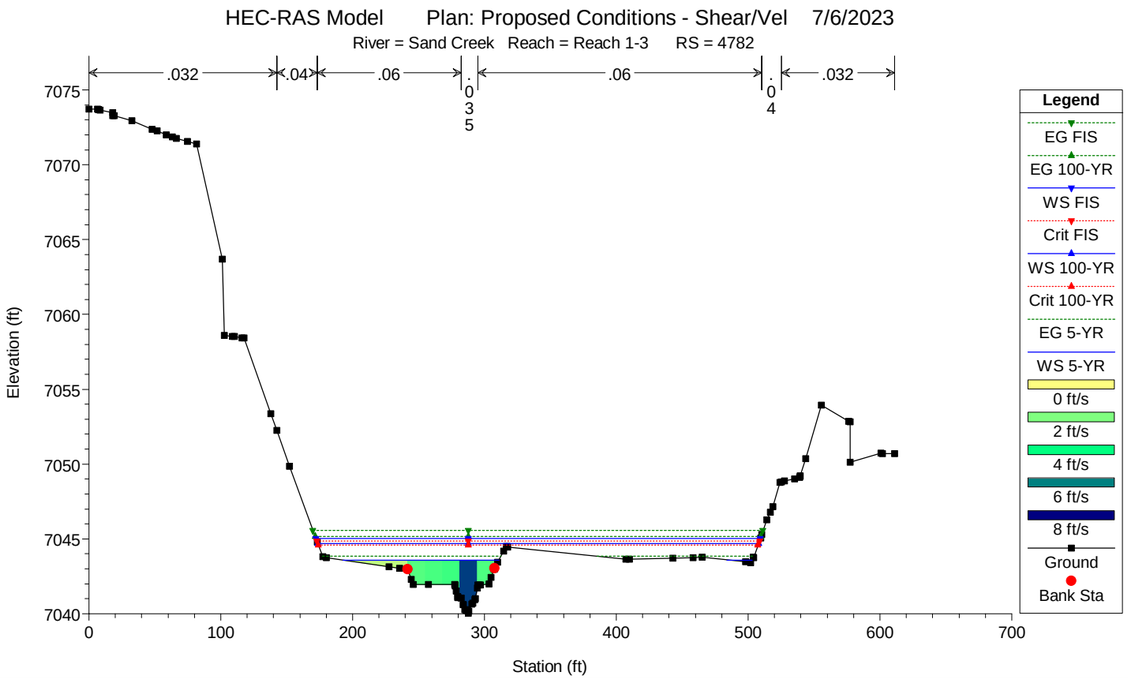


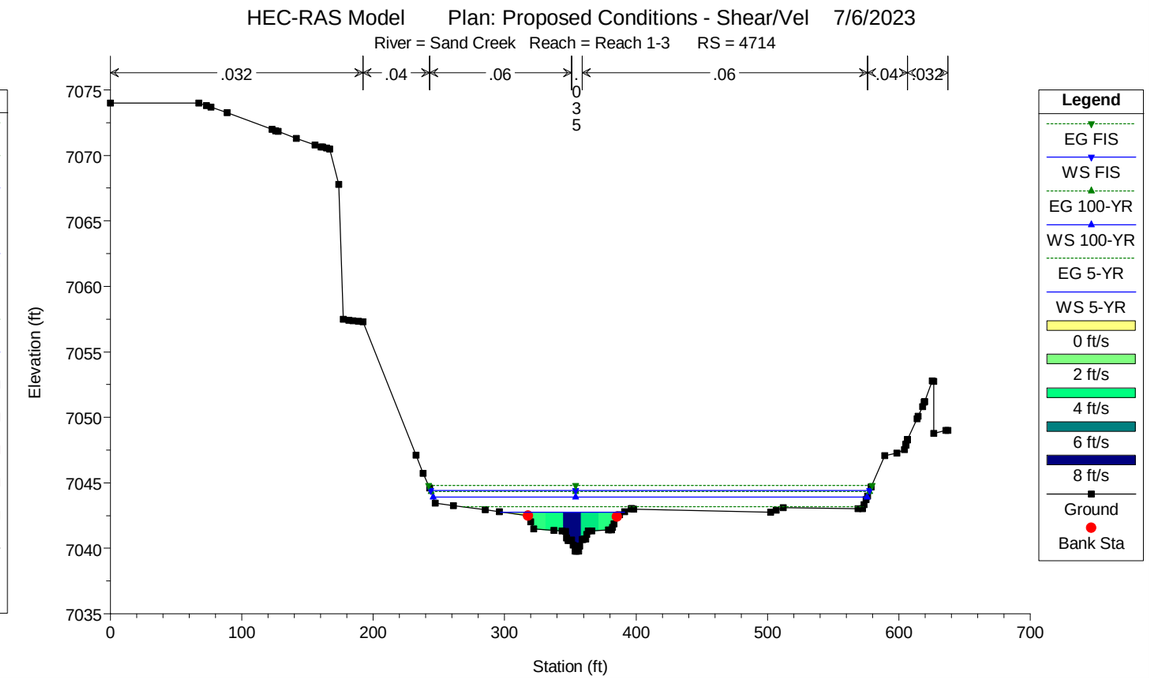


Sub-critical flow analysis for Shear/Velocity evaluation of Naturalized Channel Design

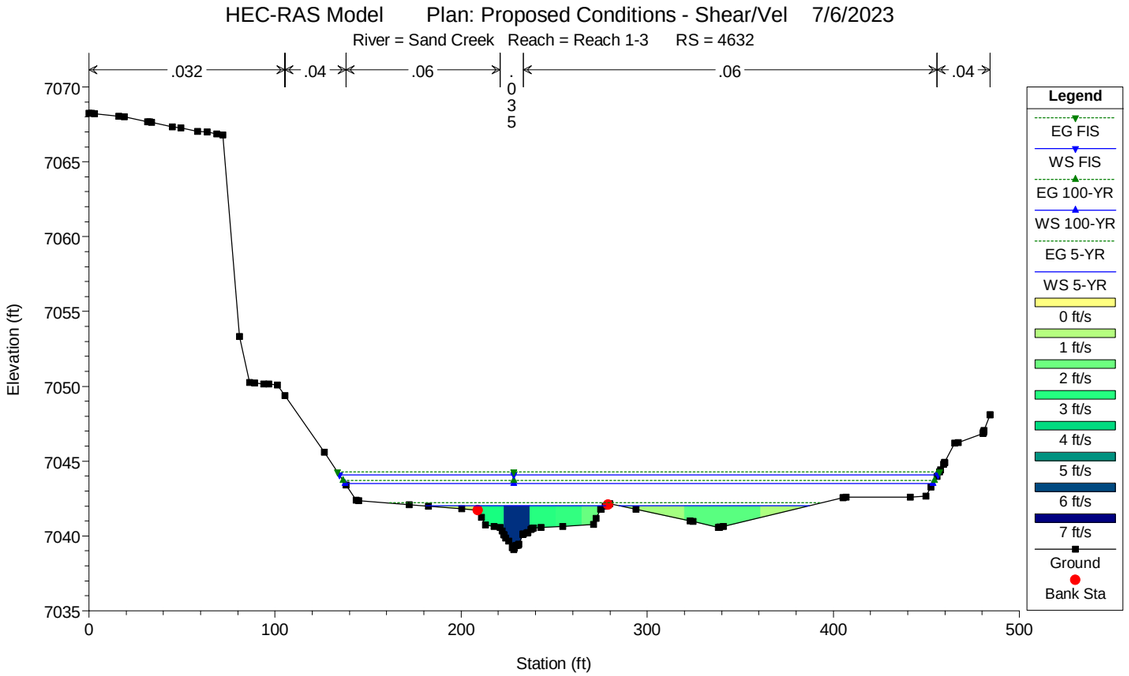


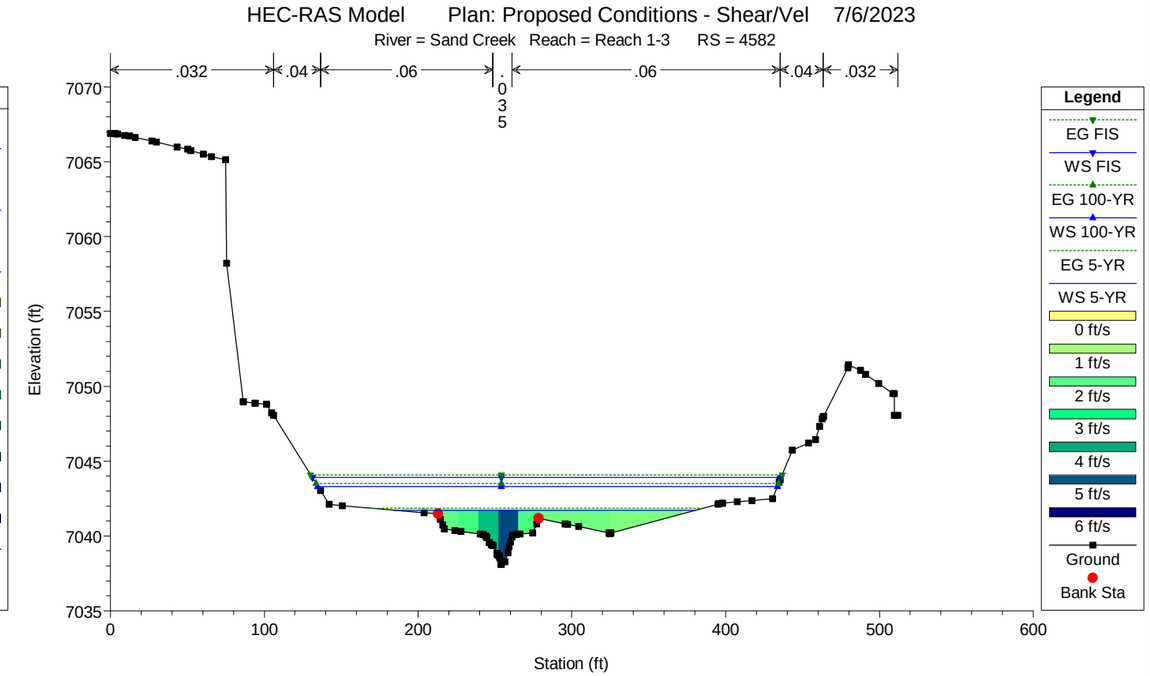


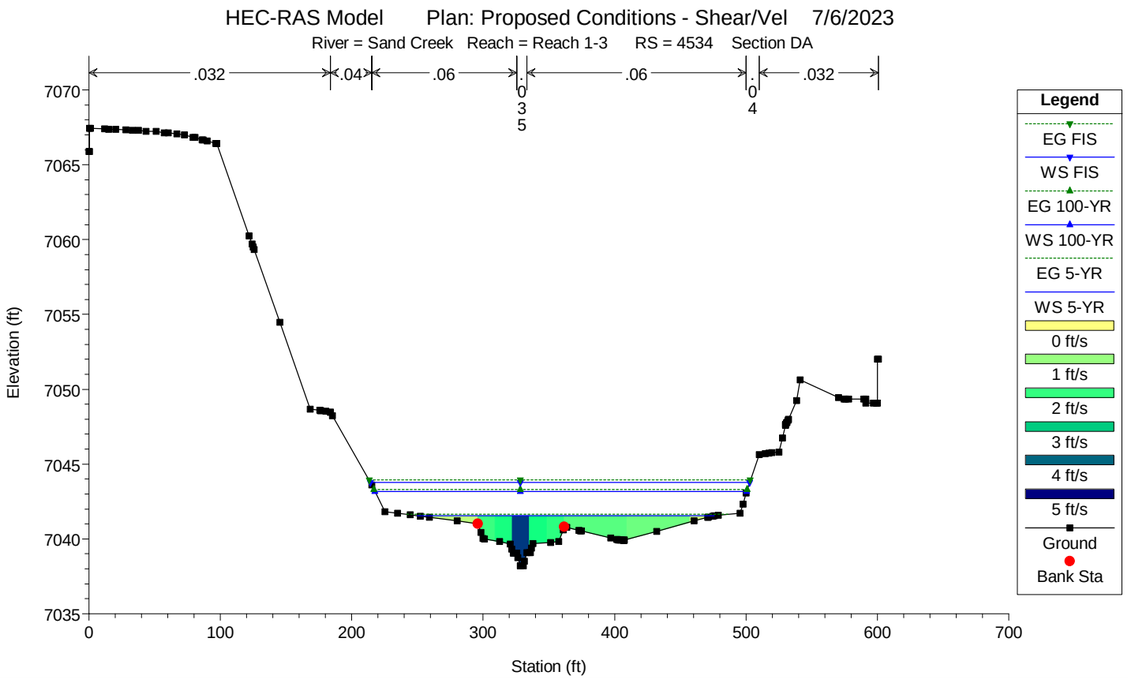


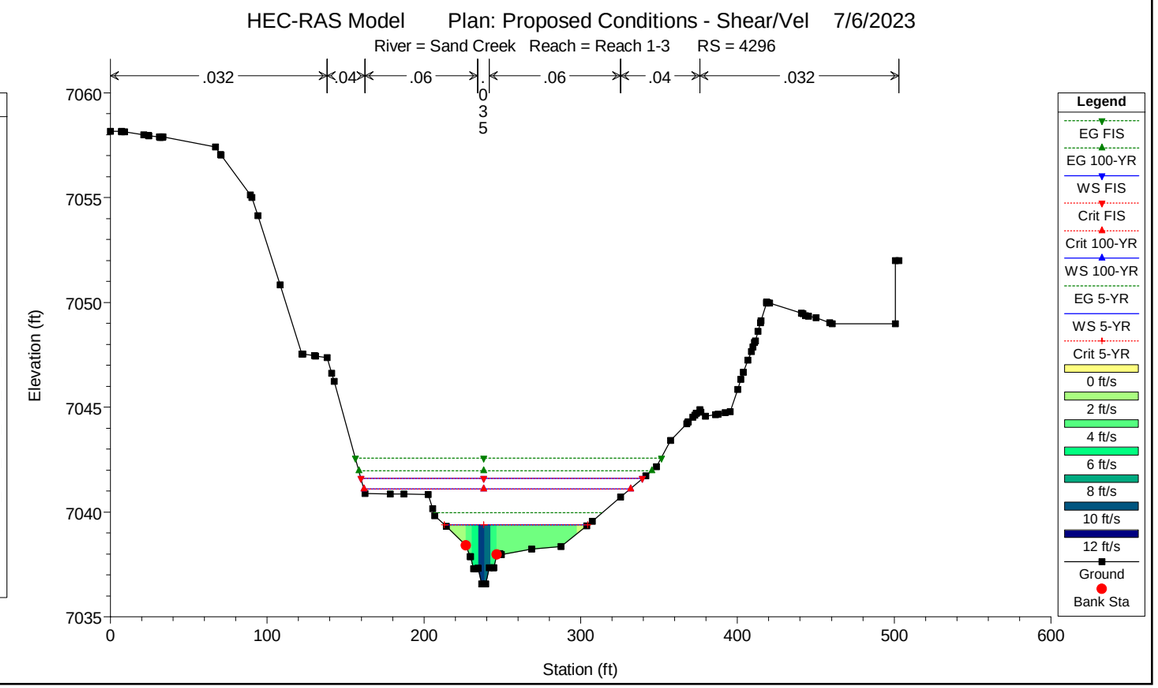


Sub-critical flow analysis for Shear/Velocity evaluation of Naturalized Channel Design

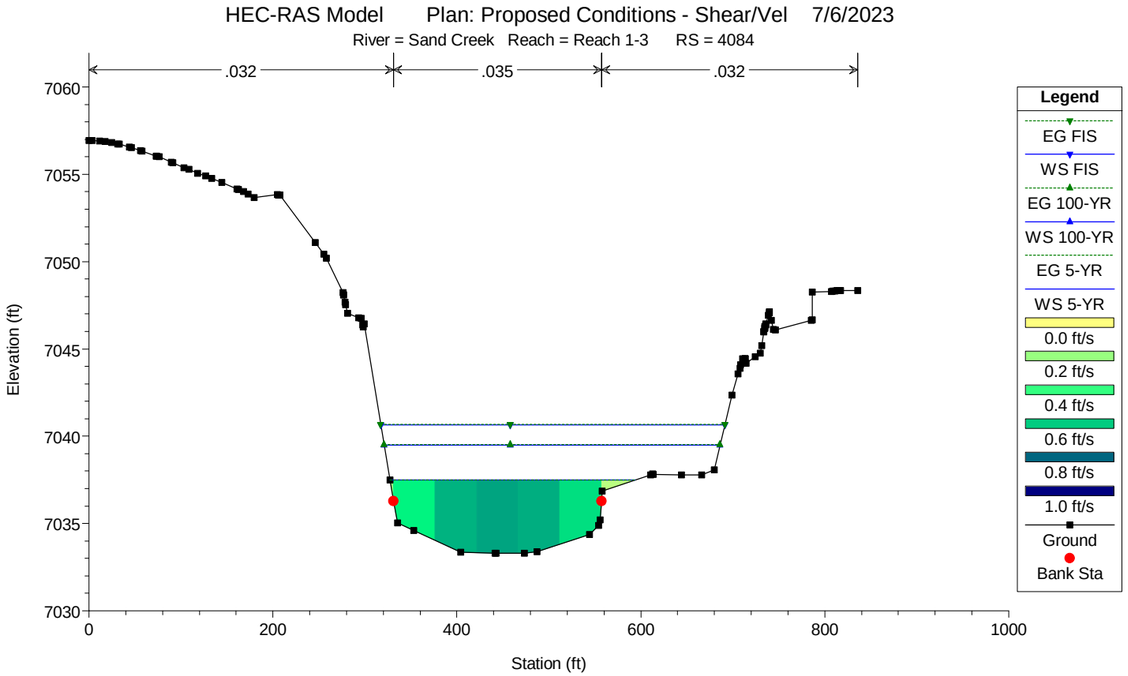


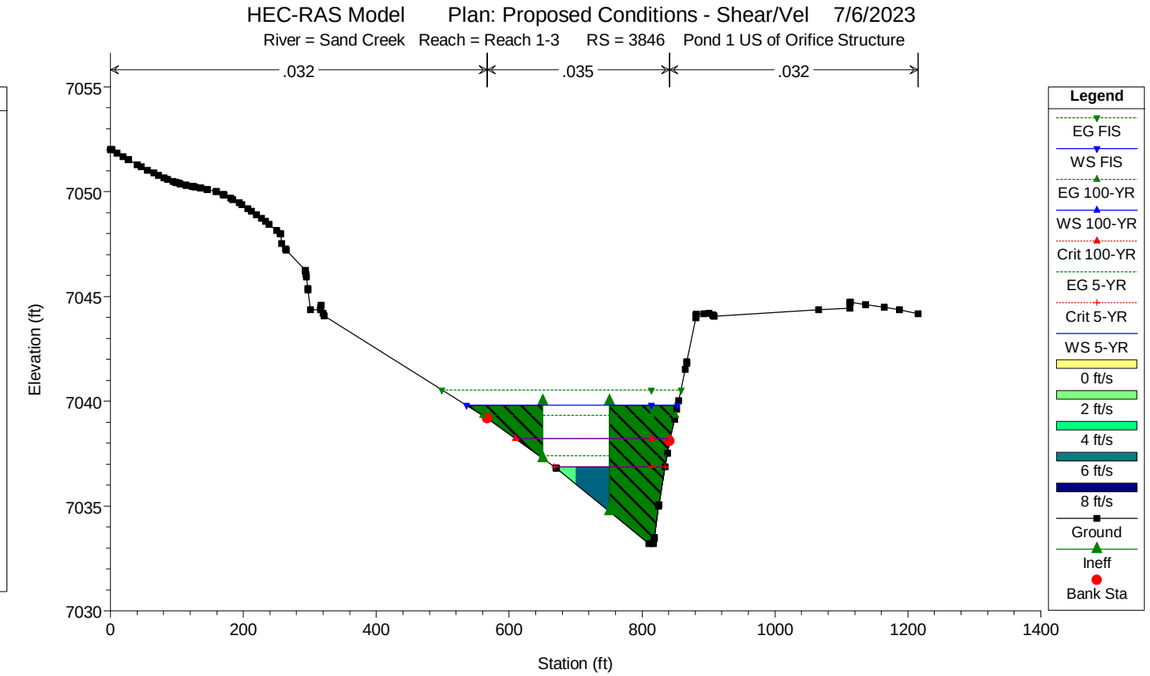


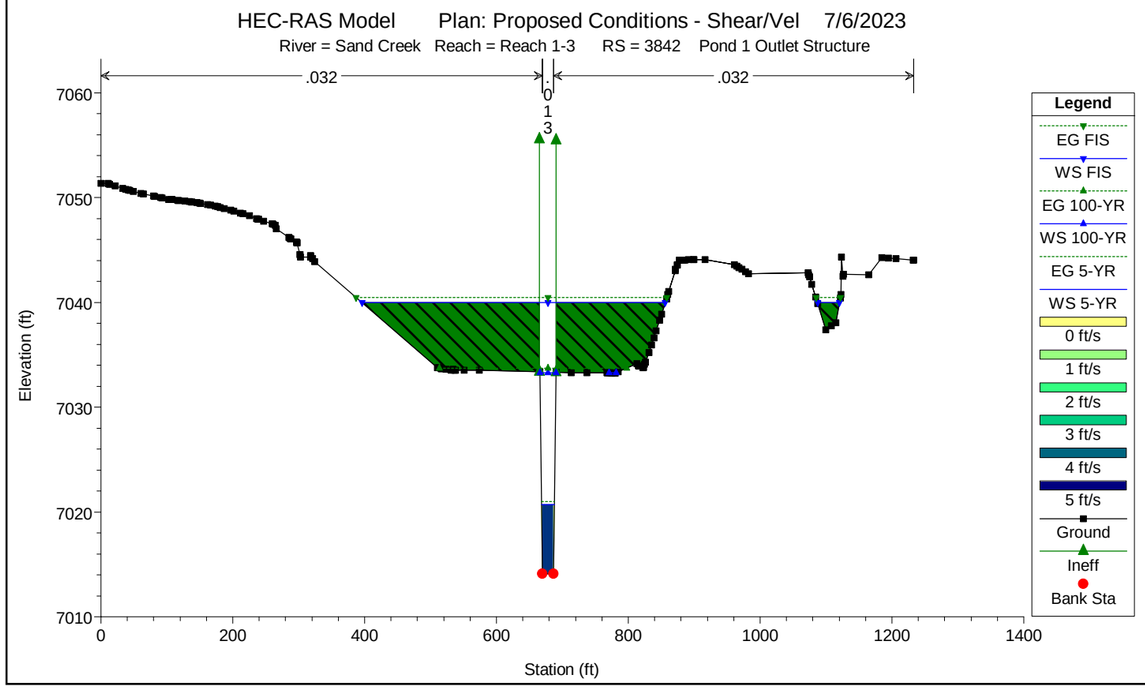


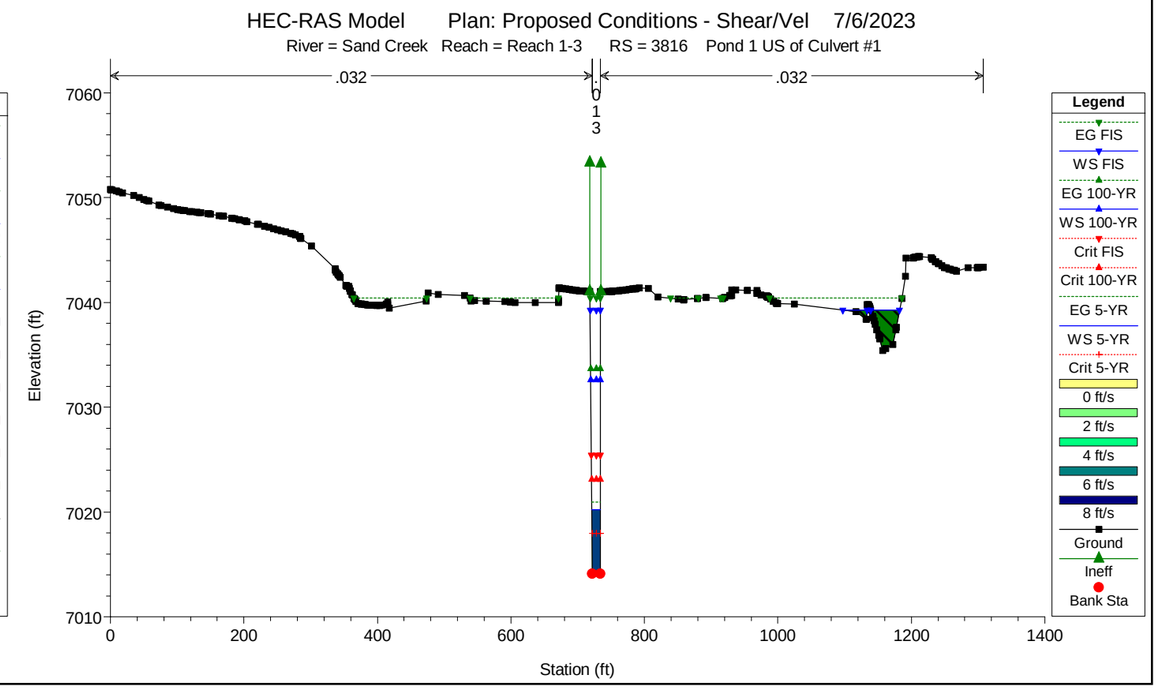


Sub-critical flow analysis for
Shear/Velocity evaluation of
Naturalized Channel Design





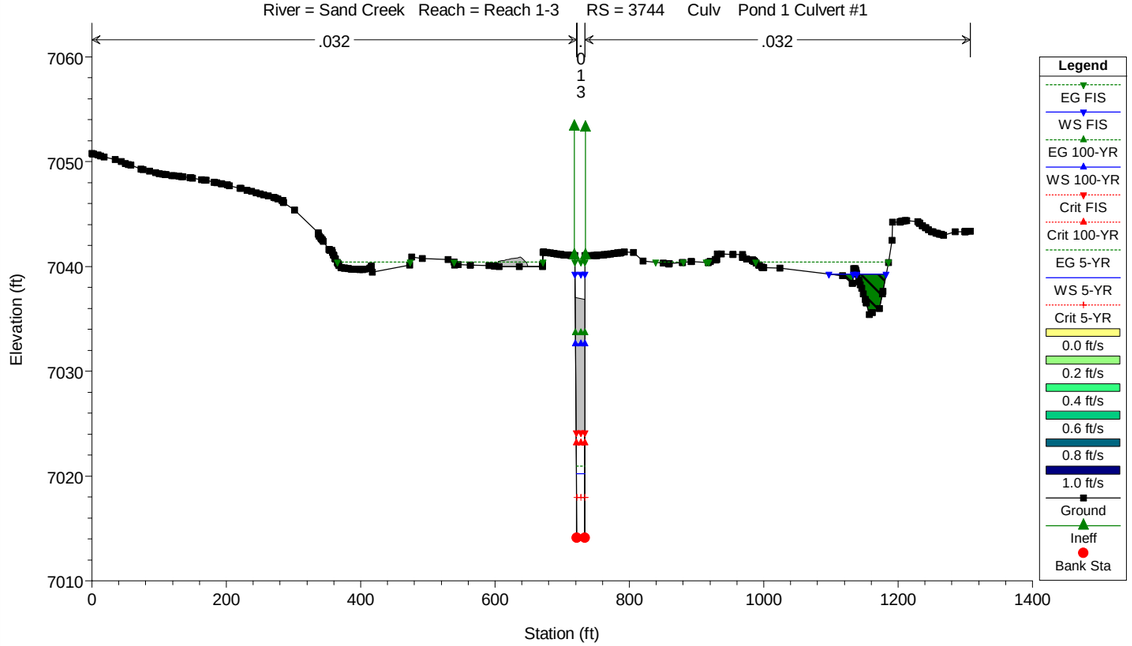




Sub-critical flow analysis for
Shear/Velocity evaluation of
Naturalized Channel Design

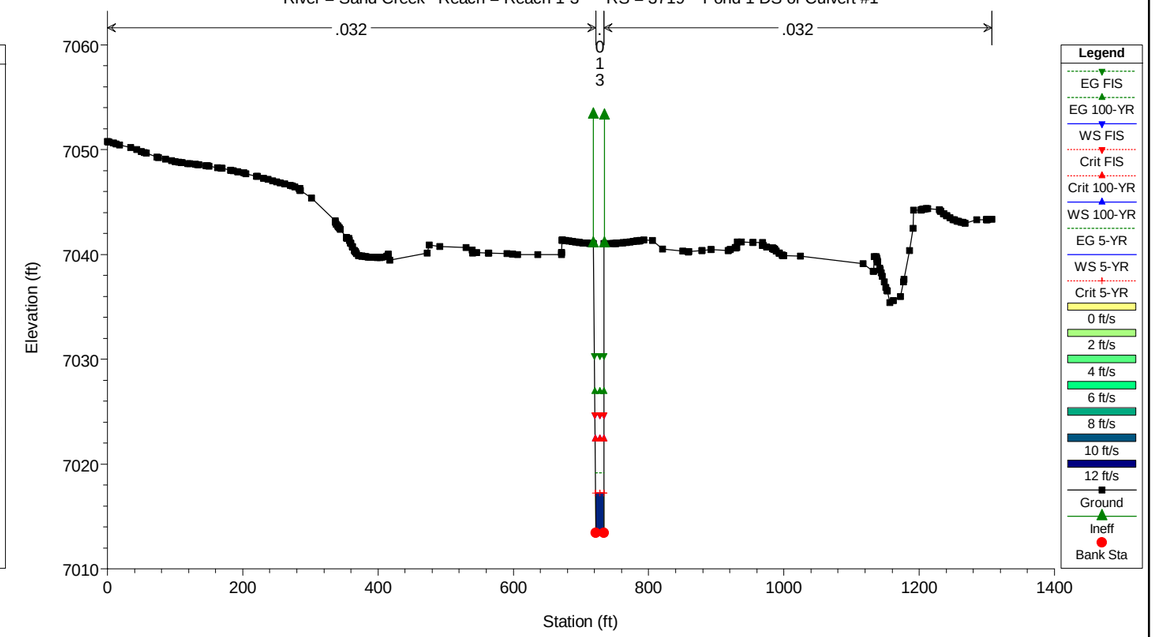
HEC-RAS Model Plan: Proposed Conditions - Shear/Vel 7/6/2023

River = Sand Creek Reach = Reach 1-3 RS = 3744 Culv Pond 1 Culvert #1



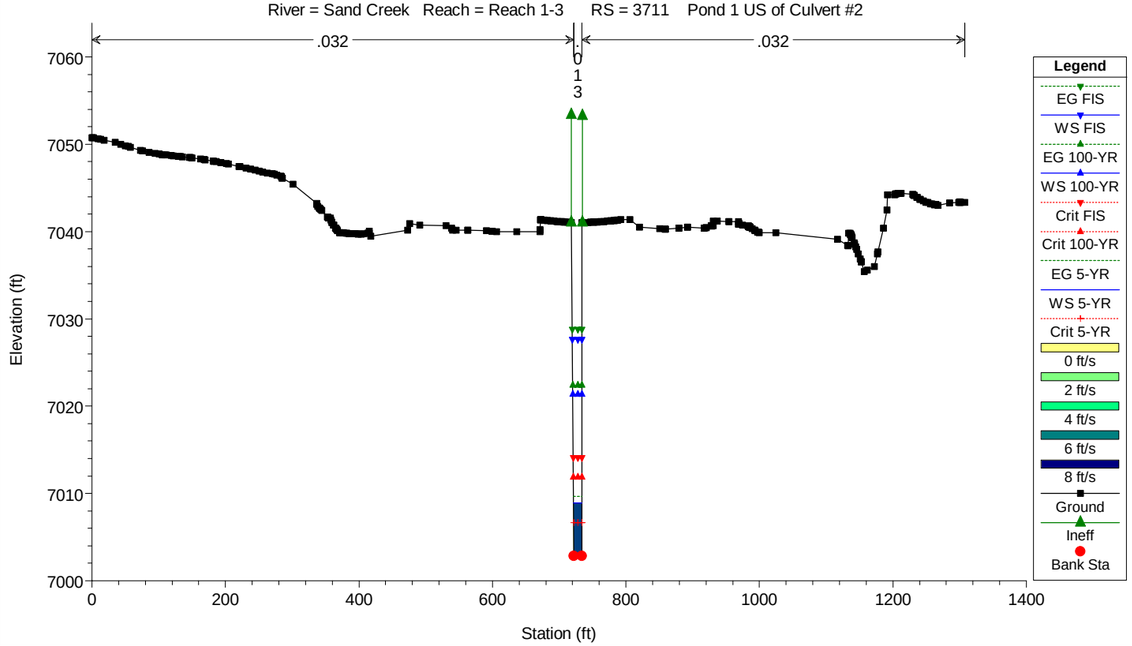
HEC-RAS Model Plan: Proposed Conditions - Shear/Vel 7/6/2023

River = Sand Creek Reach = Reach 1-3 RS = 3719 Pond 1 DS of Culvert #1



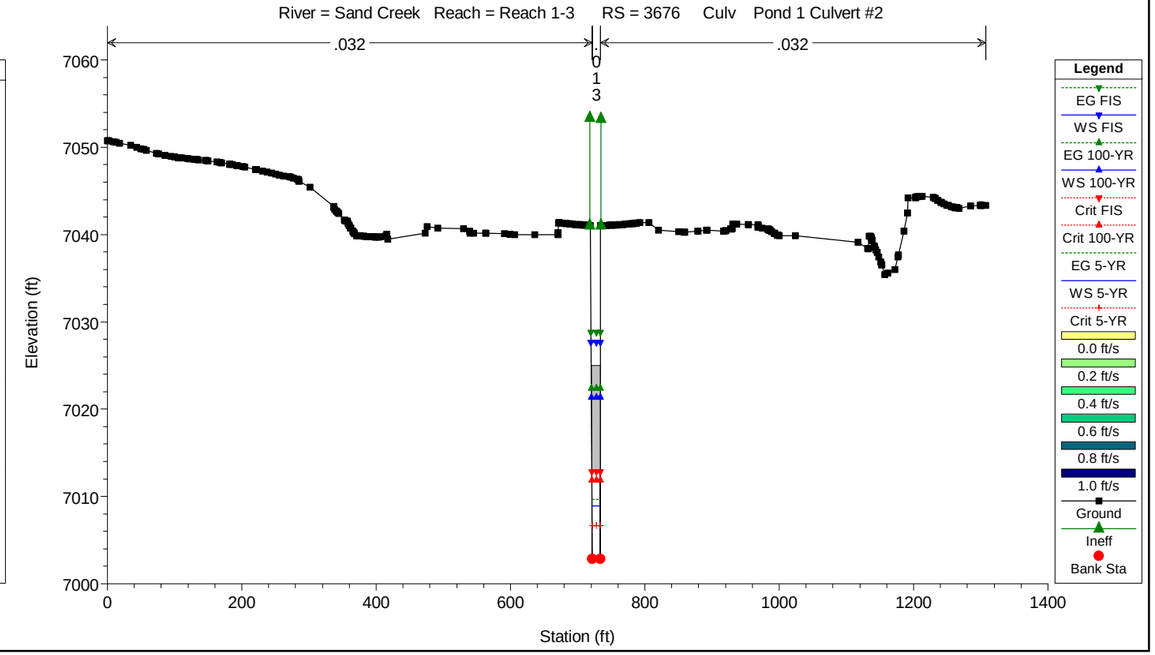
HEC-RAS Model Plan: Proposed Conditions - Shear/Vel 7/6/2023

River = Sand Creek Reach = Reach 1-3 RS = 3711 Pond 1 US of Culvert #2

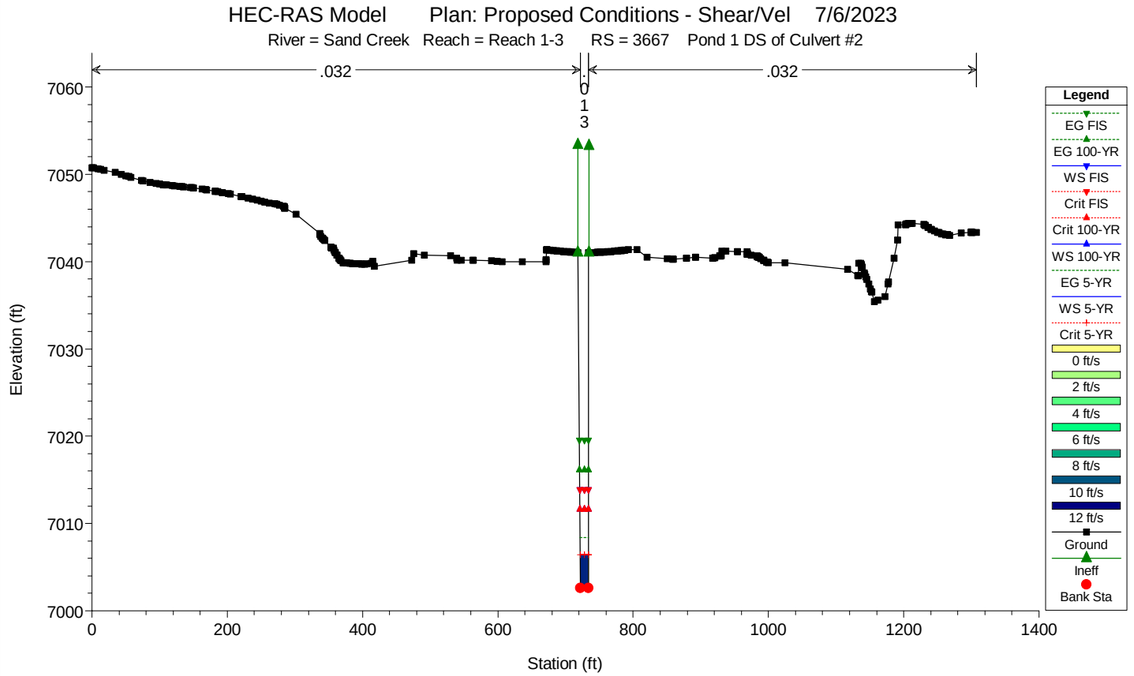


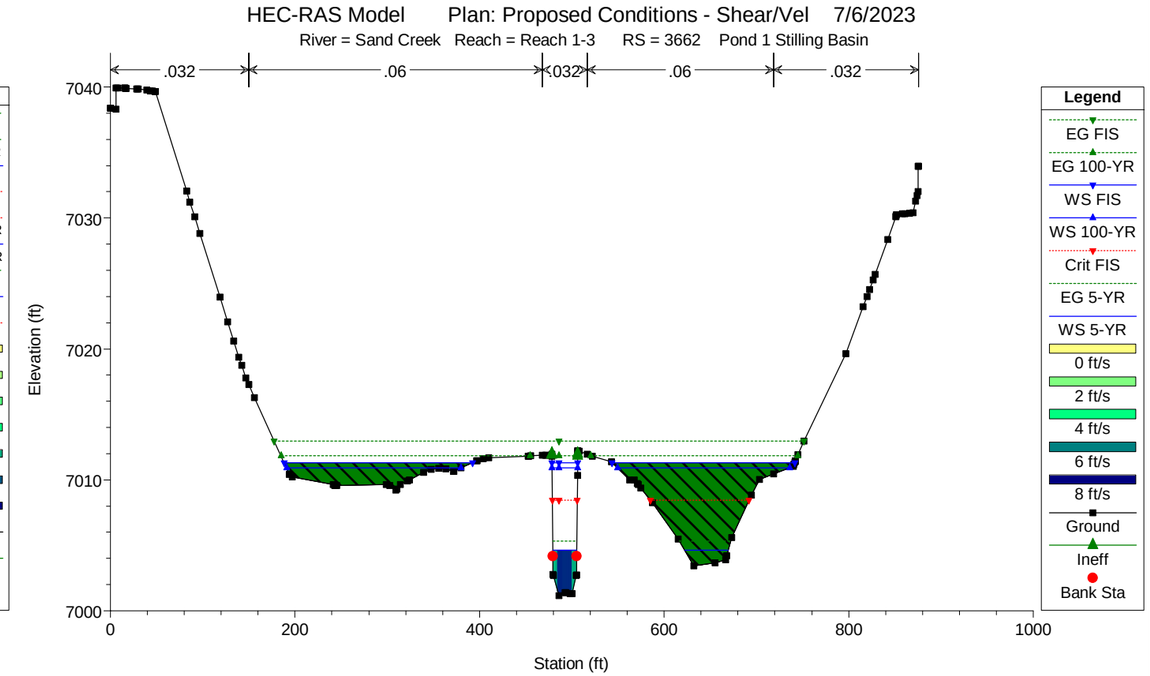
HEC-RAS Model Plan: Proposed Conditions - Shear/Vel 7/6/2023

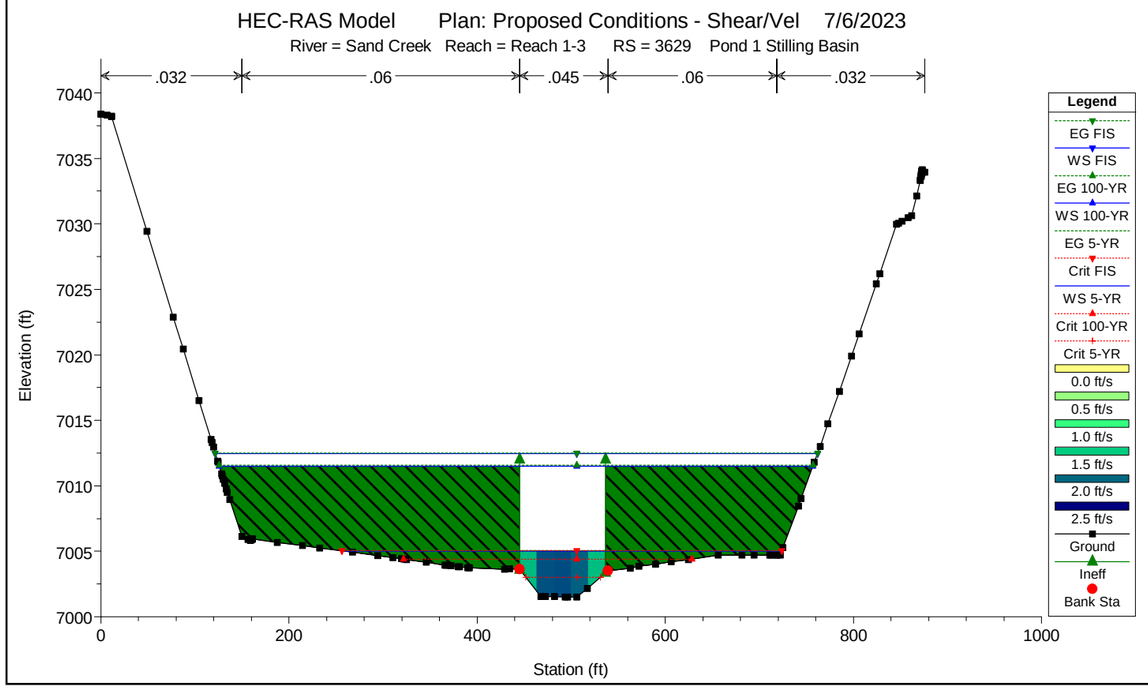
River = Sand Creek Reach = Reach 1-3 RS = 3676 Culv Pond 1 Culvert #2

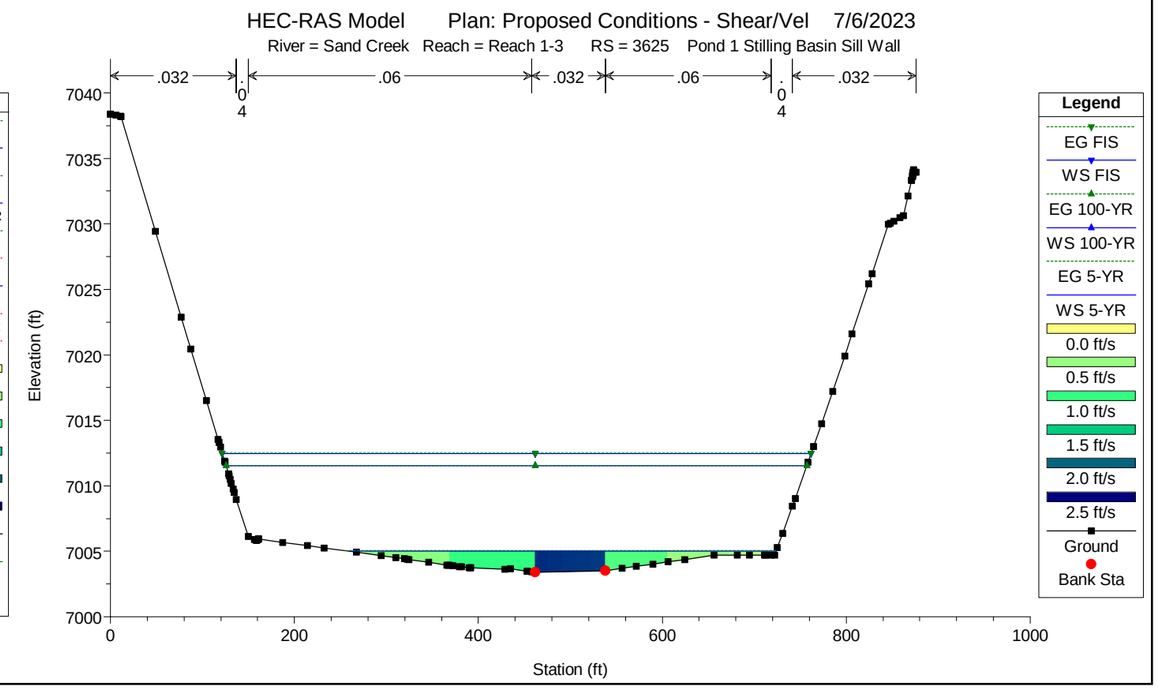


Sub-critical flow analysis for
Shear/Velocity evaluation of
Naturalized Channel Design

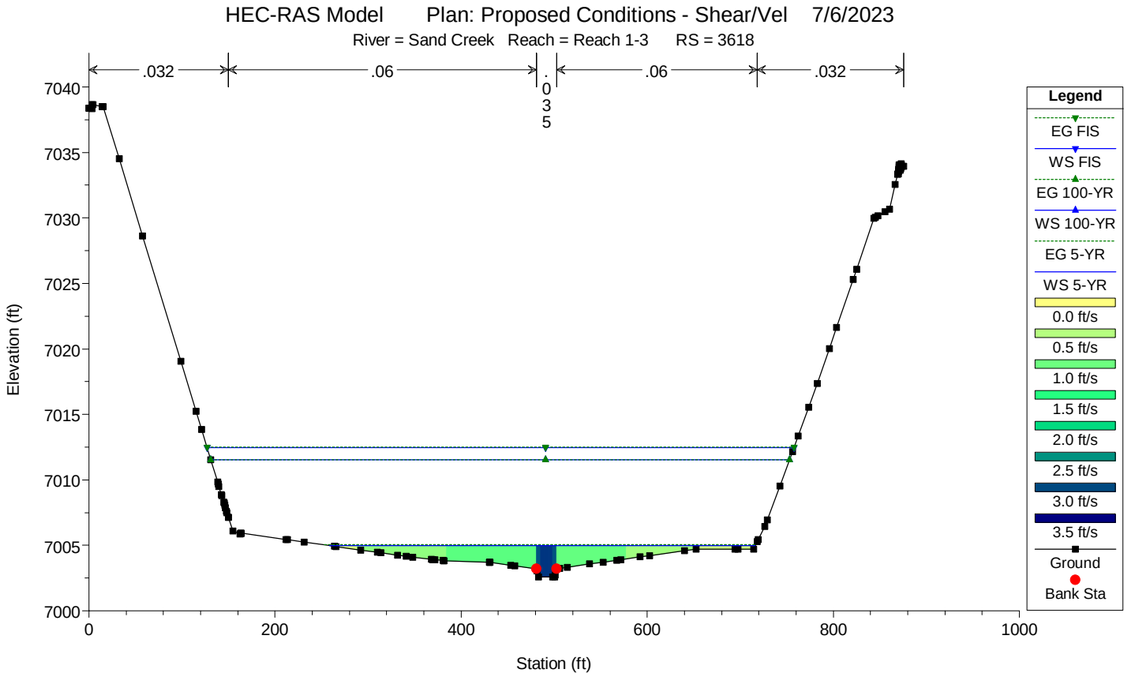


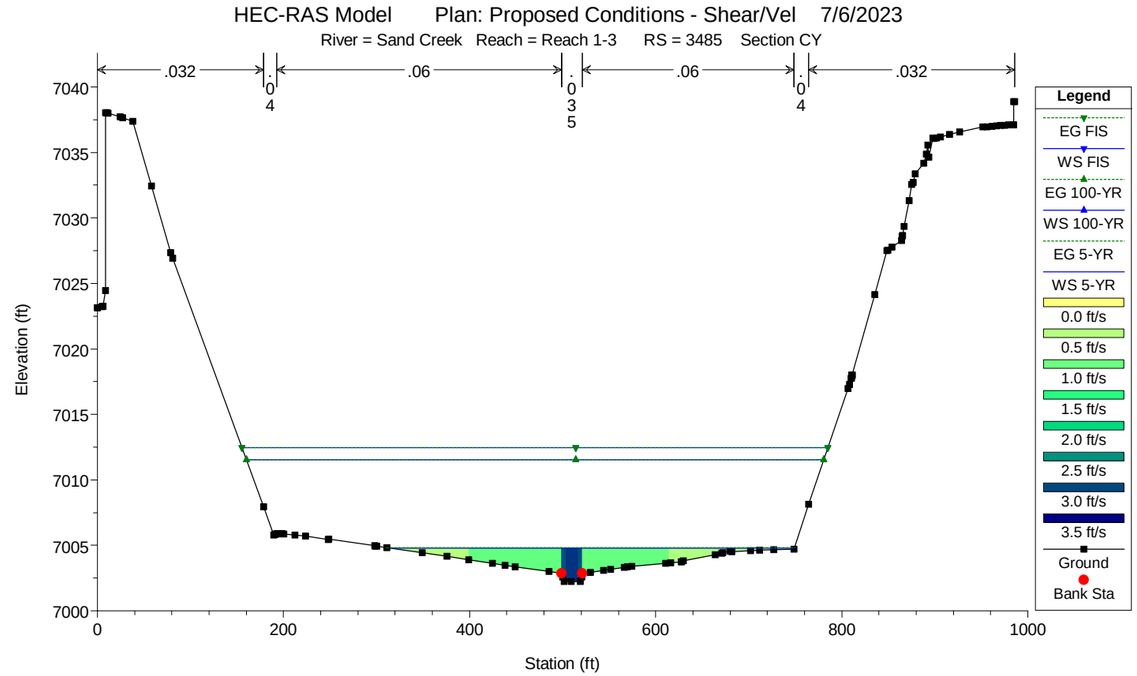


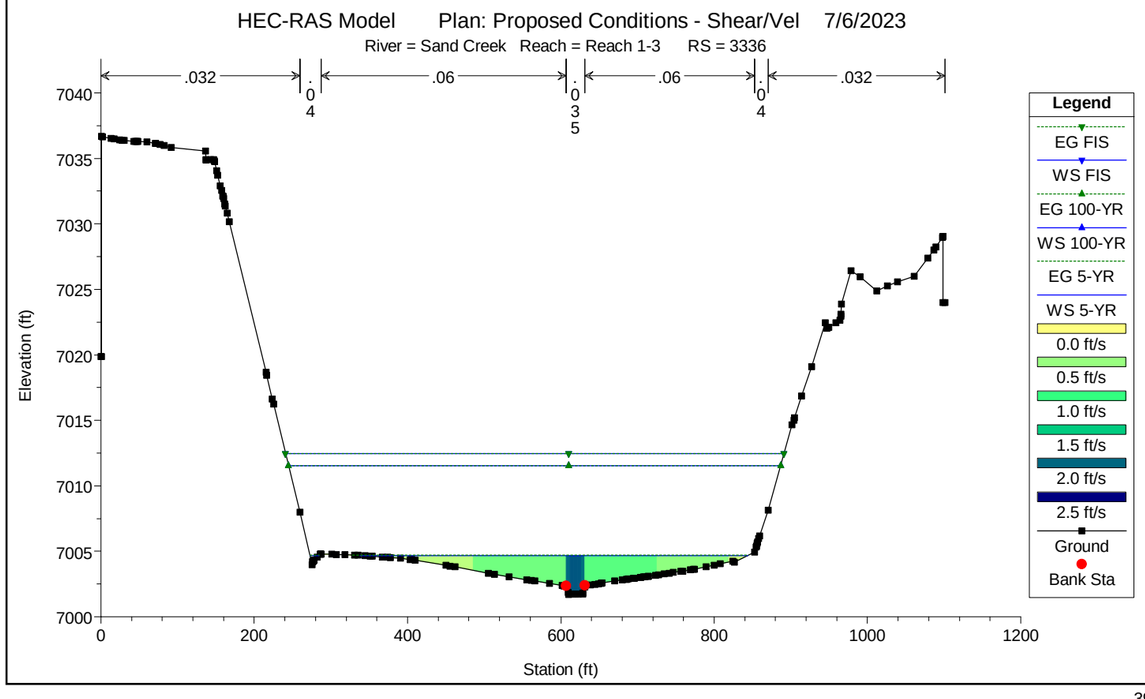


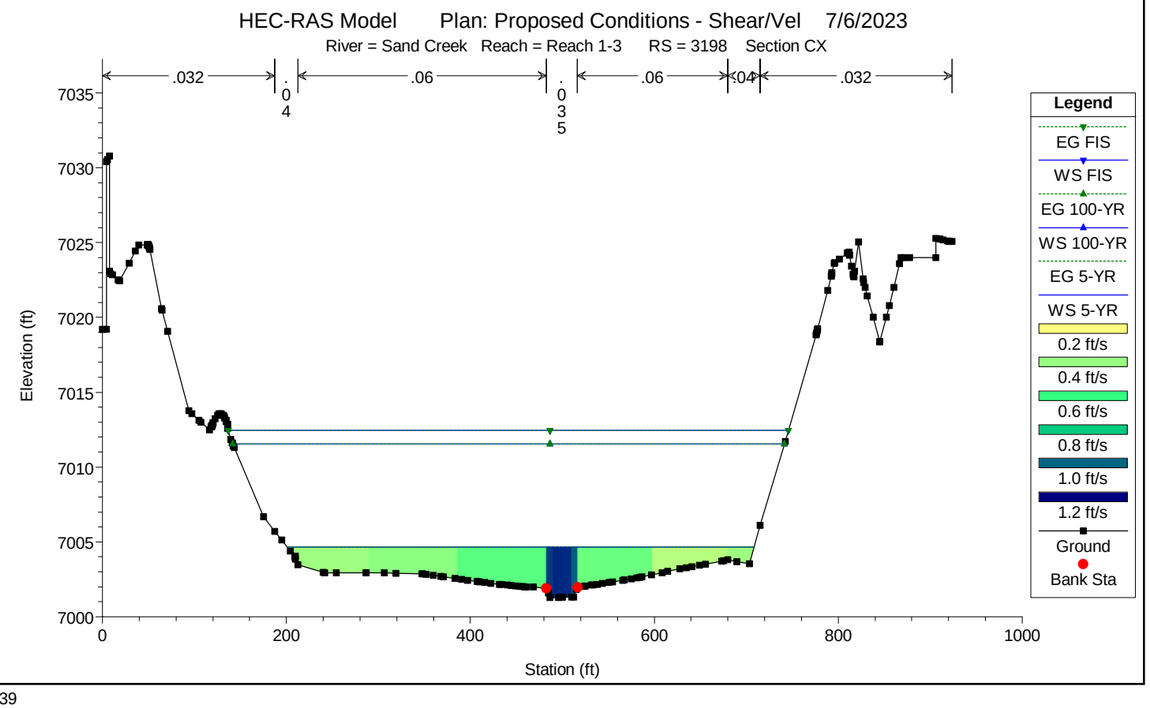


Sub-critical flow analysis for
Shear/Velocity evaluation of
Naturalized Channel Design

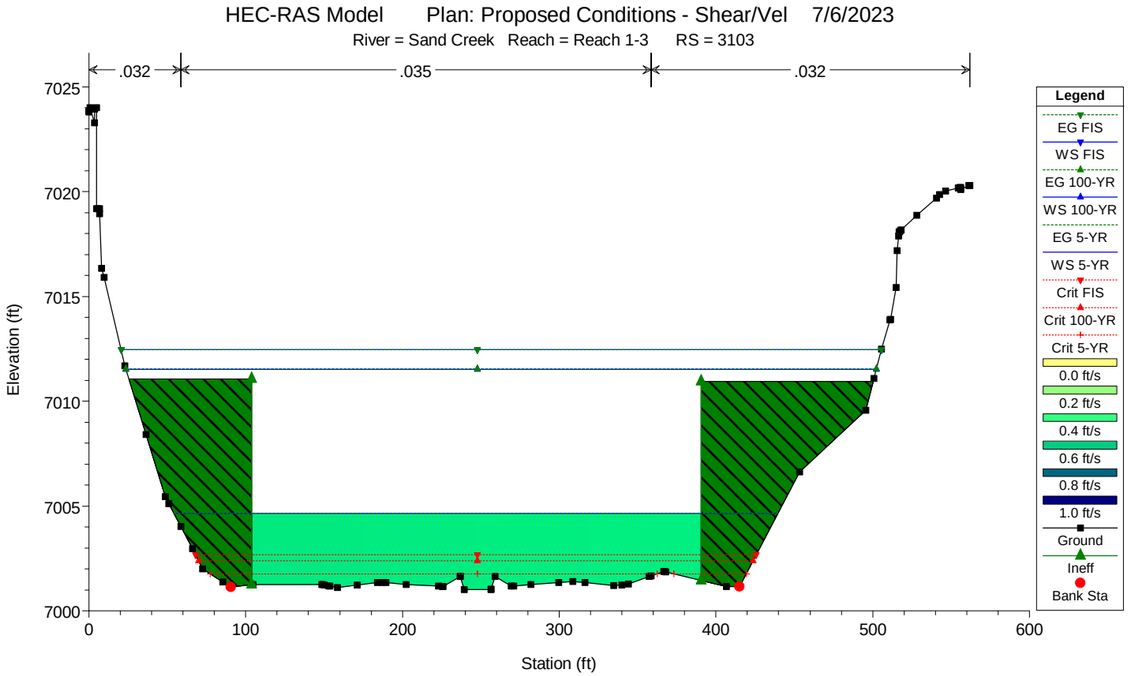


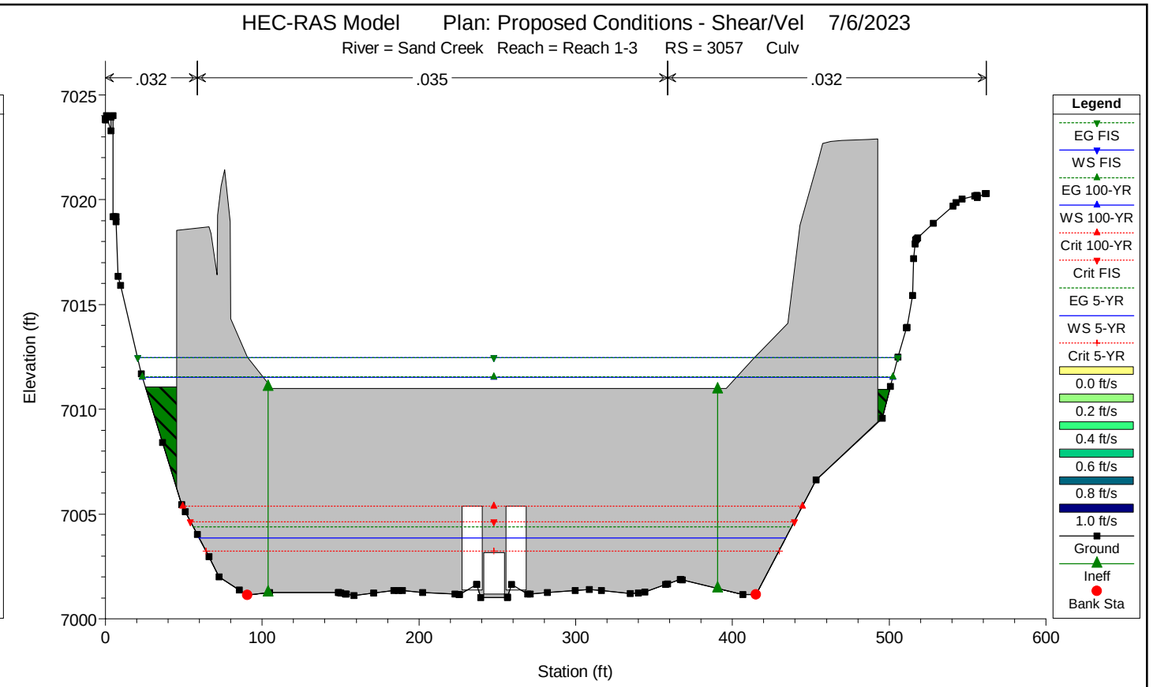


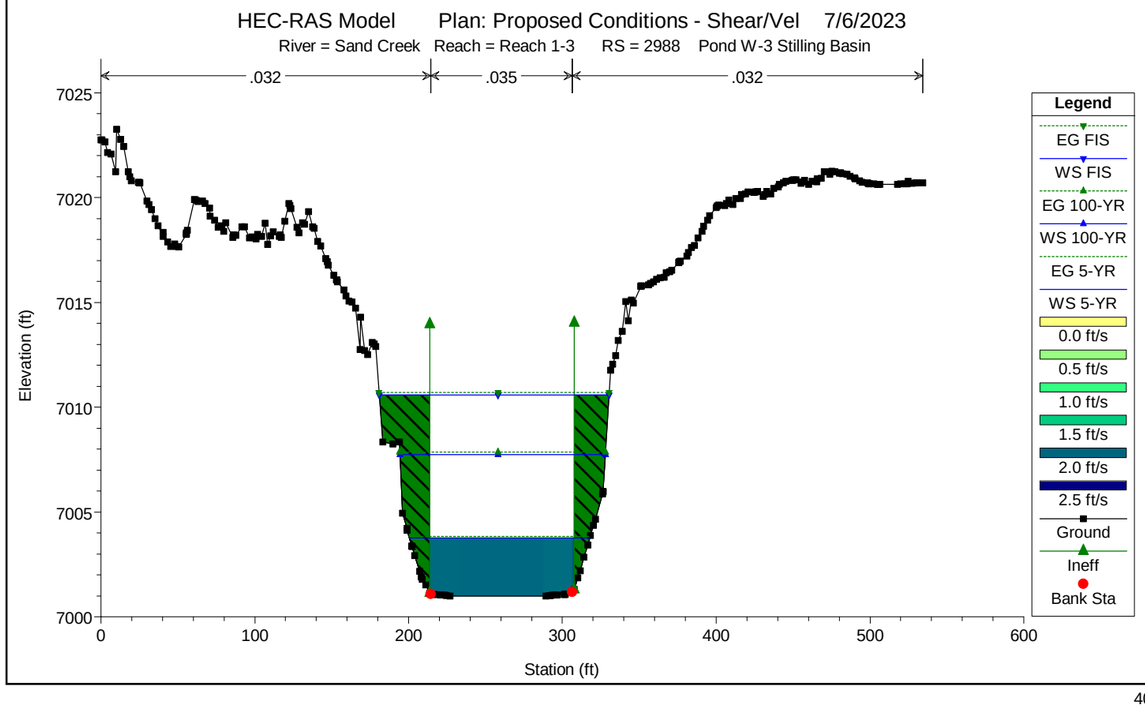


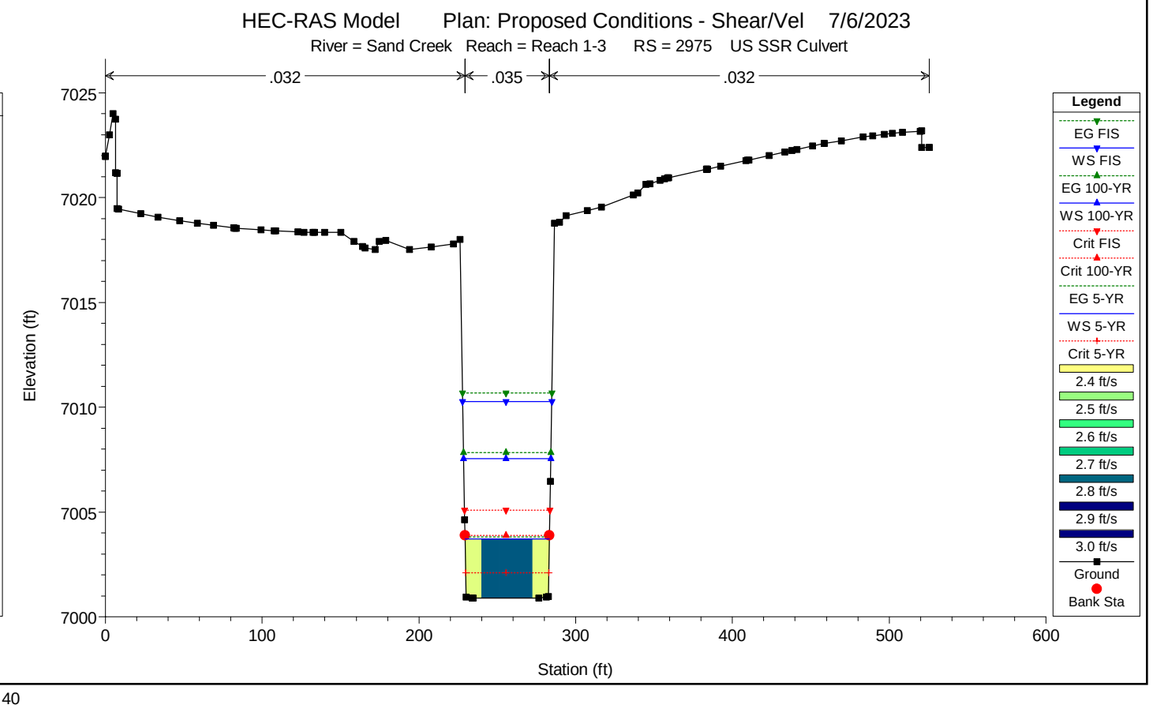


Sub-critical flow analysis for
Shear/Velocity evaluation of
Naturalized Channel Design

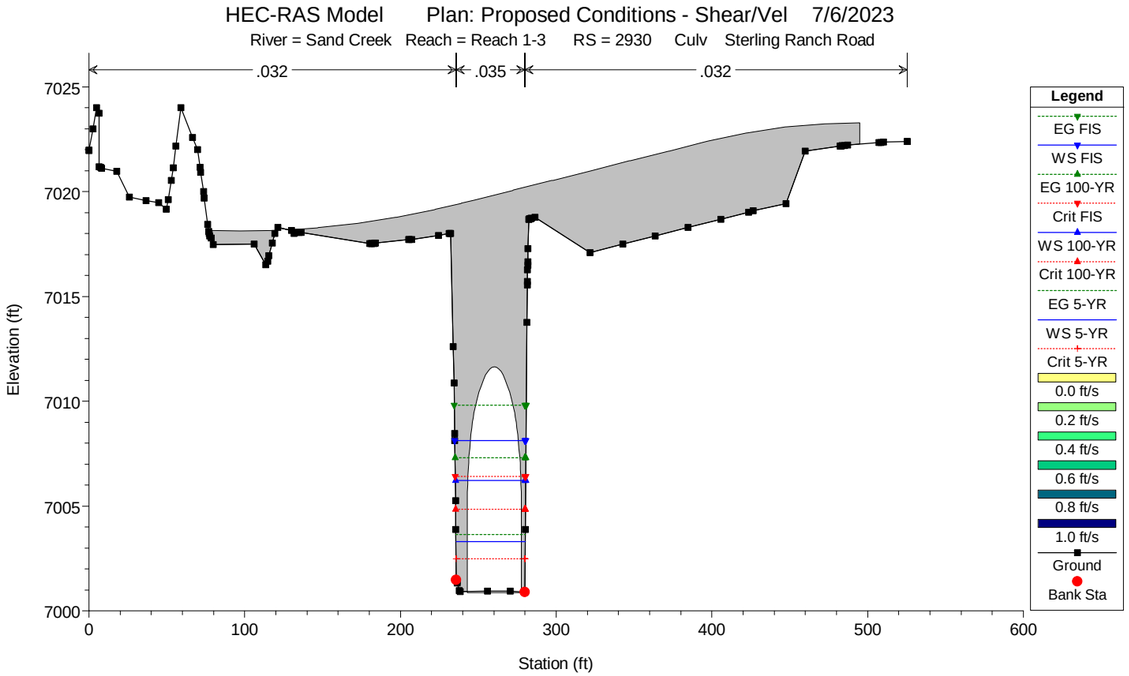


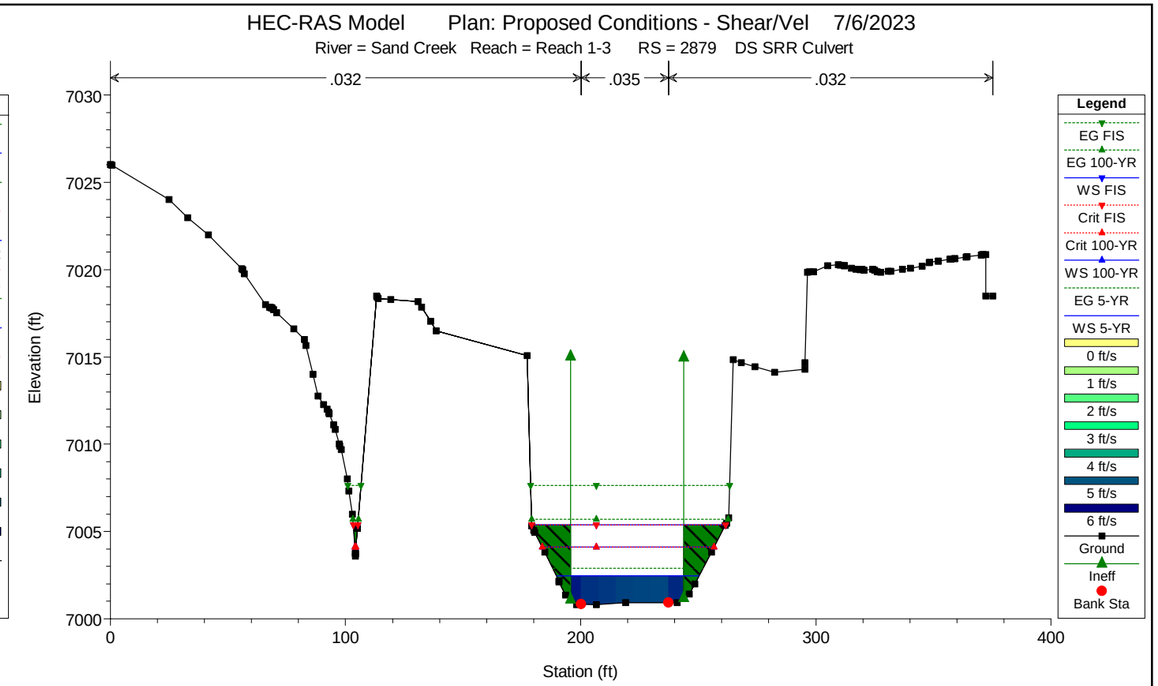


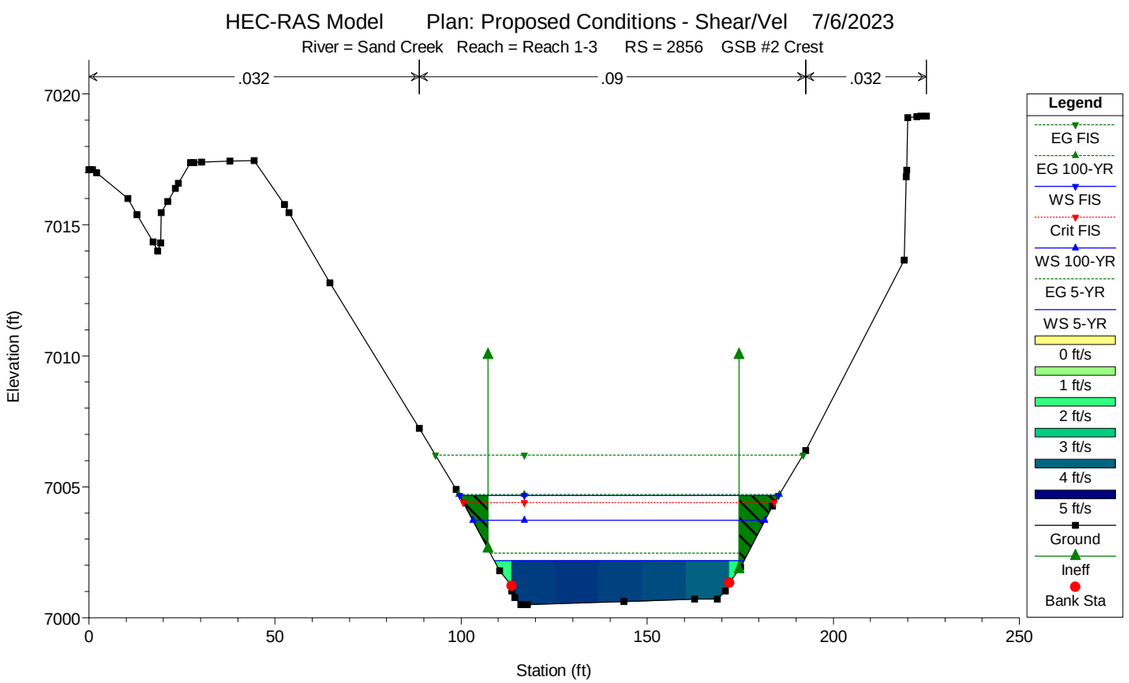


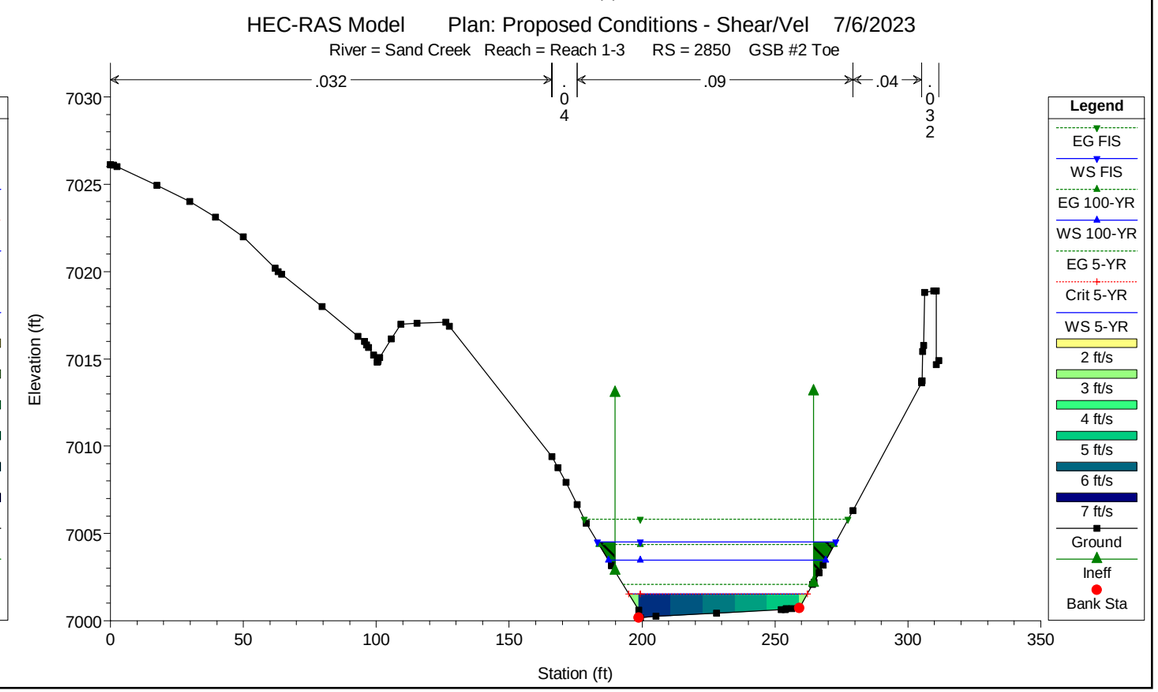


Sub-critical flow analysis for
Shear/Velocity evaluation of
Naturalized Channel Design

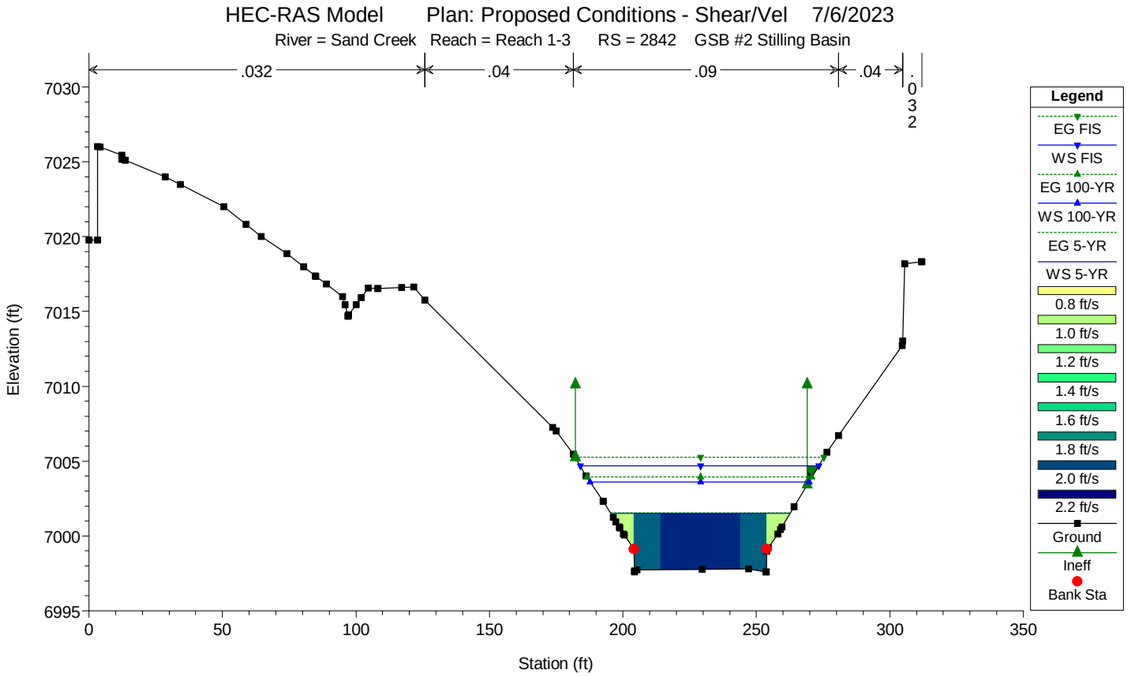


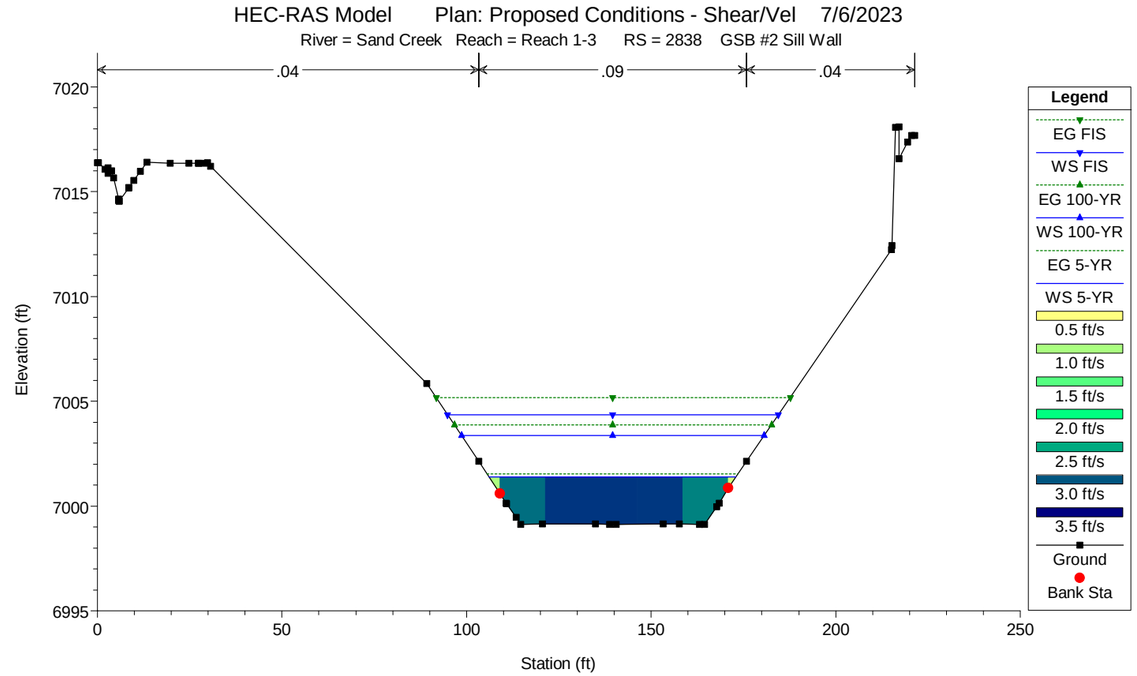


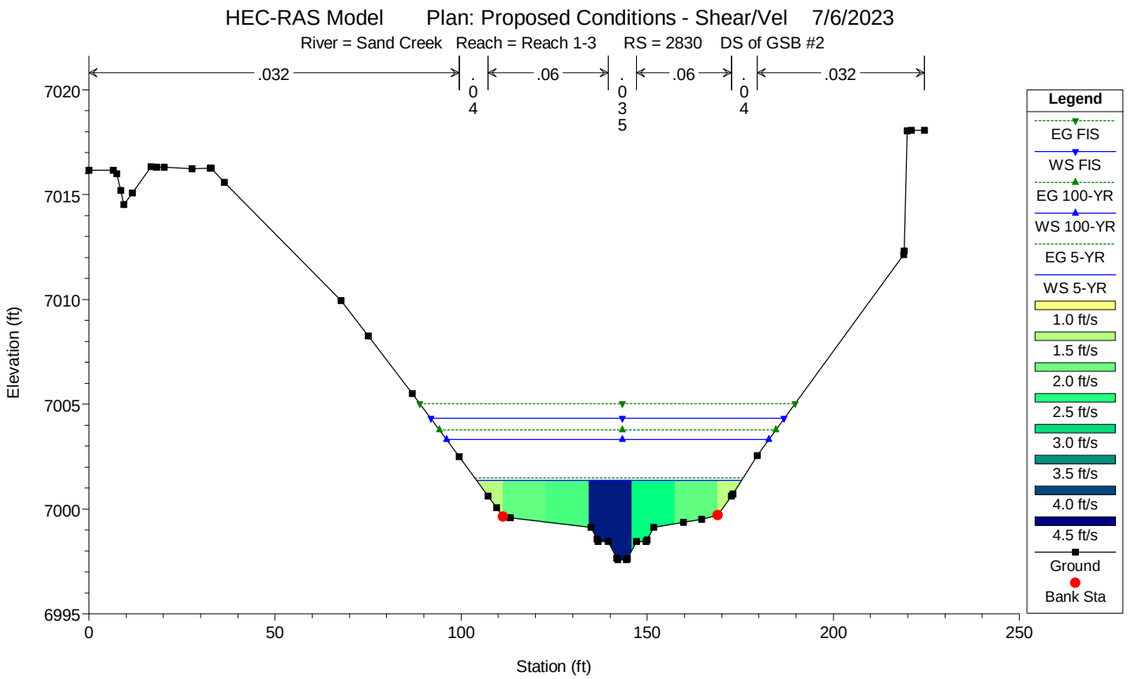


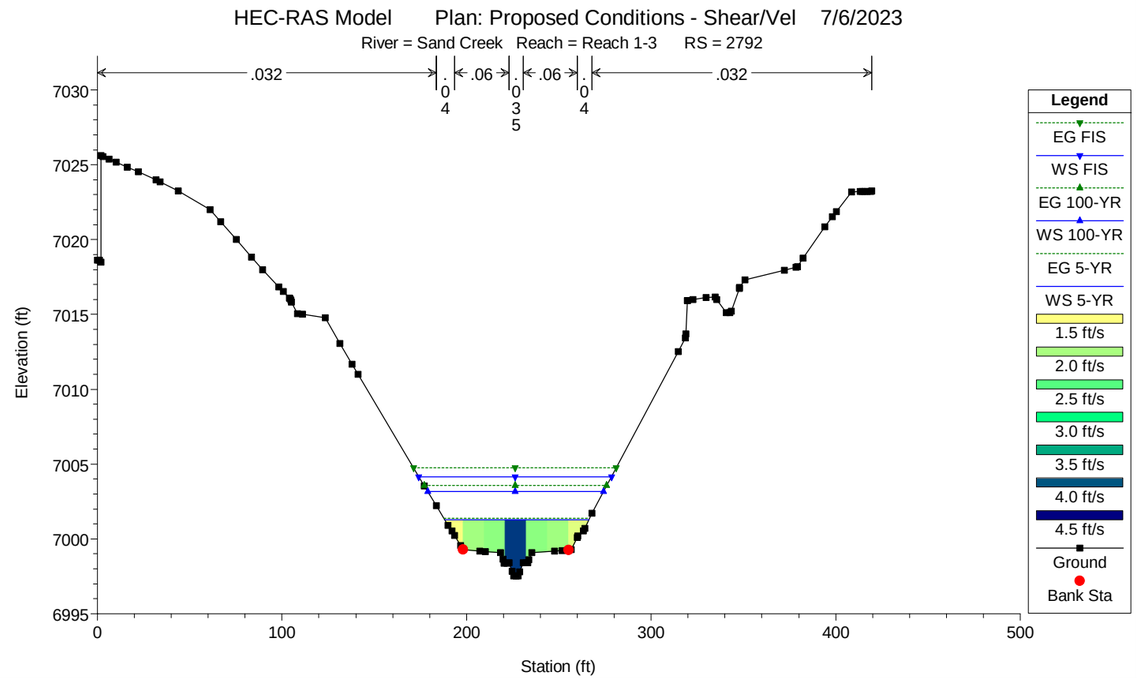


Sub-critical flow analysis for Shear/Velocity evaluation of Naturalized Channel Design

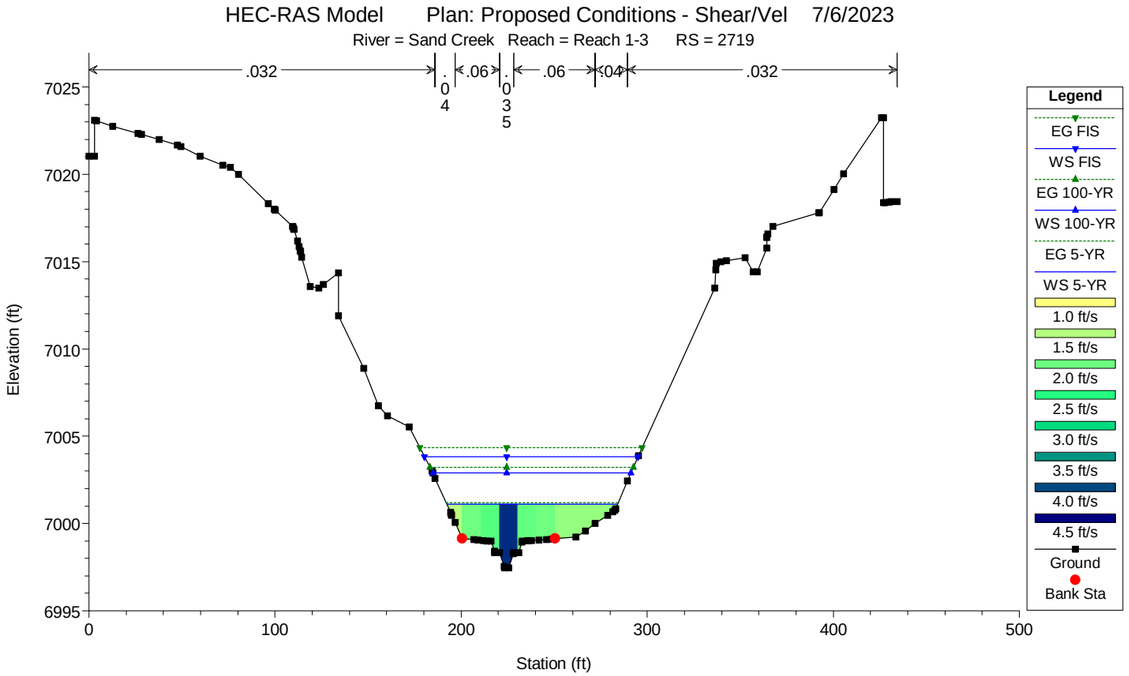


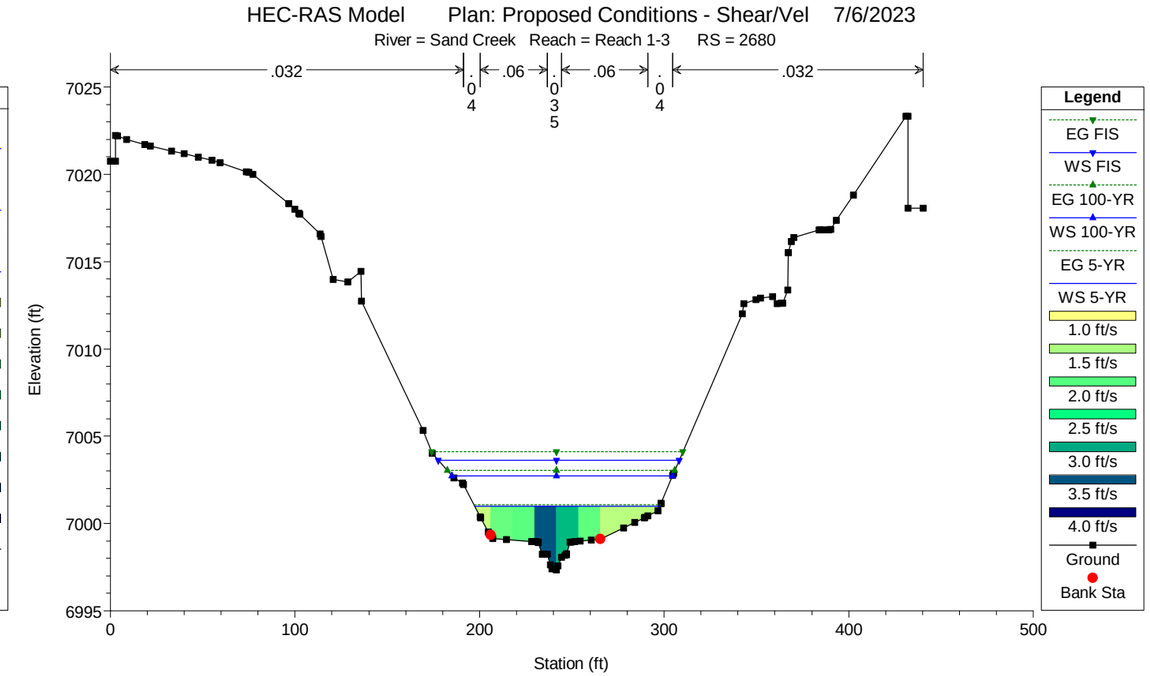


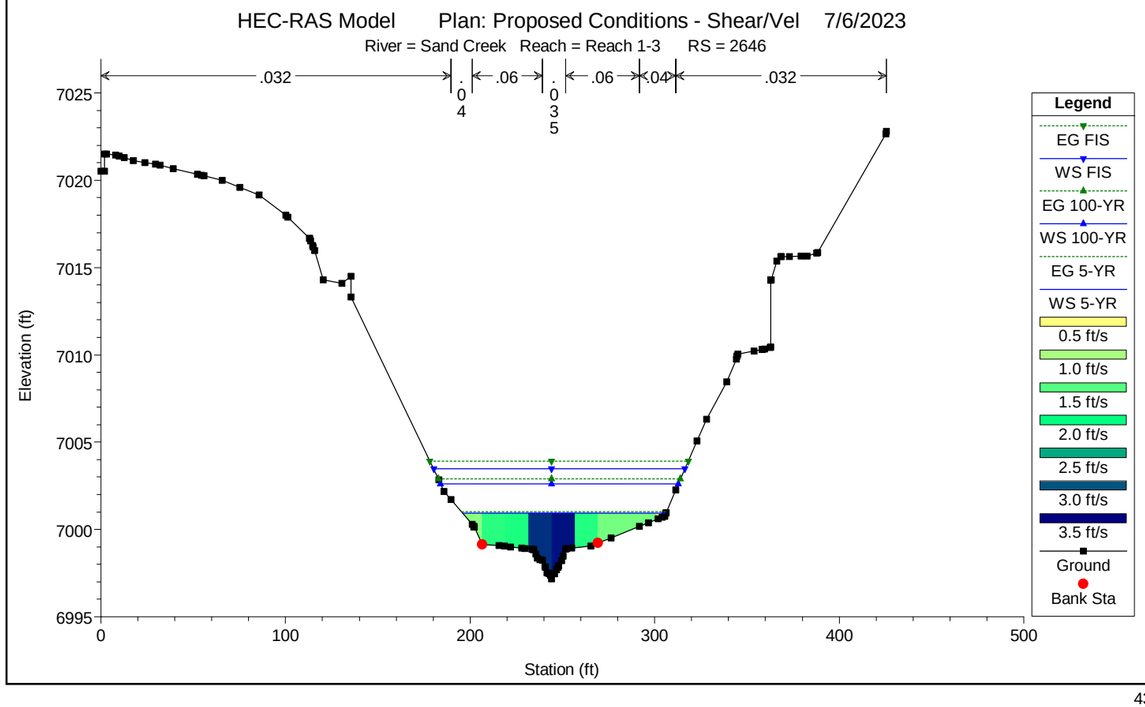


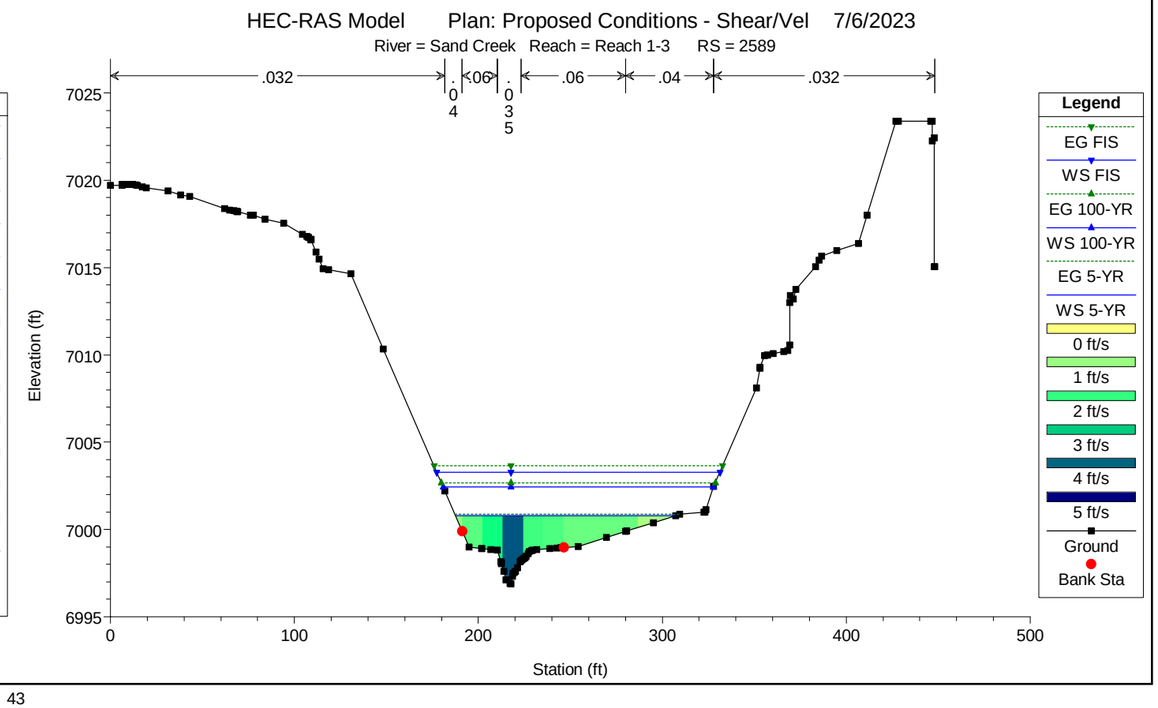


Sub-critical flow analysis for
Shear/Velocity evaluation of
Naturalized Channel Design

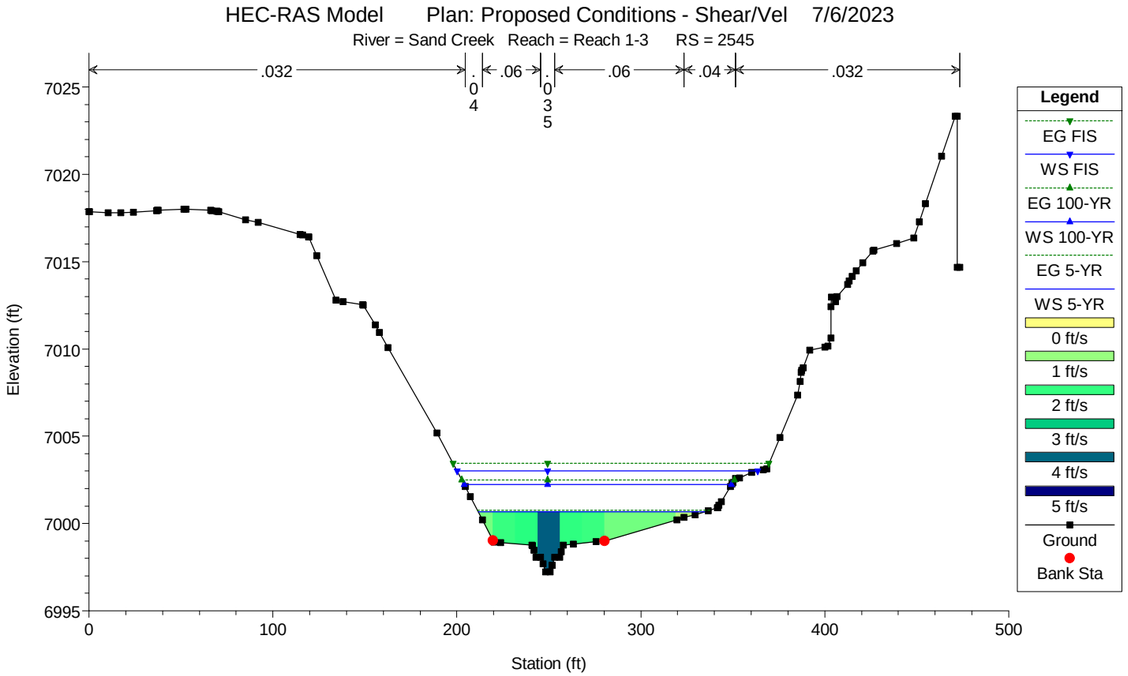


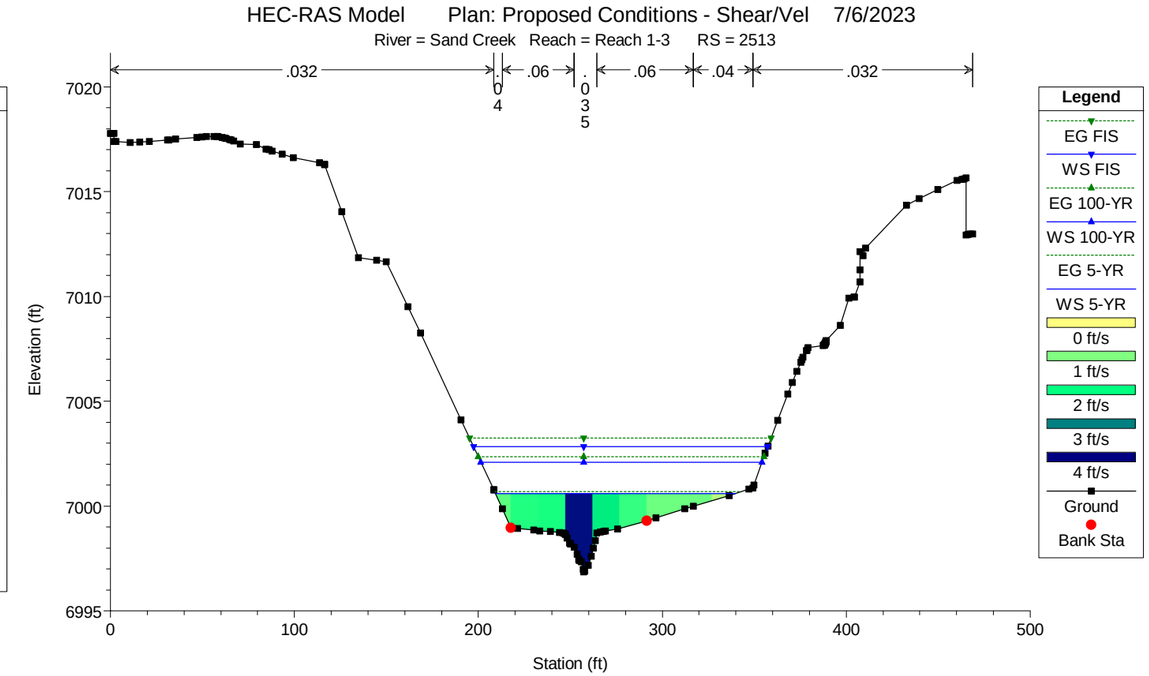


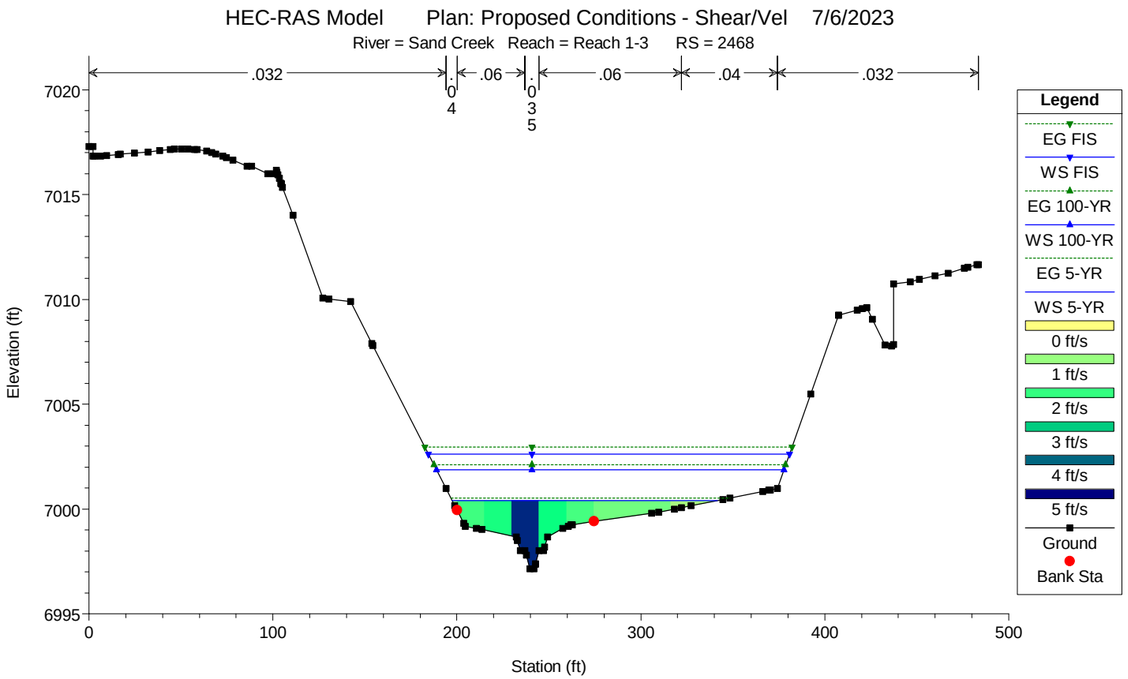


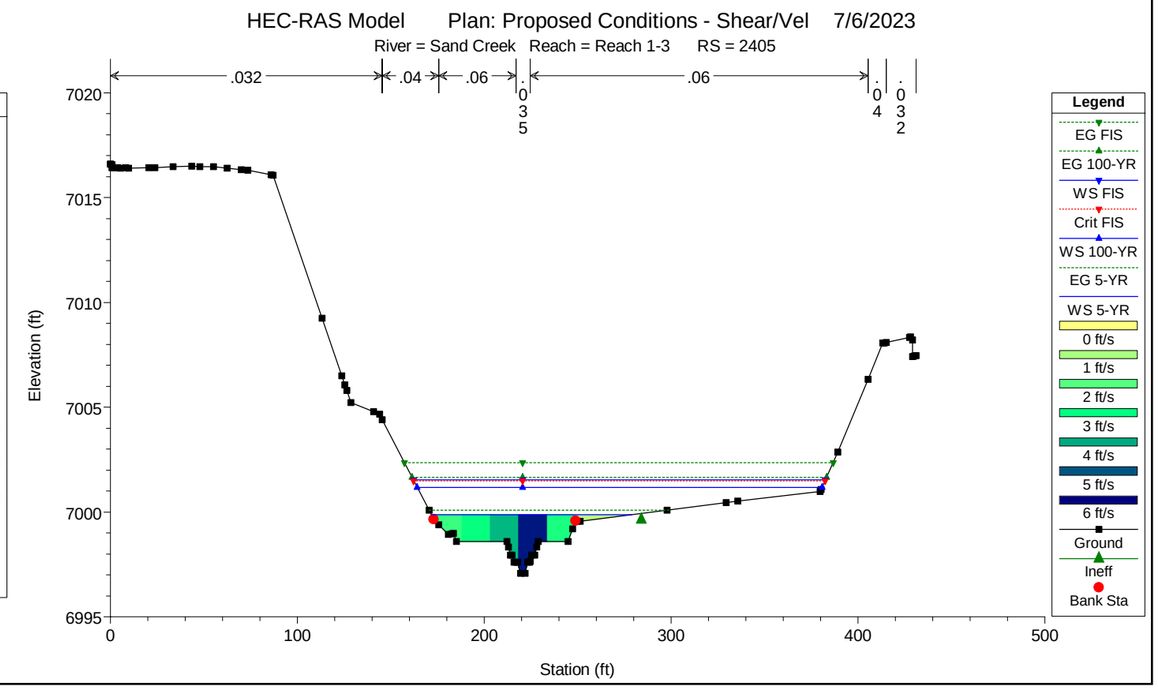


Sub-critical flow analysis for
Shear/Velocity evaluation of
Naturalized Channel Design

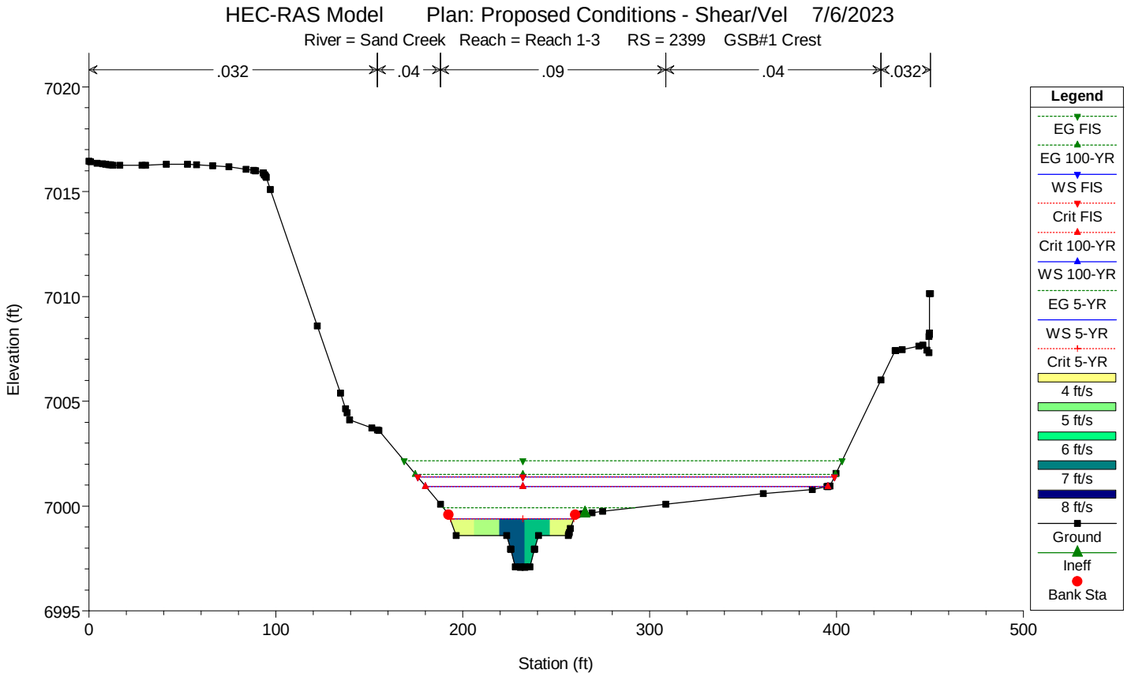


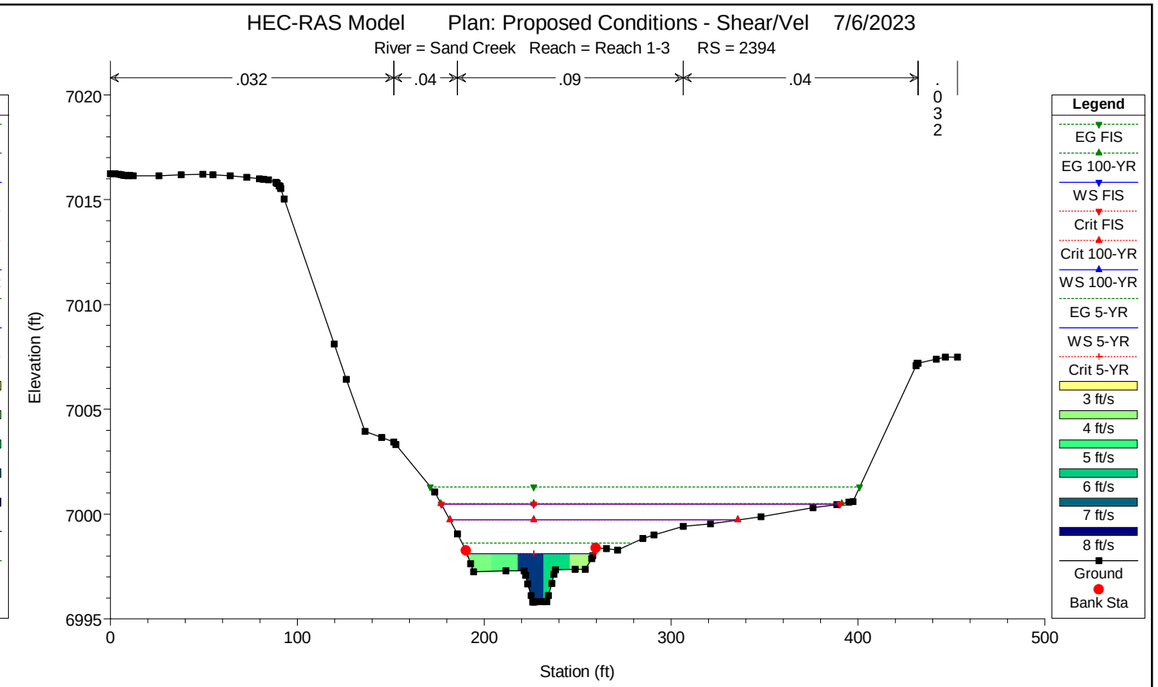


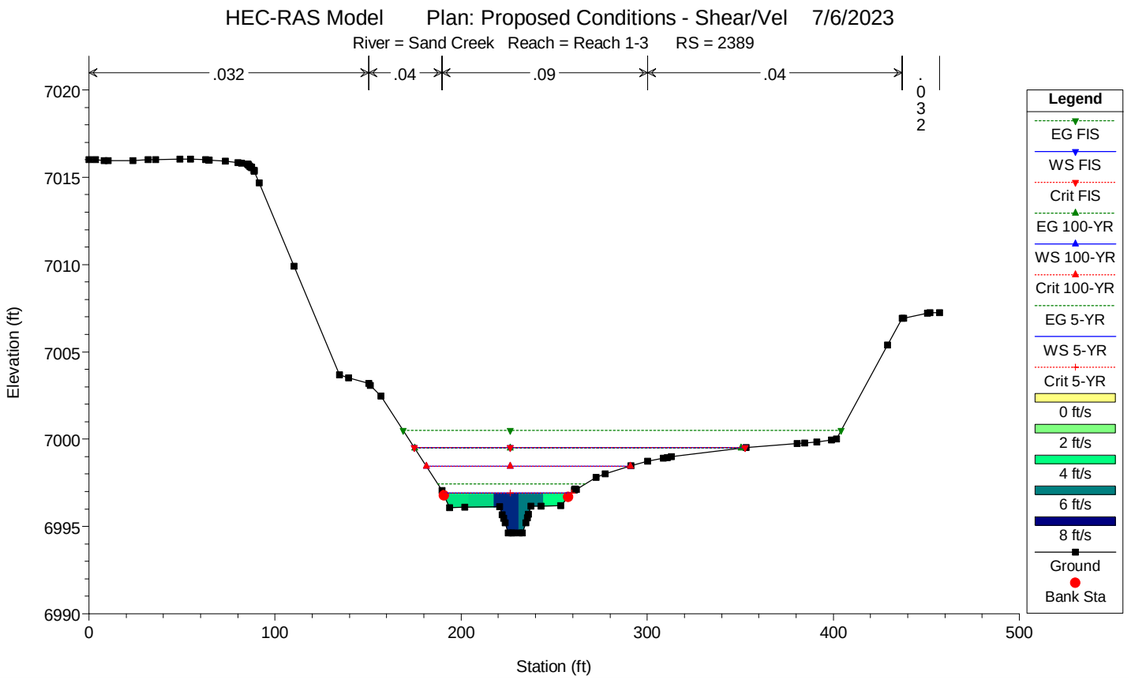


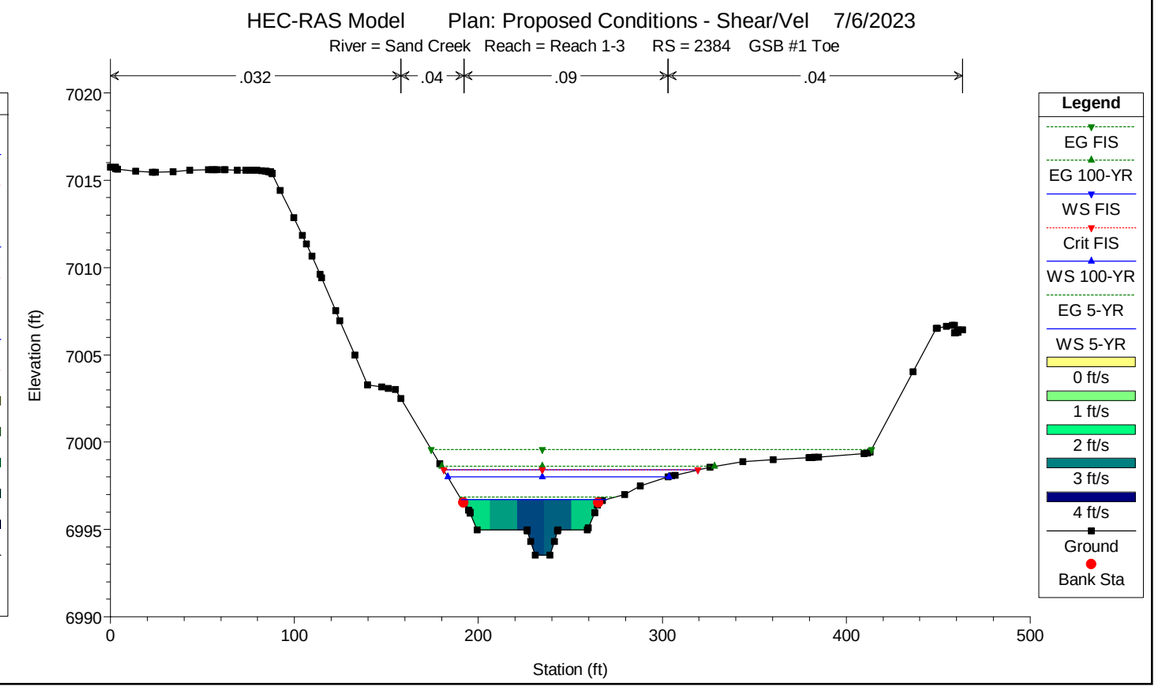


Sub-critical flow analysis for
Shear/Velocity evaluation of
Naturalized Channel Design

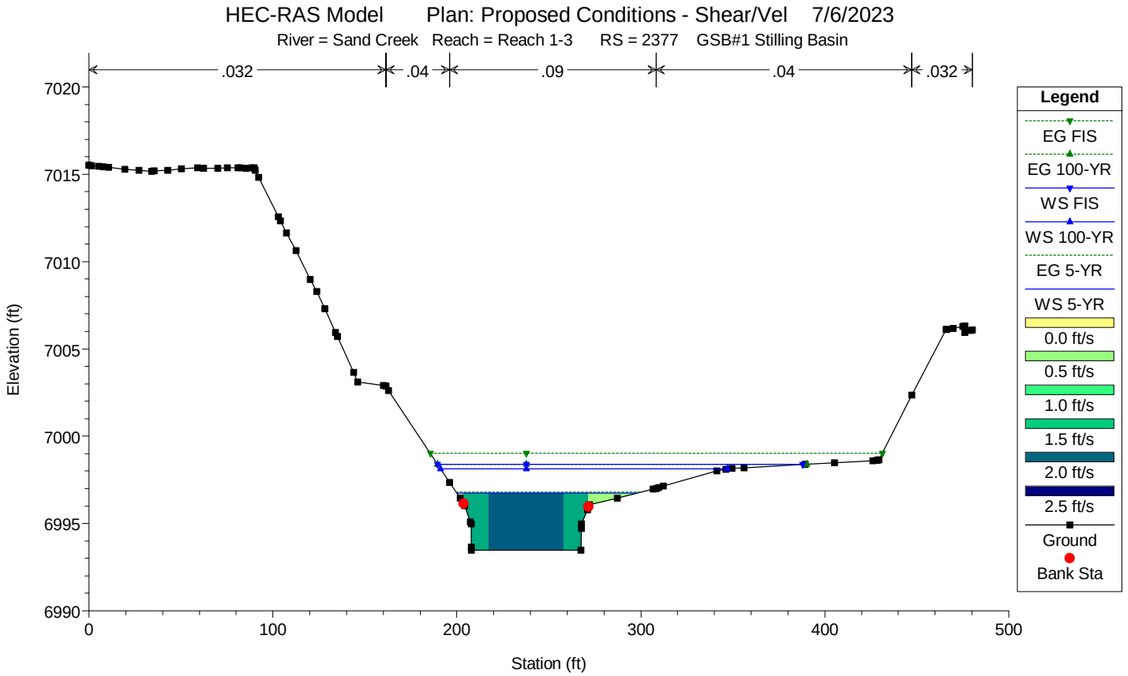


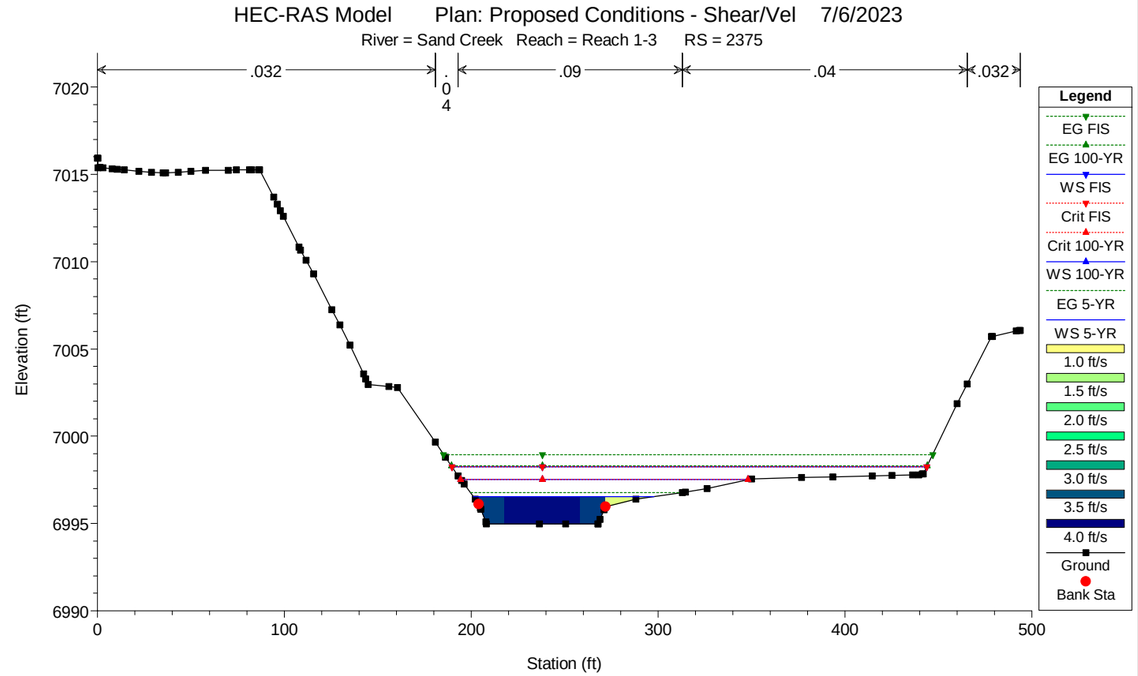


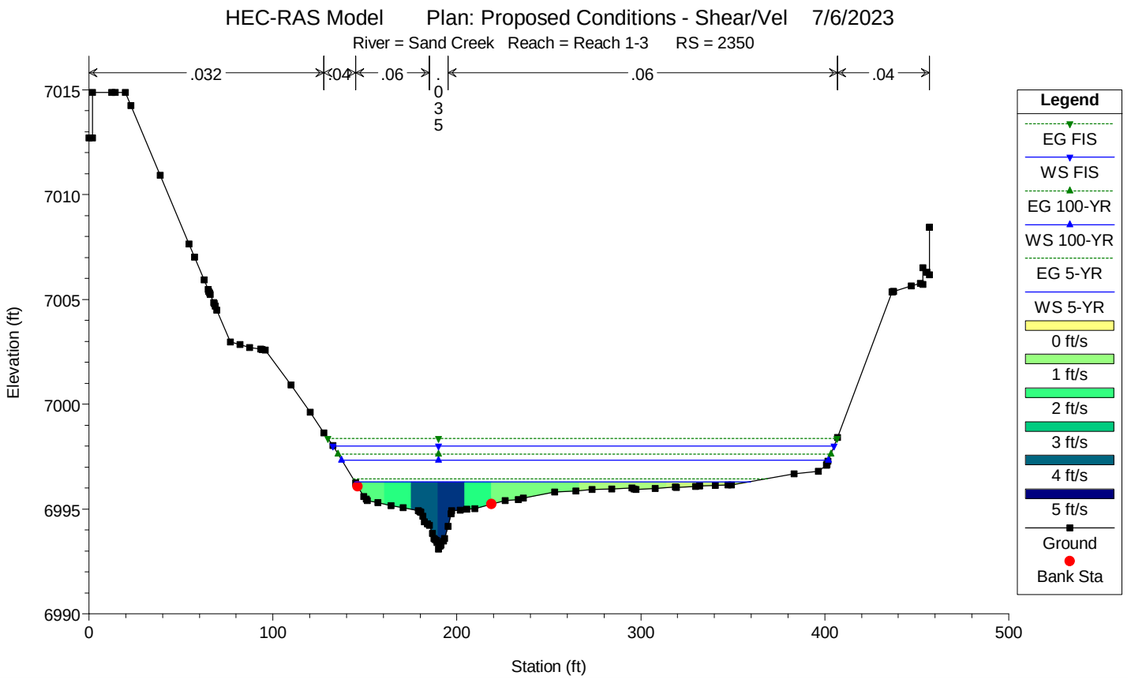


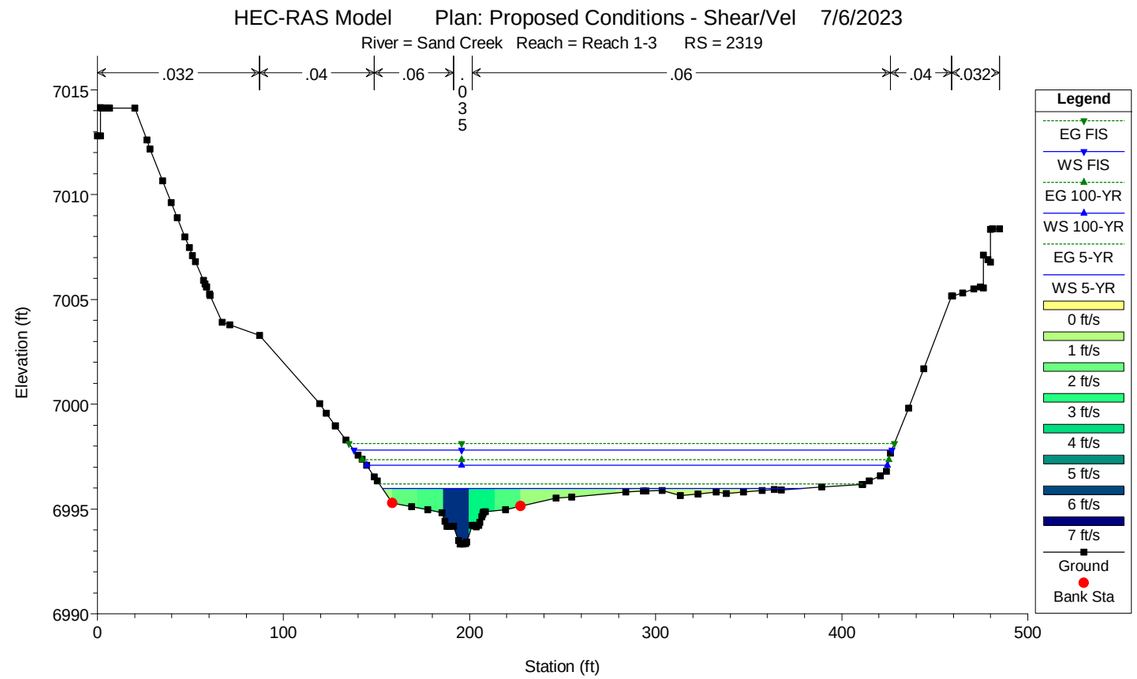


Sub-critical flow analysis for
Shear/Velocity evaluation of
Naturalized Channel Design

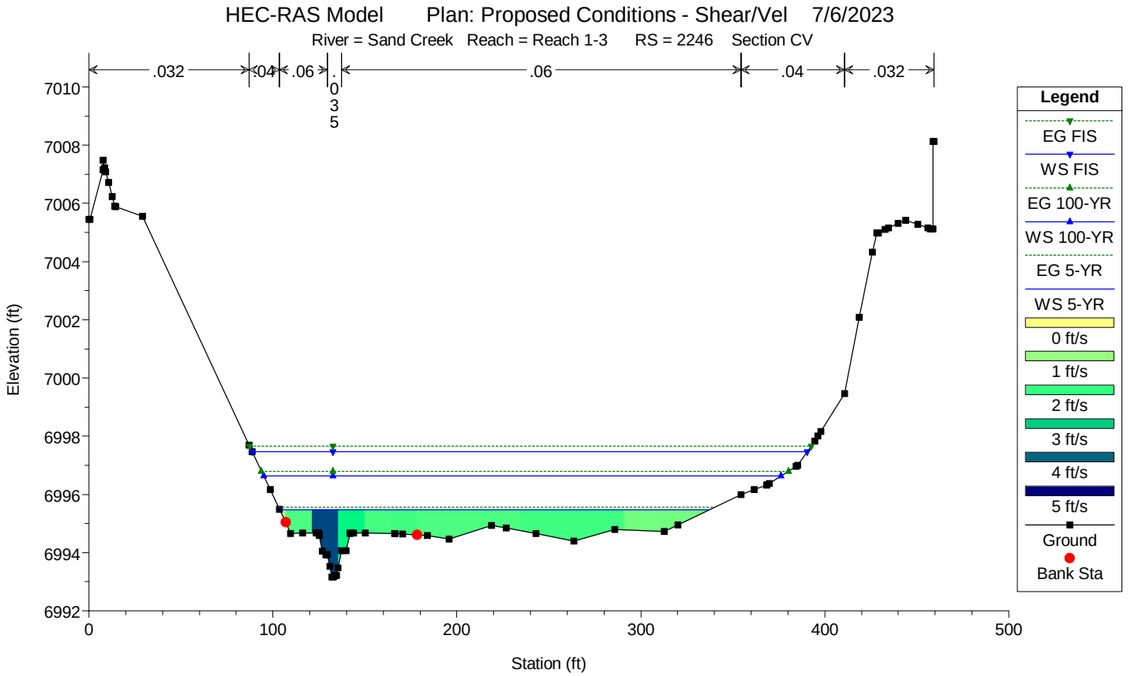


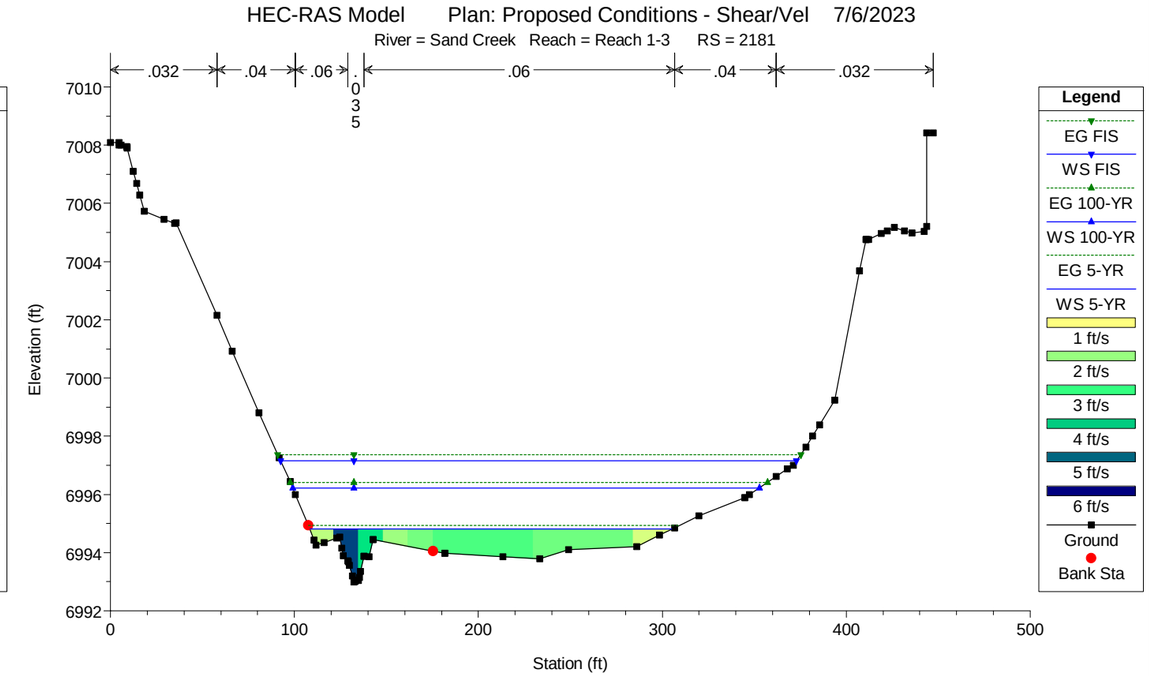


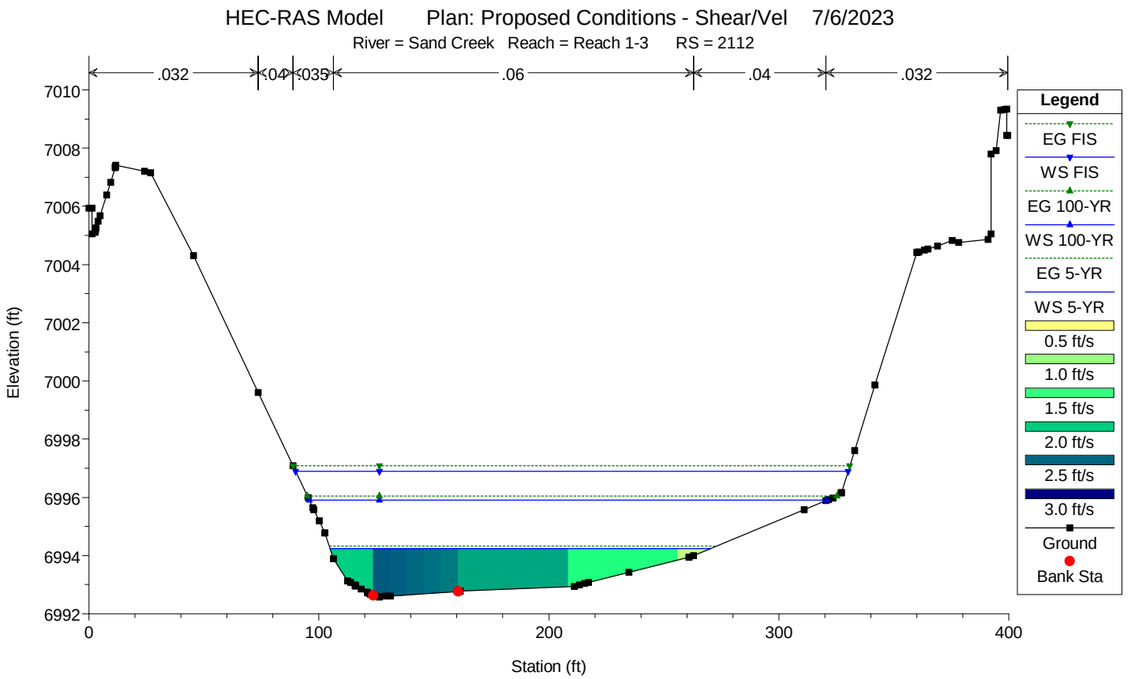


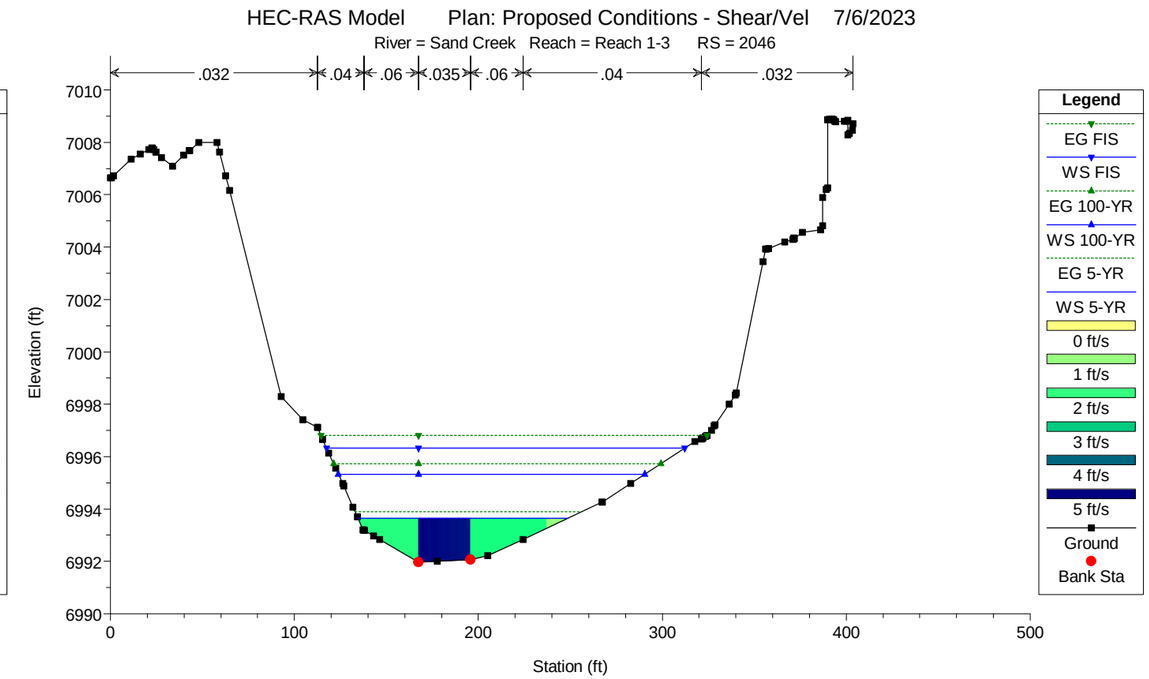


Sub-critical flow analysis for Shear/Velocity evaluation of Naturalized Channel Design





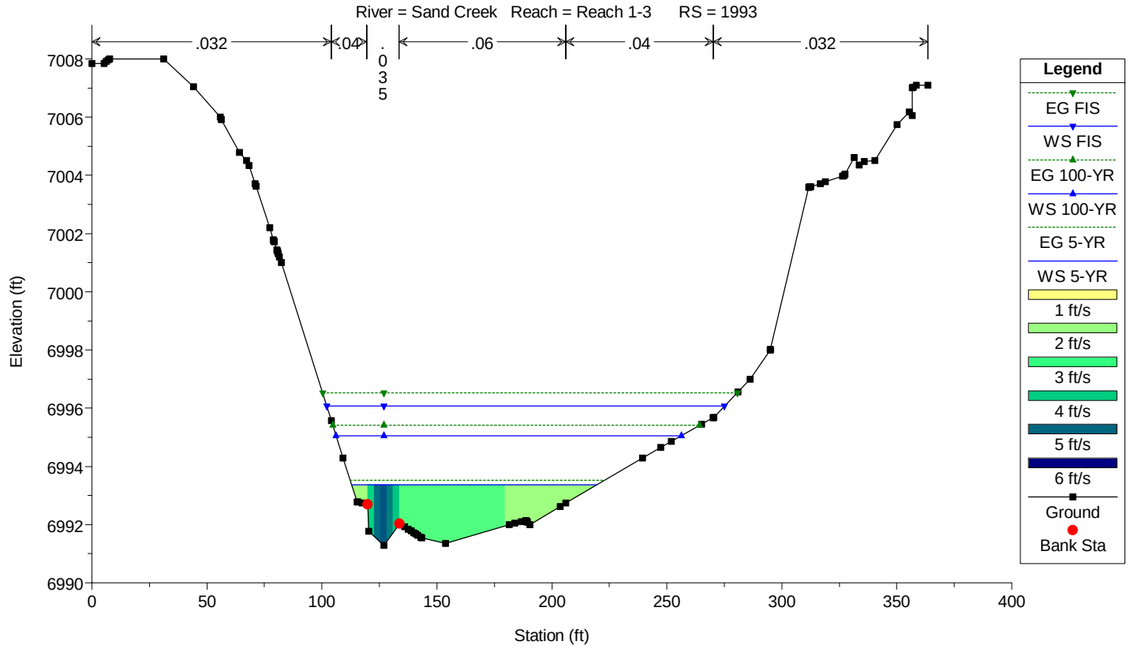




Sub-critical flow analysis for
Shear/Velocity evaluation of
Naturalized Channel Design

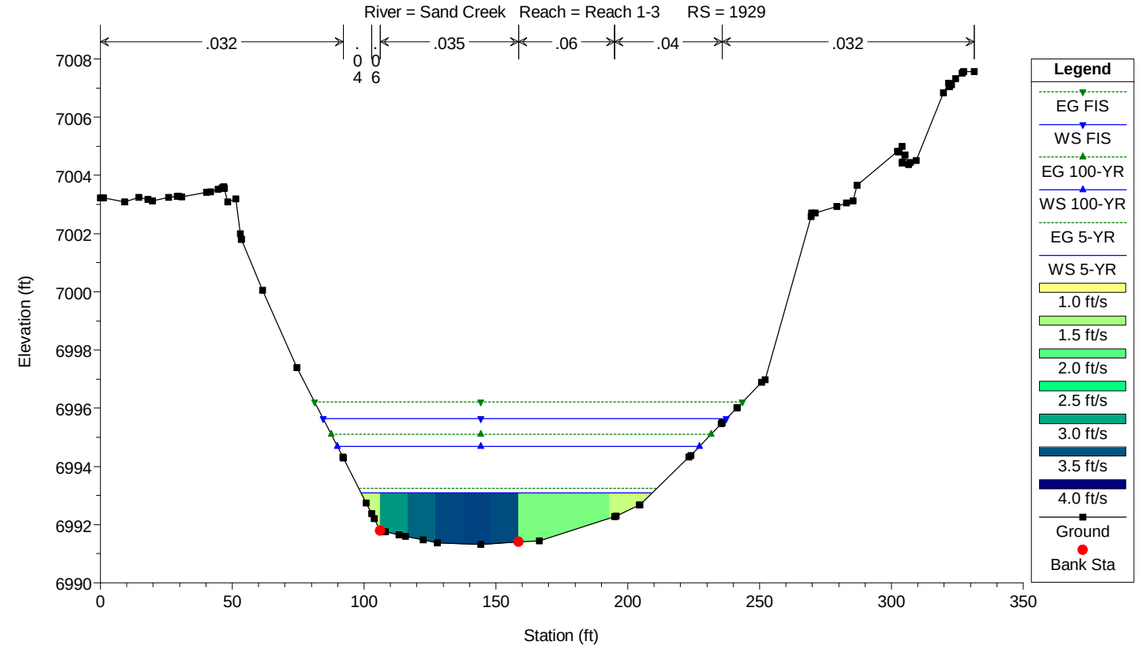
HEC-RAS Model Plan: Proposed Conditions - Shear/Vel 7/6/2023

River = Sand Creek Reach = Reach 1-3 RS = 1993



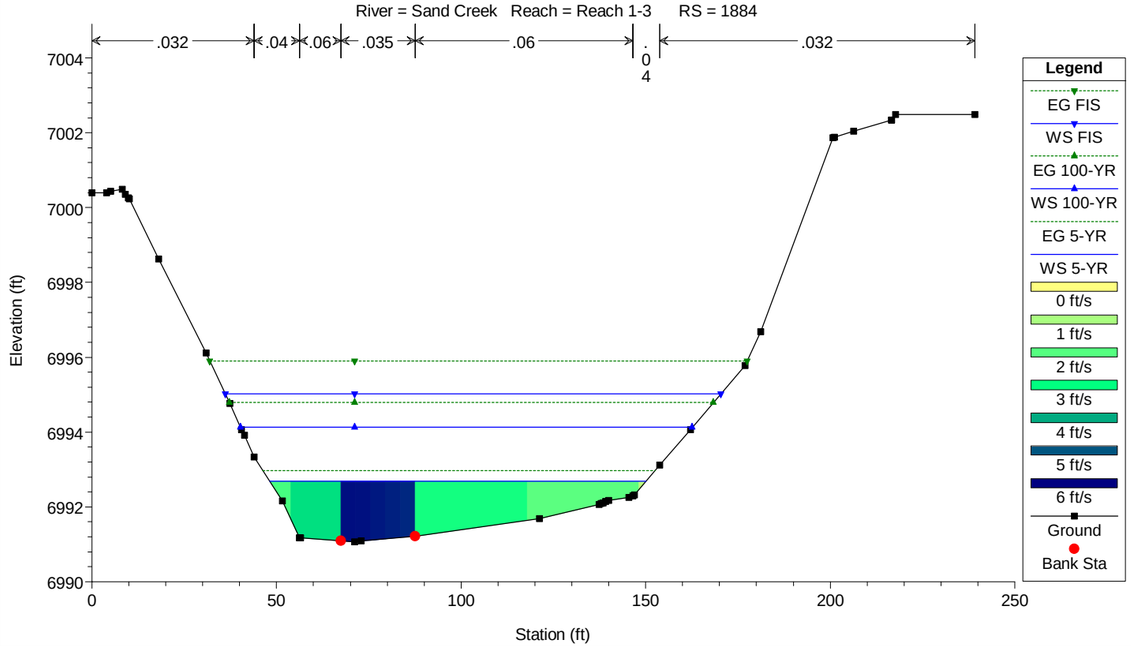
HEC-RAS Model Plan: Proposed Conditions - Shear/Vel 7/6/2023

River = Sand Creek Reach = Reach 1-3 RS = 1929



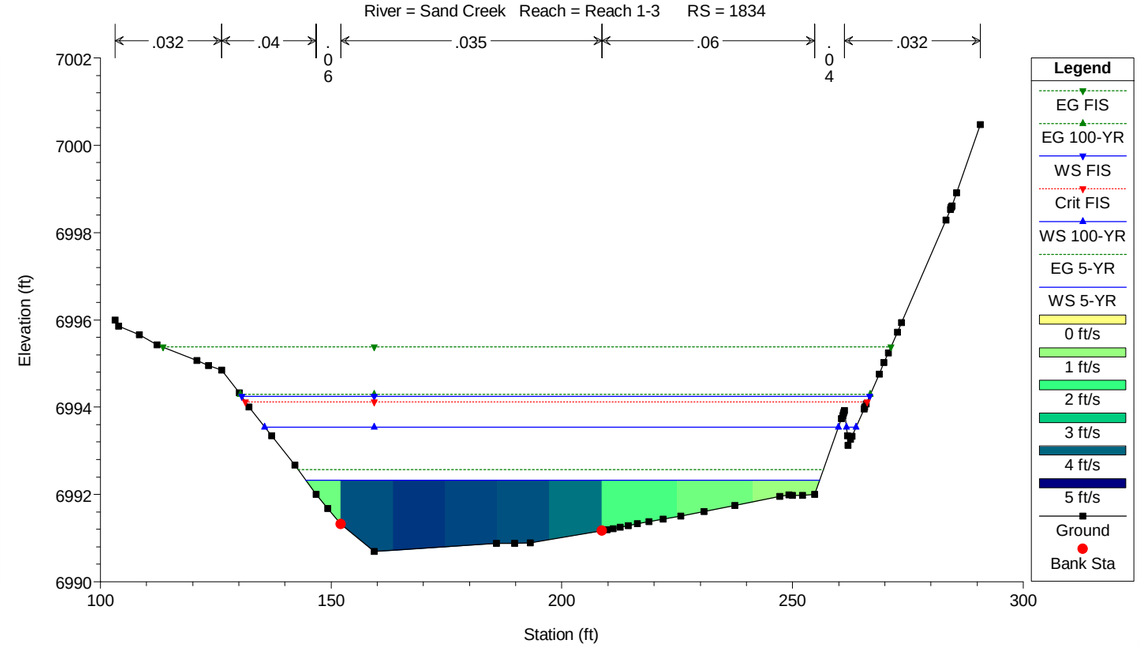
HEC-RAS Model Plan: Proposed Conditions - Shear/Vel 7/6/2023

River = Sand Creek Reach = Reach 1-3 RS = 1884

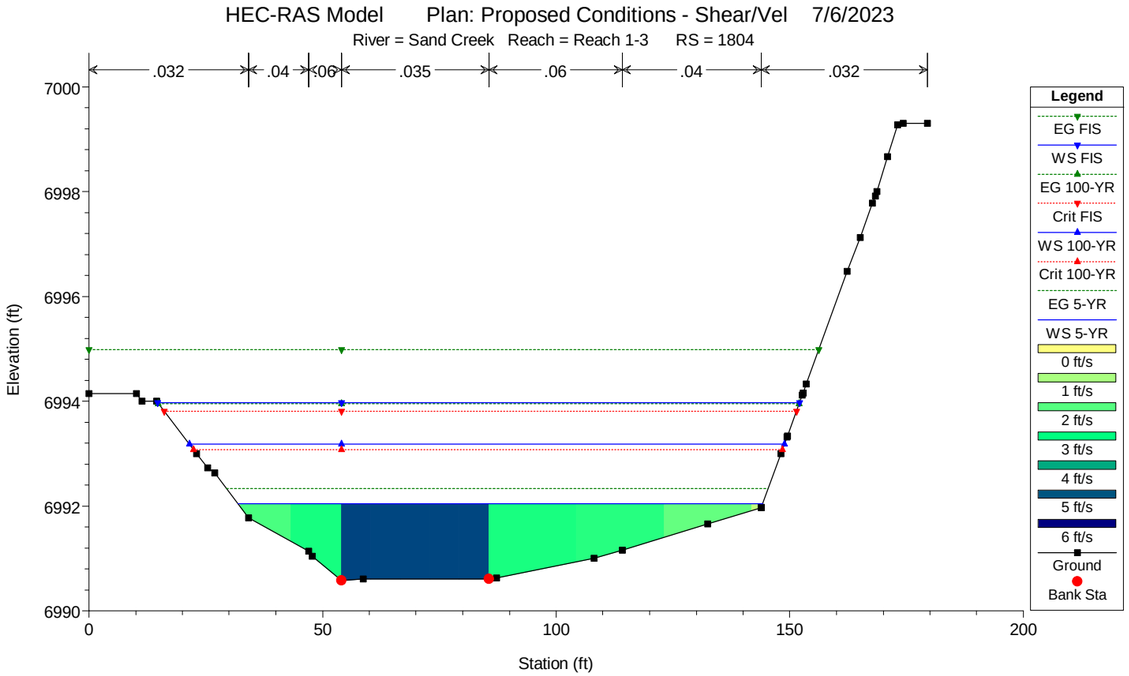


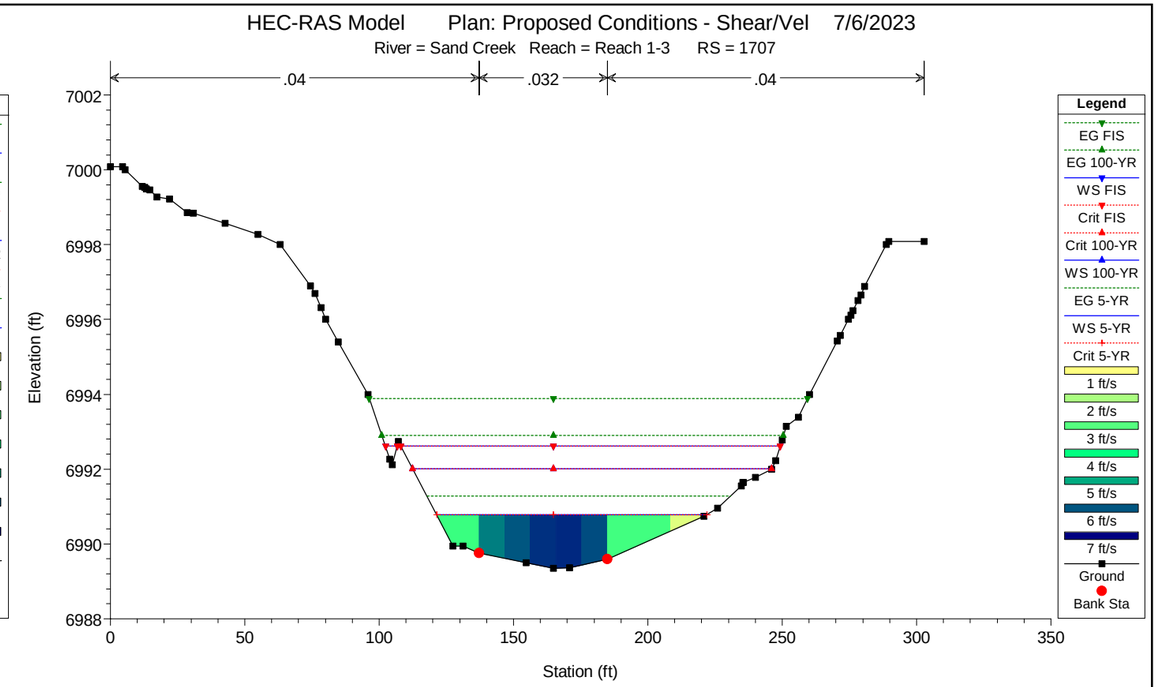
HEC-RAS Model Plan: Proposed Conditions - Shear/Vel 7/6/2023

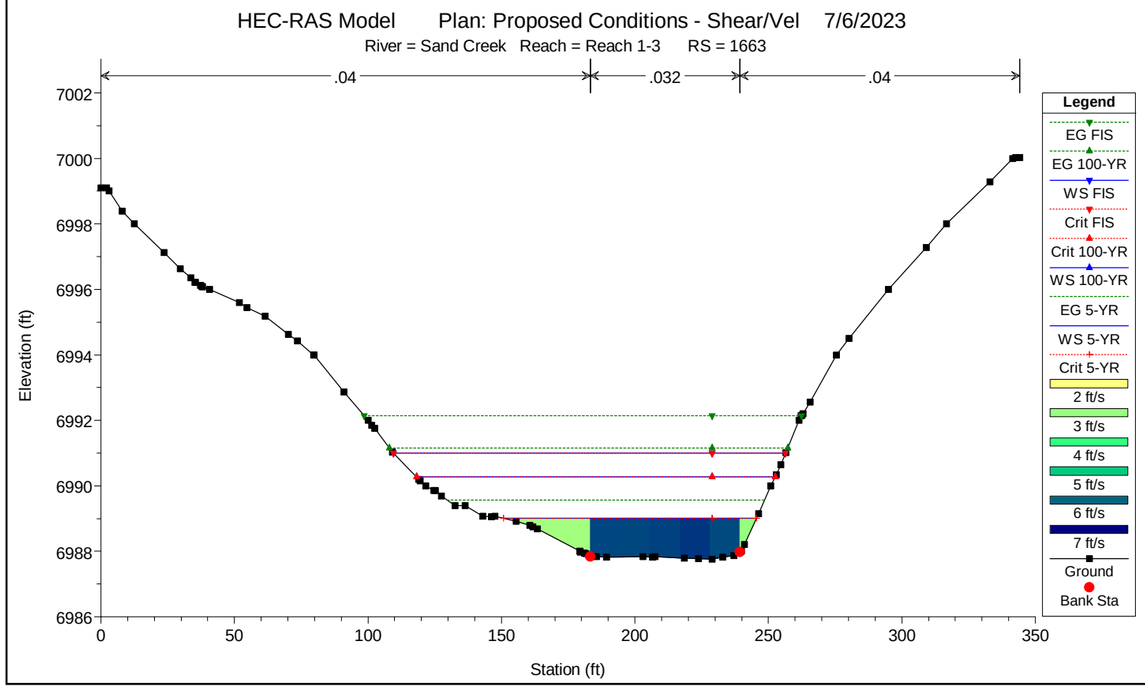
River = Sand Creek Reach = Reach 1-3 RS = 1834

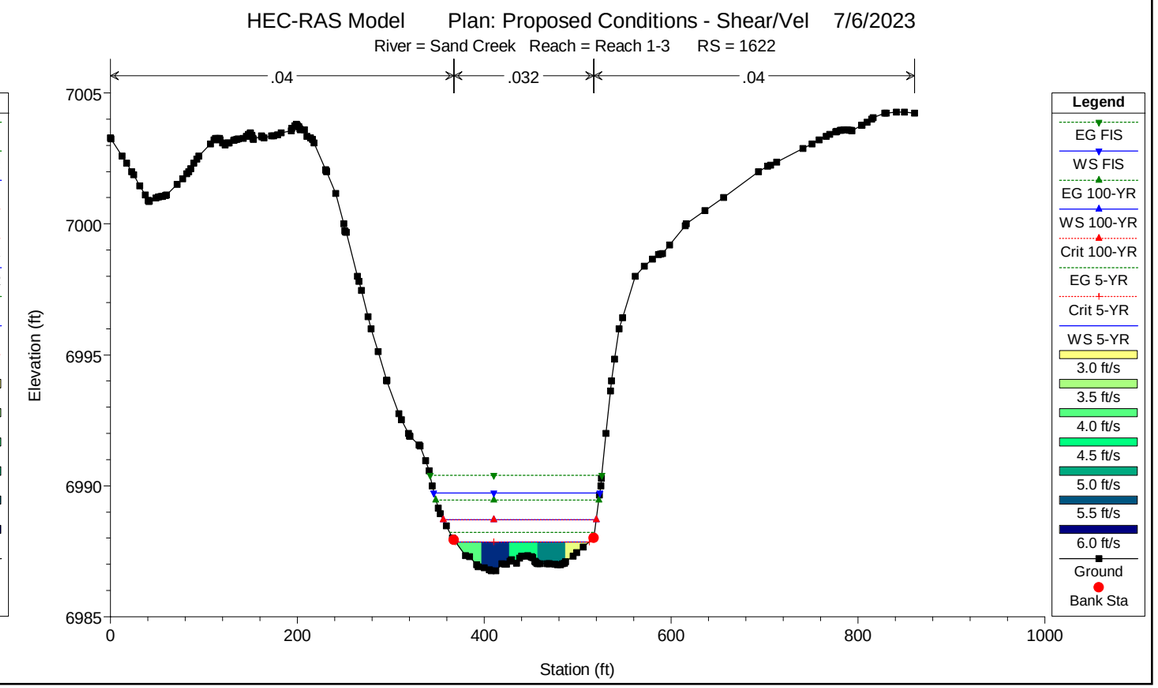


Sub-critical flow analysis for
Shear/Velocity evaluation of
Naturalized Channel Design

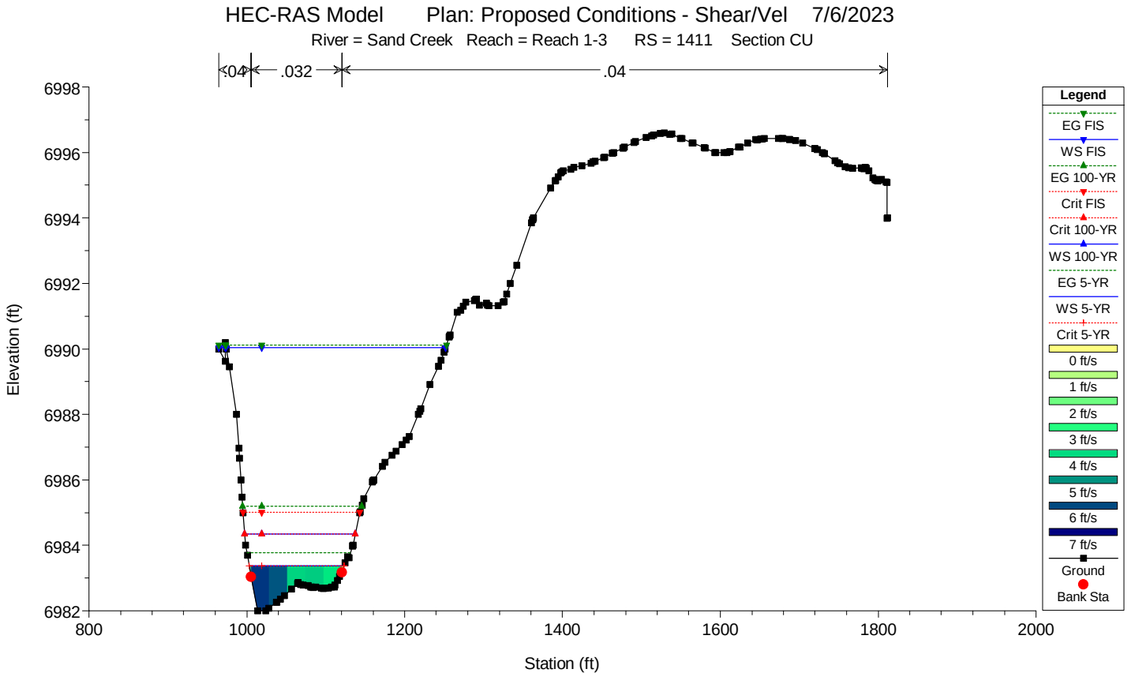








Sub-critical flow analysis for
Shear/Velocity evaluation of
Naturalized Channel Design



Sub-critical flow analysis for Shear/Velocity evaluation of Naturalized Channel Design

HEC-RAS Plan: PROP - Shear River: Sand Creek Reach: Reach 1-3

Reach	River Sta	Profile	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl	Shear LOB	Shear Chan	Shear ROB	Shear Total
			(cfs)	(ft)	(ft)	(ft)	(ft)	(ft/ft)	(ft/s)	(sq ft)	(ft)		(lb/sq ft)	(lb/sq ft)	(lb/sq ft)	(lb/sq ft)
Reach 1-3	12465	5-YR	475.50	7177.88	7179.32	7179.32	7179.97	0.026123	10.15	88.42	68.89	1.50	2.10	2.33	2.00	2.08
Reach 1-3	12465	100-YR	1643.00	7177.88	7180.95	7180.95	7182.35	0.021154	15.19	207.29	74.10	1.53	3.56	4.04	3.50	3.59
Reach 1-3	12465	FIS	2600.00	7177.88	7181.73	7181.73	7183.86	0.024157	18.86	264.83	74.32	1.70	5.08	5.78	5.02	5.13
Reach 1-3	12366		Culvert													
Reach 1-3	12253	5-YR	475.50	7168.00	7173.17		7173.21	0.000200	2.09	387.71	85.37	0.16	0.05	0.06	0.05	0.06
Reach 1-3	12253	100-YR	1643.00	7168.00	7176.23		7176.40	0.000477	4.41	667.79	97.68	0.27	0.18	0.25	0.19	0.20
Reach 1-3	12253	FIS	2600.00	7168.00	7177.89		7178.16	0.000628	5.72	834.91	104.36	0.32	0.27	0.39	0.29	0.30
Reach 1-3	12070	5-YR	475.50	7168.31	7172.74		7173.03	0.002101	5.93	170.81	69.96	0.51	0.22	0.55	0.30	0.31
Reach 1-3	12070	100-YR	1643.00	7168.31	7175.41	7173.79	7176.03	0.002822	9.50	372.93	81.57	0.64	0.60	1.21	0.79	0.77
Reach 1-3	12070	FIS	2600.00	7168.31	7176.83		7177.69	0.003201	11.46	493.61	87.66	0.70	0.85	1.65	1.11	1.07
Reach 1-3	11880	5-YR	475.50	7165.99	7167.90	7167.90	7168.45	0.024415	11.92	103.07	89.83	1.52	1.92	2.91	1.63	1.75
Reach 1-3	11880	100-YR	1643.00	7165.99	7169.24	7169.24	7170.29	0.024519	17.01	234.62	104.53	1.66	3.52	4.97	3.32	3.42
Reach 1-3	11880	FIS	2600.00	7165.99	7170.00	7170.00	7171.39	0.024399	19.54	316.99	109.70	1.72	4.37	6.12	4.30	4.37
Reach 1-3	11569	5-YR	475.50	7159.96	7161.21	7160.88	7161.43	0.016137	7.31	134.07	116.84	1.15	1.12	1.26	1.19	1.15
Reach 1-3	11569	100-YR	1643.00	7159.96	7162.43	7161.98	7163.02	0.018608	12.33	284.92	183.68	1.38	2.34	2.86	2.64	2.48
Reach 1-3	11569	FIS	2600.00	7159.96	7163.29	7162.67	7164.03	0.016394	14.13	405.84	208.71	1.37	2.60	3.40	3.08	2.80
Reach 1-3	11368	5-YR	475.50	7153.99	7156.03	7156.03	7157.00	0.029471	13.67	75.69	66.36	1.69	2.52	3.75	3.06	2.77
Reach 1-3	11368	100-YR	1643.00	7153.99	7158.33	7158.33	7159.43	0.016147	16.75	260.10	142.36	1.42	2.58	4.38	2.23	2.50
Reach 1-3	11368	FIS	2600.00	7153.99	7159.15	7159.15	7160.55	0.016977	19.28	348.35	156.38	1.50	3.46	5.47	2.96	3.31
Reach 1-3	11206	5-YR	475.50	7151.03	7154.77		7154.97	0.001922	4.93	224.81	137.95	0.47	0.17	0.41	0.19	0.19
Reach 1-3	11206	100-YR	1643.00	7151.03	7156.19		7156.69	0.003815	8.76	454.11	174.08	0.70	0.58	1.15	0.52	0.62
Reach 1-3	11206	FIS	2600.00	7151.03	7157.10		7157.70	0.003990	10.04	615.28	182.16	0.74	0.81	1.43	0.65	0.83
Reach 1-3	11103	5-YR	475.50	7150.00	7151.95	7151.95	7153.35	0.045519	16.48	62.81	44.51	2.08	4.89	5.53	2.80	3.97
Reach 1-3	11103	100-YR	1643.00	7150.00	7153.69	7153.69	7154.54	0.019817	16.66	283.22	143.67	1.53	2.40	4.57	2.34	2.43
Reach 1-3	11103	FIS	2600.00	7150.00	7154.34	7154.34	7155.42	0.020994	19.08	378.68	153.43	1.62	3.23	5.68	3.03	3.22
Reach 1-3	10925	5-YR	475.50	7148.00	7149.87		7150.15	0.009001	4.22	112.74	104.87	0.72		0.60		0.60
Reach 1-3	10925	100-YR	1643.00	7148.00	7150.98		7151.66	0.010242	6.61	248.49	129.57	0.84		1.22		1.22
Reach 1-3	10925	FIS	2600.00	7148.00	7151.60	7151.38	7152.56	0.010090	7.90	330.21	134.40	0.88	0.18	1.59	0.18	1.54
Reach 1-3	10797	5-YR	475.50	7145.39	7148.14	7147.91	7148.55	0.018364	5.17	93.64	117.85	0.78	0.29	1.55	0.52	1.40
Reach 1-3	10797	100-YR	1643.00	7145.39	7149.35	7149.14	7149.97	0.017191	7.00	284.94	156.61	0.77	1.00	2.74	1.61	1.94
Reach 1-3	10797	FIS	2600.00	7145.39	7149.94	7149.76	7150.80	0.019038	8.34	382.70	170.55	0.83	1.52	3.74	2.33	2.66
Reach 1-3	10713	5-YR	475.50	7144.30	7147.27		7147.45	0.008697	3.75	155.78	145.09	0.54		0.80	0.39	0.58
Reach 1-3	10713	100-YR	1643.00	7144.30	7148.40		7148.77	0.010588	5.59	371.61	212.30	0.61	0.53	1.71	1.13	1.15
Reach 1-3	10713	FIS	2600.00	7144.30	7149.03		7149.50	0.010786	6.40	506.88	221.23	0.63	0.91	2.16	1.49	1.53
Reach 1-3	10617	5-YR	475.50	7143.44	7146.31		7146.56	0.010761	4.07	138.59	194.63	0.58	0.19	1.01	0.14	0.48
Reach 1-3	10617	100-YR	1643.00	7143.44	7147.56		7147.86	0.008825	5.16	414.87	235.18	0.55	0.74	1.51	0.72	0.97
Reach 1-3	10617	FIS	2600.00	7143.44	7148.24		7148.60	0.008239	5.70	579.19	247.66	0.54	1.00	1.75	0.94	1.20
Reach 1-3	10543	5-YR	475.50	7142.46	7145.60		7145.83	0.008151	3.97	142.32	166.60	0.58	0.06	0.74	0.33	0.43
Reach 1-3	10543	100-YR	1643.00	7142.46	7146.85		7147.21	0.008072	5.50	392.82	213.49	0.59	0.63	1.36	0.80	0.92
Reach 1-3	10543	FIS	2600.00	7142.46	7147.52		7147.97	0.008055	6.26	542.80	232.97	0.60	0.94	1.69	0.92	1.17

Sub-critical flow analysis for Shear/Velocity evaluation of Naturalized Channel Design

HEC-RAS Plan: PROP - Shear River: Sand Creek Reach: Reach 1-3 (Continued)

Reach	River Sta	Profile	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl	Shear LOB	Shear Chan	Shear ROB	Shear Total
			(cfs)	(ft)	(ft)	(ft)	(ft)	(ft/ft)	(ft/s)	(sq ft)	(ft)		(lb/sq ft)	(lb/sq ft)	(lb/sq ft)	(lb/sq ft)
Reach 1-3	10455	5-YR	475.50	7142.32	7145.26		7145.44	0.008278	3.72	161.66	191.49	0.53	0.10	0.79	0.40	0.43
Reach 1-3	10455	100-YR	1643.00	7142.32	7146.54		7146.82	0.008016	5.09	434.26	241.43	0.53	0.69	1.39	0.73	0.90
Reach 1-3	10455	FIS	2600.00	7142.32	7147.22		7147.57	0.008191	5.85	615.37	293.42	0.55	1.01	1.77	0.77	1.07
Reach 1-3	10411	5-YR	475.50	7141.35	7144.12		7144.36	0.011186	4.08	139.45	174.91	0.59	0.18	1.04	0.25	0.55
Reach 1-3	10411	100-YR	1643.00	7141.35	7145.07		7145.56	0.015961	6.44	338.27	230.86	0.73	1.00	2.41	1.05	1.46
Reach 1-3	10411	FIS	2600.00	7141.35	7145.55	7145.38	7146.21	0.018247	7.67	455.10	256.75	0.79	1.61	3.30	1.43	2.01
Reach 1-3	10339	5-YR	475.50	7140.02	7143.07	7142.74	7143.41	0.013384	4.71	116.26	212.79	0.68	0.02	1.23	0.11	0.45
Reach 1-3	10339	100-YR	1643.00	7140.02	7144.19		7144.52	0.010483	5.58	444.11	347.80	0.61	0.48	1.69	0.69	0.83
Reach 1-3	10339	FIS	2600.00	7140.02	7144.65		7145.04	0.011174	6.32	603.96	355.48	0.64	0.79	2.11	1.04	1.18
Reach 1-3	10211	5-YR	475.50	7138.76	7141.95		7142.24	0.010900	4.33	115.42	204.67	0.61	0.12	1.04		0.70
Reach 1-3	10211	100-YR	1643.00	7138.76	7142.99		7143.40	0.012565	6.05	403.46	344.68	0.67	0.80	1.99	0.56	0.92
Reach 1-3	10211	FIS	2600.00	7138.76	7143.52		7143.95	0.011558	6.46	586.99	349.47	0.65	1.09	2.21	0.89	1.21
Reach 1-3	10113	5-YR	475.50	7137.89	7140.84	7140.52	7141.18	0.010687	4.66	109.20	218.30	0.69		0.94	0.04	0.33
Reach 1-3	10113	100-YR	1643.00	7137.89	7141.96		7142.33	0.009466	5.75	420.00	304.10	0.64	0.46	1.46	0.66	0.81
Reach 1-3	10113	FIS	2600.00	7137.89	7142.51		7142.93	0.009290	6.36	590.03	311.09	0.64	0.72	1.76	0.96	1.10
Reach 1-3	10014	5-YR	475.50	7136.24	7139.41		7139.86	0.016594	5.40	88.60	134.88	0.79	0.25	1.51		1.45
Reach 1-3	10014	100-YR	1643.00	7136.24	7140.60	7140.60	7141.18	0.016511	7.03	335.31	274.27	0.78	0.60	2.56	0.95	1.26
Reach 1-3	10014	FIS	2600.00	7136.24	7141.03	7141.03	7141.75	0.018533	8.13	459.09	287.36	0.84	1.06	3.38	1.55	1.84
Reach 1-3	9955	5-YR	475.50	7135.86	7138.52	7138.52	7138.87	0.015806	4.88	120.43	254.30	0.73	0.25	1.35	0.11	0.47
Reach 1-3	9955	100-YR	1643.00	7135.86	7139.33	7139.33	7139.84	0.019177	6.90	344.78	288.74	0.82	1.04	2.60	1.09	1.43
Reach 1-3	9955	FIS	2600.00	7135.86	7139.70	7139.70	7140.38	0.022155	8.12	452.87	293.04	0.89	1.67	3.51	1.75	2.13
Reach 1-3	9943	5-YR	475.50	7135.80	7138.25	7138.25	7138.49	0.044324	4.22	130.16	263.49	0.64	0.31	3.70	0.68	1.36
Reach 1-3	9943	100-YR	1643.00	7135.80	7138.84	7138.84	7139.34	0.047045	5.53	297.12	295.61	0.70	1.73	5.64	2.39	2.95
Reach 1-3	9943	FIS	2600.00	7135.80	7139.19	7139.19	7139.89	0.042962	5.92	403.41	299.94	0.69	2.47	6.10	3.11	3.60
Reach 1-3	9926	5-YR	475.50	7131.59	7135.21		7135.33	0.008203	2.77	180.81	92.26	0.31	0.27	1.29	0.27	1.00
Reach 1-3	9926	100-YR	1643.00	7131.59	7136.55		7137.01	0.019995	5.73	324.87	123.84	0.51	1.61	4.80	1.45	3.25
Reach 1-3	9926	FIS	2600.00	7131.59	7137.06	7136.36	7137.85	0.029977	7.62	397.32	243.07	0.64	2.46	8.15	0.86	3.05
Reach 1-3	9913	5-YR	475.50	7131.58	7135.19		7135.25	0.003170	2.03	247.27	111.15	0.20	0.09	0.64	0.08	0.43
Reach 1-3	9913	100-YR	1643.00	7131.58	7136.57		7136.78	0.007808	4.01	477.91	246.24	0.33	0.66	2.22	0.37	0.94
Reach 1-3	9913	FIS	2600.00	7131.58	7137.24		7137.50	0.008190	4.50	652.80	272.86	0.34	0.69	2.67	0.71	1.21
Reach 1-3	9910	5-YR	475.50	7132.63	7135.08		7135.23	0.011968	3.06	167.14	111.78	0.36	0.41	1.65	0.25	1.11
Reach 1-3	9910	100-YR	1643.00	7132.63	7136.46		7136.74	0.014646	4.67	402.95	244.56	0.43	1.28	3.27	0.74	1.50
Reach 1-3	9910	FIS	2600.00	7132.63	7137.15		7137.47	0.012208	4.80	581.44	270.80	0.41	1.10	3.25	1.10	1.63
Reach 1-3	9875	5-YR	475.50	7131.85	7134.54	7134.17	7134.85	0.008966	4.49	112.87	146.19	0.66	0.06	0.80	0.06	0.43
Reach 1-3	9875	100-YR	1643.00	7131.85	7136.20		7136.47	0.004812	4.88	480.04	258.88	0.49	0.37	0.92	0.43	0.56
Reach 1-3	9875	FIS	2600.00	7131.85	7136.86		7137.20	0.005212	5.68	656.47	278.92	0.52	0.51	1.21	0.66	0.76
Reach 1-3	9815	5-YR	475.50	7130.14	7134.01		7134.32	0.008585	4.50	106.04	80.43	0.65	0.01	0.78	0.03	0.70
Reach 1-3	9815	100-YR	1643.00	7130.14	7135.26	7135.26	7135.99	0.013299	7.30	297.91	229.69	0.78	0.54	2.23	0.54	1.07
Reach 1-3	9815	FIS	2600.00	7130.14	7135.85	7135.85	7136.69	0.013822	8.26	445.05	263.76	0.80	0.84	2.82	1.04	1.45
Reach 1-3	9772	5-YR	475.50	7130.91	7133.60		7133.91	0.010707	4.54	116.48	128.43	0.69		0.89	0.20	0.60
Reach 1-3	9772	100-YR	1643.00	7130.91	7134.76	7134.59	7135.36	0.012827	6.82	309.40	217.18	0.76	0.44	1.99	0.91	1.14

Sub-critical flow analysis for Shear/Velocity evaluation of Naturalized Channel Design

HEC-RAS Plan: PROP - Shear River: Sand Creek Reach: Reach 1-3 (Continued)

Reach	River Sta	Profile	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl	Shear LOB	Shear Chan	Shear ROB	Shear Total
			(cfs)	(ft)	(ft)	(ft)	(ft)	(ft/ft)	(ft/s)	(sq ft)	(ft)		(lb/sq ft)	(lb/sq ft)	(lb/sq ft)	(lb/sq ft)
Reach 1-3	9772	FIS	2600.00	7130.91	7135.31	7135.21	7136.07	0.013706	7.91	440.73	254.17	0.80	0.75	2.60	1.31	1.48
Reach 1-3	9727	5-YR	475.50	7129.87	7133.00	7132.88	7133.37	0.013269	5.00	108.69	127.42	0.77		1.08	0.26	0.70
Reach 1-3	9727	100-YR	1643.00	7129.87	7134.18	7134.09	7134.76	0.013691	6.88	323.91	240.21	0.77	0.48	2.09	1.21	1.15
Reach 1-3	9727	FIS	2600.00	7129.87	7134.69	7134.60	7135.42	0.014980	7.99	448.53	247.47	0.82	0.97	2.76	1.74	1.69
Reach 1-3	9636	5-YR	475.50	7129.38	7132.05		7132.23	0.010624	3.85	160.79	196.39	0.58	0.04	0.90	0.39	0.54
Reach 1-3	9636	100-YR	1643.00	7129.38	7132.75	7132.73	7133.24	0.020262	6.65	340.25	322.37	0.81	0.47	2.59	1.61	1.33
Reach 1-3	9636	FIS	2600.00	7129.38	7133.12	7133.12	7133.76	0.022893	7.77	459.34	326.27	0.88	1.04	3.45	2.31	2.01
Reach 1-3	9626	5-YR	475.50	7129.34	7131.74	7131.74	7132.02	0.055418	4.50	116.69	213.48	0.71	0.09	4.31	0.88	2.07
Reach 1-3	9626	100-YR	1643.00	7129.34	7132.48	7132.48	7132.96	0.042216	5.35	314.86	331.57	0.67	1.07	5.21	2.58	2.50
Reach 1-3	9626	FIS	2600.00	7129.34	7132.83	7132.83	7133.45	0.040405	5.82	430.84	335.51	0.67	1.87	5.86	3.32	3.23
Reach 1-3	9614	5-YR	475.50	7126.48	7128.87	7128.87	7129.40	0.097952	5.84	84.96	103.52	0.93	0.19	7.34	0.91	4.99
Reach 1-3	9614	100-YR	1643.00	7126.48	7130.02	7130.02	7130.68	0.061869	7.21	270.27	191.46	0.83	2.99	8.98	4.08	5.43
Reach 1-3	9614	FIS	2600.00	7126.48	7130.51	7130.51	7131.35	0.062272	8.19	367.29	208.75	0.86	4.40	10.91	5.40	6.82
Reach 1-3	9600	5-YR	475.50	7123.43	7126.83		7126.95	0.010102	2.87	174.17	104.67	0.33	0.34	1.43	0.36	1.04
Reach 1-3	9600	100-YR	1643.00	7123.43	7128.10		7128.50	0.018383	5.18	333.97	148.39	0.48	1.35	4.04	1.36	2.57
Reach 1-3	9600	FIS	2600.00	7123.43	7128.56		7129.23	0.025970	6.68	406.17	165.54	0.59	2.27	6.45	2.23	3.96
Reach 1-3	9587	5-YR	475.50	7123.38	7126.81		7126.87	0.002964	1.91	264.62	150.53	0.19	0.11	0.57	0.10	0.32
Reach 1-3	9587	100-YR	1643.00	7123.38	7128.12		7128.31	0.005905	3.38	489.18	227.72	0.28	0.59	1.60	0.42	0.91
Reach 1-3	9587	FIS	2600.00	7123.38	7128.61		7128.95	0.008524	4.35	597.88	294.28	0.34	1.03	2.57	0.30	1.07
Reach 1-3	9584	5-YR	475.50	7124.71	7126.73		7126.85	0.021540	2.68	177.47	152.36	0.44		1.56		1.56
Reach 1-3	9584	100-YR	1643.00	7124.71	7128.01		7128.28	0.022448	4.11	400.37	238.30	0.49	0.21	3.01	0.21	2.86
Reach 1-3	9584	FIS	2600.00	7124.71	7128.49		7128.91	0.027993	5.24	508.56	300.61	0.57	0.68	4.57	0.29	2.95
Reach 1-3	9558	5-YR	475.50	7122.44	7126.18		7126.34	0.016056	3.33	146.97	115.42	0.41	0.32	2.00	0.44	1.41
Reach 1-3	9558	100-YR	1643.00	7122.44	7127.44		7127.75	0.016736	4.70	371.96	295.93	0.46	0.96	3.40	0.70	1.43
Reach 1-3	9558	FIS	2600.00	7122.44	7127.96		7128.34	0.016007	5.06	523.20	322.31	0.46	1.18	3.76	0.99	1.62
Reach 1-3	9498	5-YR	475.50	7122.10	7125.02	7124.75	7125.36	0.016415	4.70	109.35	140.37	0.73		1.32	0.19	0.85
Reach 1-3	9498	100-YR	1643.00	7122.10	7126.13	7126.04	7126.68	0.017277	6.67	321.77	250.79	0.76	0.83	2.57	0.99	1.46
Reach 1-3	9498	FIS	2600.00	7122.10	7126.70	7126.54	7127.32	0.016220	7.33	461.69	257.21	0.75	1.28	2.99	1.33	1.81
Reach 1-3	9389	5-YR	475.50	7120.61	7122.59	7122.59	7122.95	0.031049	4.99	103.88	140.21	0.80	0.74	2.37	0.46	1.43
Reach 1-3	9389	100-YR	1643.00	7120.61	7123.50	7123.50	7124.28	0.029989	7.11	237.08	156.54	0.86	2.24	3.98	1.73	2.83
Reach 1-3	9389	FIS	2600.00	7120.61	7124.07	7124.07	7125.10	0.027349	7.95	328.93	168.18	0.85	2.83	4.60	2.19	3.32
Reach 1-3	9256	5-YR	475.50	7118.36	7120.60	7119.97	7120.67	0.004937	2.07	233.75	205.65	0.33	0.12	0.37	0.14	0.35
Reach 1-3	9256	100-YR	1643.00	7118.36	7122.00		7122.15	0.004229	3.15	536.43	227.70	0.34	0.31	0.69	0.29	0.62
Reach 1-3	9256	FIS	2600.00	7118.36	7123.42		7123.56	0.002272	3.08	874.41	249.32	0.27	0.27	0.57	0.27	0.50
Reach 1-3	9243	5-YR	475.50	7119.00	7119.73	7119.73	7120.04	0.131026	4.49	105.74	169.55	0.98	0.97	5.33	1.47	5.10
Reach 1-3	9243	100-YR	1643.00	7119.00	7121.68		7121.87	0.010410	3.19	486.97	215.43	0.35	0.73	1.69	1.03	1.47
Reach 1-3	9243	FIS	2600.00	7119.00	7123.26		7123.43	0.004158	2.76	846.78	241.54	0.24	0.57	1.09	0.53	0.91
Reach 1-3	9216	5-YR	475.50	7114.00	7118.78		7118.78	0.000013	0.47	1052.11	240.55	0.04	0.00	0.00	0.00	0.00
Reach 1-3	9216	100-YR	1643.00	7114.00	7121.80		7121.82	0.000027	0.95	1831.41	273.88	0.06	0.01	0.01	0.01	0.01
Reach 1-3	9216	FIS	2600.00	7114.00	7123.36		7123.38	0.000036	1.23	2269.84	293.30	0.07	0.01	0.02	0.01	0.02

Sub-critical flow analysis for Shear/Velocity evaluation of Naturalized Channel Design

HEC-RAS Plan: PROP - Shear River: Sand Creek Reach: Reach 1-3 (Continued)

Reach	River Sta	Profile	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl	Shear LOB	Shear Chan	Shear ROB	Shear Total
			(cfs)	(ft)	(ft)	(ft)	(ft)	(ft/ft)	(ft/s)	(sq ft)	(ft)		(lb/sq ft)	(lb/sq ft)	(lb/sq ft)	(lb/sq ft)
Reach 1-3	9080	5-YR	480.20	7114.00	7118.78		7118.78	0.000019	0.52	957.29	220.94	0.04	0.00	0.01	0.00	0.00
Reach 1-3	9080	100-YR	1665.90	7114.00	7121.80		7121.81	0.000040	1.06	1668.02	251.65	0.07	0.01	0.02	0.01	0.02
Reach 1-3	9080	FIS	2600.00	7114.00	7123.35		7123.37	0.000051	1.34	2071.57	268.30	0.08	0.01	0.03	0.02	0.02
Reach 1-3	9029	5-YR	480.20	7117.75	7118.70		7118.77	0.002692	2.13	226.62	242.19	0.39	0.09	0.16	0.09	0.16
Reach 1-3	9029	100-YR	1665.90	7117.75	7121.76		7121.80	0.000249	1.69	1010.66	273.00	0.15	0.03	0.06	0.03	0.06
Reach 1-3	9029	FIS	2600.00	7117.75	7123.31		7123.36	0.000196	1.86	1453.61	298.54	0.14	0.03	0.07	0.04	0.06
Reach 1-3	8989	5-YR	480.20	7117.73	7118.27	7118.27	7118.51	0.022429	4.01	120.22	242.59	1.00	0.37	0.70	0.34	0.69
Reach 1-3	8989	100-YR	1665.90	7117.73	7121.75		7121.79	0.000242	1.66	1031.42	281.20	0.15	0.03	0.06	0.03	0.06
Reach 1-3	8989	FIS	2600.00	7117.73	7123.31		7123.36	0.000187	1.82	1479.78	296.81	0.14	0.03	0.06	0.03	0.06
Reach 1-3	8983	5-YR	480.20	7103.78	7110.88		7110.99	0.000554	2.73	175.79	24.84	0.18		0.16		0.16
Reach 1-3	8983	100-YR	1665.90	7103.78	7121.66		7121.78	0.001301	2.82	616.96	281.94	0.30	0.05	0.20	0.05	0.17
Reach 1-3	8983	FIS	2600.00	7103.78	7123.26		7123.35	0.000577	2.55	1077.59	297.43	0.22	0.07	0.14	0.07	0.12
Reach 1-3	8956	5-YR	480.20	7103.78	7110.86	7106.04	7110.98	0.000558	2.74	175.39	24.84	0.18		0.16		0.16
Reach 1-3	8956	100-YR	1665.90	7103.78	7121.62	7108.97	7121.75	0.001377	2.87	605.26	281.55	0.31	0.05	0.21	0.05	0.17
Reach 1-3	8956	FIS	2600.00	7103.78	7123.24	7110.78	7123.33	0.000585	2.56	1072.80	297.27	0.22	0.07	0.14	0.07	0.12
Reach 1-3	8919		Culvert													
Reach 1-3	8888	5-YR	480.20	7103.58	7106.85	7106.85	7108.50	0.011981	10.23	46.63	47.00	1.00	2.44	2.44	2.44	2.44
Reach 1-3	8888	100-YR	1665.90	7103.58	7111.09	7111.09	7114.85	0.008998	15.44	107.17	47.20	0.99	4.22	4.22	4.22	4.22
Reach 1-3	8888	FIS	2600.00	7103.58	7113.66	7113.66	7118.74	0.008208	17.94	143.89	81.95	1.00	5.16	5.16	5.16	5.16
Reach 1-3	8886	5-YR	480.20	7102.02	7104.95	7104.95	7106.41	0.012441	9.67	49.46	46.92	1.00	2.27	2.27	2.23	2.26
Reach 1-3	8886	100-YR	1665.90	7102.02	7108.71	7108.71	7112.08	0.009454	14.64	113.27	47.09	1.00	3.95	3.94	3.90	3.94
Reach 1-3	8886	FIS	2600.00	7102.02	7111.02	7111.02	7115.55	0.008569	16.99	152.38	47.20	1.00	4.81	4.81	4.77	4.81
Reach 1-3	8852	5-YR	480.20	7102.13	7105.08		7105.14	0.000607	2.06	233.69	169.68	0.22	0.04	0.10		0.10
Reach 1-3	8852	100-YR	1665.90	7102.13	7106.82		7107.12	0.001452	4.39	380.30	265.48	0.36	0.25	0.41	0.13	0.40
Reach 1-3	8852	FIS	2600.00	7102.13	7107.84		7108.33	0.001797	5.59	466.08	273.94	0.42	0.42	0.61	0.26	0.61
Reach 1-3	8850	5-YR	480.20	7103.55	7104.59	7104.59	7105.10	0.023747	5.71	84.22	168.93	1.01	0.74	1.48		1.47
Reach 1-3	8850	100-YR	1665.90	7103.55	7105.88	7105.88	7107.03	0.018014	8.61	193.61	222.28	1.00	2.01	2.55	1.11	2.54
Reach 1-3	8850	FIS	2600.00	7103.55	7106.67	7106.67	7108.22	0.016228	9.96	260.97	265.71	1.00	2.62	3.09	1.81	3.09
Reach 1-3	8818	5-YR	480.20	7101.03	7104.37		7104.57	0.007287	3.87	157.31	201.46	0.56	0.22	0.67	0.05	0.35
Reach 1-3	8818	100-YR	1665.90	7101.03	7105.50		7105.82	0.007942	5.34	425.75	246.06	0.58	0.77	1.28	0.54	0.85
Reach 1-3	8818	FIS	2600.00	7101.03	7106.15		7106.53	0.007599	5.92	586.80	251.54	0.58	1.01	1.53	0.81	1.10
Reach 1-3	8786	5-YR	480.20	7101.10	7104.10		7104.31	0.009760	3.96	165.08	258.17	0.57	0.19	0.89	0.22	0.39
Reach 1-3	8786	100-YR	1665.90	7101.10	7105.35		7105.56	0.006517	4.49	498.31	271.30	0.48	0.61	1.10	0.63	0.74
Reach 1-3	8786	FIS	2600.00	7101.10	7106.02		7106.28	0.006106	4.95	681.67	276.51	0.47	0.81	1.28	0.84	0.93
Reach 1-3	8750	5-YR	480.20	7100.37	7103.36		7103.56	0.008654	3.83	158.49	214.41	0.53	0.27	0.85	0.05	0.49
Reach 1-3	8750	100-YR	1665.90	7100.37	7104.36		7104.81	0.013164	6.17	342.97	253.11	0.68	1.20	2.11	0.46	1.44
Reach 1-3	8750	FIS	2600.00	7100.37	7104.88		7105.50	0.014860	7.31	448.68	275.56	0.73	1.81	2.86	0.76	2.00
Reach 1-3	8683	5-YR	480.20	7099.61	7102.59	7102.31	7102.83	0.010815	4.18	149.27	260.20	0.60	0.23	1.01	0.10	0.39
Reach 1-3	8683	100-YR	1665.90	7099.61	7103.66		7103.96	0.009631	5.27	433.41	268.73	0.58	0.82	1.54	0.72	0.96
Reach 1-3	8683	FIS	2600.00	7099.61	7104.22		7104.59	0.009550	5.89	584.85	272.51	0.59	1.13	1.86	1.03	1.27

Sub-critical flow analysis for Shear/Velocity evaluation of Naturalized Channel Design

HEC-RAS Plan: PROP - Shear River: Sand Creek Reach: Reach 1-3 (Continued)

Reach	River Sta	Profile	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl	Shear LOB	Shear Chan	Shear ROB	Shear Total
			(cfs)	(ft)	(ft)	(ft)	(ft)	(ft/ft)	(ft/s)	(sq ft)	(ft)		(lb/sq ft)	(lb/sq ft)	(lb/sq ft)	(lb/sq ft)
Reach 1-3	8578	5-YR	480.20	7099.09	7102.05		7102.17	0.006139	3.14	207.05	246.17	0.44	0.19	0.60	0.21	0.32
Reach 1-3	8578	100-YR	1665.90	7099.09	7102.99		7103.25	0.008740	4.88	442.40	253.08	0.54	0.76	1.37	0.79	0.95
Reach 1-3	8578	FIS	2600.00	7099.09	7103.51		7103.87	0.009563	5.70	573.92	257.09	0.58	1.11	1.80	1.15	1.33
Reach 1-3	8429	5-YR	480.20	7098.29	7101.06	7100.98	7101.42	0.012937	4.95	110.40	218.17	0.77	0.21	1.03	0.02	0.41
Reach 1-3	8429	100-YR	1665.90	7098.29	7102.02		7102.47	0.009476	6.16	330.72	233.18	0.72	0.69	1.32	0.56	0.83
Reach 1-3	8429	FIS	2600.00	7098.29	7102.56		7103.10	0.008387	6.71	457.25	236.30	0.71	0.88	1.45	0.77	1.01
Reach 1-3	8326	5-YR	480.20	7096.32	7099.25	7099.25	7099.72	0.012631	4.98	89.61	96.87	0.95	0.12	0.67	0.95	0.72
Reach 1-3	8326	100-YR	1665.90	7096.32	7100.64	7100.64	7101.39	0.007129	7.10	258.38	195.05	0.84	0.16	0.99	1.00	0.58
Reach 1-3	8326	FIS	2600.00	7096.32	7101.20	7101.20	7102.10	0.006901	8.13	370.28	199.91	0.86	0.39	1.20	1.12	0.79
Reach 1-3	8290	5-YR	480.20	7097.00	7098.50		7098.73	0.009227	3.83	125.37	94.21	0.59		0.76		0.76
Reach 1-3	8290	100-YR	1665.90	7097.00	7099.73		7100.43	0.013374	6.71	248.22	106.02	0.77		1.95		1.95
Reach 1-3	8290	FIS	2600.00	7097.00	7100.38	7100.06	7101.41	0.015200	8.14	319.37	112.30	0.85		2.68		2.68
Reach 1-3	8276	5-YR	480.20	7097.00	7098.37	7098.01	7098.60	0.010226	3.81	126.12	103.33	0.61		0.78		0.78
Reach 1-3	8276	100-YR	1665.90	7097.00	7099.58	7099.17	7100.23	0.013181	6.48	257.22	114.69	0.76		1.84		1.84
Reach 1-3	8276	FIS	2600.00	7097.00	7100.23	7099.86	7101.17	0.014446	7.79	333.87	120.85	0.83		2.48		2.48
Reach 1-3	8267	5-YR	480.20	7097.00	7097.97	7097.97	7098.39	0.031384	5.23	91.84	108.53	1.00		1.66		1.66
Reach 1-3	8267	100-YR	1665.90	7097.00	7099.06	7099.06	7099.99	0.024521	7.73	215.63	117.65	1.01		2.80		2.80
Reach 1-3	8267	FIS	2600.00	7097.00	7099.71	7099.71	7100.93	0.022639	8.85	293.86	123.07	1.01		3.36		3.36
Reach 1-3	8229	5-YR	480.20	7091.00	7095.09		7095.15	0.000860	1.91	251.59	89.99	0.20		0.15		0.15
Reach 1-3	8229	100-YR	1665.90	7091.00	7096.97		7097.20	0.002063	3.83	434.80	105.08	0.33		0.53		0.53
Reach 1-3	8229	FIS	2600.00	7091.00	7098.34		7098.65	0.002122	4.43	586.44	116.11	0.35		0.66		0.66
Reach 1-3	8210	5-YR	480.20	7091.00	7095.08		7095.13	0.000856	1.89	253.61	91.50	0.20		0.15		0.15
Reach 1-3	8210	100-YR	1665.90	7091.00	7096.93		7097.16	0.002060	3.81	437.29	106.48	0.33		0.52		0.52
Reach 1-3	8210	FIS	2600.00	7091.00	7098.30		7098.61	0.002103	4.40	590.88	117.56	0.35		0.65		0.65
Reach 1-3	8209	5-YR	480.20	7093.00	7094.97		7095.11	0.003948	3.01	159.34	90.59	0.40		0.43		0.43
Reach 1-3	8209	100-YR	1665.90	7093.00	7096.71		7097.10	0.005143	5.06	329.37	104.66	0.50		1.00		1.00
Reach 1-3	8209	FIS	2600.00	7093.00	7098.11		7098.56	0.003989	5.37	484.18	115.99	0.46		1.03		1.03
Reach 1-3	8175	5-YR	480.20	7093.00	7094.73		7094.92	0.006290	3.51	136.83	87.84	0.50		0.61		0.61
Reach 1-3	8175	100-YR	1665.90	7093.00	7096.33		7096.85	0.007627	5.78	288.07	100.68	0.60		1.35		1.35
Reach 1-3	8175	FIS	2600.00	7093.00	7097.88		7098.39	0.004818	5.74	452.71	113.00	0.51		1.19		1.19
Reach 1-3	8165	5-YR	480.20	7093.00	7094.62	7094.11	7094.84	0.007898	3.77	127.27	86.96	0.55		0.72		0.72
Reach 1-3	8165	100-YR	1665.90	7093.00	7096.17		7096.75	0.009119	6.13	271.56	99.36	0.65		1.54		1.54
Reach 1-3	8165	FIS	2600.00	7093.00	7097.80		7098.34	0.005082	5.85	444.62	112.43	0.52		1.24		1.24
Reach 1-3	8155	5-YR	480.20	7093.00	7094.11	7094.11	7094.62	0.029657	5.72	83.90	82.88	1.00		1.87		1.87
Reach 1-3	8155	100-YR	1665.90	7093.00	7095.56	7095.43	7096.52	0.019178	7.83	212.87	94.51	0.92		2.68		2.68
Reach 1-3	8155	FIS	2600.00	7093.00	7097.72		7098.28	0.005405	5.97	435.43	111.77	0.53		1.30		1.30
Reach 1-3	8125	5-YR	480.20	7087.00	7092.55		7092.60	0.000512	1.80	267.39	70.39	0.16		0.12		0.12
Reach 1-3	8125	100-YR	1665.90	7087.00	7095.90		7096.04	0.000870	3.04	547.90	97.17	0.23		0.30		0.30
Reach 1-3	8125	FIS	2600.00	7087.00	7097.85		7098.04	0.000897	3.45	753.17	112.81	0.24		0.37		0.37
Reach 1-3	8105	5-YR	480.20	7087.00	7092.54		7092.59	0.000516	1.80	266.67	70.34	0.16		0.12		0.12
Reach 1-3	8105	100-YR	1665.90	7087.00	7095.88		7096.02	0.000878	3.05	546.40	97.15	0.23		0.30		0.30

Sub-critical flow analysis for Shear/Velocity evaluation of Naturalized Channel Design

HEC-RAS Plan: PROP - Shear River: Sand Creek Reach: Reach 1-3 (Continued)

Reach	River Sta	Profile	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl	Shear LOB	Shear Chan	Shear ROB	Shear Total
			(cfs)	(ft)	(ft)	(ft)	(ft)	(ft/ft)	(ft/s)	(sq ft)	(ft)		(lb/sq ft)	(lb/sq ft)	(lb/sq ft)	(lb/sq ft)
Reach 1-3	8105	FIS	2600.00	7087.00	7097.83		7098.02	0.000903	3.46	751.61	112.83	0.24		0.37		0.37
Reach 1-3	8104	5-YR	480.20	7089.00	7092.48		7092.57	0.001449	2.47	194.56	69.87	0.26		0.25		0.25
Reach 1-3	8104	100-YR	1665.90	7089.00	7095.81		7096.01	0.001409	3.53	472.15	96.63	0.28		0.42		0.42
Reach 1-3	8104	FIS	2600.00	7089.00	7097.78		7098.00	0.001265	3.84	677.18	112.38	0.28		0.47		0.47
Reach 1-3	8074	5-YR	480.20	7089.00	7092.32	7090.82	7092.49	0.003022	3.35	143.42	56.43	0.37		0.47		0.47
Reach 1-3	8074	100-YR	1665.90	7089.00	7095.50	7092.79	7095.89	0.002382	5.04	330.84	69.00	0.37		0.82		0.82
Reach 1-3	8074	FIS	2600.00	7089.00	7097.31	7093.80	7097.86	0.002281	5.94	437.75	69.00	0.38		1.04		1.04
Reach 1-3	7949		Culvert													
Reach 1-3	7828	5-YR	512.38	7088.70	7091.37	7090.77	7091.79	0.003393	5.24	97.87	48.09	0.63		0.44		0.44
Reach 1-3	7828	100-YR	1763.93	7088.70	7092.84	7092.84	7094.60	0.006906	10.62	166.03	60.55	0.99		1.53		1.53
Reach 1-3	7828	FIS	2600.00	7088.70	7093.90	7093.90	7096.17	0.006333	12.09	215.07	60.61	0.99		1.81		1.81
Reach 1-3	7788	5-YR	512.38	7088.52	7091.42		7091.55	0.001723	3.06	181.49	83.83	0.32	0.13	0.30	0.18	0.23
Reach 1-3	7788	100-YR	1763.93	7088.52	7093.30		7093.70	0.002728	5.42	352.85	98.90	0.44	0.36	0.80	0.53	0.60
Reach 1-3	7788	FIS	2600.00	7088.52	7094.14		7094.70	0.003107	6.46	438.65	105.67	0.48	0.49	1.07	0.71	0.80
Reach 1-3	7765	5-YR	512.38	7088.50	7091.39		7091.52	0.001325	3.11	188.17	91.24	0.32	0.11	0.24	0.12	0.17
Reach 1-3	7765	100-YR	1763.93	7088.50	7093.27		7093.63	0.002069	5.44	375.24	107.55	0.44	0.30	0.61	0.38	0.45
Reach 1-3	7765	FIS	2600.00	7088.50	7094.11		7094.62	0.002346	6.46	468.98	114.53	0.48	0.41	0.82	0.52	0.59
Reach 1-3	7742	5-YR	512.38	7088.50	7091.00		7091.43	0.006301	5.51	105.47	75.67	0.67	0.25	0.82	0.25	0.55
Reach 1-3	7742	100-YR	1763.93	7088.50	7092.31	7092.31	7093.47	0.009738	9.47	217.85	95.52	0.90	1.02	2.06	0.79	1.38
Reach 1-3	7742	FIS	2600.00	7088.50	7093.05	7093.05	7094.44	0.009298	10.54	292.45	106.84	0.91	1.28	2.40	0.96	1.58
Reach 1-3	7708	5-YR	512.38	7088.50	7090.83		7091.08	0.012845	4.85	137.54	107.96	0.56	0.71	1.82	0.85	1.02
Reach 1-3	7708	100-YR	1763.93	7088.50	7092.15		7092.74	0.015759	7.27	292.87	124.74	0.67	1.92	3.52	2.09	2.30
Reach 1-3	7708	FIS	2600.00	7088.50	7092.69		7093.53	0.017894	8.50	361.88	130.39	0.73	2.66	4.59	2.82	3.08
Reach 1-3	7669	5-YR	512.38	7087.30	7090.47		7090.72	0.006768	4.24	138.18	124.40	0.58	0.08	0.70	0.27	0.47
Reach 1-3	7669	100-YR	1763.93	7087.30	7091.90		7092.35	0.005685	5.90	340.51	151.11	0.59	0.44	1.09	0.68	0.79
Reach 1-3	7669	FIS	2600.00	7087.30	7092.47		7093.07	0.006066	6.83	428.56	157.35	0.63	0.64	1.38	0.88	1.02
Reach 1-3	7624	5-YR	512.38	7086.89	7089.85	7089.71	7090.26	0.015686	5.22	106.43	114.27	0.78		1.35	0.23	0.91
Reach 1-3	7624	100-YR	1763.93	7086.89	7091.05	7091.05	7091.88	0.019399	7.93	274.96	168.42	0.87	0.42	3.08	1.35	1.97
Reach 1-3	7624	FIS	2600.00	7086.89	7091.56	7091.56	7092.58	0.020140	8.96	368.93	198.01	0.90	0.64	3.84	1.96	2.33
Reach 1-3	7584	5-YR	512.38	7086.36	7089.48		7089.73	0.009505	4.16	147.87	177.72	0.57	0.31	0.98	0.10	0.49
Reach 1-3	7584	100-YR	1763.93	7086.36	7090.60		7091.03	0.011571	6.09	378.49	213.53	0.64	1.10	1.99	0.85	1.27
Reach 1-3	7584	FIS	2600.00	7086.36	7091.12		7091.64	0.011861	6.82	489.61	218.70	0.66	1.43	2.42	1.23	1.65
Reach 1-3	7534	5-YR	512.38	7085.85	7088.93		7089.15	0.014175	3.76	136.48	184.38	0.75	0.03	0.69	0.04	0.65
Reach 1-3	7534	100-YR	1763.93	7085.85	7090.02		7090.41	0.013491	5.12	362.02	214.80	0.66	0.47	1.56	0.80	1.41
Reach 1-3	7534	FIS	2600.00	7085.85	7090.50		7091.01	0.013776	5.85	467.43	219.56	0.67	0.69	2.01	1.16	1.82
Reach 1-3	7485	5-YR	512.38	7085.30	7088.30		7088.55	0.010959	4.37	157.25	205.91	0.61	0.25	1.06	0.31	0.52
Reach 1-3	7485	100-YR	1763.93	7085.30	7089.32		7089.76	0.013244	6.28	374.94	218.10	0.69	1.09	2.12	1.16	1.41
Reach 1-3	7485	FIS	2600.00	7085.30	7089.83		7090.36	0.013173	6.95	487.29	224.23	0.69	1.45	2.53	1.52	1.78
Reach 1-3	7455	5-YR	512.38	7085.01	7088.15		7088.32	0.004929	3.68	185.15	232.10	0.49	0.17	0.54	0.18	0.27
Reach 1-3	7455	100-YR	1763.93	7085.01	7089.00		7089.46	0.008375	6.14	367.76	251.31	0.67	0.70	1.35	0.69	0.87

Sub-critical flow analysis for Shear/Velocity evaluation of Naturalized Channel Design

HEC-RAS Plan: PROP - Shear River: Sand Creek Reach: Reach 1-3 (Continued)

Reach	River Sta	Profile	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl	Shear LOB	Shear Chan	Shear ROB	Shear Total
			(cfs)	(ft)	(ft)	(ft)	(ft)	(ft/ft)	(ft/s)	(sq ft)	(ft)		(lb/sq ft)	(lb/sq ft)	(lb/sq ft)	(lb/sq ft)
Reach 1-3	7455	FIS	2600.00	7085.01	7089.34		7090.01	0.010264	7.36	445.18	259.08	0.76	1.05	1.87	1.04	1.25
Reach 1-3	7445	5-YR	512.38	7085.12	7087.88	7087.88	7088.20	0.029482	4.89	135.27	239.63	0.69	0.65	2.86	0.46	1.18
Reach 1-3	7445	100-YR	1763.93	7085.12	7088.67	7088.67	7089.28	0.038885	7.37	308.27	259.65	0.85	2.63	5.67	2.40	3.31
Reach 1-3	7445	FIS	2600.00	7085.12	7089.03	7089.03	7089.81	0.040836	8.32	392.06	268.88	0.89	3.57	6.88	3.33	4.29
Reach 1-3	7430	5-YR	512.38	7081.82	7084.45	7084.45	7085.06	0.057728	6.33	84.28	71.97	0.94	1.28	4.98		4.18
Reach 1-3	7430	100-YR	1763.93	7081.82	7085.91	7085.91	7086.83	0.039344	8.41	254.49	148.67	0.88	3.09	6.93	2.15	4.18
Reach 1-3	7430	FIS	2600.00	7081.82	7086.65	7086.65	7087.47	0.028411	8.32	398.78	217.37	0.77	1.86	6.29	2.55	3.24
Reach 1-3	7422	5-YR	512.38	7080.12	7083.43		7083.68	0.004677	4.13	131.55	90.01	0.50	0.15	0.60	0.07	0.42
Reach 1-3	7422	100-YR	1763.93	7080.12	7084.48	7084.41	7085.46	0.011218	8.39	243.90	121.38	0.83	0.74	2.18	0.66	1.40
Reach 1-3	7422	FIS	2600.00	7080.12	7085.12	7085.12	7086.32	0.011233	9.50	327.49	138.08	0.86	0.97	2.63	0.94	1.65
Reach 1-3	7409	5-YR	512.38	7080.12	7083.50		7083.61	0.001246	2.71	212.24	112.44	0.27	0.05	0.23	0.05	0.14
Reach 1-3	7409	100-YR	1763.93	7080.12	7084.83		7085.21	0.003099	5.42	410.55	208.92	0.45	0.16	0.82	0.30	0.38
Reach 1-3	7409	FIS	2600.00	7080.12	7085.20		7085.79	0.004545	6.93	489.47	216.09	0.56	0.33	1.31	0.51	0.63
Reach 1-3	7406	5-YR	512.38	7081.53	7083.06	7083.06	7083.56	0.033673	5.84	97.36	104.85	0.85	0.56	3.06	0.73	1.95
Reach 1-3	7406	100-YR	1763.93	7081.53	7084.41	7084.41	7085.15	0.024451	7.70	277.62	187.87	0.81	1.07	4.28	2.05	2.25
Reach 1-3	7406	FIS	2600.00	7081.53	7084.91	7084.91	7085.74	0.023306	8.37	378.69	213.30	0.81	1.52	4.80	2.39	2.58
Reach 1-3	7351	5-YR	512.38	7079.22	7082.24		7082.51	0.010699	4.36	139.79	138.31	0.59	0.19	1.10	0.34	0.67
Reach 1-3	7351	100-YR	1763.93	7079.22	7083.34	7083.23	7083.94	0.015970	7.08	343.17	240.45	0.75	0.65	2.74	1.14	1.42
Reach 1-3	7351	FIS	2600.00	7079.22	7083.79	7083.71	7084.49	0.016806	7.94	459.15	267.29	0.78	0.96	3.34	1.62	1.80
Reach 1-3	7279	5-YR	512.38	7078.10	7081.41		7081.67	0.012541	4.38	143.09	166.36	0.61	0.08	1.22	0.39	0.67
Reach 1-3	7279	100-YR	1763.93	7078.10	7082.59		7082.93	0.010907	5.70	440.59	292.60	0.60	0.66	1.86	0.87	1.02
Reach 1-3	7279	FIS	2600.00	7078.10	7083.05		7083.45	0.010862	6.26	576.74	296.89	0.61	0.94	2.16	1.16	1.31
Reach 1-3	7213	5-YR	512.38	7077.30	7080.96		7081.15	0.005269	3.75	181.06	204.61	0.49	0.09	0.59	0.17	0.29
Reach 1-3	7213	100-YR	1763.93	7077.30	7082.07		7082.39	0.006921	5.50	489.44	308.65	0.57	0.45	1.25	0.59	0.68
Reach 1-3	7213	FIS	2600.00	7077.30	7082.49		7082.88	0.007815	6.30	618.38	312.68	0.61	0.69	1.61	0.85	0.96
Reach 1-3	7167	5-YR	512.38	7077.47	7080.66		7080.86	0.007315	3.78	172.36	216.88	0.49	0.14	0.83	0.16	0.36
Reach 1-3	7167	100-YR	1763.93	7077.47	7081.55		7081.96	0.012378	6.15	424.34	324.35	0.66	0.84	2.09	0.66	1.01
Reach 1-3	7167	FIS	2600.00	7077.47	7081.98		7082.43	0.012256	6.68	563.79	328.35	0.66	1.13	2.39	0.97	1.31
Reach 1-3	7102	5-YR	512.38	7076.78	7079.61	7079.54	7080.06	0.023497	5.48	109.57	167.22	0.83	0.38	1.98		1.13
Reach 1-3	7102	100-YR	1763.93	7076.78	7080.59	7080.59	7081.10	0.015620	6.76	371.75	328.79	0.78	1.06	2.26	0.65	1.10
Reach 1-3	7102	FIS	2600.00	7076.78	7080.86	7080.86	7081.54	0.017429	7.76	461.73	331.71	0.85	1.46	2.81	1.01	1.51
Reach 1-3	7093	5-YR	512.38	7076.86	7079.48	7079.48	7079.70	0.040238	4.11	154.76	305.84	0.61	0.69	3.47	0.64	1.27
Reach 1-3	7093	100-YR	1763.93	7076.86	7080.02	7080.02	7080.51	0.051832	5.78	326.18	330.15	0.73	2.30	6.18	2.52	3.19
Reach 1-3	7093	FIS	2600.00	7076.86	7080.30	7080.30	7080.94	0.049662	6.19	418.35	333.32	0.73	3.02	6.77	3.24	3.88
Reach 1-3	7073	5-YR	512.38	7072.92	7076.06		7076.26	0.020384	3.66	147.04	105.48	0.46	0.53	2.46	0.13	1.76
Reach 1-3	7073	100-YR	1763.93	7072.92	7077.14	7076.91	7077.77	0.040125	6.88	304.03	176.79	0.70	2.40	7.51	1.96	4.29
Reach 1-3	7073	FIS	2600.00	7072.92	7077.68	7077.68	7078.39	0.038460	7.52	424.49	283.73	0.70	2.57	8.50	1.64	3.58
Reach 1-3	7066	5-YR	512.38	7072.86	7076.07		7076.16	0.005663	2.48	228.37	148.68	0.26	0.18	1.00	0.10	0.53
Reach 1-3	7066	100-YR	1763.93	7072.86	7077.22		7077.52	0.014342	4.92	464.22	273.65	0.43	0.80	3.52	0.83	1.50
Reach 1-3	7066	FIS	2600.00	7072.86	7077.67		7078.06	0.017164	5.77	597.00	308.37	0.48	1.34	4.67	1.26	2.06

Sub-critical flow analysis for Shear/Velocity evaluation of Naturalized Channel Design

HEC-RAS Plan: PROP - Shear River: Sand Creek Reach: Reach 1-3 (Continued)

Reach	River Sta	Profile	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl	Shear LOB	Shear Chan	Shear ROB	Shear Total
			(cfs)	(ft)	(ft)	(ft)	(ft)	(ft/ft)	(ft/s)	(sq ft)	(ft)		(lb/sq ft)	(lb/sq ft)	(lb/sq ft)	(lb/sq ft)
Reach 1-3	7061	5-YR	512.38	7074.14	7075.57	7075.57	7076.08	0.012979	5.77	95.39	115.56	0.89	0.16	1.06	0.14	0.67
Reach 1-3	7061	100-YR	1763.93	7074.14	7076.77	7076.77	7077.43	0.009219	7.50	330.83	274.11	0.84	0.41	1.44	0.49	0.69
Reach 1-3	7061	FIS	2600.00	7074.14	7077.21	7077.21	7077.96	0.009236	8.35	460.12	309.39	0.86	0.61	1.69	0.64	0.86
Reach 1-3	7044	5-YR	512.38	7071.83	7074.80	7074.66	7075.31	0.021737	5.77	90.85	105.45	0.89		1.75	0.08	1.16
Reach 1-3	7044	100-YR	1763.93	7071.83	7076.53		7076.70	0.004947	4.22	625.04	377.98	0.43	0.37	0.93	0.43	0.51
Reach 1-3	7044	FIS	2600.00	7071.83	7077.05		7077.25	0.004733	4.53	823.57	382.68	0.42	0.50	1.04	0.56	0.63
Reach 1-3	7005	5-YR	512.38	7071.87	7074.57		7074.84	0.005923	4.18	132.79	143.82	0.55	0.04	0.66	0.07	0.34
Reach 1-3	7005	100-YR	1763.93	7071.87	7076.01		7076.47	0.006787	6.17	440.41	332.67	0.61	0.55	1.36	0.31	0.56
Reach 1-3	7005	FIS	2600.00	7071.87	7076.58		7077.04	0.006162	6.48	633.98	337.64	0.59	0.70	1.45	0.50	0.72
Reach 1-3	6941	5-YR	512.38	7070.47	7074.02		7074.37	0.009299	4.74	113.43	101.64	0.65	0.12	0.93	0.08	0.64
Reach 1-3	6941	100-YR	1763.93	7070.47	7075.77		7076.06	0.005171	5.18	511.97	293.37	0.50	0.51	1.07	0.38	0.56
Reach 1-3	6941	FIS	2600.00	7070.47	7076.34		7076.67	0.005167	5.67	680.39	298.36	0.50	0.66	1.25	0.56	0.73
Reach 1-3	6868	5-YR	512.38	7069.50	7073.14		7073.58	0.012344	5.35	96.45	70.32	0.78	0.13	1.11		1.04
Reach 1-3	6868	100-YR	1763.93	7069.50	7074.74	7074.74	7075.49	0.011840	7.49	320.61	238.94	0.76	0.85	2.22	0.46	0.99
Reach 1-3	6868	FIS	2600.00	7069.50	7075.26	7075.21	7076.10	0.012147	8.30	446.34	243.17	0.77	1.16	2.67	0.86	1.38
Reach 1-3	6769	5-YR	512.38	7068.73	7072.13		7072.47	0.009672	4.68	118.99	119.46	0.64	0.11	0.98	0.14	0.60
Reach 1-3	6769	100-YR	1763.93	7068.73	7073.53		7074.13	0.011292	6.87	328.26	167.72	0.69	0.90	2.12	0.88	1.37
Reach 1-3	6769	FIS	2600.00	7068.73	7074.14		7074.89	0.011904	7.83	437.81	191.70	0.72	1.31	2.69	1.08	1.69
Reach 1-3	6673	5-YR	512.38	7067.90	7071.19		7071.49	0.010309	4.44	121.66	160.38	0.60	0.17	1.08	0.10	0.75
Reach 1-3	6673	100-YR	1763.93	7067.90	7072.85	7072.19	7073.19	0.007137	5.36	420.22	195.21	0.52	0.73	1.48	0.66	0.95
Reach 1-3	6673	FIS	2600.00	7067.90	7073.45		7073.88	0.007520	6.07	539.48	200.58	0.54	0.98	1.83	0.95	1.25
Reach 1-3	6588	5-YR	512.38	7067.13	7070.15		7070.50	0.013207	4.77	113.70	101.07	0.66	0.21	1.31	0.13	0.92
Reach 1-3	6588	100-YR	1763.93	7067.13	7071.36	7071.31	7072.23	0.019877	7.98	265.84	156.21	0.84	1.58	3.46	0.68	2.10
Reach 1-3	6588	FIS	2600.00	7067.13	7072.01	7071.99	7072.94	0.017886	8.56	380.06	195.58	0.81	2.02	3.82	0.92	2.16
Reach 1-3	6504	5-YR	512.38	7066.40	7069.44		7069.63	0.007635	3.68	172.04	183.12	0.49	0.13	0.82	0.29	0.45
Reach 1-3	6504	100-YR	1763.93	7066.40	7070.95		7071.22	0.006029	4.72	460.45	197.07	0.46	0.62	1.21	0.75	0.87
Reach 1-3	6504	FIS	2600.00	7066.40	7071.65		7071.98	0.005822	5.24	600.04	203.01	0.46	0.81	1.42	0.95	1.07
Reach 1-3	6417	5-YR	512.38	7065.42	7068.17	7067.97	7068.60	0.018819	5.28	101.92	133.74	0.78	0.18	1.67	0.10	1.13
Reach 1-3	6417	100-YR	1763.93	7065.42	7069.52	7069.37	7070.30	0.018775	7.63	269.36	196.40	0.81	1.62	3.23	0.90	2.39
Reach 1-3	6417	FIS	2600.00	7065.42	7070.09	7070.09	7071.06	0.019306	8.66	370.67	205.90	0.83	2.27	4.00	0.57	2.15
Reach 1-3	6369	5-YR	512.38	7064.37	7067.84		7068.03	0.006720	3.58	159.75	137.83	0.47	0.18	0.73	0.09	0.48
Reach 1-3	6369	100-YR	1763.93	7064.37	7069.07		7069.55	0.010497	5.97	346.17	209.95	0.61	1.03	1.94	0.18	1.07
Reach 1-3	6369	FIS	2600.00	7064.37	7069.64		7070.21	0.010612	6.66	467.87	213.93	0.62	1.38	2.34	0.55	1.44
Reach 1-3	6298	5-YR	512.38	7064.05	7066.99	7066.79	7067.34	0.014253	4.92	123.85	163.29	0.69	0.05	1.38	0.29	0.67
Reach 1-3	6298	100-YR	1763.93	7064.05	7068.35		7068.79	0.011118	6.14	368.98	186.03	0.63	0.88	2.02	1.13	1.37
Reach 1-3	6298	FIS	2600.00	7064.05	7068.87		7069.44	0.012002	7.03	466.29	190.70	0.67	1.27	2.56	1.57	1.82
Reach 1-3	6265	5-YR	512.38	7063.23	7066.14	7066.14	7066.75	0.022793	6.26	82.48	73.43	0.99		1.75	0.13	1.58
Reach 1-3	6265	100-YR	1763.93	7063.23	7067.62	7067.62	7068.34	0.016172	7.58	311.83	206.34	0.81	0.94	2.70	0.95	1.52
Reach 1-3	6265	FIS	2600.00	7063.23	7068.07	7068.07	7068.95	0.017523	8.60	406.50	211.02	0.85	1.45	3.42	1.50	2.10
Reach 1-3	6232	5-YR	512.38	7063.38	7065.98		7066.20	0.008641	3.98	142.50	184.98	0.60	0.06	0.73	0.34	0.41
Reach 1-3	6232	100-YR	1763.93	7063.38	7066.87		7067.41	0.011541	6.25	318.78	209.34	0.73	0.69	1.61	0.92	1.09

Sub-critical flow analysis for Shear/Velocity evaluation of Naturalized Channel Design

HEC-RAS Plan: PROP - Shear River: Sand Creek Reach: Reach 1-3 (Continued)

Reach	River Sta	Profile	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl	Shear LOB	Shear Chan	Shear ROB	Shear Total
			(cfs)	(ft)	(ft)	(ft)	(ft)	(ft/ft)	(ft/s)	(sq ft)	(ft)		(lb/sq ft)	(lb/sq ft)	(lb/sq ft)	(lb/sq ft)
Reach 1-3	6232	FIS	2600.00	7063.38	7067.20	7067.12	7067.99	0.013589	7.39	388.95	212.09	0.81	1.07	2.18	1.35	1.55
Reach 1-3	6223	5-YR	512.38	7063.07	7065.61	7065.61	7066.00	0.075480	5.30	111.22	152.15	0.83	0.47	5.95	1.66	3.43
Reach 1-3	6223	100-YR	1763.93	7063.07	7066.52	7066.52	7067.18	0.068421	7.23	285.78	209.31	0.86	3.37	9.26	4.65	5.81
Reach 1-3	6223	FIS	2600.00	7063.07	7066.92	7066.92	7067.74	0.066254	7.95	369.00	212.55	0.87	4.75	10.58	6.05	7.15
Reach 1-3	6212	5-YR	512.38	7060.43	7062.98	7062.98	7063.49	0.091843	5.81	93.70	104.64	0.91	1.62	7.17	0.73	5.10
Reach 1-3	6212	100-YR	1763.93	7060.43	7064.21	7064.21	7065.09	0.073523	8.13	252.69	148.43	0.91	5.48	11.24	4.23	7.77
Reach 1-3	6212	FIS	2600.00	7060.43	7064.78	7064.78	7065.82	0.068990	9.04	341.81	166.23	0.91	6.70	12.96	5.30	8.81
Reach 1-3	6199	5-YR	512.38	7057.41	7060.62		7060.82	0.020155	3.64	143.86	84.42	0.46	0.40	2.44	0.47	2.12
Reach 1-3	6199	100-YR	1763.93	7057.41	7062.15		7062.77	0.030034	6.54	296.15	117.54	0.62	2.02	6.48	1.82	4.69
Reach 1-3	6199	FIS	2600.00	7057.41	7062.76		7063.64	0.035434	7.90	372.83	135.34	0.69	3.05	8.97	2.59	6.05
Reach 1-3	6184	5-YR	512.38	7057.42	7060.56		7060.65	0.005209	2.44	223.72	111.45	0.25	0.13	0.95	0.16	0.64
Reach 1-3	6184	100-YR	1763.93	7057.42	7062.12		7062.42	0.011156	4.72	425.24	145.16	0.39	0.98	3.10	1.08	2.01
Reach 1-3	6184	FIS	2600.00	7057.42	7062.76		7063.19	0.013556	5.69	522.89	157.86	0.44	1.52	4.31	1.63	2.77
Reach 1-3	6182	5-YR	512.38	7058.72	7060.01	7060.01	7060.58	0.045857	6.06	86.08	81.93	0.96	0.23	3.50	0.50	2.99
Reach 1-3	6182	100-YR	1763.93	7058.72	7061.41	7061.41	7062.33	0.030039	8.15	245.65	133.77	0.89	1.69	4.91	2.03	3.43
Reach 1-3	6182	FIS	2600.00	7058.72	7062.00	7062.00	7063.09	0.028075	9.02	328.13	145.46	0.89	2.27	5.62	2.58	3.94
Reach 1-3	6164	5-YR	512.38	7056.45	7059.80	7059.57	7060.10	0.012330	4.63	129.24	126.76	0.63	0.36	1.28	0.09	0.78
Reach 1-3	6164	100-YR	1763.93	7056.45	7061.13	7060.80	7061.61	0.011792	6.33	369.81	244.89	0.64	1.13	2.19	0.47	1.11
Reach 1-3	6164	FIS	2600.00	7056.45	7061.54		7062.15	0.013774	7.39	476.00	269.30	0.70	1.58	2.90	0.80	1.51
Reach 1-3	6091	5-YR	512.38	7055.75	7058.66	7058.44	7059.05	0.016986	5.05	106.88	115.19	0.75	0.03	1.47	0.17	0.98
Reach 1-3	6091	100-YR	1763.93	7055.75	7059.86	7059.72	7060.53	0.018551	7.31	332.32	268.84	0.80	0.77	2.98	0.88	1.43
Reach 1-3	6091	FIS	2600.00	7055.75	7060.36	7060.32	7061.04	0.017020	7.76	479.38	310.21	0.78	0.96	3.26	1.21	1.64
Reach 1-3	6042	5-YR	512.38	7054.55	7058.12		7058.42	0.009289	4.45	129.16	156.30	0.63	0.10	0.90	0.13	0.48
Reach 1-3	6042	100-YR	1763.93	7054.55	7059.25	7059.04	7059.77	0.011623	6.64	389.52	293.90	0.71	0.74	1.93	0.60	0.96
Reach 1-3	6042	FIS	2600.00	7054.55	7059.67	7059.56	7060.30	0.012769	7.58	527.21	351.84	0.76	1.12	2.45	0.78	1.19
Reach 1-3	5977	5-YR	512.38	7054.61	7057.67		7057.92	0.009917	4.18	141.74	162.30	0.57	0.23	1.04	0.10	0.54
Reach 1-3	5977	100-YR	1763.93	7054.61	7058.63	7058.55	7059.12	0.014765	6.57	397.87	339.08	0.71	0.91	2.42	0.62	1.08
Reach 1-3	5977	FIS	2600.00	7054.61	7058.99	7058.92	7059.59	0.016700	7.54	531.55	411.65	0.77	1.38	3.11	0.80	1.34
Reach 1-3	5928	5-YR	512.38	7053.68	7056.31	7056.15	7056.68	0.018251	4.94	116.53	149.61	0.74	0.02	1.55	0.28	0.88
Reach 1-3	5928	100-YR	1763.93	7053.68	7057.34	7057.26	7057.74	0.015181	6.16	436.41	399.53	0.70	0.75	2.25	0.77	1.03
Reach 1-3	5928	FIS	2600.00	7053.68	7057.75		7058.17	0.014327	6.57	606.54	446.62	0.69	1.06	2.48	0.91	1.21
Reach 1-3	5824	5-YR	512.38	7052.15	7055.58	7055.07	7055.81	0.007850	4.09	168.02	273.30	0.55	0.12	0.84	0.14	0.30
Reach 1-3	5824	100-YR	1763.93	7052.15	7056.50	7056.29	7056.86	0.010472	5.94	469.84	381.97	0.64	0.75	1.72	0.50	0.80
Reach 1-3	5824	FIS	2600.00	7052.15	7056.90	7056.63	7057.31	0.010792	6.55	631.73	423.50	0.66	1.03	2.03	0.67	1.00
Reach 1-3	5791	5-YR	512.38	7052.28	7055.03	7055.03	7055.36	0.016271	4.84	136.80	251.22	0.72	0.26	1.41	0.09	0.55
Reach 1-3	5791	100-YR	1763.93	7052.28	7055.83	7055.83	7056.29	0.018900	6.65	403.70	405.32	0.79	1.22	2.57	0.59	1.17
Reach 1-3	5791	FIS	2600.00	7052.28	7056.10	7056.10	7056.68	0.022113	7.69	516.45	438.25	0.86	1.79	3.37	0.93	1.62
Reach 1-3	5744	5-YR	512.38	7051.51	7054.87	7054.69	7055.00	0.005474	3.26	235.41	423.61	0.45	0.14	0.56	0.10	0.19
Reach 1-3	5744	100-YR	1763.93	7051.51	7055.62		7055.80	0.005983	4.32	577.37	489.50	0.49	0.42	0.89	0.32	0.44
Reach 1-3	5744	FIS	2600.00	7051.51	7055.91		7056.15	0.006485	4.84	723.13	503.36	0.52	0.57	1.08	0.45	0.58

Sub-critical flow analysis for Shear/Velocity evaluation of Naturalized Channel Design

HEC-RAS Plan: PROP - Shear River: Sand Creek Reach: Reach 1-3 (Continued)

Reach	River Sta	Profile	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl	Shear LOB	Shear Chan	Shear ROB	Shear Total
			(cfs)	(ft)	(ft)	(ft)	(ft)	(ft/ft)	(ft/s)	(sq ft)	(ft)		(lb/sq ft)	(lb/sq ft)	(lb/sq ft)	(lb/sq ft)
Reach 1-3	5688	5-YR	533.15	7051.38	7054.17	7054.17	7054.46	0.011578	4.72	145.85	321.65	0.78	0.01	0.82	0.23	0.33
Reach 1-3	5688	100-YR	1880.40	7051.38	7055.02		7055.32	0.008191	5.43	506.84	441.12	0.68	0.42	1.01	0.57	0.59
Reach 1-3	5688	FIS	2600.00	7051.38	7055.36		7055.68	0.007382	5.67	654.47	449.48	0.66	0.52	1.06	0.64	0.67
Reach 1-3	5628	5-YR	533.15	7050.55	7053.93		7054.04	0.003904	2.99	271.36	411.83	0.39	0.11	0.44	0.10	0.16
Reach 1-3	5628	100-YR	1880.40	7050.55	7054.84		7055.00	0.004092	3.99	654.46	429.43	0.43	0.33	0.68	0.33	0.39
Reach 1-3	5628	FIS	2600.00	7050.55	7055.16		7055.37	0.004275	4.40	794.55	432.15	0.44	0.43	0.80	0.43	0.49
Reach 1-3	5568	5-YR	533.15	7049.82	7052.96	7052.68	7053.35	0.013503	5.07	117.69	261.88	0.73	0.14	1.26	0.03	0.38
Reach 1-3	5568	100-YR	1880.40	7049.82	7053.80	7053.80	7054.30	0.013141	6.72	407.98	387.78	0.77	0.59	1.91	0.71	0.86
Reach 1-3	5568	FIS	2600.00	7049.82	7054.05	7054.04	7054.64	0.013945	7.40	503.47	389.82	0.81	0.83	2.24	0.96	1.12
Reach 1-3	5429	5-YR	533.15	7048.55	7051.57	7051.57	7051.91	0.014174	4.83	148.20	312.05	0.69	0.14	1.32	0.19	0.42
Reach 1-3	5429	100-YR	1880.40	7048.55	7052.47		7052.84	0.013996	6.12	460.96	359.67	0.70	0.82	2.07	0.95	1.12
Reach 1-3	5429	FIS	2600.00	7048.55	7052.81		7053.21	0.013267	6.44	586.14	362.51	0.68	1.06	2.25	1.18	1.33
Reach 1-3	5365	5-YR	533.15	7047.14	7050.42	7050.42	7050.87	0.014541	5.52	116.73	174.03	0.82		1.26	0.21	0.60
Reach 1-3	5365	100-YR	1880.40	7047.14	7051.38	7051.38	7051.90	0.015246	7.16	424.36	362.14	0.82	0.78	2.21	0.92	1.11
Reach 1-3	5365	FIS	2600.00	7047.14	7051.64	7051.64	7052.25	0.016954	7.98	517.99	364.22	0.87	1.13	2.72	1.29	1.50
Reach 1-3	5289	5-YR	533.15	7046.36	7049.40	7049.40	7049.81	0.017763	5.34	119.84	170.27	0.80		1.53	0.29	0.78
Reach 1-3	5289	100-YR	1880.40	7046.36	7050.66		7050.98	0.010381	5.62	493.34	340.78	0.61	0.64	1.69	0.81	0.93
Reach 1-3	5289	FIS	2600.00	7046.36	7051.00		7051.37	0.010692	6.11	611.14	343.68	0.62	0.87	1.97	1.05	1.18
Reach 1-3	5227	5-YR	533.15	7045.43	7048.67		7048.91	0.009009	4.14	160.51	180.47	0.56	0.12	0.96	0.28	0.50
Reach 1-3	5227	100-YR	1880.40	7045.43	7049.69	7049.64	7050.19	0.014333	6.73	418.86	325.94	0.72	0.78	2.43	0.84	1.15
Reach 1-3	5227	FIS	2600.00	7045.43	7050.04		7050.58	0.014230	7.20	533.97	328.87	0.72	1.07	2.72	1.14	1.44
Reach 1-3	5171	5-YR	533.15	7044.55	7047.23	7046.97	7047.66	0.018216	5.28	105.70	117.72	0.76	0.04	1.70	0.19	1.02
Reach 1-3	5171	100-YR	1880.40	7044.55	7048.72		7049.05	0.009263	5.59	495.90	340.45	0.57	0.81	1.72	0.51	0.84
Reach 1-3	5171	FIS	2600.00	7044.55	7049.26		7049.56	0.007278	5.49	680.99	344.39	0.52	0.87	1.59	0.64	0.90
Reach 1-3	5047	5-YR	533.15	7042.80	7045.86		7046.11	0.010111	4.22	146.38	137.71	0.58	0.31	1.04	0.02	0.67
Reach 1-3	5047	100-YR	1880.40	7042.80	7046.87	7046.72	7047.59	0.018391	7.40	292.14	151.86	0.80	1.64	3.04	0.52	2.20
Reach 1-3	5047	FIS	2600.00	7042.80	7047.20	7047.13	7048.18	0.022166	8.70	341.97	156.96	0.89	2.38	4.11	0.84	3.00
Reach 1-3	4948	5-YR	533.15	7041.66	7044.83		7045.11	0.010093	4.36	138.23	162.94	0.58	0.18	1.10	0.09	0.53
Reach 1-3	4948	100-YR	1880.40	7041.66	7046.26		7046.49	0.006084	4.75	578.76	339.84	0.47	0.60	1.20	0.48	0.64
Reach 1-3	4948	FIS	2600.00	7041.66	7046.64		7046.91	0.006423	5.23	709.10	342.87	0.49	0.77	1.42	0.66	0.83
Reach 1-3	4855	5-YR	533.15	7040.34	7044.13		7044.45	0.008687	4.54	122.99	100.22	0.60	0.10	0.93	0.15	0.66
Reach 1-3	4855	100-YR	1880.40	7040.34	7045.39	7045.29	7045.92	0.011040	6.76	421.14	326.27	0.69	0.88	2.04	0.53	0.89
Reach 1-3	4855	FIS	2600.00	7040.34	7045.75		7046.33	0.011347	7.32	541.59	329.78	0.70	1.12	2.35	0.80	1.16
Reach 1-3	4782	5-YR	533.15	7040.04	7043.59		7043.86	0.007174	4.19	141.44	137.41	0.54	0.14	0.83	0.05	0.46
Reach 1-3	4782	100-YR	1880.40	7040.04	7044.69	7044.57	7045.15	0.010364	6.42	448.51	334.43	0.66	0.82	1.90	0.54	0.86
Reach 1-3	4782	FIS	2600.00	7040.04	7045.05	7044.87	7045.55	0.010822	6.99	566.75	337.30	0.68	1.07	2.22	0.79	1.13
Reach 1-3	4714	5-YR	533.15	7039.78	7042.77		7043.16	0.015233	5.04	109.08	94.37	0.71	0.14	1.46	0.15	1.09
Reach 1-3	4714	100-YR	1880.40	7039.78	7043.90		7044.35	0.013749	6.46	432.84	330.19	0.69	0.79	2.28	0.83	1.12
Reach 1-3	4714	FIS	2600.00	7039.78	7044.41		7044.80	0.010539	6.26	600.03	334.07	0.62	0.92	2.08	0.96	1.18
Reach 1-3	4632	5-YR	533.15	7039.10	7042.01		7042.21	0.009113	3.97	176.05	198.73	0.58	0.08	0.81	0.41	0.50
Reach 1-3	4632	100-YR	1880.40	7039.10	7043.52		7043.71	0.005156	4.37	604.43	316.07	0.45	0.45	0.93	0.55	0.61

Sub-critical flow analysis for Shear/Velocity evaluation of Naturalized Channel Design

HEC-RAS Plan: PROP - Shear River: Sand Creek Reach: Reach 1-3 (Continued)

Reach	River Sta	Profile	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl	Shear LOB	Shear Chan	Shear ROB	Shear Total
			(cfs)	(ft)	(ft)	(ft)	(ft)	(ft/ft)	(ft/s)	(sq ft)	(ft)		(lb/sq ft)	(lb/sq ft)	(lb/sq ft)	(lb/sq ft)
Reach 1-3	4632	FIS	2600.00	7039.10	7044.09		7044.29	0.004444	4.50	785.02	321.62	0.42	0.52	0.96	0.63	0.68
Reach 1-3	4582	5-YR	533.15	7038.10	7041.73		7041.87	0.004826	3.38	208.99	196.25	0.45	0.04	0.52	0.27	0.32
Reach 1-3	4582	100-YR	1880.40	7038.10	7043.32		7043.49	0.003796	4.17	640.90	298.93	0.40	0.34	0.78	0.47	0.51
Reach 1-3	4582	FIS	2600.00	7038.10	7043.90		7044.09	0.003496	4.39	817.94	304.85	0.39	0.43	0.84	0.56	0.58
Reach 1-3	4534	5-YR	533.15	7038.20	7041.55		7041.64	0.003897	2.84	248.74	226.04	0.36	0.06	0.46	0.24	0.27
Reach 1-3	4534	100-YR	1880.40	7038.20	7043.18		7043.32	0.002994	3.56	694.46	282.77	0.33	0.31	0.66	0.45	0.46
Reach 1-3	4534	FIS	2600.00	7038.20	7043.77		7043.93	0.002931	3.87	862.63	288.50	0.34	0.39	0.75	0.54	0.54
Reach 1-3	4296	5-YR	512.29	7036.56	7039.40	7039.40	7039.98	0.017573	7.46	106.45	91.61	0.91	0.54	2.25	1.11	1.27
Reach 1-3	4296	100-YR	1848.80	7036.56	7041.11	7041.11	7041.96	0.015516	9.95	309.42	170.17	0.90	0.79	3.60	2.06	1.75
Reach 1-3	4296	FIS	2600.00	7036.56	7041.60	7041.60	7042.57	0.016050	10.90	394.30	179.57	0.93	1.27	4.20	2.42	2.19
Reach 1-3	4084	5-YR	512.29	7033.29	7037.49		7037.49	0.000039	0.62	834.01	266.74	0.06	0.00	0.01	0.00	0.01
Reach 1-3	4084	100-YR	1848.80	7033.29	7039.49		7039.52	0.000096	1.32	1527.52	365.16	0.10	0.01	0.03	0.01	0.03
Reach 1-3	4084	FIS	2600.00	7033.29	7040.66		7040.69	0.000091	1.45	1956.49	374.03	0.10	0.01	0.04	0.02	0.03
Reach 1-3	3846	5-YR	512.29	7033.20	7036.87	7036.87	7037.40	0.017706	5.86	87.35	166.03	1.01		1.17		1.17
Reach 1-3	3846	100-YR	1848.80	7033.20	7038.22	7038.22	7039.33	0.013956	8.45	218.78	233.23	1.01		1.91		1.91
Reach 1-3	3846	FIS	2600.00	7033.20	7039.80		7040.54	0.004486	6.89	377.33	317.58	0.63		1.06		1.06
Reach 1-3	3842	5-YR	512.29	7014.12	7020.70		7021.01	0.000126	4.50	121.28	19.69	0.31	0.01	0.05	0.00	0.03
Reach 1-3	3842	100-YR	1848.80	7014.12	7033.28		7033.74	0.000045	5.52	399.11	35.16	0.22	0.01	0.05	0.00	0.02
Reach 1-3	3842	FIS	2600.00	7014.12	7039.98		7040.47	0.000032	5.69	570.89	493.19	0.20	0.01	0.05	0.01	0.02
Reach 1-3	3816	5-YR	512.29	7014.12	7020.20	7017.95	7020.96	0.000339	7.01	75.45	12.83	0.50	0.01	0.13	0.00	0.07
Reach 1-3	3816	100-YR	1848.80	7014.12	7032.63	7023.13	7033.68	0.000107	8.27	245.34	14.52	0.34	0.01	0.12	0.00	0.03
Reach 1-3	3816	FIS	2600.00	7014.12	7039.28	7025.41	7040.40	0.000076	8.53	344.92	95.24	0.30	0.01	0.12	0.00	0.03
Reach 1-3	3744		Culvert													
Reach 1-3	3719	5-YR	512.29	7013.40	7017.22	7017.22	7019.15	0.001594	11.16	46.83	12.51	1.01	0.02	0.38	0.00	0.24
Reach 1-3	3719	100-YR	1848.80	7013.40	7022.41	7022.41	7026.91	0.001184	17.04	113.55	13.19	1.00	0.04	0.67	0.00	0.28
Reach 1-3	3719	FIS	2600.00	7013.40	7024.68	7024.68	7030.35	0.001107	19.13	143.82	13.49	1.00	0.05	0.78	0.00	0.29
Reach 1-3	3711	5-YR	512.29	7002.83	7008.91	7006.66	7009.67	0.000340	7.02	74.68	12.58	0.50	0.01	0.13	0.00	0.07
Reach 1-3	3711	100-YR	1848.80	7002.83	7021.33	7011.85	7022.39	0.000108	8.30	238.31	13.77	0.34	0.01	0.12	0.00	0.03
Reach 1-3	3711	FIS	2600.00	7002.83	7027.64	7014.13	7028.81	0.000080	8.69	327.20	14.38	0.31	0.01	0.12	0.00	0.03
Reach 1-3	3676		Culvert													
Reach 1-3	3667	5-YR	512.29	7002.61	7006.44	7006.44	7008.37	0.001588	11.15	46.62	12.36	1.00	0.02	0.38	0.00	0.24
Reach 1-3	3667	100-YR	1848.80	7002.61	7011.61	7011.61	7016.14	0.001193	17.08	111.88	12.86	1.00	0.03	0.67	0.00	0.28
Reach 1-3	3667	FIS	2600.00	7002.61	7013.91	7013.91	7019.58	0.001106	19.14	141.63	13.08	1.00	0.04	0.78	0.00	0.28
Reach 1-3	3662	5-YR	512.29	7001.15	7004.61		7005.31	0.005541	6.67	76.85	73.06	0.68	0.01	0.93	0.01	0.90
Reach 1-3	3662	100-YR	1848.80	7001.15	7010.93		7011.84	0.001608	7.68	246.05	403.80	0.44	0.05	0.84	0.04	0.58
Reach 1-3	3662	FIS	2600.00	7001.15	7011.32	7008.44	7012.98	0.002773	10.36	256.80	429.70	0.59	0.09	1.51	0.08	1.03
Reach 1-3	3629	5-YR	512.29	7001.51	7005.00	7003.02	7005.05	0.000825	1.93	265.09	463.34	0.20		0.15		0.15
Reach 1-3	3629	100-YR	1848.80	7001.51	7011.50	7004.41	7011.57	0.000215	2.16	856.79	631.19	0.12		0.13		0.13
Reach 1-3	3629	FIS	2600.00	7001.51	7012.47	7005.04	7012.48	0.000022	0.73	5019.20	640.28	0.04	0.01	0.01	0.01	0.01

Sub-critical flow analysis for Shear/Velocity evaluation of Naturalized Channel Design

HEC-RAS Plan: PROP - Shear River: Sand Creek Reach: Reach 1-3 (Continued)

Reach	River Sta	Profile	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl	Shear LOB	Shear Chan	Shear ROB	Shear Total
			(cfs)	(ft)	(ft)	(ft)	(ft)	(ft/ft)	(ft/s)	(sq ft)	(ft)		(lb/sq ft)	(lb/sq ft)	(lb/sq ft)	(lb/sq ft)
Reach 1-3	3625	5-YR	512.29	7003.41	7005.00		7005.05	0.001316	2.25	425.11	463.76	0.32	0.07	0.13	0.06	0.08
Reach 1-3	3625	100-YR	1848.80	7003.41	7011.55		7011.55	0.000016	0.76	4303.02	631.62	0.05	0.01	0.01	0.01	0.01
Reach 1-3	3625	FIS	2600.00	7003.41	7012.47		7012.48	0.000022	0.93	4892.07	640.26	0.05	0.01	0.01	0.01	0.01
Reach 1-3	3618	5-YR	512.29	7002.58	7004.98		7005.04	0.001701	3.06	430.63	457.91	0.35	0.10	0.25	0.08	0.10
Reach 1-3	3618	100-YR	1848.80	7002.58	7011.55		7011.55	0.000020	0.82	4257.09	622.19	0.05	0.01	0.01	0.01	0.01
Reach 1-3	3618	FIS	2600.00	7002.58	7012.47		7012.48	0.000027	1.00	4837.77	630.95	0.06	0.01	0.02	0.01	0.01
Reach 1-3	3485	5-YR	512.29	7002.22	7004.78		7004.84	0.001575	3.07	426.89	433.07	0.34	0.09	0.24	0.08	0.10
Reach 1-3	3485	100-YR	1848.80	7002.22	7011.54		7011.55	0.000019	0.81	4323.96	620.53	0.05	0.01	0.01	0.01	0.01
Reach 1-3	3485	FIS	2600.00	7002.22	7012.47		7012.48	0.000025	0.99	4903.01	629.77	0.05	0.01	0.02	0.01	0.01
Reach 1-3	3336	5-YR	512.29	7001.71	7004.68		7004.70	0.000566	2.04	633.91	517.73	0.21	0.04	0.10	0.05	0.04
Reach 1-3	3336	100-YR	1848.80	7001.71	7011.54		7011.55	0.000014	0.71	4822.48	642.15	0.04	0.01	0.01	0.01	0.01
Reach 1-3	3336	FIS	2600.00	7001.71	7012.47		7012.47	0.000019	0.88	5420.81	650.45	0.05	0.01	0.01	0.01	0.01
Reach 1-3	3198	5-YR	512.29	7001.27	7004.65		7004.66	0.000139	1.09	977.96	507.50	0.11	0.02	0.03	0.01	0.02
Reach 1-3	3198	100-YR	1848.80	7001.27	7011.54		7011.54	0.000011	0.66	4817.29	599.85	0.04	0.01	0.01	0.01	0.01
Reach 1-3	3198	FIS	2600.00	7001.27	7012.47		7012.47	0.000016	0.82	5376.90	609.22	0.04	0.01	0.01	0.01	0.01
Reach 1-3	3103	5-YR	512.29	7001.02	7004.65	7001.77	7004.65	0.000031	0.54	955.85	385.40	0.05		0.01		0.01
Reach 1-3	3103	100-YR	1848.80	7001.02	7011.54	7002.40	7011.54	0.000011	0.62	3035.87	478.75	0.04	0.00	0.01	0.00	0.00
Reach 1-3	3103	FIS	2600.00	7001.02	7012.46	7002.68	7012.47	0.000015	0.78	3480.66	485.10	0.04	0.00	0.01	0.00	0.01
Reach 1-3	3057		Culvert													
Reach 1-3	2988	5-YR	512.29	7001.00	7003.77		7003.83	0.000564	1.98	258.46	117.29	0.21	0.09	0.10	0.09	0.10
Reach 1-3	2988	100-YR	1848.80	7001.00	7007.74		7007.87	0.000375	2.93	631.03	133.64	0.20	0.15	0.16	0.15	0.16
Reach 1-3	2988	FIS	2600.00	7001.00	7010.57		7010.70	0.000229	2.89	897.66	149.46	0.16	0.13	0.14	0.13	0.14
Reach 1-3	2975	5-YR	398.70	7000.89	7003.71	7002.10	7003.82	0.001118	2.66	149.73	53.95	0.28		0.18		0.18
Reach 1-3	2975	100-YR	1562.40	7000.89	7007.55	7003.89	7007.85	0.000950	4.36	360.47	55.68	0.30	0.02	0.36	0.02	0.32
Reach 1-3	2975	FIS	2600.00	7000.89	7010.26	7005.10	7010.67	0.000834	5.14	512.99	56.85	0.30	0.04	0.45	0.04	0.37
Reach 1-3	2930		Culvert													
Reach 1-3	2879	5-YR	398.70	7000.82	7002.45		7002.90	0.008564	5.28	74.43	60.40	0.75	0.82	0.83	0.78	0.83
Reach 1-3	2879	100-YR	1562.40	7000.82	7004.10	7004.10	7005.71	0.011700	9.99	153.77	73.42	0.98	2.32	2.34	2.27	2.33
Reach 1-3	2879	FIS	2600.00	7000.82	7005.39	7005.39	7007.65	0.010460	11.83	215.85	84.44	0.98	2.92	2.94	2.87	2.92
Reach 1-3	2856	5-YR	398.70	7000.50	7002.18		7002.47	0.038527	4.32	94.37	67.04	0.61	1.24	3.70	1.39	3.43
Reach 1-3	2856	100-YR	1562.40	7000.50	7003.73		7004.71	0.053721	8.09	197.99	78.57	0.81	6.10	10.30	7.01	9.77
Reach 1-3	2856	FIS	2600.00	7000.50	7004.66	7004.39	7006.22	0.059821	10.17	260.93	85.75	0.89	10.19	14.94	11.22	14.34
Reach 1-3	2850	5-YR	398.70	7000.17	7001.55	7001.55	7002.07	0.111722	5.87	69.37	67.25	0.99	2.91	7.66	2.75	7.13
Reach 1-3	2850	100-YR	1562.40	7000.17	7003.47		7004.37	0.050787	7.78	208.98	81.81	0.79	5.13	9.58	6.21	8.76
Reach 1-3	2850	FIS	2600.00	7000.17	7004.50		7005.81	0.050313	9.41	285.90	89.57	0.82	8.08	12.72	9.28	11.88
Reach 1-3	2842	5-YR	398.70	6997.59	7001.50		7001.56	0.002796	2.03	207.56	67.18	0.19	0.21	0.62	0.21	0.51
Reach 1-3	2842	100-YR	1562.40	6997.59	7003.61		7003.93	0.008315	4.72	364.60	81.98	0.34	1.13	2.88	1.20	2.22
Reach 1-3	2842	FIS	2600.00	6997.59	7004.68		7005.25	0.012030	6.35	453.98	89.34	0.43	2.04	4.93	2.51	3.82
Reach 1-3	2838	5-YR	398.70	6999.13	7001.40		7001.54	0.012715	3.05	132.12	66.96	0.37	0.31	1.66	0.21	1.55
Reach 1-3	2838	100-YR	1562.40	6999.13	7003.36		7003.87	0.019350	5.83	278.48	82.02	0.51	1.61	4.89	1.46	4.05

Sub-critical flow analysis for Shear/Velocity evaluation of Naturalized Channel Design

HEC-RAS Plan: PROP - Shear River: Sand Creek Reach: Reach 1-3 (Continued)

Reach	River Sta	Profile	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl	Shear LOB	Shear Chan	Shear ROB	Shear Total
			(cfs)	(ft)	(ft)	(ft)	(ft)	(ft/ft)	(ft/s)	(sq ft)	(ft)		(lb/sq ft)	(lb/sq ft)	(lb/sq ft)	(lb/sq ft)
Reach 1-3	2838	FIS	2600.00	6999.13	7004.35		7005.17	0.023504	7.43	363.60	89.63	0.58	2.66	7.38	2.48	5.86
Reach 1-3	2830	5-YR	398.70	6997.58	7001.36		7001.49	0.003085	2.87	144.56	71.10	0.33	0.16	0.44	0.16	0.39
Reach 1-3	2830	100-YR	1562.40	6997.58	7003.33		7003.77	0.005548	5.52	299.22	86.69	0.47	0.62	1.47	0.60	1.18
Reach 1-3	2830	FIS	2600.00	6997.58	7004.32		7005.04	0.006975	7.05	389.78	94.98	0.54	0.99	2.27	0.96	1.76
Reach 1-3	2792	5-YR	398.70	6997.53	7001.27		7001.37	0.002631	2.67	157.88	77.82	0.31	0.16	0.39	0.18	0.33
Reach 1-3	2792	100-YR	1562.40	6997.53	7003.18		7003.56	0.004764	5.12	323.58	95.39	0.44	0.57	1.27	0.62	0.99
Reach 1-3	2792	FIS	2600.00	6997.53	7004.16		7004.77	0.005965	6.51	421.39	104.39	0.50	0.89	1.95	0.96	1.48
Reach 1-3	2719	5-YR	398.70	6997.47	7001.10		7001.19	0.002536	2.64	170.08	91.73	0.30	0.15	0.37	0.21	0.29
Reach 1-3	2719	100-YR	1562.40	6997.47	7002.91		7003.23	0.004501	4.94	349.35	106.60	0.43	0.52	1.16	0.77	0.91
Reach 1-3	2719	FIS	2600.00	6997.47	7003.82		7004.36	0.005660	6.27	451.10	114.78	0.49	0.79	1.78	1.19	1.37
Reach 1-3	2680	5-YR	398.70	6997.33	7001.00		7001.09	0.002535	2.55	175.35	100.39	0.30	0.14	0.35	0.17	0.27
Reach 1-3	2680	100-YR	1562.40	6997.33	7002.73		7003.04	0.004586	4.80	363.78	119.52	0.42	0.42	1.13	0.70	0.86
Reach 1-3	2680	FIS	2600.00	6997.33	7003.62		7004.11	0.005711	6.07	474.85	130.47	0.48	0.66	1.72	1.10	1.29
Reach 1-3	2646	5-YR	398.70	6997.18	7000.92		7001.01	0.002291	2.53	178.21	109.98	0.30	0.10	0.31	0.13	0.23
Reach 1-3	2646	100-YR	1562.40	6997.18	7002.61		7002.89	0.003936	4.61	381.48	128.84	0.41	0.40	0.95	0.57	0.72
Reach 1-3	2646	FIS	2600.00	6997.18	7003.48		7003.92	0.004885	5.80	496.17	136.11	0.47	0.67	1.44	0.90	1.10
Reach 1-3	2589	5-YR	398.70	6996.89	7000.79		7000.88	0.002215	2.59	183.01	119.28	0.31	0.06	0.30	0.14	0.21
Reach 1-3	2589	100-YR	1562.40	6996.89	7002.43		7002.68	0.003504	4.43	412.24	146.97	0.40	0.27	0.83	0.50	0.61
Reach 1-3	2589	FIS	2600.00	6996.89	7003.28		7003.66	0.004217	5.48	539.31	153.88	0.45	0.43	1.22	0.80	0.91
Reach 1-3	2545	5-YR	398.70	6997.22	7000.68		7000.77	0.002949	2.61	178.63	123.07	0.32	0.15	0.38	0.15	0.27
Reach 1-3	2545	100-YR	1562.40	6997.22	7002.23		7002.50	0.004868	4.64	390.39	145.31	0.43	0.48	1.09	0.64	0.81
Reach 1-3	2545	FIS	2600.00	6997.22	7003.01		7003.44	0.006022	5.82	509.73	163.48	0.49	0.73	1.65	0.91	1.16
Reach 1-3	2513	5-YR	398.70	6996.86	7000.60		7000.68	0.002478	2.45	182.91	130.63	0.31	0.12	0.30	0.10	0.22
Reach 1-3	2513	100-YR	1562.40	6996.86	7002.09		7002.35	0.004210	4.37	399.61	152.83	0.41	0.40	0.90	0.50	0.68
Reach 1-3	2513	FIS	2600.00	6996.86	7002.84		7003.25	0.005326	5.52	516.41	159.86	0.47	0.63	1.39	0.84	1.07
Reach 1-3	2468	5-YR	398.70	6997.15	7000.40		7000.52	0.004871	2.92	157.10	144.02	0.41	0.07	0.49	0.17	0.33
Reach 1-3	2468	100-YR	1562.40	6997.15	7001.88		7002.12	0.005157	4.28	416.90	188.94	0.43	0.31	0.99	0.55	0.71
Reach 1-3	2468	FIS	2600.00	6997.15	7002.61		7002.96	0.005801	5.16	557.26	196.12	0.47	0.48	1.37	0.86	1.02
Reach 1-3	2405	5-YR	398.70	6997.08	6999.86		7000.09	0.010282	3.84	108.10	107.24	0.58	0.06	0.86	0.11	0.64
Reach 1-3	2405	100-YR	1562.40	6997.08	7001.18		7001.65	0.012297	6.05	330.06	216.73	0.65	0.57	2.03	0.70	1.16
Reach 1-3	2405	FIS	2600.00	6997.08	7001.53	7001.50	7002.36	0.019514	8.21	406.16	220.48	0.83	1.12	3.64	1.52	2.24
Reach 1-3	2399	5-YR	398.70	6997.08	6999.38	6999.38	6999.91	0.124367	5.88	67.81	66.14	1.02		7.88		7.88
Reach 1-3	2399	100-YR	1562.40	6997.08	7000.93	7000.93	7001.51	0.047494	6.67	271.58	215.32	0.74	1.97	7.48	1.98	3.73
Reach 1-3	2399	FIS	2600.00	6997.08	7001.39	7001.39	7002.17	0.050148	7.64	371.53	223.00	0.78	2.79	9.31	3.45	5.20
Reach 1-3	2394	5-YR	398.70	6995.80	6998.11	6998.11	6998.62	0.119014	5.75	69.36	67.75	1.00		7.53		7.53
Reach 1-3	2394	100-YR	1562.40	6995.80	6999.72	6999.72	7000.50	0.057768	7.46	236.96	154.06	0.82	2.57	9.30	2.35	5.52
Reach 1-3	2394	FIS	2600.00	6995.80	7000.48	7000.48	7001.30	0.046189	7.91	376.05	213.32	0.76	3.13	9.60	2.82	5.06
Reach 1-3	2389	5-YR	398.70	6994.62	6996.92	6996.92	6997.44	0.117053	5.76	69.46	69.14	1.00	0.58	7.52	0.84	7.27
Reach 1-3	2389	100-YR	1562.40	6994.62	6998.46	6998.46	6999.48	0.072588	8.31	202.37	109.65	0.91	3.59	11.56	3.12	8.30
Reach 1-3	2389	FIS	2600.00	6994.62	6999.50	6999.50	7000.49	0.047009	8.39	346.99	177.77	0.78	3.83	10.53	2.61	5.70

Sub-critical flow analysis for Shear/Velocity evaluation of Naturalized Channel Design

HEC-RAS Plan: PROP - Shear River: Sand Creek Reach: Reach 1-3 (Continued)

Reach	River Sta	Profile	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl	Shear LOB	Shear Chan	Shear ROB	Shear Total
			(cfs)	(ft)	(ft)	(ft)	(ft)	(ft/ft)	(ft/s)	(sq ft)	(ft)		(lb/sq ft)	(lb/sq ft)	(lb/sq ft)	(lb/sq ft)
Reach 1-3	2384	5-YR	398.70	6993.53	6996.73		6996.86	0.014166	2.94	135.88	79.23	0.38	0.09	1.62	0.06	1.50
Reach 1-3	2384	100-YR	1562.40	6993.53	6998.02		6998.61	0.032434	6.34	264.72	120.28	0.63	1.49	6.29	1.49	4.42
Reach 1-3	2384	FIS	2600.00	6993.53	6998.40	6998.40	6999.58	0.055840	8.99	314.76	138.02	0.84	3.23	12.16	2.98	7.89
Reach 1-3	2377	5-YR	398.70	6993.46	6996.74		6996.80	0.003243	1.91	216.10	98.15	0.19	0.06	0.59	0.07	0.43
Reach 1-3	2377	100-YR	1562.40	6993.46	6998.12		6998.40	0.010895	4.50	390.59	155.77	0.38	0.67	2.87	0.71	1.67
Reach 1-3	2377	FIS	2600.00	6993.46	6998.39		6999.03	0.023014	6.81	438.52	198.56	0.55	1.60	6.44	1.29	3.12
Reach 1-3	2375	5-YR	398.70	6994.97	6996.54		6996.76	0.031436	3.83	109.14	96.66	0.55	0.41	2.94	0.50	2.21
Reach 1-3	2375	100-YR	1562.40	6994.97	6997.52	6997.52	6998.30	0.062814	7.56	233.96	153.78	0.85	2.74	9.69	3.03	5.95
Reach 1-3	2375	FIS	2600.00	6994.97	6998.24	6998.24	6998.94	0.042318	7.36	399.84	253.98	0.73	2.83	8.43	2.57	4.15
Reach 1-3	2350	5-YR	398.70	6993.08	6996.30		6996.44	0.005964	3.26	161.48	215.20	0.48	0.04	0.53	0.15	0.28
Reach 1-3	2350	100-YR	1562.40	6993.08	6997.33		6997.62	0.008754	5.12	417.17	264.63	0.58	0.34	1.33	0.69	0.86
Reach 1-3	2350	FIS	2600.00	6993.08	6998.01		6998.36	0.008319	5.72	599.80	272.36	0.57	0.50	1.62	1.00	1.14
Reach 1-3	2319	5-YR	398.70	6993.33	6995.98		6996.20	0.010339	3.99	130.80	225.97	0.62	0.22	0.83	0.17	0.37
Reach 1-3	2319	100-YR	1562.40	6993.33	6997.08		6997.36	0.009234	5.13	424.88	279.89	0.58	0.51	1.37	0.72	0.87
Reach 1-3	2319	FIS	2600.00	6993.33	6997.81		6998.12	0.007732	5.47	633.05	288.88	0.55	0.58	1.50	0.95	1.06
Reach 1-3	2246	5-YR	398.70	6993.16	6995.47		6995.55	0.007248	2.73	189.89	233.72	0.48	0.10	0.45	0.33	0.37
Reach 1-3	2246	100-YR	1562.40	6993.16	6996.63		6996.80	0.006503	3.84	488.72	281.21	0.46	0.32	0.87	0.67	0.70
Reach 1-3	2246	FIS	2600.00	6993.16	6997.46		6997.67	0.005141	4.14	732.67	301.74	0.42	0.39	0.95	0.75	0.78
Reach 1-3	2181	5-YR	398.70	6992.99	6994.81		6994.94	0.015439	3.44	141.60	196.64	0.74		0.65	0.72	0.69
Reach 1-3	2181	100-YR	1562.40	6992.99	6996.23		6996.41	0.006454	3.78	463.03	253.91	0.46	0.26	0.84	0.72	0.73
Reach 1-3	2181	FIS	2600.00	6992.99	6997.16		6997.37	0.004687	4.02	713.14	280.52	0.41	0.32	0.88	0.73	0.74
Reach 1-3	2112	5-YR	398.70	6992.58	6994.25		6994.32	0.005522	2.49	189.38	165.50	0.35	0.37	0.54	0.35	0.39
Reach 1-3	2112	100-YR	1562.40	6992.58	6995.91		6996.05	0.003969	3.41	512.96	225.20	0.33	0.51	0.80	0.52	0.56
Reach 1-3	2112	FIS	2600.00	6992.58	6996.90		6997.09	0.003359	3.75	746.87	240.30	0.32	0.55	0.89	0.62	0.65
Reach 1-3	2046	5-YR	398.70	6991.97	6993.65		6993.90	0.006971	4.91	124.24	114.24	0.68	0.43	0.71	0.37	0.47
Reach 1-3	2046	100-YR	1562.40	6991.97	6995.33		6995.73	0.005230	6.81	362.33	166.62	0.66	0.72	1.08	0.59	0.71
Reach 1-3	2046	FIS	2600.00	6991.97	6996.32		6996.80	0.004637	7.64	542.14	194.56	0.65	0.83	1.24	0.69	0.81
Reach 1-3	1993	5-YR	398.70	6991.29	6993.36		6993.52	0.006017	4.61	140.92	106.59	0.62	0.19	0.63	0.50	0.49
Reach 1-3	1993	100-YR	1562.40	6991.29	6995.06		6995.42	0.005932	7.19	357.93	150.12	0.68	0.56	1.22	0.87	0.88
Reach 1-3	1993	FIS	2600.00	6991.29	6996.08		6996.53	0.005323	8.10	523.89	173.01	0.68	0.68	1.42	1.00	1.00
Reach 1-3	1929	5-YR	398.70	6991.32	6993.09		6993.24	0.003442	3.47	145.97	110.40	0.48	0.14	0.35	0.23	0.28
Reach 1-3	1929	100-YR	1562.40	6991.32	6994.68		6995.10	0.004151	5.99	343.88	137.27	0.59	0.37	0.84	0.57	0.65
Reach 1-3	1929	FIS	2600.00	6991.32	6995.64		6996.22	0.004246	7.19	481.96	152.80	0.62	0.50	1.11	0.74	0.83
Reach 1-3	1884	5-YR	398.70	6991.07	6992.68		6992.97	0.010106	5.71	113.55	101.92	0.81	0.75	0.98	0.60	0.70
Reach 1-3	1884	100-YR	1562.40	6991.07	6994.13		6994.79	0.010382	8.98	275.84	122.31	0.92	1.34	1.94	1.37	1.46
Reach 1-3	1884	FIS	2600.00	6991.07	6995.02		6995.90	0.009870	10.42	390.70	134.25	0.93	1.61	2.39	1.70	1.79
Reach 1-3	1834	5-YR	398.70	6990.69	6992.33		6992.57	0.006123	4.23	117.76	111.41	0.62	0.20	0.55	0.26	0.40
Reach 1-3	1834	100-YR	1562.40	6990.69	6993.55		6994.30	0.009141	7.78	261.45	126.55	0.84	0.64	1.51	0.98	1.17
Reach 1-3	1834	FIS	2600.00	6990.69	6994.25	6994.12	6995.38	0.010347	9.68	354.19	136.06	0.93	0.95	2.17	1.46	1.67
Reach 1-3	1804	5-YR	398.70	6990.58	6992.05		6992.33	0.009181	5.18	109.93	112.32	0.76	0.42	0.82	0.47	0.56
Reach 1-3	1804	100-YR	1562.40	6990.58	6993.19	6993.08	6993.96	0.012176	8.81	246.28	127.37	0.97	1.10	1.96	1.41	1.47

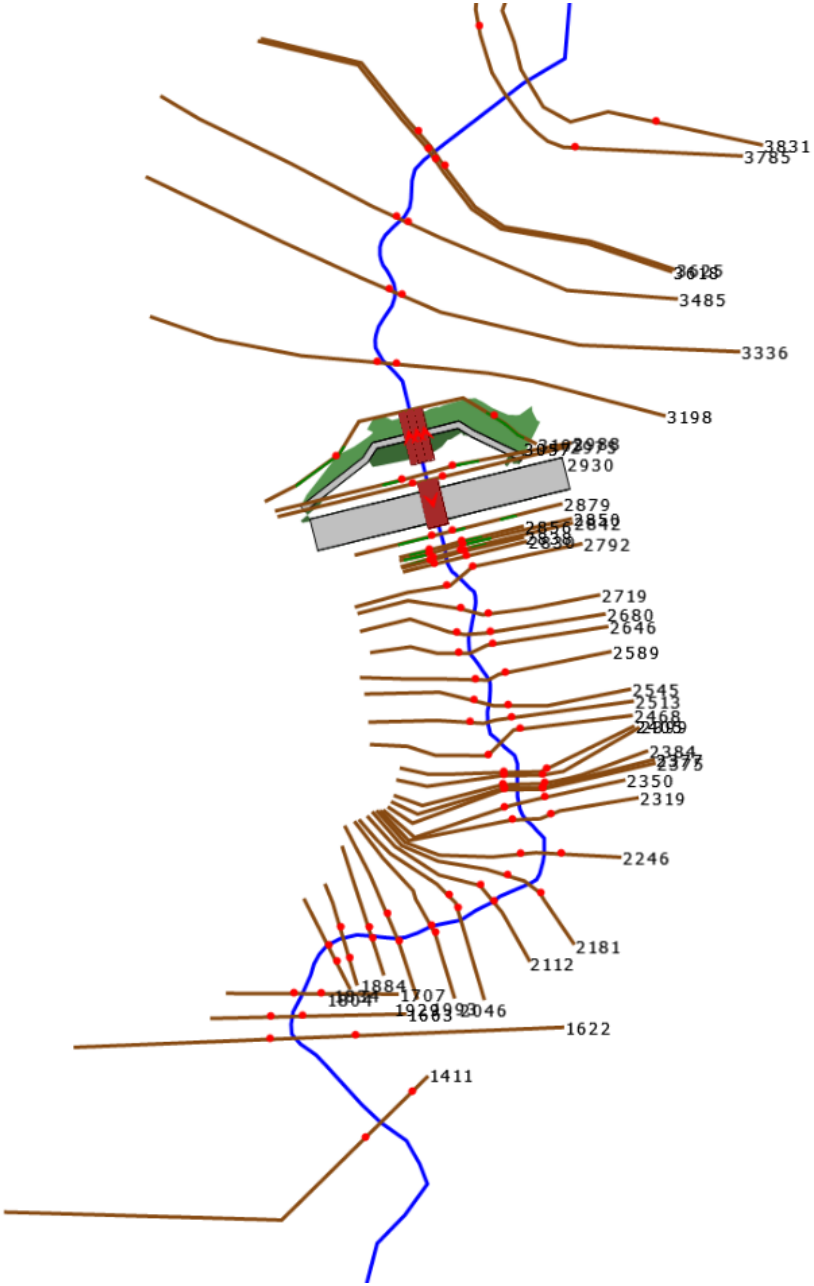
Sub-critical flow analysis for Shear/Velocity evaluation of Naturalized Channel Design

HEC-RAS Plan: PROP - Shear River: Sand Creek Reach: Reach 1-3 (Continued)

Reach	River Sta	Profile	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl	Shear LOB	Shear Chan	Shear ROB	Shear Total
			(cfs)	(ft)	(ft)	(ft)	(ft)	(ft/ft)	(ft/s)	(sq ft)	(ft)		(lb/sq ft)	(lb/sq ft)	(lb/sq ft)	(lb/sq ft)
Reach 1-3	1804	FIS	2600.00	6990.58	6993.97	6993.81	6994.99	0.011343	10.15	350.67	137.38	0.98	1.36	2.38	1.79	1.80
Reach 1-3	1707	5-YR	480.40	6989.35	6990.79	6990.79	6991.28	0.012597	6.15	94.90	100.66	0.96	0.56	1.01	0.47	0.74
Reach 1-3	1707	100-YR	1585.20	6989.35	6992.01	6992.01	6992.90	0.010246	8.68	237.51	133.63	0.97	0.93	1.60	0.85	1.14
Reach 1-3	1707	FIS	2600.00	6989.35	6992.61	6992.61	6993.89	0.011525	10.61	320.97	145.48	1.06	1.14	2.23	1.33	1.58
Reach 1-3	1663	5-YR	480.40	6987.76	6989.01	6989.01	6989.57	0.014826	6.35	86.60	94.76	1.03	0.47	1.10	0.51	0.84
Reach 1-3	1663	100-YR	1585.20	6987.76	6990.27	6990.27	6991.15	0.009946	8.42	236.56	134.20	0.95	0.80	1.52	0.73	1.09
Reach 1-3	1663	FIS	2600.00	6987.76	6990.99	6990.99	6992.14	0.009572	9.82	338.69	146.87	0.97	1.09	1.90	0.92	1.37
Reach 1-3	1622	5-YR	480.40	6986.76	6987.86	6987.86	6988.22	0.017410	4.81	99.86	143.49	1.02		0.76		0.76
Reach 1-3	1622	100-YR	1585.20	6986.76	6988.71	6988.71	6989.45	0.012924	6.95	231.72	163.70	1.00	0.32	1.22	0.28	1.14
Reach 1-3	1622	FIS	2600.00	6986.76	6989.73		6990.40	0.005951	6.65	406.62	177.65	0.74	0.38	0.94	0.31	0.85
Reach 1-3	1411	5-YR	480.40	6982.00	6983.37	6983.37	6983.78	0.016346	5.16	93.68	119.99	1.01	0.17	0.83	0.10	0.80
Reach 1-3	1411	100-YR	1585.20	6982.00	6984.35	6984.35	6985.19	0.011788	7.44	223.21	140.15	0.98	0.54	1.32	0.48	1.17
Reach 1-3	1411	FIS	2600.00	6982.00	6990.04	6985.00	6990.11	0.000175	2.35	1397.28	286.43	0.15	0.03	0.08	0.04	0.05

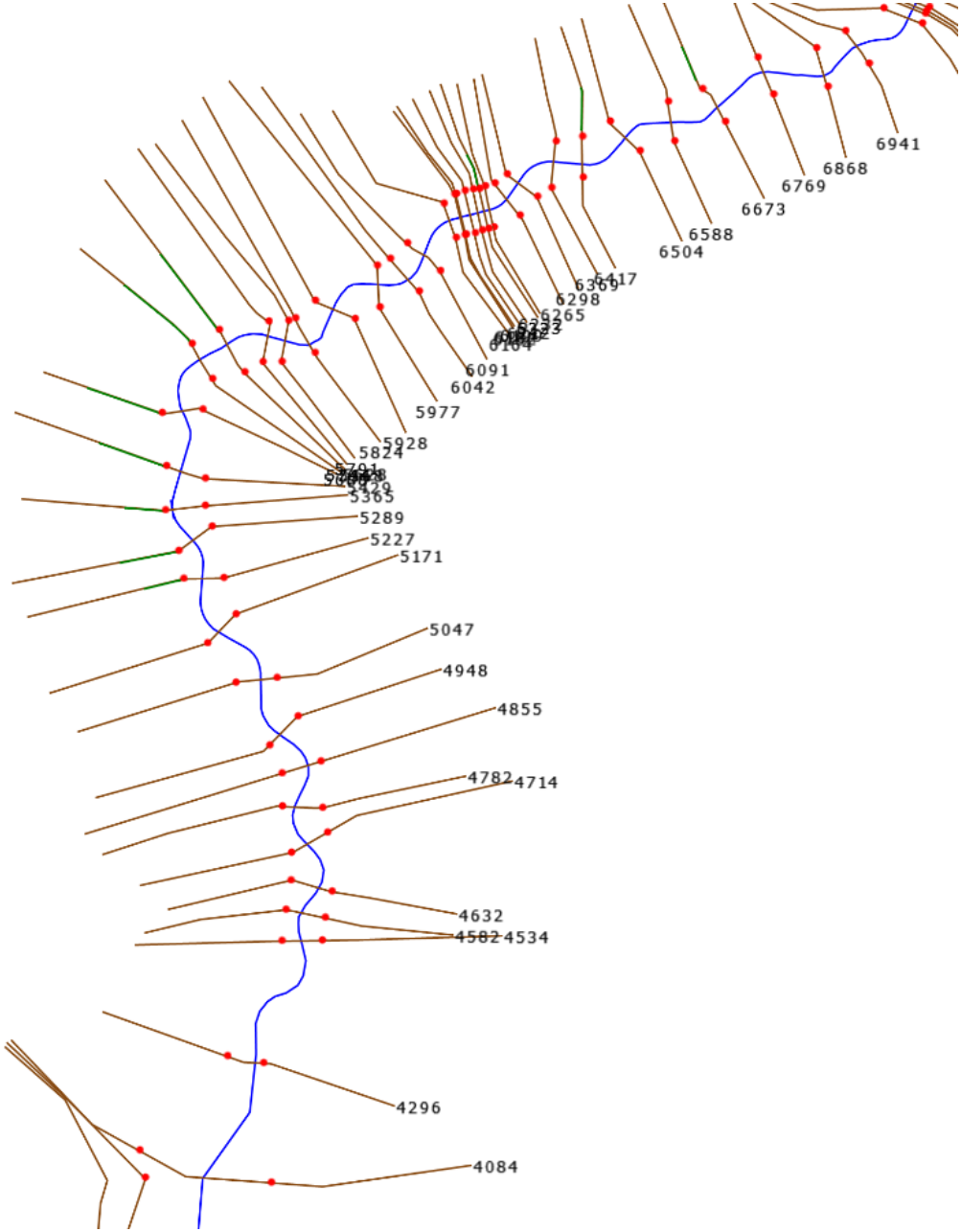
Water Surface Elevation HEC-RAS Analysis For FIS Flows

FIS Modeling Analysis
Model Layout

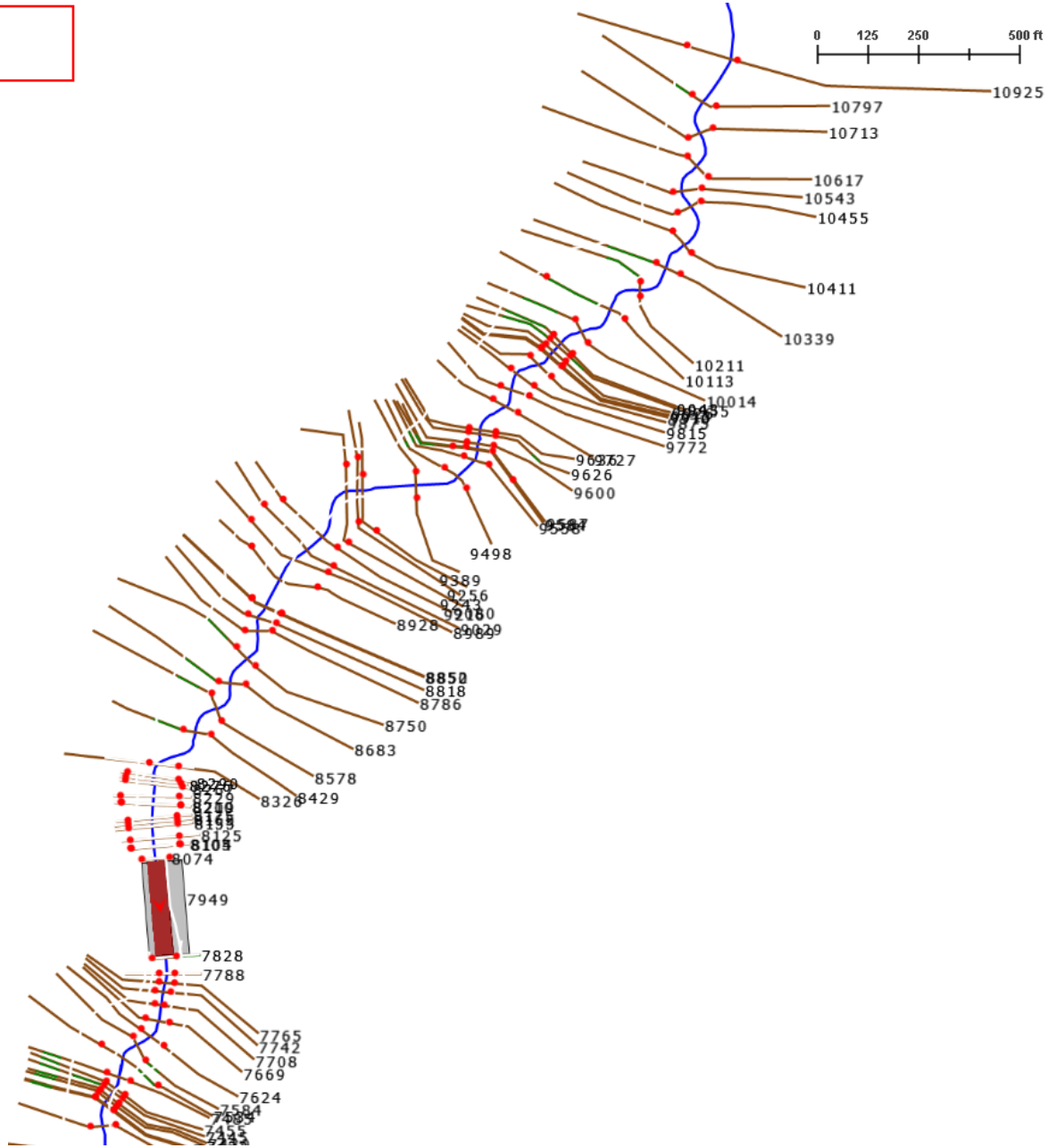


Created with GeoHECRAS v4.0.0.2094

FIS Modeling Analysis
Model Layout

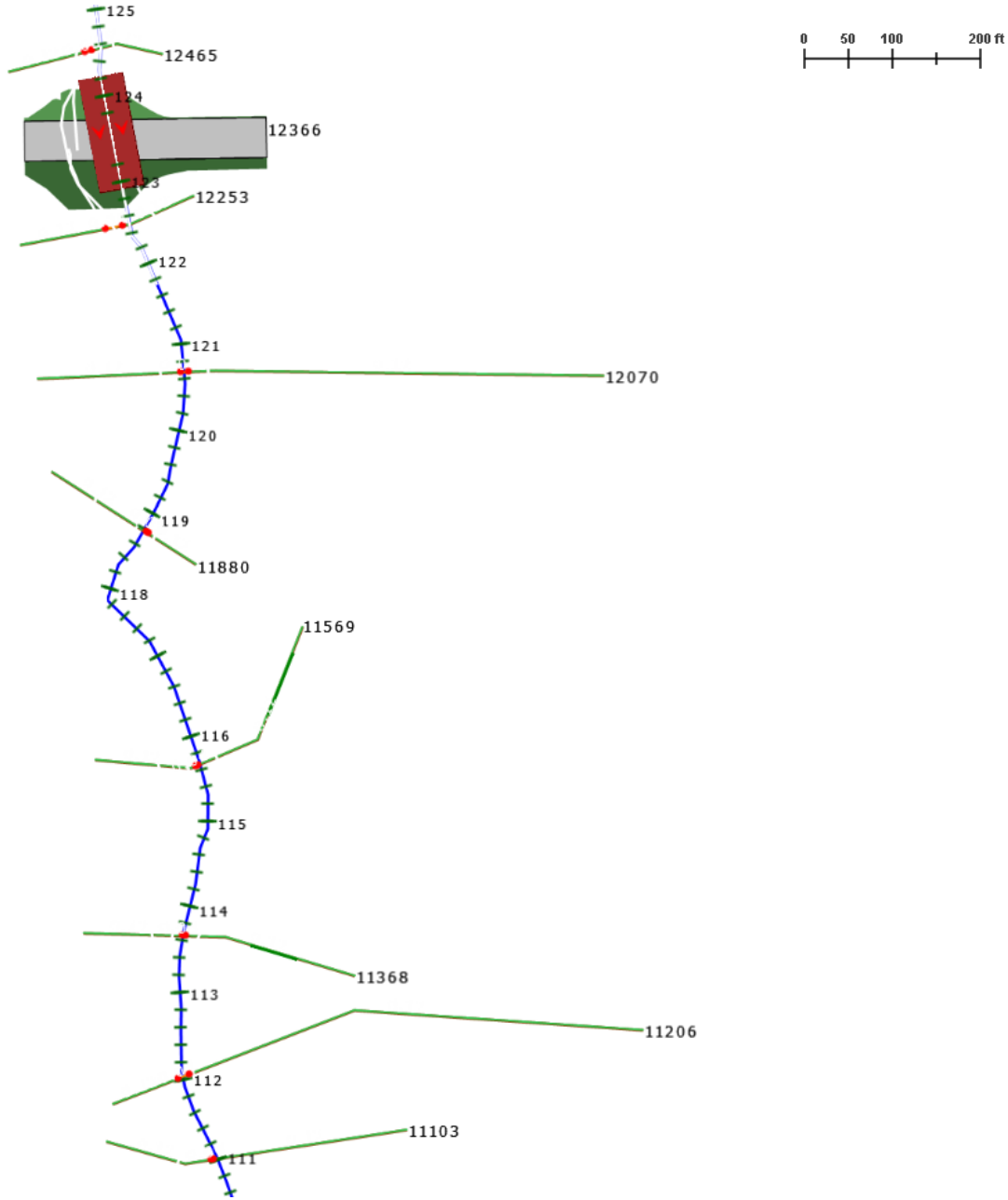


FIS Modeling Analysis
Model Layout



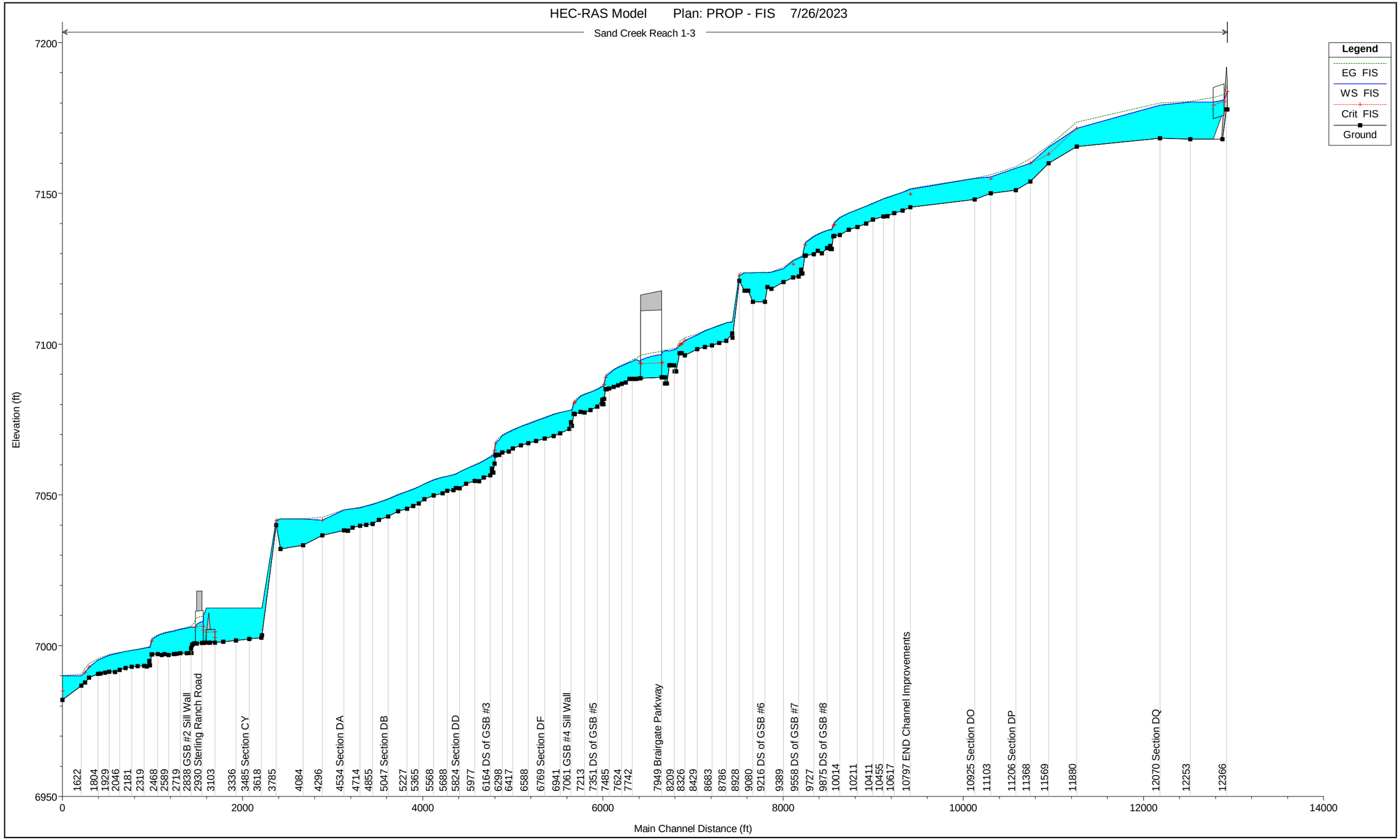
Created with GeoHECRAS v4.0.0.2094

FIS Modeling Analysis
Model Layout



Created with GeoHECRAS v4.0.0.2094

Sub-critical flow analysis for Water Surface evaluation of Naturalized Channel Design at the FIS flow rate only



Sub-critical flow analysis for Water Surface evaluation of Naturalized Channel Design at the FIS flow rate only

HEC-RAS Plan: PROP - FIS River: Sand Creek Reach: Reach 1-3 Profile: FIS

Reach	River Sta	Profile	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl
			(cfs)	(ft)	(ft)	(ft)	(ft)	(ft/ft)	(ft/s)	(sq ft)	(ft)	
Reach 1-3	12465	FIS	2600.00	7177.88	7183.81	7183.81	7186.24	0.015014	19.86	433.01	89.70	1.44
Reach 1-3	12366		Culvert									
Reach 1-3	12253	FIS	2600.00	7168.00	7180.28		7180.54	0.000793	5.57	1095.66	114.53	0.28
Reach 1-3	12070	FIS	2600.00	7168.31	7179.30		7180.02	0.003331	10.41	722.99	98.57	0.56
Reach 1-3	11880	FIS	2600.00	7165.52	7171.62	7171.62	7173.59	0.022534	24.81	462.08	106.92	1.77
Reach 1-3	11569	FIS	2600.00	7159.96	7165.28	7162.96	7165.70	0.014648	13.70	746.49	249.28	1.05
Reach 1-3	11368	FIS	2600.00	7153.99	7160.00	7160.00	7161.48	0.029320	21.03	452.92	175.32	1.51
Reach 1-3	11206	FIS	2600.00	7151.03	7158.39		7158.91	0.004715	9.36	857.47	192.20	0.62
Reach 1-3	11103	FIS	2600.00	7150.00	7155.43	7154.87	7156.24	0.025523	18.34	555.70	170.22	1.39
Reach 1-3	10925	FIS	2600.00	7148.00	7154.93		7155.09	0.002314	3.31	857.76	189.28	0.24
Reach 1-3	10797	FIS	2600.00	7145.39	7151.35	7149.76	7151.63	0.016596	4.88	644.30	199.99	0.40
Reach 1-3	10713	FIS	2600.00	7144.30	7150.30		7150.48	0.010815	3.92	797.66	233.26	0.33
Reach 1-3	10617	FIS	2600.00	7143.44	7149.40		7149.55	0.009292	3.63	880.12	267.93	0.30
Reach 1-3	10543	FIS	2600.00	7142.46	7148.62		7148.80	0.009939	4.13	816.24	266.41	0.34
Reach 1-3	10455	FIS	2600.00	7142.32	7148.20		7148.34	0.009943	3.76	928.12	341.21	0.31
Reach 1-3	10411	FIS	2600.00	7141.35	7146.64		7146.86	0.017672	4.59	769.78	324.44	0.40
Reach 1-3	10339	FIS	2600.00	7140.02	7145.68		7145.81	0.010263	3.61	999.97	398.17	0.31
Reach 1-3	10211	FIS	2600.00	7138.89	7144.56		7144.75	0.011698	4.74	845.69	370.25	0.41
Reach 1-3	10113	FIS	2600.00	7137.89	7143.49		7143.62	0.011758	3.07	899.94	326.13	0.31
Reach 1-3	10014	FIS	2600.00	7136.24	7141.94		7142.19	0.020116	4.94	725.37	301.55	0.44
Reach 1-3	9955	FIS	2600.00	7135.86	7140.19	7139.70	7140.55	0.038751	5.97	598.07	298.75	0.60
Reach 1-3	9943	FIS	2600.00	7135.80	7139.25	7139.25	7139.92	0.071985	7.78	419.98	300.61	0.90
Reach 1-3	9926	FIS	2600.00	7131.59	7137.96		7138.30	0.011452	5.33	637.40	286.56	0.41
Reach 1-3	9913	FIS	2600.00	7131.58	7137.97		7138.15	0.005251	3.92	862.47	297.77	0.28
Reach 1-3	9910	FIS	2600.00	7132.63	7137.94		7138.13	0.007210	4.13	807.37	298.69	0.32
Reach 1-3	9875	FIS	2600.00	7131.85	7137.68		7137.86	0.008711	4.14	897.36	301.86	0.34
Reach 1-3	9815	FIS	2600.00	7130.14	7136.97		7137.23	0.013818	4.87	754.04	288.83	0.41
Reach 1-3	9772	FIS	2600.00	7130.91	7136.39		7136.64	0.013857	4.77	732.67	278.79	0.41
Reach 1-3	9727	FIS	2600.00	7129.87	7135.72		7135.98	0.016089	4.92	717.47	276.63	0.43
Reach 1-3	9636	FIS	2600.00	7129.38	7133.68		7133.98	0.034211	5.37	644.86	337.18	0.55
Reach 1-3	9626	FIS	2600.00	7129.34	7132.88	7132.88	7133.49	0.063676	7.42	449.04	336.10	0.84
Reach 1-3	9600	FIS	2600.00	7123.43	7128.92		7129.48	0.022439	6.58	468.91	178.46	0.55
Reach 1-3	9587	FIS	2600.00	7123.38	7128.94		7129.21	0.009500	4.79	696.21	307.49	0.37
Reach 1-3	9584	FIS	2600.00	7124.71	7128.89		7129.18	0.016507	4.43	632.55	315.92	0.45
Reach 1-3	9558	FIS	2600.00	7122.44	7128.54		7128.79	0.012213	4.86	714.32	330.58	0.41
Reach 1-3	9498	FIS	2600.00	7122.10	7127.64	7126.54	7127.88	0.018086	4.58	717.43	276.25	0.41
Reach 1-3	9389	FIS	2600.00	7120.61	7124.97		7125.48	0.029075	4.97	491.90	195.20	0.46
Reach 1-3	9256	FIS	2600.00	7118.36	7123.89		7124.00	0.005203	2.73	993.22	258.84	0.23
Reach 1-3	9243	FIS	2600.00	7119.00	7123.68		7123.80	0.003948	2.87	949.75	249.96	0.24
Reach 1-3	9216	FIS	2600.00	7114.00	7123.74		7123.76	0.000077	1.19	2384.15	300.87	0.07
Reach 1-3	9080	FIS	2600.00	7114.00	7123.73		7123.75	0.000163	1.23	2173.73	272.38	0.07
Reach 1-3	9029	FIS	2600.00	7117.75	7123.68		7123.72	0.000599	1.70	1564.05	304.59	0.12
Reach 1-3	8989	FIS	2600.00	7117.73	7123.66		7123.70	0.000582	1.67	1584.26	301.54	0.12
Reach 1-3	8928	FIS	2600.00	7121.00	7122.77	7122.77	7123.54	0.007432	7.18	375.02	246.75	0.98
Reach 1-3	8852	FIS	2600.00	7102.13	7107.49		7107.63	0.002438	3.11	880.44	270.97	0.24
Reach 1-3	8850	FIS	2600.00	7103.55	7107.38		7107.61	0.005176	3.24	768.30	271.54	0.29
Reach 1-3	8786	FIS	2600.00	7101.10	7107.04		7107.16	0.008195	3.36	967.15	284.32	0.28
Reach 1-3	8750	FIS	2600.00	7100.37	7106.12		7106.32	0.013509	4.28	788.37	287.95	0.36
Reach 1-3	8683	FIS	2600.00	7099.61	7105.31		7105.46	0.010461	3.69	885.82	280.05	0.32
Reach 1-3	8578	FIS	2600.00	7099.09	7104.43		7104.60	0.012802	3.88	813.45	264.23	0.34
Reach 1-3	8429	FIS	2600.00	7098.29	7103.09		7103.41	0.015440	5.12	582.45	239.87	0.50
Reach 1-3	8326	FIS	2600.00	7096.32	7101.20	7101.20	7102.10	0.006901	8.13	370.28	199.91	0.86
Reach 1-3	8290	FIS	2600.00	7097.00	7100.38	7100.06	7101.41	0.015200	8.14	319.37	112.30	0.85
Reach 1-3	8276	FIS	2600.00	7097.00	7100.23	7099.86	7101.17	0.014446	7.79	333.87	120.85	0.83
Reach 1-3	8267	FIS	2600.00	7097.00	7099.71	7099.71	7100.93	0.022639	8.85	293.86	123.07	1.01
Reach 1-3	8229	FIS	2600.00	7091.00	7098.35		7098.66	0.002108	4.42	587.80	116.20	0.35
Reach 1-3	8210	FIS	2600.00	7091.00	7098.32		7098.62	0.002089	4.39	592.31	117.66	0.34
Reach 1-3	8209	FIS	2600.00	7093.00	7098.13		7098.57	0.003948	5.35	485.88	116.11	0.46
Reach 1-3	8175	FIS	2600.00	7093.00	7097.90		7098.40	0.004752	5.72	454.86	113.16	0.50
Reach 1-3	8165	FIS	2600.00	7093.00	7097.82		7098.35	0.005005	5.82	446.93	112.59	0.51
Reach 1-3	8155	FIS	2600.00	7093.00	7097.74		7098.29	0.005316	5.94	437.88	111.95	0.53
Reach 1-3	8125	FIS	2600.00	7087.00	7097.87		7098.06	0.000890	3.44	755.43	112.97	0.23
Reach 1-3	8105	FIS	2600.00	7087.00	7097.85		7098.04	0.000896	3.45	753.87	112.99	0.24
Reach 1-3	8104	FIS	2600.00	7089.00	7097.80		7098.02	0.001252	3.83	679.54	112.54	0.27
Reach 1-3	8074	FIS	2600.00	7089.00	7097.34	7093.80	7097.88	0.002257	5.92	439.19	69.00	0.38
Reach 1-3	7949		Culvert									
Reach 1-3	7828	FIS	2600.00	7088.70	7094.36	7093.90	7096.24	0.004610	10.99	236.57	60.61	0.86
Reach 1-3	7788	FIS	2600.00	7088.52	7094.88		7095.27	0.007128	5.32	519.08	111.63	0.37
Reach 1-3	7765	FIS	2600.00	7088.50	7094.73		7095.12	0.006179	5.62	541.89	119.69	0.40
Reach 1-3	7742	FIS	2600.00	7088.50	7094.27		7094.90	0.012430	7.24	437.06	125.69	0.55
Reach 1-3	7708	FIS	2600.00	7088.50	7093.89		7094.28	0.022368	5.62	523.76	139.68	0.43
Reach 1-3	7669	FIS	2600.00	7087.30	7093.37		7093.70	0.009660	5.00	573.51	164.19	0.41
Reach 1-3	7624	FIS	2600.00	7086.89	7092.78		7093.11	0.019079	5.32	631.57	224.91	0.45
Reach 1-3	7584	FIS	2600.00	7086.36	7092.24		7092.45	0.013480	4.35	741.29	229.47	0.36
Reach 1-3	7534	FIS	2600.00	7085.85	7091.47		7091.70	0.017138	3.99	684.93	229.01	0.39
Reach 1-3	7485	FIS	2600.00	7085.30	7090.28		7090.63	0.029483	5.64	589.40	247.31	0.53

Sub-critical flow analysis for Water Surface evaluation of Naturalized Channel Design at the FIS flow rate only

HEC-RAS Plan: PROP - FIS River: Sand Creek Reach: Reach 1-3 Profile: FIS (Continued)

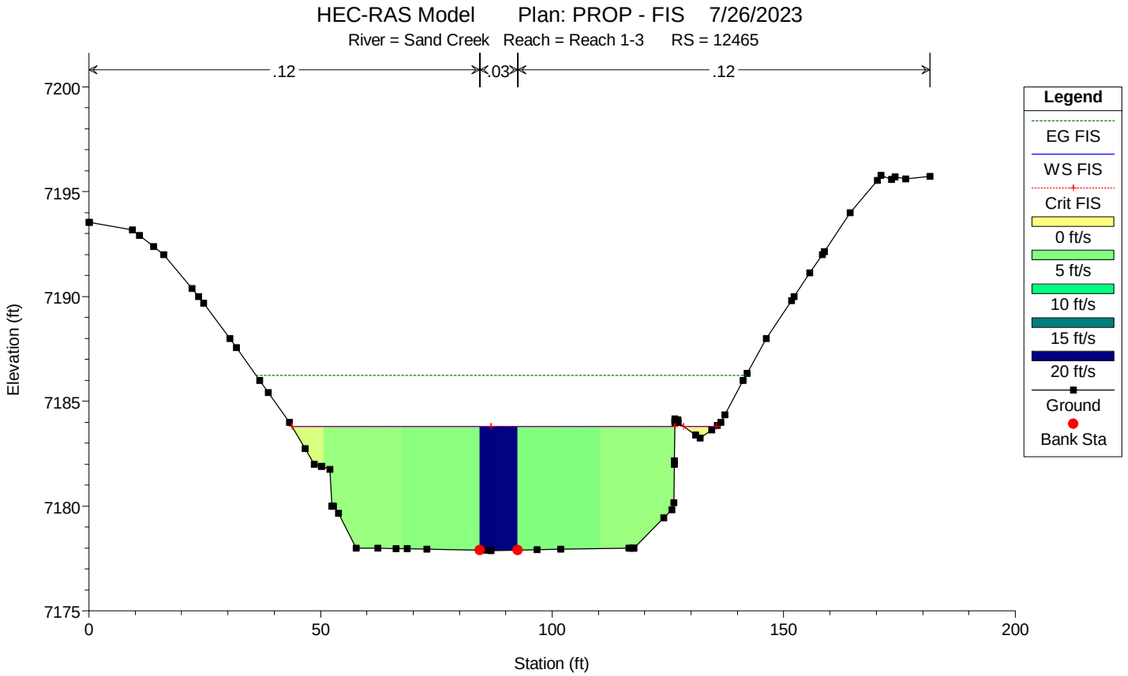
Reach	River Sta	Profile	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl
			(cfs)	(ft)	(ft)	(ft)	(ft)	(ft/ft)	(ft/s)	(sq ft)	(ft)	
Reach 1-3	7455	FIS	2600.00	7085.01	7089.66		7090.08	0.012977	5.94	516.84	266.51	0.58
Reach 1-3	7445	FIS	2600.00	7085.12	7089.04	7089.04	7089.82	0.041658	8.42	393.99	269.09	0.90
Reach 1-3	7430	FIS	2600.00	7081.82	7086.64	7086.64	7087.50	0.030071	8.54	396.02	217.12	0.80
Reach 1-3	7422	FIS	2600.00	7080.12	7085.90		7086.50	0.018940	6.98	468.05	211.59	0.58
Reach 1-3	7409	FIS	2600.00	7080.12	7085.97		7086.26	0.007748	4.99	660.10	229.62	0.37
Reach 1-3	7406	FIS	2600.00	7081.53	7085.91		7086.22	0.023499	5.02	602.74	231.75	0.43
Reach 1-3	7351	FIS	2600.00	7079.22	7084.96		7085.18	0.014902	4.53	782.52	281.90	0.38
Reach 1-3	7279	FIS	2600.00	7078.10	7084.06		7084.22	0.011983	3.91	881.27	306.28	0.33
Reach 1-3	7213	FIS	2600.00	7077.30	7083.35		7083.52	0.010560	4.19	892.89	321.14	0.36
Reach 1-3	7167	FIS	2600.00	7077.47	7082.73		7082.92	0.016555	4.42	813.10	335.13	0.39
Reach 1-3	7102	FIS	2600.00	7076.78	7080.84	7080.84	7081.47	0.035048	7.69	454.45	331.49	0.84
Reach 1-3	7093	FIS	2600.00	7076.86	7080.38	7080.38	7080.98	0.069798	7.52	444.91	334.23	0.88
Reach 1-3	7073	FIS	2600.00	7072.92	7078.03		7078.52	0.025006	6.45	530.79	331.70	0.57
Reach 1-3	7066	FIS	2600.00	7072.86	7078.08		7078.35	0.010921	4.88	729.28	332.82	0.39
Reach 1-3	7061	FIS	2600.00	7074.14	7077.98		7078.28	0.012058	5.58	717.47	353.96	0.51
Reach 1-3	7044	FIS	2600.00	7071.83	7077.99		7078.07	0.006156	2.97	1184.56	390.23	0.25
Reach 1-3	6941	FIS	2600.00	7070.47	7077.31		7077.45	0.007234	3.83	974.79	307.30	0.30
Reach 1-3	6868	FIS	2600.00	7069.50	7076.64		7076.87	0.010322	4.64	790.90	254.95	0.37
Reach 1-3	6769	FIS	2600.00	7068.73	7075.58		7075.82	0.011294	4.64	748.57	228.35	0.36
Reach 1-3	6673	FIS	2600.00	7067.90	7074.53		7074.73	0.010731	4.21	760.06	209.34	0.33
Reach 1-3	6588	FIS	2600.00	7067.13	7073.52		7073.77	0.013650	4.68	686.23	209.05	0.37
Reach 1-3	6504	FIS	2600.00	7066.40	7072.65		7072.82	0.009254	3.81	806.62	211.38	0.30
Reach 1-3	6417	FIS	2600.00	7065.42	7071.45		7071.74	0.016586	4.96	658.69	216.03	0.40
Reach 1-3	6369	FIS	2600.00	7064.37	7070.82		7071.04	0.012090	4.23	724.12	222.20	0.34
Reach 1-3	6298	FIS	2600.00	7064.05	7069.67		7069.97	0.019992	5.16	621.50	197.90	0.44
Reach 1-3	6265	FIS	2600.00	7063.23	7068.31		7068.99	0.050615	7.62	457.17	213.42	0.73
Reach 1-3	6232	FIS	2600.00	7063.38	7067.58		7068.11	0.018191	5.96	469.17	215.20	0.61
Reach 1-3	6223	FIS	2600.00	7063.07	7066.95	7066.95	7067.78	0.071436	8.32	375.43	212.79	0.91
Reach 1-3	6212	FIS	2600.00	7060.43	7064.78	7064.78	7065.82	0.068412	9.01	342.87	166.47	0.91
Reach 1-3	6199	FIS	2600.00	7057.41	7063.02		7063.76	0.027759	7.29	408.68	141.22	0.62
Reach 1-3	6184	FIS	2600.00	7057.42	7063.01		7063.39	0.011570	5.42	562.59	162.87	0.41
Reach 1-3	6182	FIS	2600.00	7058.72	7062.75		7063.33	0.046558	6.67	441.61	160.16	0.59
Reach 1-3	6164	FIS	2600.00	7056.45	7062.50		7062.73	0.015828	4.63	741.08	279.32	0.39
Reach 1-3	6091	FIS	2600.00	7055.75	7061.31		7061.53	0.017401	4.62	780.91	322.71	0.40
Reach 1-3	6042	FIS	2600.00	7054.55	7060.52		7060.74	0.014780	4.71	829.29	359.68	0.42
Reach 1-3	5977	FIS	2600.00	7054.61	7059.87		7060.03	0.015476	4.24	913.36	438.96	0.38
Reach 1-3	5928	FIS	2600.00	7053.68	7058.59		7058.72	0.013687	3.78	1029.47	528.83	0.35
Reach 1-3	5824	FIS	2600.00	7052.15	7057.60		7057.76	0.014782	4.33	956.04	501.99	0.39
Reach 1-3	5791	FIS	2600.00	7052.28	7056.92		7057.08	0.018835	4.22	914.99	512.15	0.41
Reach 1-3	5744	FIS	2600.00	7051.51	7056.66		7056.76	0.006679	2.89	1104.60	510.62	0.27
Reach 1-3	5688	FIS	2600.00	7051.38	7056.16		7056.29	0.007461	3.44	1026.13	469.56	0.34
Reach 1-3	5628	FIS	2600.00	7050.55	7055.83		7055.94	0.006347	3.06	1085.09	437.77	0.28
Reach 1-3	5568	FIS	2600.00	7049.82	7054.93		7055.11	0.011654	4.12	848.11	397.07	0.39
Reach 1-3	5429	FIS	2600.00	7048.55	7053.58		7053.74	0.016002	4.09	866.99	368.80	0.38
Reach 1-3	5365	FIS	2600.00	7047.14	7052.66		7052.82	0.013523	4.29	894.61	372.48	0.40
Reach 1-3	5289	FIS	2600.00	7046.36	7051.92		7052.06	0.012026	3.80	929.15	351.39	0.34
Reach 1-3	5227	FIS	2600.00	7045.43	7051.13		7051.29	0.012474	4.04	896.18	337.93	0.35
Reach 1-3	5171	FIS	2600.00	7044.55	7050.06		7050.20	0.010383	3.73	959.10	350.20	0.32
Reach 1-3	5047	FIS	2600.00	7042.80	7048.55		7048.81	0.015895	4.63	738.42	339.86	0.39
Reach 1-3	4948	FIS	2600.00	7041.66	7047.53		7047.65	0.008547	3.46	1017.44	349.91	0.29
Reach 1-3	4855	FIS	2600.00	7040.34	7046.88		7047.05	0.010285	4.13	920.24	339.63	0.34
Reach 1-3	4782	FIS	2600.00	7040.04	7046.28		7046.42	0.008646	3.77	990.57	347.24	0.31
Reach 1-3	4714	FIS	2600.00	7039.78	7045.76		7045.87	0.007473	3.27	1060.74	345.59	0.27
Reach 1-3	4632	FIS	2600.00	7039.10	7045.40		7045.48	0.004533	2.76	1214.07	334.31	0.22
Reach 1-3	4582	FIS	2600.00	7038.10	7045.18		7045.26	0.004099	2.81	1216.49	317.76	0.22
Reach 1-3	4534	FIS	2600.00	7038.20	7045.00		7045.07	0.003919	2.63	1223.37	301.12	0.20
Reach 1-3	4296	FIS	2600.00	7036.56	7041.56	7041.56	7042.56	0.067049	10.78	387.91	178.88	0.93
Reach 1-3	4084	FIS	2600.00	7033.29	7042.06		7042.07	0.000157	1.08	2487.77	384.73	0.07
Reach 1-3	3831	FIS	2600.00	7032.08	7042.05		7042.05	0.000029	0.51	5200.74	627.72	0.03
Reach 1-3	3785	FIS	2600.00	7039.97	7041.40	7041.40	7041.99	0.007652	6.31	434.21	379.57	0.96
Reach 1-3	3625	FIS	2600.00	7003.41	7012.50		7012.51	0.000074	1.11	4908.33	640.50	0.07
Reach 1-3	3618	FIS	2600.00	7002.58	7012.50		7012.51	0.000103	0.98	4854.41	631.20	0.06
Reach 1-3	3485	FIS	2600.00	7002.22	7012.49		7012.49	0.000099	0.99	4913.78	629.94	0.05
Reach 1-3	3336	FIS	2600.00	7001.71	7012.48		7012.48	0.000073	0.88	5426.21	650.52	0.05
Reach 1-3	3198	FIS	2600.00	7001.27	7012.47		7012.47	0.000061	0.81	5377.79	609.23	0.04
Reach 1-3	3103	FIS	2600.00	7001.02	7012.45	7002.68	7012.46	0.000057	0.78	3478.53	485.07	0.04
Reach 1-3	3057		Culvert									
Reach 1-3	2988	FIS	2600.00	7001.00	7010.59		7010.72	0.000900	2.87	898.86	149.49	0.16
Reach 1-3	2975	FIS	2600.00	7000.89	7010.26	7005.09	7010.67	0.003326	5.13	513.05	56.85	0.30
Reach 1-3	2930		Culvert									
Reach 1-3	2879	FIS	2600.00	7000.82	7006.11		7007.90	0.022275	9.54	250.82	86.95	0.74
Reach 1-3	2856	FIS	2600.00	7000.50	7006.13		7006.94	0.020557	7.34	360.13	98.05	0.55
Reach 1-3	2850	FIS	2600.00	7000.17	7006.15		7006.78	0.015412	6.54	408.98	101.57	0.48
Reach 1-3	2842	FIS	2600.00	6997.59	7006.22		7006.55	0.005468	4.89	587.36	100.64	0.30
Reach 1-3	2838	FIS	2600.00	6999.13	7006.13		7006.53	0.007986	5.29	534.88	103.78	0.36
Reach 1-3	2830	FIS	2600.00	6997.58	7006.11		7006.43	0.008562	4.70	572.65	109.86	0.31

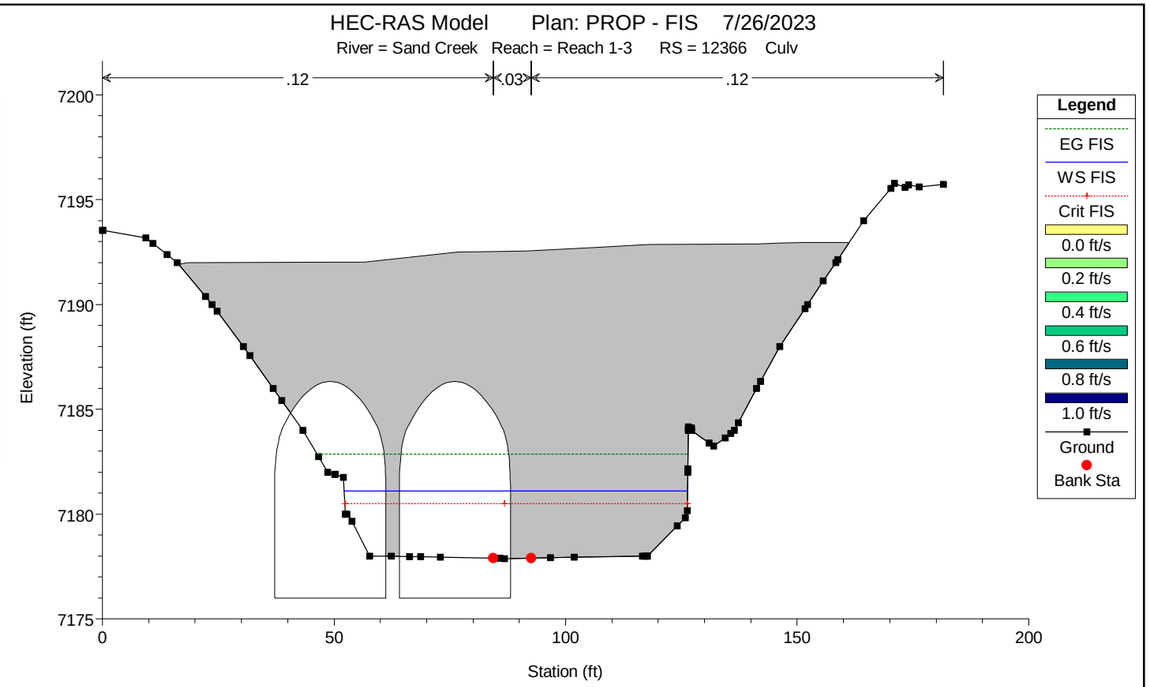
Sub-critical flow analysis for Water Surface evaluation of Naturalized Channel Design at the FIS flow rate only

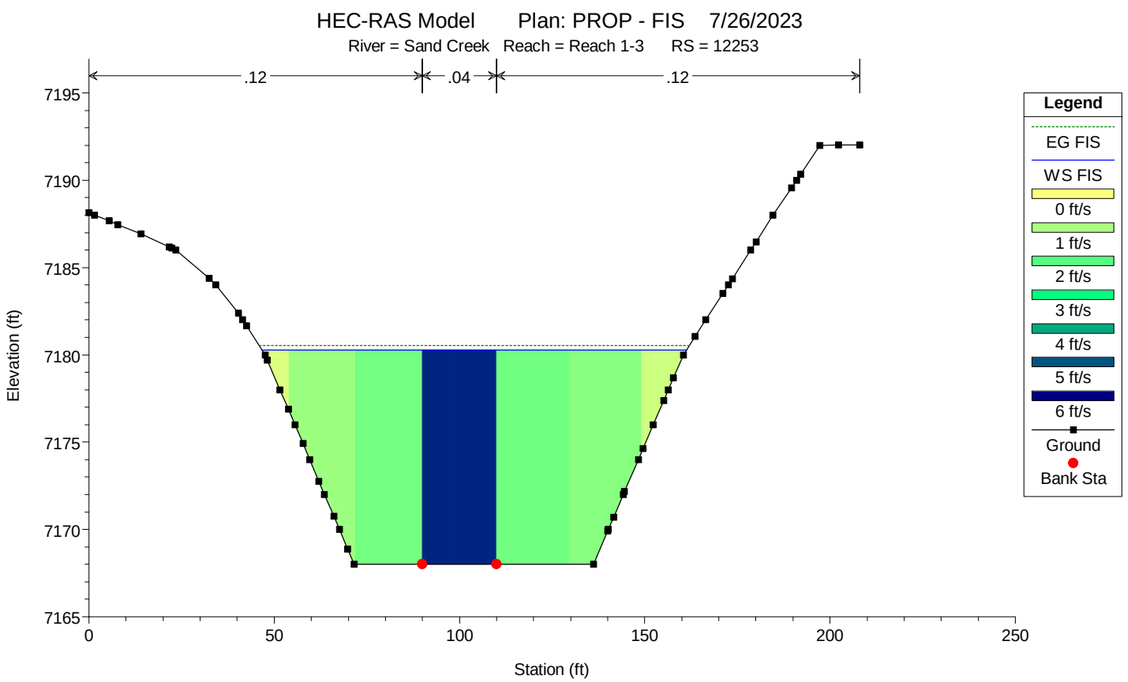
HEC-RAS Plan: PROP - FIS River: Sand Creek Reach: Reach 1-3 Profile: FIS (Continued)

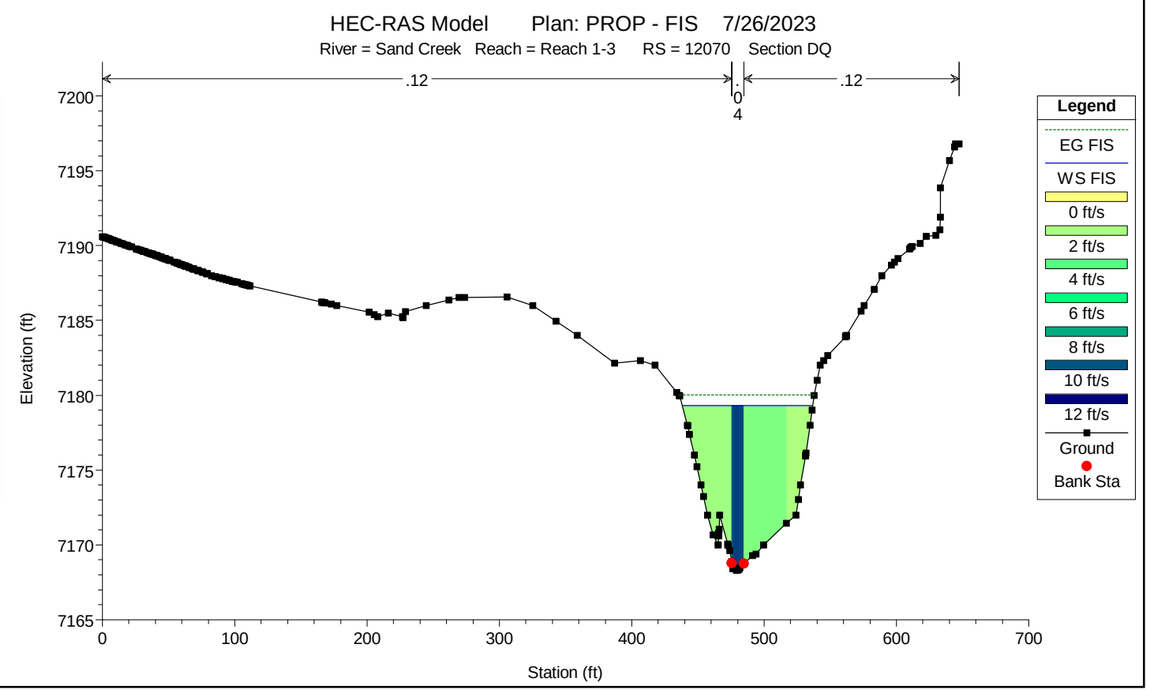
Reach	River Sta	Profile	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl
			(cfs)	(ft)	(ft)	(ft)	(ft)	(ft/ft)	(ft/s)	(sq ft)	(ft)	
Reach 1-3	2792	FIS	2600.00	6997.53	7005.85		7006.13	0.007523	4.36	610.05	119.79	0.29
Reach 1-3	2719	FIS	2600.00	6997.47	7005.36		7005.62	0.007720	4.33	637.50	128.78	0.30
Reach 1-3	2680	FIS	2600.00	6997.33	7005.06		7005.30	0.007713	4.15	673.07	143.59	0.29
Reach 1-3	2646	FIS	2600.00	6997.18	7004.83		7005.05	0.007011	4.07	688.08	147.75	0.29
Reach 1-3	2589	FIS	2600.00	6996.89	7004.48		7004.68	0.006505	3.91	730.31	163.76	0.28
Reach 1-3	2545	FIS	2600.00	6997.22	7004.15		7004.36	0.008920	4.09	705.49	178.12	0.31
Reach 1-3	2513	FIS	2600.00	6996.86	7003.83		7004.06	0.008884	4.06	679.74	169.54	0.31
Reach 1-3	2468	FIS	2600.00	6997.15	7003.37		7003.58	0.010665	3.91	709.51	203.63	0.32
Reach 1-3	2405	FIS	2600.00	6997.08	7002.14		7002.58	0.034259	6.09	542.74	227.05	0.56
Reach 1-3	2399	FIS	2600.00	6997.08	7001.49	7001.49	7002.30	0.054615	8.17	395.57	224.57	0.82
Reach 1-3	2384	FIS	2600.00	6993.53	6999.36		6999.92	0.021150	6.48	482.37	234.99	0.54
Reach 1-3	2377	FIS	2600.00	6993.46	6999.48		6999.75	0.008347	4.71	699.46	250.81	0.35
Reach 1-3	2375	FIS	2600.00	6994.97	6999.48		6999.71	0.009824	4.42	724.84	267.64	0.37
Reach 1-3	2350	FIS	2600.00	6993.08	6999.32		6999.44	0.007666	3.37	964.93	288.04	0.28
Reach 1-3	2319	FIS	2600.00	6993.33	6999.12		6999.23	0.007008	3.21	1021.58	306.19	0.27
Reach 1-3	2246	FIS	2600.00	6993.16	6998.73		6998.81	0.005271	2.61	1127.87	323.94	0.22
Reach 1-3	2181	FIS	2600.00	6992.99	6998.41		6998.50	0.005064	2.59	1076.43	302.13	0.22
Reach 1-3	2112	FIS	2600.00	6992.58	6998.06		6998.16	0.004647	2.59	1032.46	251.83	0.20
Reach 1-3	2046	FIS	2600.00	6991.97	6997.62		6997.82	0.005490	4.96	819.27	230.88	0.37
Reach 1-3	1993	FIS	2600.00	6991.29	6997.27		6997.48	0.007262	5.54	740.83	191.22	0.41
Reach 1-3	1929	FIS	2600.00	6991.32	6996.74		6997.04	0.006573	5.23	660.14	170.85	0.40
Reach 1-3	1884	FIS	2600.00	6991.07	6996.22		6996.62	0.012461	7.01	561.14	148.73	0.55
Reach 1-3	1834	FIS	2600.00	6990.69	6995.57		6996.02	0.011363	6.32	547.43	162.08	0.52
Reach 1-3	1804	FIS	2600.00	6990.58	6995.24		6995.64	0.011292	6.27	545.08	157.25	0.51
Reach 1-3	1707	FIS	2600.00	6989.35	6992.93	6992.93	6994.10	0.023245	10.29	367.51	149.70	0.98
Reach 1-3	1663	FIS	2600.00	6987.76	6991.10	6991.10	6992.33	0.023796	10.14	354.92	148.53	0.99
Reach 1-3	1622	FIS	2600.00	6986.76	6989.97		6990.53	0.010731	6.08	450.42	180.45	0.64
Reach 1-3	1411	FIS	2600.00	6982.00	6990.04	6985.02	6990.12	0.000473	2.47	1397.28	286.43	0.16

Sub-critical flow analysis for Water Surface evaluation of Naturalized Channel Design at the FIS flow rate only

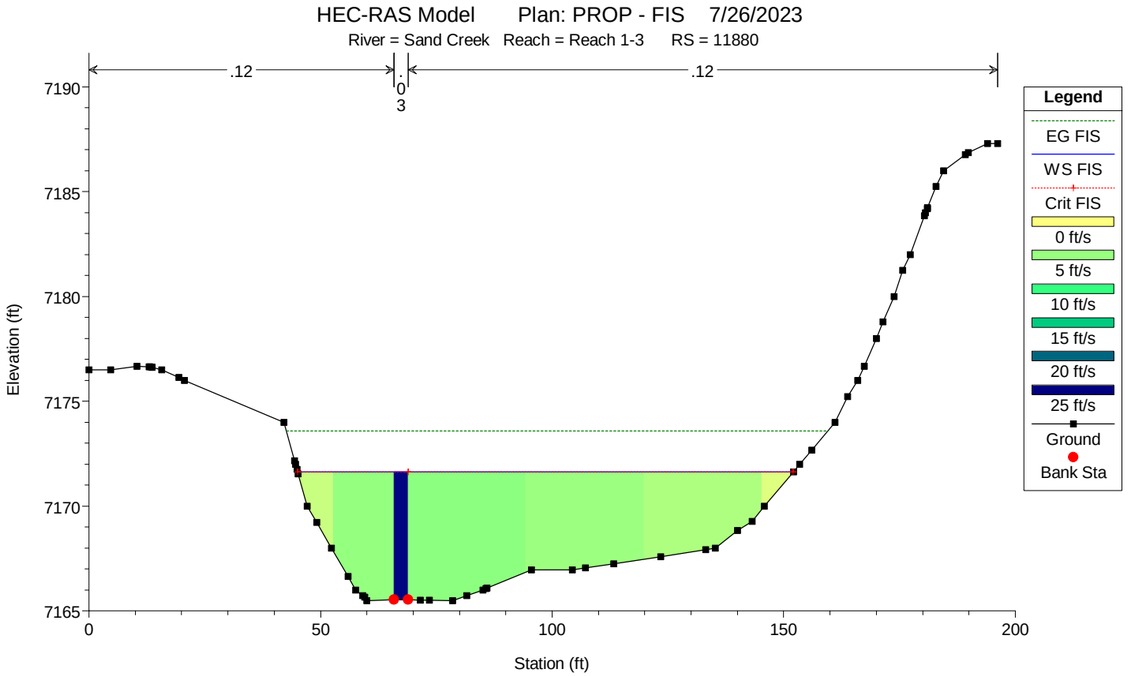


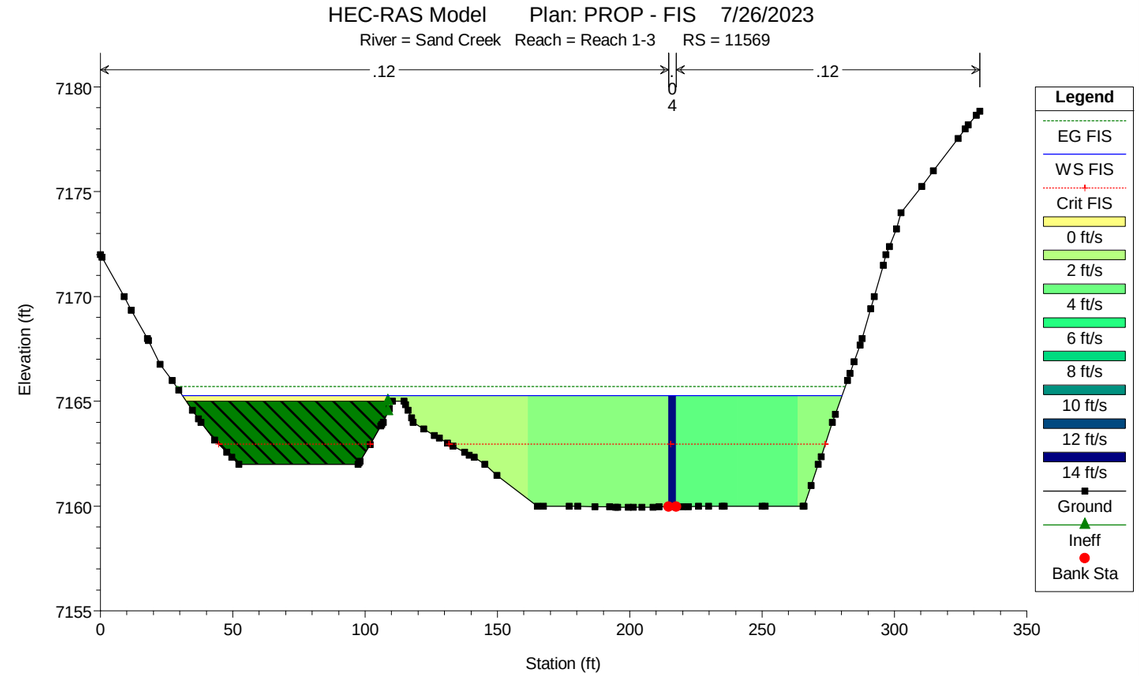


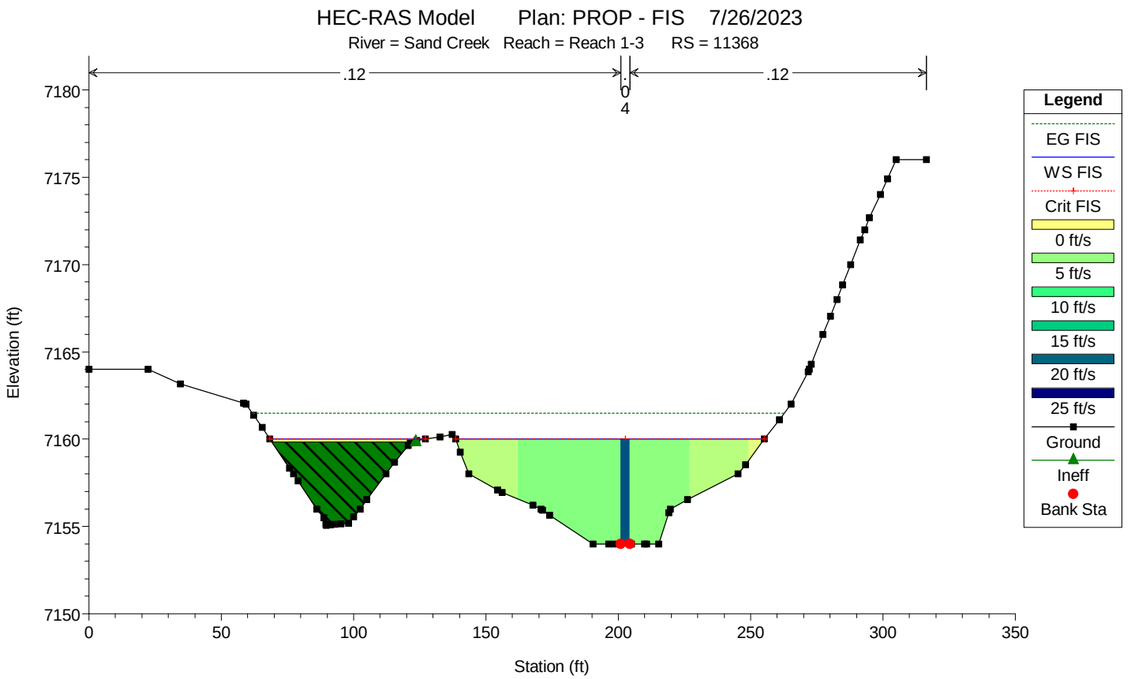


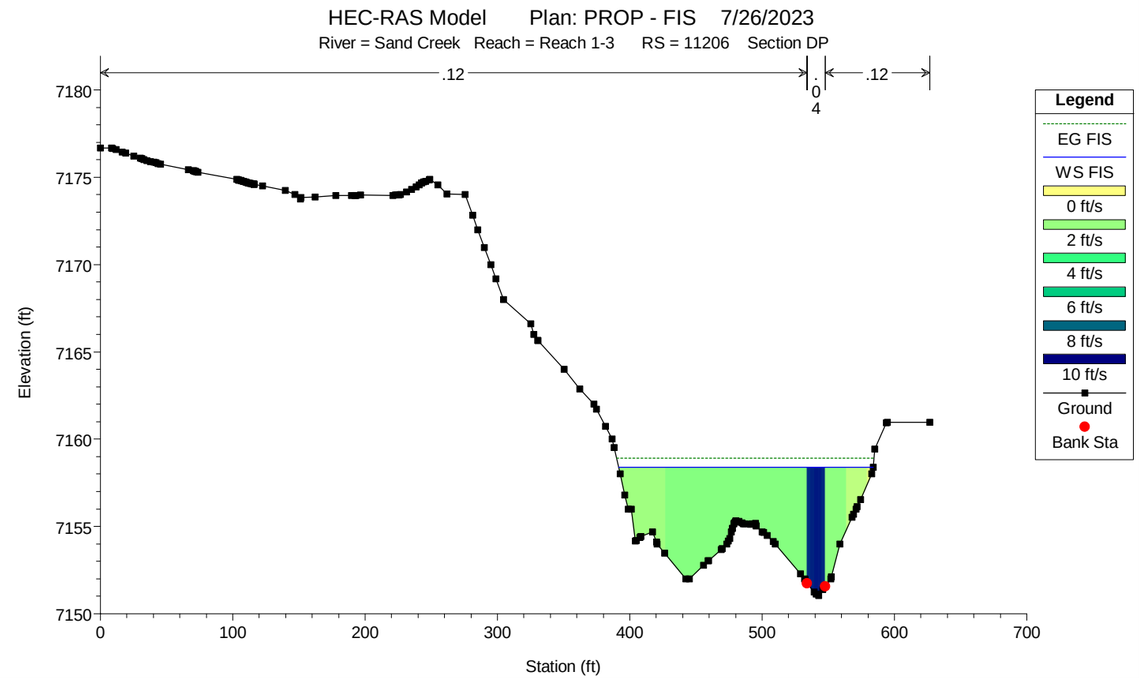


Sub-critical flow analysis for Water Surface evaluation of Naturalized Channel Design at the FIS flow rate only





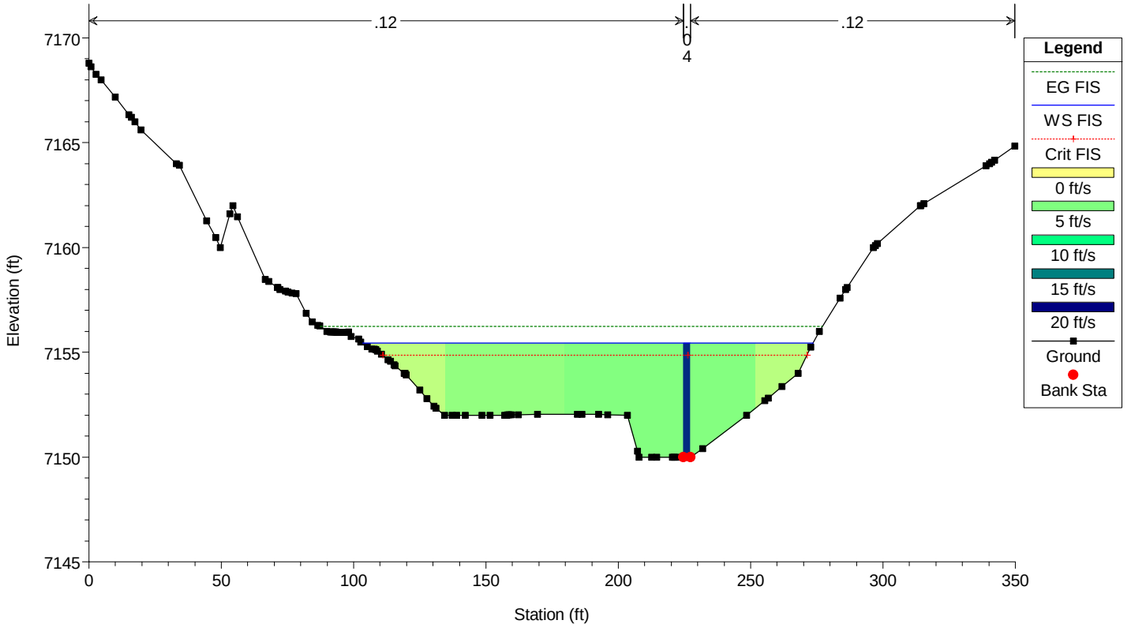




Sub-critical flow analysis for Water Surface evaluation of Naturalized Channel Design at the FIS flow rate only

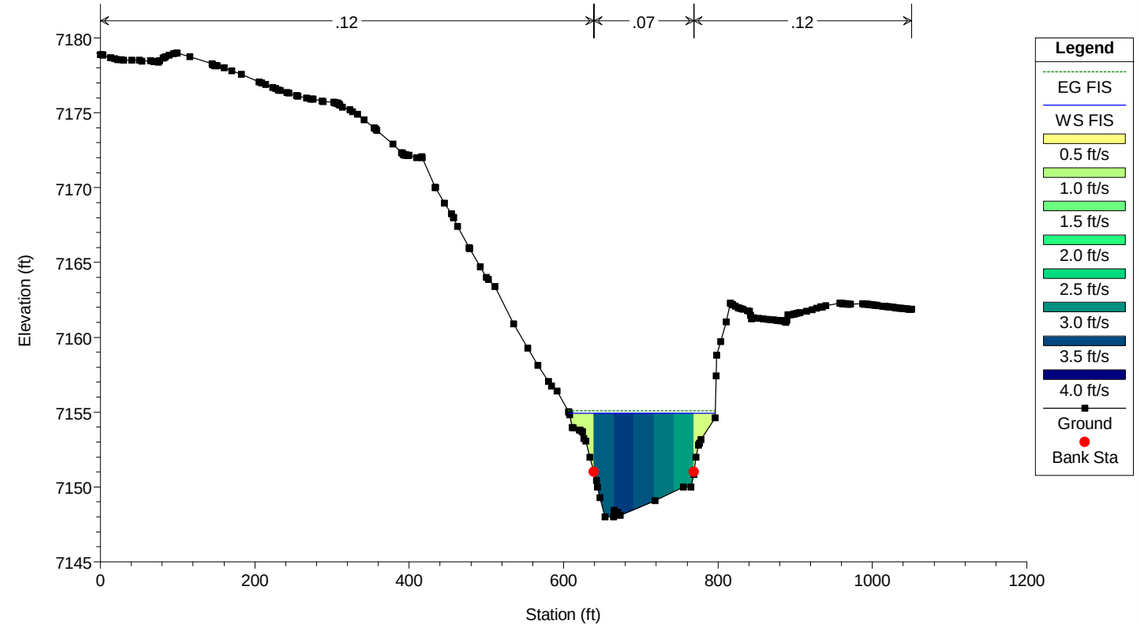
HEC-RAS Model Plan: PROP - FIS 7/26/2023

River = Sand Creek Reach = Reach 1-3 RS = 11103



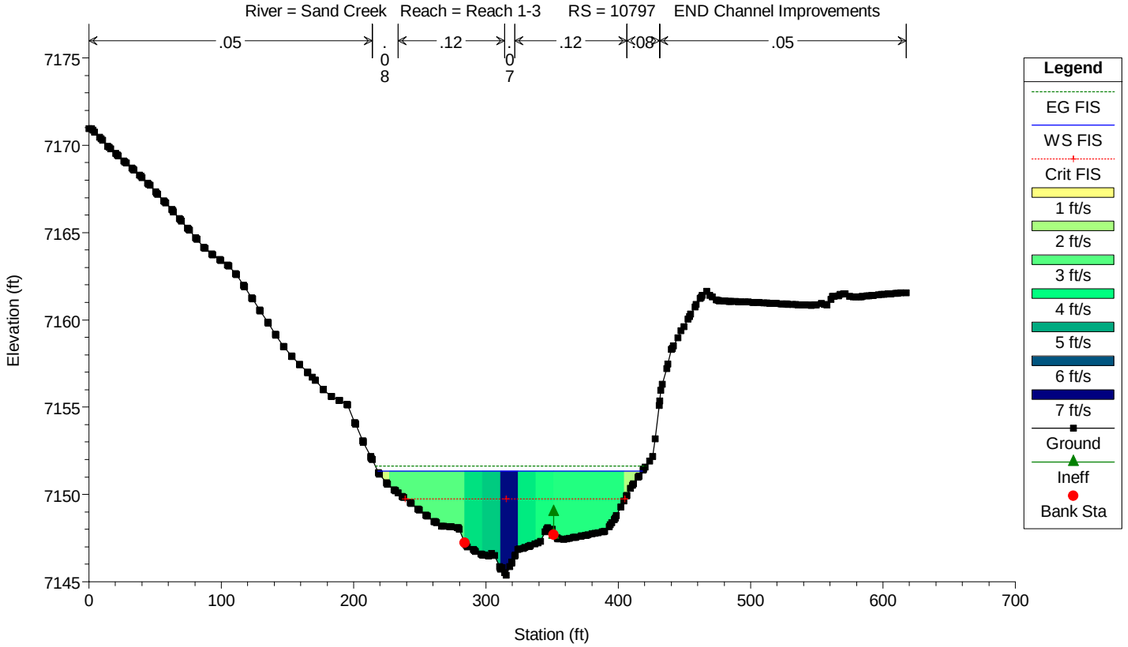
HEC-RAS Model Plan: PROP - FIS 7/26/2023

River = Sand Creek Reach = Reach 1-3 RS = 10925 Section DO



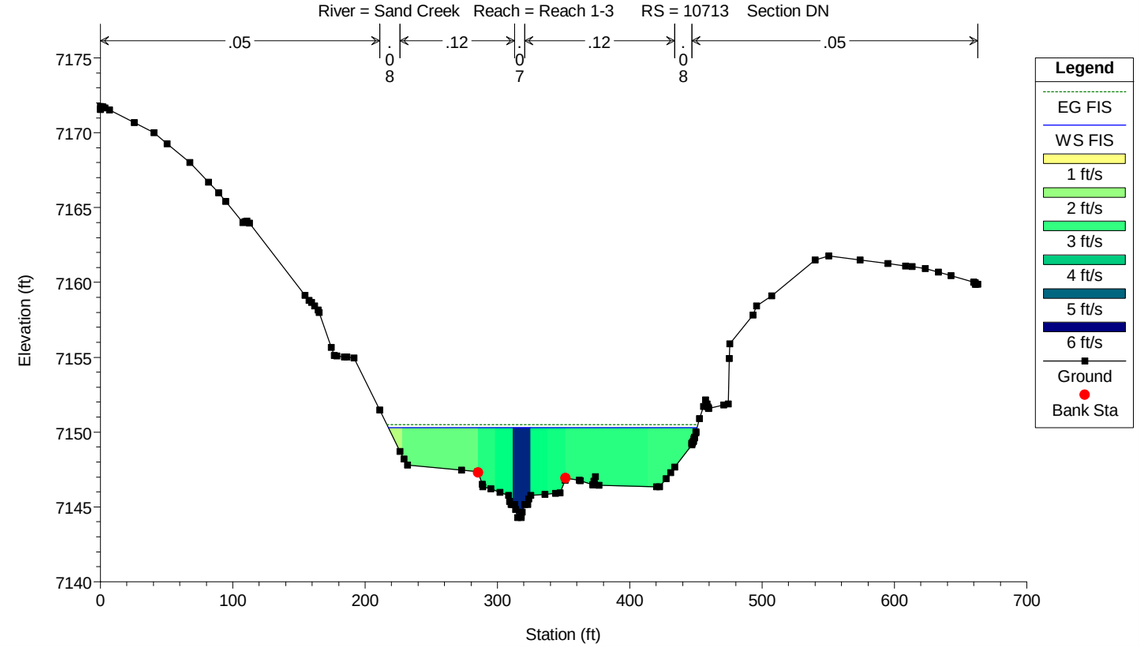
HEC-RAS Model Plan: PROP - FIS 7/26/2023

River = Sand Creek Reach = Reach 1-3 RS = 10797 END Channel Improvements

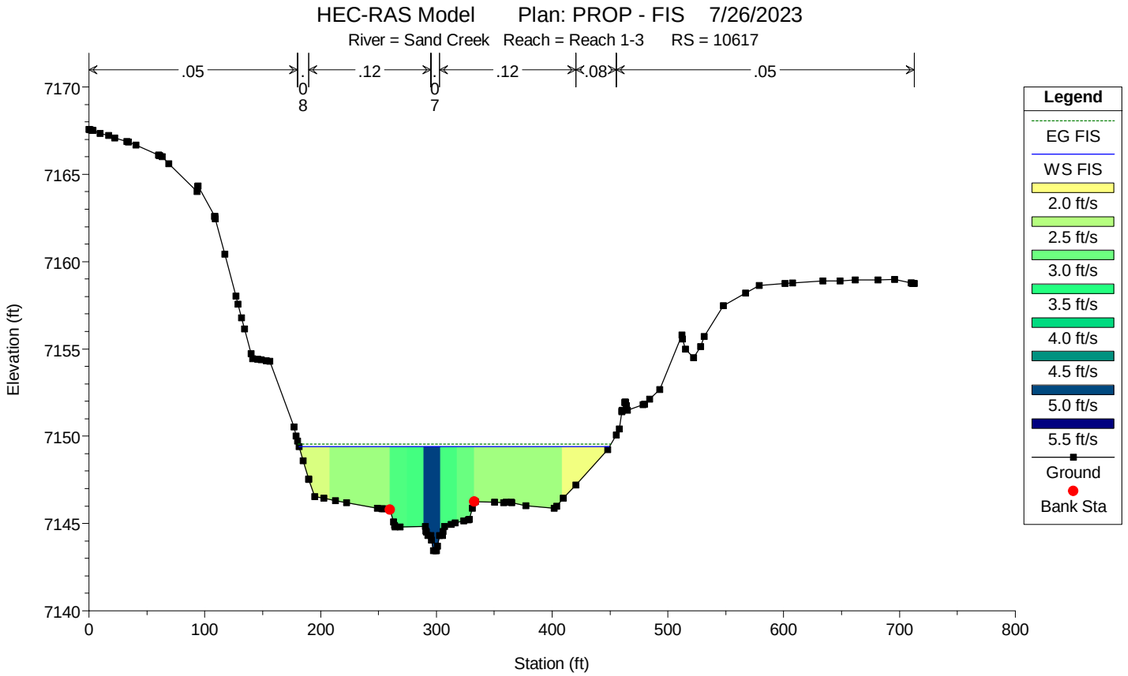


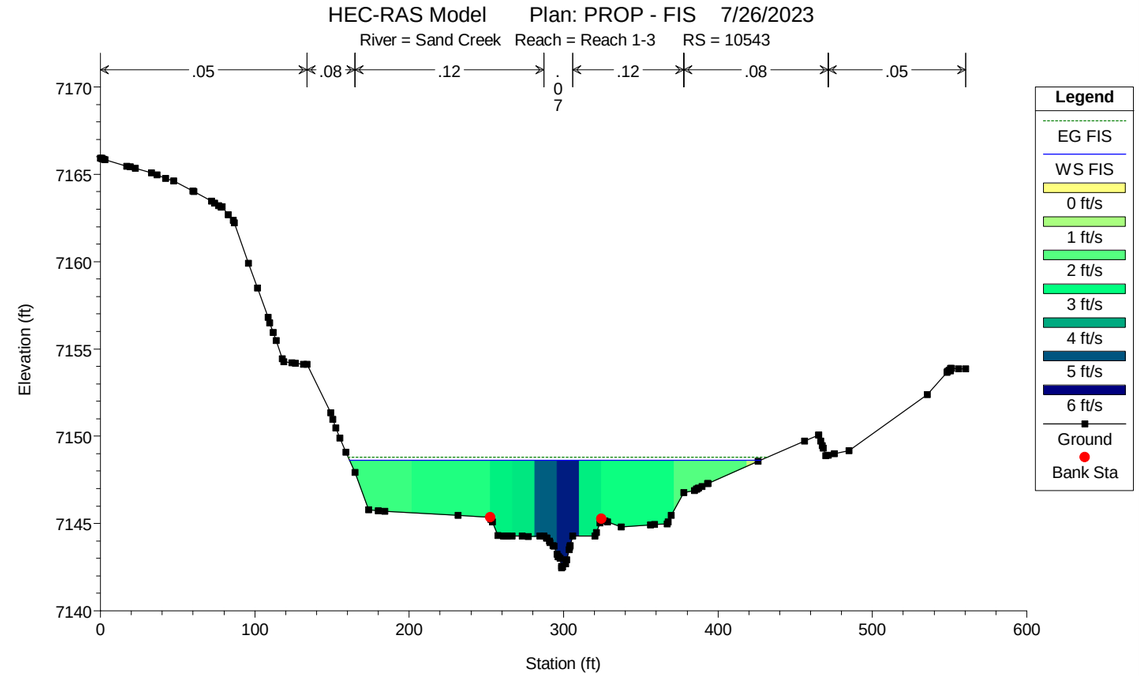
HEC-RAS Model Plan: PROP - FIS 7/26/2023

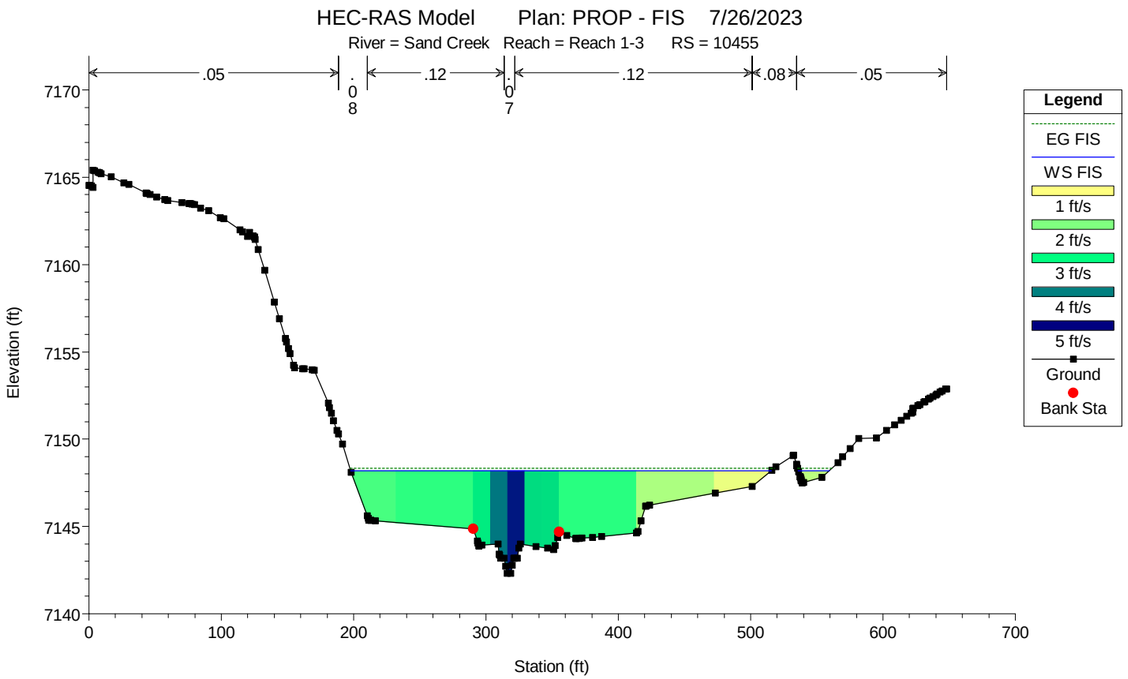
River = Sand Creek Reach = Reach 1-3 RS = 10713 Section DN

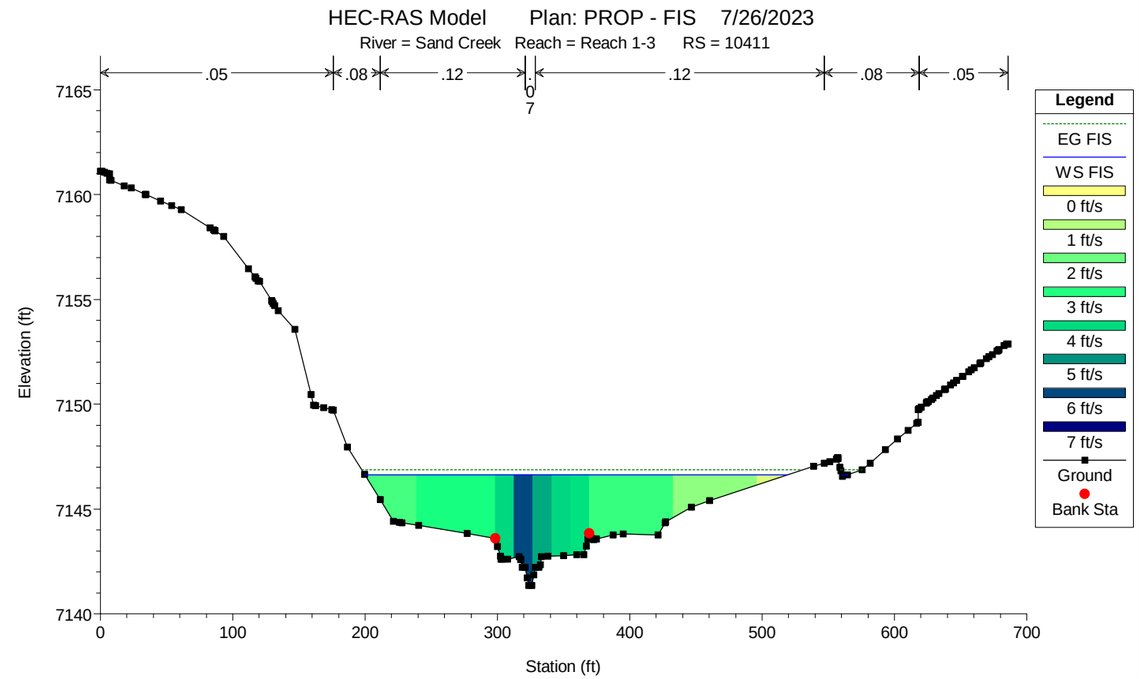


Sub-critical flow analysis for Water Surface evaluation of Naturalized Channel Design at the FIS flow rate only

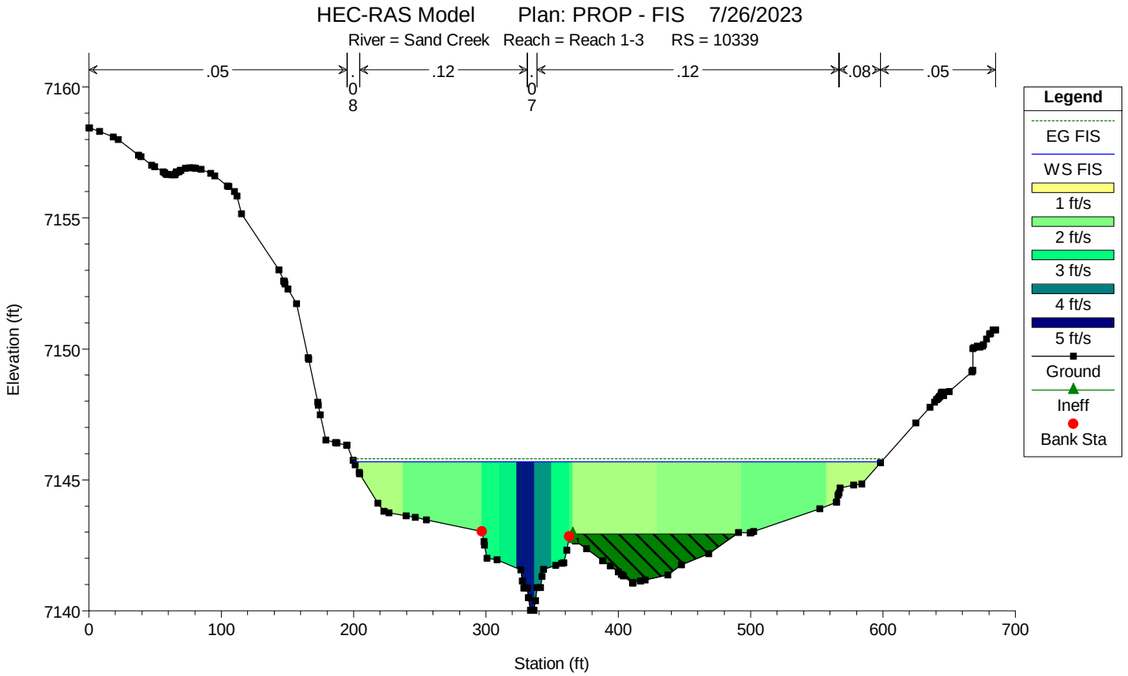


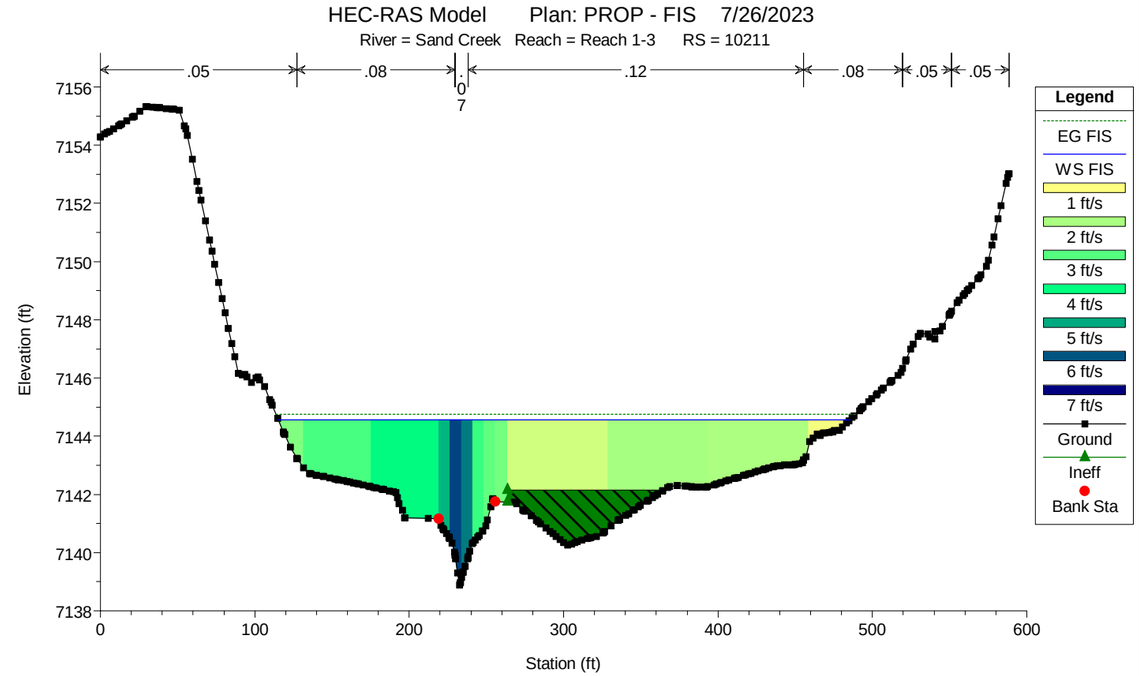


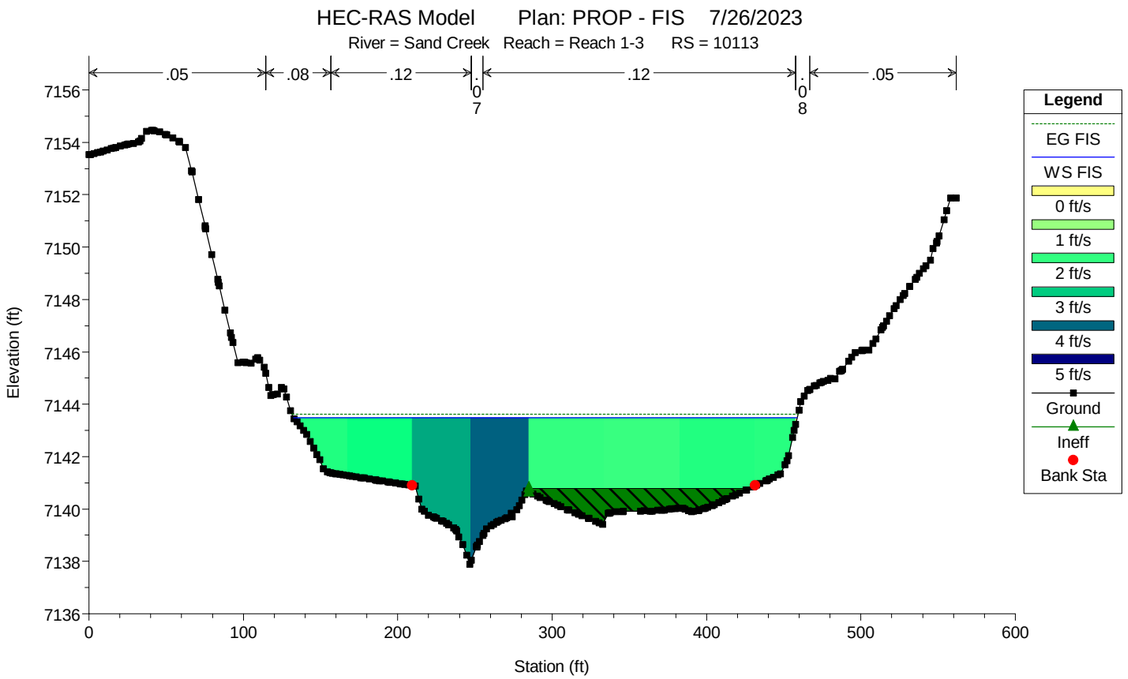


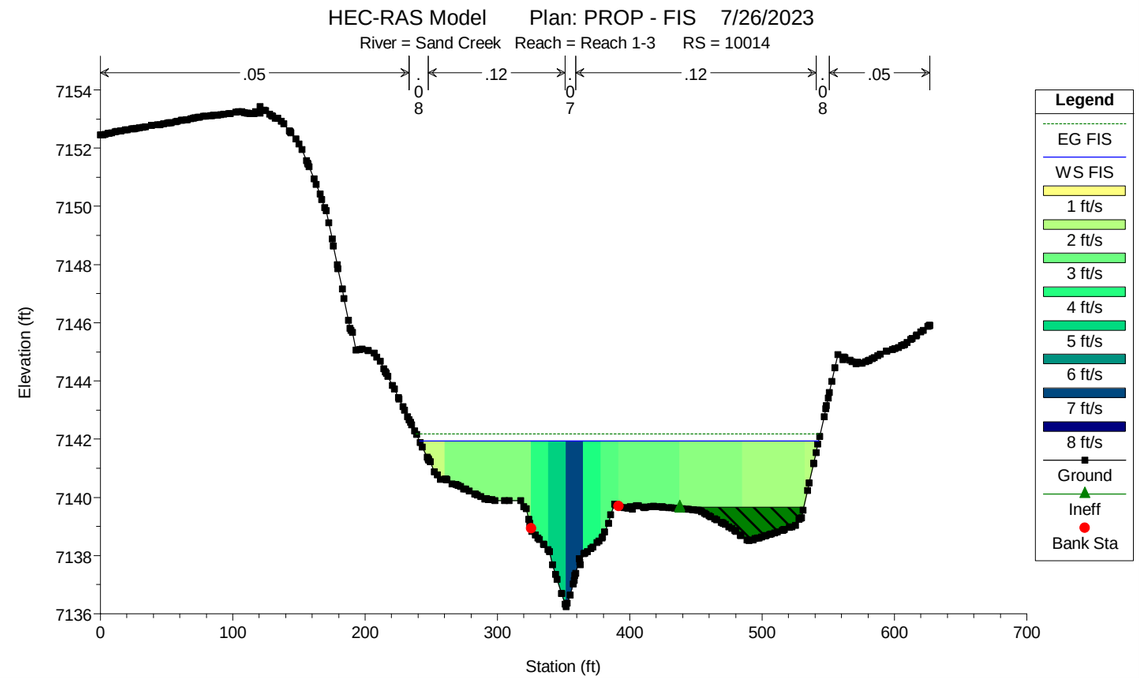


Sub-critical flow analysis for Water Surface evaluation of Naturalized Channel Design at the FIS flow rate only

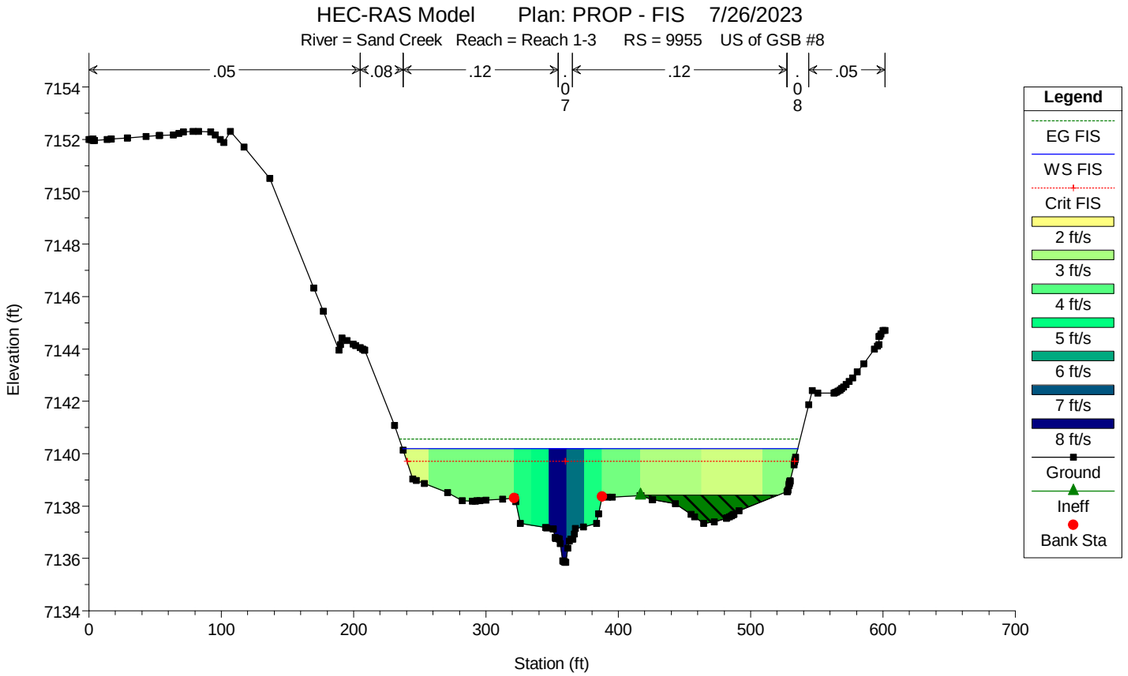


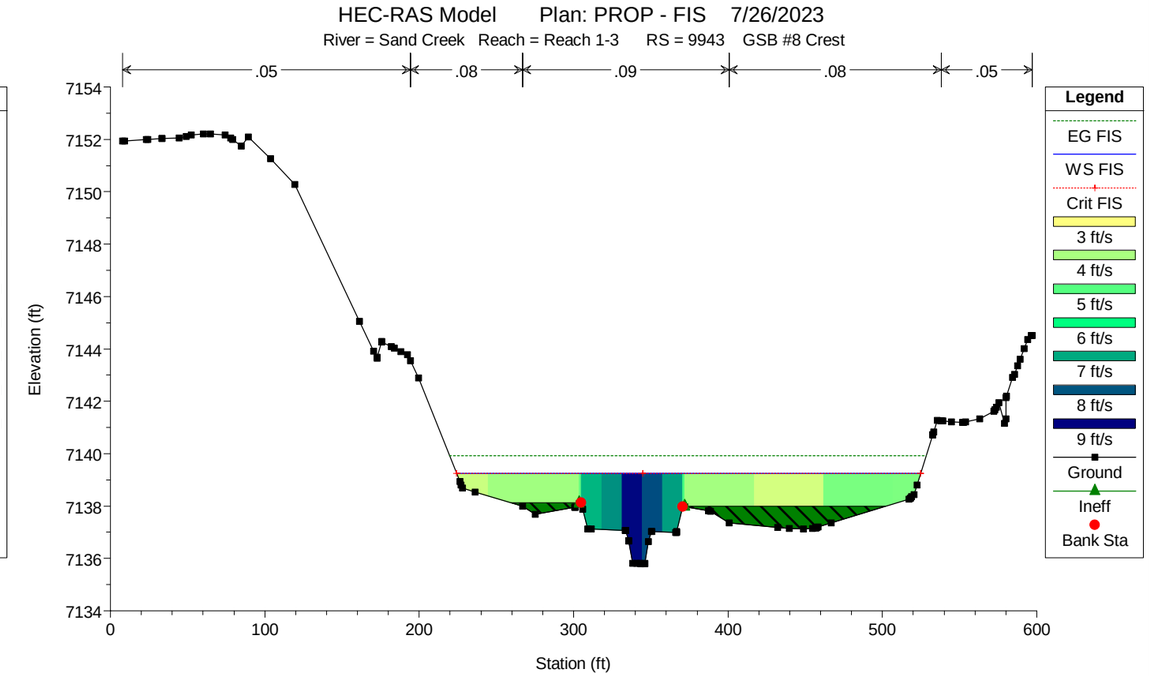


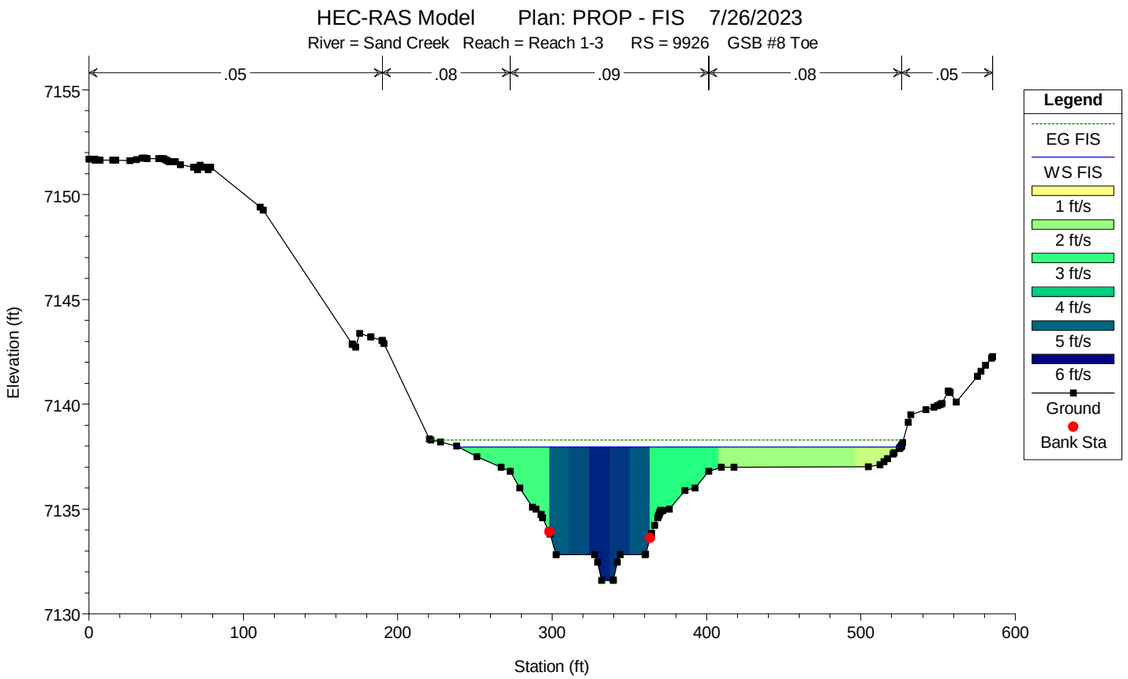


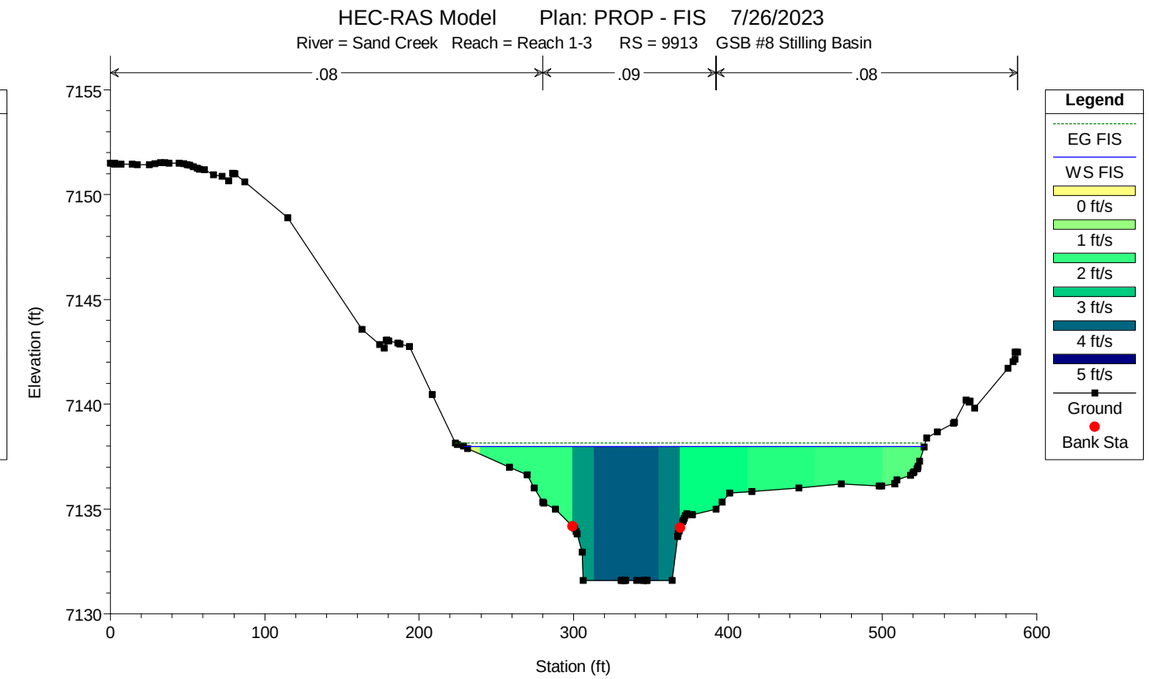


Sub-critical flow analysis for Water Surface evaluation of Naturalized Channel Design at the FIS flow rate only

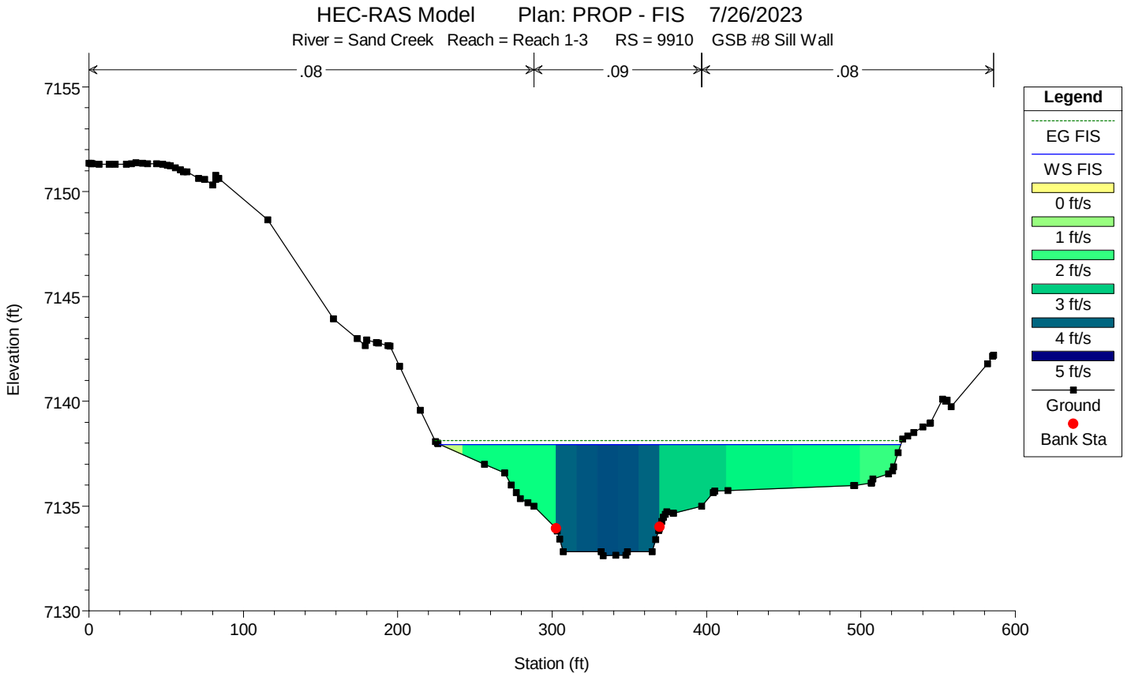


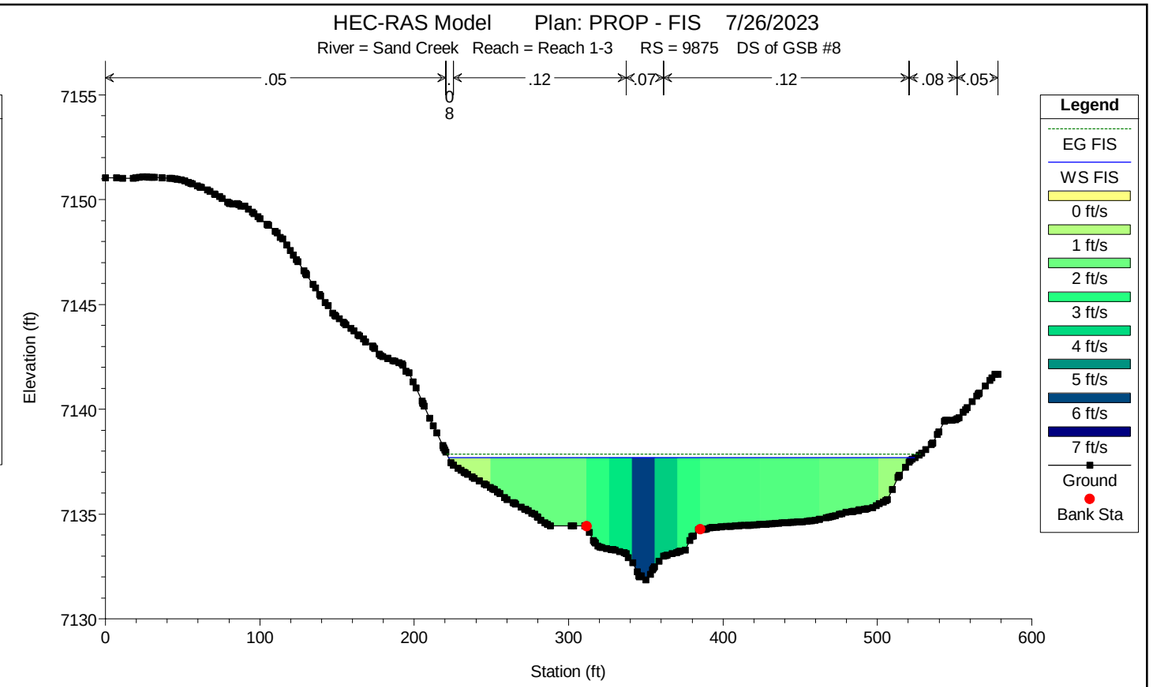


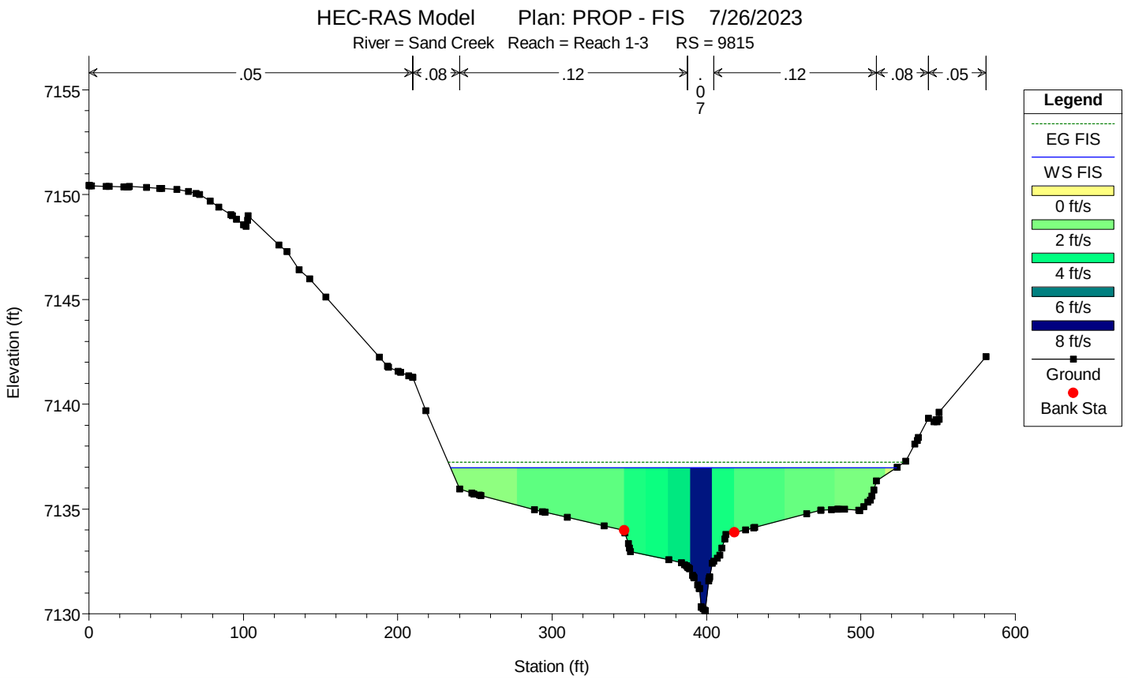


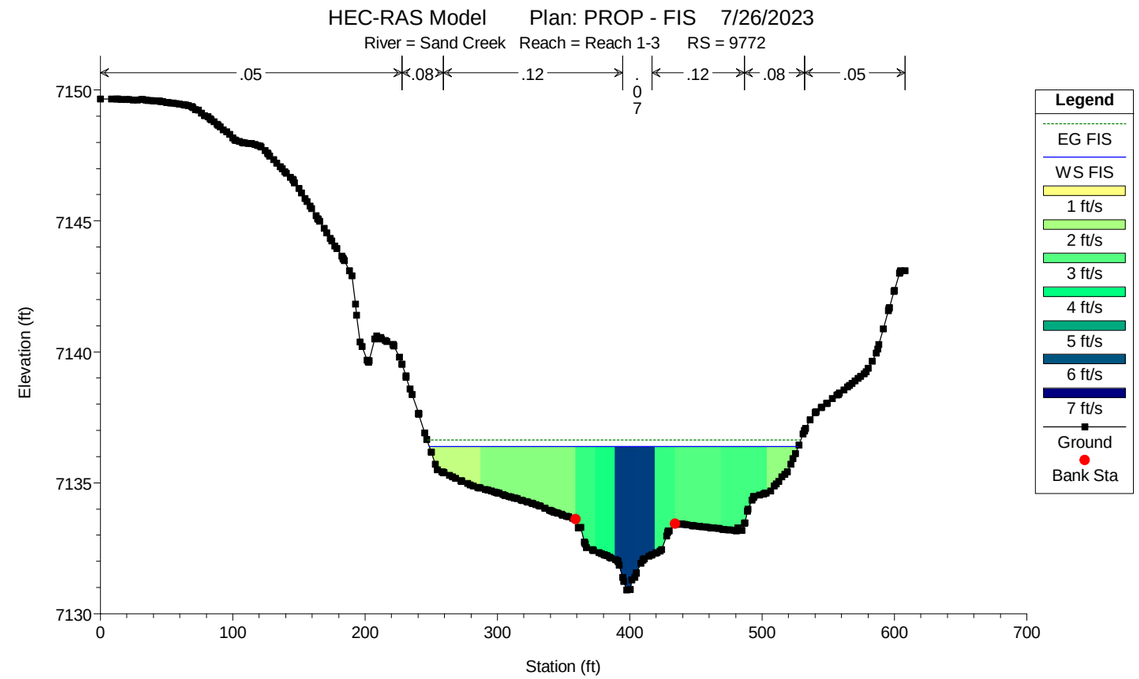


Sub-critical flow analysis for Water Surface evaluation of Naturalized Channel Design at the FIS flow rate only

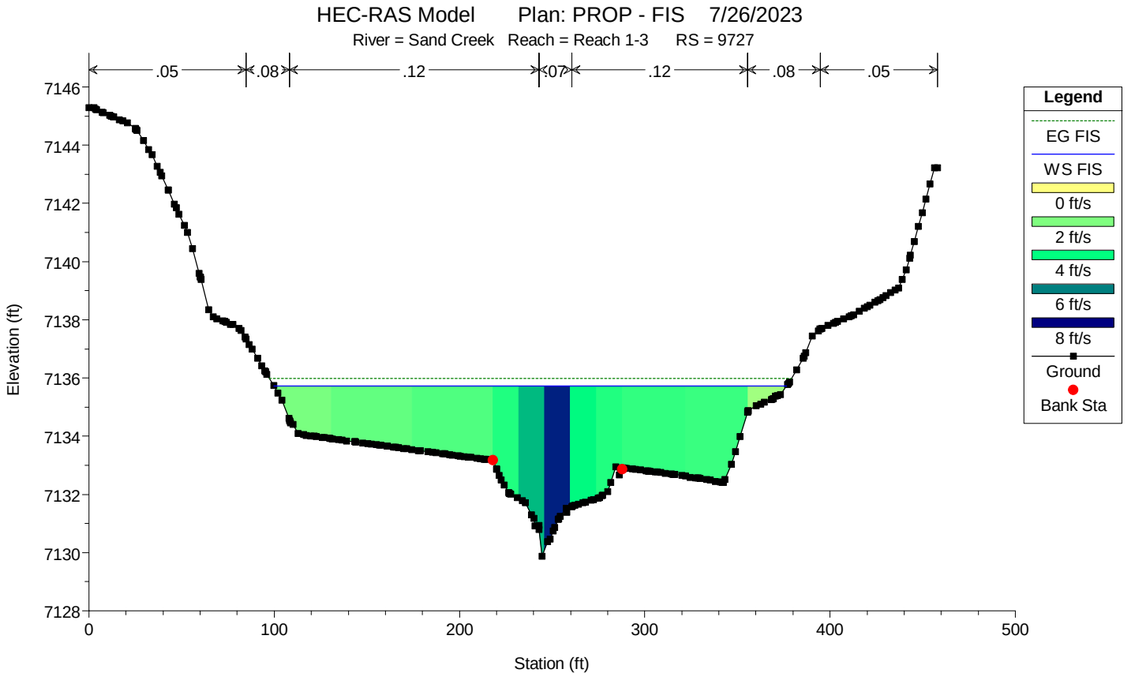


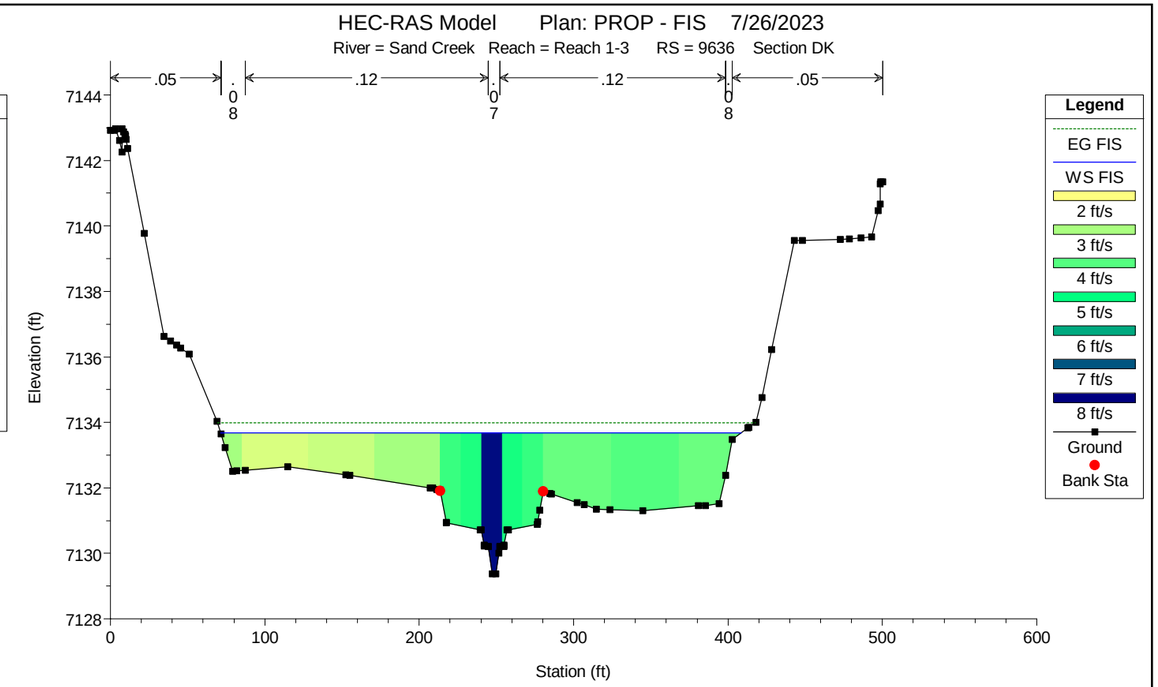


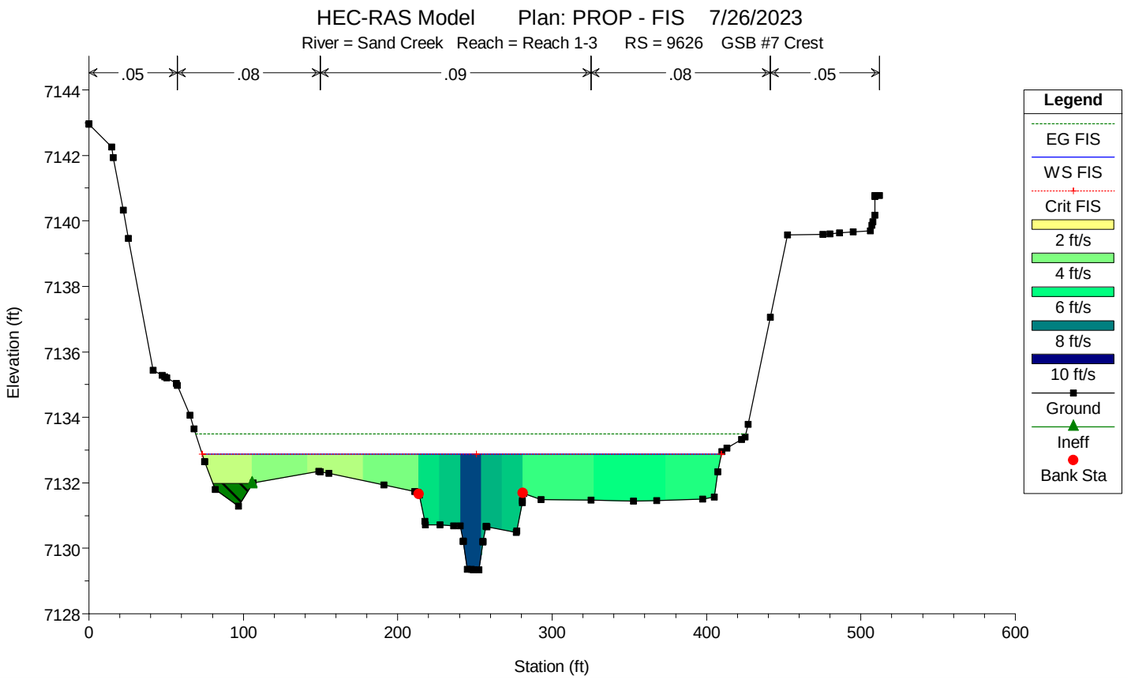


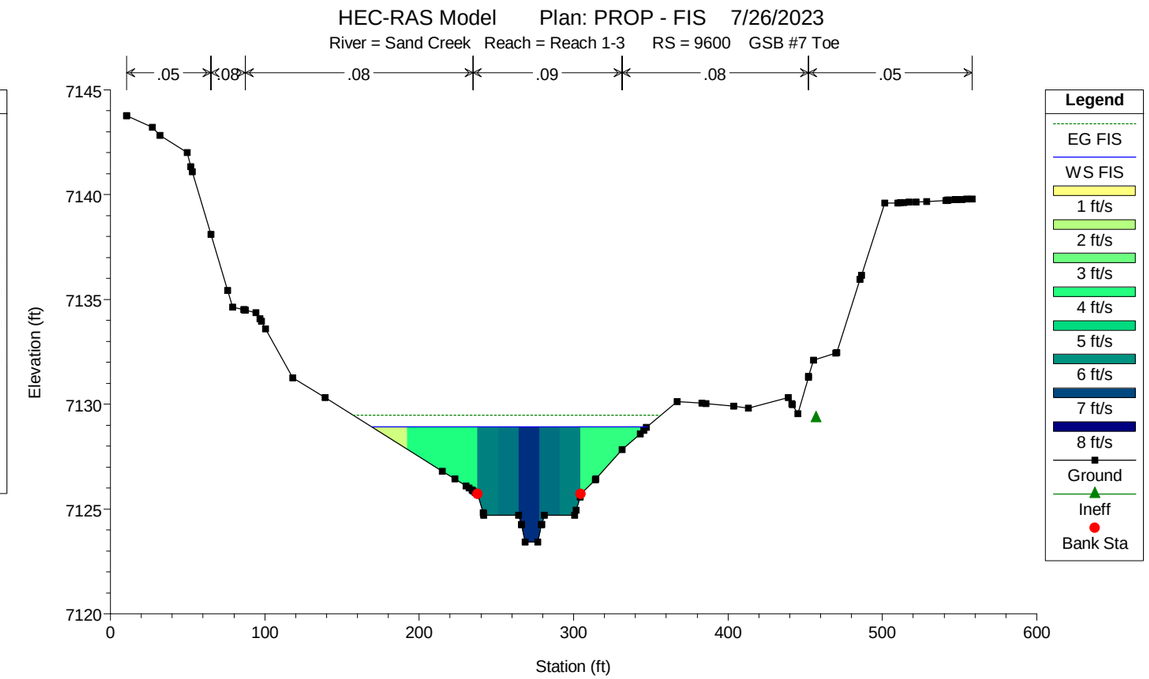


Sub-critical flow analysis for Water Surface evaluation of Naturalized Channel Design at the FIS flow rate only

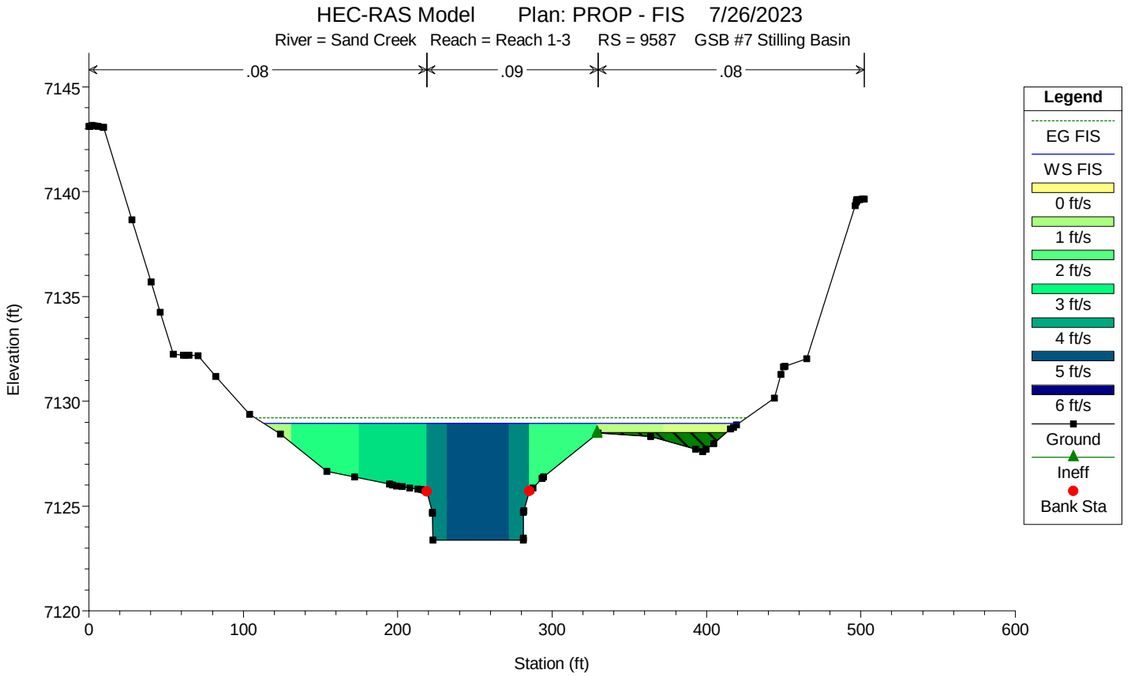


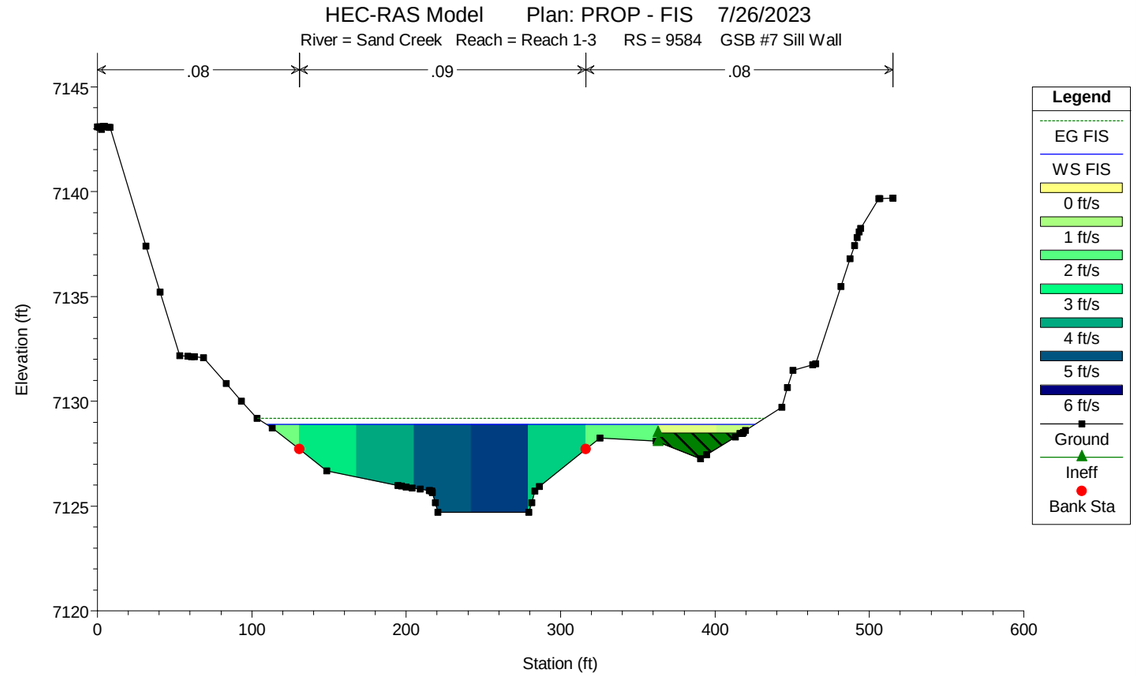


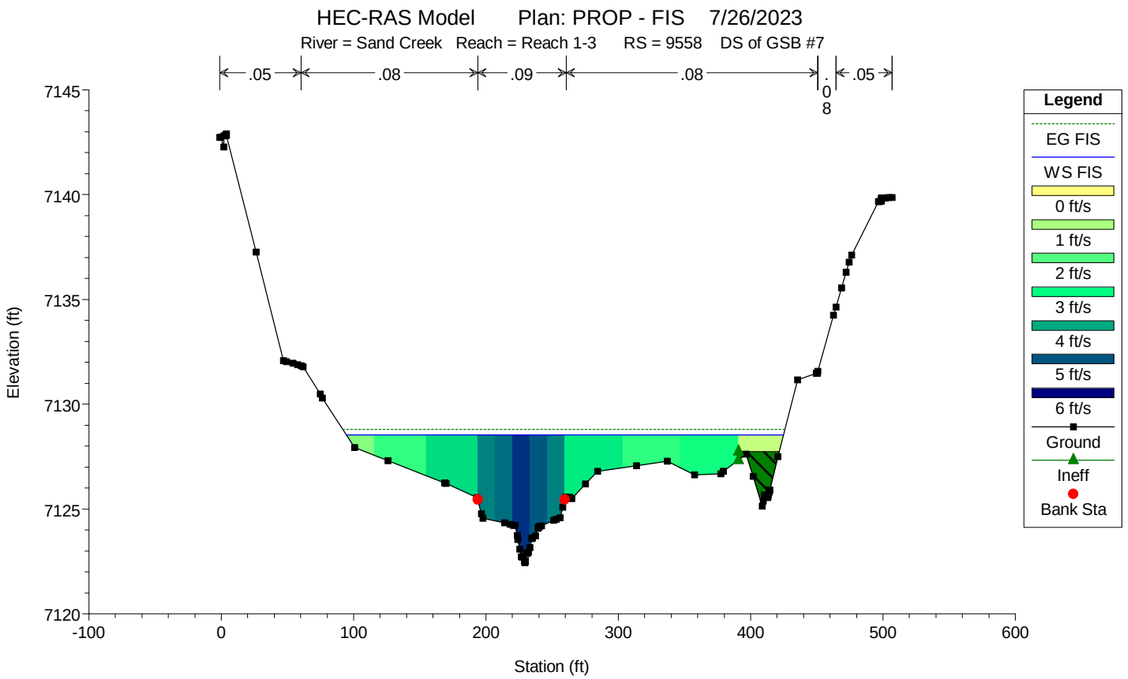


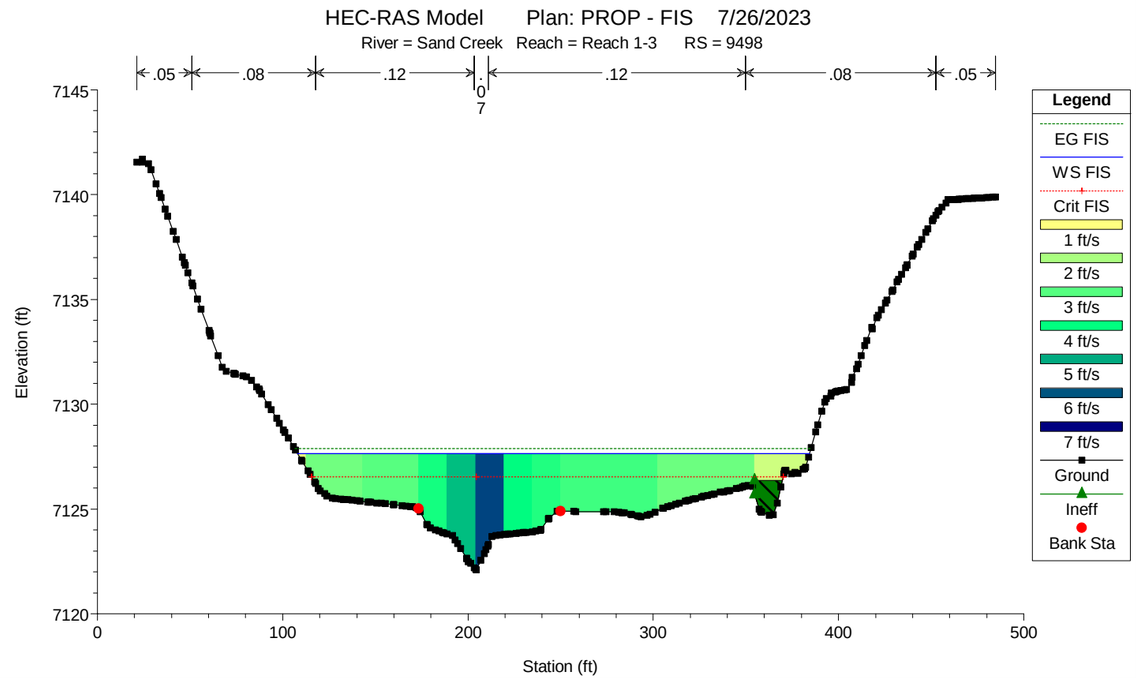


Sub-critical flow analysis for Water Surface evaluation of Naturalized Channel Design at the FIS flow rate only

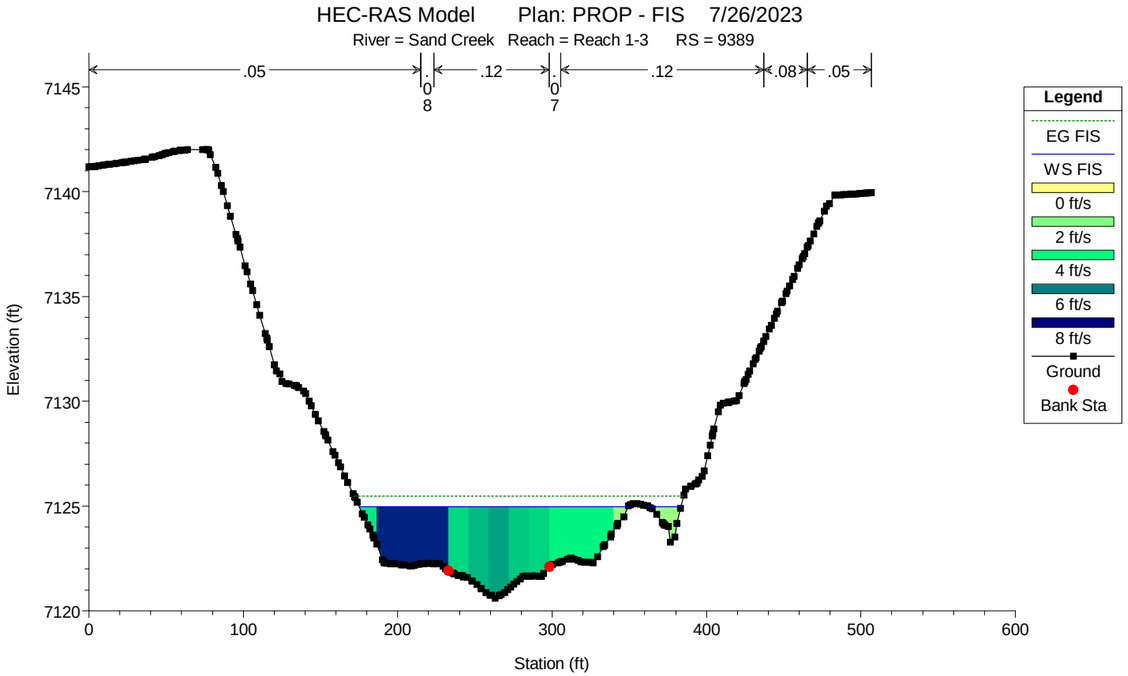


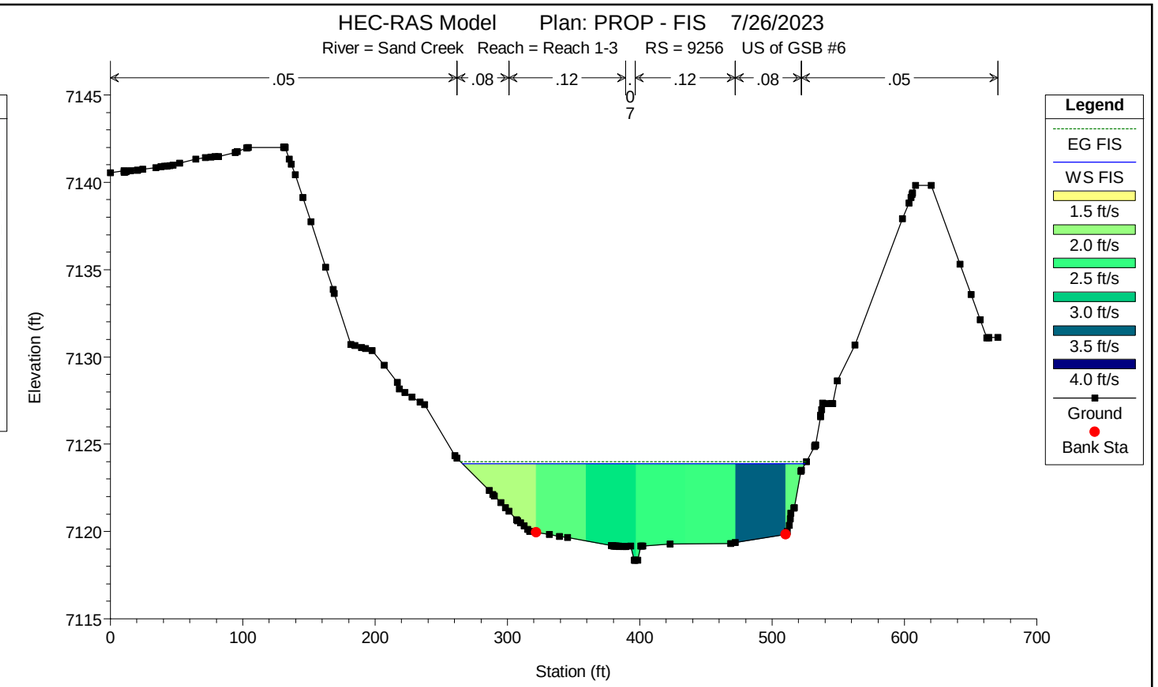


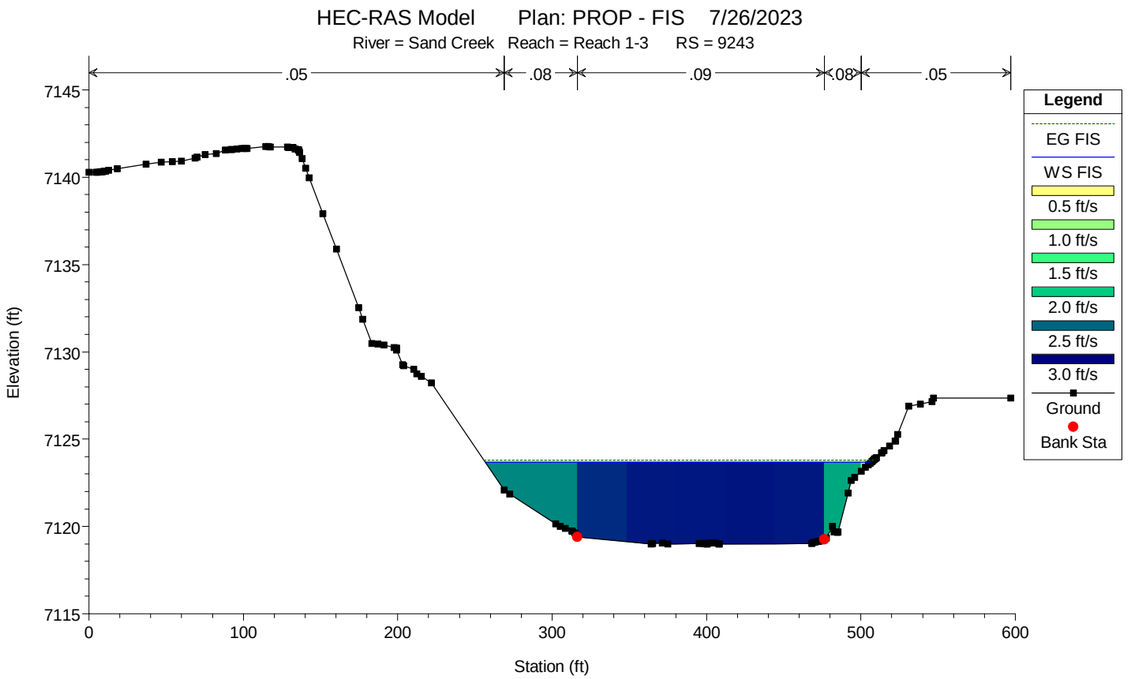


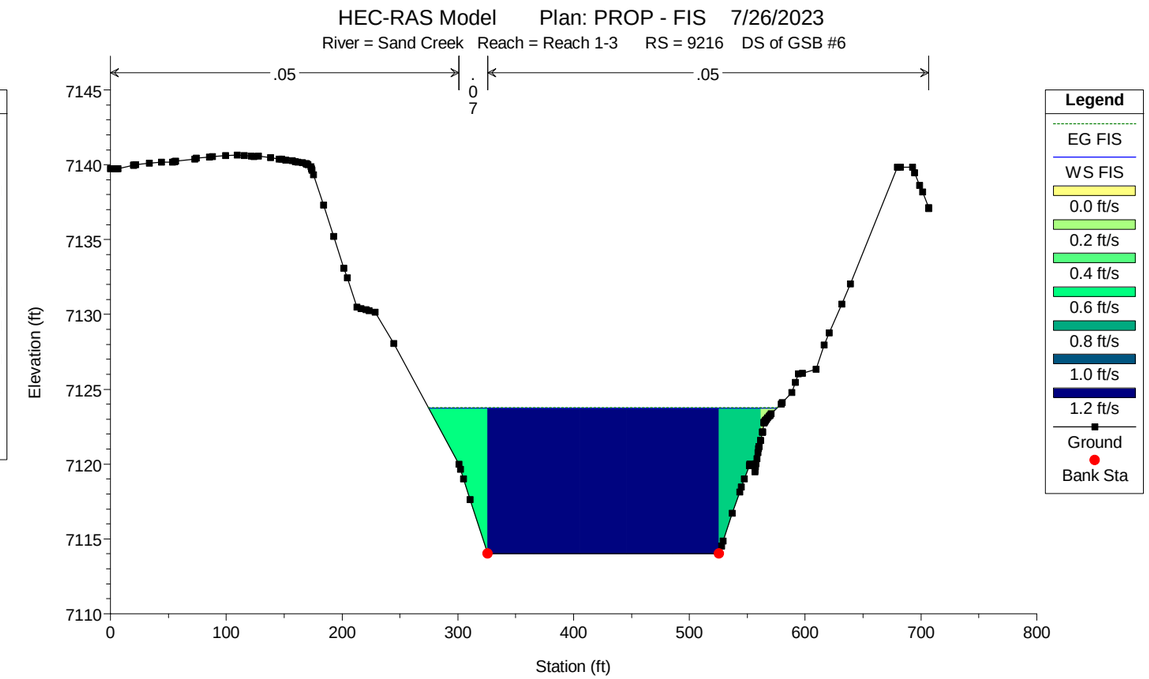


Sub-critical flow analysis for Water Surface evaluation of Naturalized Channel Design at the FIS flow rate only





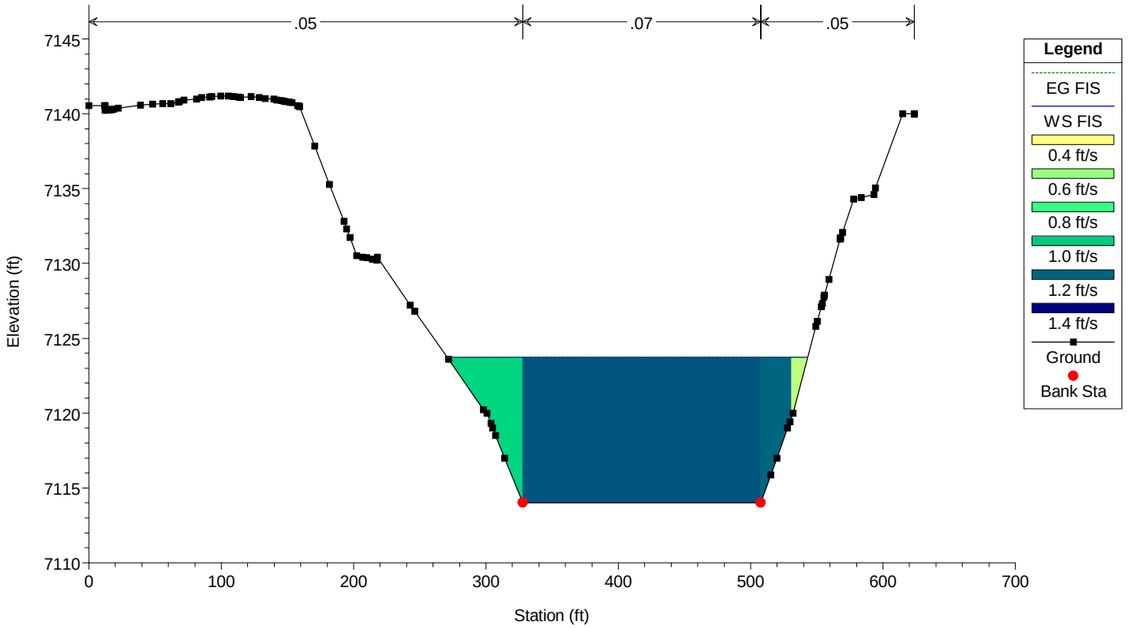




Sub-critical flow analysis for Water Surface evaluation of Naturalized Channel Design at the FIS flow rate only

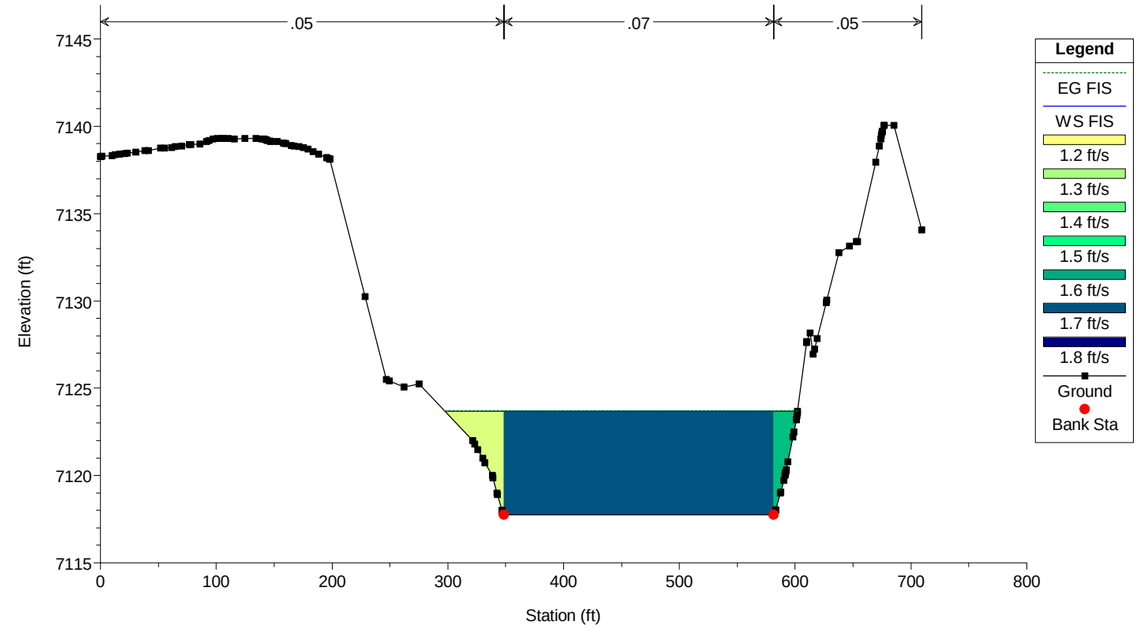
HEC-RAS Model Plan: PROP - FIS 7/26/2023

River = Sand Creek Reach = Reach 1-3 RS = 9080



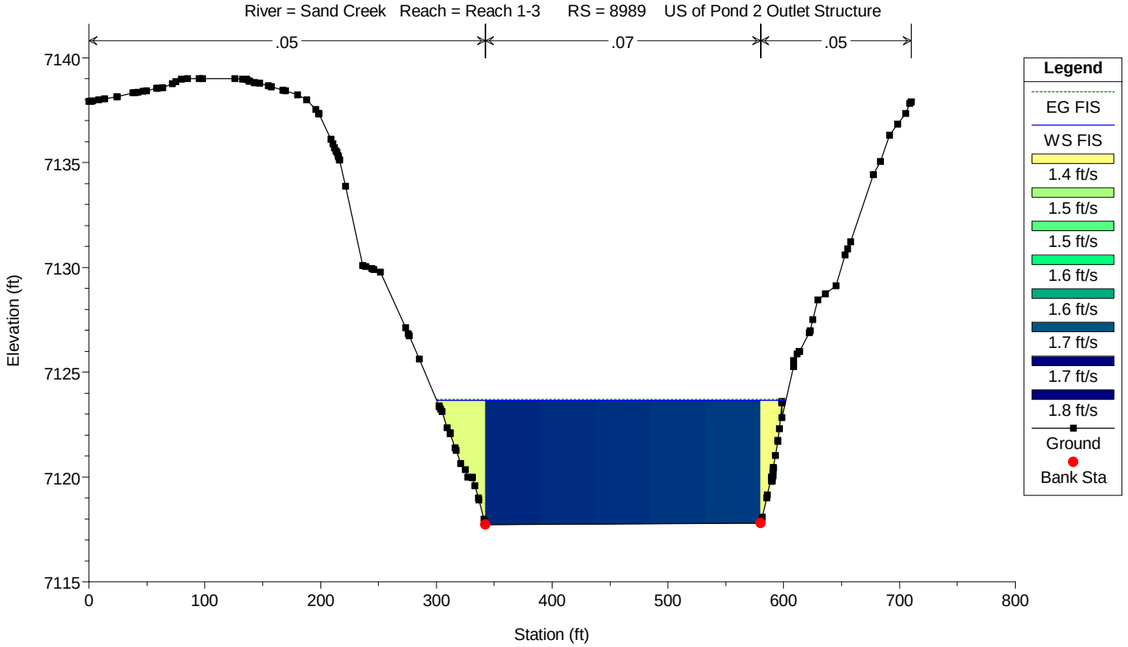
HEC-RAS Model Plan: PROP - FIS 7/26/2023

River = Sand Creek Reach = Reach 1-3 RS = 9029



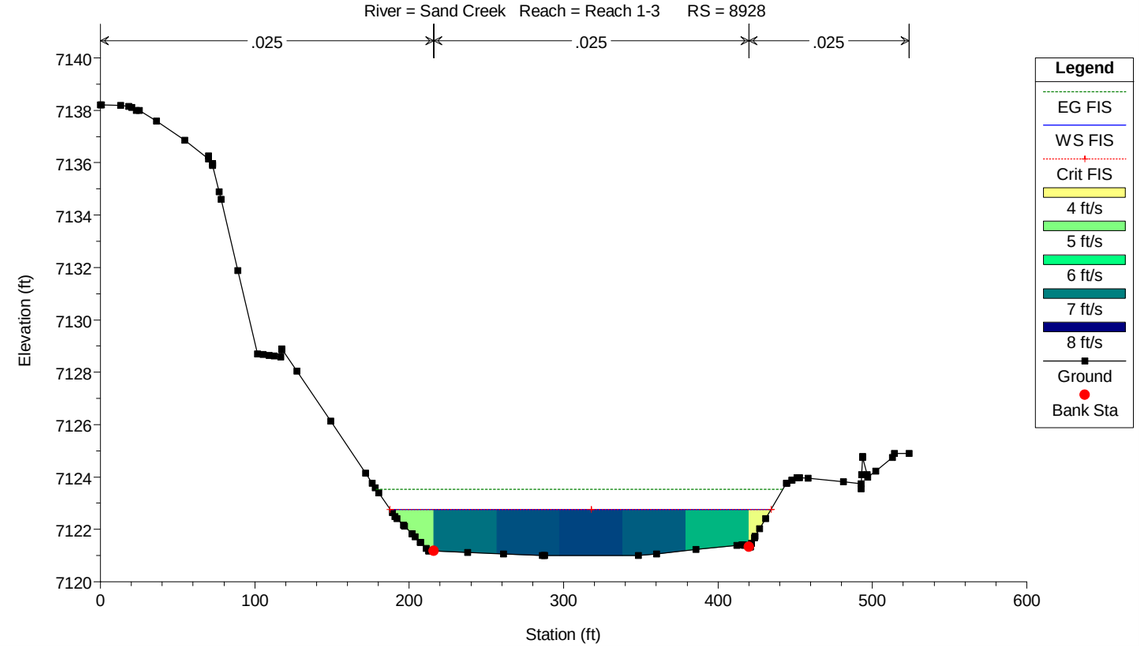
HEC-RAS Model Plan: PROP - FIS 7/26/2023

River = Sand Creek Reach = Reach 1-3 RS = 8989 US of Pond 2 Outlet Structure

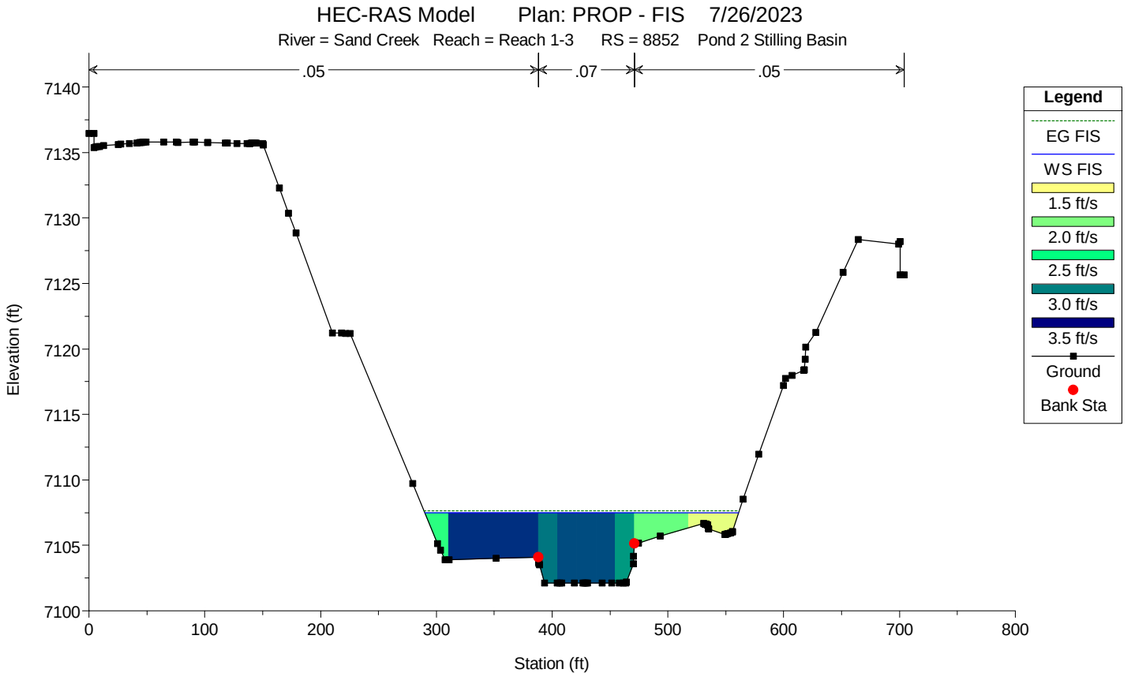


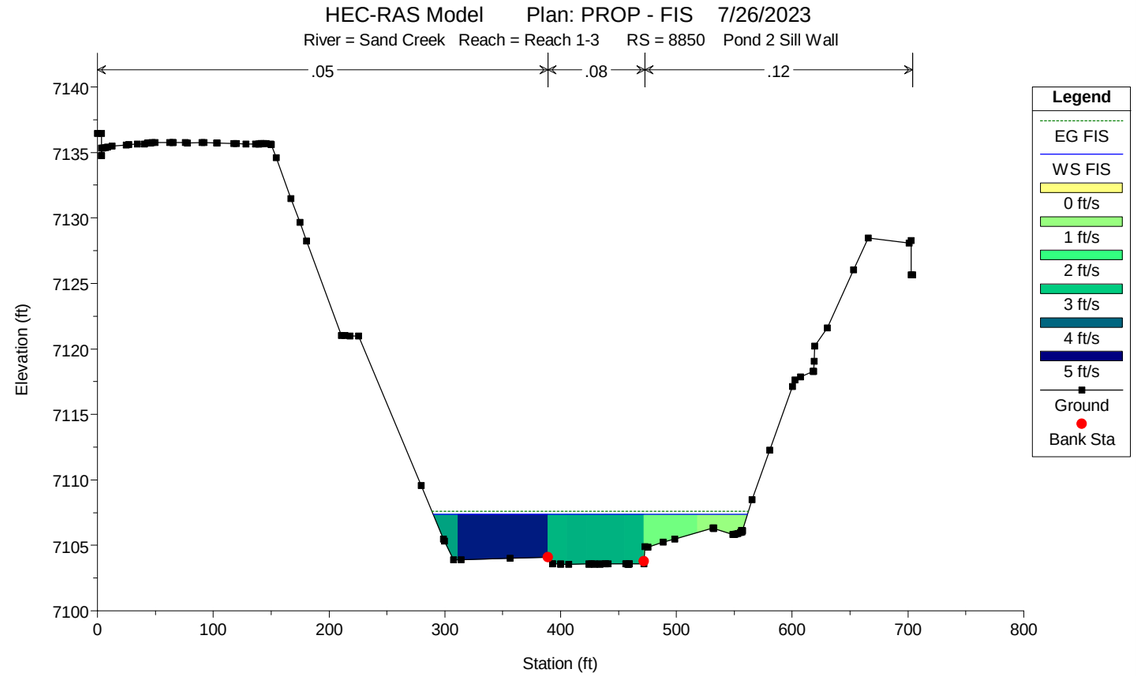
HEC-RAS Model Plan: PROP - FIS 7/26/2023

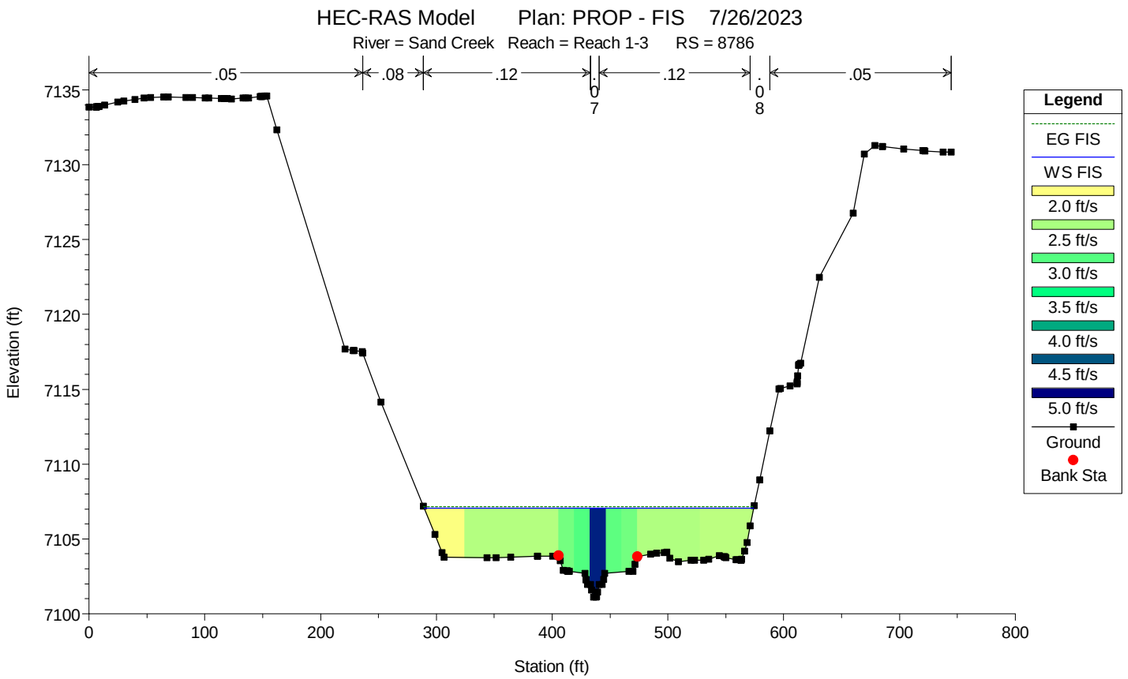
River = Sand Creek Reach = Reach 1-3 RS = 8928

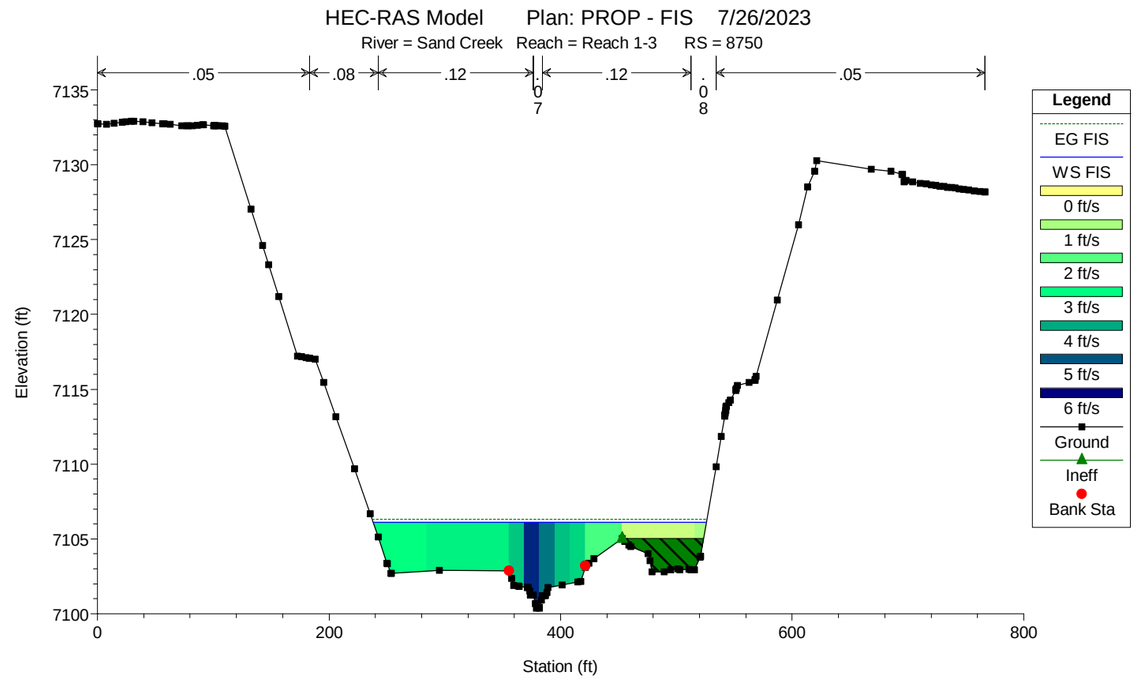


Sub-critical flow analysis for Water Surface evaluation of Naturalized Channel Design at the FIS flow rate only

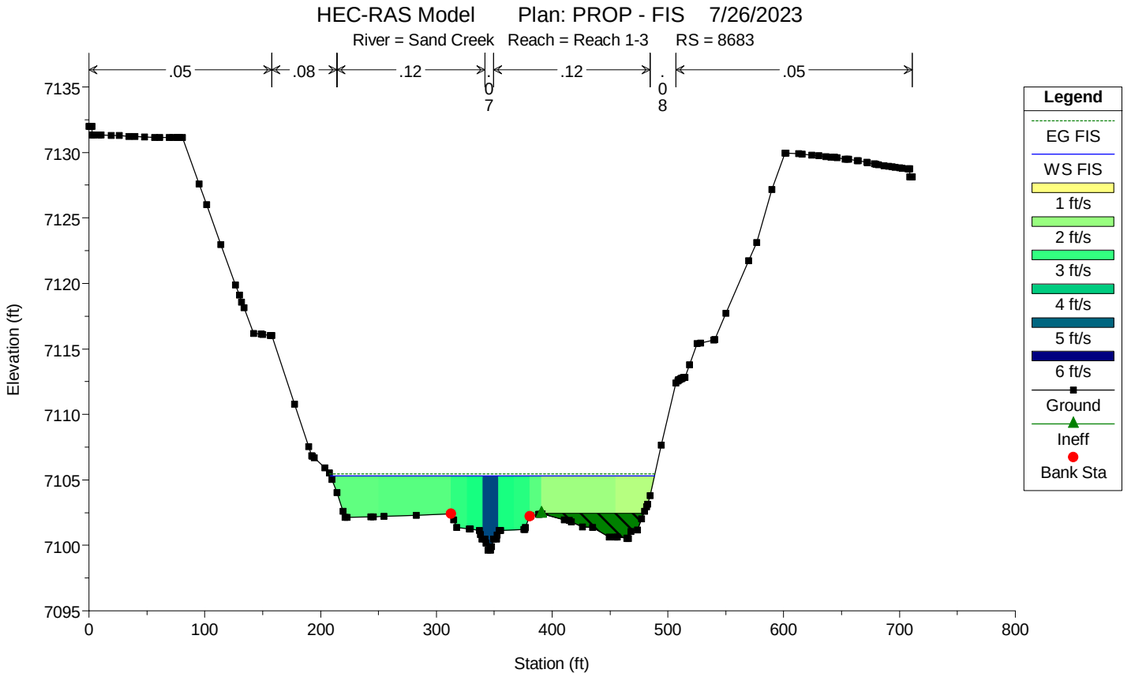


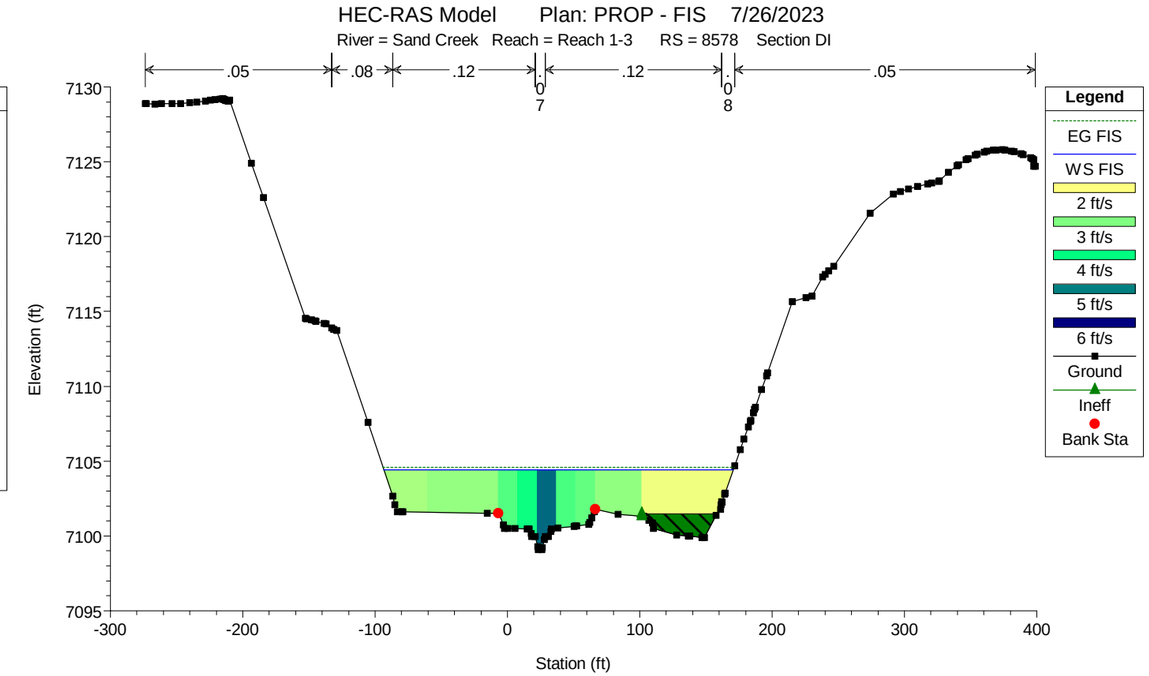


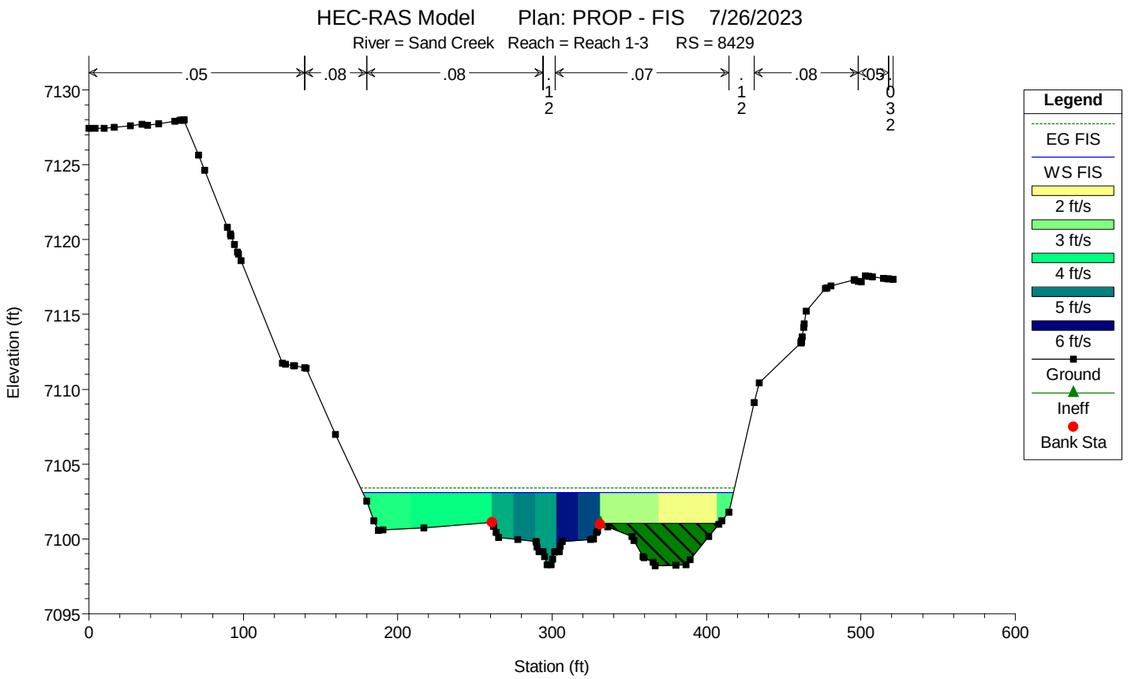


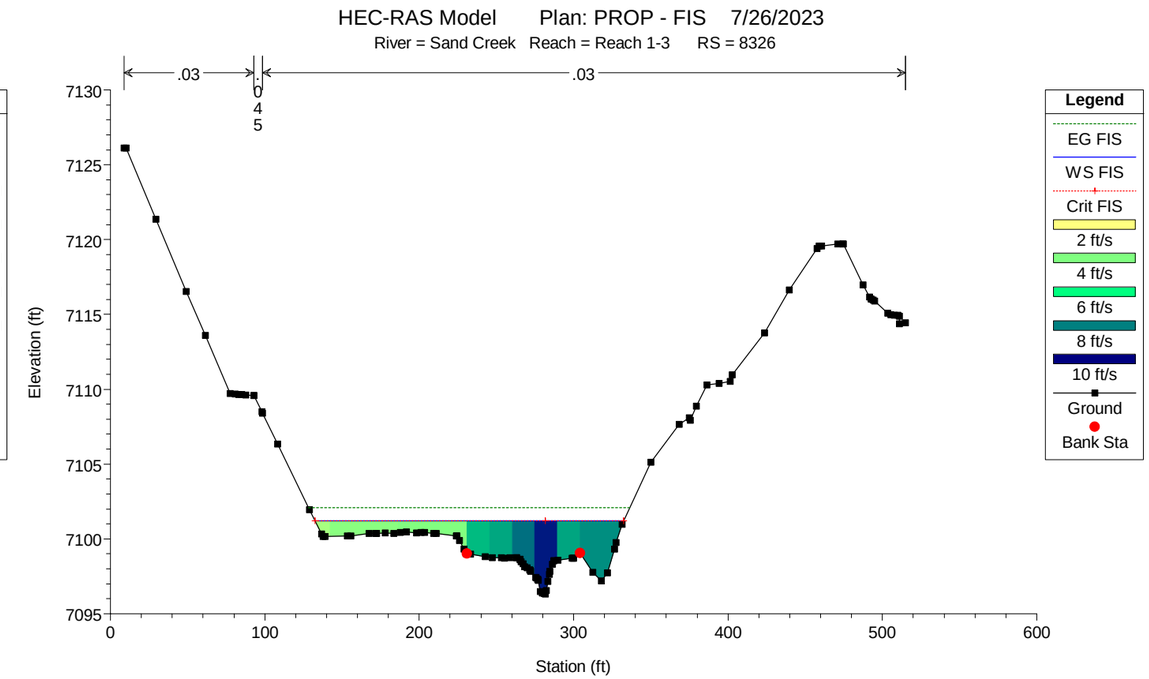


Sub-critical flow analysis for Water Surface evaluation of Naturalized Channel Design at the FIS flow rate only

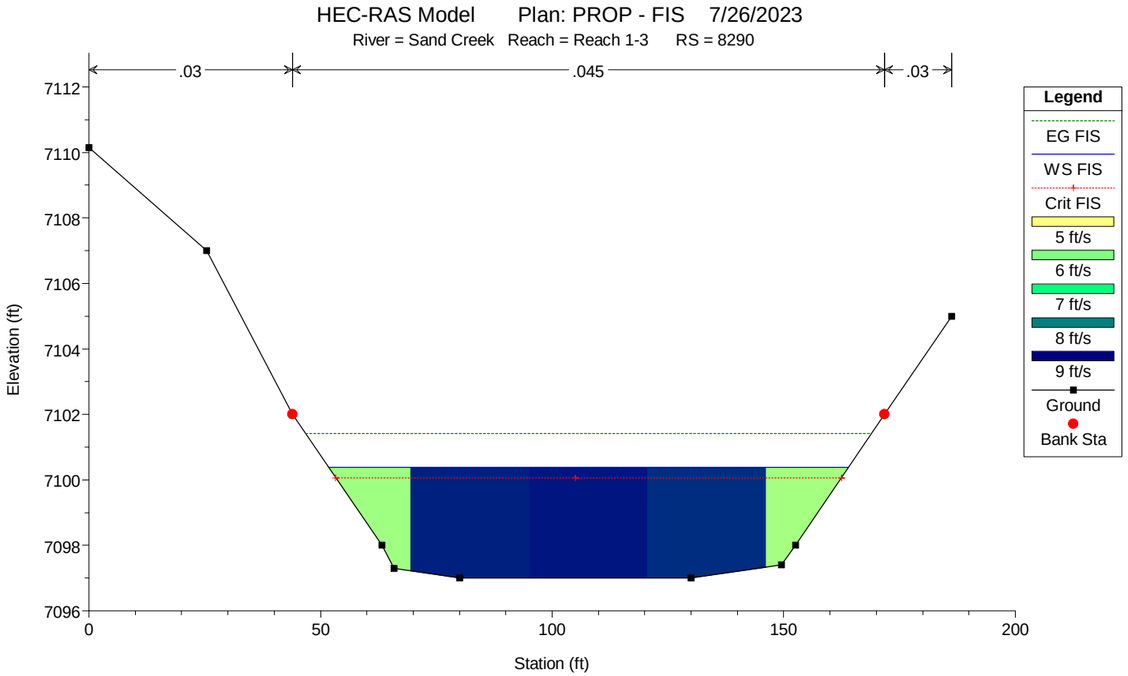


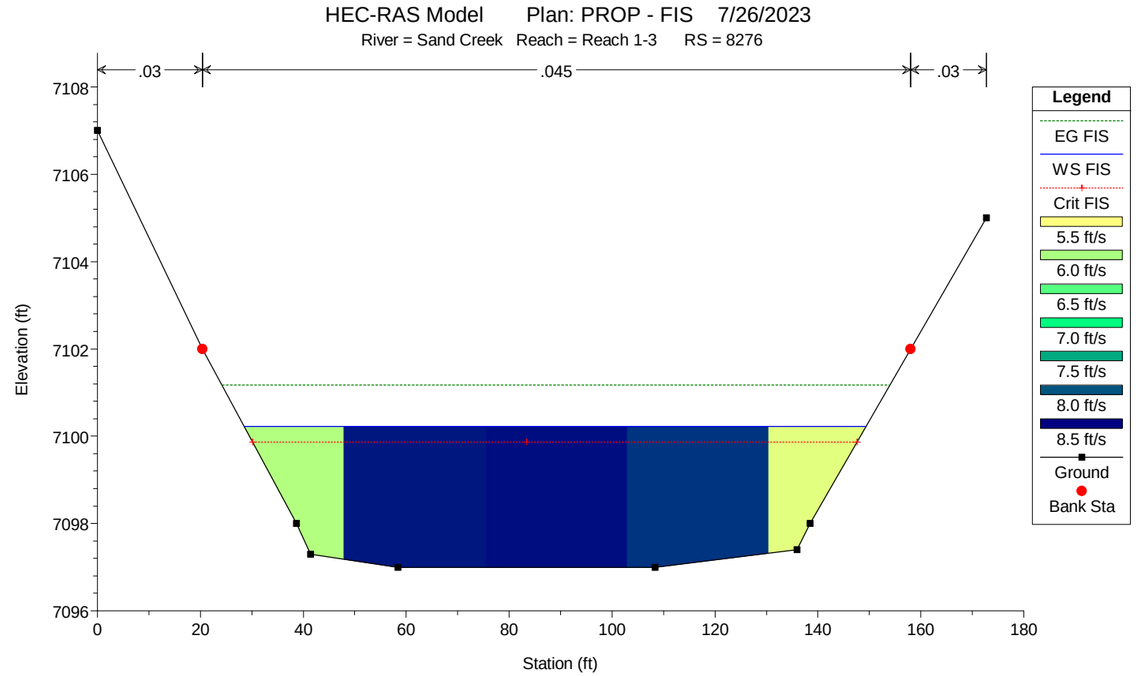


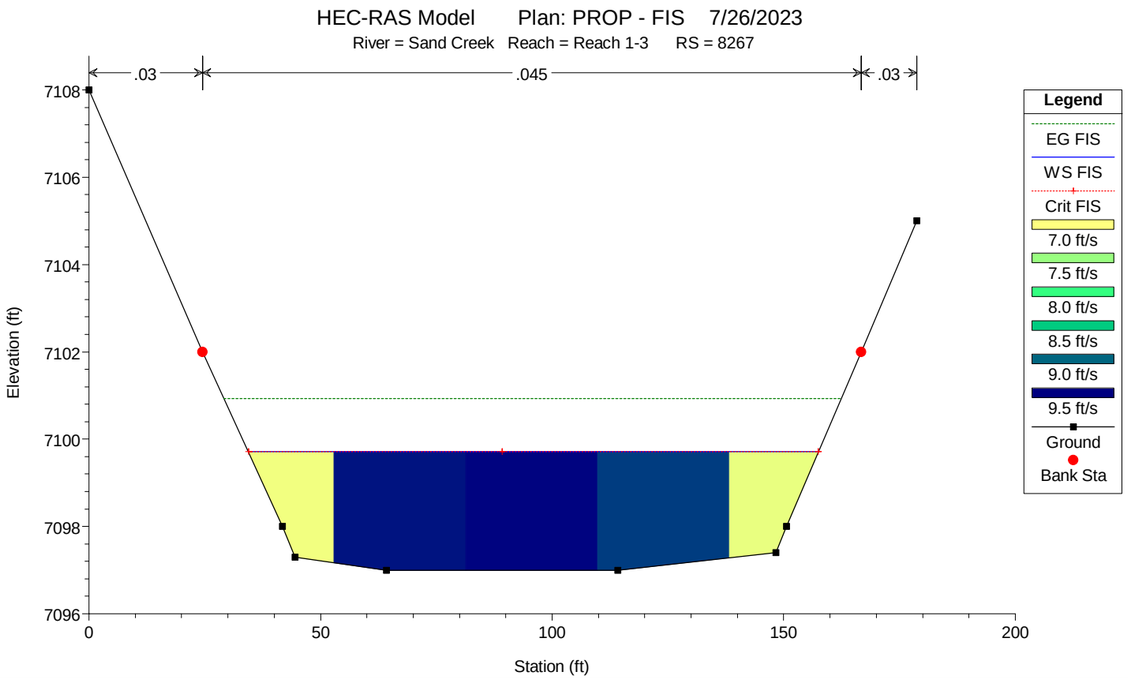


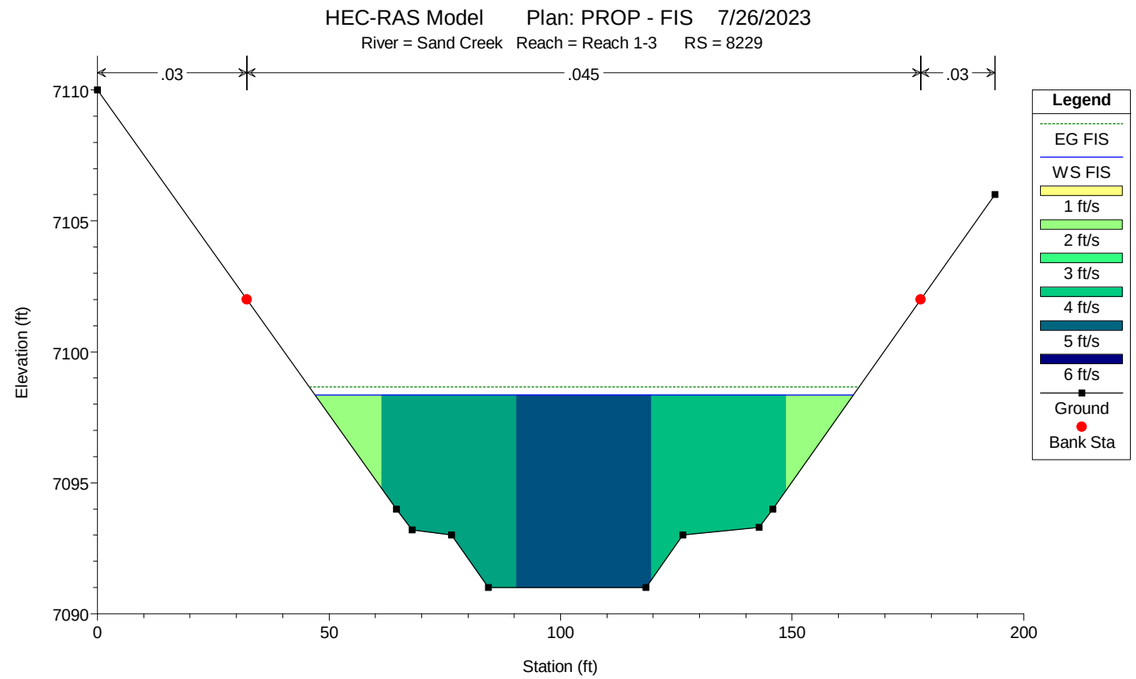


Sub-critical flow analysis for Water Surface evaluation of Naturalized Channel Design at the FIS flow rate only



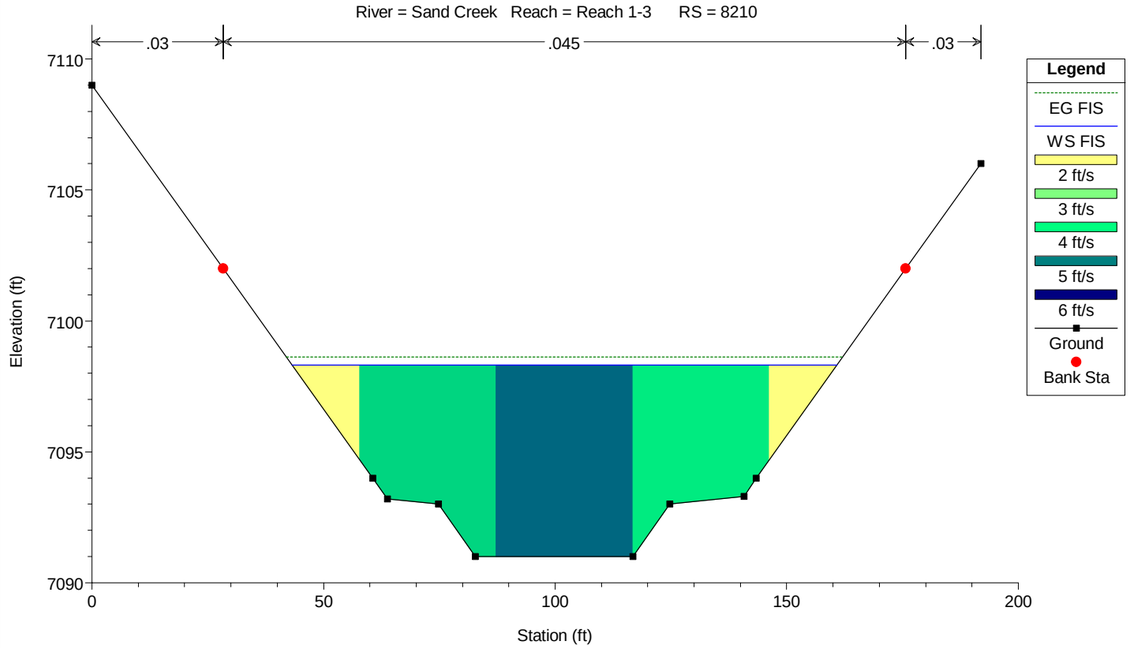




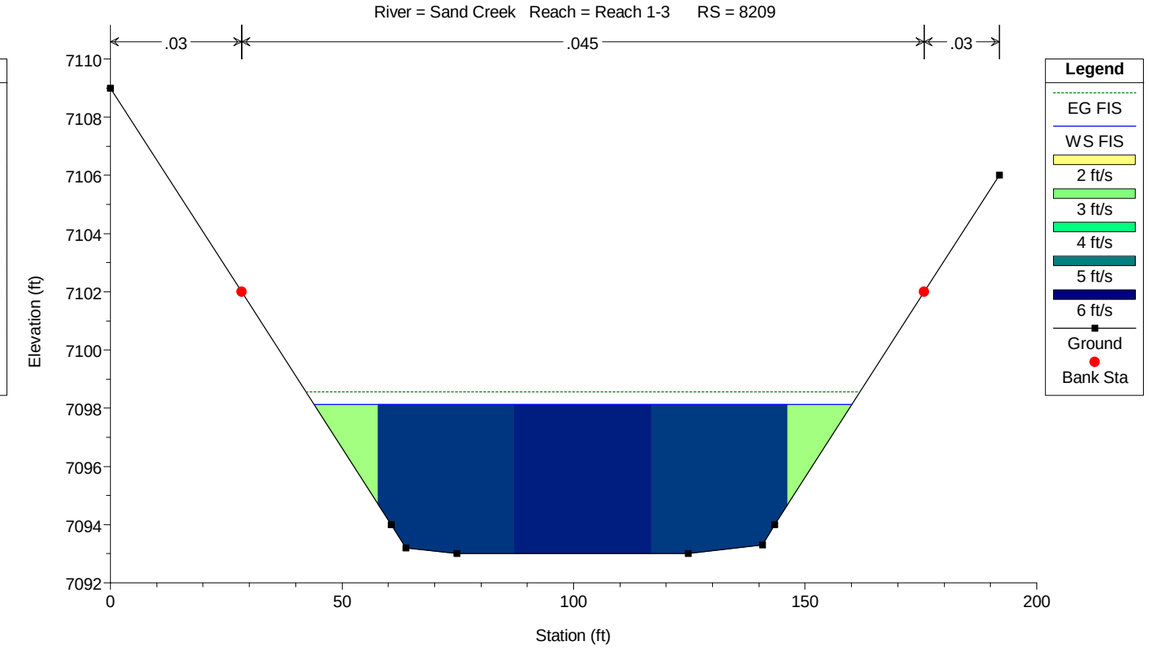


Sub-critical flow analysis for Water Surface evaluation of Naturalized Channel Design at the FIS flow rate only

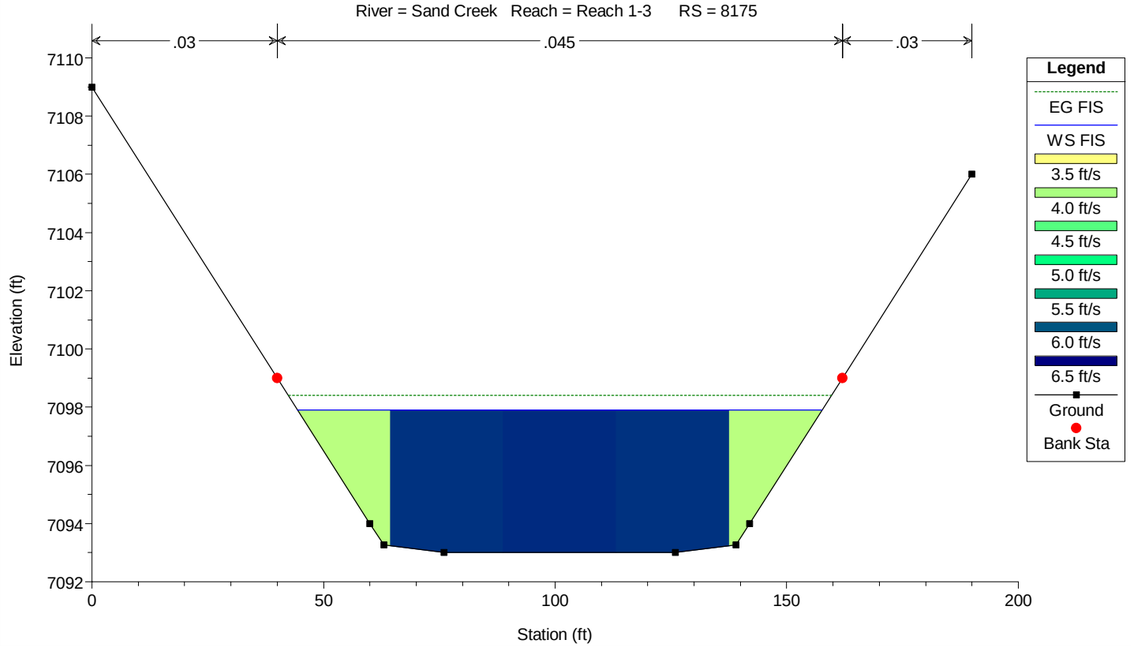
HEC-RAS Model Plan: PROP - FIS 7/26/2023
River = Sand Creek Reach = Reach 1-3 RS = 8210



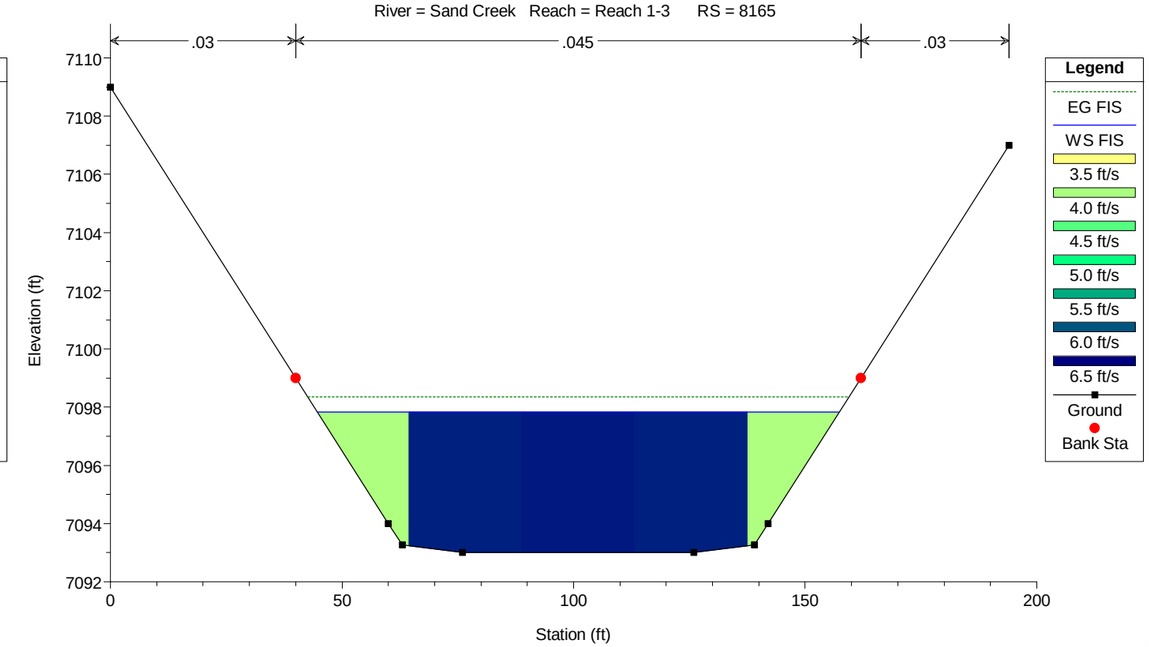
HEC-RAS Model Plan: PROP - FIS 7/26/2023
River = Sand Creek Reach = Reach 1-3 RS = 8209



HEC-RAS Model Plan: PROP - FIS 7/26/2023
River = Sand Creek Reach = Reach 1-3 RS = 8175



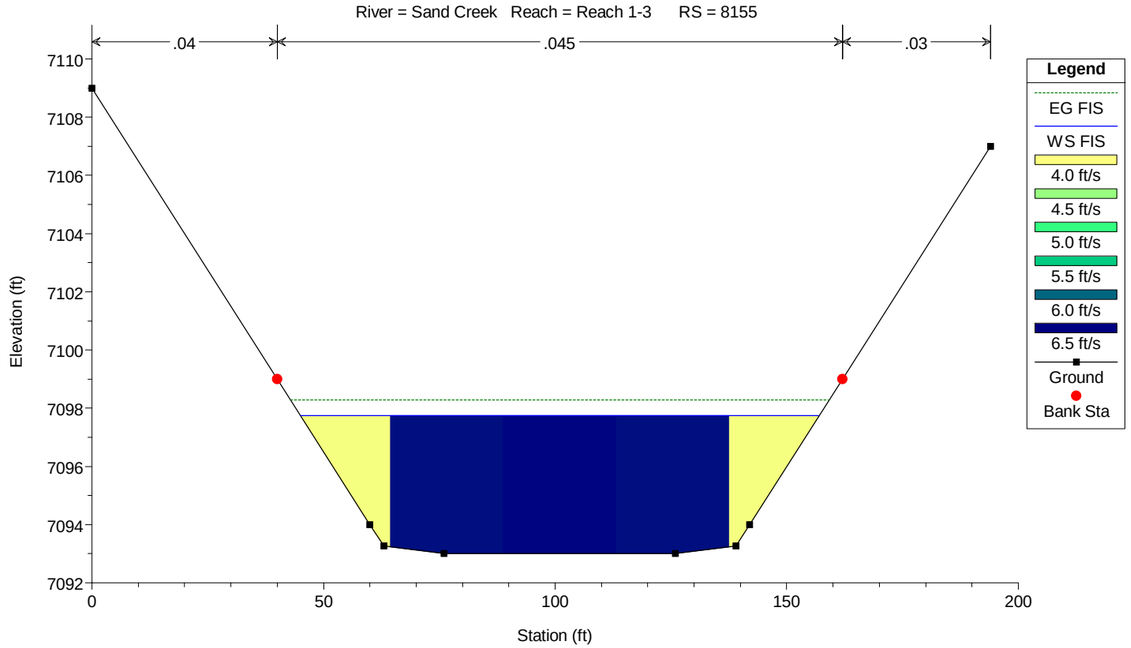
HEC-RAS Model Plan: PROP - FIS 7/26/2023
River = Sand Creek Reach = Reach 1-3 RS = 8165



Sub-critical flow analysis for Water Surface evaluation of Naturalized Channel Design at the FIS flow rate only

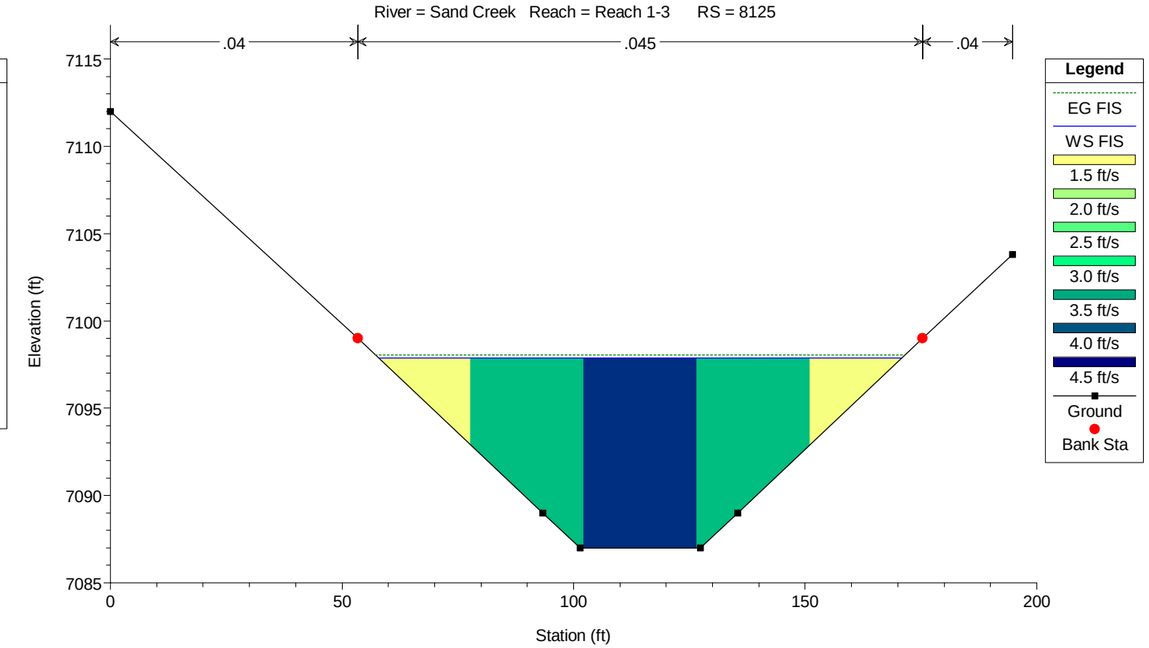
HEC-RAS Model Plan: PROP - FIS 7/26/2023

River = Sand Creek Reach = Reach 1-3 RS = 8155



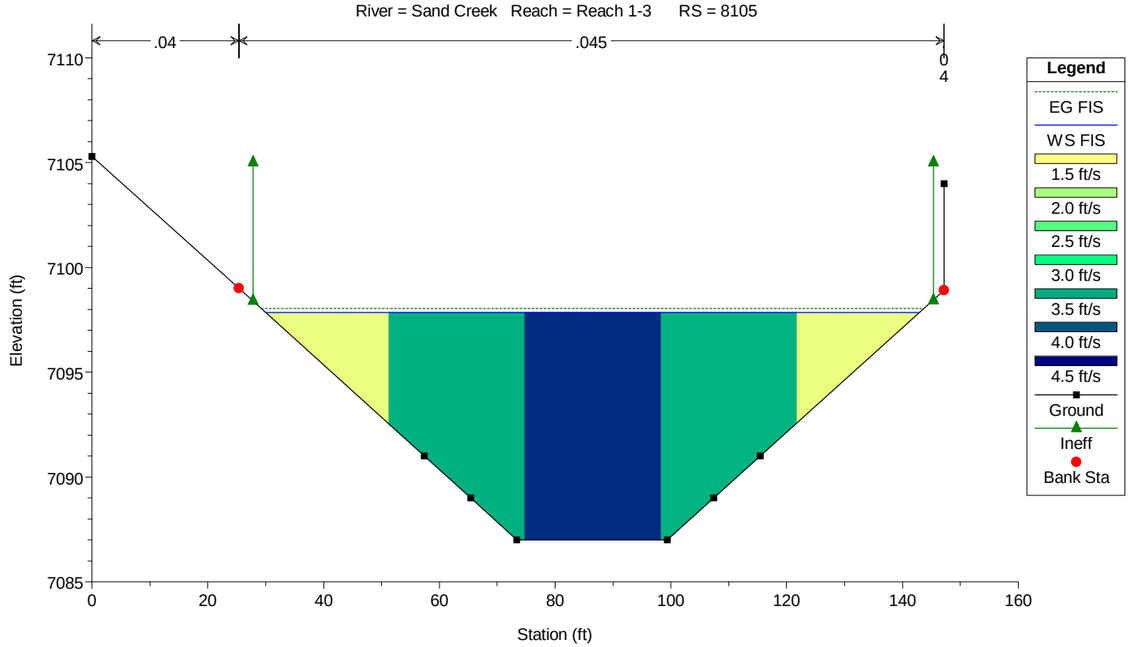
HEC-RAS Model Plan: PROP - FIS 7/26/2023

River = Sand Creek Reach = Reach 1-3 RS = 8125



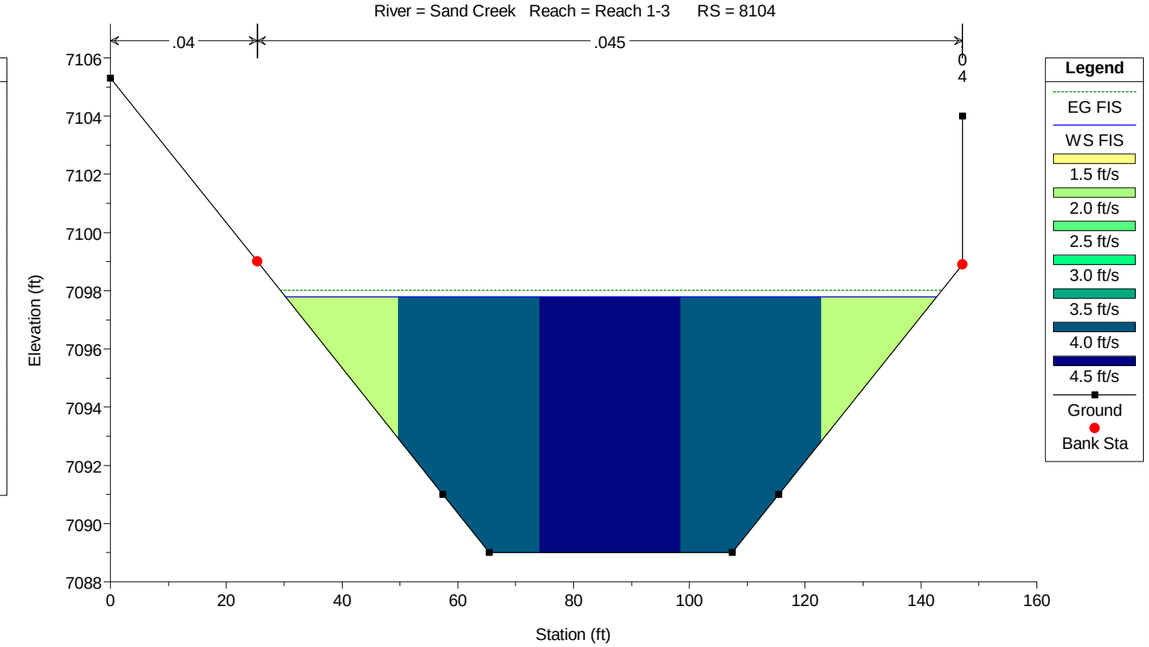
HEC-RAS Model Plan: PROP - FIS 7/26/2023

River = Sand Creek Reach = Reach 1-3 RS = 8105



HEC-RAS Model Plan: PROP - FIS 7/26/2023

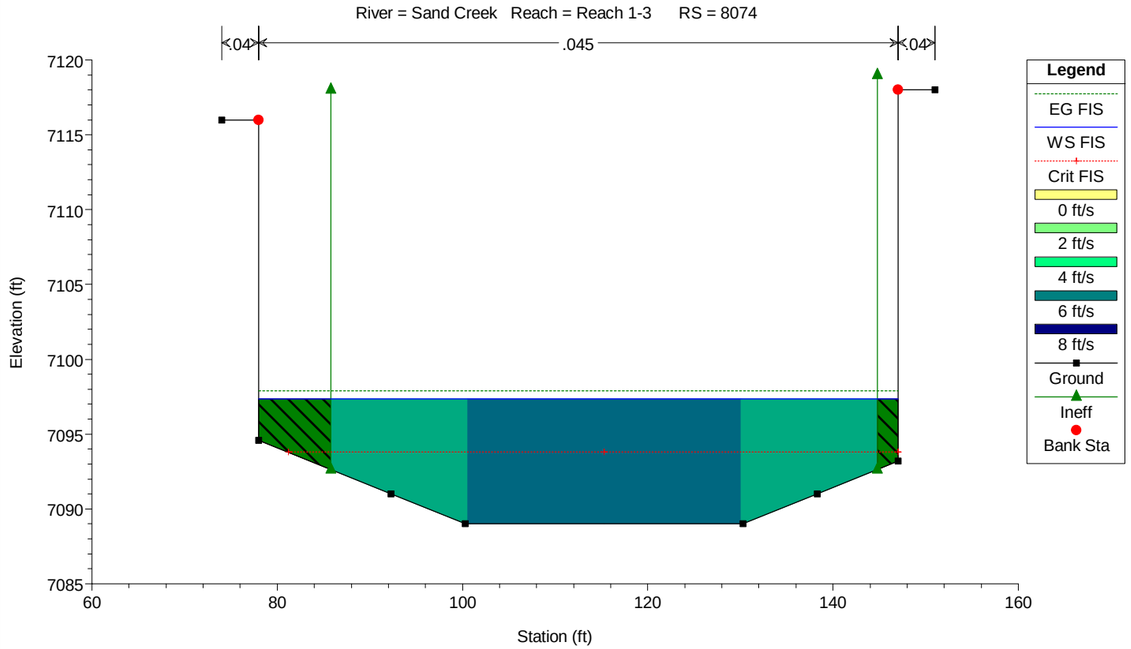
River = Sand Creek Reach = Reach 1-3 RS = 8104



Sub-critical flow analysis for Water Surface evaluation of Naturalized Channel Design at the FIS flow rate only

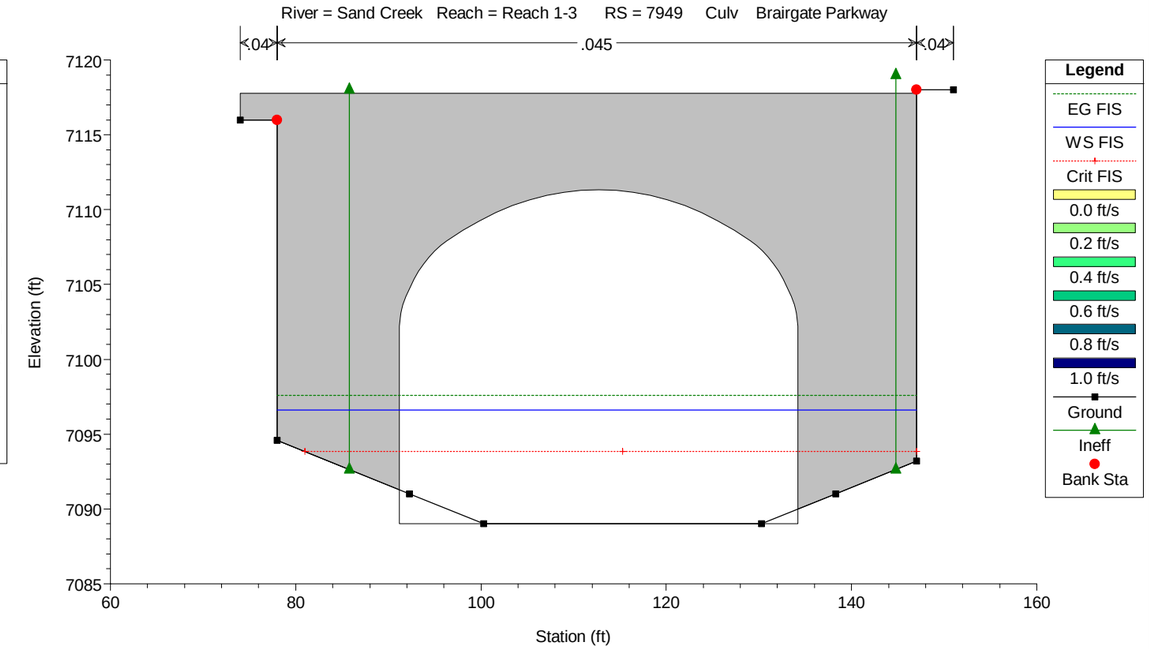
HEC-RAS Model Plan: PROP - FIS 7/26/2023

River = Sand Creek Reach = Reach 1-3 RS = 8074



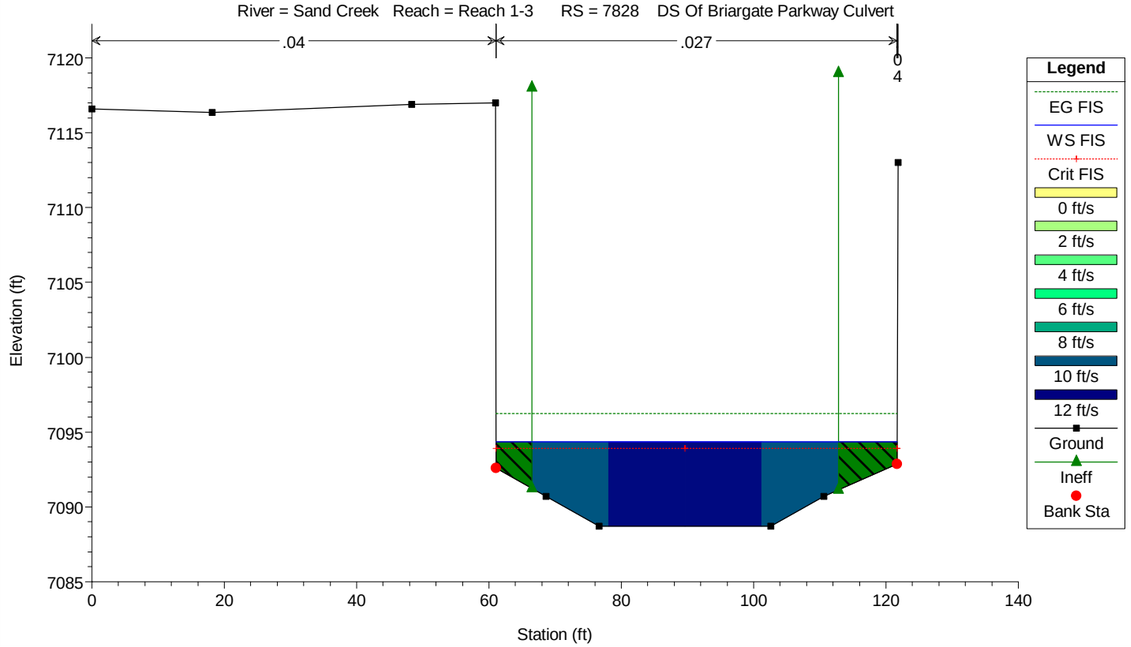
HEC-RAS Model Plan: PROP - FIS 7/26/2023

River = Sand Creek Reach = Reach 1-3 RS = 7949 Culv Braingate Parkway



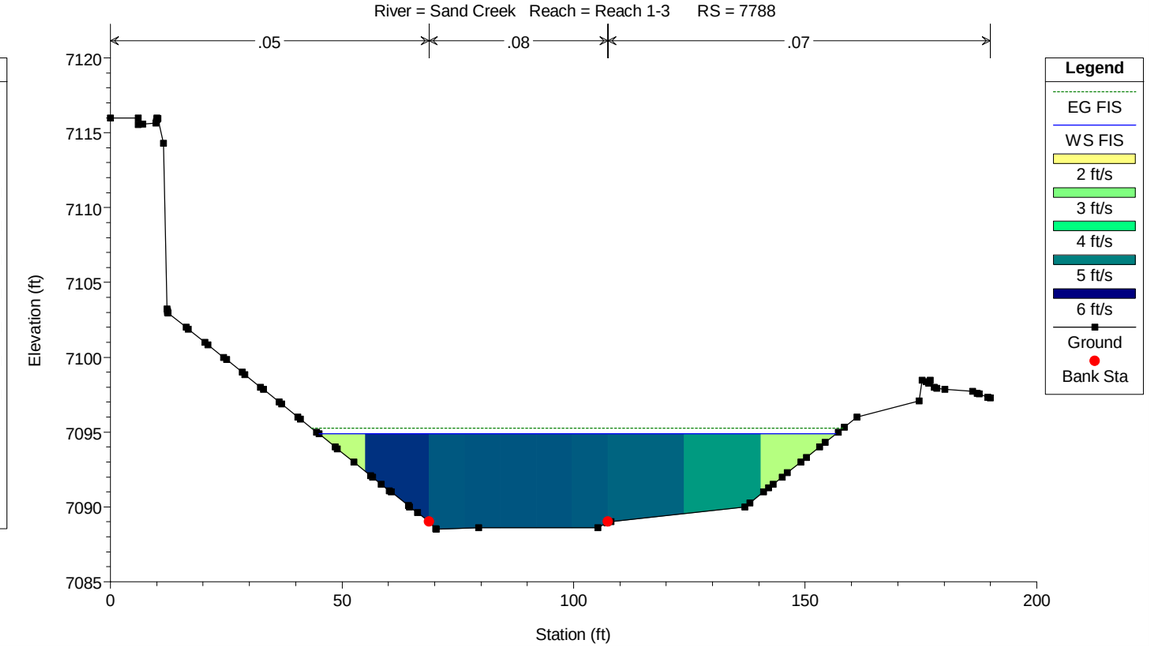
HEC-RAS Model Plan: PROP - FIS 7/26/2023

River = Sand Creek Reach = Reach 1-3 RS = 7828 DS Of Briargate Parkway Culvert

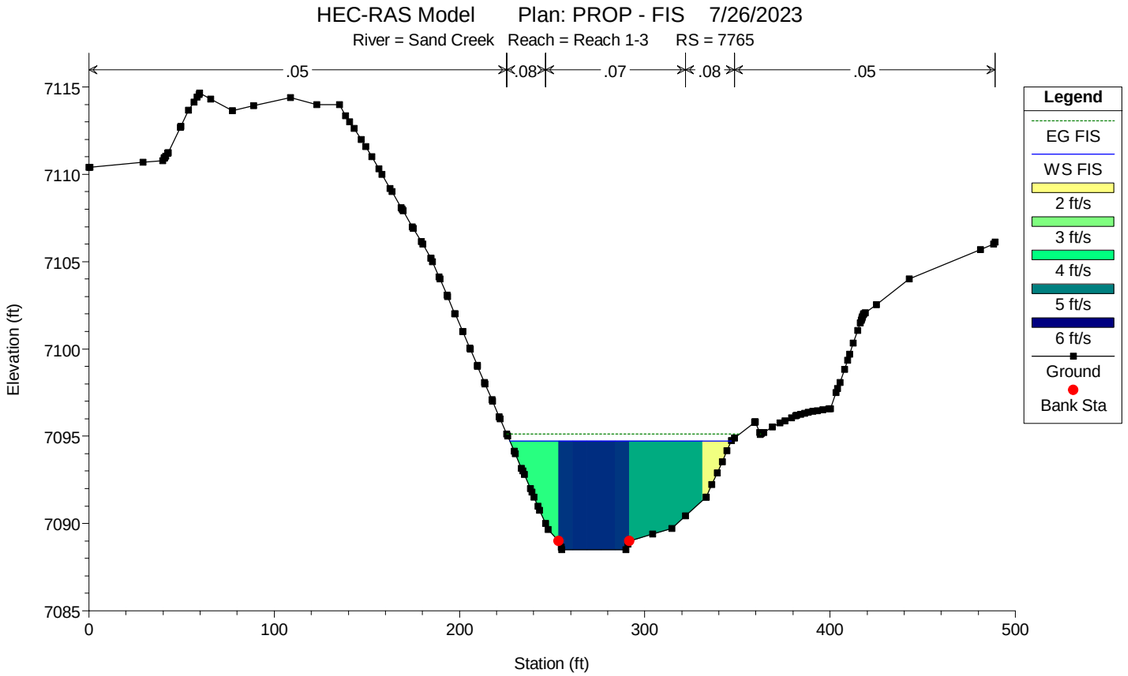


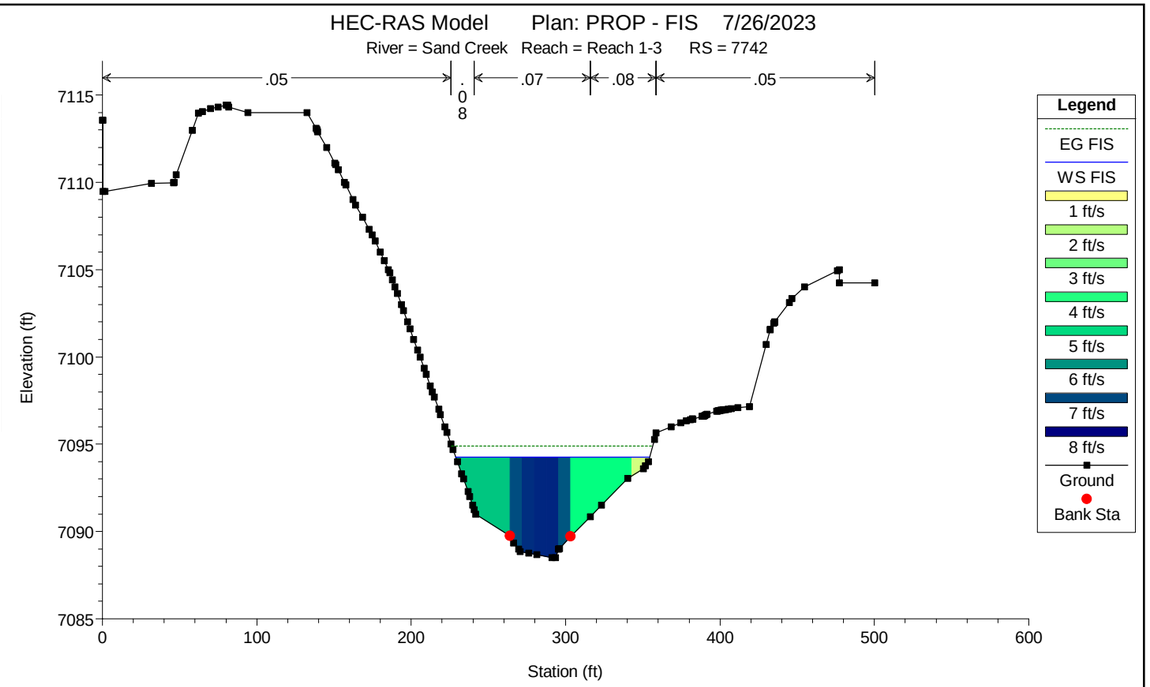
HEC-RAS Model Plan: PROP - FIS 7/26/2023

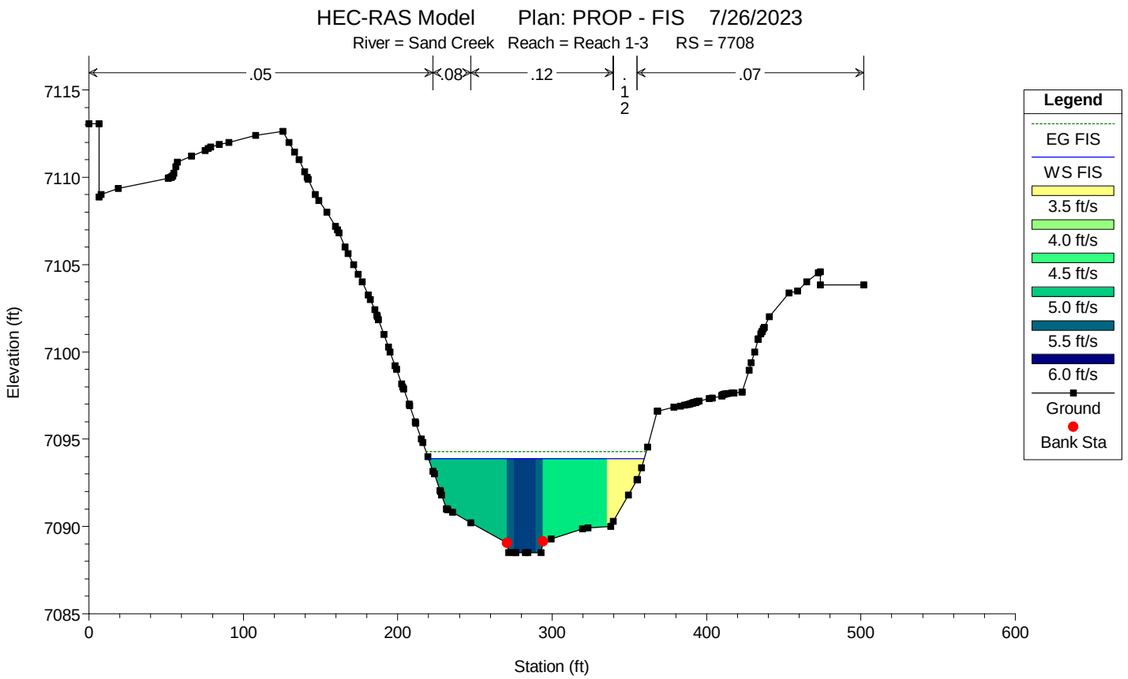
River = Sand Creek Reach = Reach 1-3 RS = 7788

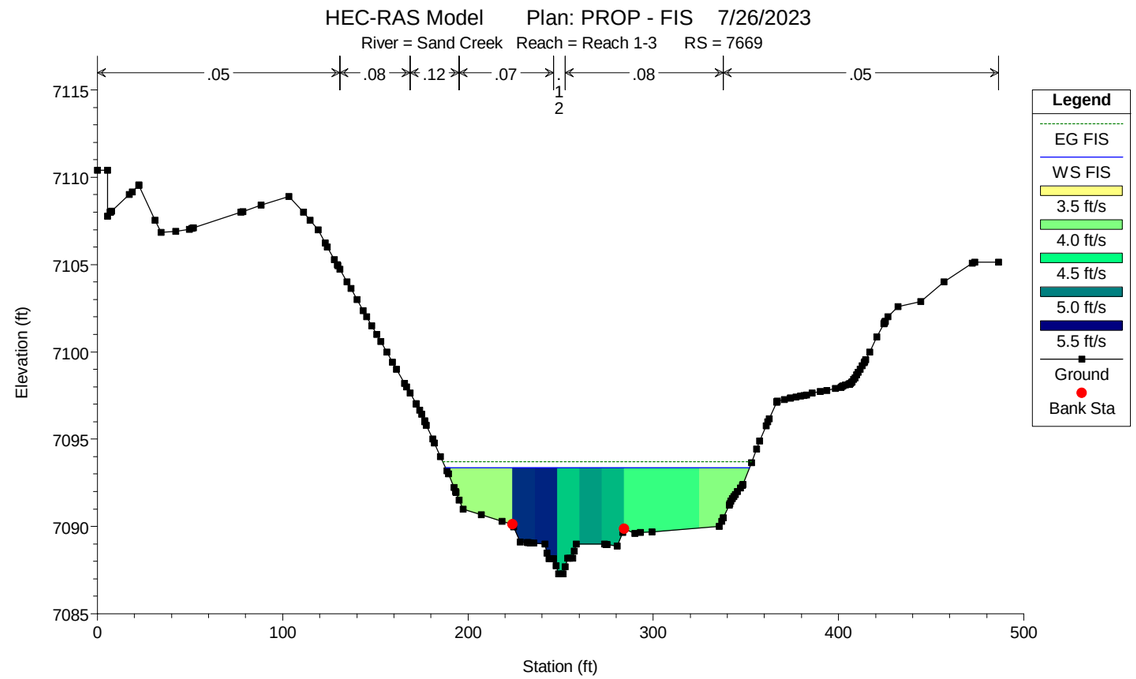


Sub-critical flow analysis for Water Surface evaluation of Naturalized Channel Design at the FIS flow rate only

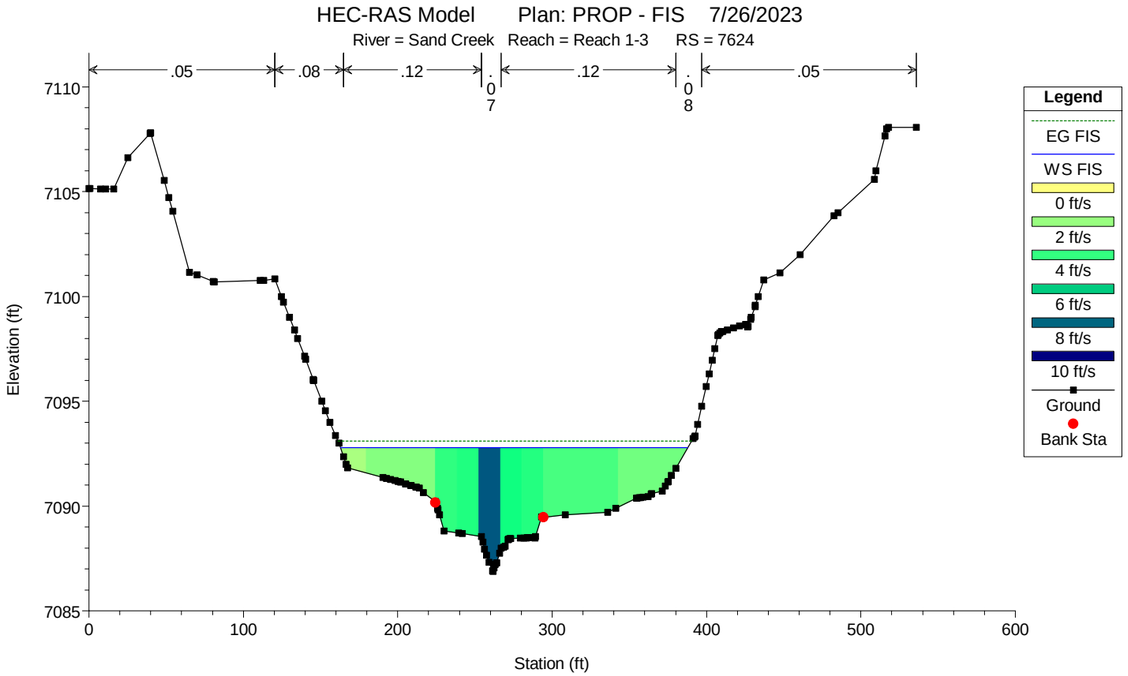


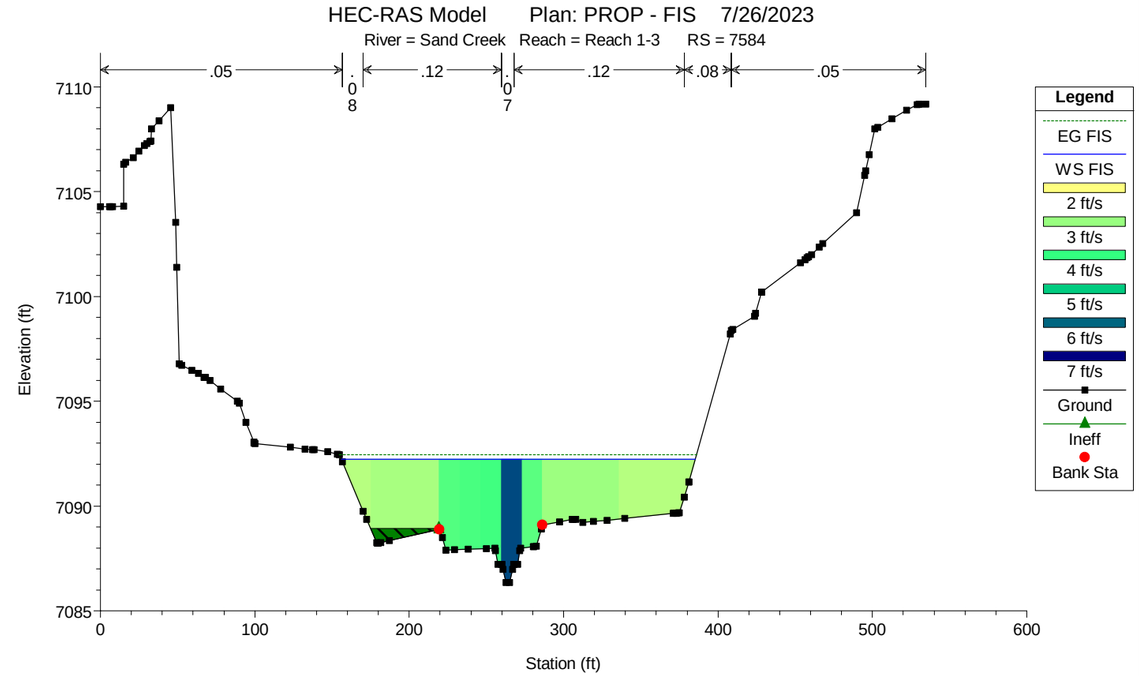


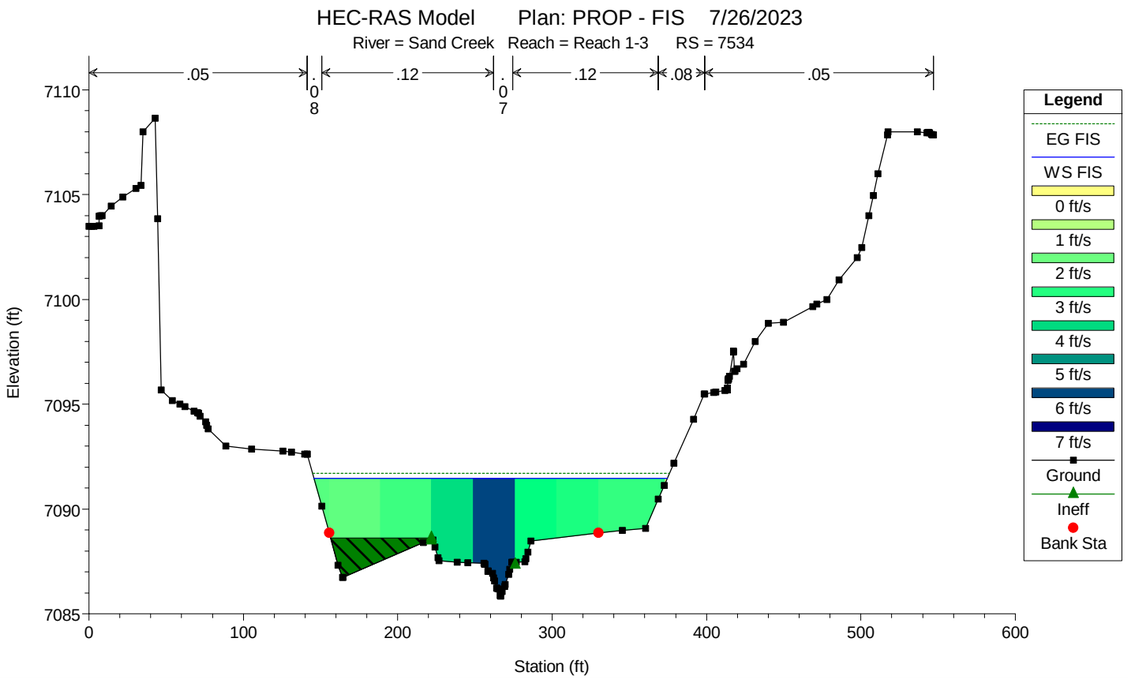


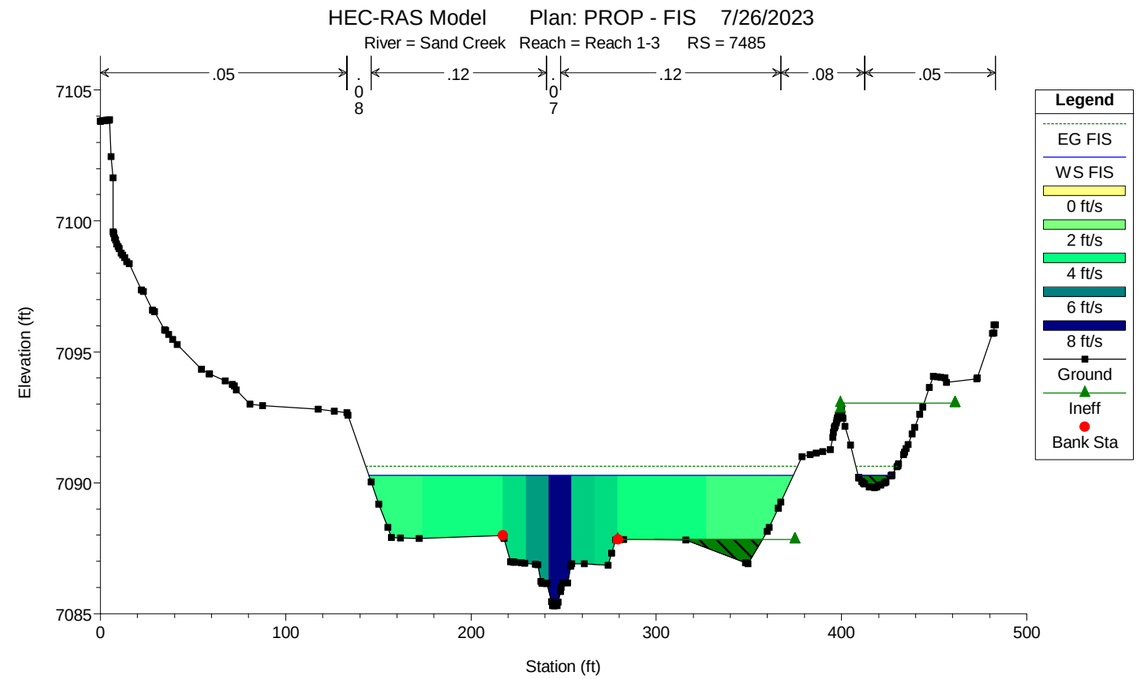


Sub-critical flow analysis for Water Surface evaluation of Naturalized Channel Design at the FIS flow rate only

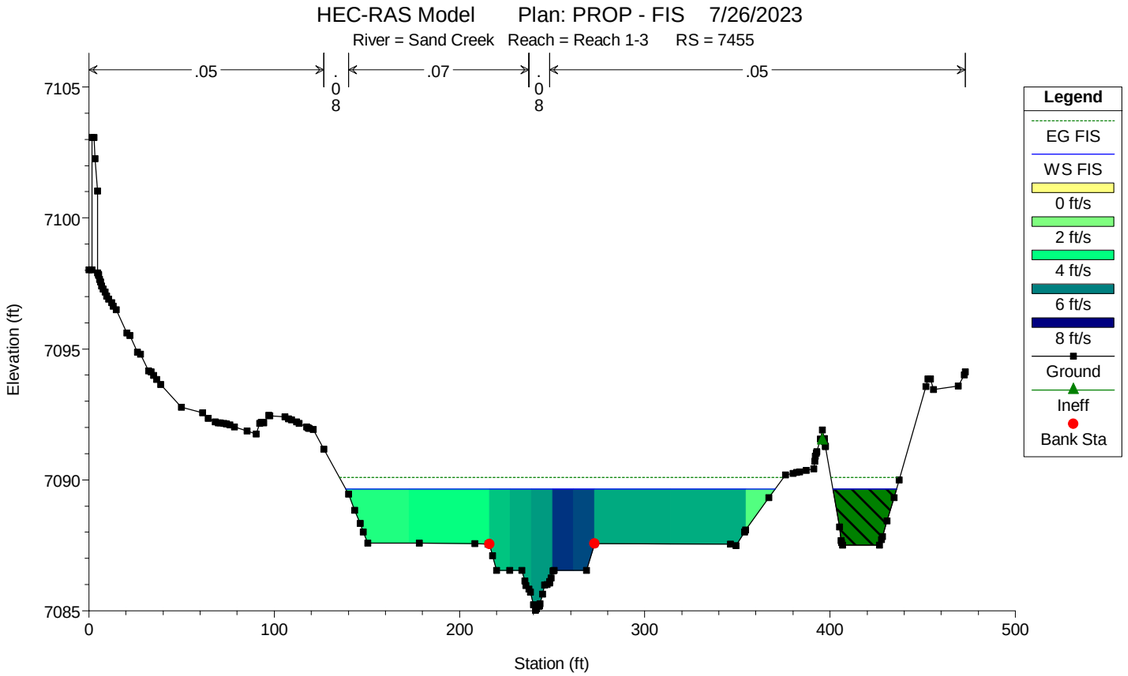


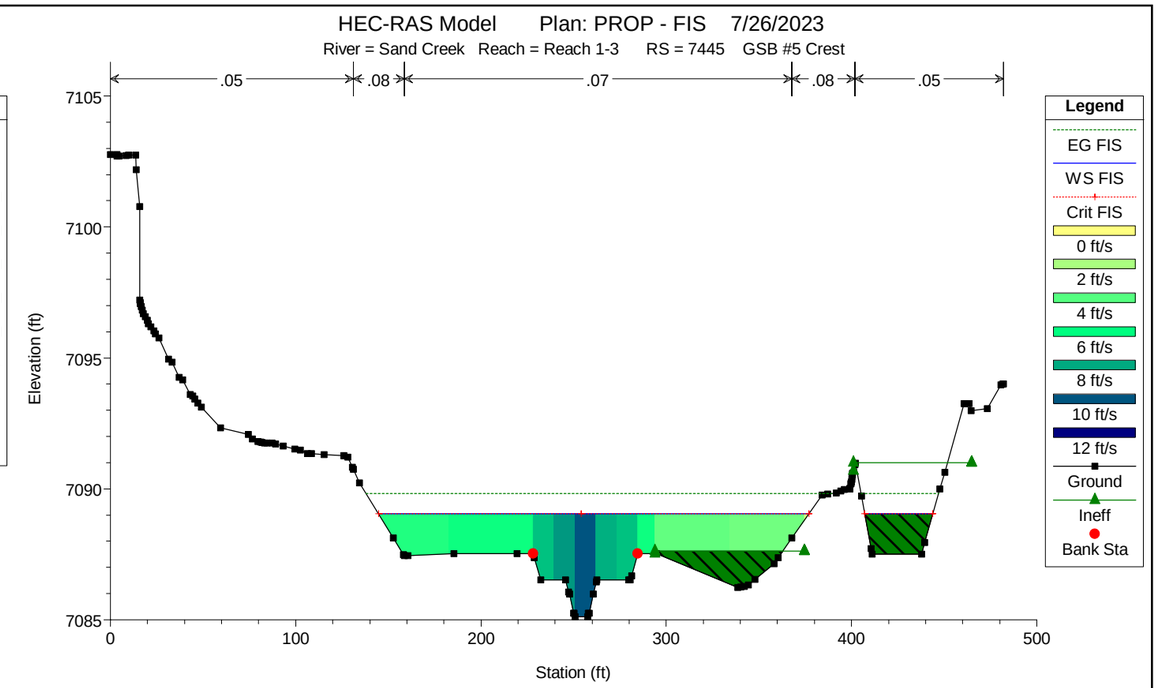


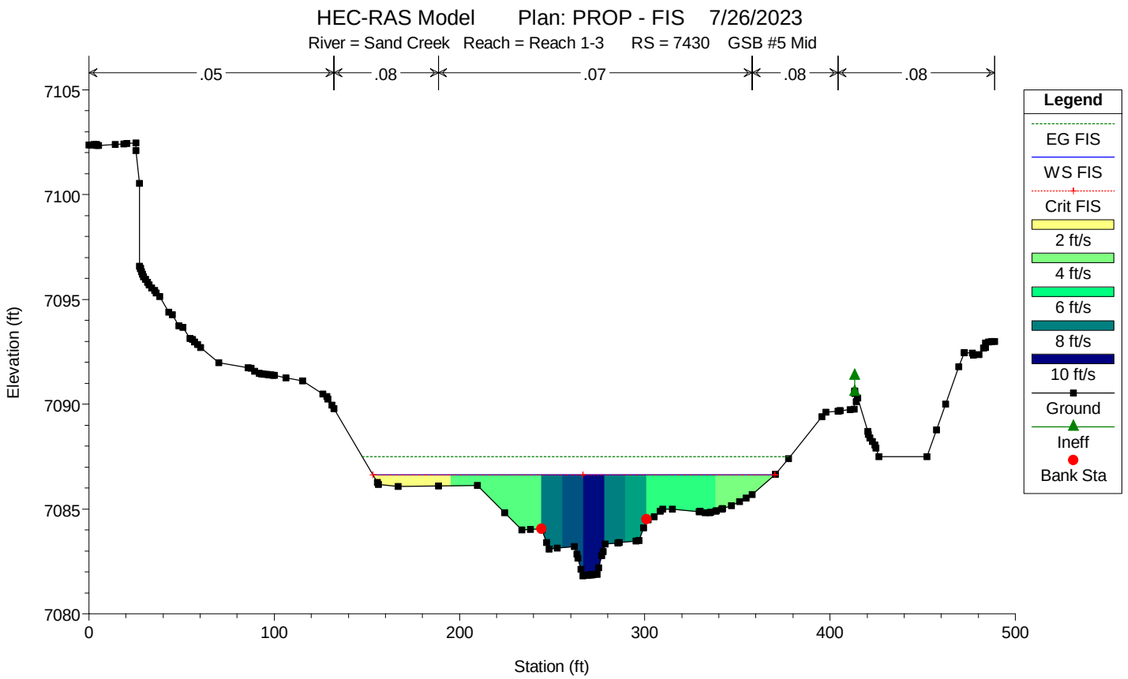


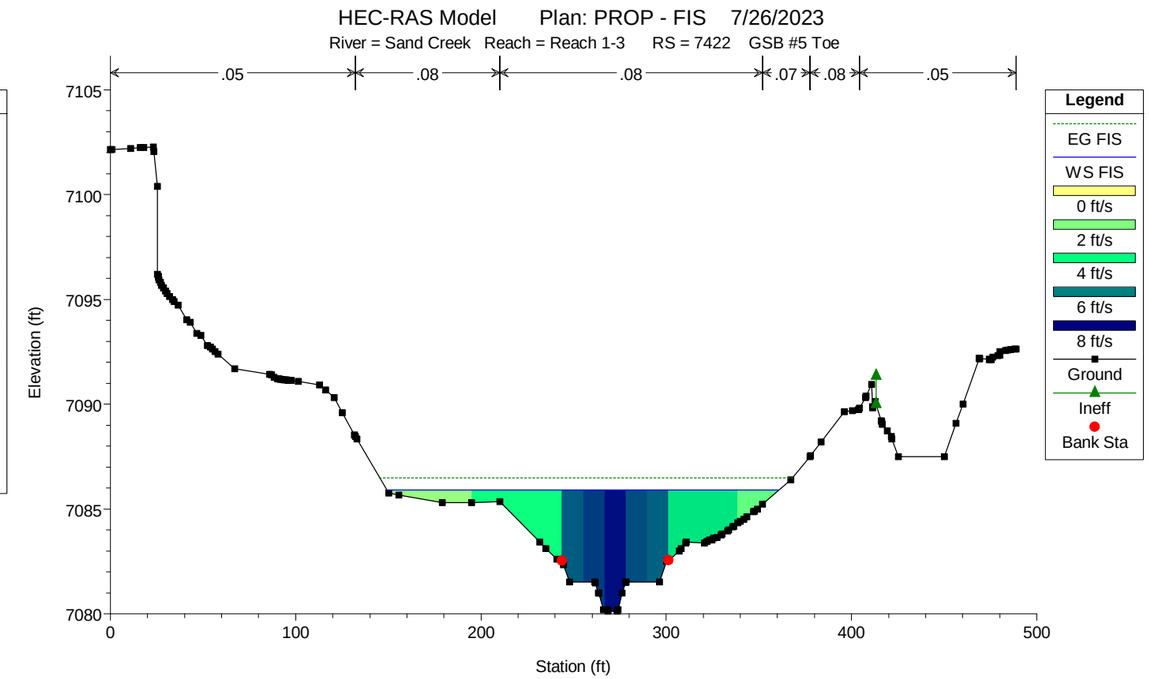


Sub-critical flow analysis for Water Surface evaluation of Naturalized Channel Design at the FIS flow rate only

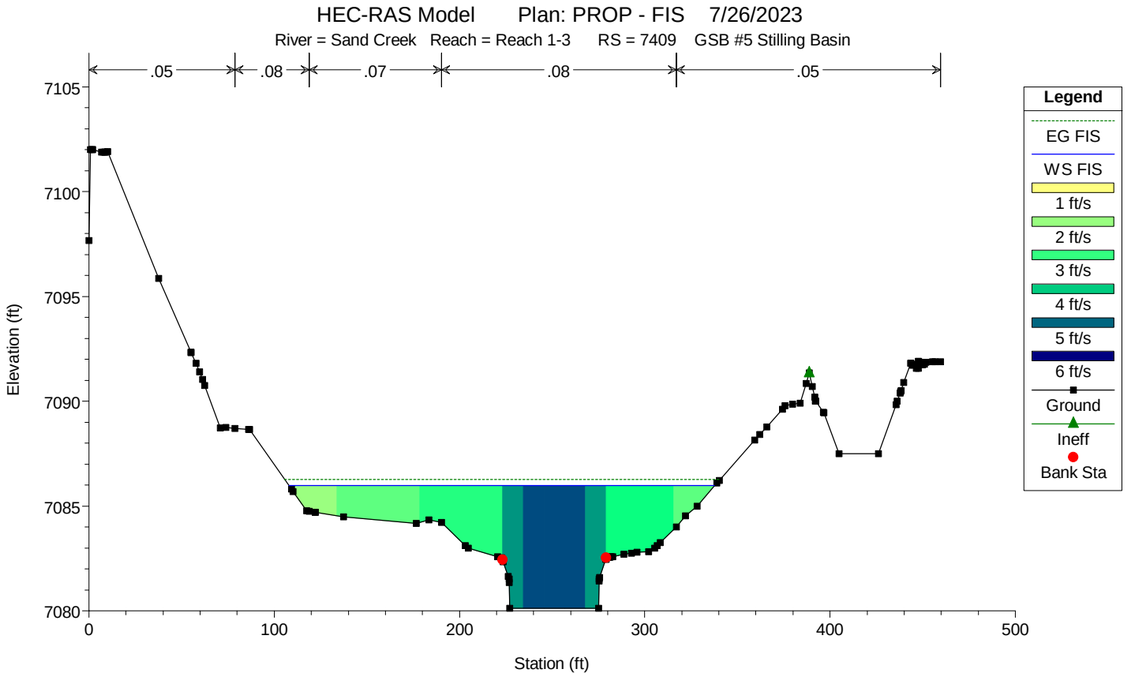


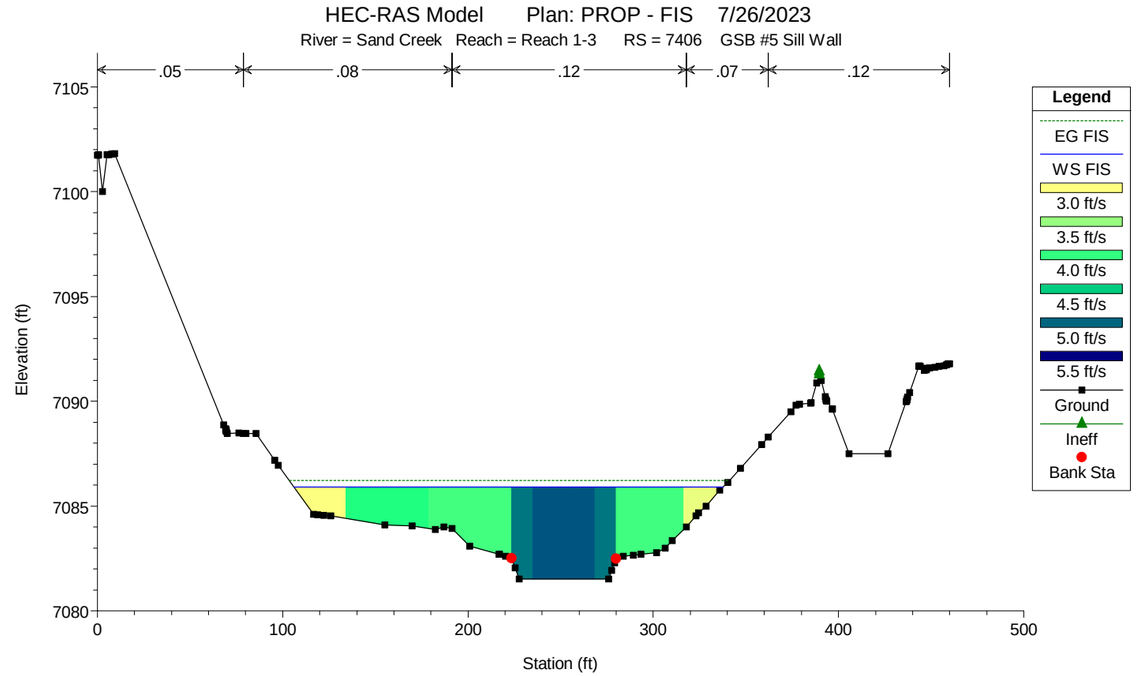


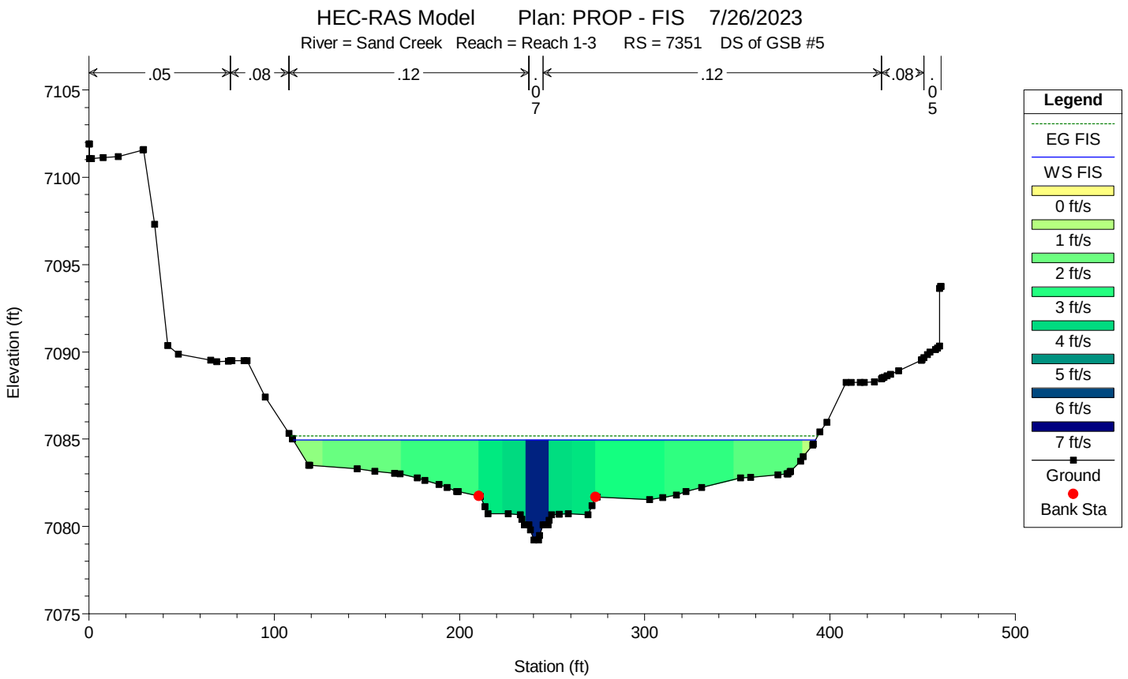


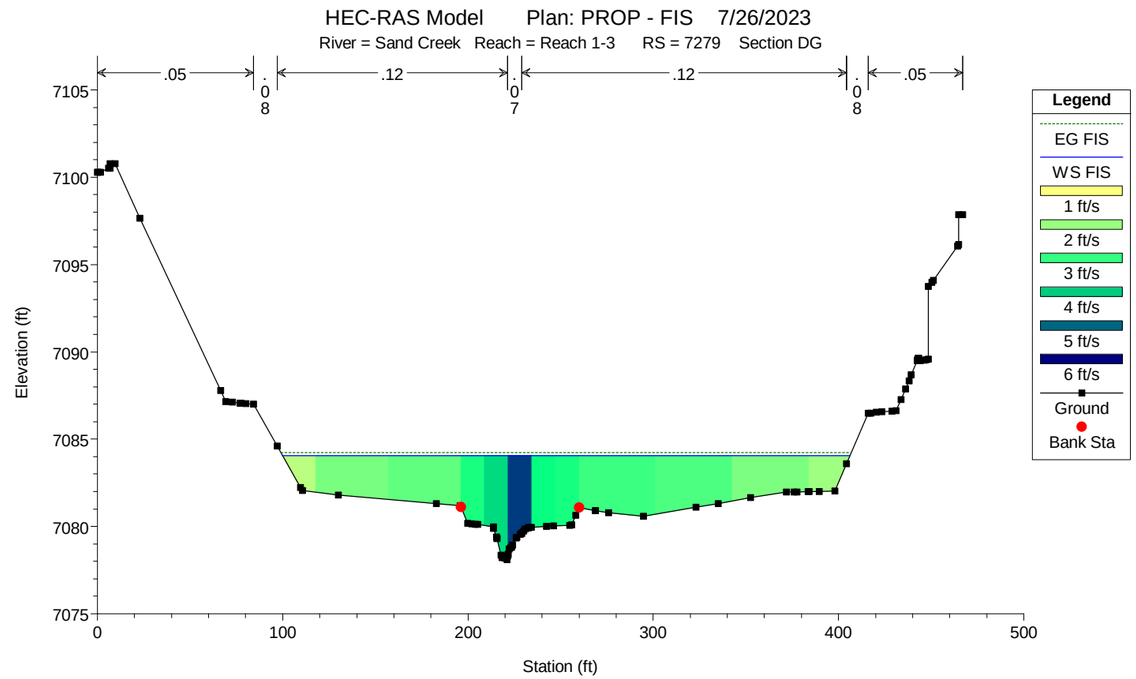


Sub-critical flow analysis for Water Surface evaluation of Naturalized Channel Design at the FIS flow rate only

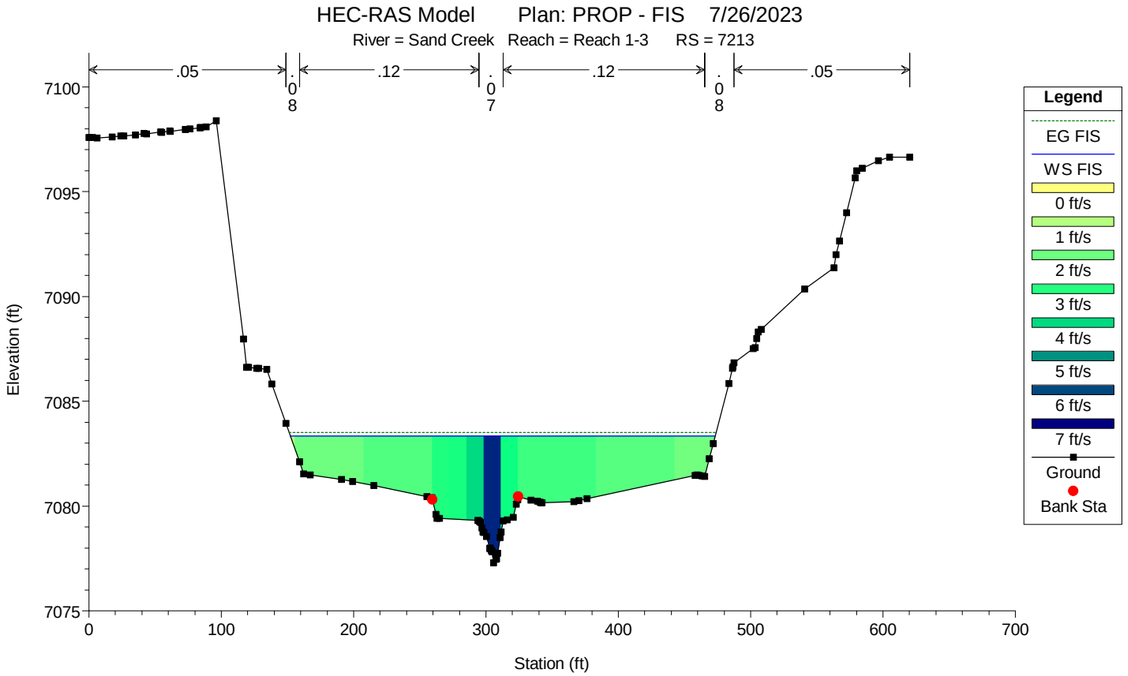


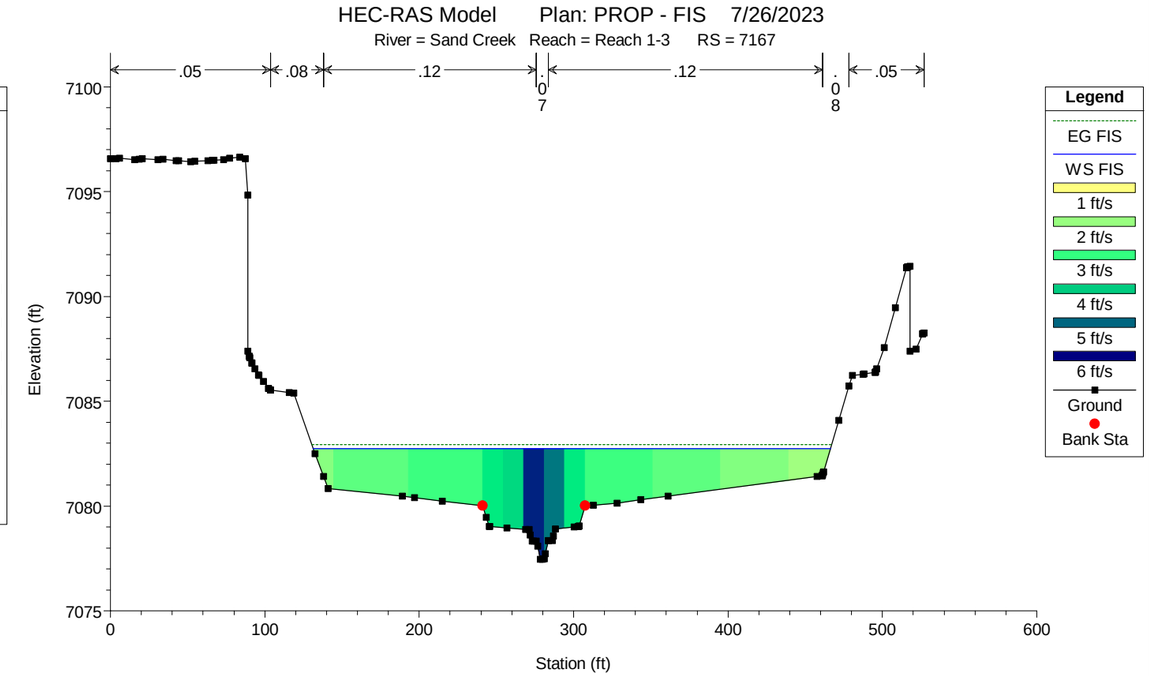


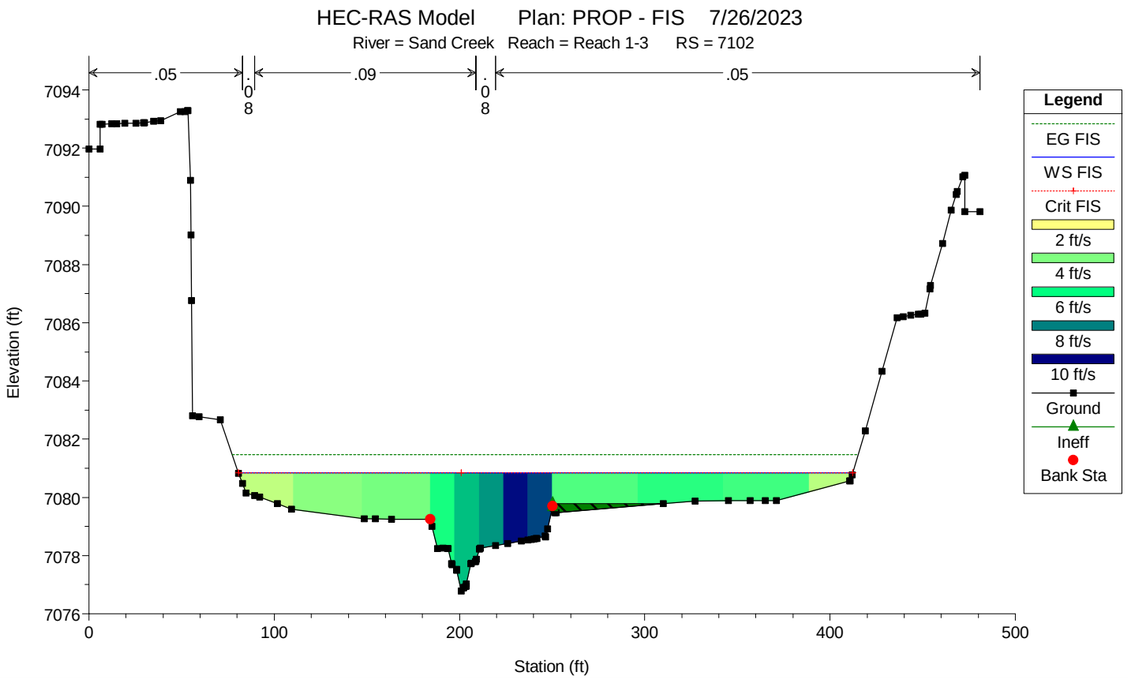


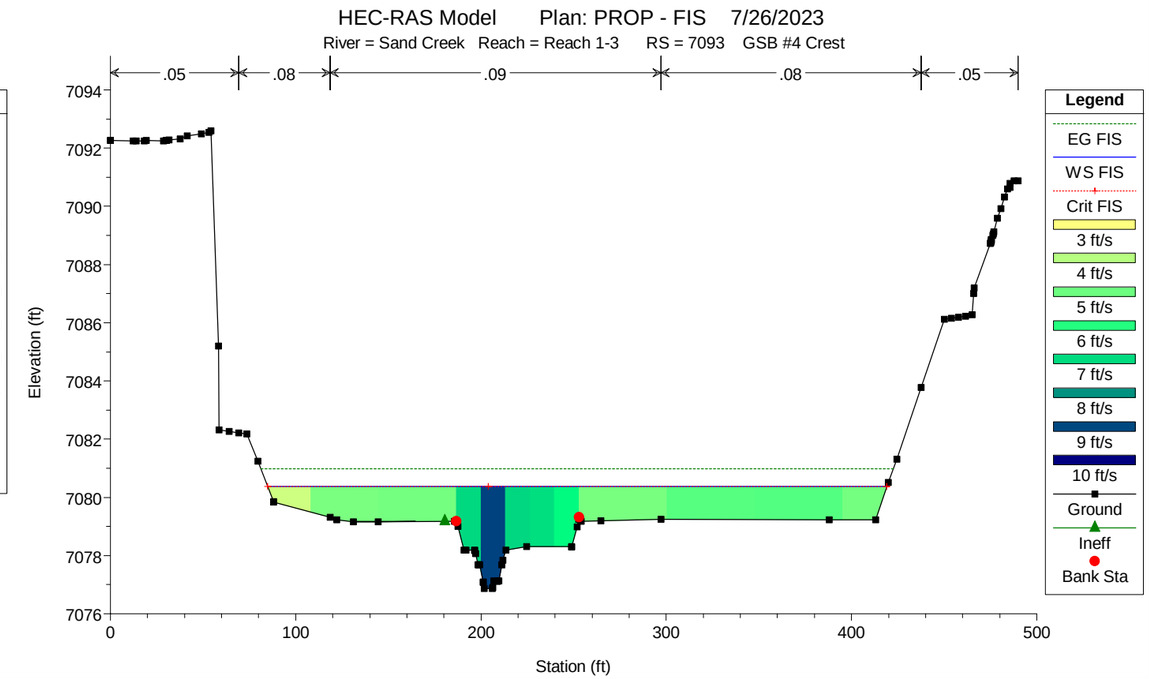


Sub-critical flow analysis for Water Surface evaluation of Naturalized Channel Design at the FIS flow rate only

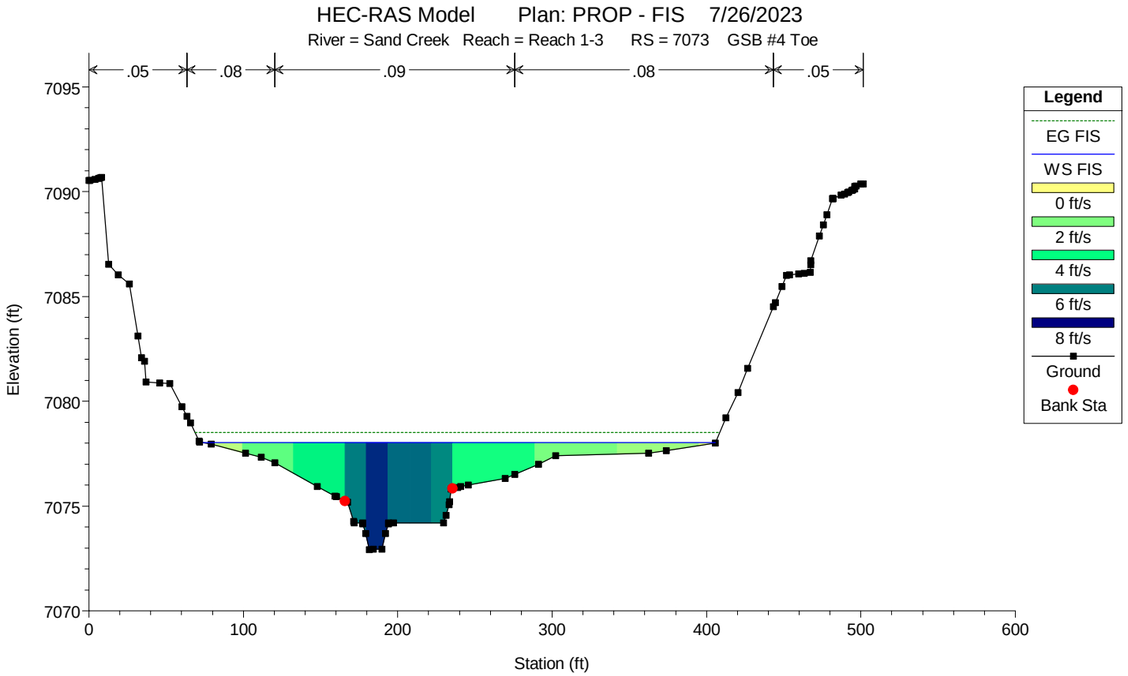


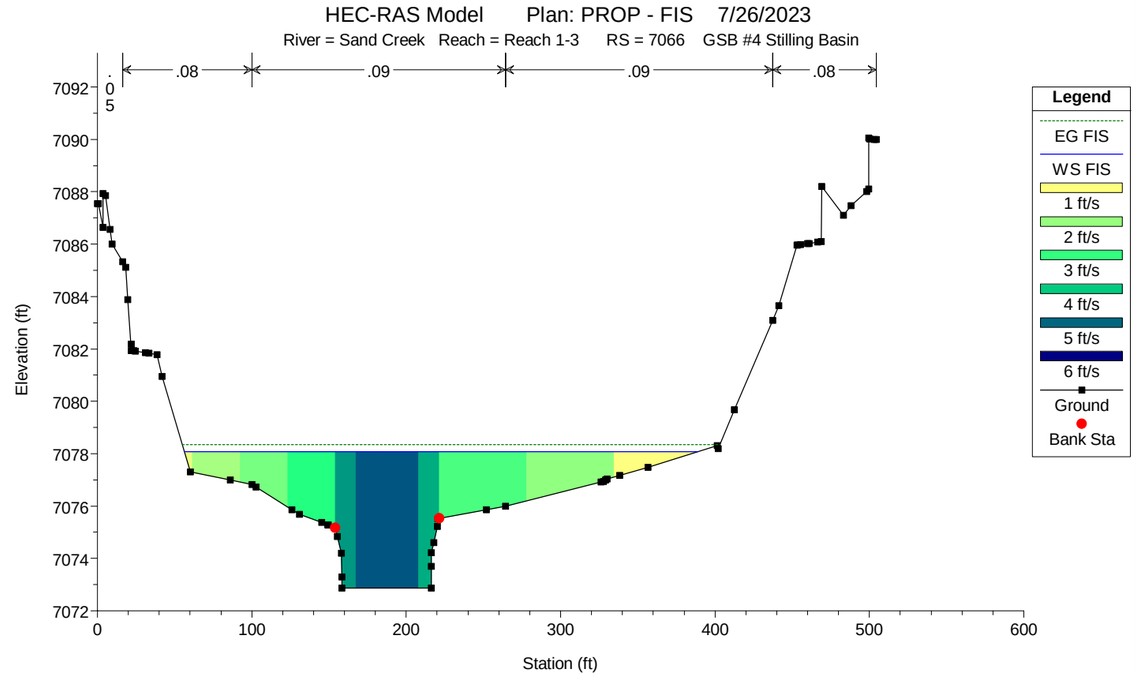


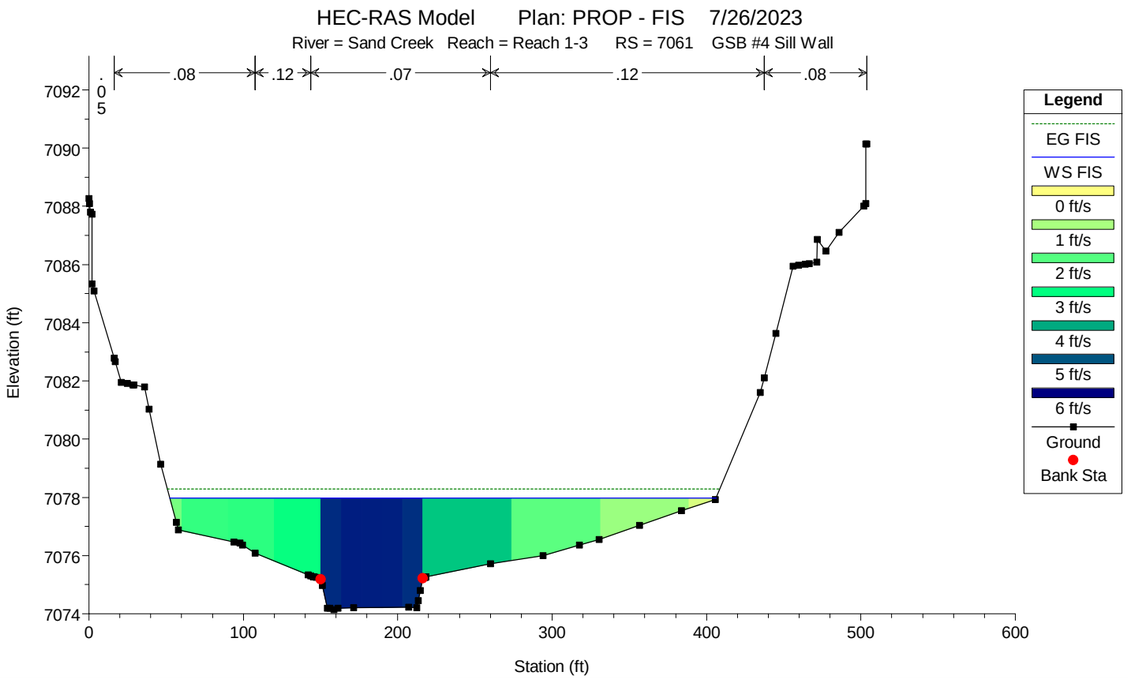


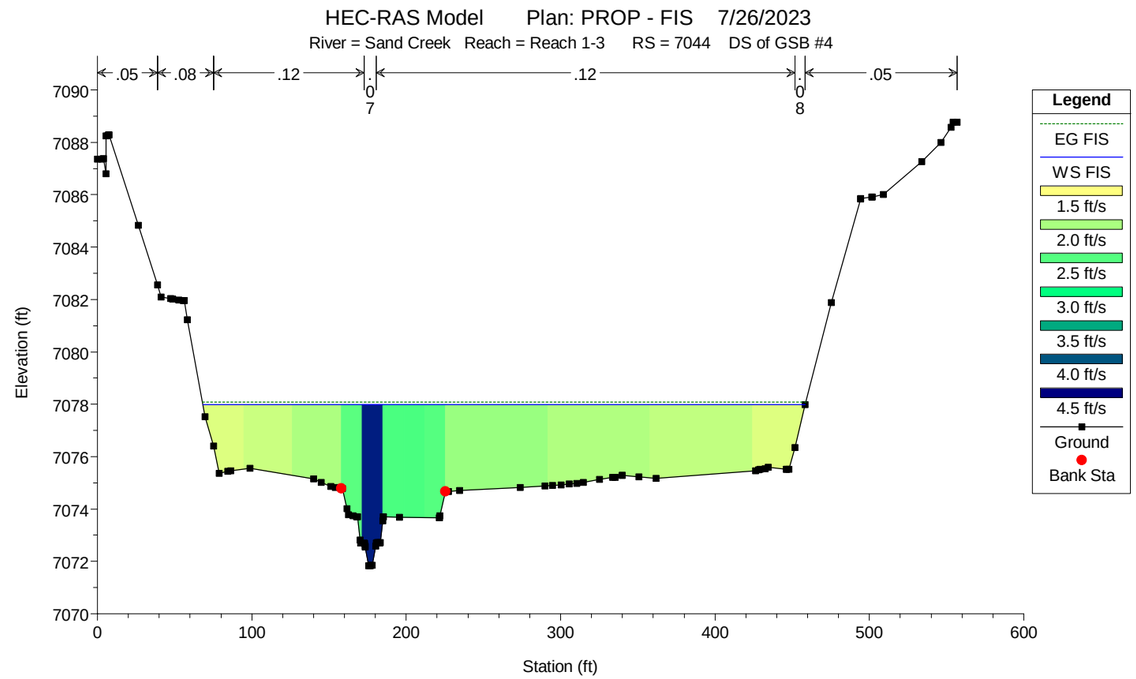


Sub-critical flow analysis for Water Surface evaluation of Naturalized Channel Design at the FIS flow rate only

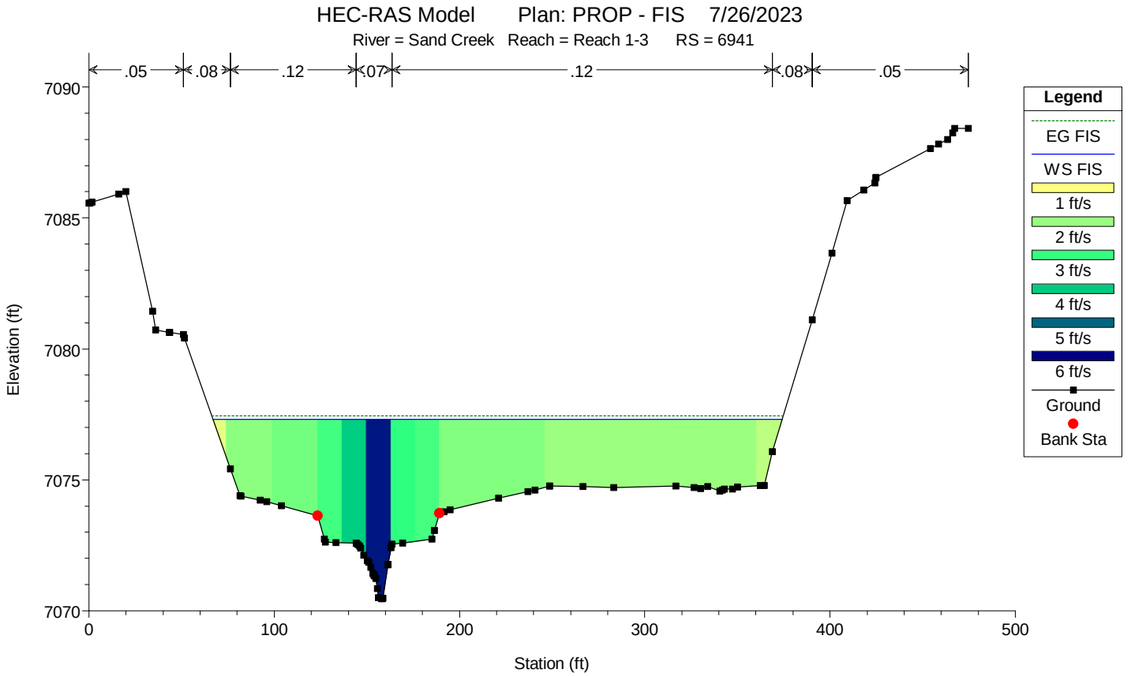


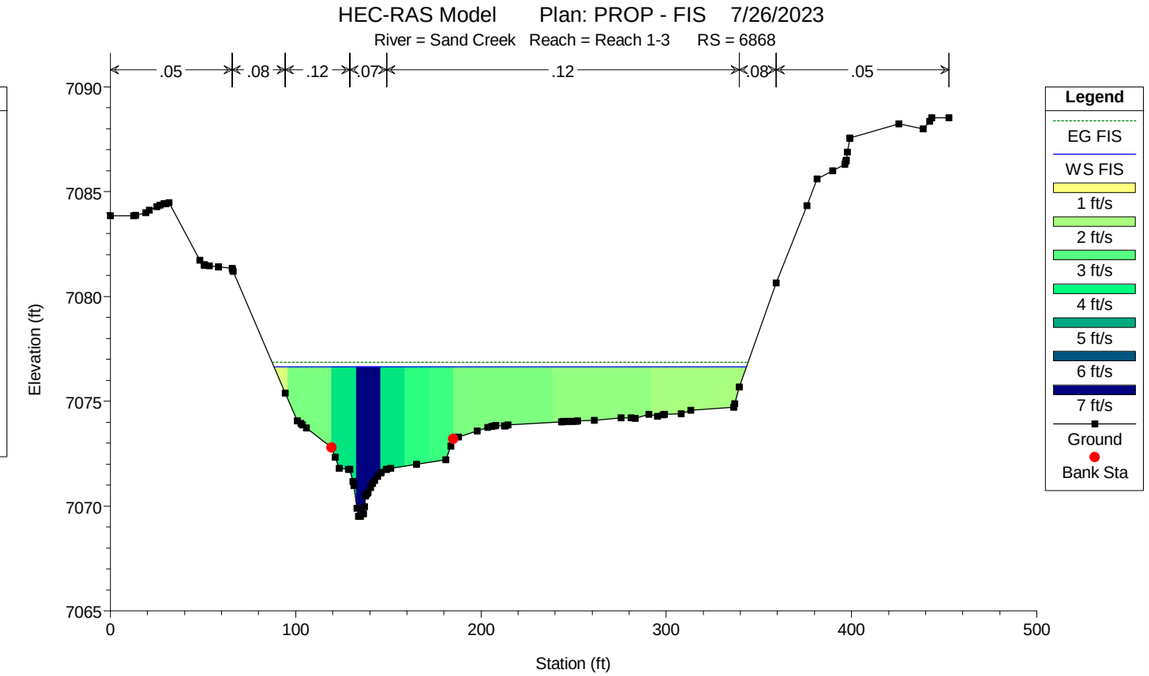


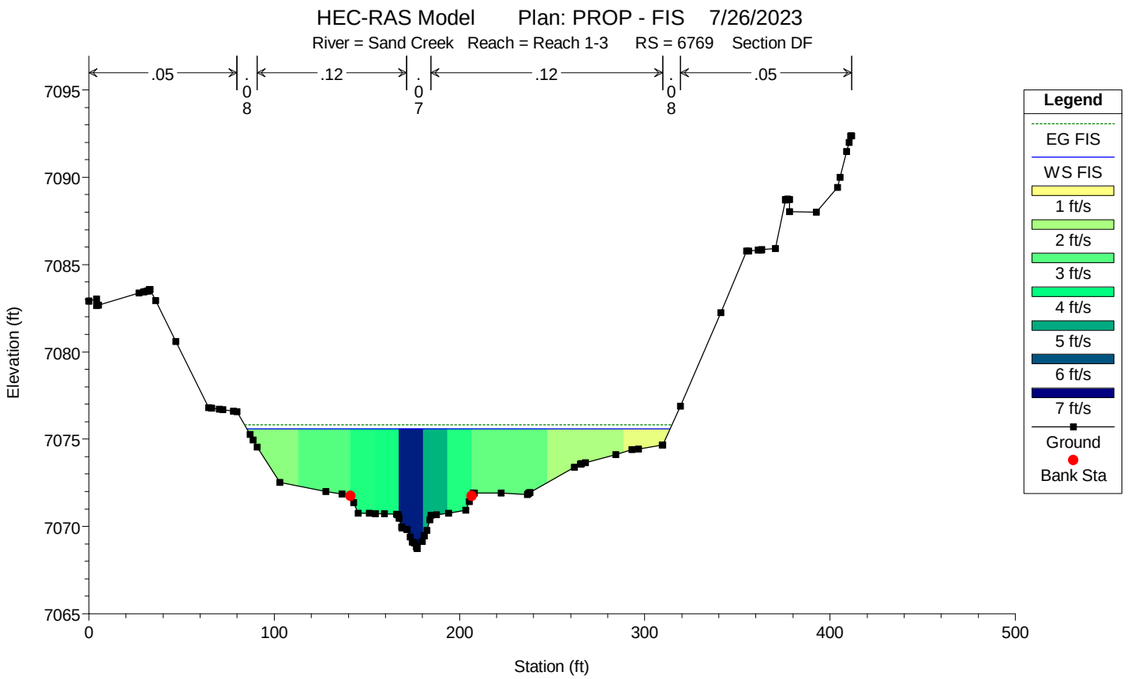


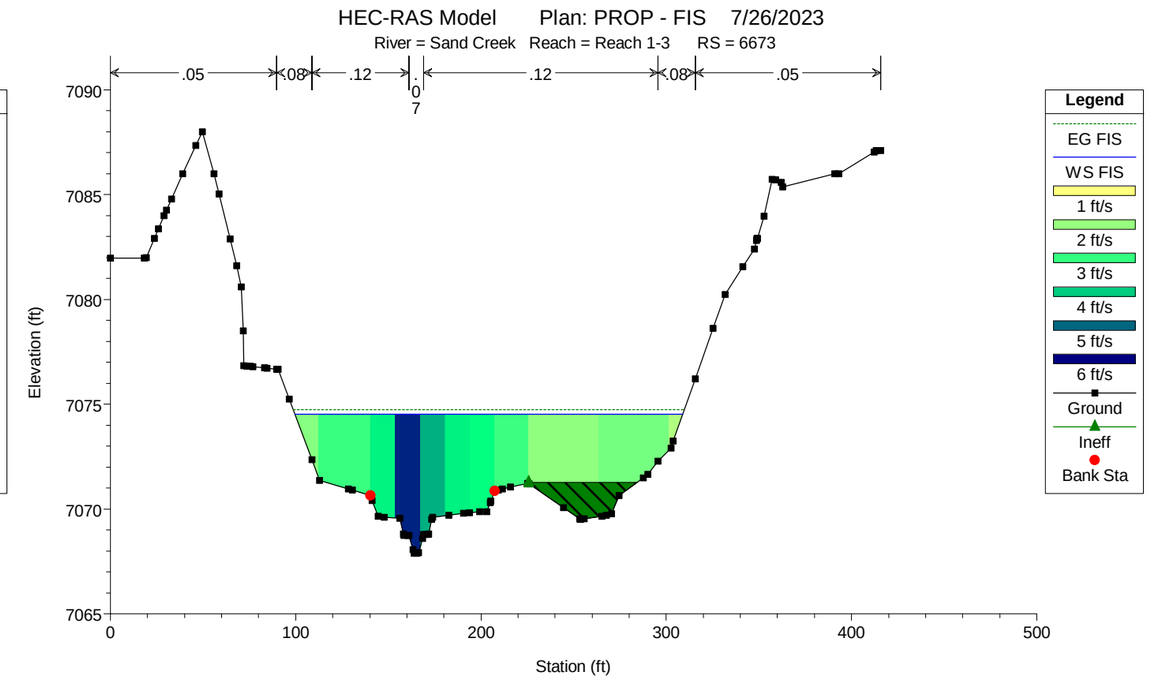


Sub-critical flow analysis for Water Surface evaluation of Naturalized Channel Design at the FIS flow rate only

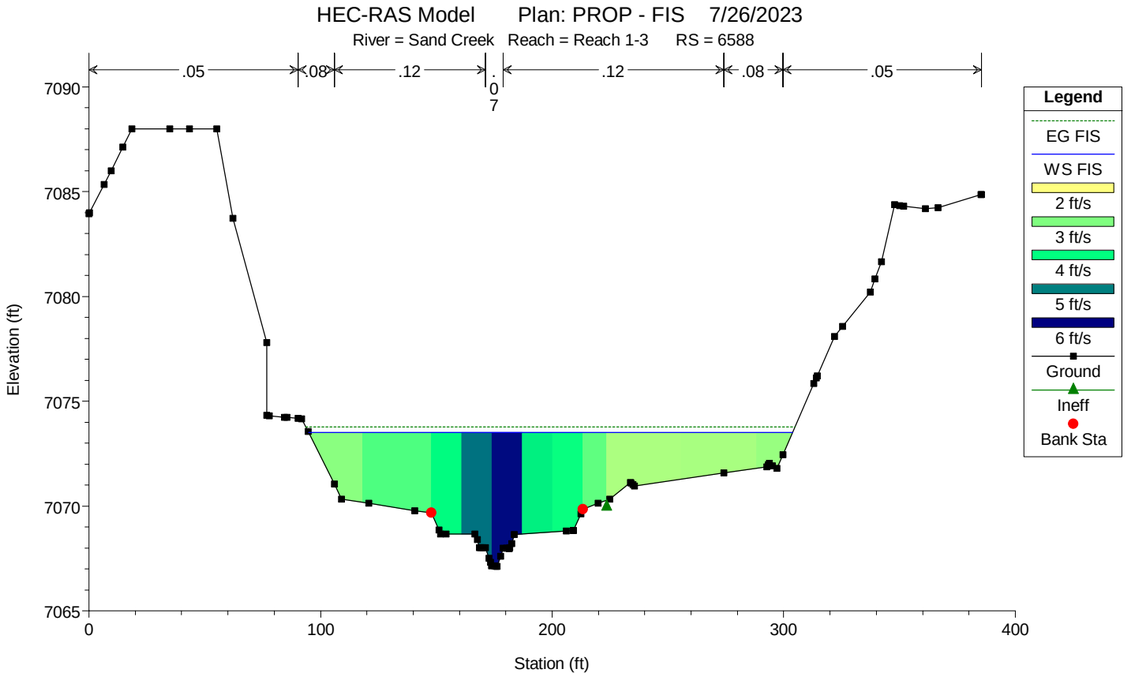


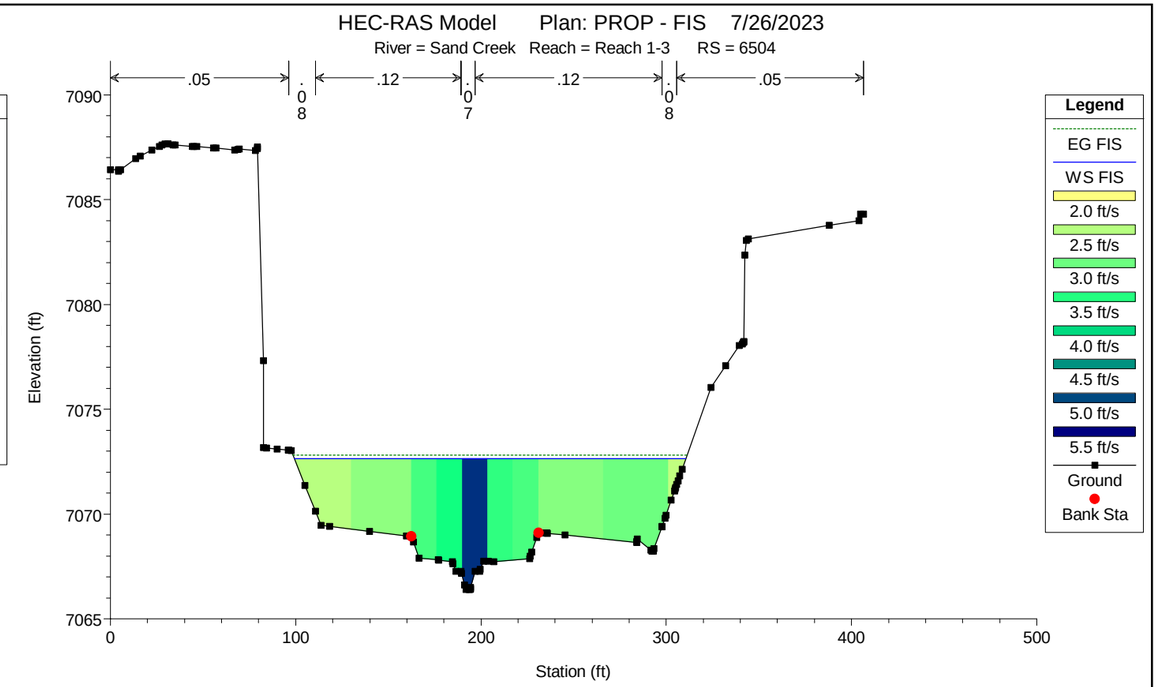


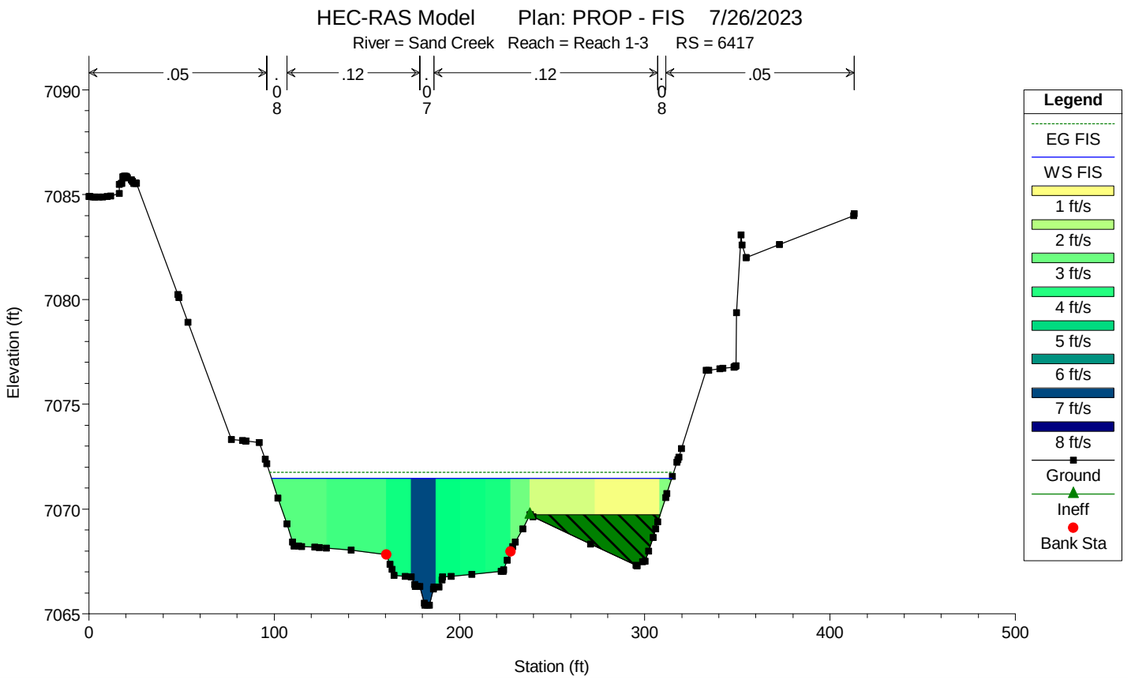


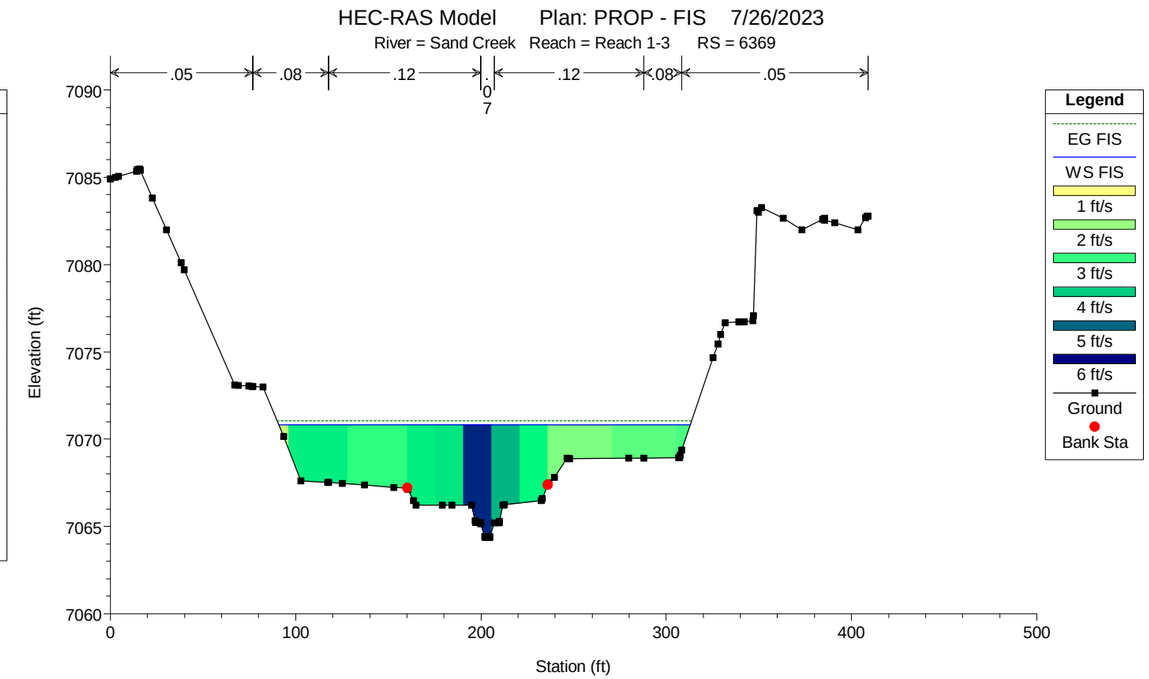


Sub-critical flow analysis for Water Surface evaluation of Naturalized Channel Design at the FIS flow rate only

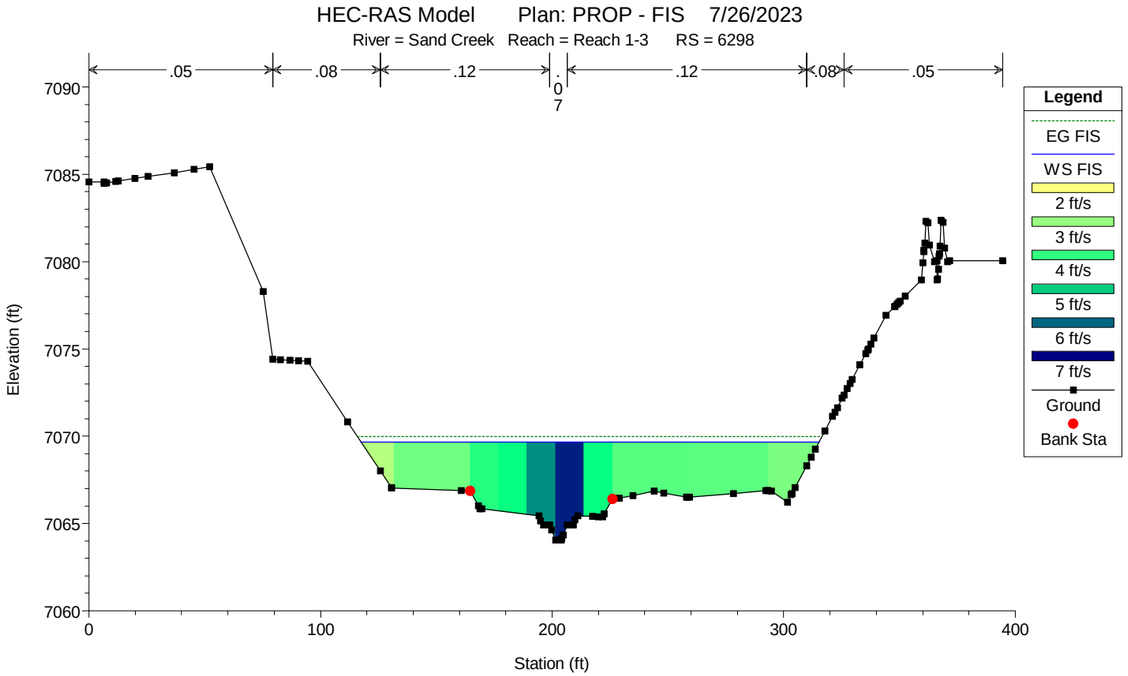


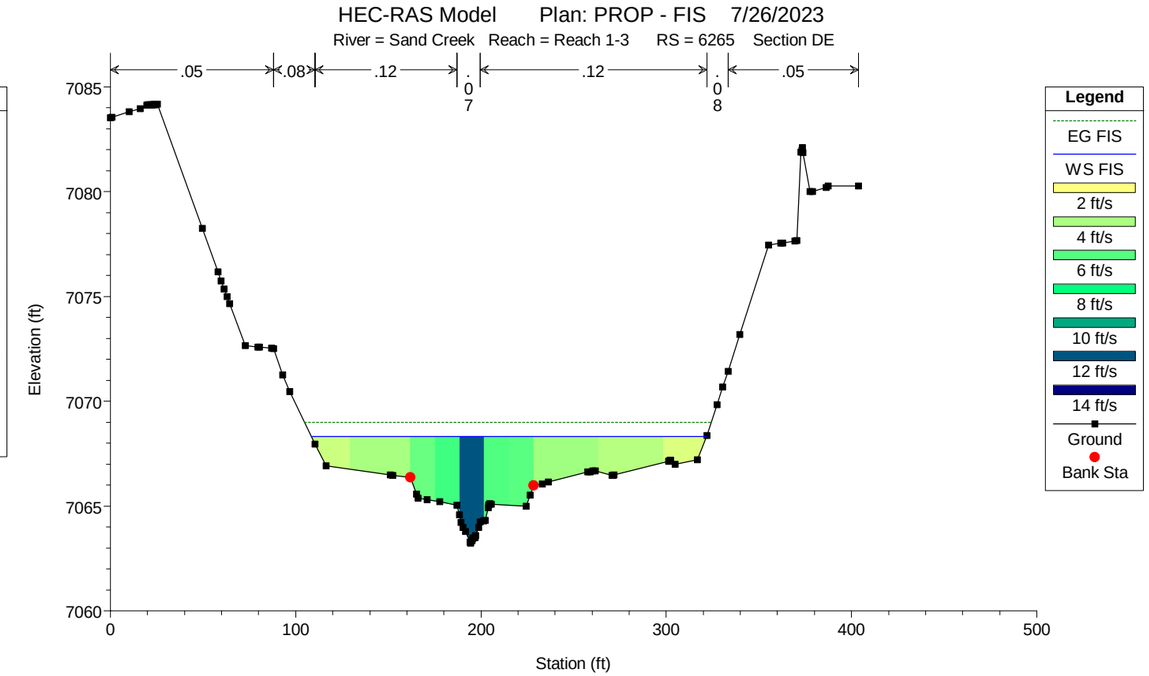


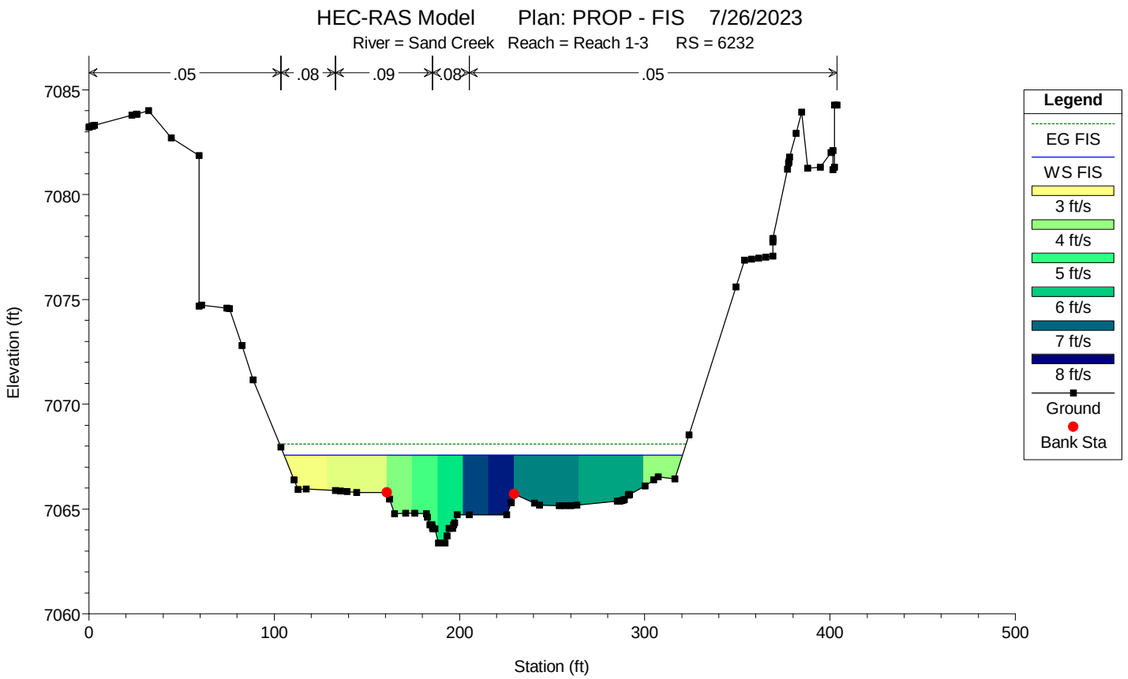


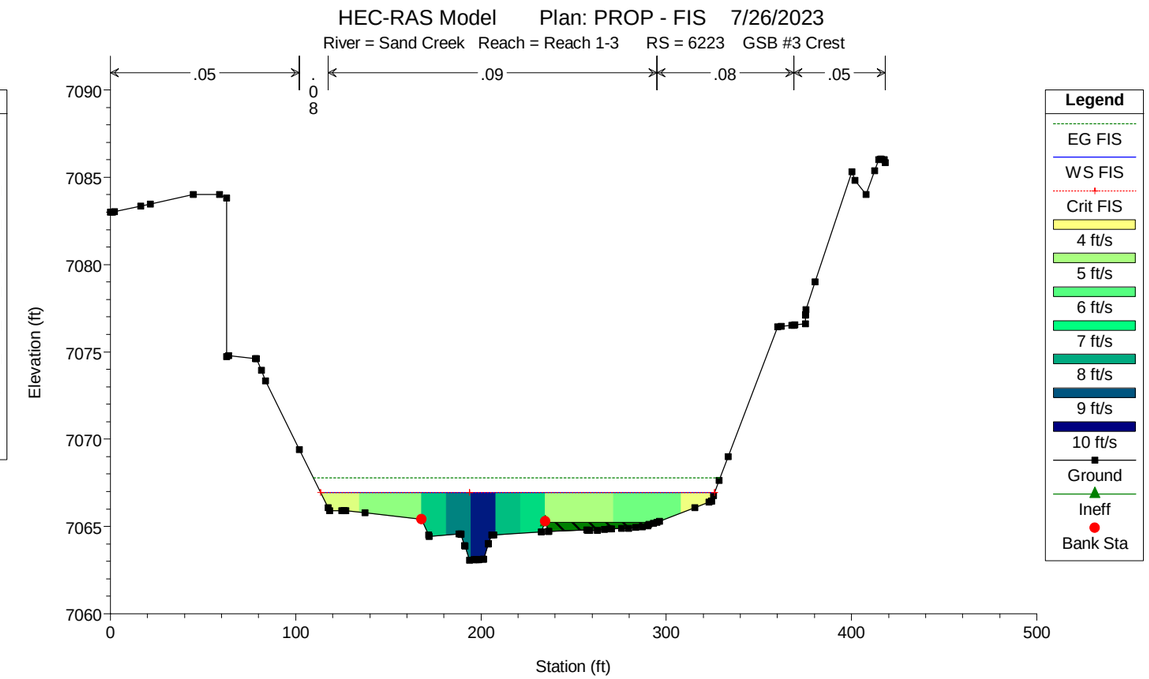


Sub-critical flow analysis for Water Surface evaluation of Naturalized Channel Design at the FIS flow rate only

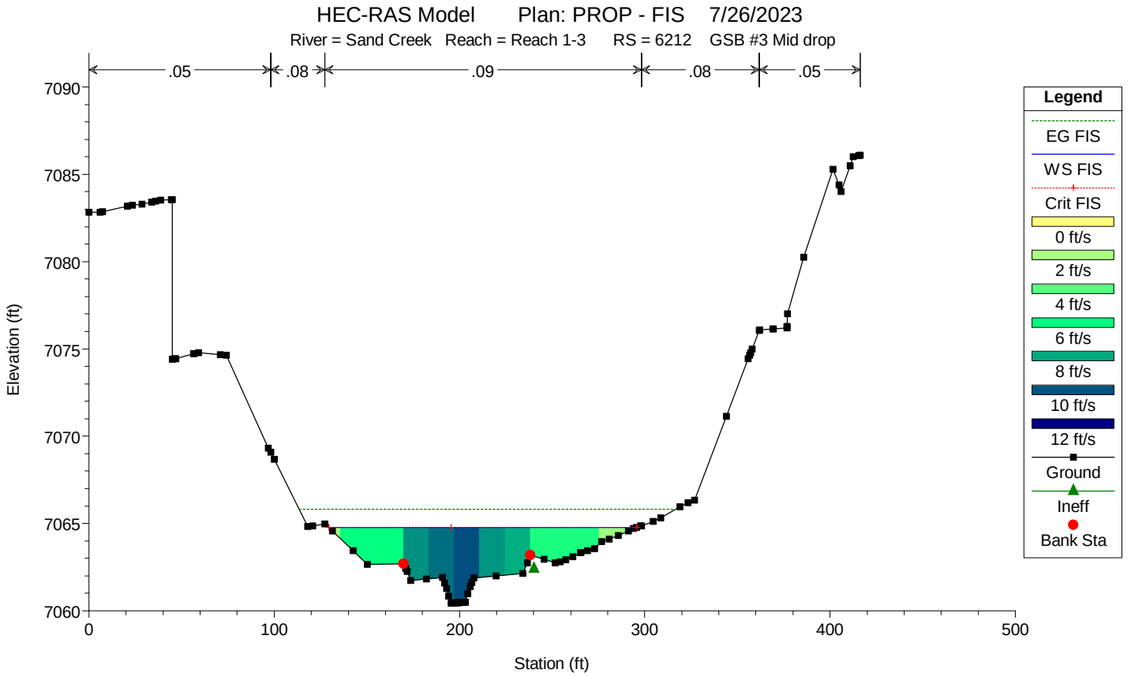


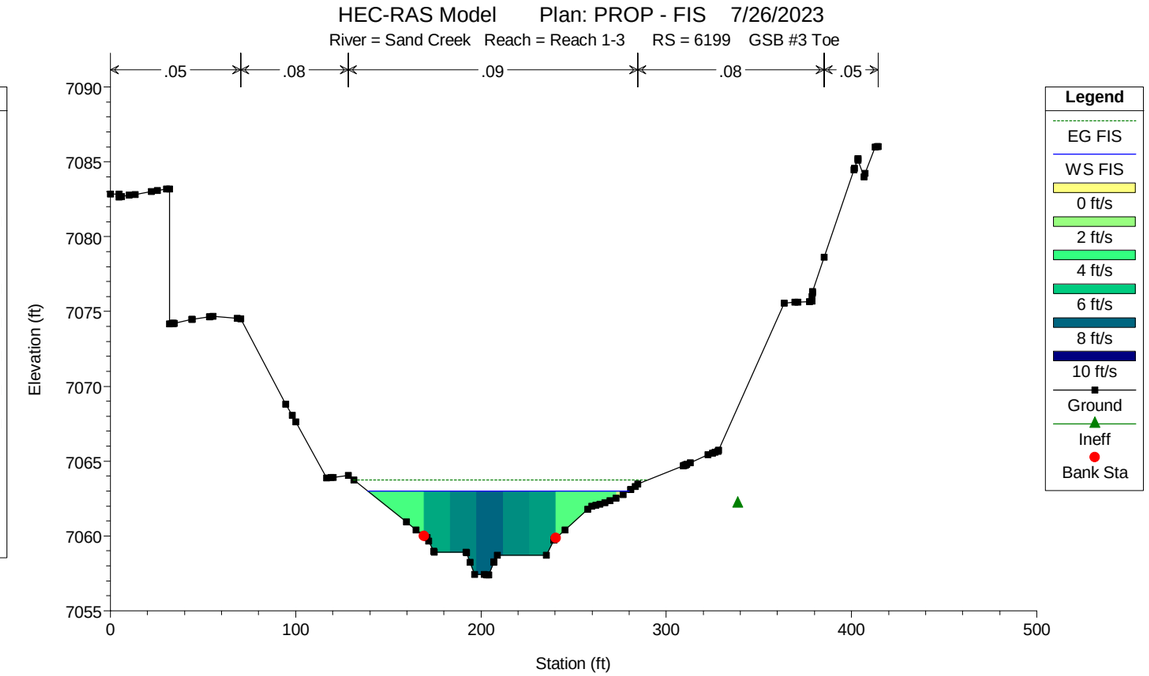


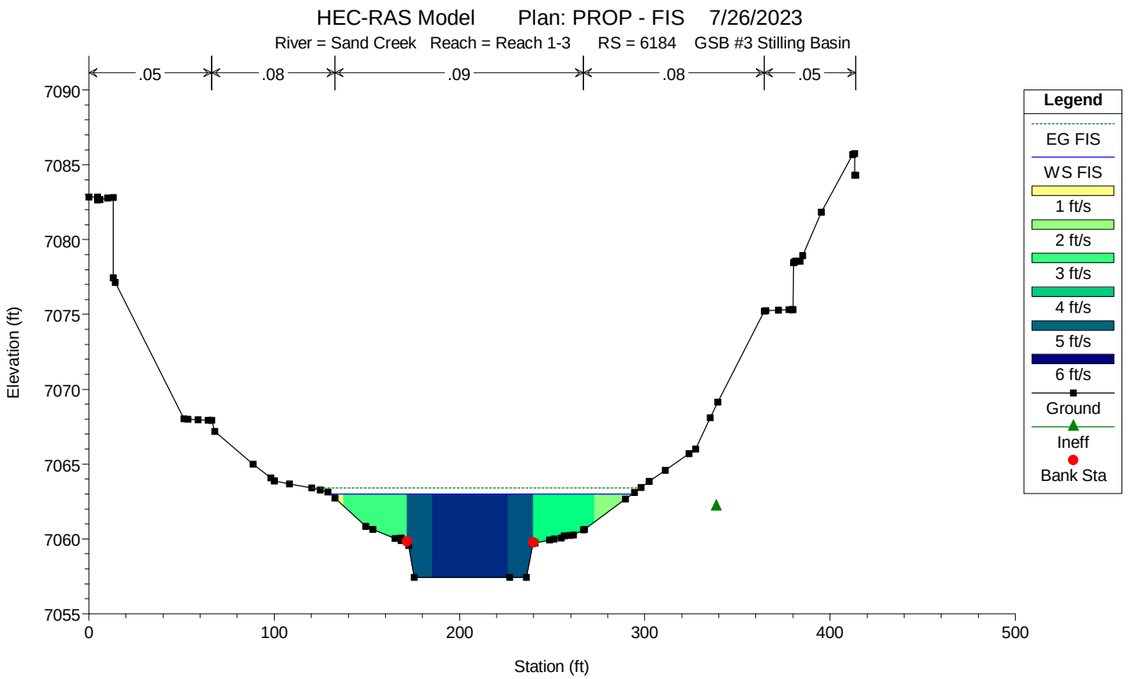


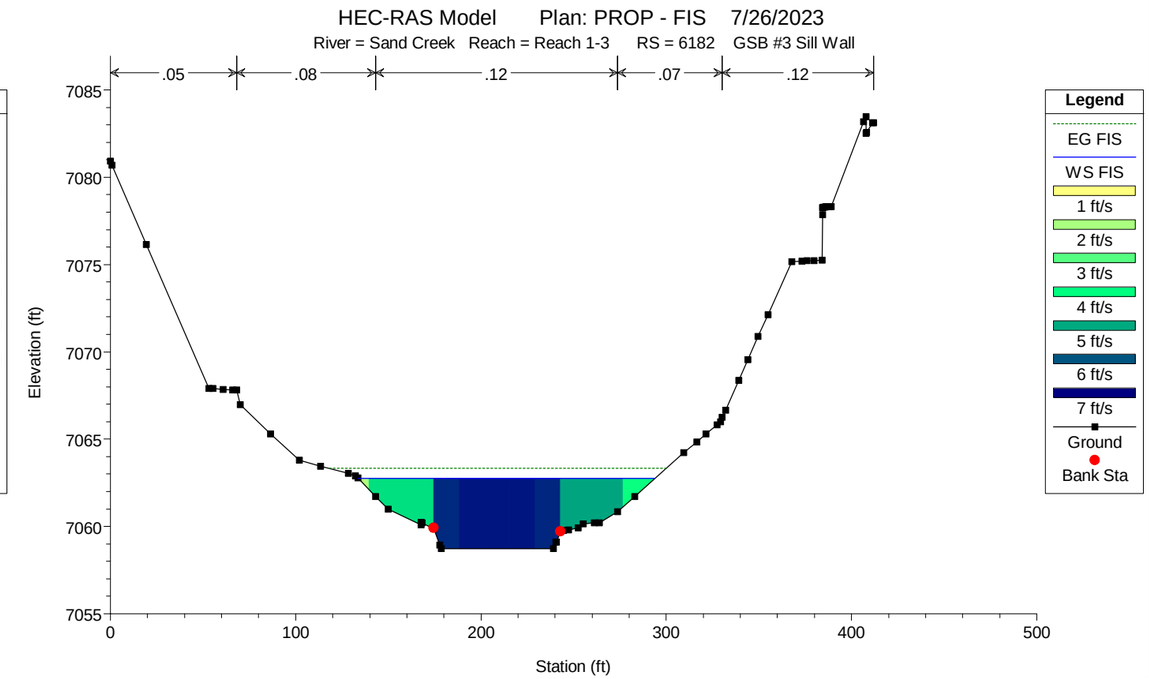


Sub-critical flow analysis for Water Surface evaluation of Naturalized Channel Design at the FIS flow rate only

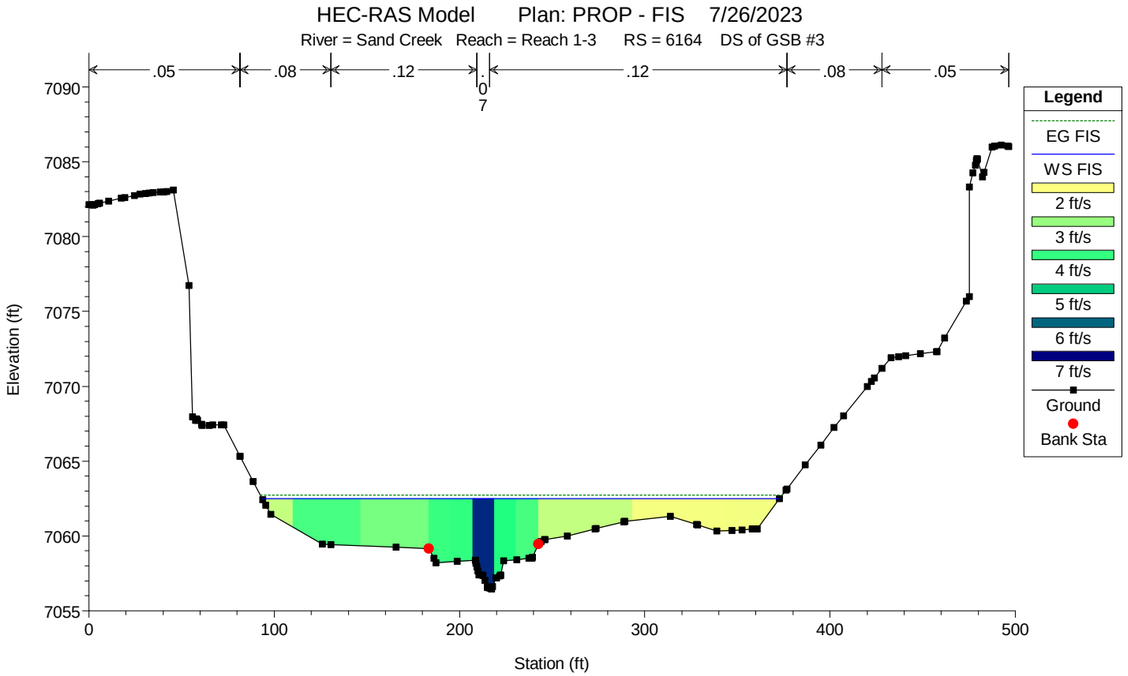


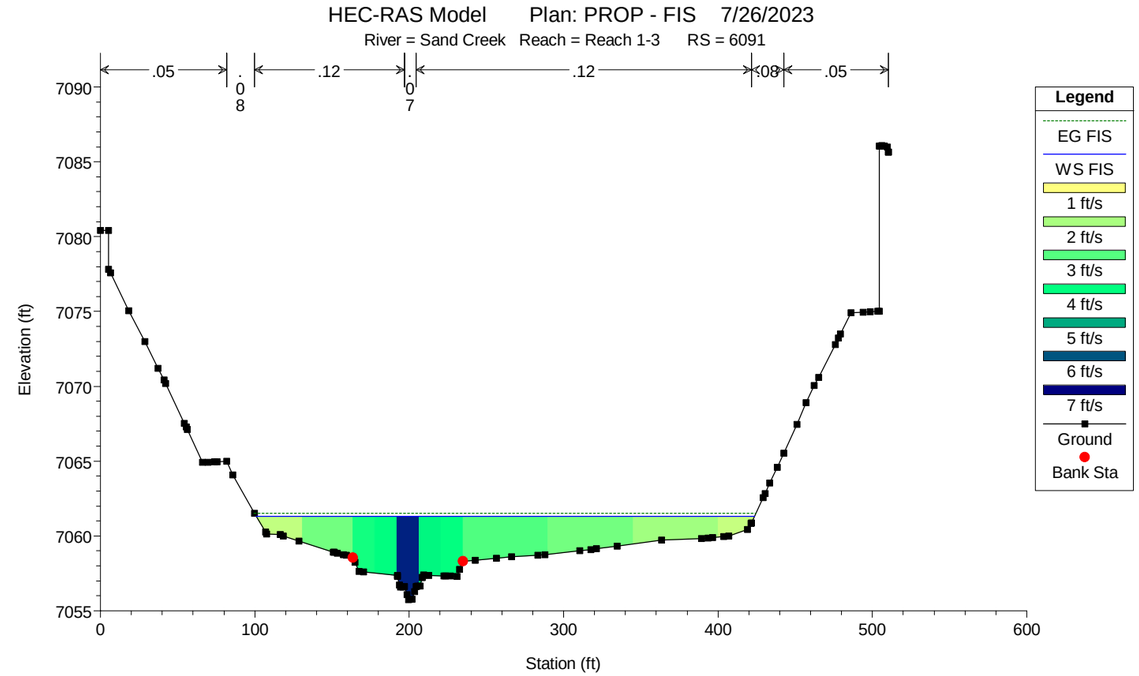


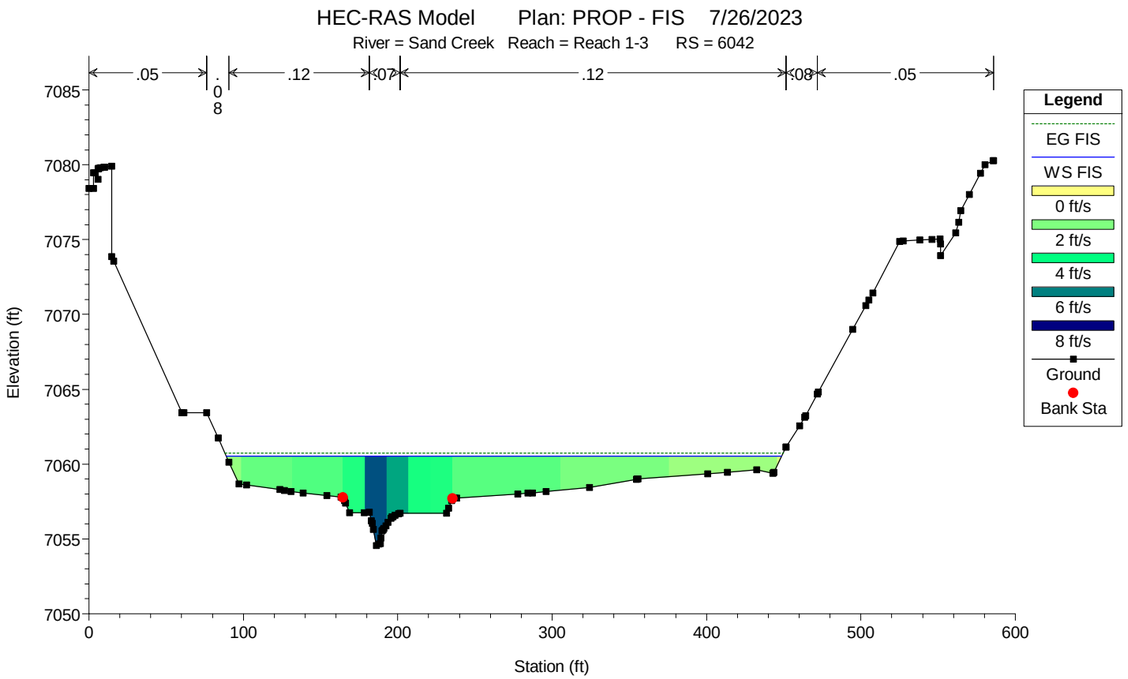


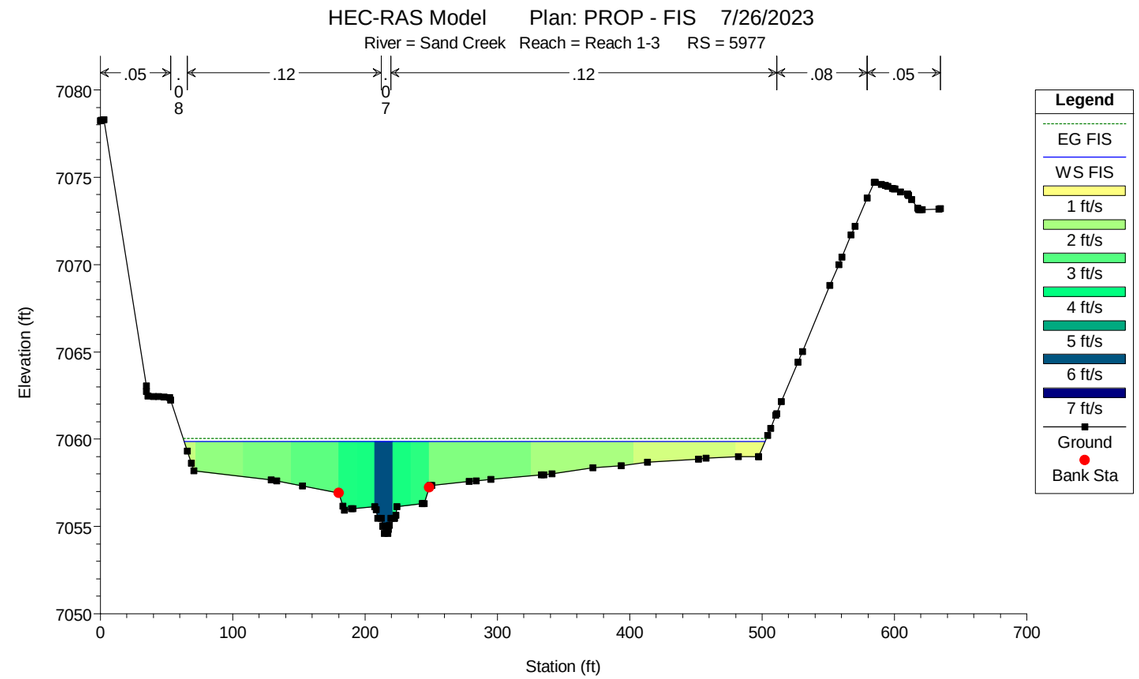


Sub-critical flow analysis for Water Surface evaluation of Naturalized Channel Design at the FIS flow rate only

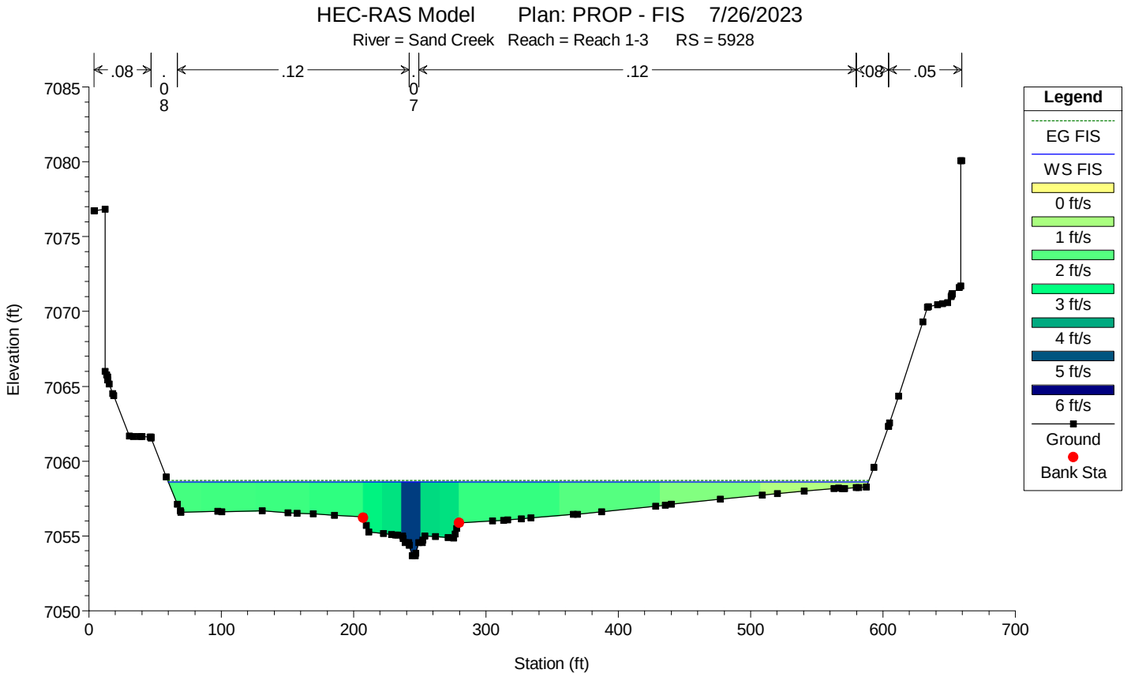


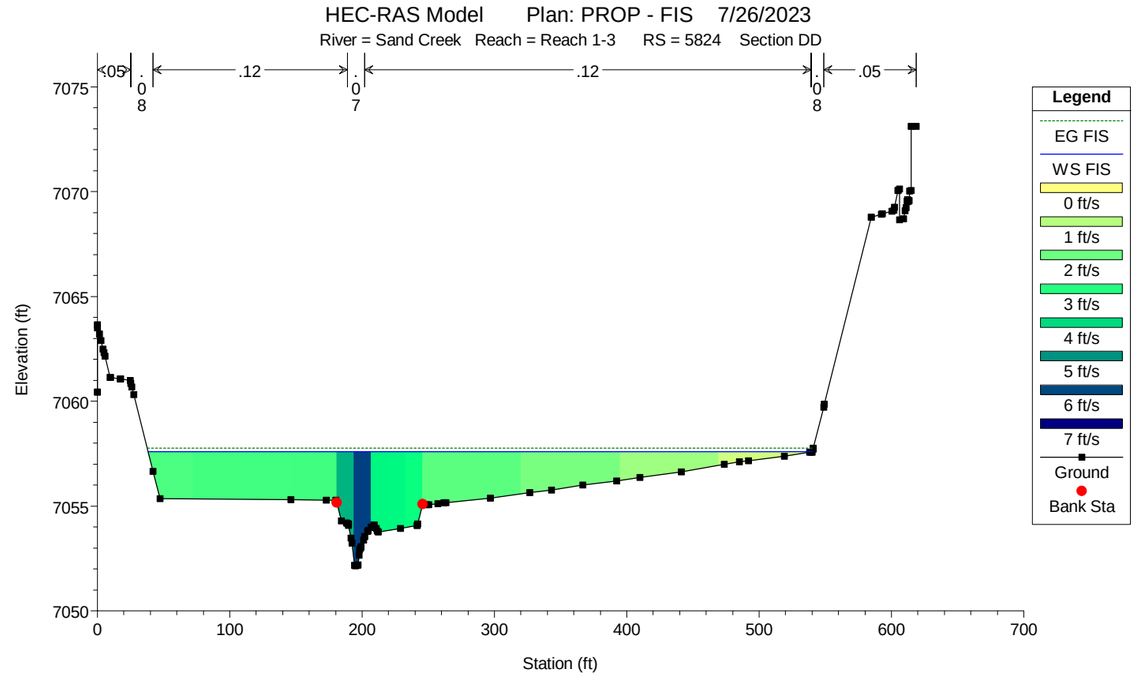


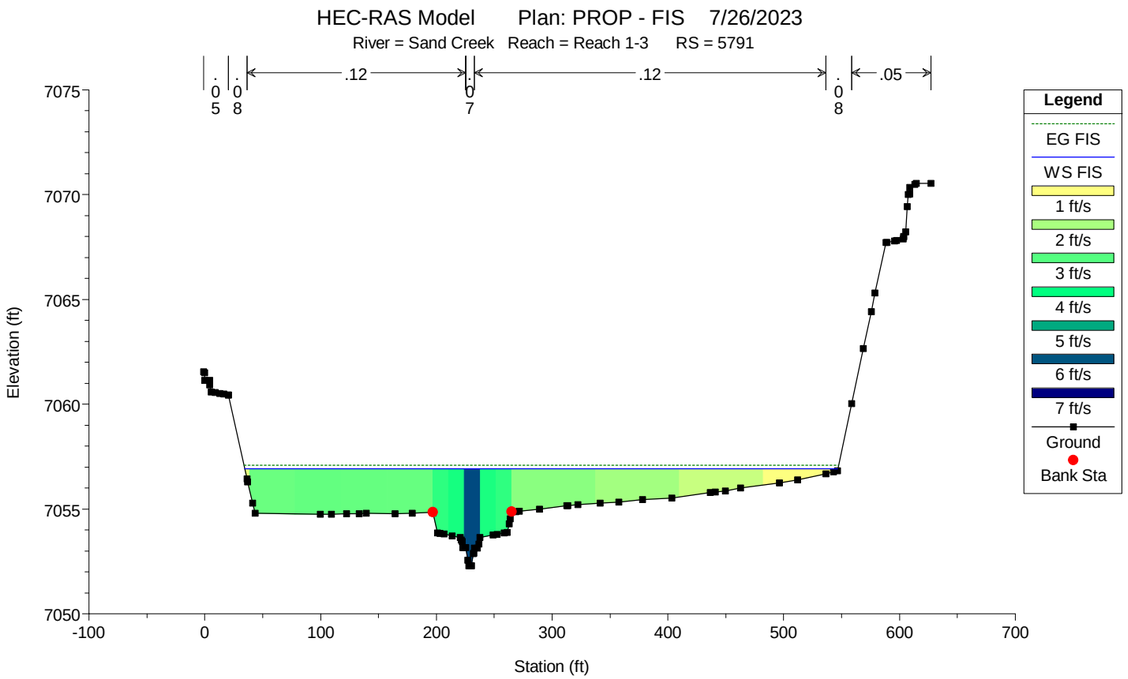


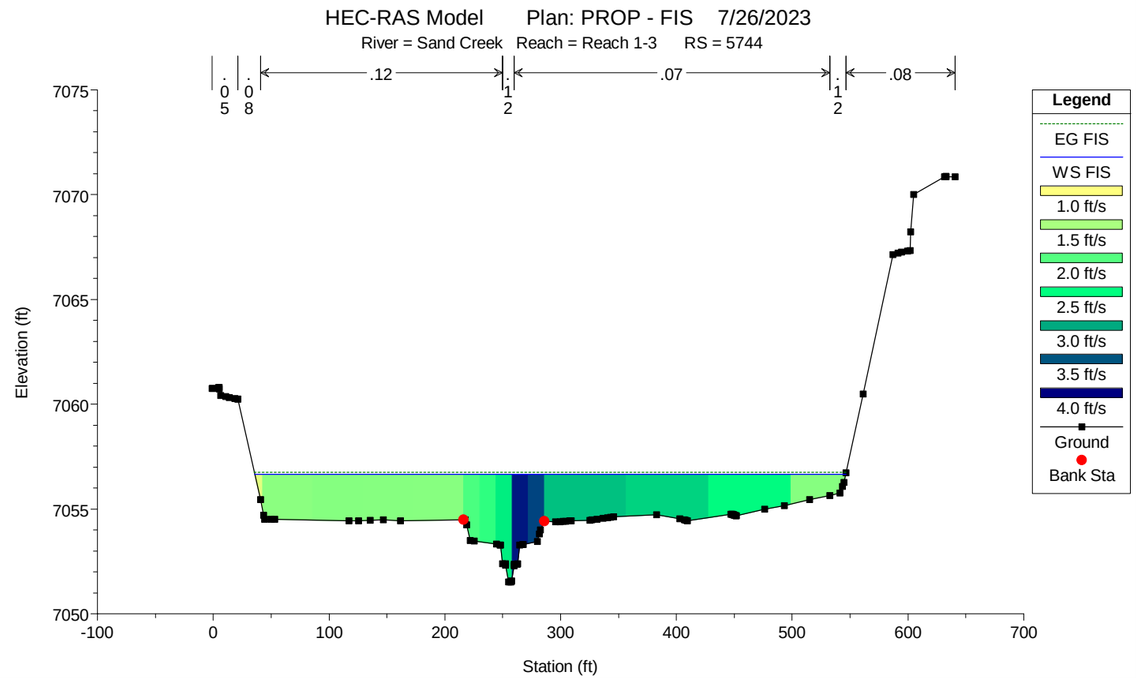


Sub-critical flow analysis for Water Surface evaluation of Naturalized Channel Design at the FIS flow rate only

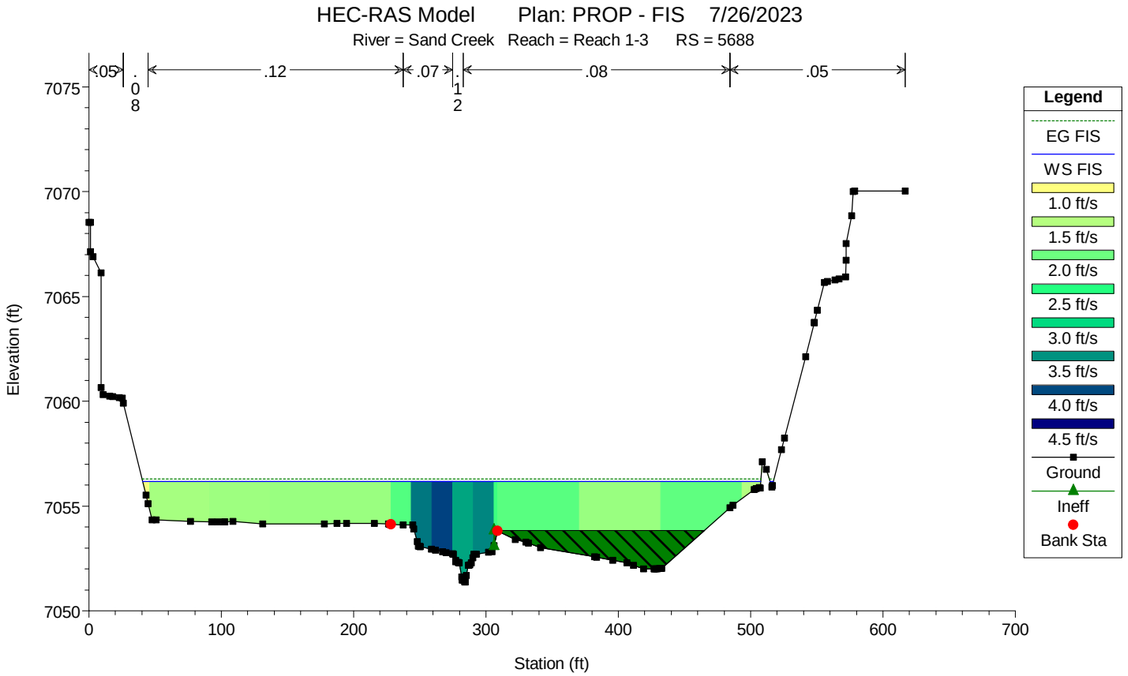


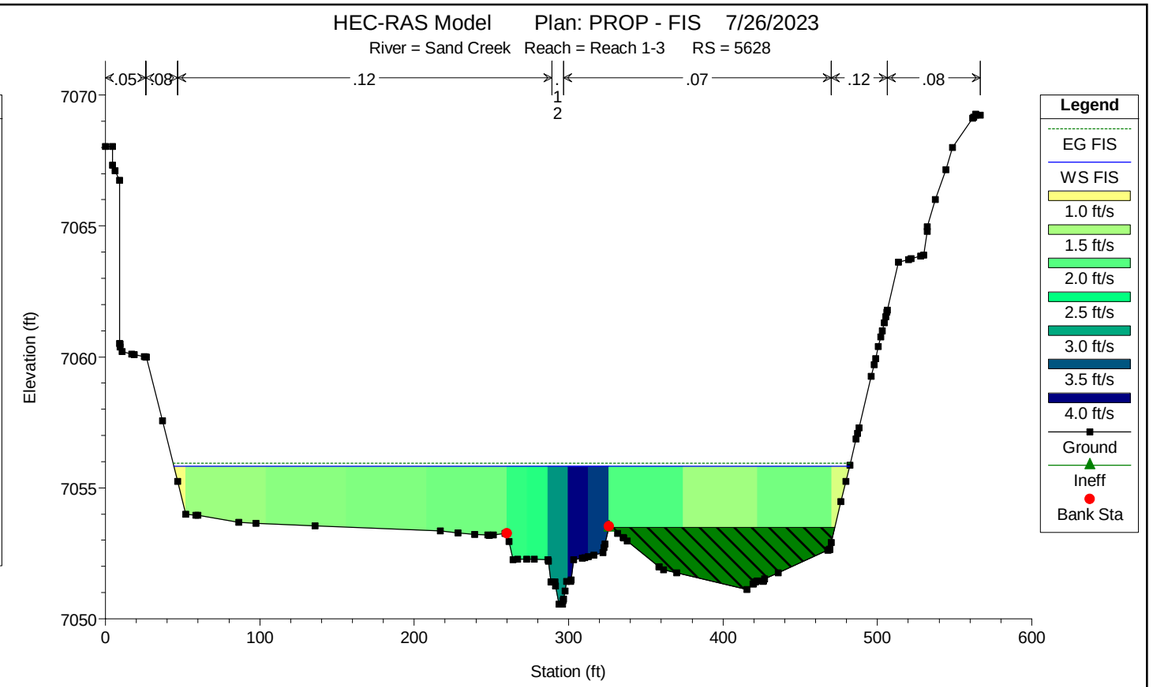


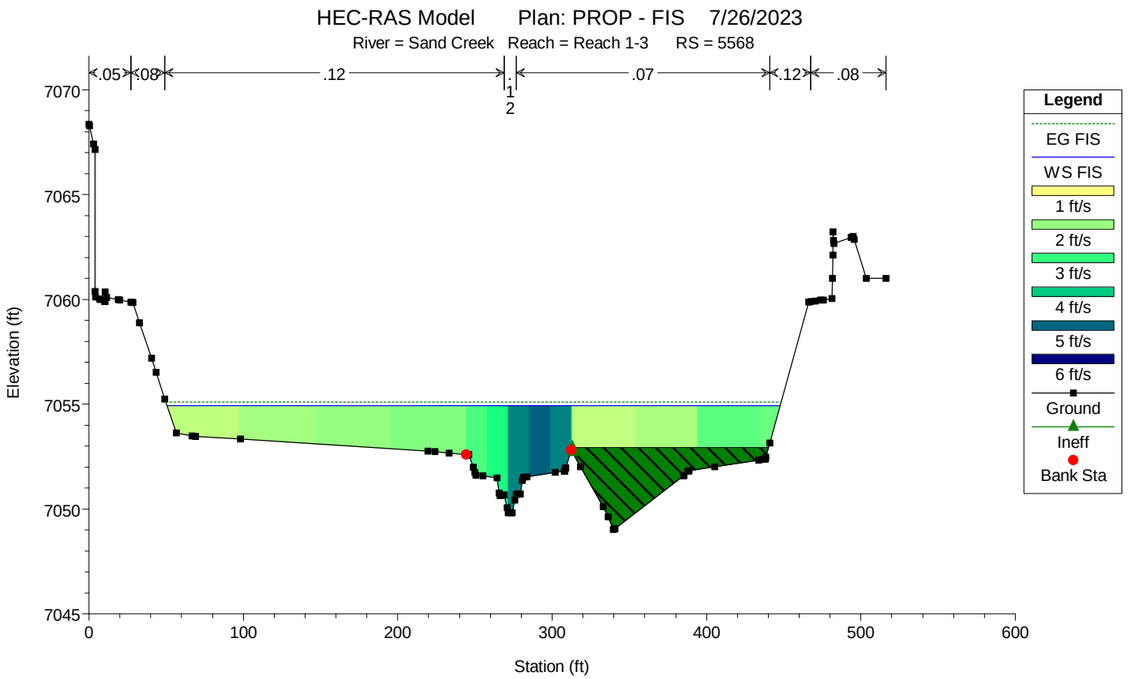


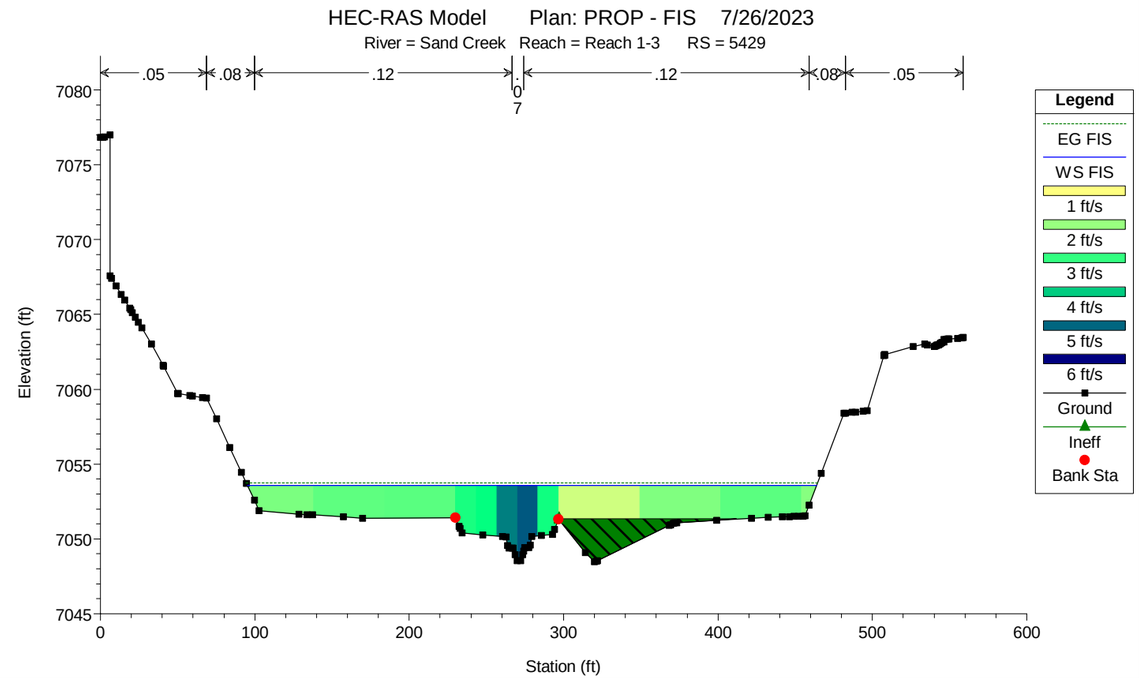


Sub-critical flow analysis for Water Surface evaluation of Naturalized Channel Design at the FIS flow rate only

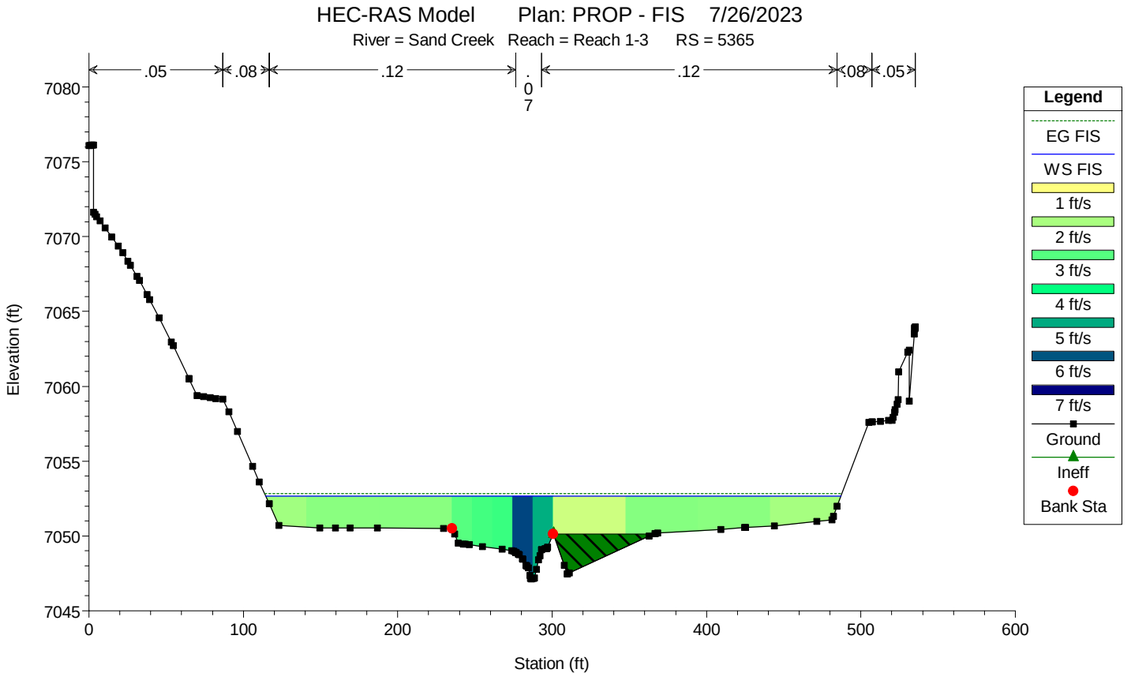


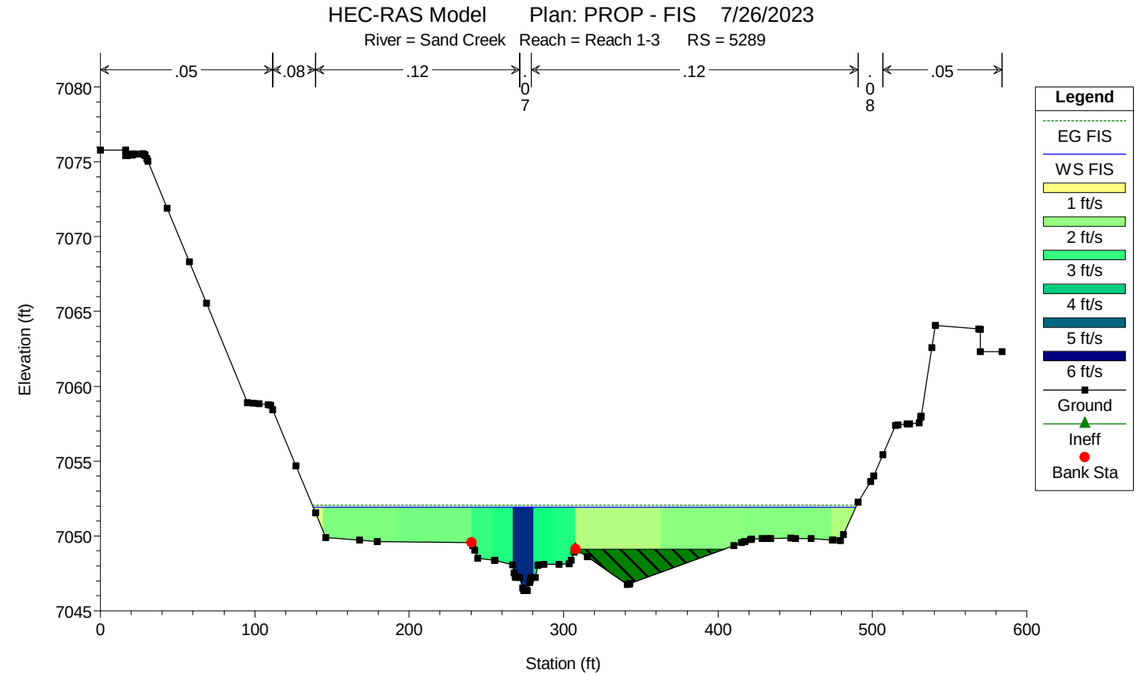


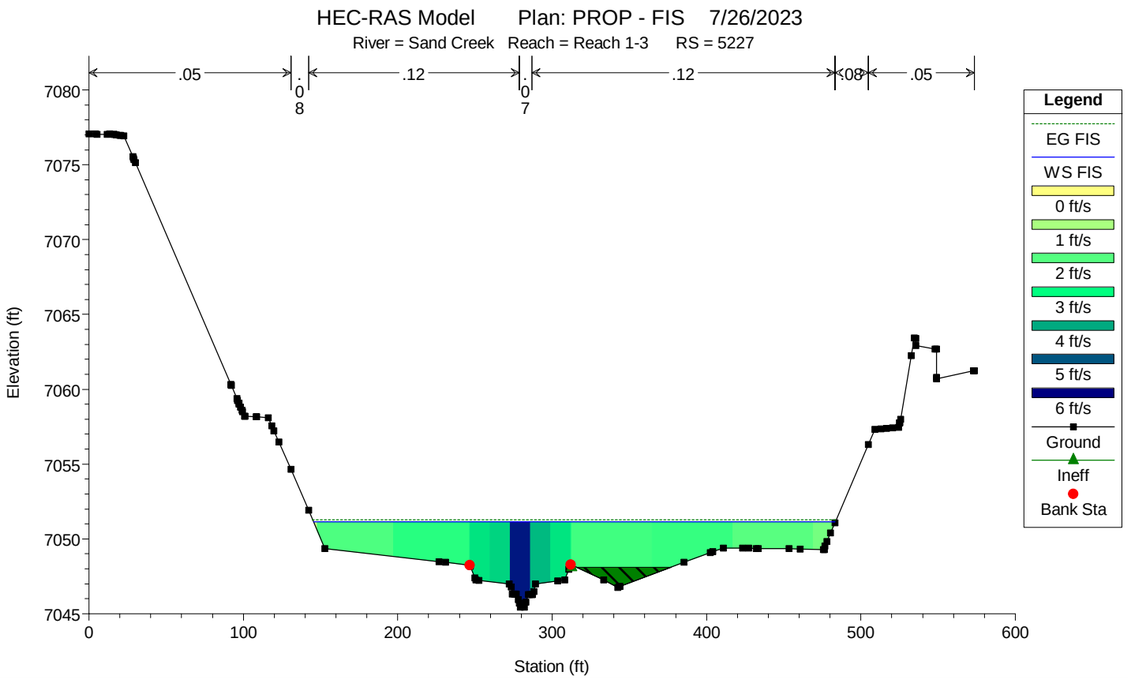


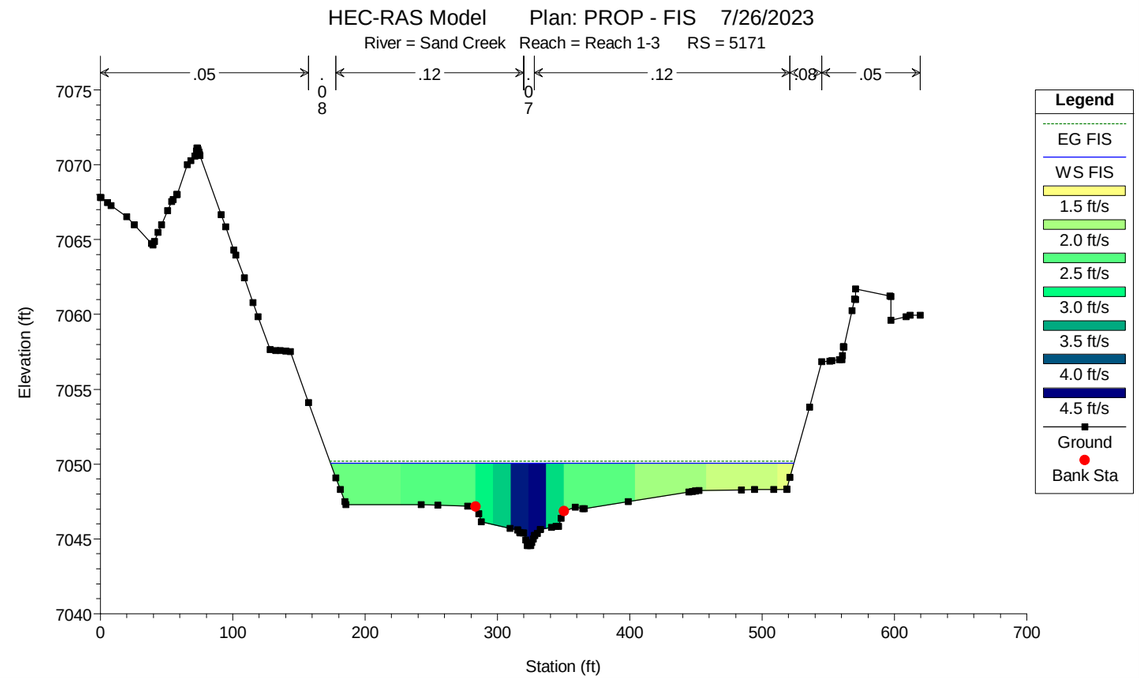


Sub-critical flow analysis for Water Surface evaluation of Naturalized Channel Design at the FIS flow rate only

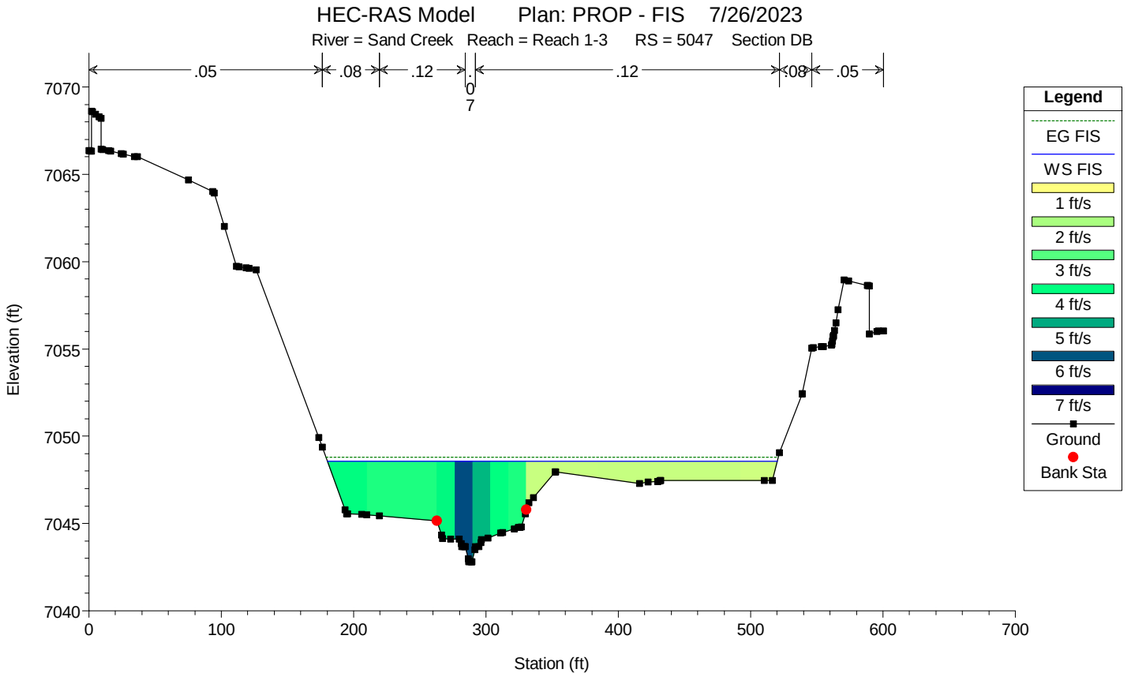


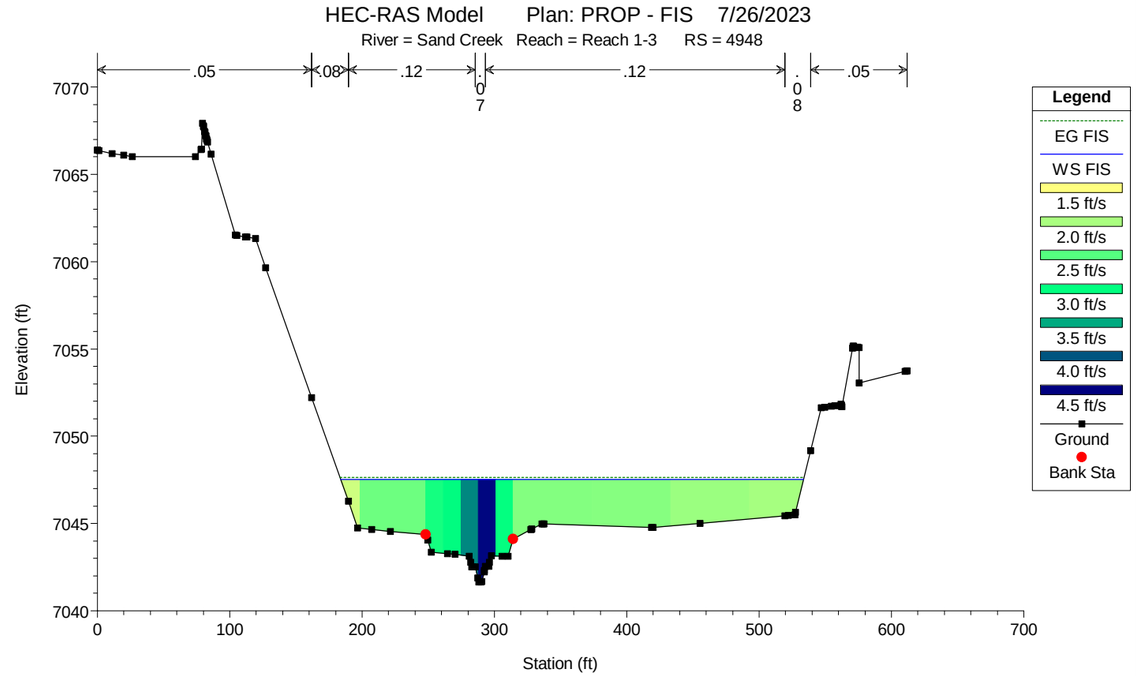


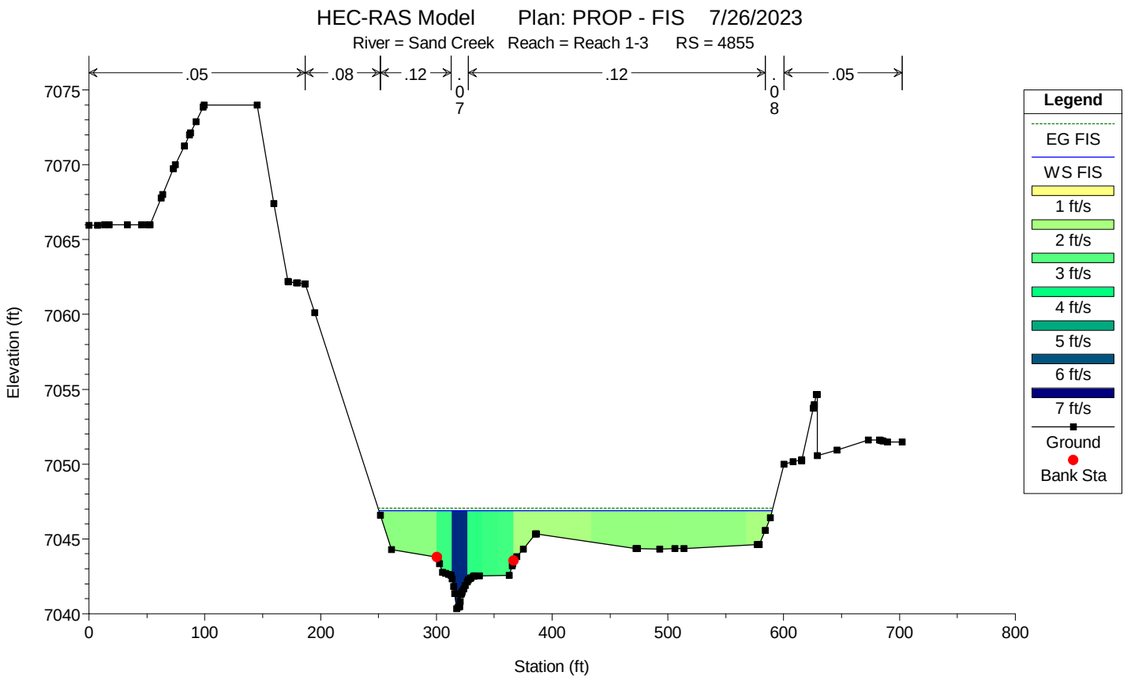


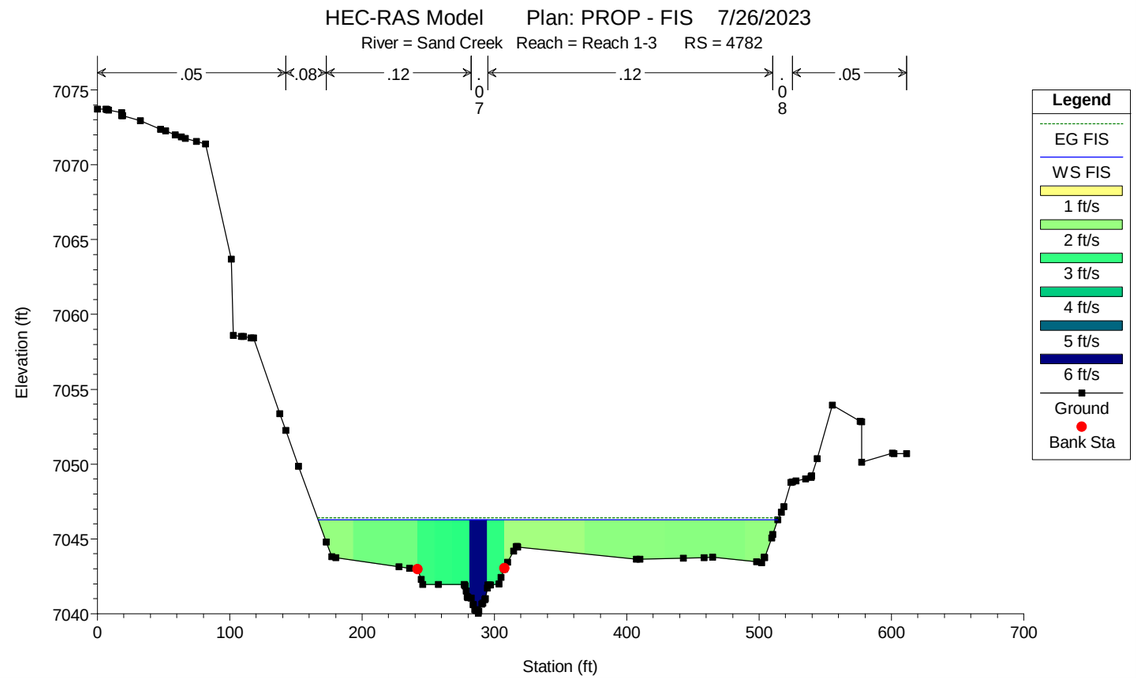


Sub-critical flow analysis for Water Surface evaluation of Naturalized Channel Design at the FIS flow rate only

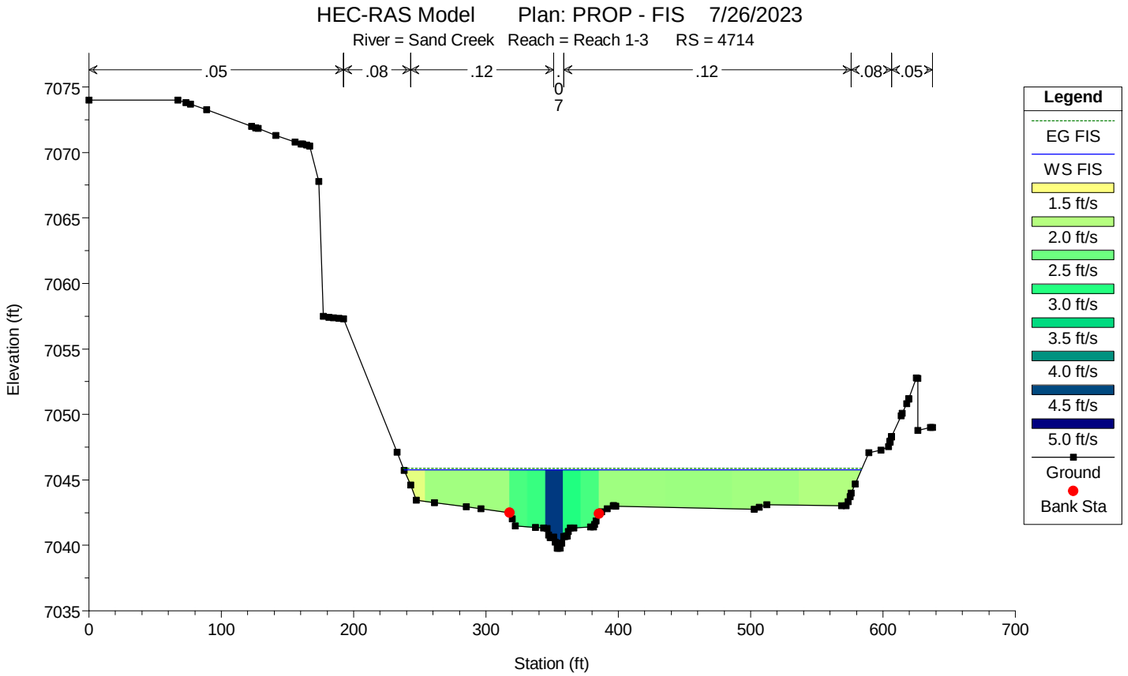


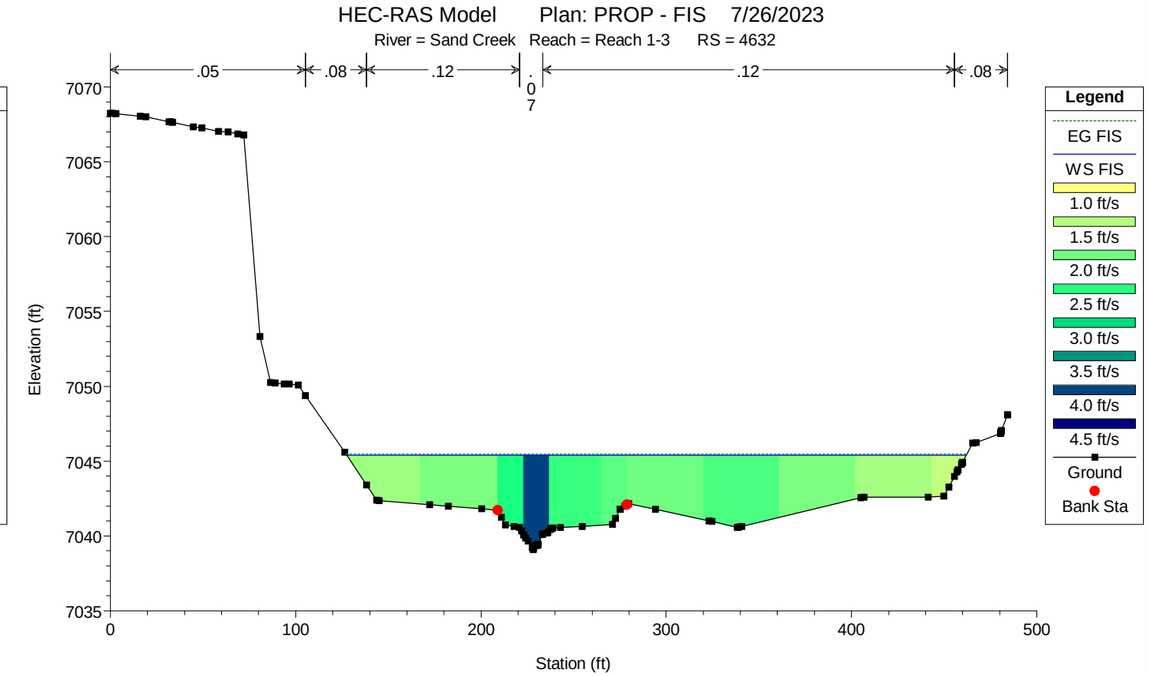


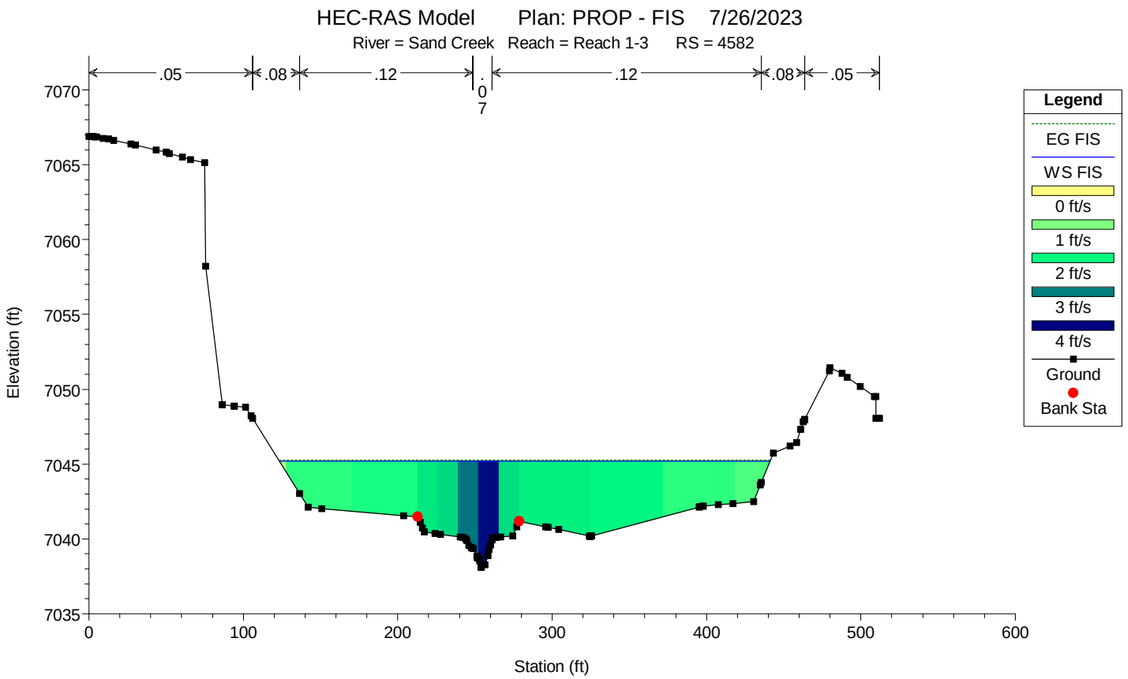


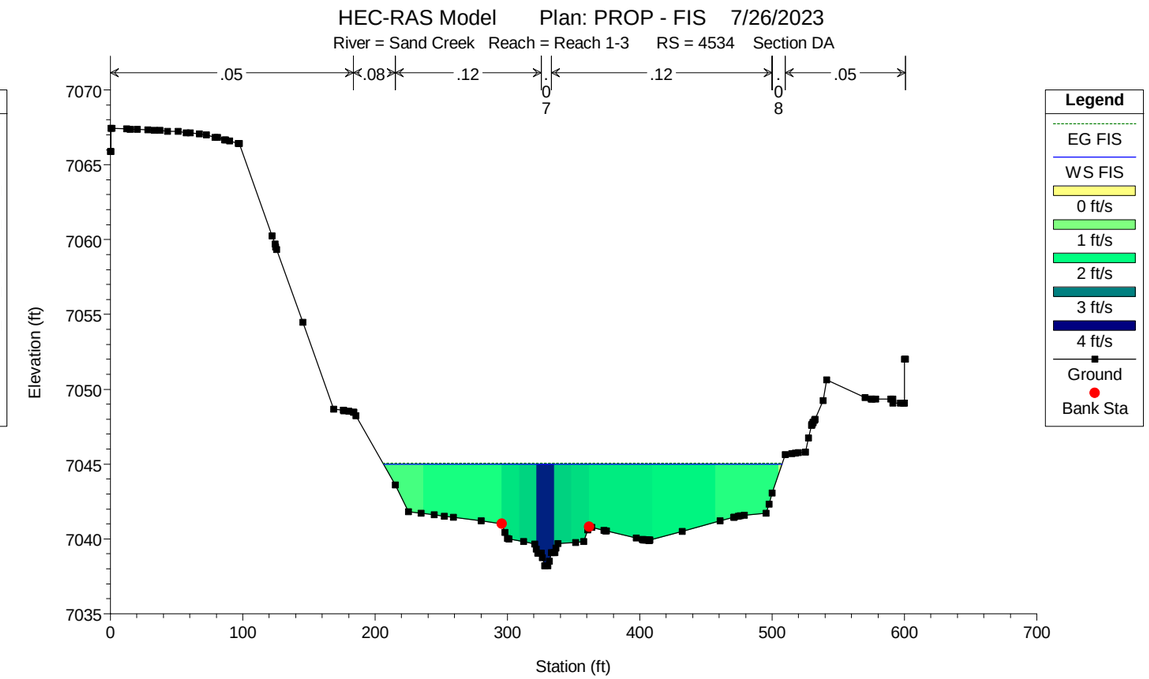


Sub-critical flow analysis for Water Surface evaluation of Naturalized Channel Design at the FIS flow rate only

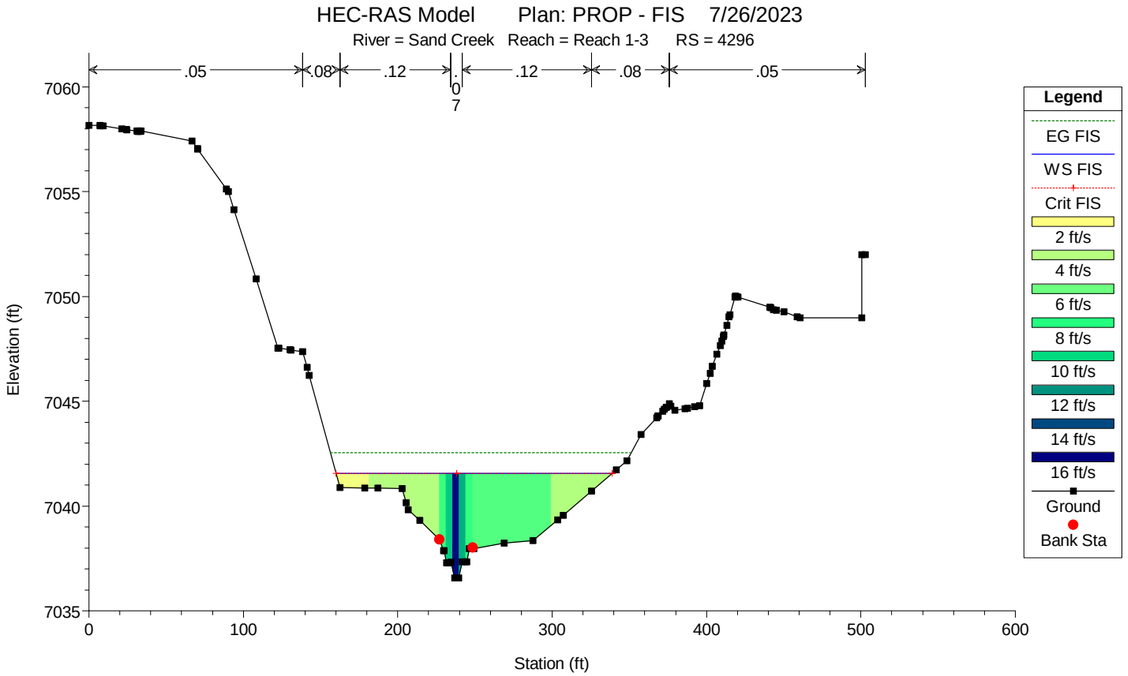


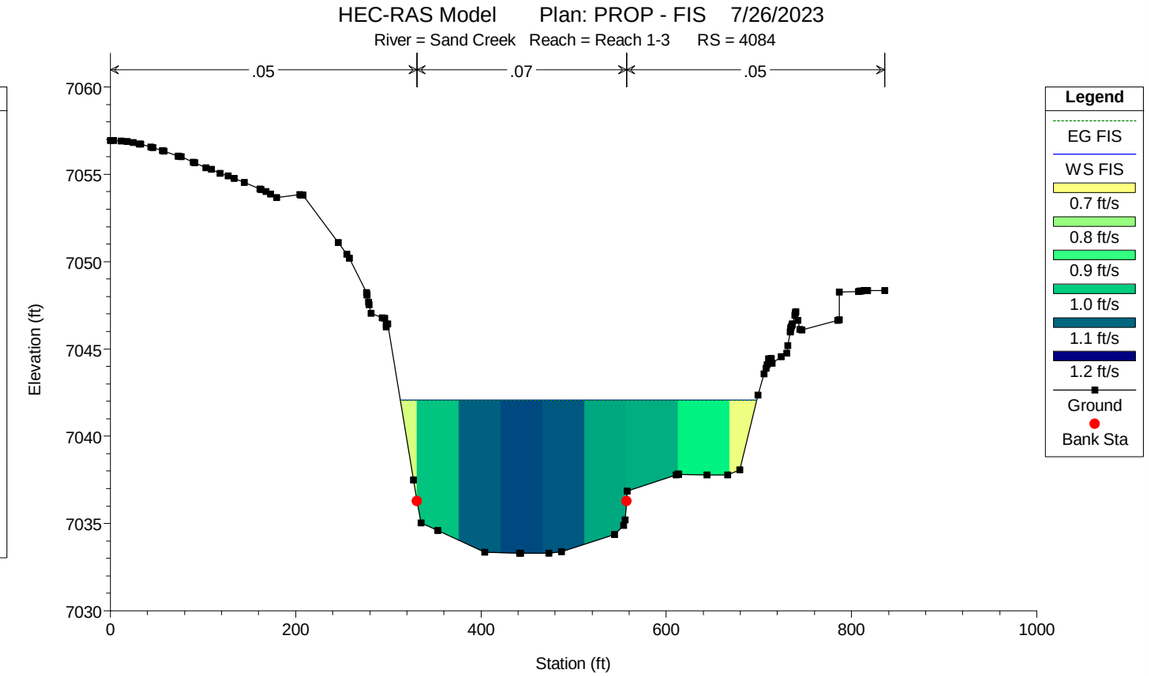


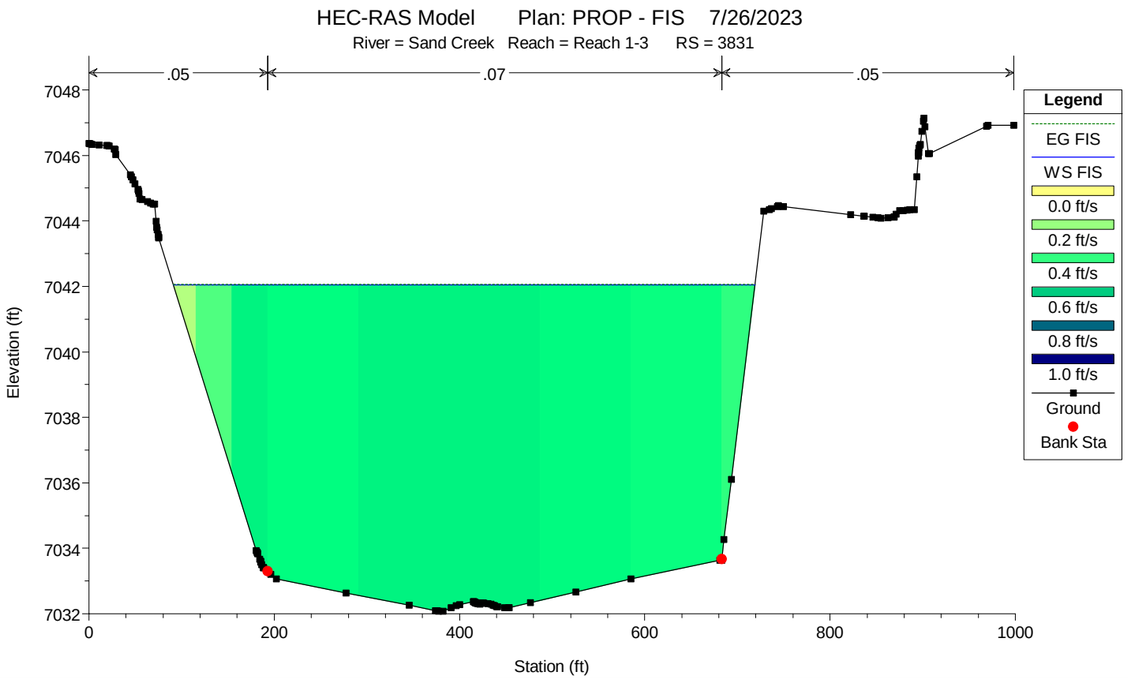


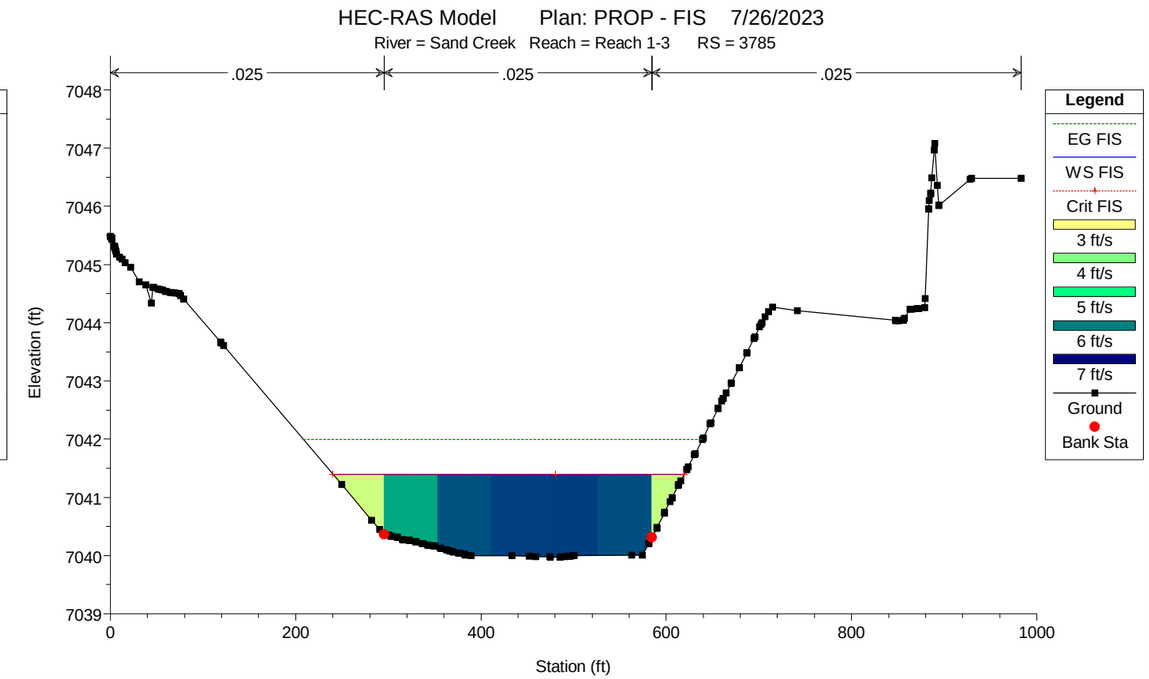


Sub-critical flow analysis for Water Surface evaluation of Naturalized Channel Design at the FIS flow rate only

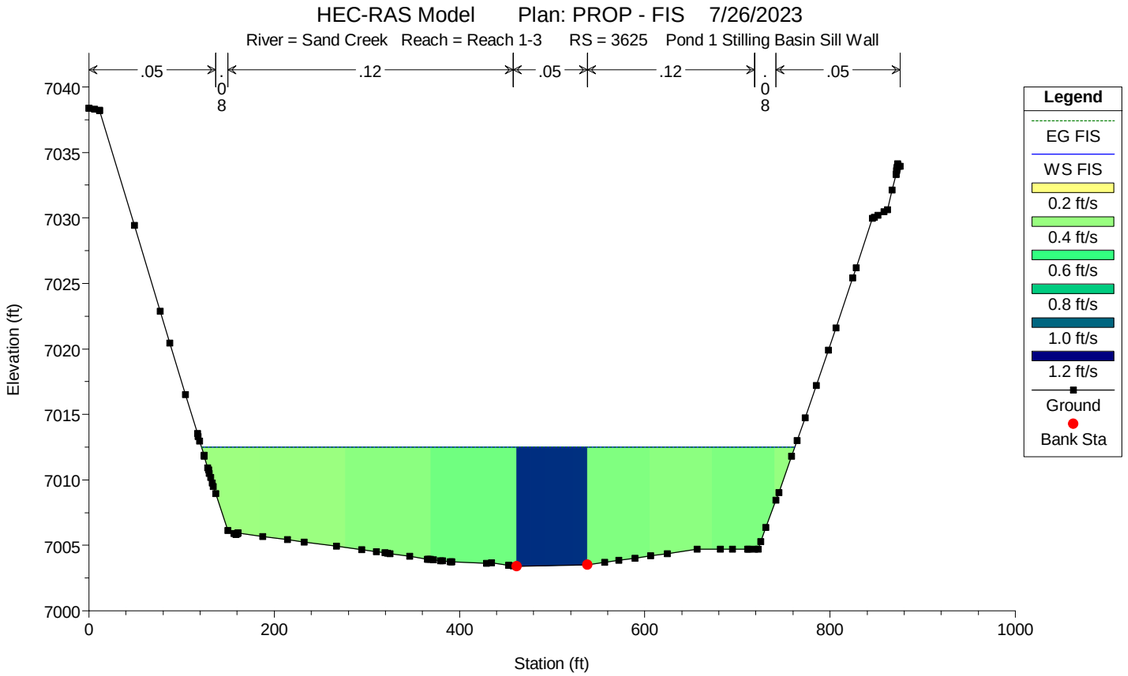


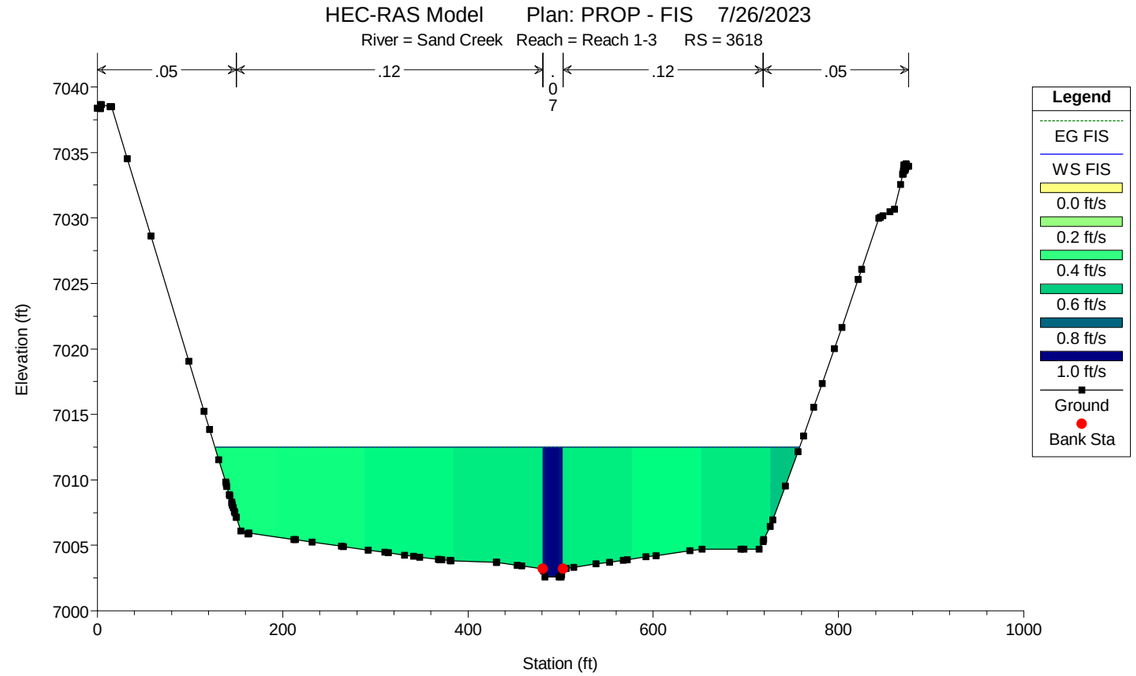


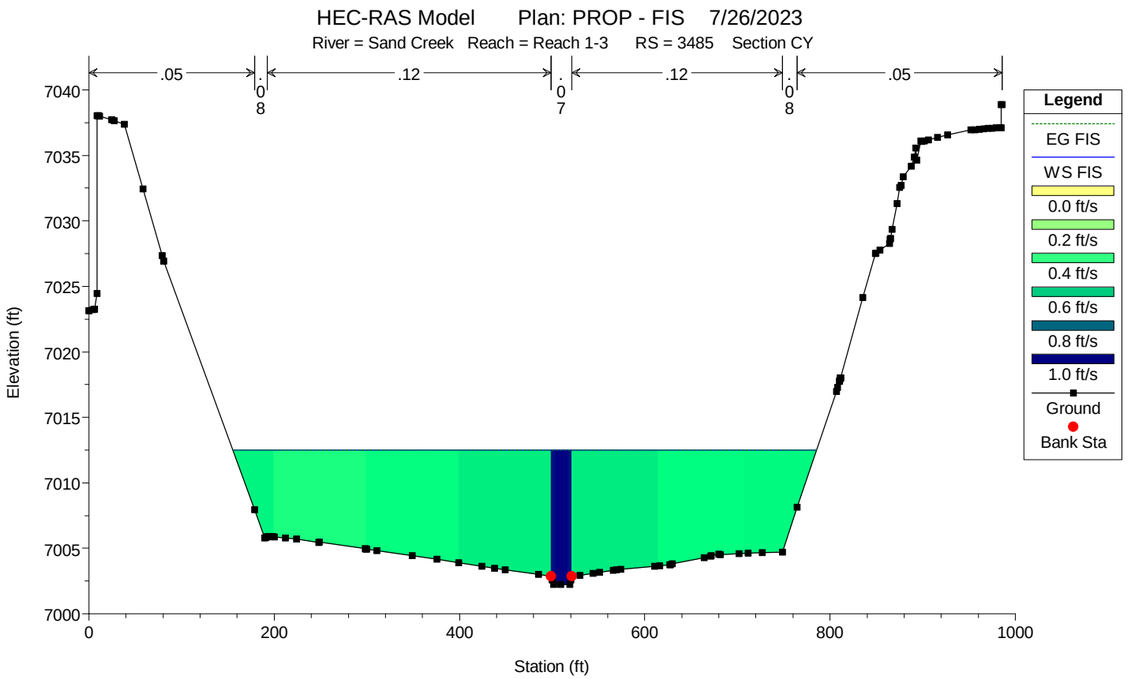


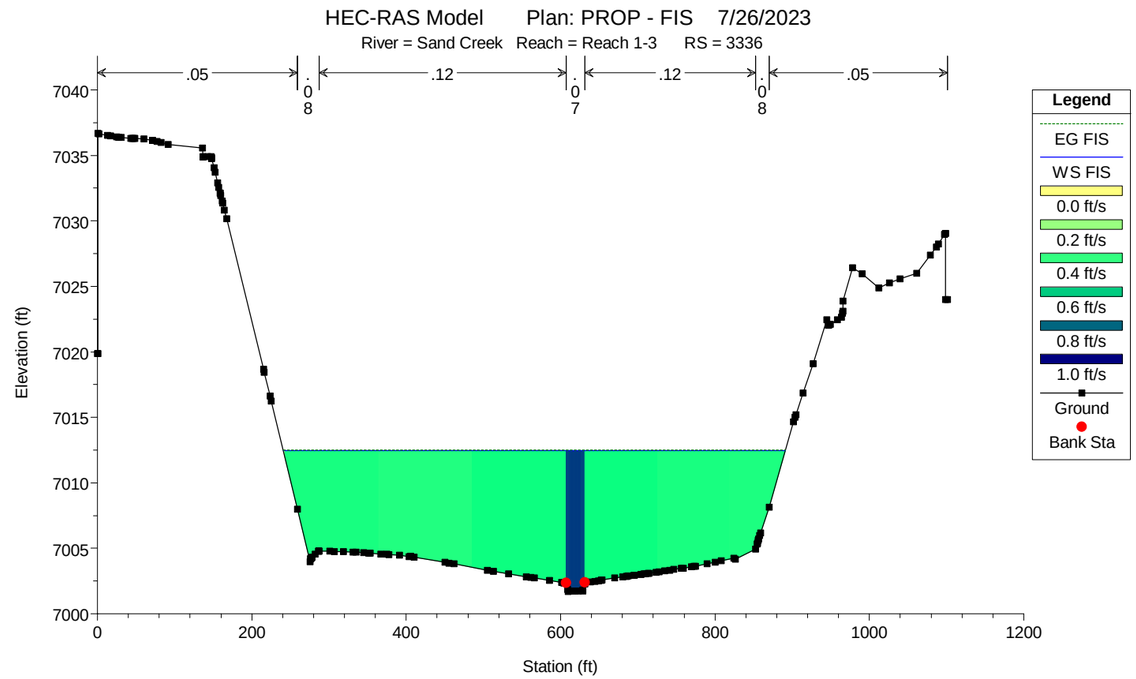


Sub-critical flow analysis for Water Surface evaluation of Naturalized Channel Design at the FIS flow rate only





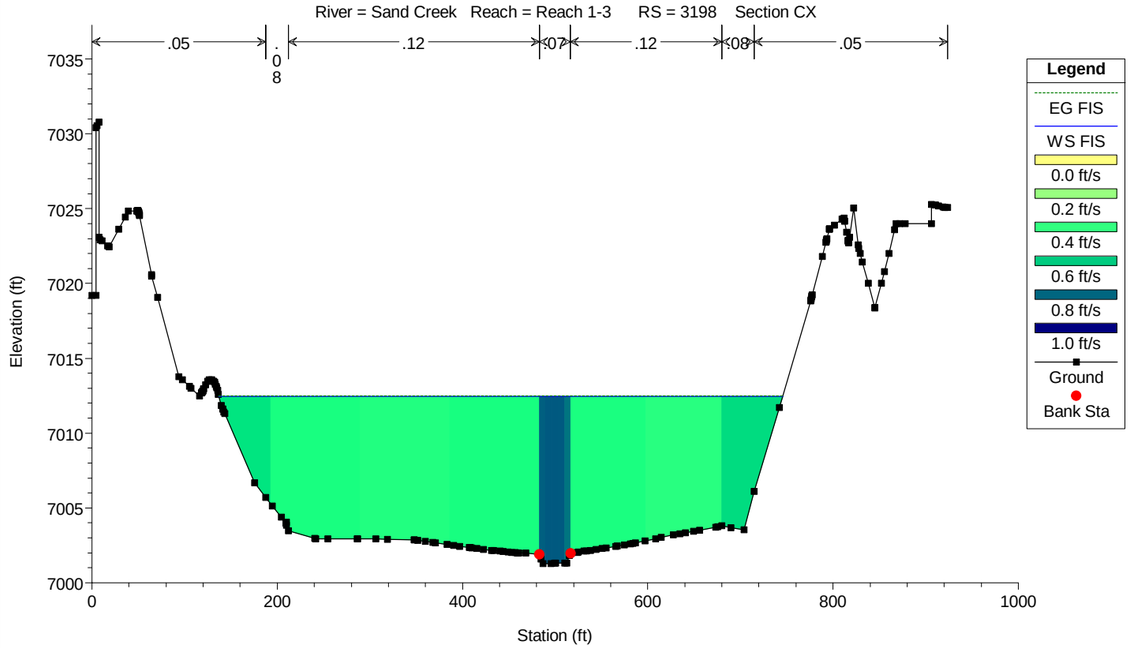




Sub-critical flow analysis for Water Surface evaluation of Naturalized Channel Design at the FIS flow rate only

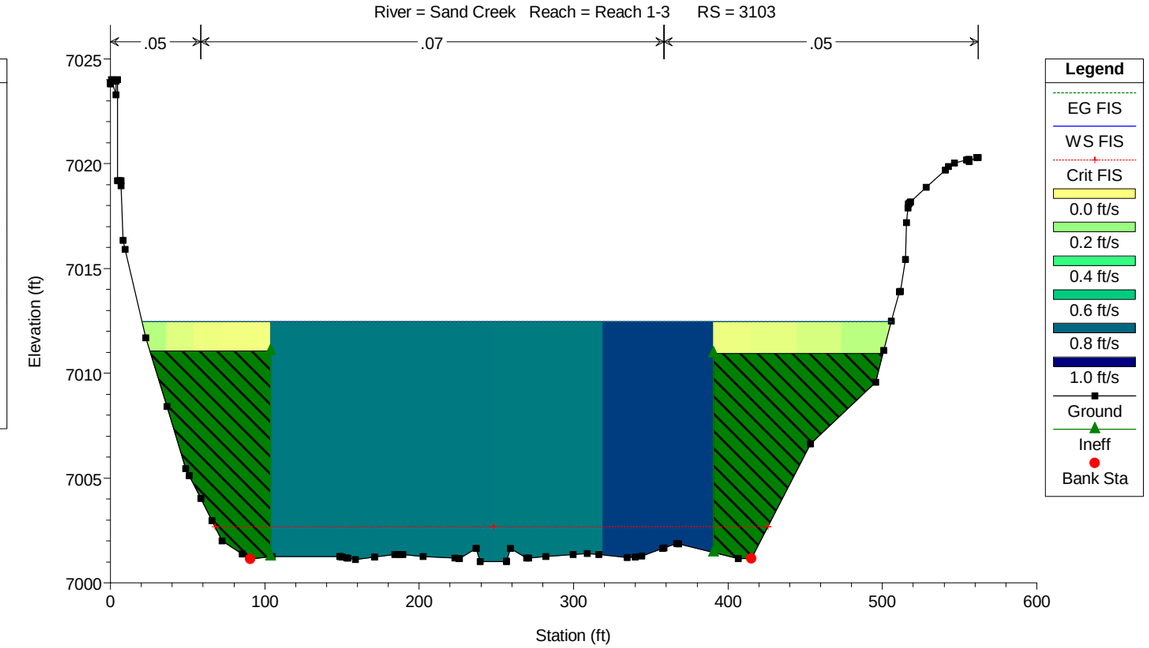
HEC-RAS Model Plan: PROP - FIS 7/26/2023

River = Sand Creek Reach = Reach 1-3 RS = 3198 Section CX



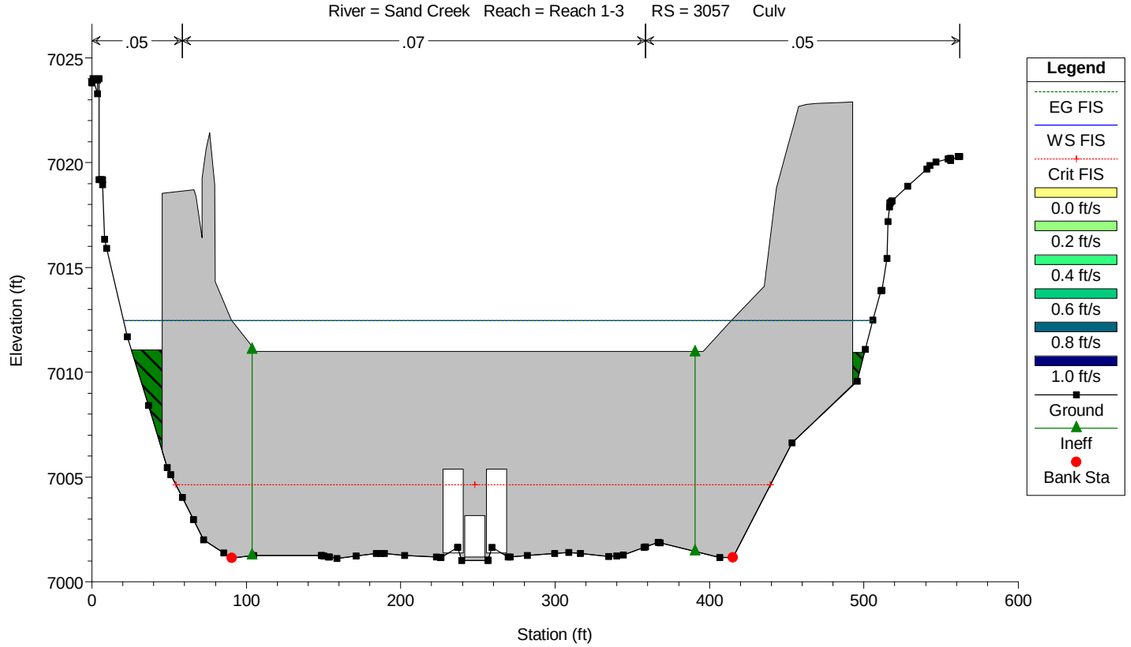
HEC-RAS Model Plan: PROP - FIS 7/26/2023

River = Sand Creek Reach = Reach 1-3 RS = 3103



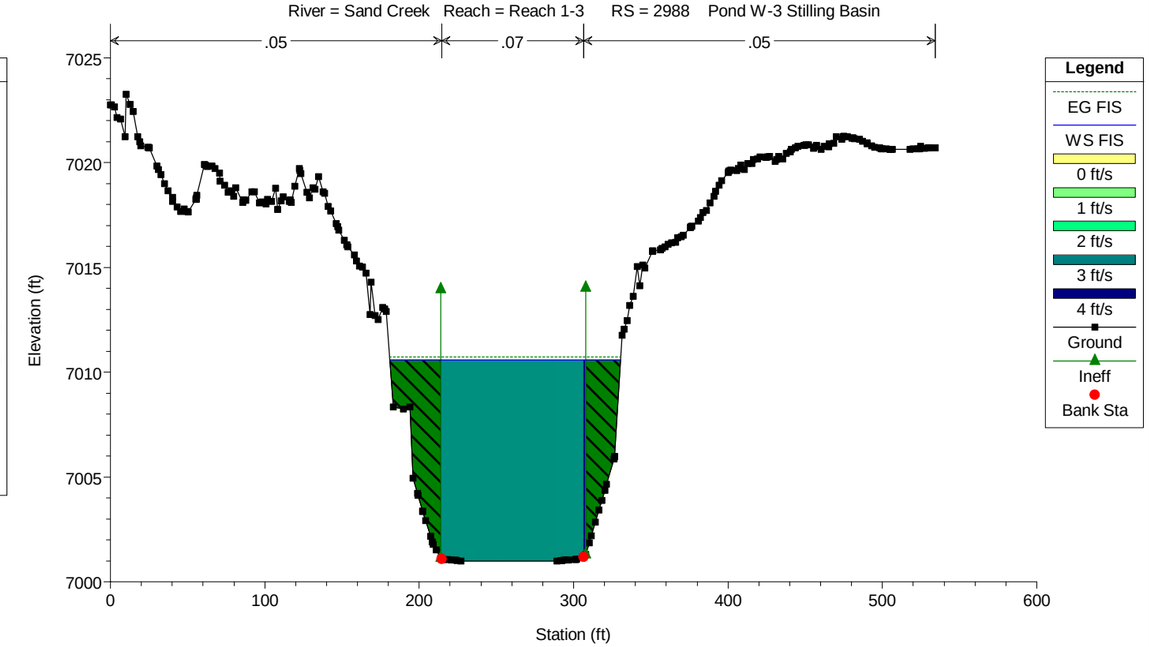
HEC-RAS Model Plan: PROP - FIS 7/26/2023

River = Sand Creek Reach = Reach 1-3 RS = 3057 Culv

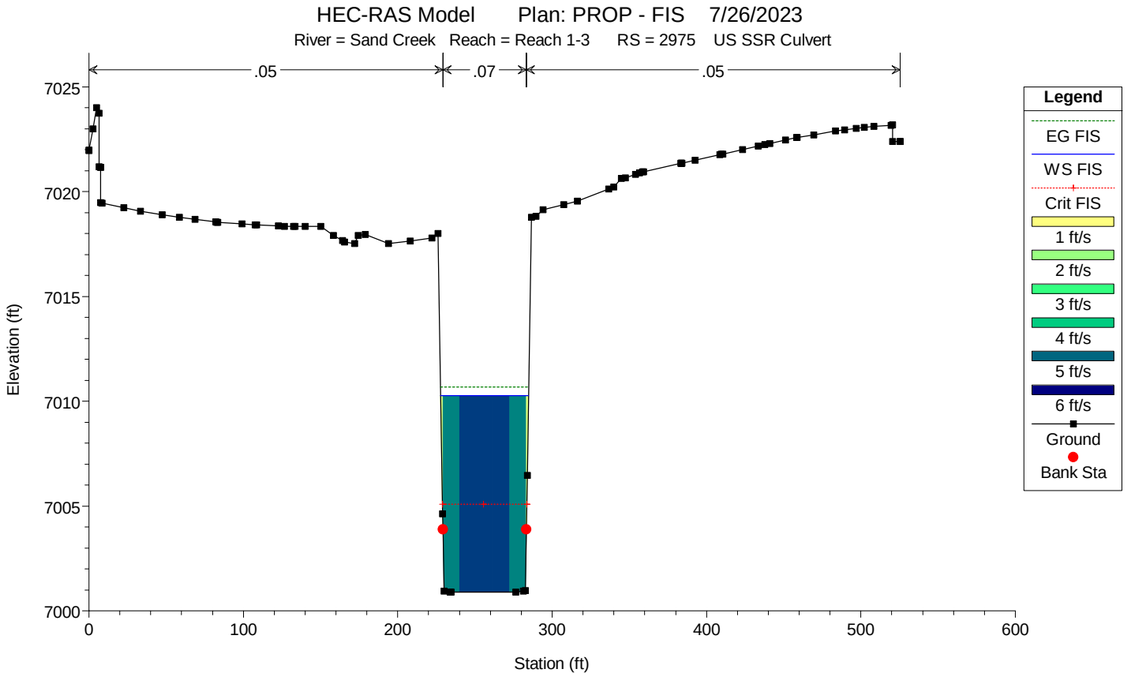


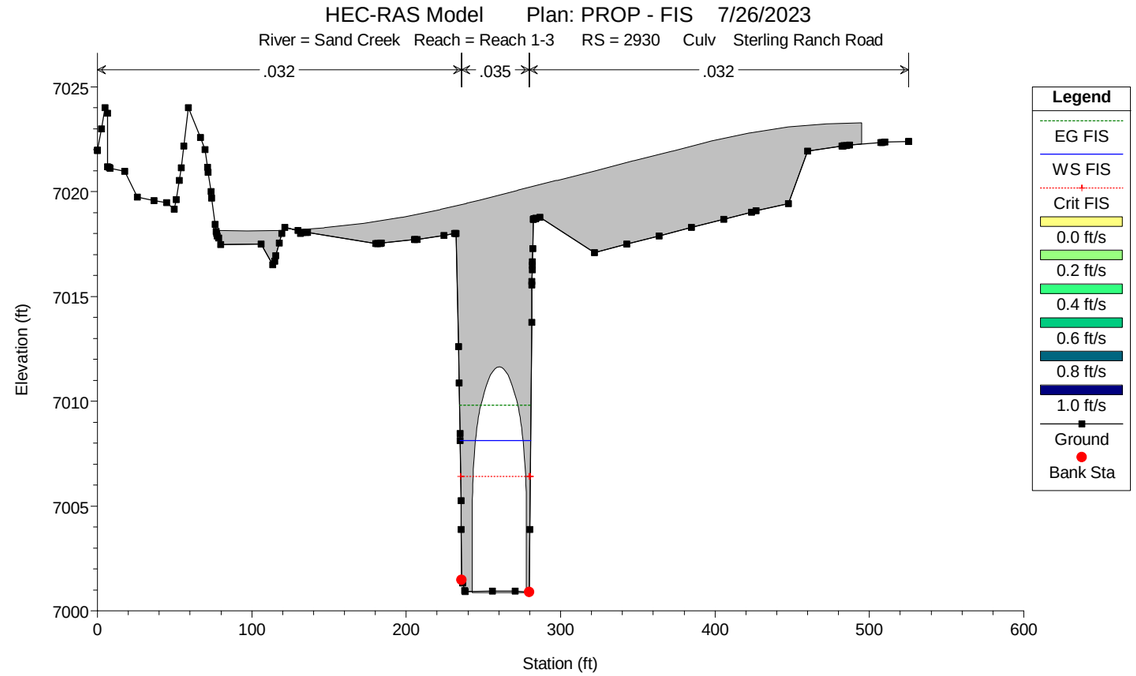
HEC-RAS Model Plan: PROP - FIS 7/26/2023

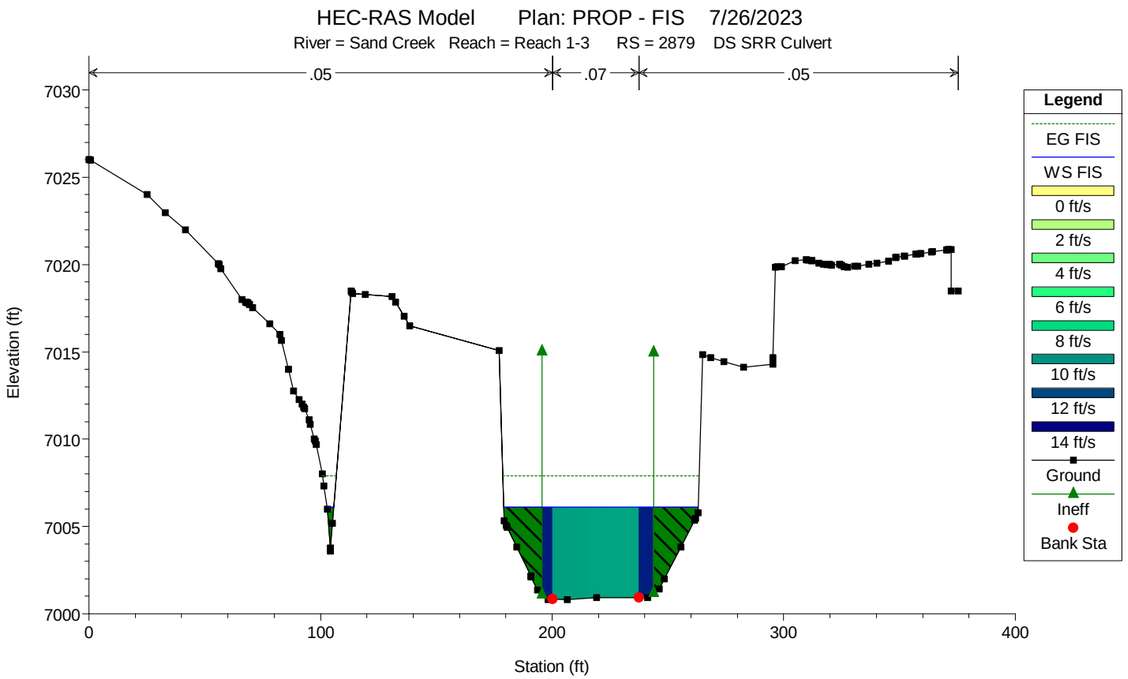
River = Sand Creek Reach = Reach 1-3 RS = 2988 Pond W-3 Stilling Basin

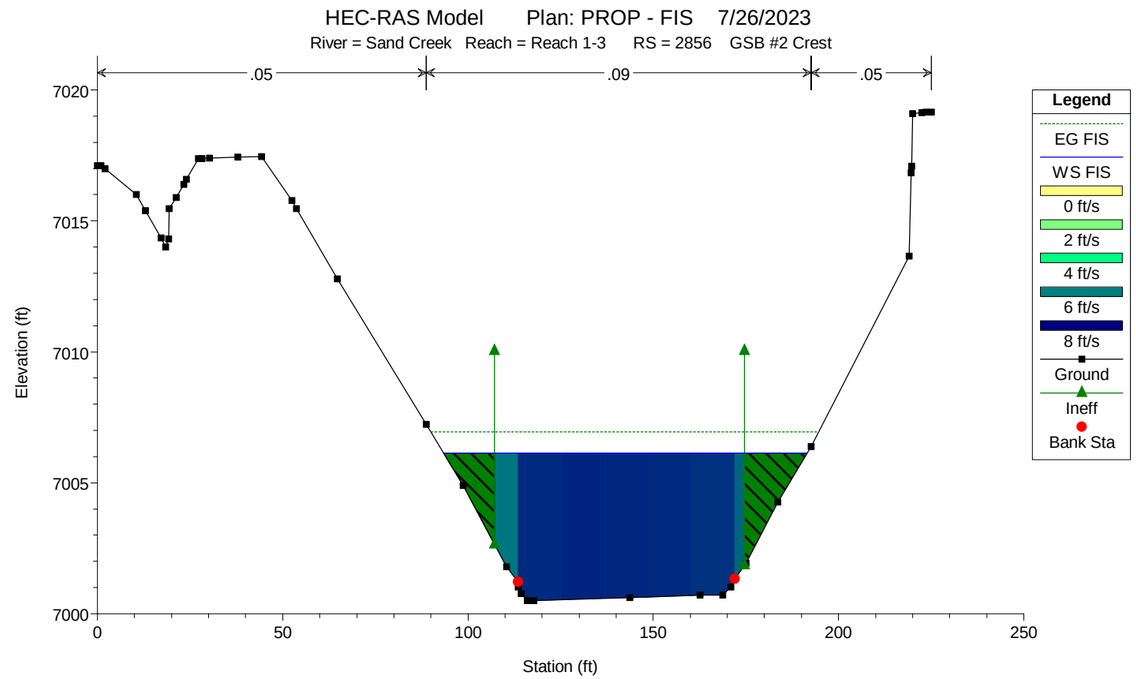


Sub-critical flow analysis for Water Surface evaluation of Naturalized Channel Design at the FIS flow rate only

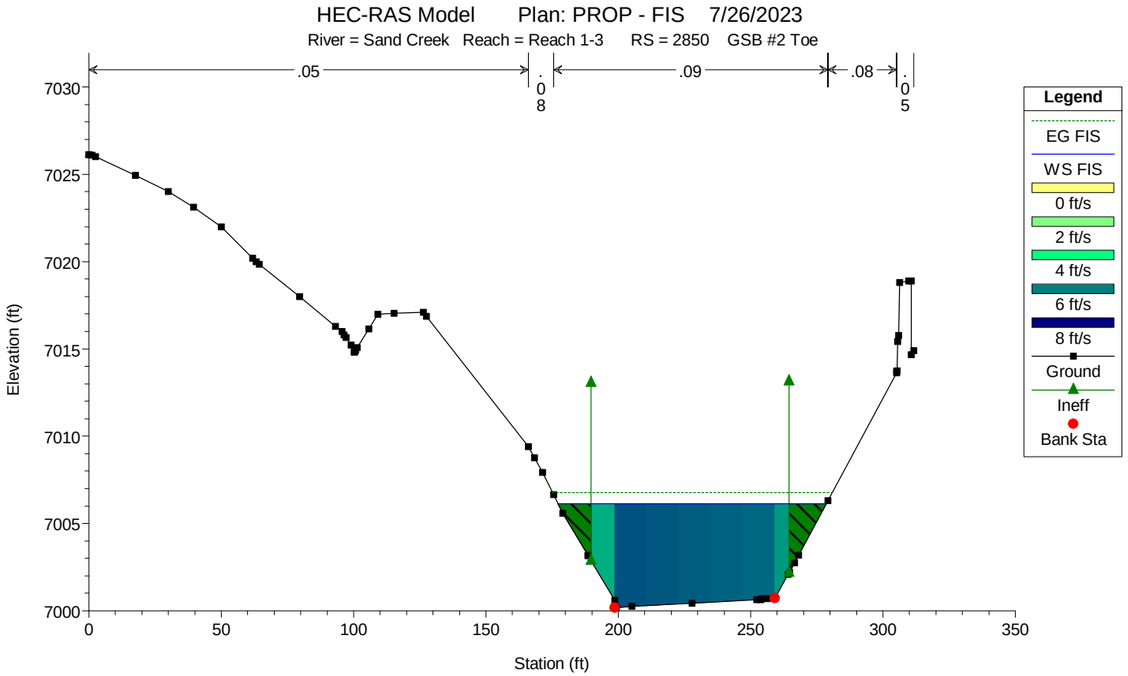


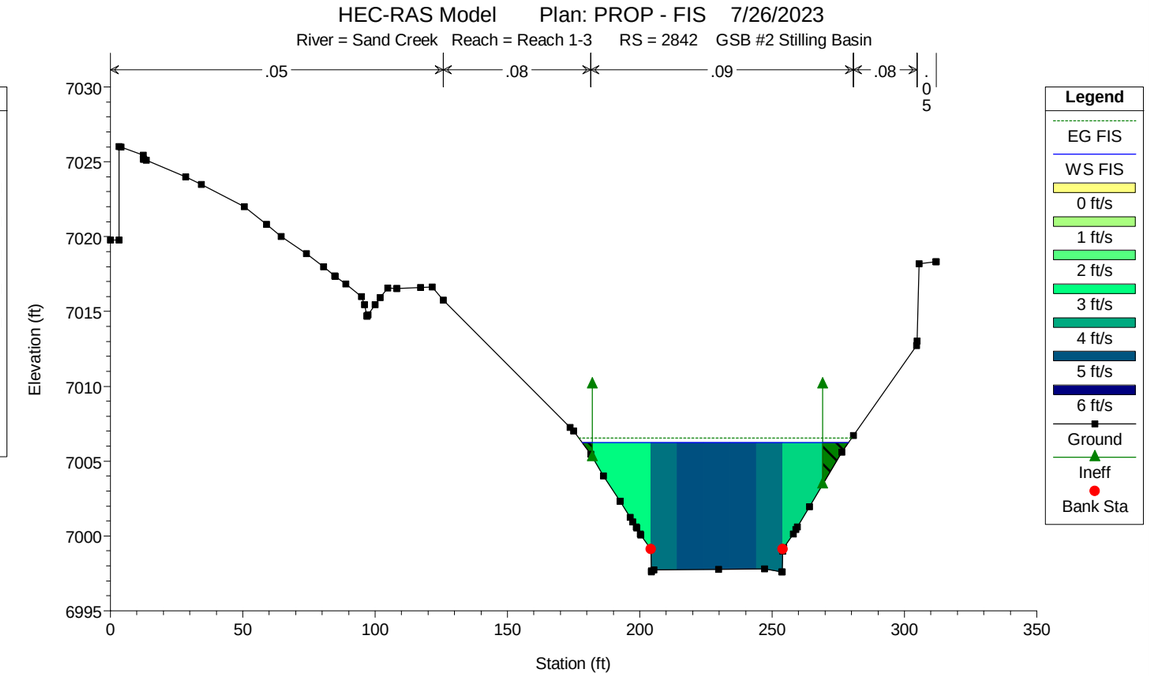


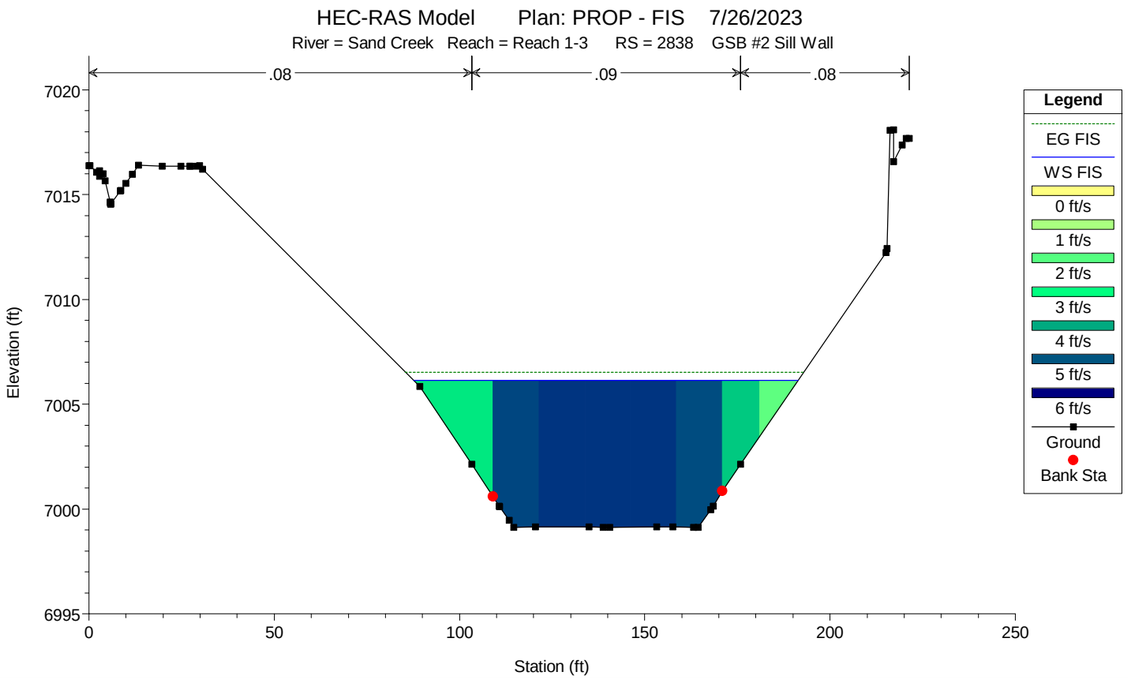


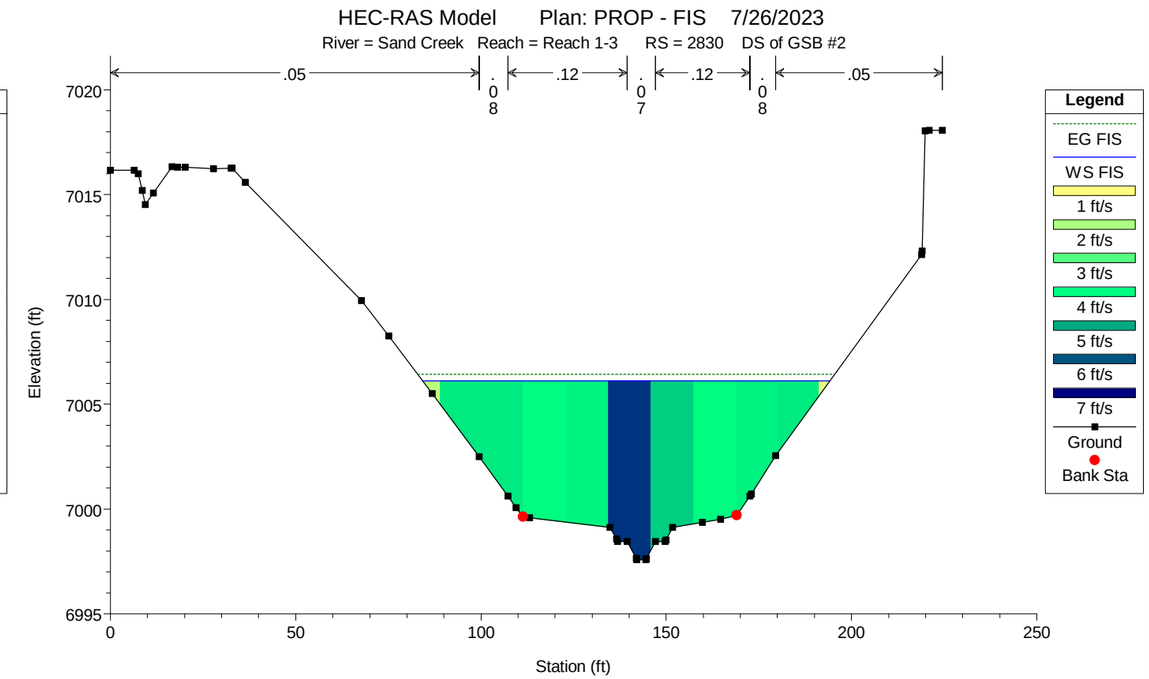


Sub-critical flow analysis for Water Surface evaluation of Naturalized Channel Design at the FIS flow rate only

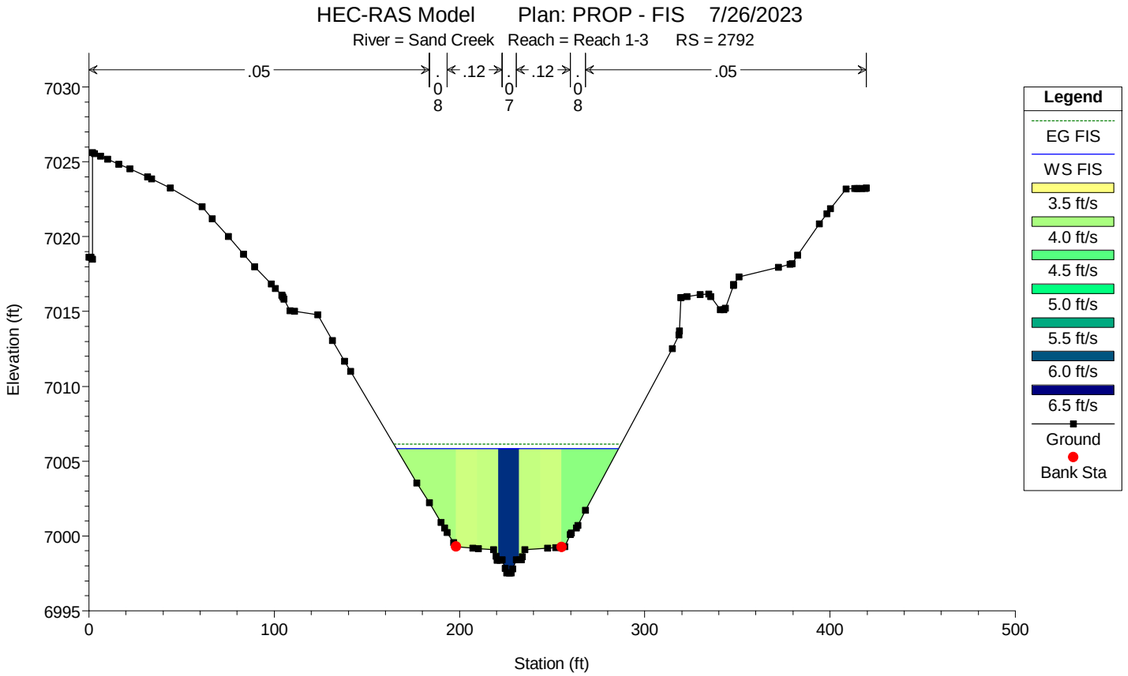


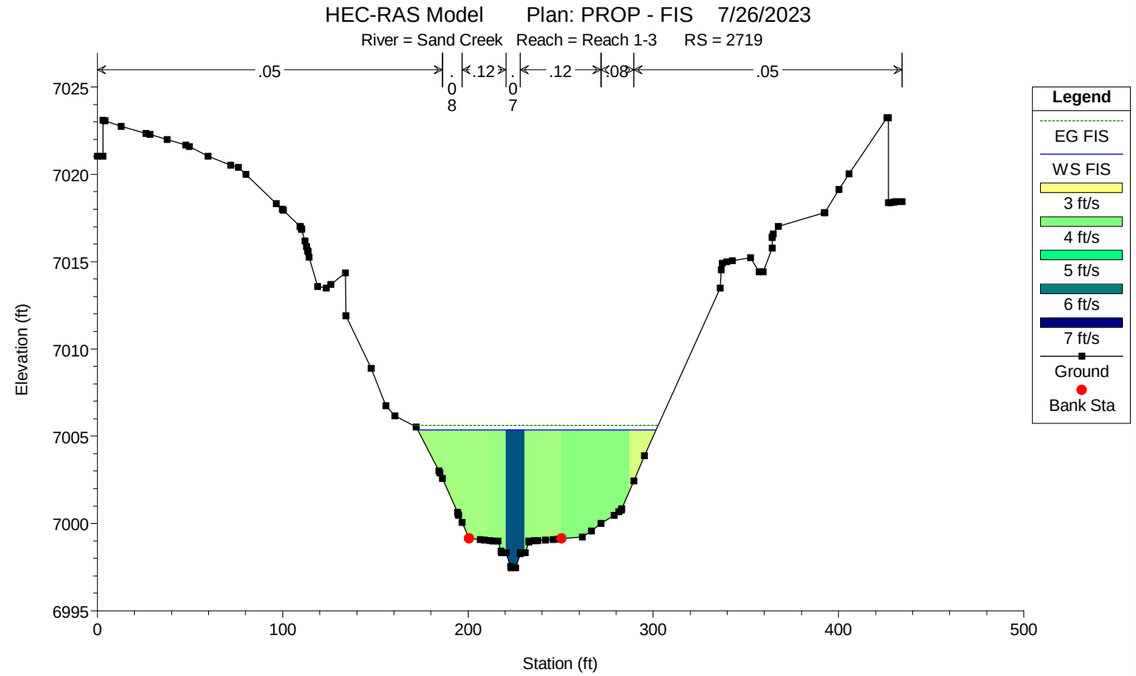


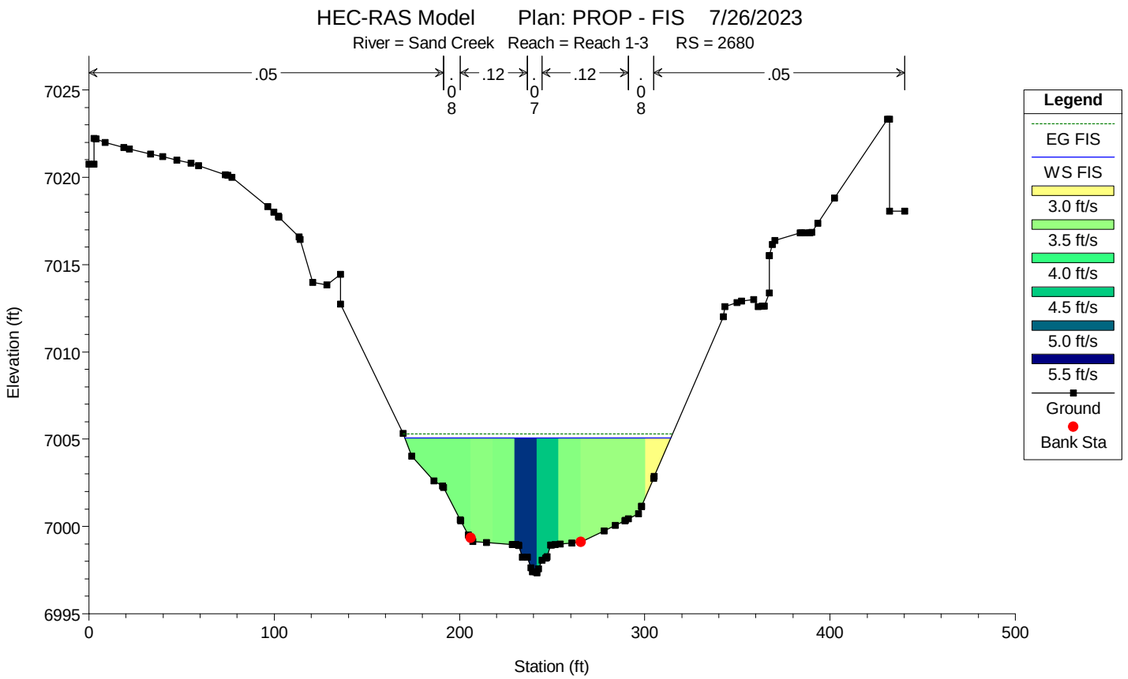


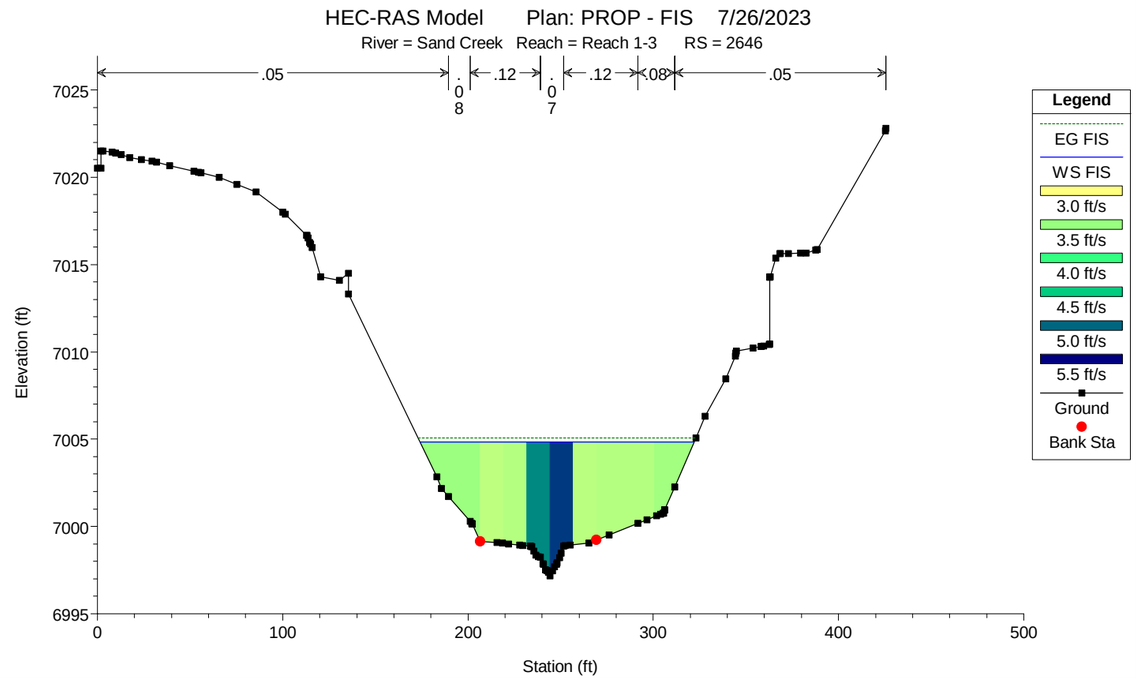


Sub-critical flow analysis for Water Surface evaluation of Naturalized Channel Design at the FIS flow rate only

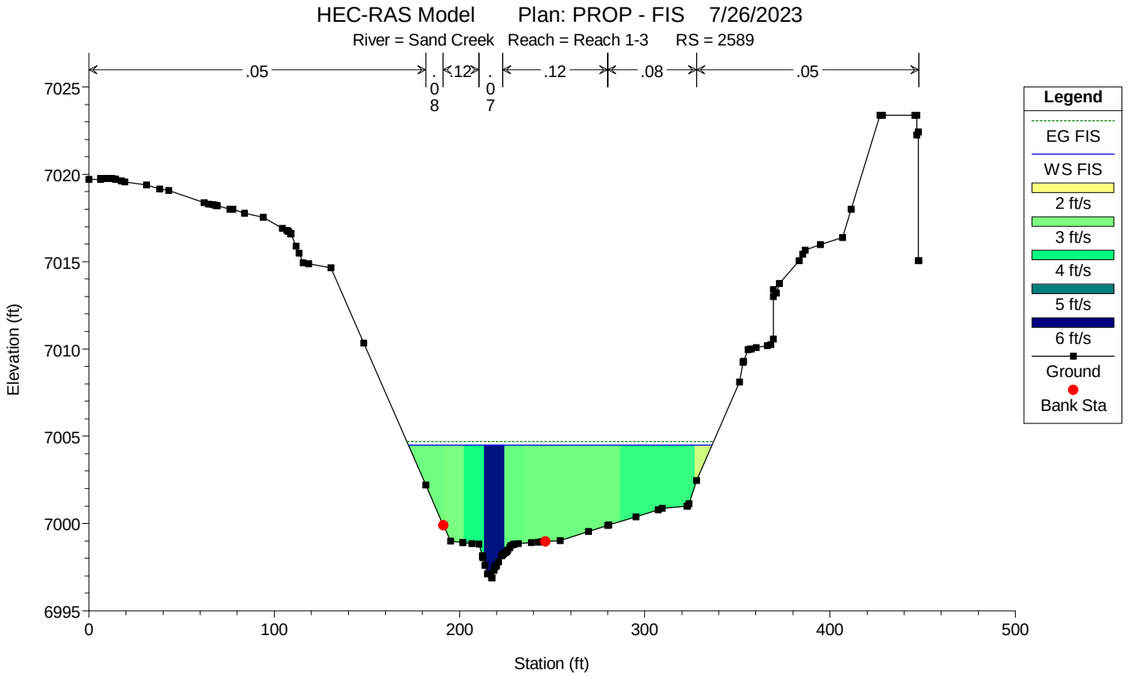


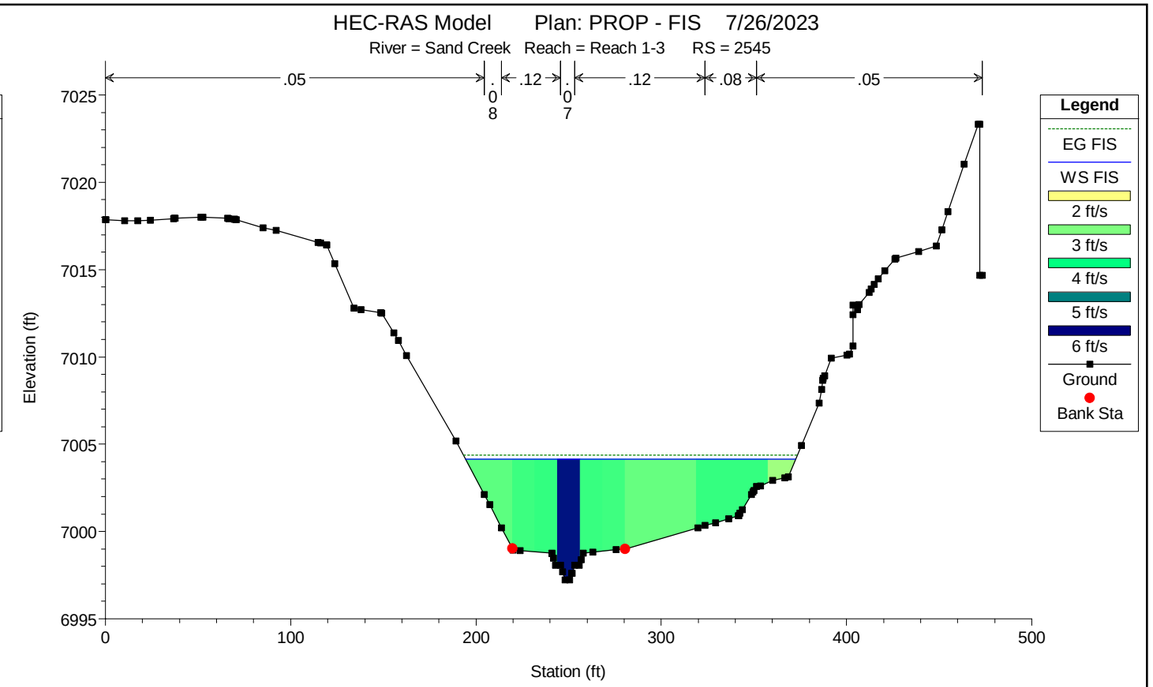


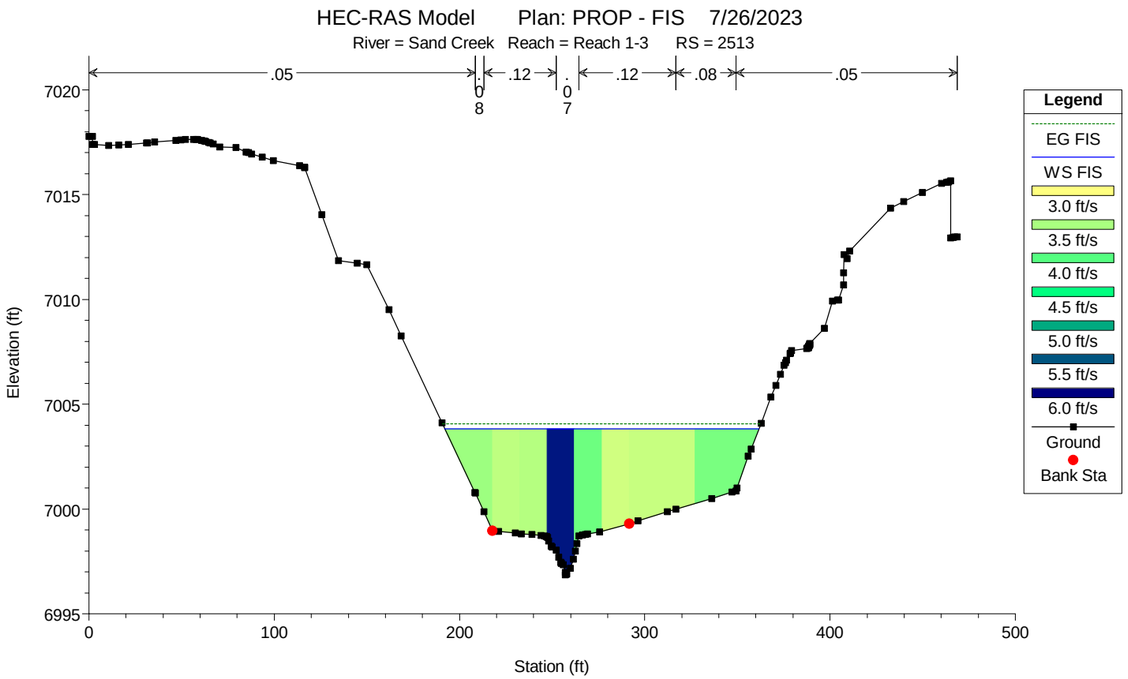


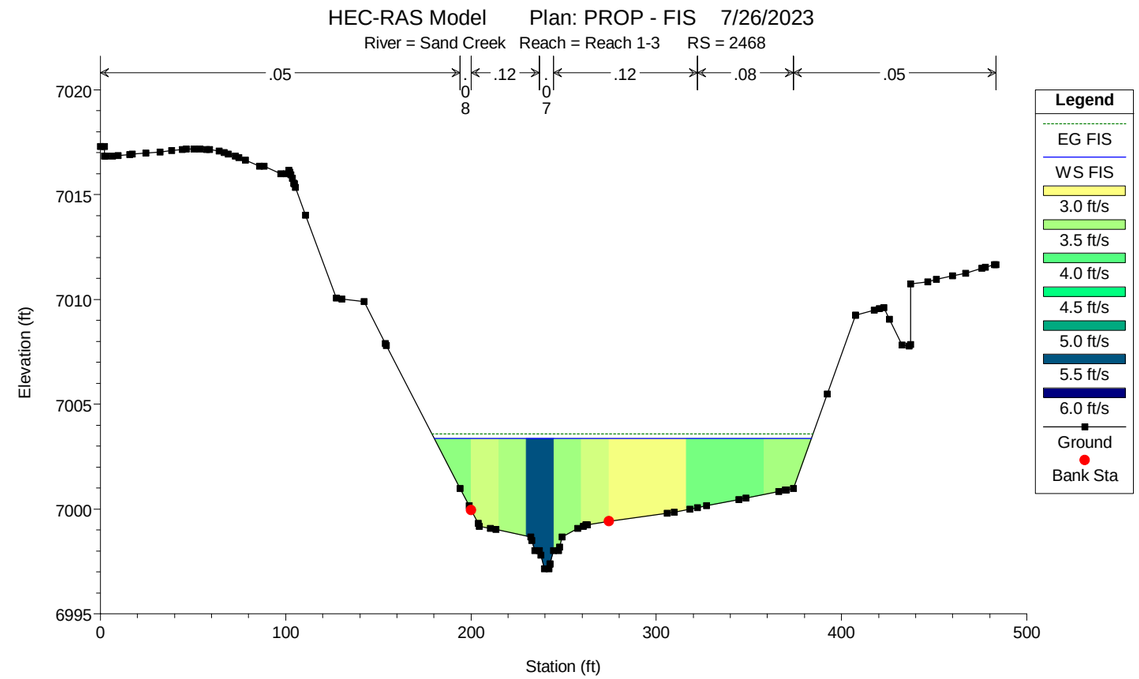


Sub-critical flow analysis for Water Surface evaluation of Naturalized Channel Design at the FIS flow rate only

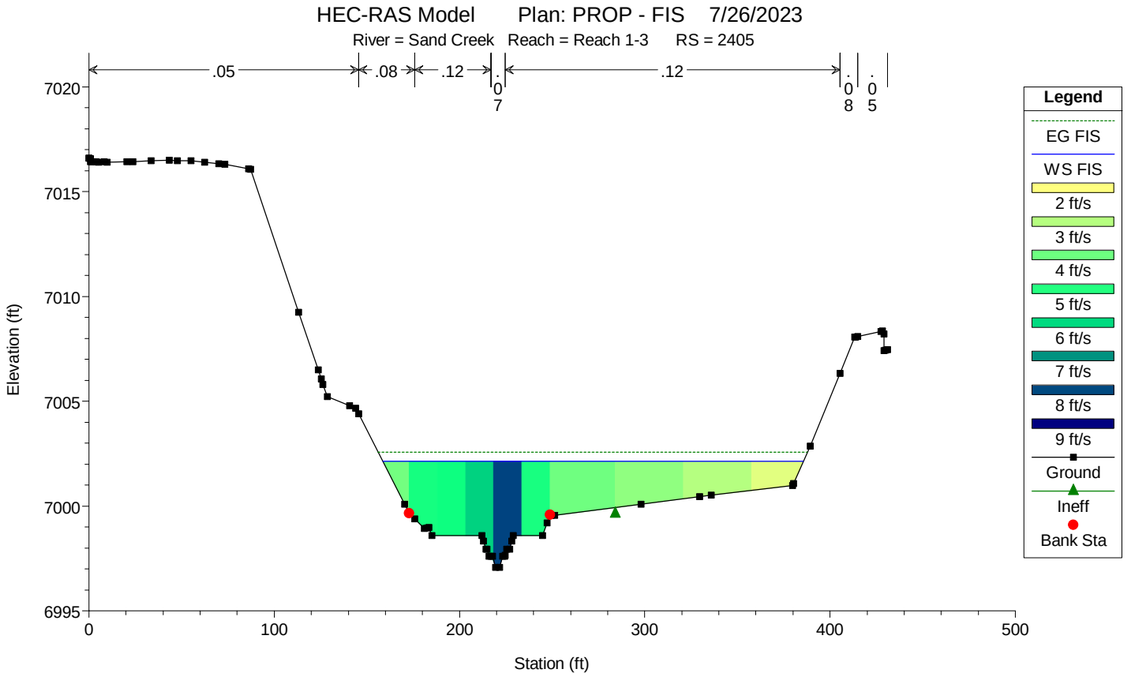


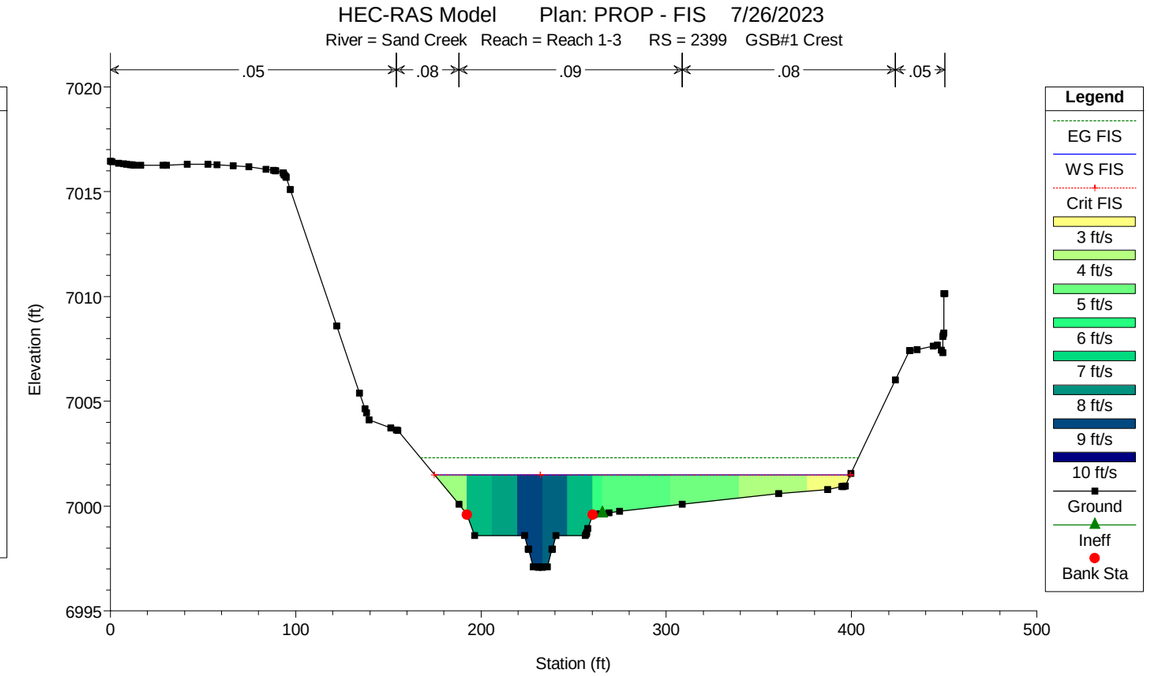


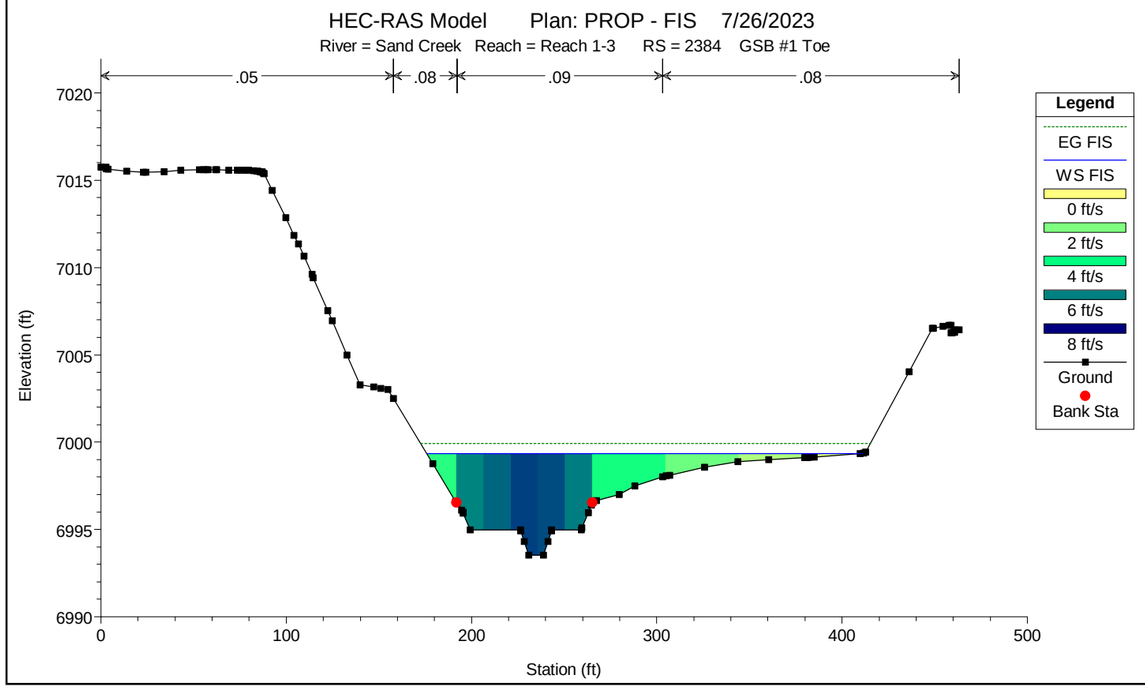


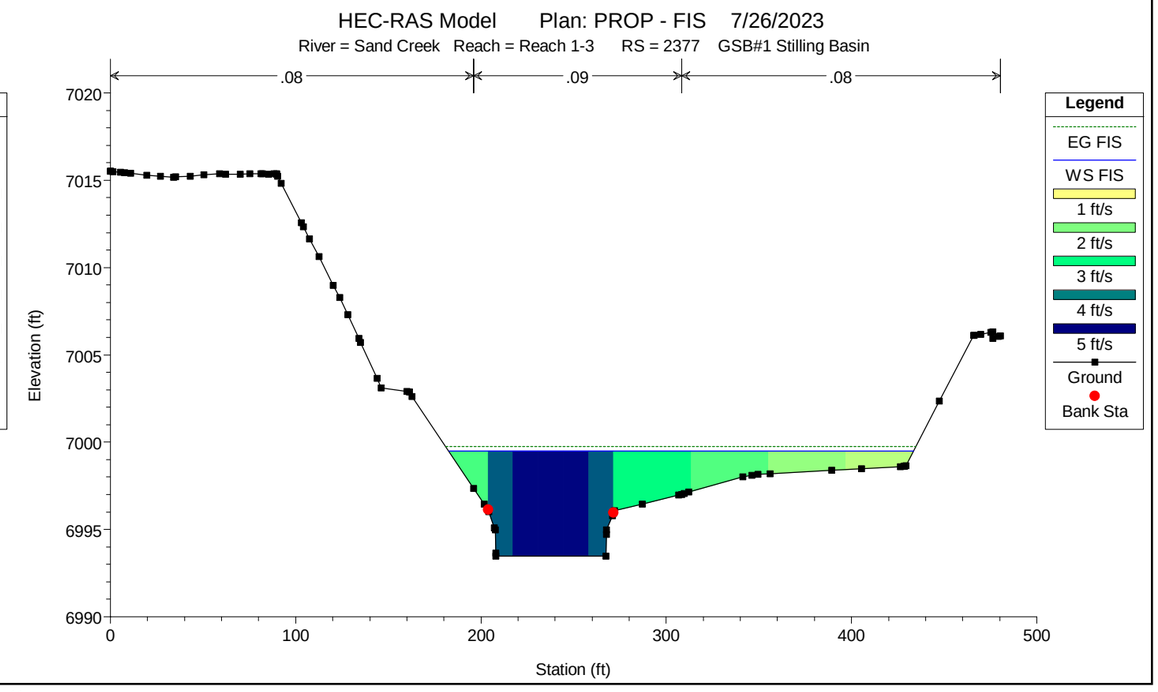


Sub-critical flow analysis for Water Surface evaluation of Naturalized Channel Design at the FIS flow rate only

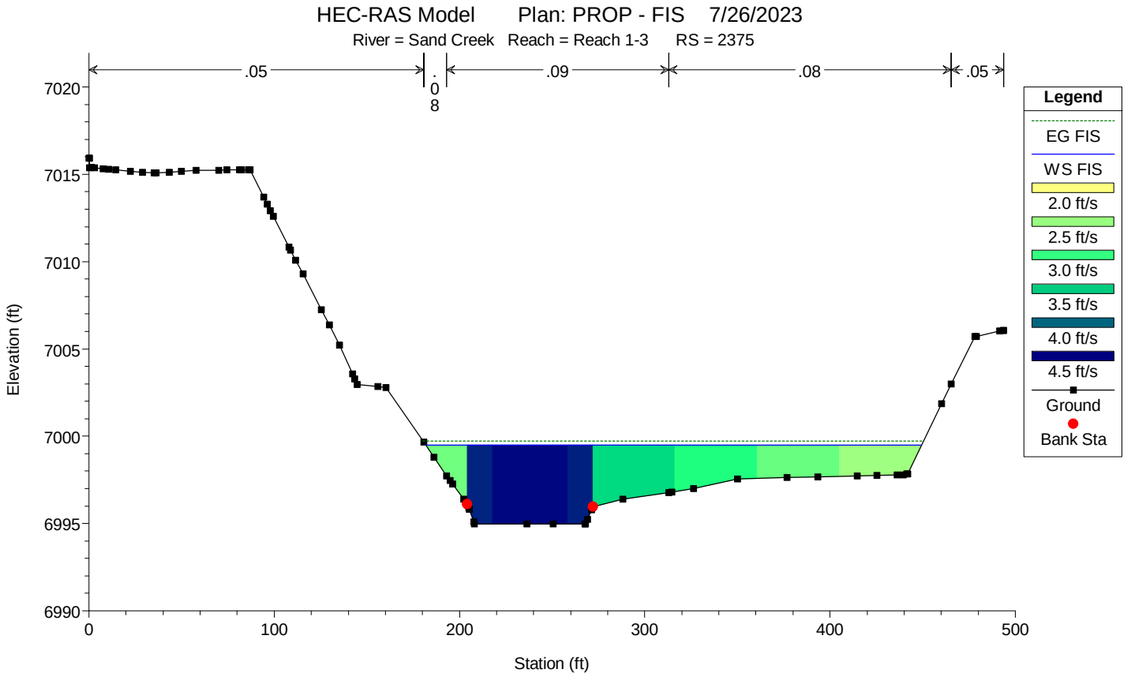


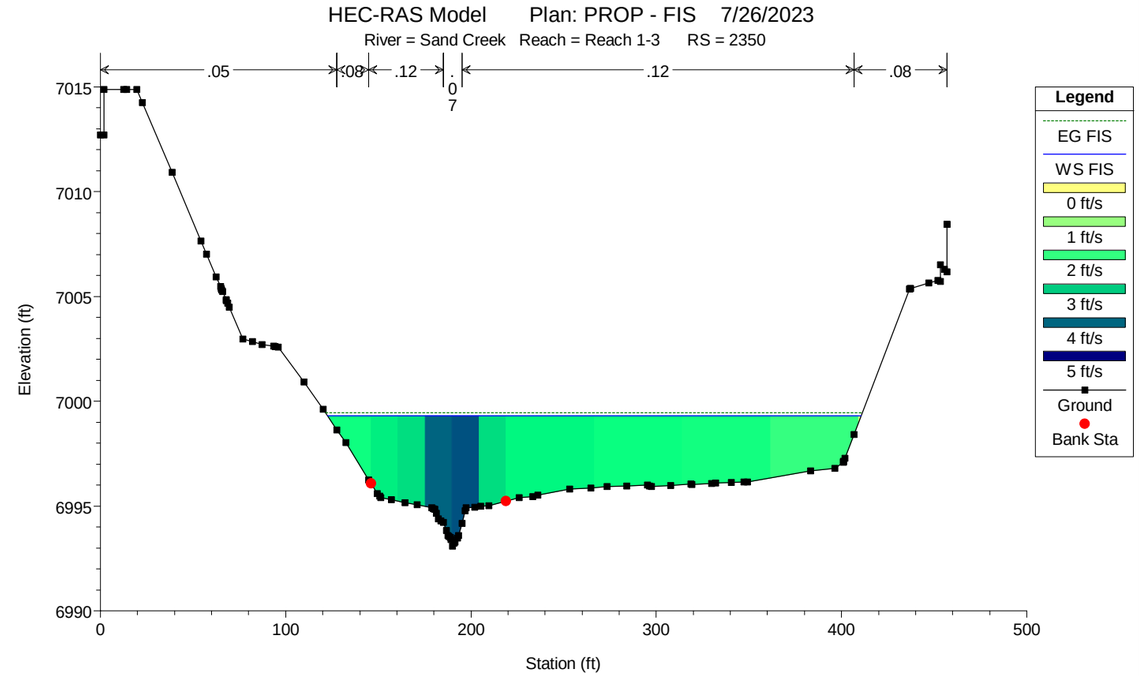


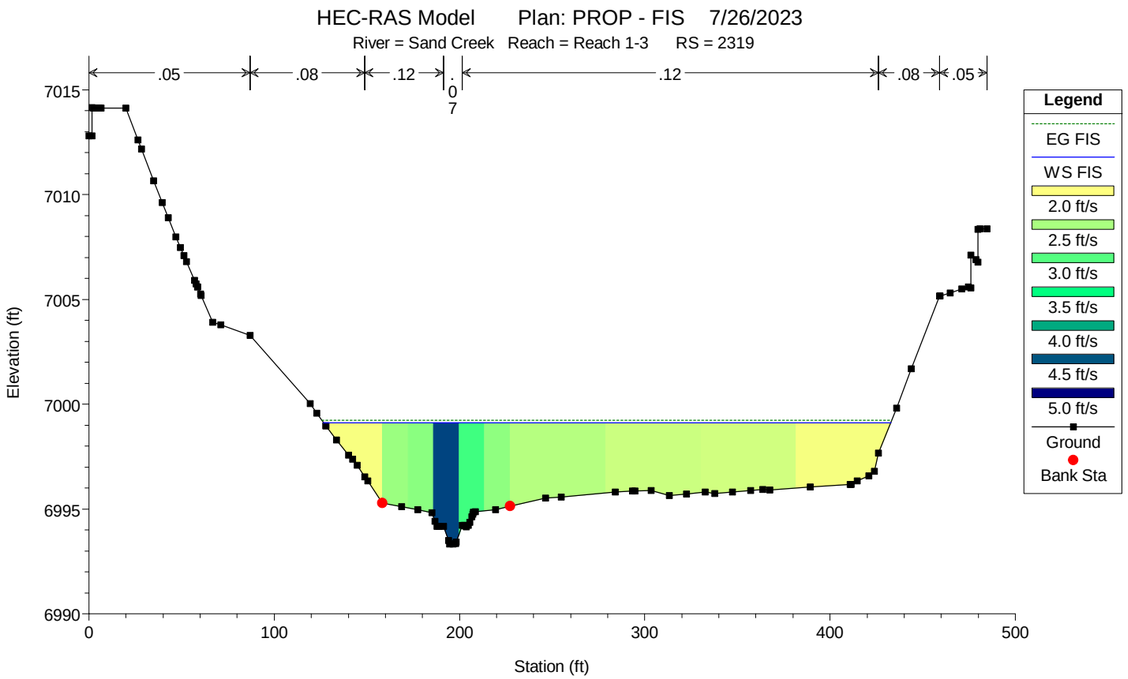


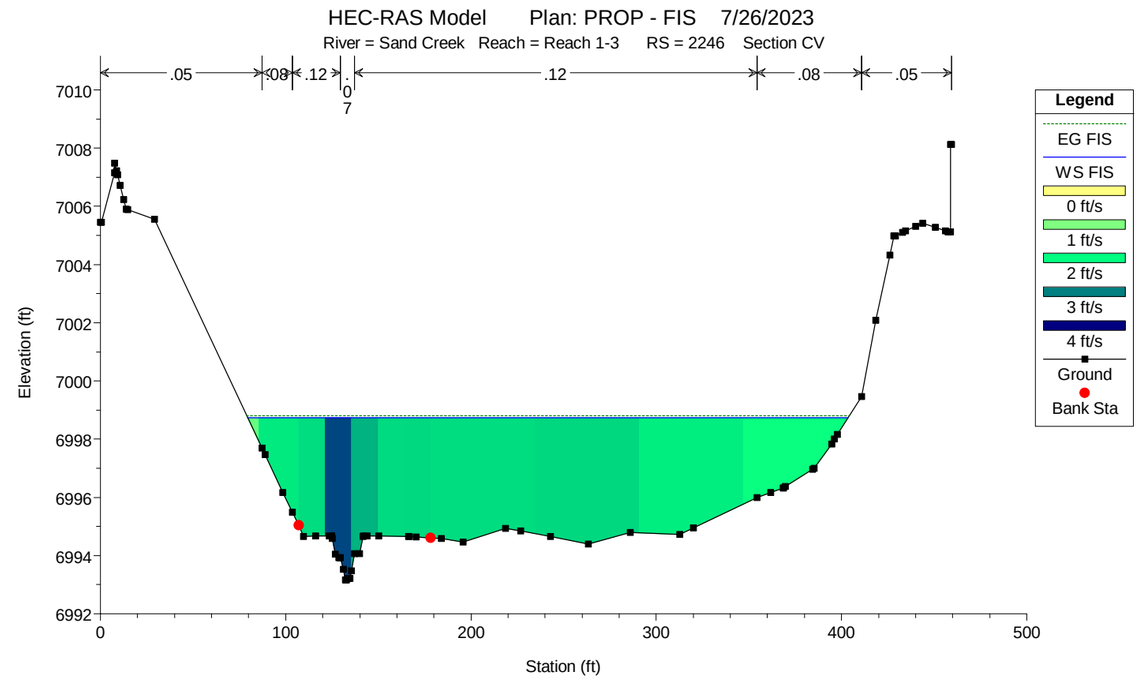


Sub-critical flow analysis for Water Surface evaluation of Naturalized Channel Design at the FIS flow rate only

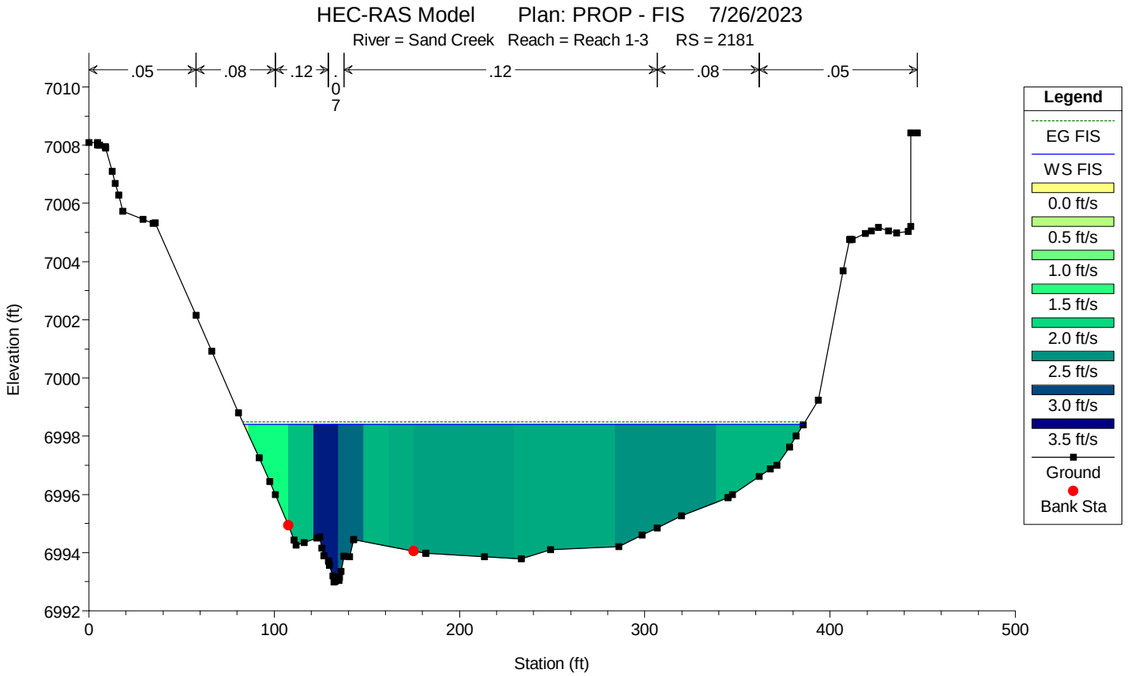


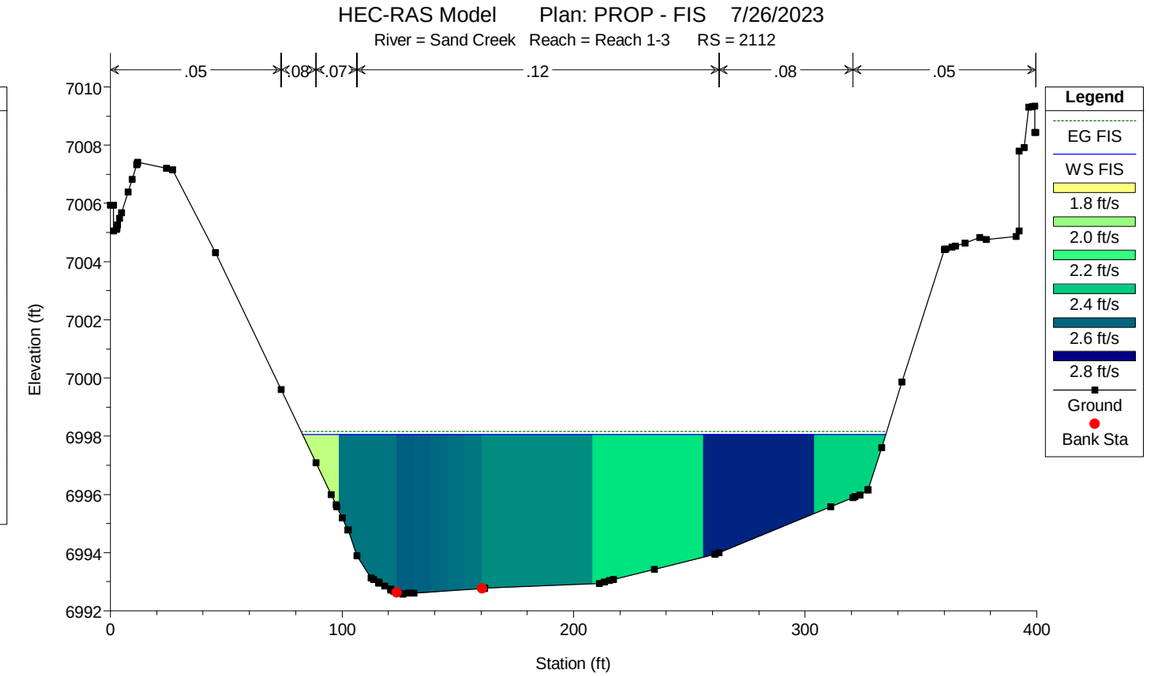


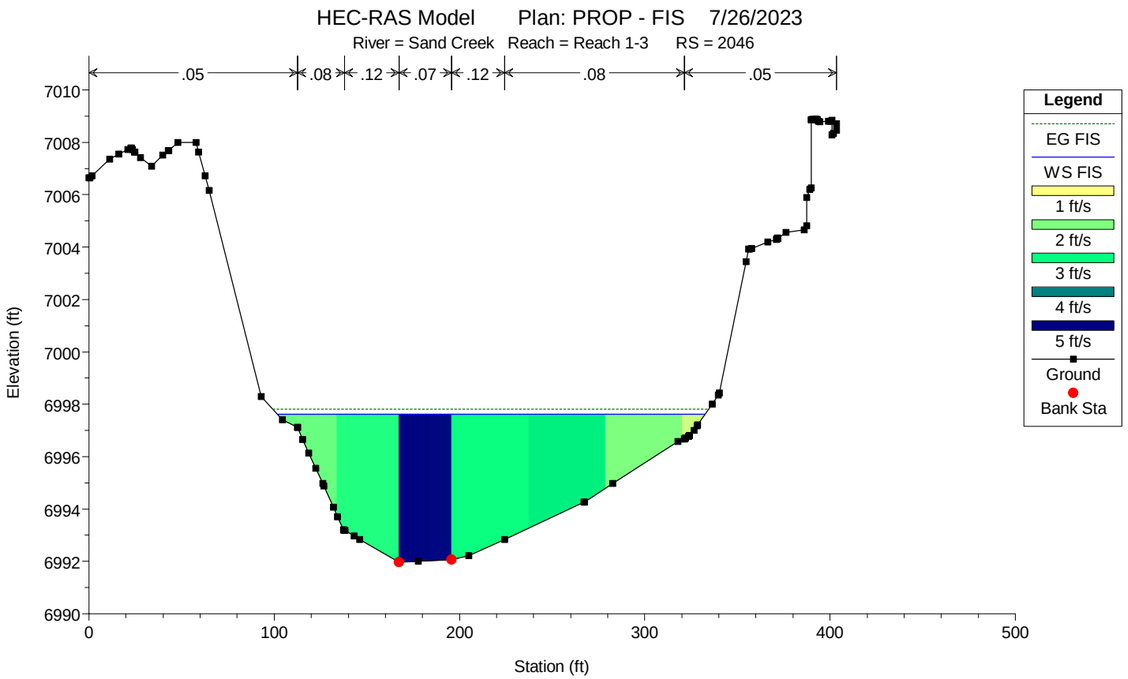


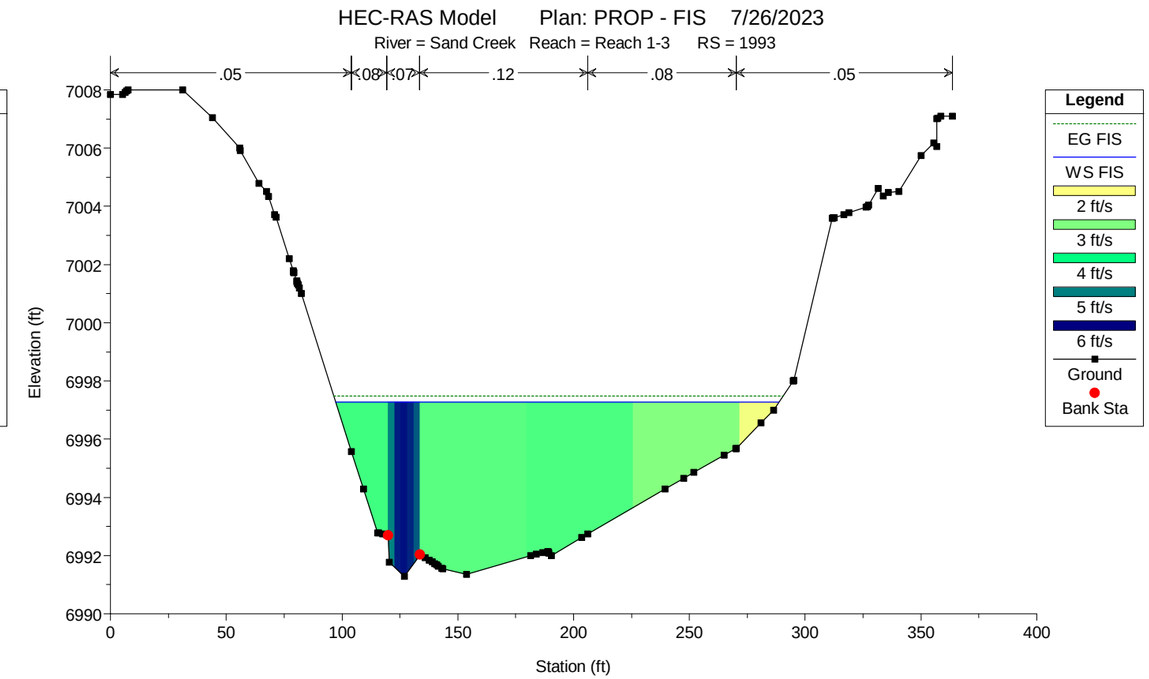


Sub-critical flow analysis for Water Surface evaluation of Naturalized Channel Design at the FIS flow rate only

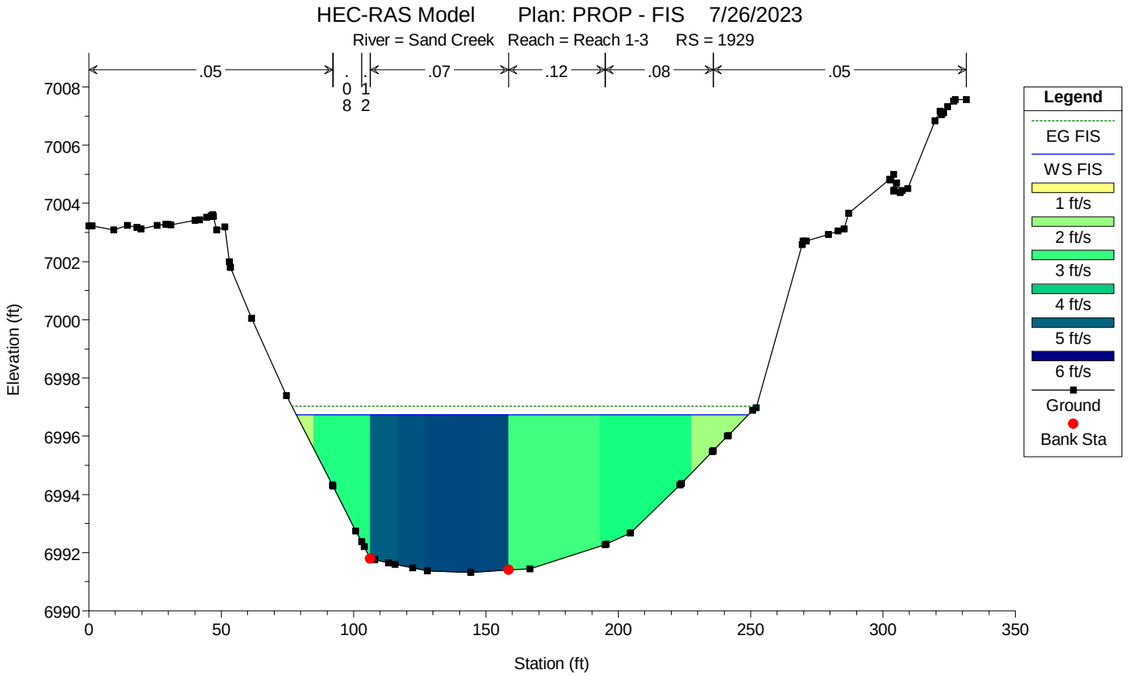


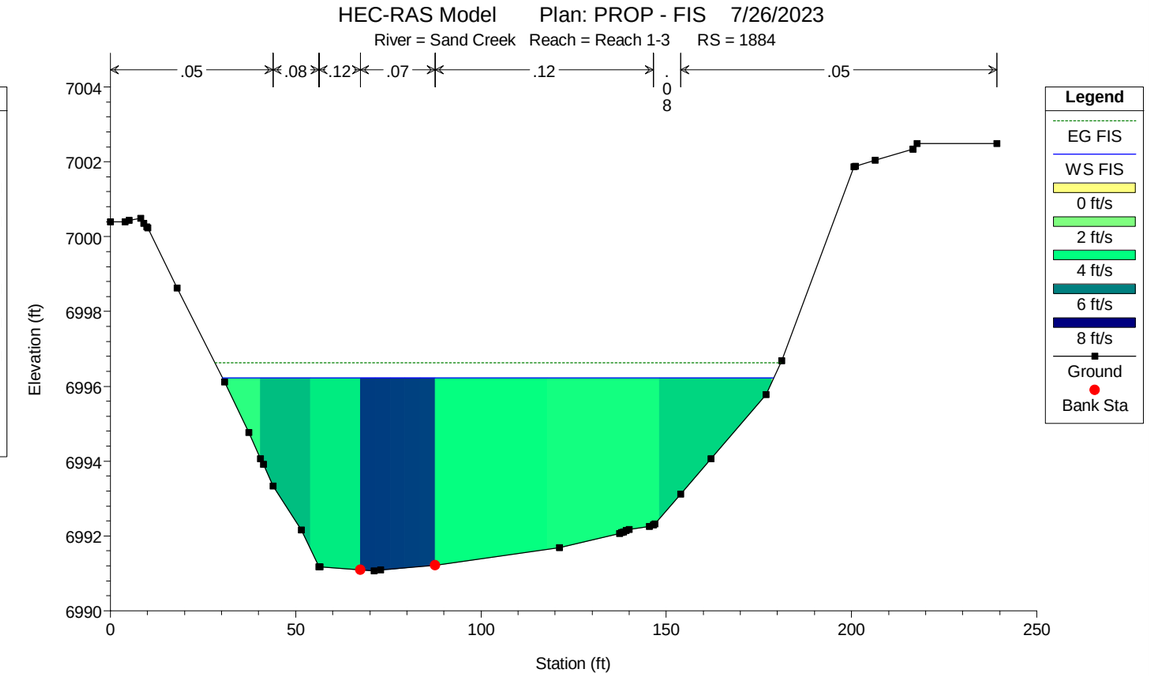


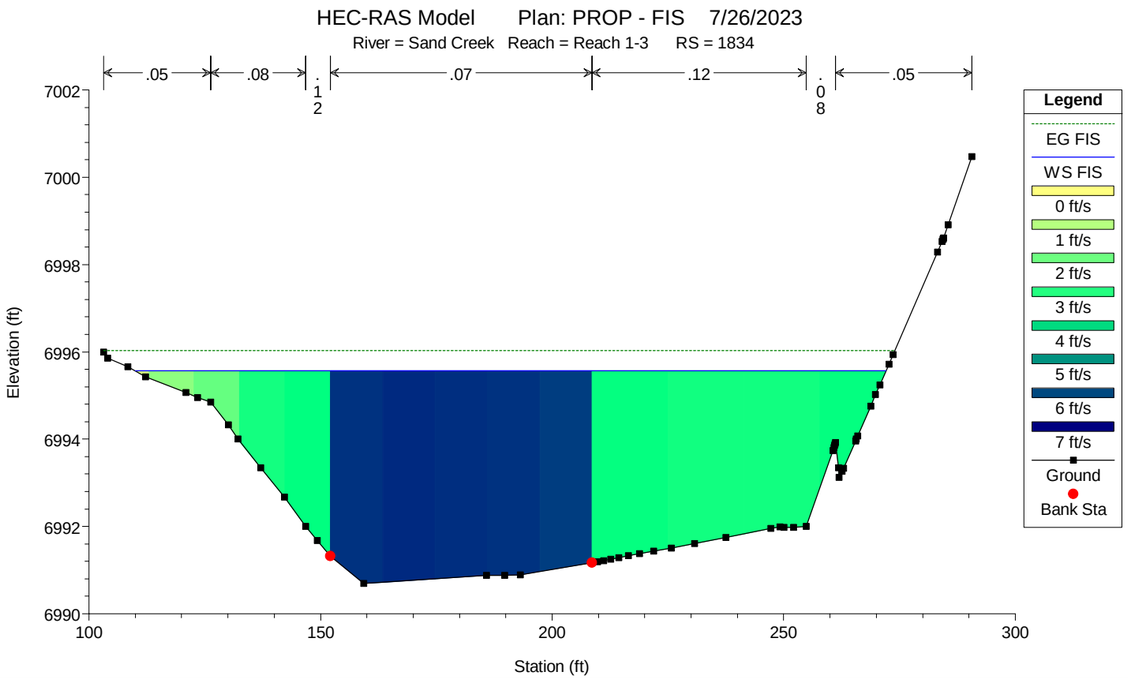


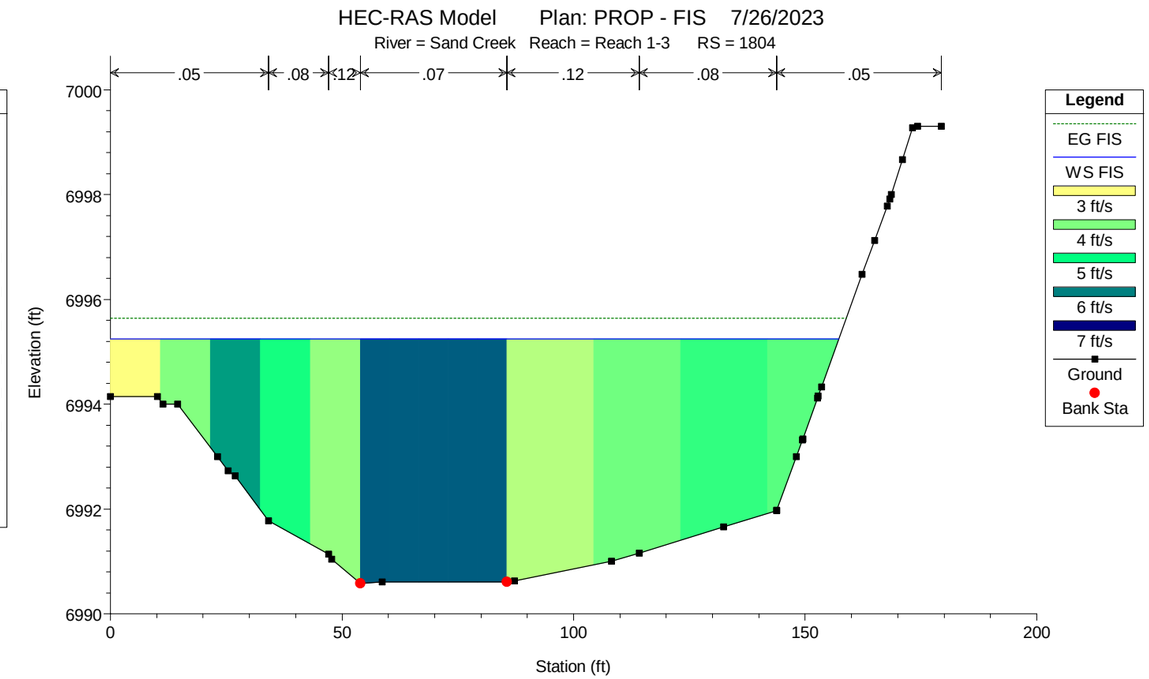


Sub-critical flow analysis for Water Surface evaluation of Naturalized Channel Design at the FIS flow rate only

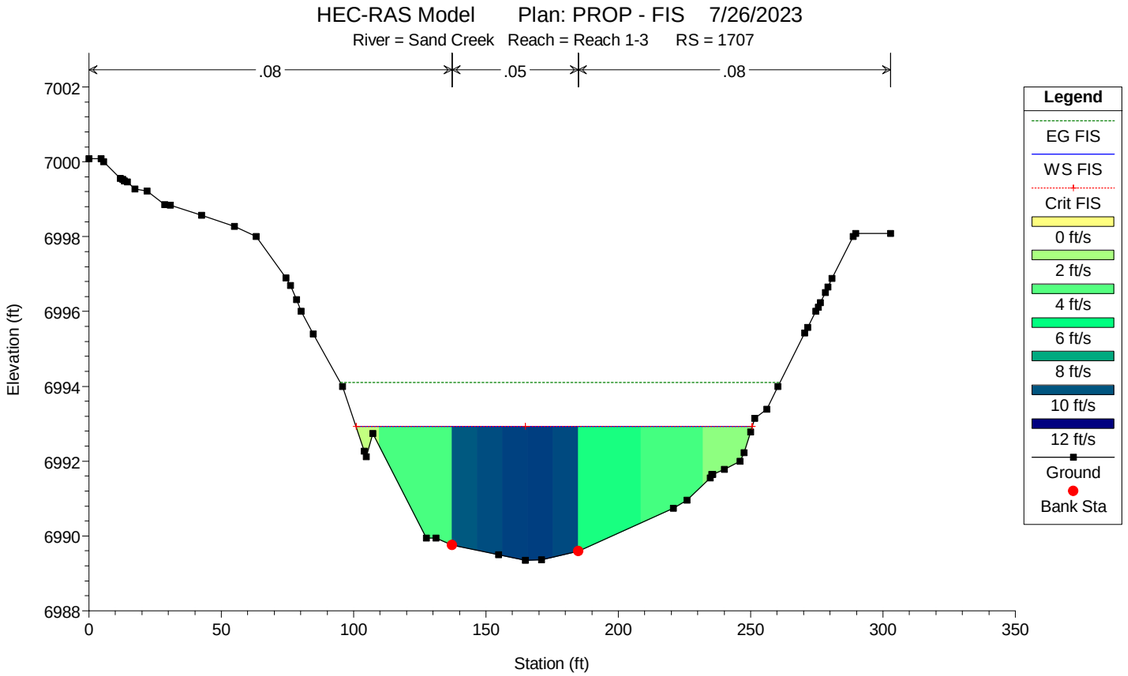


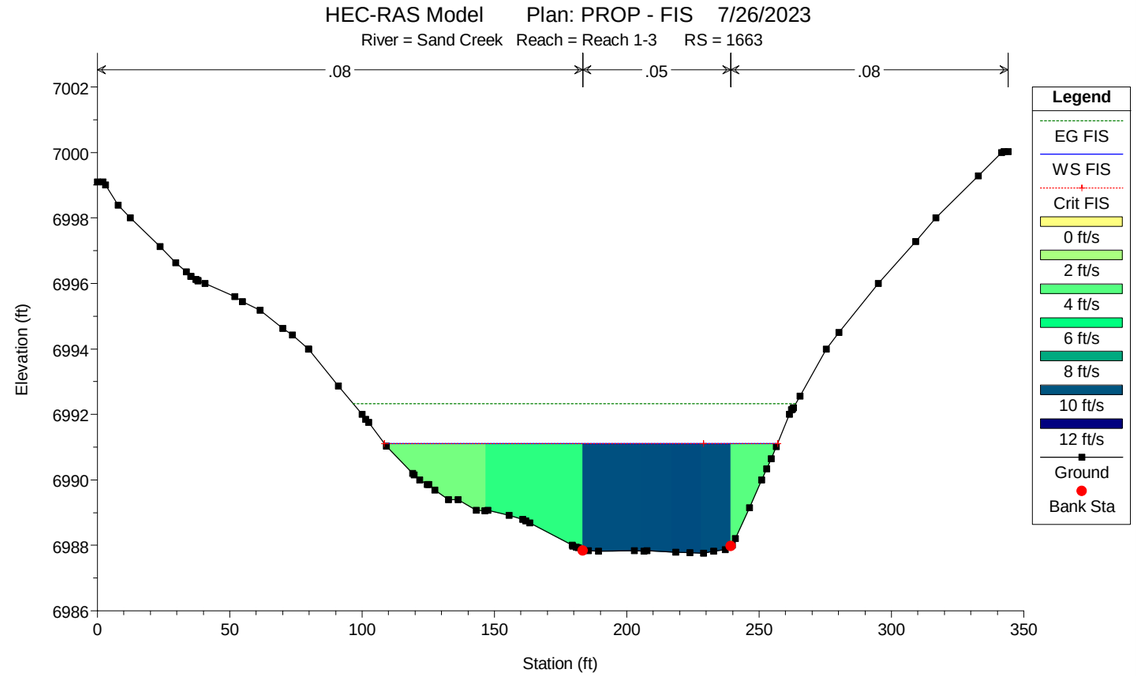


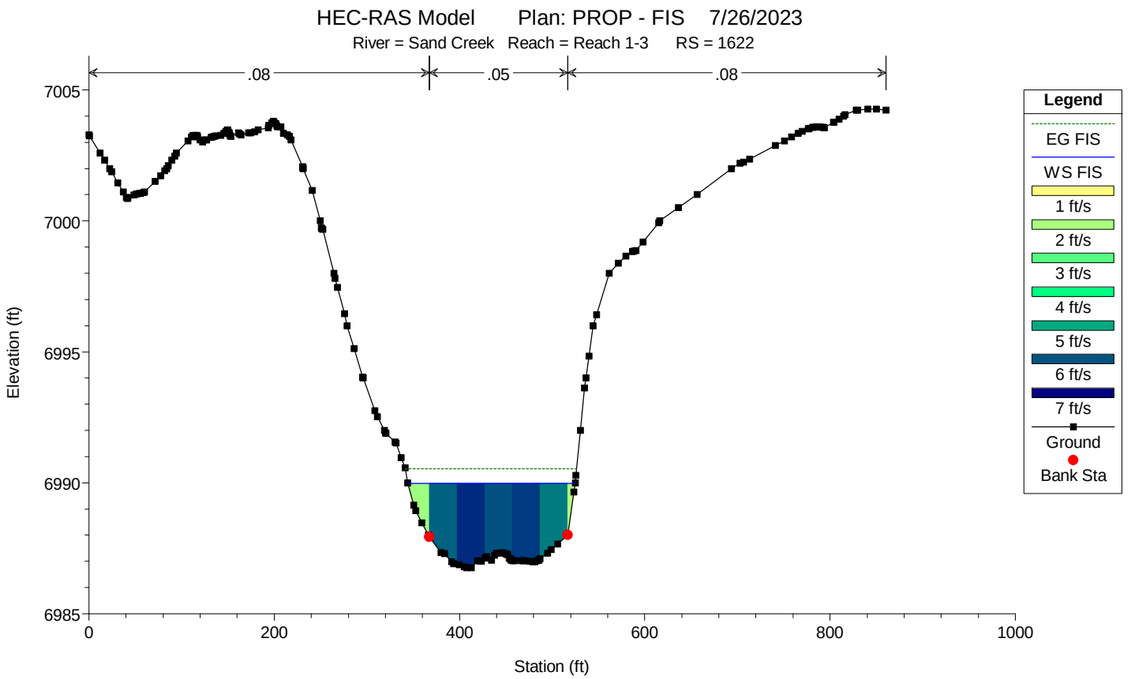


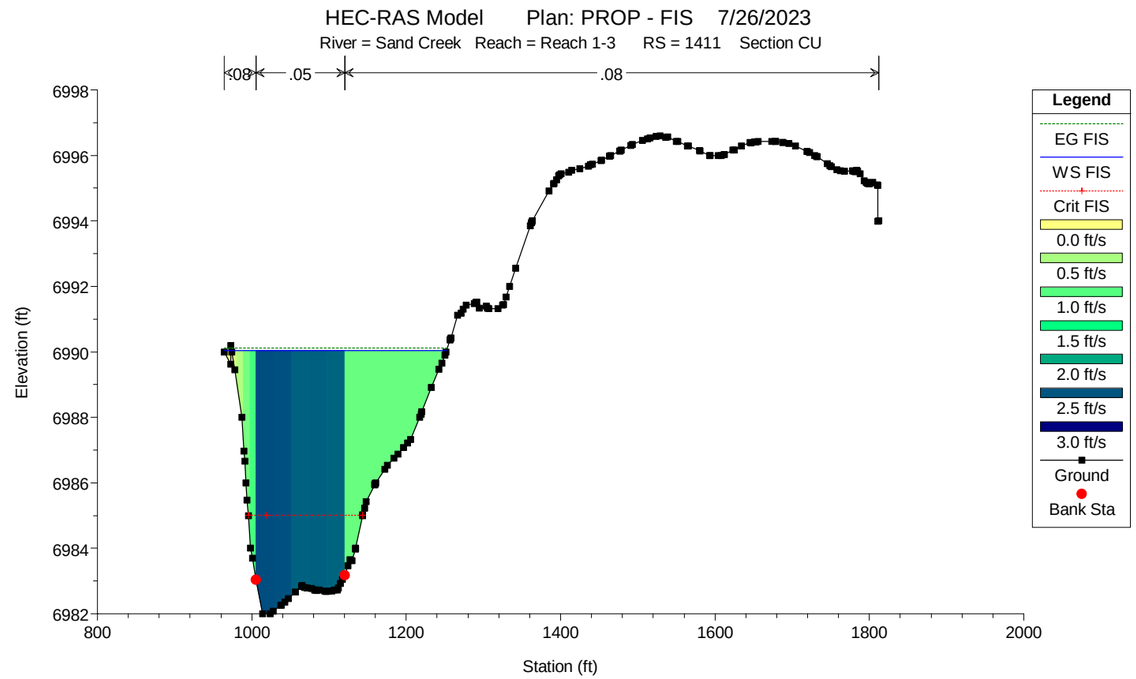


Sub-critical flow analysis for Water Surface evaluation of Naturalized Channel Design at the FIS flow rate only









Comparison Info with Timber Ridge Modeling

HEC-RAS Plan: PROP - FIS Locations: User Defined

River	Reach	River Sta	Profile	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Flow Area	Top Width	Vel Total	Shear Total	Froude # XS
				(cfs)	(ft)	(ft)	(ft)	(ft)	(ft/ft)	(sq ft)	(ft)	(ft/s)	(lb/sq ft)	
Sand Creek	Reach 1-3	12465	100-YR	1665.90	7177.88	7181.73	7181.73	7184.15	0.026303	265.23	74.32	6.28	5.59	1.16
Sand Creek	Reach 1-3	12465	FIS	2600.00	7177.88	7183.81	7183.81	7186.24	0.015014	433.01	89.70	6.00	4.24	1.00
Sand Creek	Reach 1-3	12366		Culvert										
Sand Creek	Reach 1-3	12253	100-YR	1665.90	7168.00	7178.17		7178.34	0.000630	864.42	105.49	1.93	0.31	0.20
Sand Creek	Reach 1-3	12253	FIS	2600.00	7168.00	7180.28		7180.54	0.000793	1095.66	114.53	2.37	0.45	0.24
Sand Creek	Reach 1-3	12070	100-YR	1665.90	7168.31	7177.38		7177.91	0.002996	541.96	89.95	3.07	1.07	0.42
Sand Creek	Reach 1-3	12070	FIS	2600.00	7168.31	7179.30		7180.02	0.003331	722.99	98.57	3.60	1.44	0.44
Sand Creek	Reach 1-3	11880	100-YR	1665.90	7165.52	7170.54	7170.54	7172.06	0.021199	349.13	101.40	4.77	4.50	0.94
Sand Creek	Reach 1-3	11880	FIS	2600.00	7165.52	7171.62	7171.62	7173.59	0.022534	462.08	106.92	5.63	5.98	0.95
Sand Creek	Reach 1-3	11569	100-YR	1665.90	7159.96	7163.94	7162.22	7164.22	0.013386	506.03	225.92	3.29	2.67	0.42
Sand Creek	Reach 1-3	11569	FIS	2600.00	7159.96	7165.28	7162.96	7165.70	0.014648	746.49	249.28	3.48	2.72	0.53
Sand Creek	Reach 1-3	11368	100-YR	1665.90	7153.99	7158.97	7158.97	7160.23	0.029290	327.67	153.14	5.08	5.45	0.92
Sand Creek	Reach 1-3	11368	FIS	2600.00	7153.99	7160.00	7160.00	7161.48	0.029320	452.92	175.32	5.74	4.67	1.07
Sand Creek	Reach 1-3	11206	100-YR	1665.90	7151.03	7157.39	7155.97	7157.77	0.003920	668.38	184.63	2.49	0.88	0.46
Sand Creek	Reach 1-3	11206	FIS	2600.00	7151.03	7158.39		7158.91	0.004715	857.47	192.20	3.03	1.30	0.48
Sand Creek	Reach 1-3	11103	100-YR	1665.90	7150.00	7154.18	7154.18	7155.13	0.038059	355.69	151.37	4.68	5.55	0.90
Sand Creek	Reach 1-3	11103	FIS	2600.00	7150.00	7155.43	7154.87	7156.24	0.025523	555.70	170.22	4.68	5.17	0.70
Sand Creek	Reach 1-3	10925	100-YR	1665.90	7148.00	7153.76		7153.87	0.002068	645.01	163.17	2.58	0.51	0.24
Sand Creek	Reach 1-3	10925	FIS	2600.00	7148.00	7154.93		7155.09	0.002314	857.76	189.28	3.03	0.65	0.27
Sand Creek	Reach 1-3	10797	100-YR	1665.90	7145.39	7150.49	7149.13	7150.71	0.016255	478.88	183.43	3.48	2.64	0.41
Sand Creek	Reach 1-3	10797	FIS	2600.00	7145.39	7151.35	7149.76	7151.63	0.016596	644.30	199.99	4.04	3.32	0.42

Appendix D

Grouted Boulder Drop Structure Design Calculations

Subdivision: Sterling Ranch
Project Name: Sand Creek Channel Improvements
Project No.: 25188.04
Calculated By: DJV
Date: April 13, 2023

1) GSB Rock Sizing Calculations

		GSB #1	GSB #2	GSB #3	GSB #4	GSB #5	GSB #6	GSB #7	GSB #8
[1]	Q_{100} (cfs):	1562.4	1562.4	1763.9	1763.9	1763.9	1665.9	1643.0	1643.0
[2]	RS 9943	11.82	7.78	12.57	10.22	15.66	3.19	13.01	6.53
[3]	S (ft/ft)	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25
[4]	Rock Sizing Parameter	6.99	4.60	7.44	6.05	9.26	1.89	7.70	3.86
[5]	Design Diameter (in):	48	36	42	36	48	36	48	42

[1] Channel total flow rate, Q_{100}
[2] Critical velocity in drop from HEC-RAS
[3] GSB slope
[4] Rock Sizing Parameter:

$$R_p = \frac{V_c S^{0.17}}{(S_s-1)^{0.66}}$$

Vc from HEC-RAS model
*Assumed Ss=2.55

[5] Design rock size

Table HS-5—Boulder Sizes for Various Rock Sizing Parameters

Rock Sizing Parameter, R_p	Ungrouted Boulders		Grouted Boulders *	
	Minimum Dimensions of Boulder, D_r	Boulder Classification	Minimum Dimensions of Boulder, D_r	Boulder Classification
Less than 4.50	18 inches	B18	18 inches	B18
4.50 to 4.99	24 inches	B24	18 inches	B18
5.00 to 5.59	30 inches	B30	24 inches	B24
5.60 to 6.39	36 inches	B36	30 inches	B30
6.40 to 6.99	42 inches	B42	36 inches	B36
7.00 to 7.49	48 inches	B48	42 inches	B42
7.50 to 8.00	n/a	n/a	48 inches	B48

* Grouted to no less than ½ the height (+1"/- 0"), no more than ⅓ (+0"/- 1") of boulder height.

Rock Sizing Parameters based on MHFD DCM Volume 2

Subdivision: Sterling Ranch
Project Name: Sand Creek Channel Improvements
Project No.: 25188.04
Calculated By: DJV
Date: April 13, 2023

2) GSB Stilling Basin Calculations

		GSB #1	GSB #2	GSB #3	GSB #4	GSB #5	GSB #6	GSB #7	GSB #8
[1]	Crest STA:	23+99.00	28+56.00	62+23.00	70+93.00	74+45.00	92+56.00	96+26.00	99+43.00
[2]	RS 9943	1562.4	1562.4	1763.9	1763.9	1763.9	1665.9	1643.0	1643.0
[3]	V_1 (ft/s)	11.25	7.78	6.54	10.22	15.66	0.95	5.18	5.73
[4]	Fr_1:	1.44	0.79	0.62	1.18	1.99	0.06	0.48	0.51
[5]	y_1 (ft):	3.24	3.30	4.74	3.50	3.13	7.80	4.67	4.96
[6]	y_2 (ft)(w/o basin):	3.85	3.23	3.45	3.16	3.55	2.68	3.14	3.04
[7]	L/y_2:	4.00	4.00	4.00	4.00	4.30	4.00	4.00	4.00
[8]	L (ft):	15.40	12.92	13.80	12.64	15.27	10.72	12.56	12.16
[9]	0.60L* (ft):	9.24	7.75	8.28	7.58	9.16	6.43	7.54	7.30
[10]	Design Length* (ft):	10.00	10.00	15.00	12.00	15.00	15.00	15.00	15.00

[1] Sand Creek ℄ Station
[2] Channel total flow rate, Q_{100}
[3] Supercritical velocity from HEC-RAS @ Toe
[4] Supercritical Froude Number from HEC-RAS @ Toe
[5] Supercritical depth from HEC-RAS @ Toe
[6] Sequent depth from HEC-RAS @ crest
[7] Values from Figure "Length in Terms of Sequent Depth of Jumps in Horizontal Channels", USBR, 1955.
[8] Jump Length: Row [7]*Row [6]
[9] Stilling basin to contain minimum of 60% of the hydraulic jump. 60% of Jump Length. 0.60*Row [8].
[10] Proposed stilling basin length.

Subdivision:	Sterling Ranch
Project Name:	Sand Creek Channel Improvements
Project No.:	25188.04
Calculated By:	DJV
Date:	April 13, 2023

3) GSB Seepage Calculations

		GSB #1	GSB #2	GSB #3	GSB #4	GSB #5	GSB #6	GSB #7	GSB #8
[1]	WSEL (ft):	7000.93	7002.75	7066.52	7079.74	7088.67	7121.97	7132.48	7138.71
[2]	RS 9943	6997.08	7000.50	7063.07	7076.86	7085.12	7119.00	7129.34	7135.80
[3]	Sill Elev (ft):	6994.97	6999.13	7058.72	7074.14	7081.53	7114.00	7124.71	7132.63
[4]	Drop Height (ft):	2.11	1.37	4.35	2.72	3.59	5.00	4.63	3.17
[5]	U/S Boulder Apron STA:	24+07.00	28+64.00	62+31.00	71+05.00	74+57.00	92+51.00	96+34.00	99+51.00
[6]	Crest STA:	23+99.00	28+56.00	62+23.00	70+93.00	74+45.00	92+43.00	96+26.00	99+43.00
[7]	Toe STA:	23+84.00	28+50.00	61+99.00	70+73.00	74+22.00	92+16.00	96+00.00	99+26.00
[8]	Sill STA:	23+75.00	28+38.00	61+82.00	70+61.00	74+06.00		95+84.00	99+10.00
[9]	Total Length (ft):	32.0	26.0	49.00	44.00	51.00	35.00	50.00	41.00
[10]	Boulder Diameter (ft):	4.0	3.0	3.5	3.0	4.0	3.0	4.0	3.5
[11a]	Minimum Seepage Cutoff Depth (ft):	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0
[11b]	Cutoff Wall depth (ft):	6.0	8.0	10.0	14.0	15.0	13.0	10	16
[12]	Sill Diameter (ft):	2.00	2.00	2.00	2.00	2.00	2.00	3.00	3.00
[13]	L_V (ft)=	18.0	21.0	25.5	33.0	36.0	31.0	27.0	38.5
[14]	L_H (ft)=	36.00	29.00	52.50	47.00	55.00	38.00	54.00	44.50
[15]	H_S (ft)=	5.96	3.62	7.80	5.60	7.14	7.97	7.77	6.08
[16]	C_W=	5.0	8.5	5.5	8.7	7.6	5.5	5.8	8.8

Table 8-3. Lane's Weighted Creep: Recommended Minimum Ratios

Material	Ratio
Very fine sand or silt	8.5
Fine sand	7.0
Medium sand	6.0
Coarse sand	5.0
Fine gravel	4.0
Medium gravel	3.0
Coarse gravel including cobbles	3.0
Boulders with some cobbles and gravel	3.0
Soft clay	3.0
Medium clay	2.0
Hard clay	1.8
Very hard clay or hardpan	1.6

[1] Water surface elevation at drop crest from HEC-RAS
[2] Finish grade Elevation at drop crest
[3] Finish grade Elevation at top of sill wall
[4] Total drop height along flow path crest to toe Row[2]-Row[3]
[5] Sand Creek ℄ Station
[6] Sand Creek ℄ Station
[7] Sand Creek ℄ Station
[8] Sand Creek ℄ Station
[9] Total Horizontal length along drop Row[5]-Row[7]
[10] Grouted boulder D_{50}
[11a] Minimum Seepage Cutoff Depth. Max of 0.80*Hd or 4'.
[11b] Sheet Pile Cutoff Wall depth below grouted boulders
[12] Sill wall boulder diameter
[13] Vertical Distance for Lane's Creep Method Row[9]+2*Row[10]+Row[11]
[14] Horizontal Distance for Lane's Creep Method Row[8]+Row[9]
[15] Differential Head between analysis points for Lane's Creep Method
[16] Creep Ratio (Row[13]/3+Row[12])/Row[14]

Subdivision: Sterling Ranch
Project Name: Sand Creek Channel Improvements
Project No.: 25188.04
Calculated By: DJV
Date: April 13, 2023

4) GSB Bouyancy Calculations

		GSB #1	GSB #2	GSB #3	GSB #4	GSB #5	GSB #6	GSB #7	GSB #8
[1]	U/S Boulder Apron STA:	24+07.00	28+64.00	62+31.00	71+05.00	74+57.00	92+51.00	96+34.00	99+51.00
[2]	RS 9943	23+84.00	28+50.00	61+99.00	70+73.00	74+22.00	92+16.00	96+00.00	99+26.00
[3]	Sill STA:	23+75.00	28+38.00	61+82.00	70+61.00	74+06.00		95+84.00	99+10.00
[4]	Total Length (ft):	32.0	26.0	49.00	44.00	51.00	35.00	50.00	41.00
[5]	Boulder Diameter (ft):	4.0	3.0	3.5	3.0	4.0	3.0	4.0	3.5
[6]	GSB Area (sf):	1,943	1,691	1,816	2,716	2,972	2,440	2156.0	2707.0
[7]	Sill Diameter (ft):	2.00	2.00	2.00	2.00	2.00	2.00	3.00	3.00
[8]	Total GSB Volume (cu ft):	7,772	5,073	6,356	8,148	11,888	7,320	8,624	9,475
[9]	Total GSB Weight (lbs):	1,165,800	760,950	953,400	1,222,200	1,783,200	1,098,000	1,293,600	1,421,175
[10]	Displaced Water Weight (lbs):	484,973	316,555	396,614	508,435	741,811	456,768	538,138	591,209
[11]	Bouyant Force (lbs):	-680,827	-444,395	-556,786	-713,765	-1,041,389	-641,232	-755,462	-829,966

[1] Sand Creek ℄ Station
[2] Sand Creek ℄ Station
[3] Sand Creek ℄ Station
[4] Total Horizontal length along drop Row[1]-Row[3]
[5] Grouted boulder D_{50}
[6] Area of GSB structure
[7] Sill wall boulder diameter
[8] GSB volume Row[5]*Row[6]
[9] GSB Weight Row[8]*150 pcf (150 psf assumed for combined boulder/grout)
[10] Displaced Water Weight Row[8]*62.4 pcf
[11] Net Buoyant Force, (negative values denote stablity) Row[9]-Row[10]

Subdivision: Sterling Ranch
Project Name: Sand Creek Channel Improvements
Project No.: 25188.04
Calculated By: DJV
Date: April 13, 2023

5) GSB Shear Stress Calculations

		GSB #1	GSB #2	GSB #3	GSB #4	GSB #5	GSB #6	GSB #7	GSB #8
[1]	Crest STA:	23+99.00	28+56.00	62+23.00	70+93.00	74+45.00	92+43.00	96+26.00	99+43.00
[2]	RS 9943	23+84.00	28+50.00	61+99.00	70+73.00	74+22.00	92+16.00	96+00.00	99+26.00
[3]	Sill STA:	23+75.00	28+38.00	61+82.00	70+61.00	74+06.00	+.00	95+84.00	99+10.00
[4]	Depth at Crest (ft):	3.85	2.25	3.45	2.88	3.55	2.68	3.14	2.91
[5]	Depth at Toe (ft):	3.24	3.30	4.74	3.50	3.13	7.80	4.67	4.96
[6]	Depth at Sill (ft):	2.54	4.23	2.69	2.63	2.69		3.30	3.83
[7]	EGL Slope at Crest:	0.047494	0.199976	0.068421	0.144097	0.038885	0.010410	0.042216	0.071473
[8]	EGL Slope at Toe:	0.200807	0.050787	0.030034	0.126848	0.075843	0.000027	0.018383	0.019995
[9]	EGL Slope at Sill:	0.062814	0.019350	0.030039	0.009219	0.034244		0.022448	0.014646
[10]	Shear Stress at Crest (lbs/ft^2):	11.410	28.077	14.730	25.896	8.614	1.741	8.272	12.978
[11]	Shear Stress at Toe (lbs/ft^2):	40.598	10.458	8.883	27.704	14.813	0.013	5.357	6.189
[12]	Shear Stress at Sill (lbs/ft^2):	9.956	5.107	5.042	1.513	5.748		4.622	3.500
[13]	Shear Stress at Flood Plain (lbs/ft2):								

[1] Sand Creek ℄ Station
[2] Sand Creek ℄ Station
[3] Sand Creek ℄ Station
[4] 100-Year flow depth at ℄ from HEC-RAS
[5] 100-Year flow depth at ℄ from HEC-RAS
[6] 100-Year flow depth at ℄ from HEC-RAS
[7] Energy Grade Line slope from HEC-RAS
[8] Energy Grade Line slope from HEC-RAS
[9] Energy Grade Line slope from HEC-RAS
[10] Shear Stress: 62.4*Row[4]*Row[7]
[11] Shear Stress: 62.4*Row[5]*Row[8]
[12] Shear Stress: 62.4*Row[6]*Row[9]
[13] Calculated from Maximum Depth in the Flood Terrace & E.G. Slope

Subdivision: Sterling Ranch
Project Name: Sand Creek Channel Improvements
Project No.: 25188.04
Calculated By: DJV
Date: April 13, 2023

6) GSB Shear Stress Calculations

		GSB #1	GSB #2	GSB #3	GSB #4	GSB #5	GSB #6	GSB #7	GSB #8
[1]	GSB STA:	23+99.00	28+56.00	62+23.00	70+93.00	74+45.00	92+56.00	96+26.00	99+43.00
[2]	RS 9943	1.44	0.79	0.62	1.18	1.99	0.06	0.48	0.51
[3]	Coefficient of Pressure Fluctuation, C_P:	< 0.4	< 0.4	< 0.4	< 0.4	< 0.4	< 0.4	< 0.4	< 0.4

[1] Sand Creek. Location of highest Froude Number on drop.
[2] Froude Number from HEC-RAS model, mixed-flow analysis.
[3] Coefficient of Pressure Fluctuation, C_P from Figure HS-4, UDFCD DCM Chapter 8, for toe of jump at base.
Maximum recommended value is 0.7.

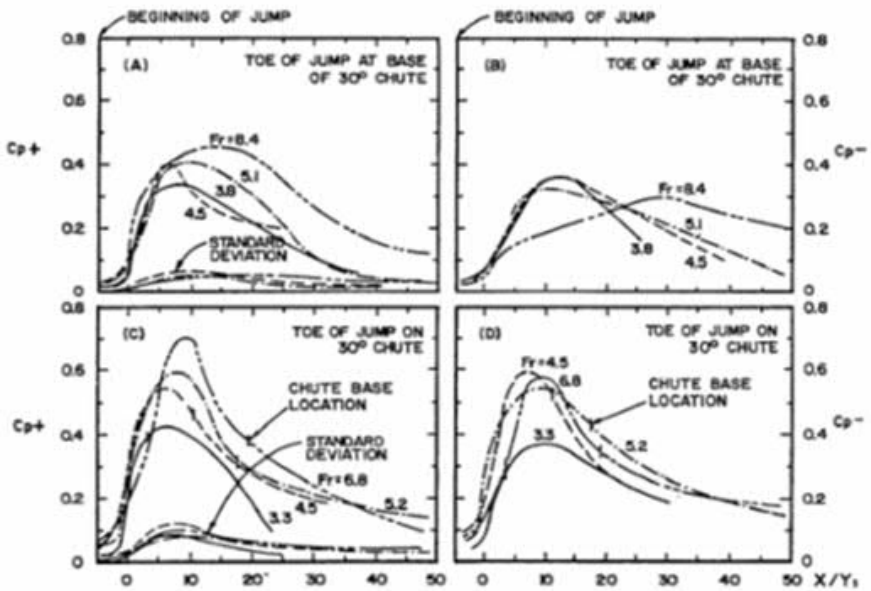


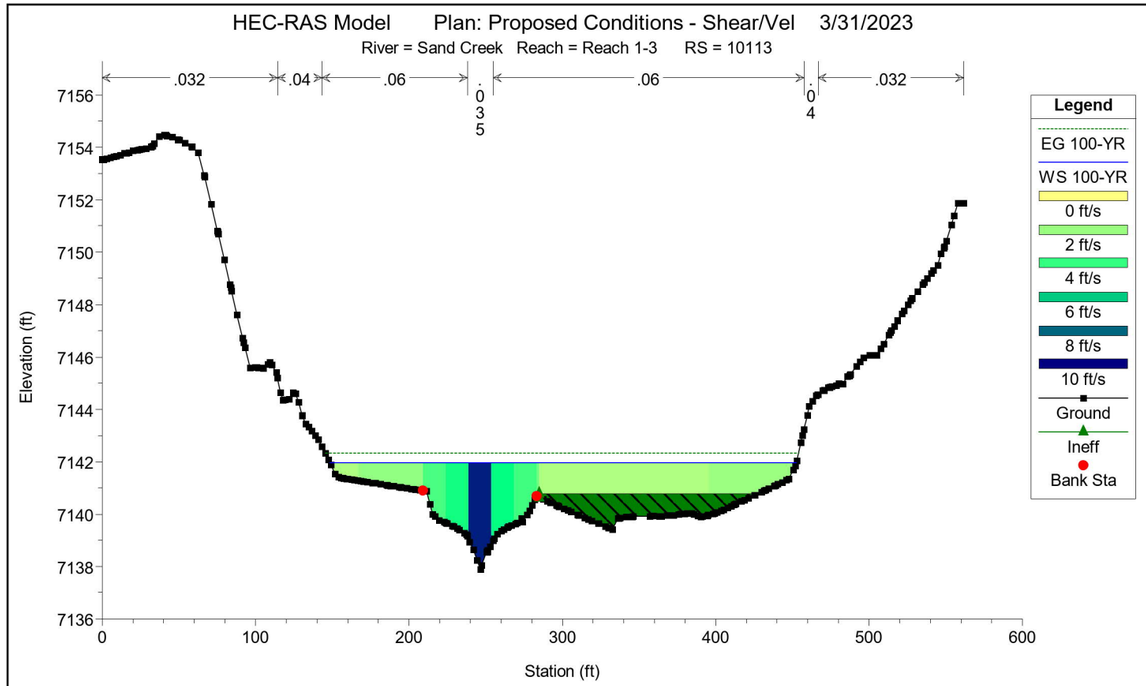
Figure HS-4—Coefficient of Pressure Fluctuation, C_p, at a Hydraulic Jump

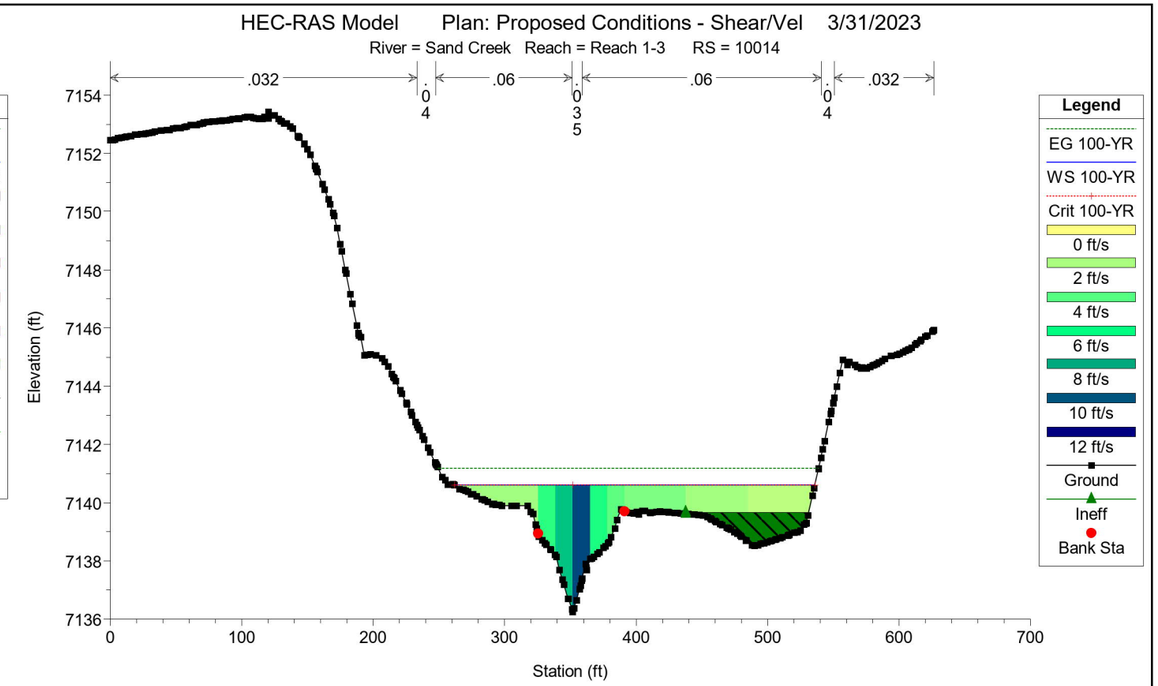
Subdivision: Sterling Ranch
Project Name: Sand Creek Channel Improvements
Project No.: 25188.04
Calculated By: DJV
Date: April 13, 2023

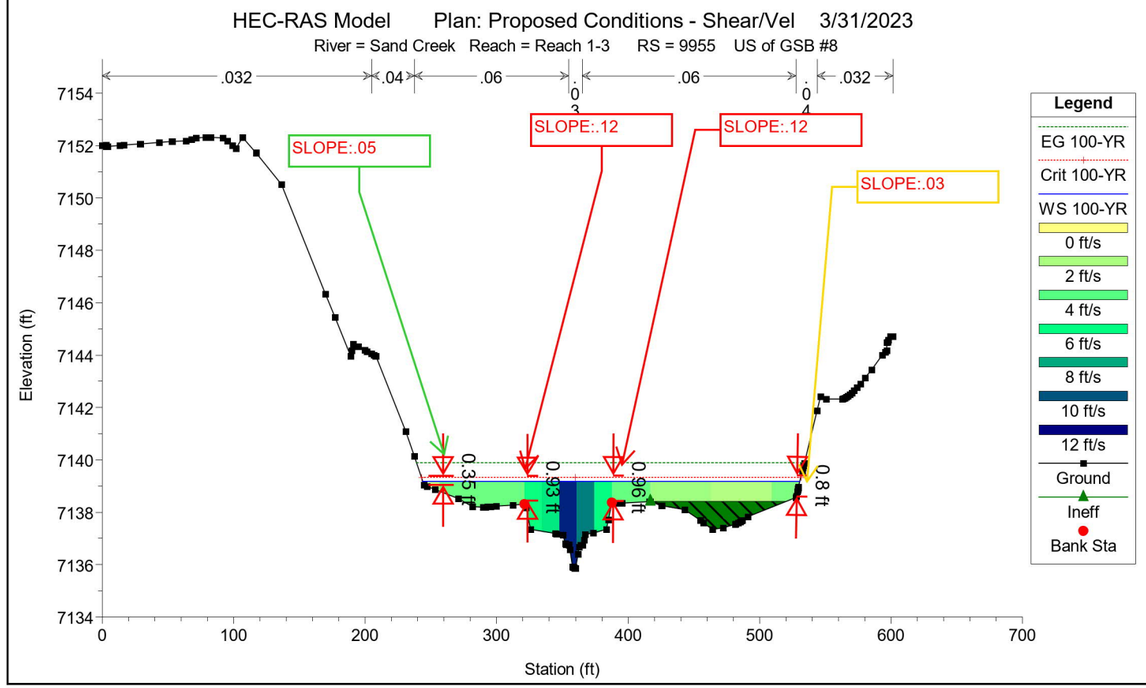
	POINT #	FLOW DEPTH (FT)	SLOPE (FT/FT)	SHEAR (LB/FT^2)
RS 9955	1	0.35	0.05	1.09
	2	0.93	0.12	6.96
	3	0.96	0.12	7.19
	4	0.8	0.03	1.50
RS 9943	1	0.3	0.05	0.94
	2	0.68	0.12	5.09
	3	0.82	0.12	6.14
	4	0.55	0.02	0.69
RS 9913	1	1.22	0.05	3.81
	2	0.8	0.03	1.50
	3	0.41	0.03	0.77
RS 9910	1	0.75	0.03	1.40
	2	0.49	0.03	0.92
RS 9626	1	0.57	0.12	4.27
	2	0.8	0.12	5.99
	3	0.98	0.02	1.22
RS 9600	1	1.33	0.12	9.96
RS 9587	1	0.75	0.08	3.74
RS 9584	1	0.78	0.08	3.89
RS 7445	1	1.09	0.13	8.84
	2	0.87	0.075	4.07
RS 7430	1	0.83	0.19	9.84
	2	0.68	0.1	4.24
RS 7406	1	0.33	0.04	0.82
	2	0.51	0.095	3.02
RS 7093	1	0.72	0.0175	0.79
RS 7073	1	0.61	0.083	3.16
RS 7061	1	0.55	0.085	2.92
	2	0.63	0.08	3.14
RS 6223	1	0.55	0.12	4.12
	2	1	0.15	9.36
	3	0.42	0.15	3.93
RS 6212	1	0.74	0.14	6.46
RS 6199	1	1.47	0.13	11.92
	2	0.56	0.15	5.24
RS 6184	1	1.19	0.13	9.65
	2	0.92	0.14	8.04
RS 2405	1	1.41	0.01	0.88
	2	0.9	0.01	0.56
	3	0.51	0.01	0.32
RS 2399	1	1.24	0.12	9.29
	2	0.73	0.047	2.14
	3	0.25	0.057	0.89
RS 2377	1	1.24	0.12	9.29
	2	0.73	0.047	2.14
	3	0.25	0.057	0.89

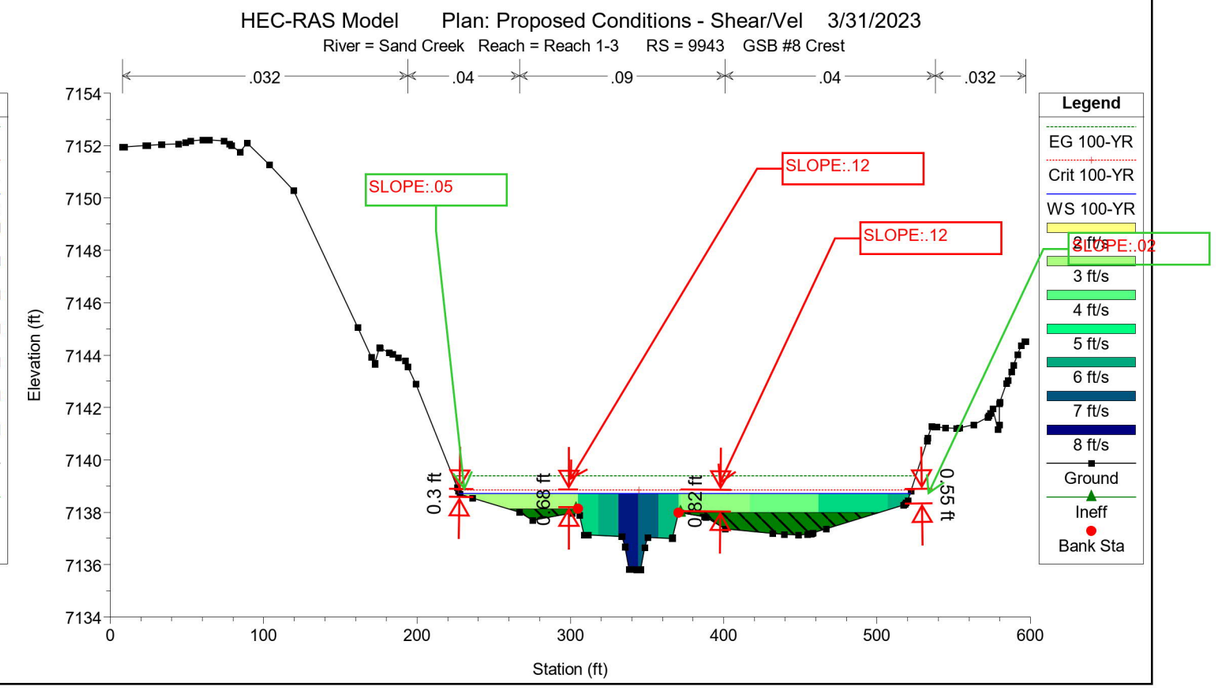
Mixed Flow HEC-RAS Analysis for GSB Design

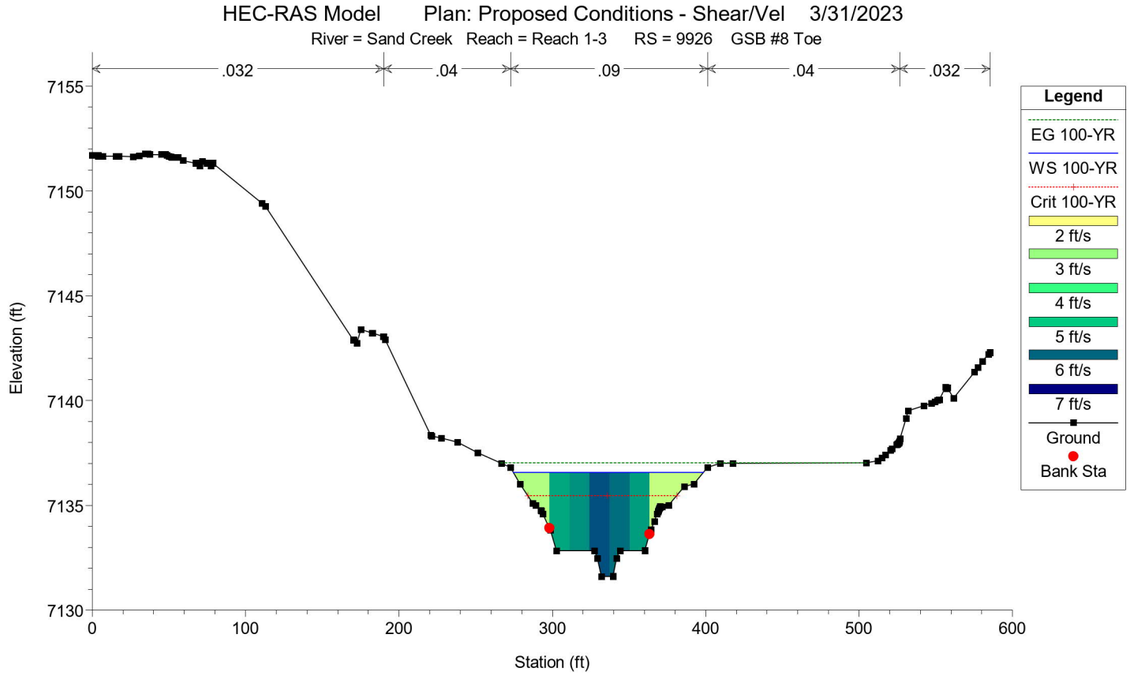
Slope/Depth Calculations for GSB Armoring Extents

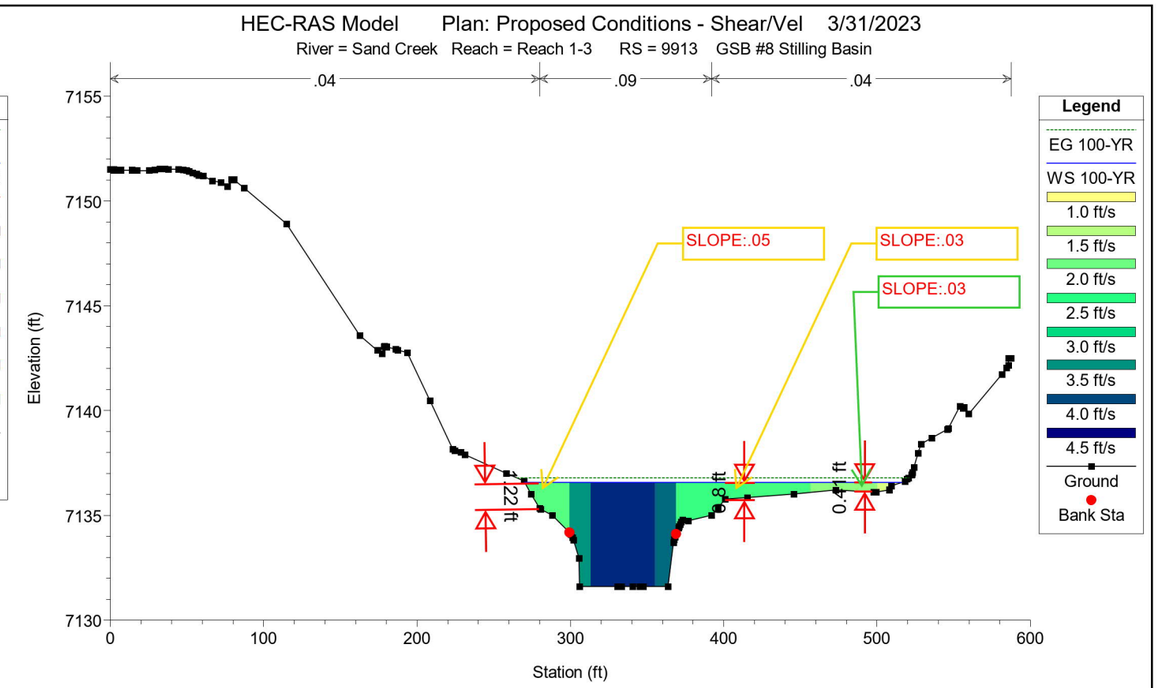


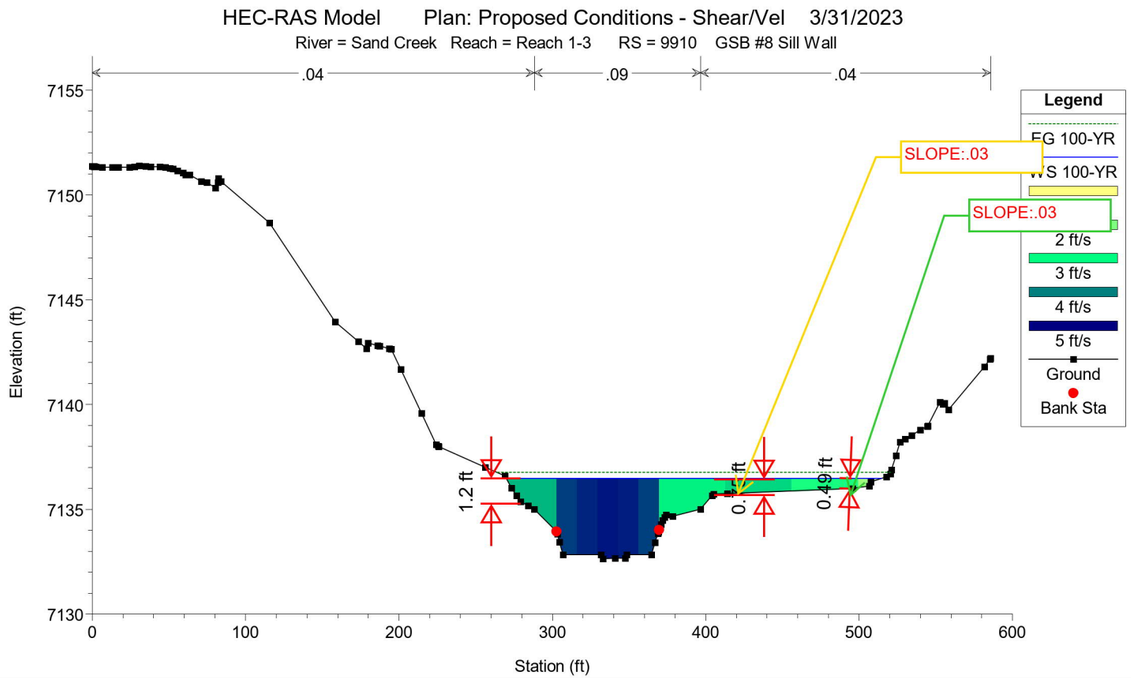


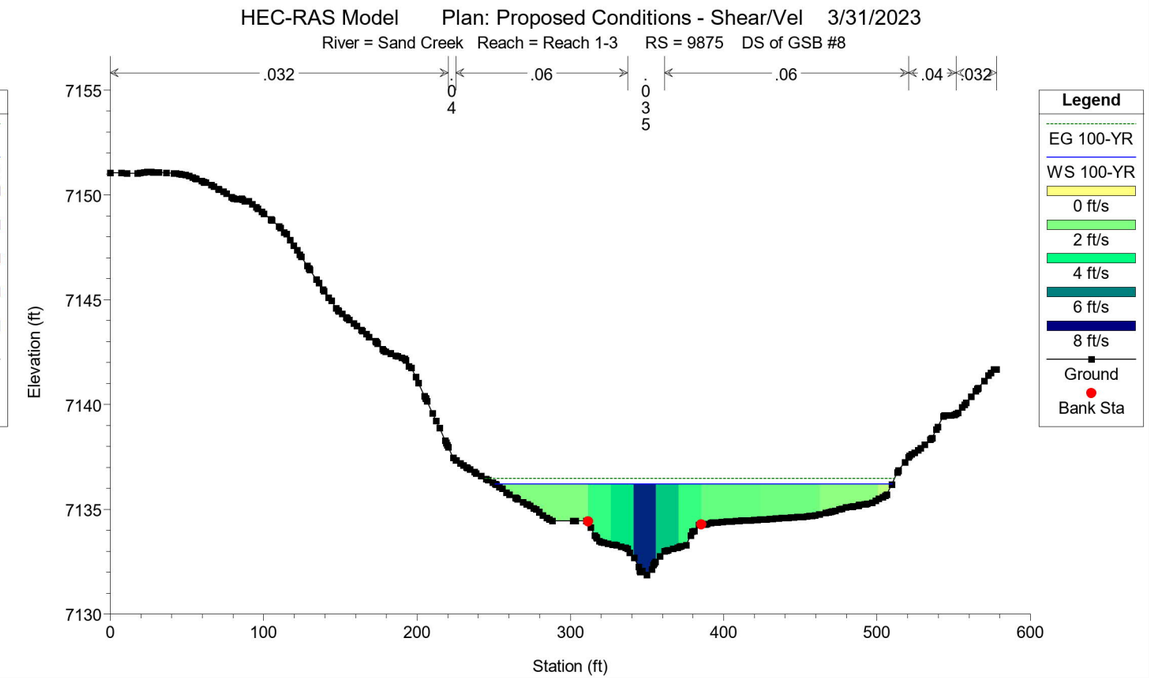


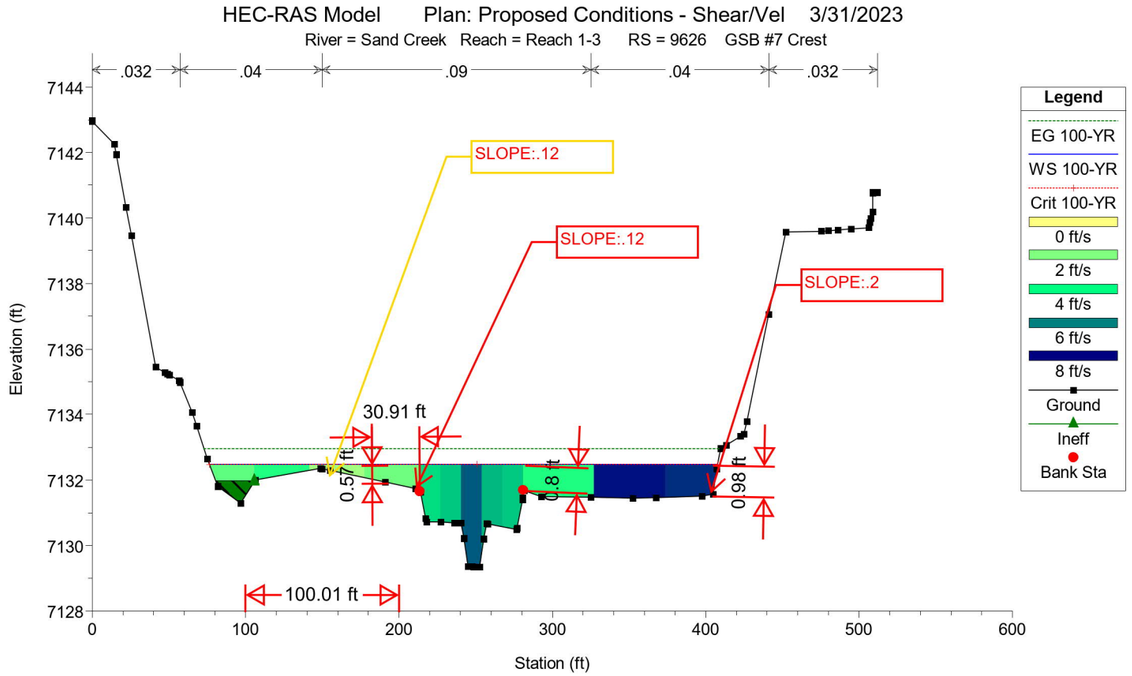


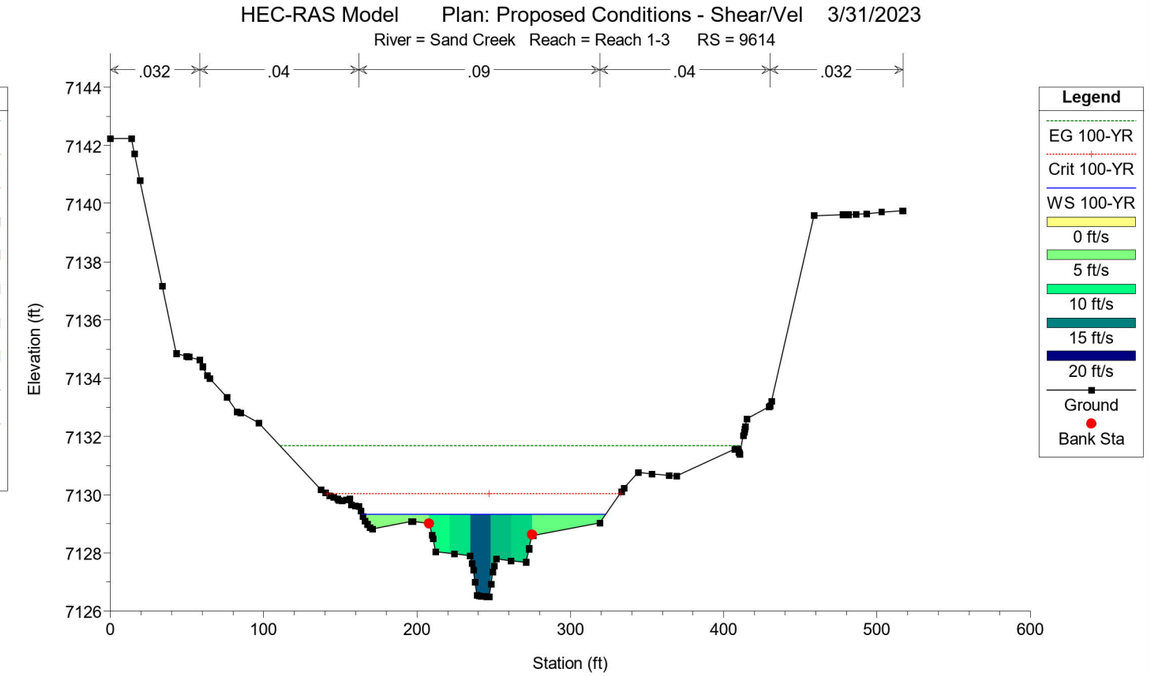

HEC-RAS Model Plan: Proposed Conditions - Shear/Vel 3/31/2023
River = Sand Creek Reach = Reach 1-3 RS = 9926 GSB #8 Toe
.032
.04
.09
.04
.032
Legend
EG 100-YR
WS 100-YR
Crit 100-YR
2 ft/s
3 ft/s
4 ft/s
5 ft/s
6 ft/s
7 ft/s
Ground
Bank Sta
Elevation (ft)
Station (ft)

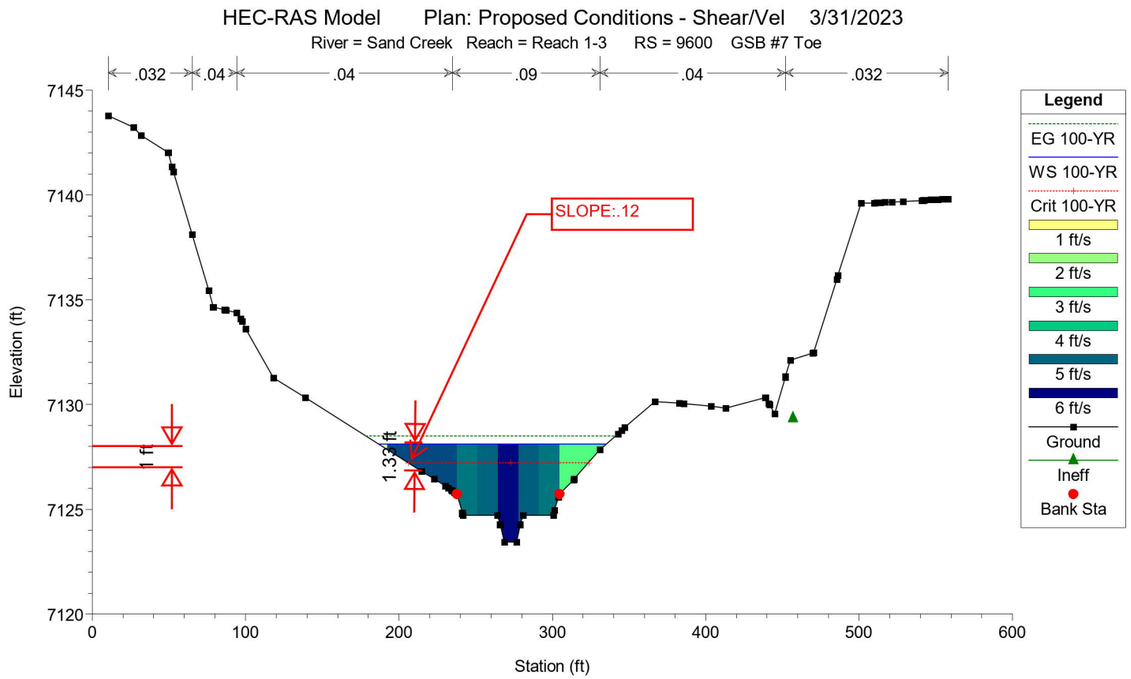

HEC-RAS Model Plan: Proposed Conditions - Shear/Vel 3/31/2023
River = Sand Creek Reach = Reach 1-3 RS = 9913 GSB #8 Stilling Basin
.04
.09
.04
SLOPE:.05
SLOPE:.03
SLOPE:.03
1.22 ft
0.8 ft
0.4 ft
Legend
EG 100-YR
WS 100-YR
1.0 ft/s
1.5 ft/s
2.0 ft/s
2.5 ft/s
3.0 ft/s
3.5 ft/s
4.0 ft/s
4.5 ft/s
Ground
Bank Sta
Elevation (ft)
Station (ft)

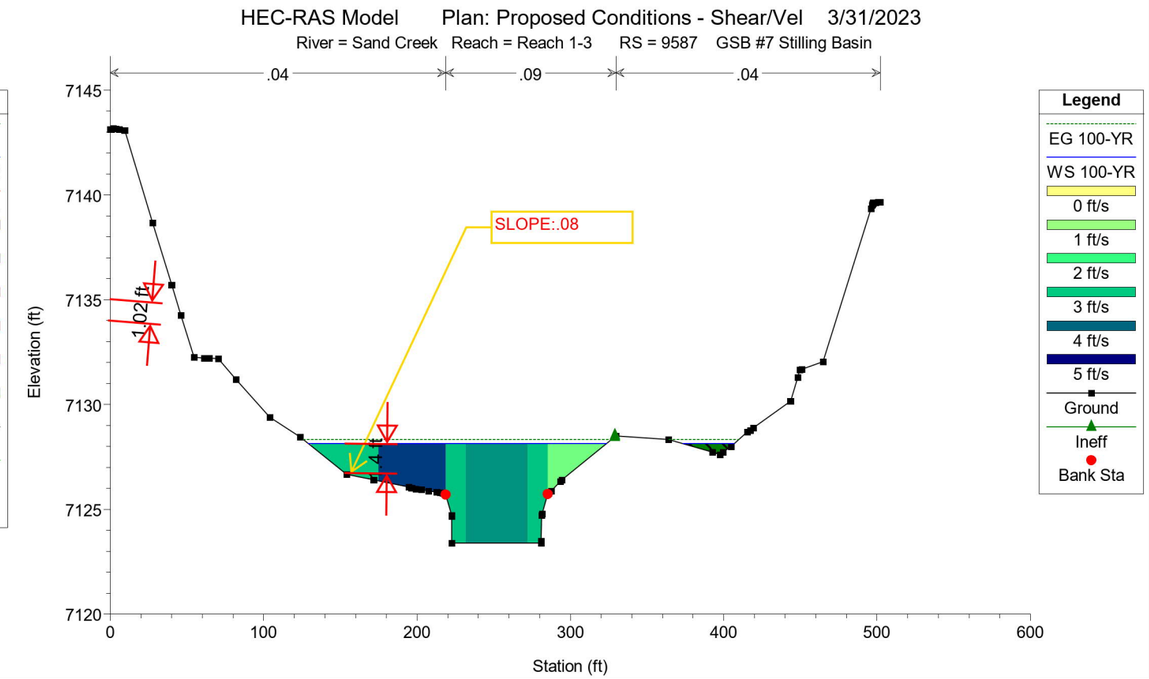

HEC-RAS Model Plan: Proposed Conditions - Shear/Vel 3/31/2023
River = Sand Creek Reach = Reach 1-3 RS = 9910 GSB #8 Sill Wall
.04
.09
.04
SLOPE:.03
SLOPE:.03
1.2 ft
0.7 ft
0.49 ft
Legend
EG 100-YR
WS 100-YR
2 ft/s
3 ft/s
4 ft/s
5 ft/s
Ground
Bank Sta
Elevation (ft)
Station (ft)

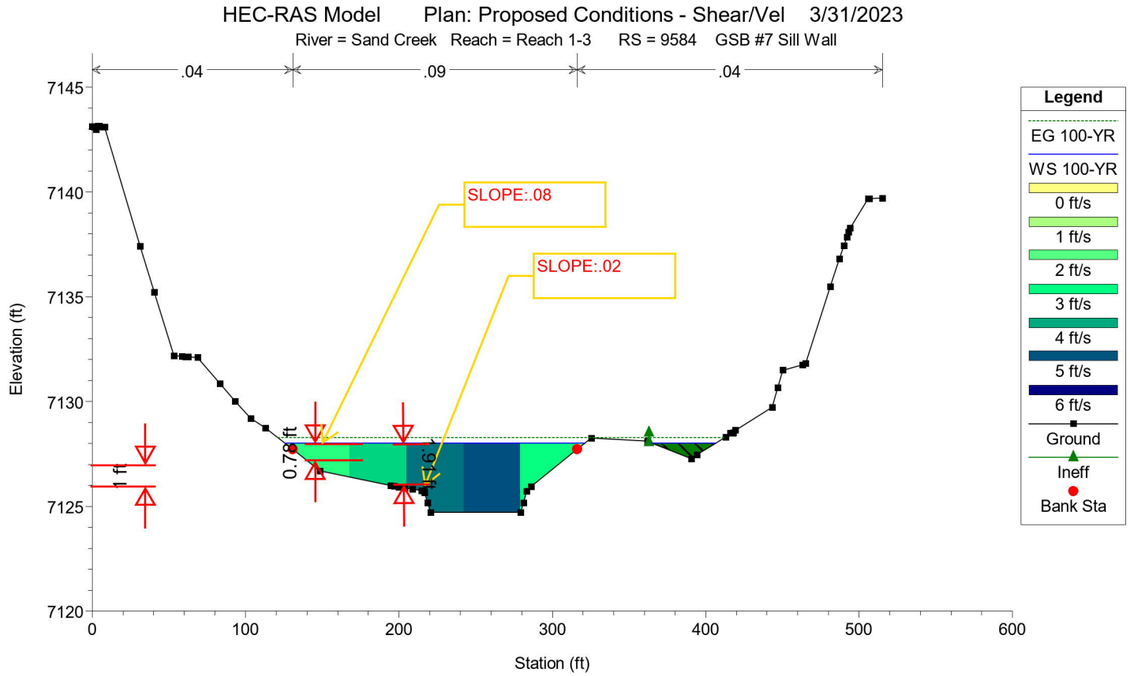

HEC-RAS Model Plan: Proposed Conditions - Shear/Vel 3/31/2023
River = Sand Creek Reach = Reach 1-3 RS = 9875 DS of GSB #8
.032
.06
.06
.04
.032
Legend
EG 100-YR
WS 100-YR
0 ft/s
2 ft/s
4 ft/s
6 ft/s
8 ft/s
Ground
Bank Sta
Elevation (ft)
Station (ft)

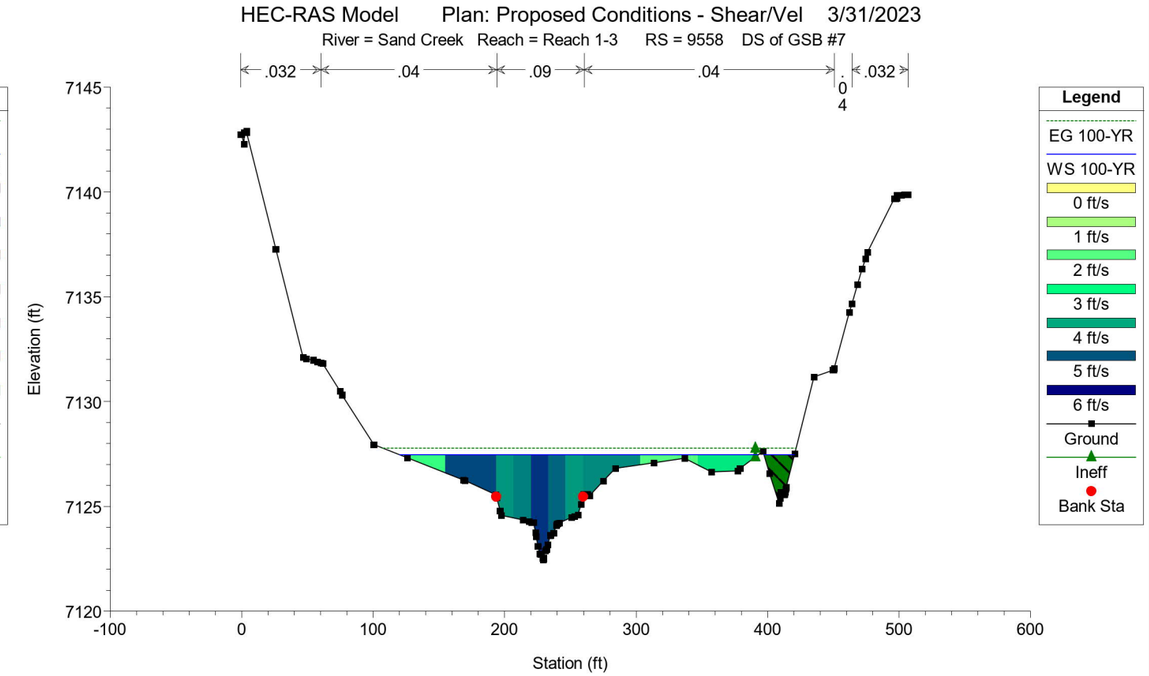

HEC-RAS Model Plan: Proposed Conditions - Shear/Vel 3/31/2023
River = Sand Creek Reach = Reach 1-3 RS = 9626 GSB #7 Crest
.032
.04
.09
.04
.032
SLOPE:.12
SLOPE:.12
SLOPE:.2
30.91 ft
0.57 ft
0.8 ft
0.98 ft
100.01 ft
Elevation (ft)
Station (ft)
Legend
EG 100-YR
WS 100-YR
Crit 100-YR
0 ft/s
2 ft/s
4 ft/s
6 ft/s
8 ft/s
Ground
Ineff
Bank Sta

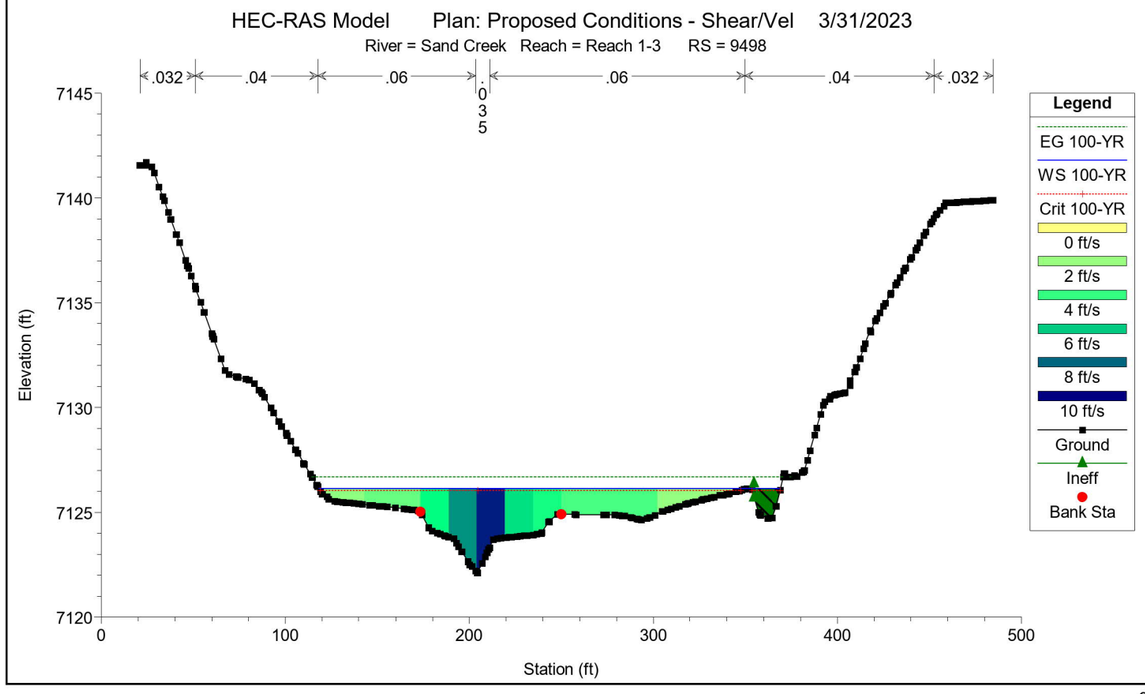

HEC-RAS Model Plan: Proposed Conditions - Shear/Vel 3/31/2023
River = Sand Creek Reach = Reach 1-3 RS = 9614
.032
.04
.09
.04
.032
Elevation (ft)
Station (ft)
Legend
EG 100-YR
Crit 100-YR
WS 100-YR
0 ft/s
5 ft/s
10 ft/s
15 ft/s
20 ft/s
Ground
Bank Sta

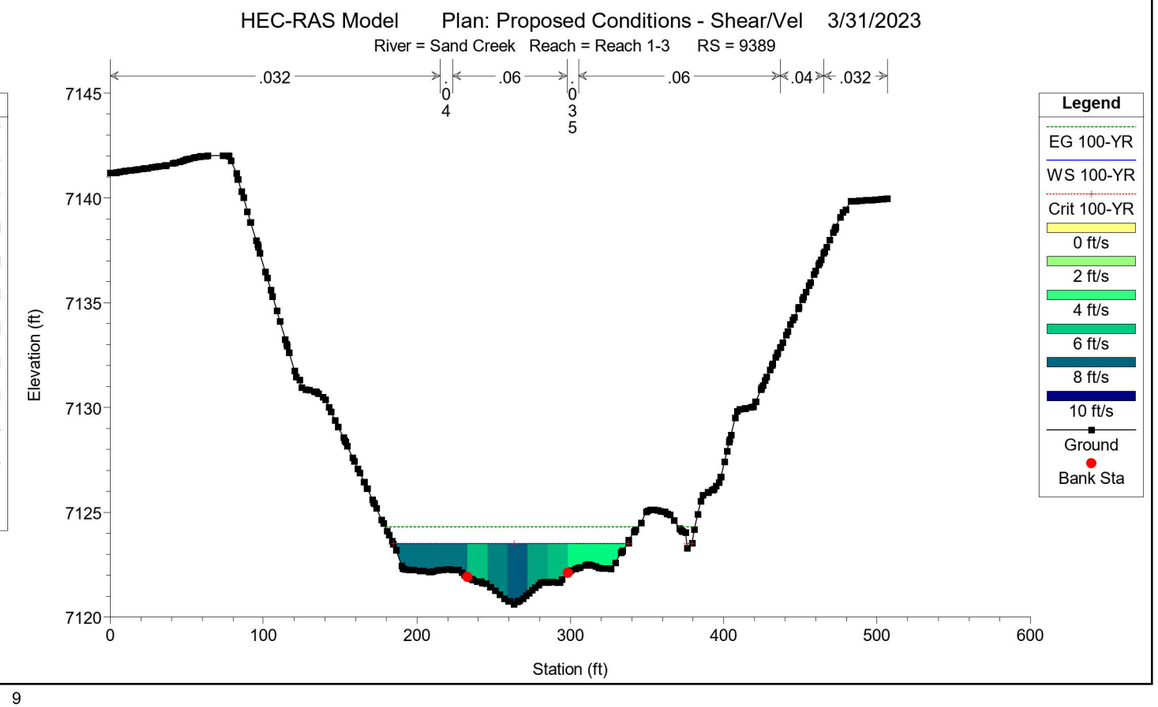

HEC-RAS Model Plan: Proposed Conditions - Shear/Vel 3/31/2023
River = Sand Creek Reach = Reach 1-3 RS = 9600 GSB #7 Toe
.032
.04
.04
.09
.04
.032
SLOPE:.12
1 ft
1.32 ft
Elevation (ft)
Station (ft)
Legend
EG 100-YR
WS 100-YR
Crit 100-YR
1 ft/s
2 ft/s
3 ft/s
4 ft/s
5 ft/s
6 ft/s
Ground
Ineff
Bank Sta


HEC-RAS Model Plan: Proposed Conditions - Shear/Vel 3/31/2023
River = Sand Creek Reach = Reach 1-3 RS = 9587 GSB #7 Stilling Basin
.04
.09
.04
SLOPE:.08
1.02 ft
Elevation (ft)
Station (ft)
Legend
EG 100-YR
WS 100-YR
0 ft/s
1 ft/s
2 ft/s
3 ft/s
4 ft/s
5 ft/s
Ground
Ineff
Bank Sta


HEC-RAS Model Plan: Proposed Conditions - Shear/Vel 3/31/2023
River = Sand Creek Reach = Reach 1-3 RS = 9584 GSB #7 Sill Wall
.04
.09
.04
SLOPE:.08
SLOPE:.02
0.78 ft
1 ft
Elevation (ft)
Station (ft)
Legend
EG 100-YR
WS 100-YR
0 ft/s
1 ft/s
2 ft/s
3 ft/s
4 ft/s
5 ft/s
6 ft/s
Ground
Ineff
Bank Sta

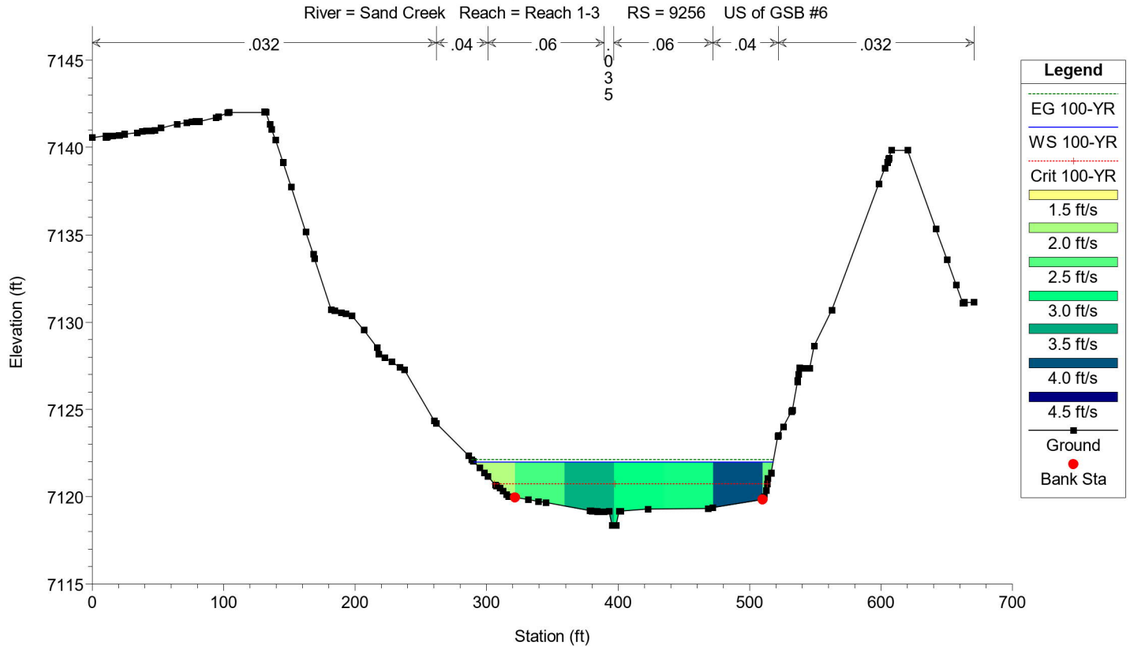

HEC-RAS Model Plan: Proposed Conditions - Shear/Vel 3/31/2023
River = Sand Creek Reach = Reach 1-3 RS = 9558 DS of GSB #7
.032
.04
.09
.04
.04
.032
Elevation (ft)
Station (ft)
Legend
EG 100-YR
WS 100-YR
0 ft/s
1 ft/s
2 ft/s
3 ft/s
4 ft/s
5 ft/s
6 ft/s
Ground
Ineff
Bank Sta


HEC-RAS Model Plan: Proposed Conditions - Shear/Vel 3/31/2023
River = Sand Creek Reach = Reach 1-3 RS = 9498
.032
.04
.06
.06
.04
.032
Elevation (ft)
Station (ft)
Legend
EG 100-YR
WS 100-YR
Crit 100-YR
0 ft/s
2 ft/s
4 ft/s
6 ft/s
8 ft/s
10 ft/s
Ground
Ineff
Bank Sta


HEC-RAS Model Plan: Proposed Conditions - Shear/Vel 3/31/2023
River = Sand Creek Reach = Reach 1-3 RS = 9389
.032
.06
.06
.04
.032
Elevation (ft)
Station (ft)
Legend
EG 100-YR
WS 100-YR
Crit 100-YR
0 ft/s
2 ft/s
4 ft/s
6 ft/s
8 ft/s
10 ft/s
Ground
Bank Sta

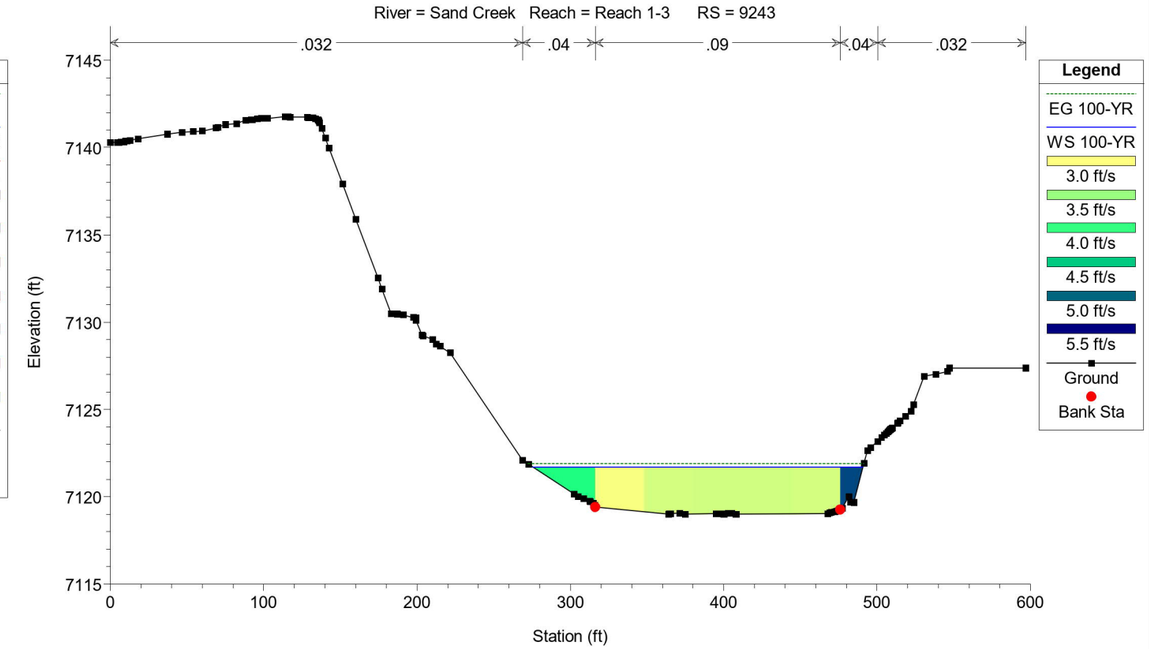
HEC-RAS Model Plan: Proposed Conditions - Shear/Vel 3/31/2023

River = Sand Creek Reach = Reach 1-3 RS = 9256 US of GSB #6



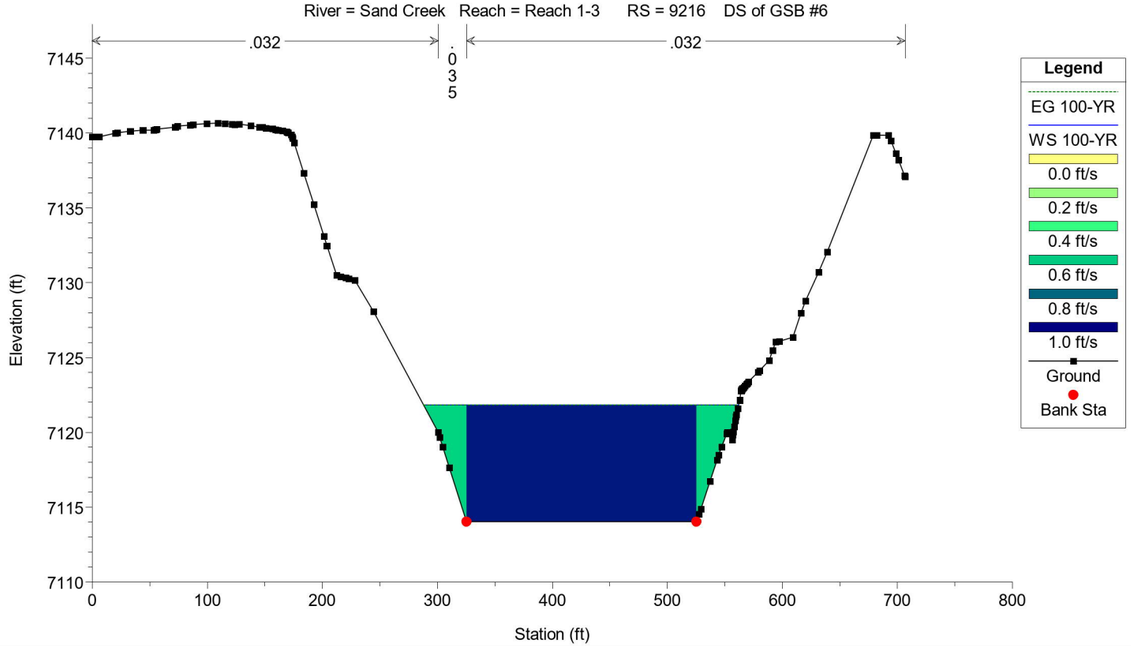
HEC-RAS Model Plan: Proposed Conditions - Shear/Vel 3/31/2023

River = Sand Creek Reach = Reach 1-3 RS = 9243



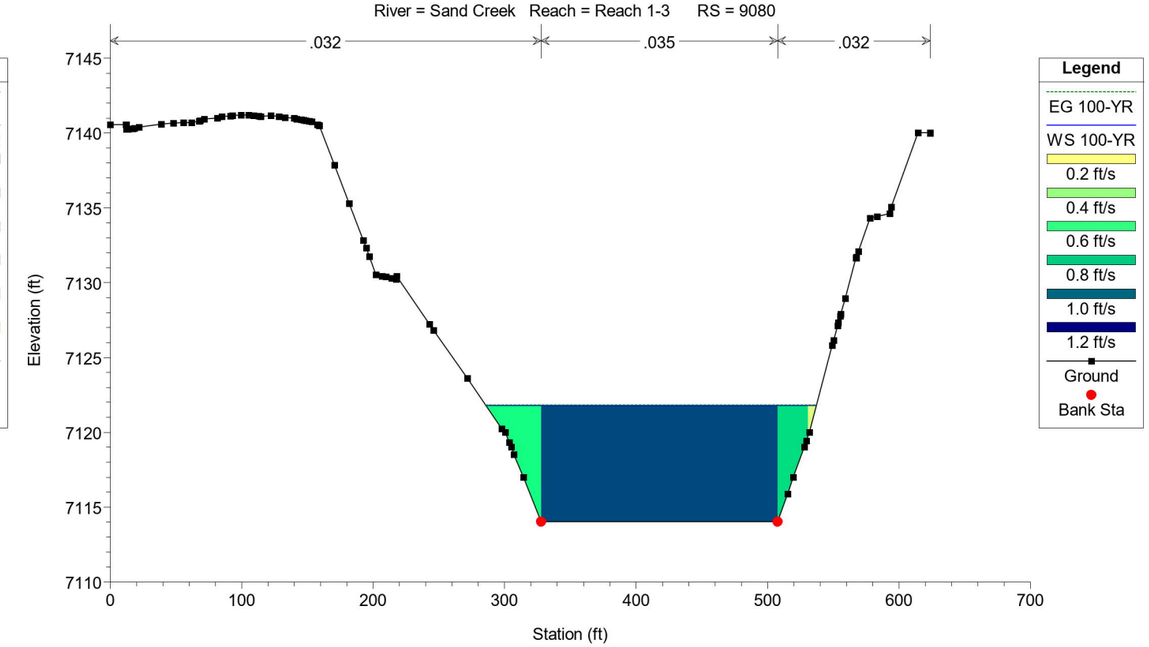
HEC-RAS Model Plan: Proposed Conditions - Shear/Vel 3/31/2023

River = Sand Creek Reach = Reach 1-3 RS = 9216 DS of GSB #6



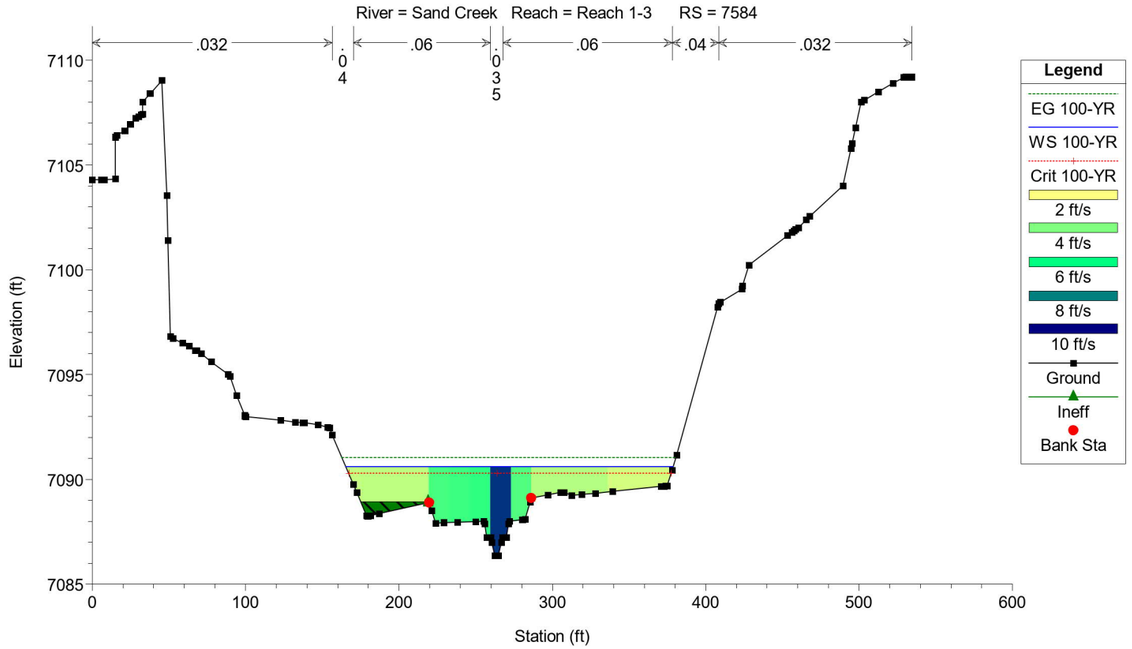
HEC-RAS Model Plan: Proposed Conditions - Shear/Vel 3/31/2023

River = Sand Creek Reach = Reach 1-3 RS = 9080



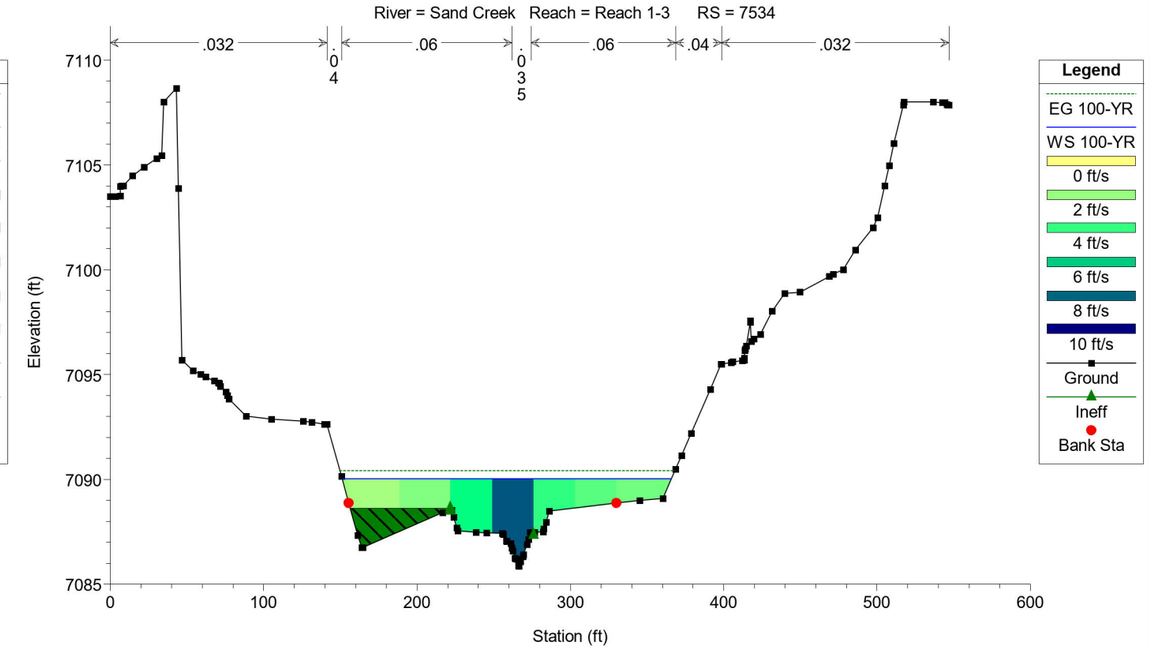
HEC-RAS Model Plan: Proposed Conditions - Shear/Vel 3/31/2023

River = Sand Creek Reach = Reach 1-3 RS = 7584



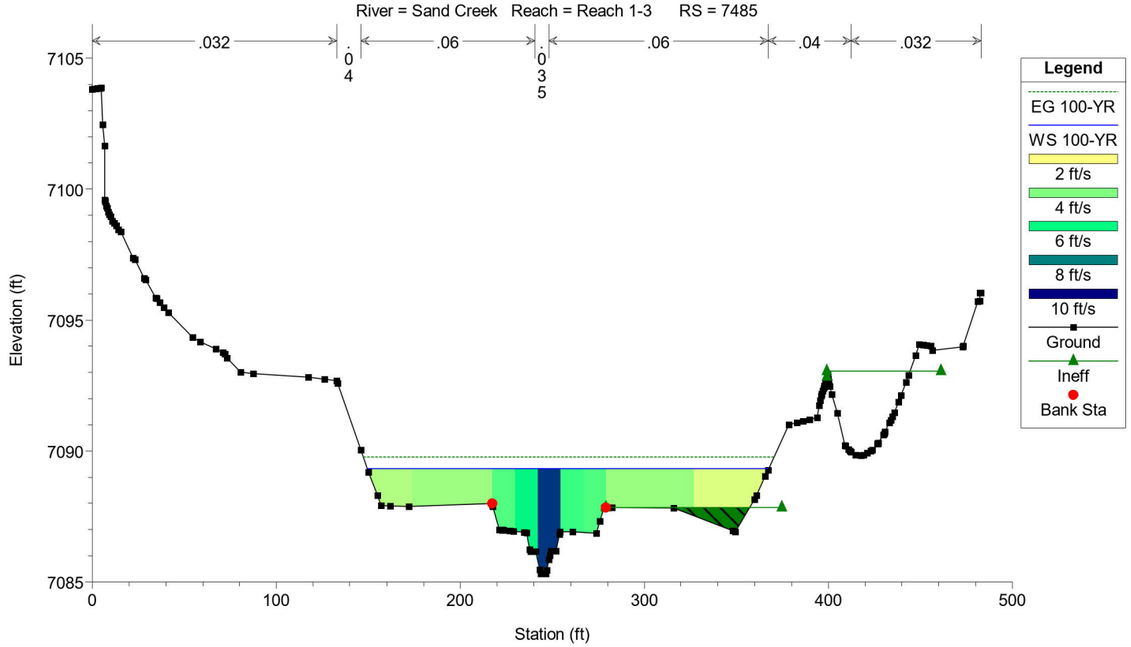
HEC-RAS Model Plan: Proposed Conditions - Shear/Vel 3/31/2023

River = Sand Creek Reach = Reach 1-3 RS = 7534



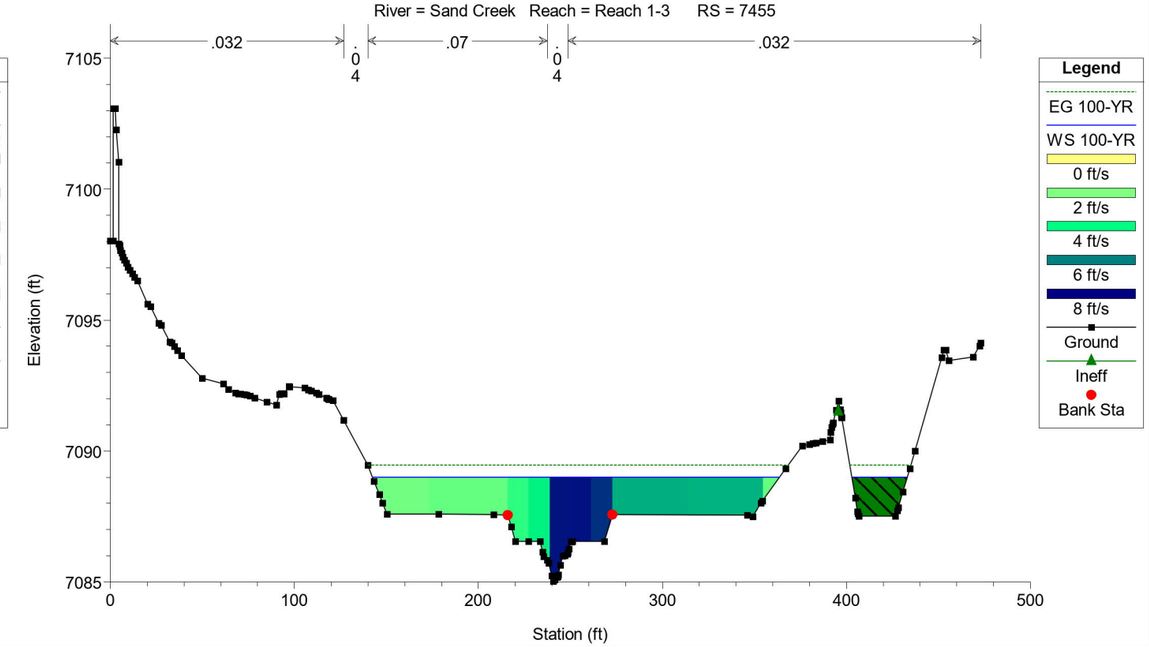
HEC-RAS Model Plan: Proposed Conditions - Shear/Vel 3/31/2023

River = Sand Creek Reach = Reach 1-3 RS = 7485



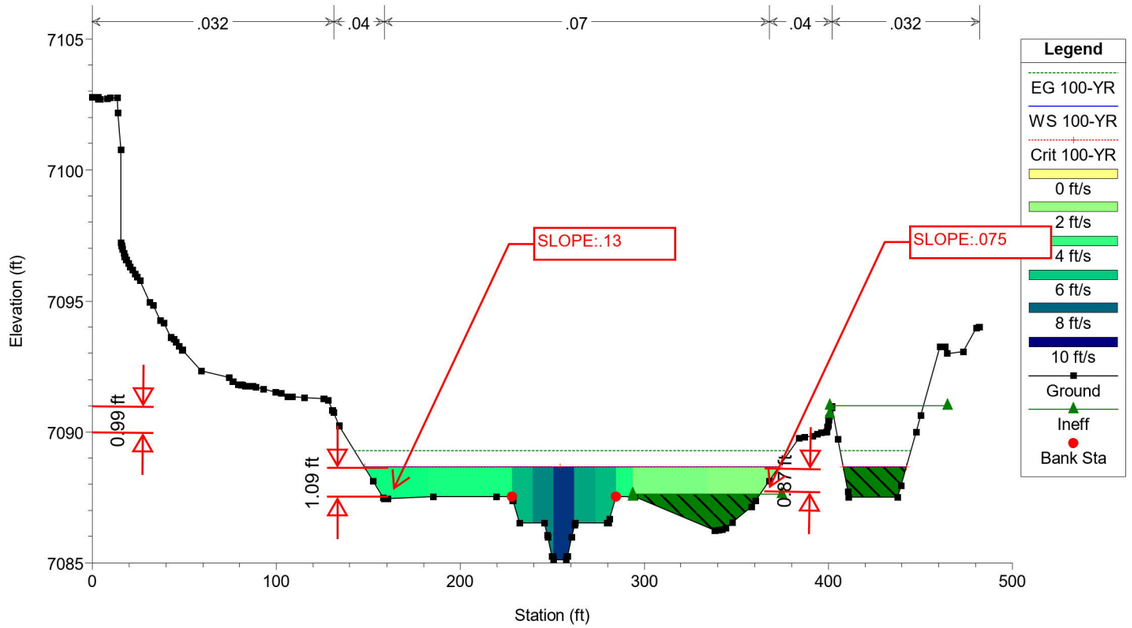
HEC-RAS Model Plan: Proposed Conditions - Shear/Vel 3/31/2023

River = Sand Creek Reach = Reach 1-3 RS = 7455



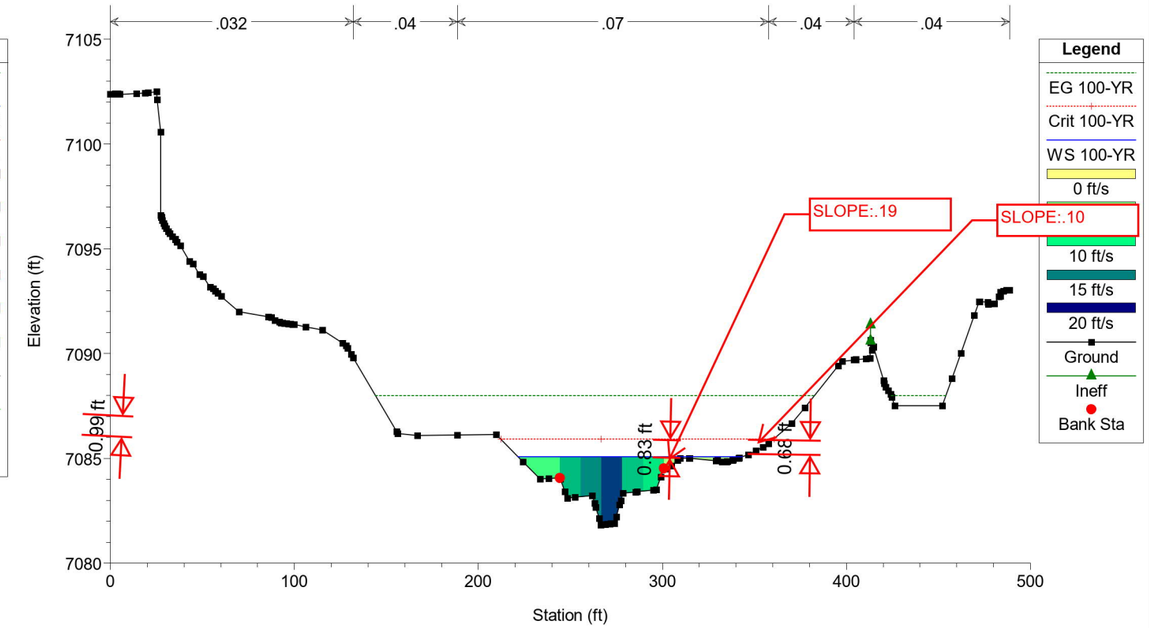
HEC-RAS Model Plan: Proposed Conditions - Shear/Vel 3/31/2023

River = Sand Creek Reach = Reach 1-3 RS = 7445 GSB #5 Crest



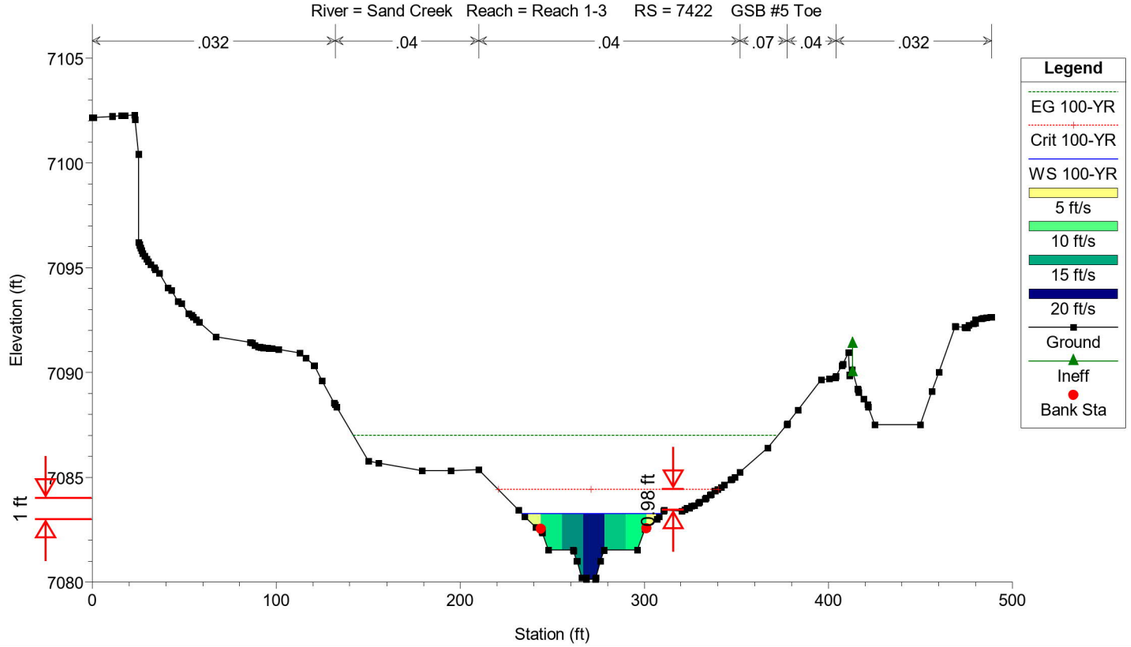
HEC-RAS Model Plan: Proposed Conditions - Shear/Vel 3/31/2023

River = Sand Creek Reach = Reach 1-3 RS = 7430 GSB #5 Mid



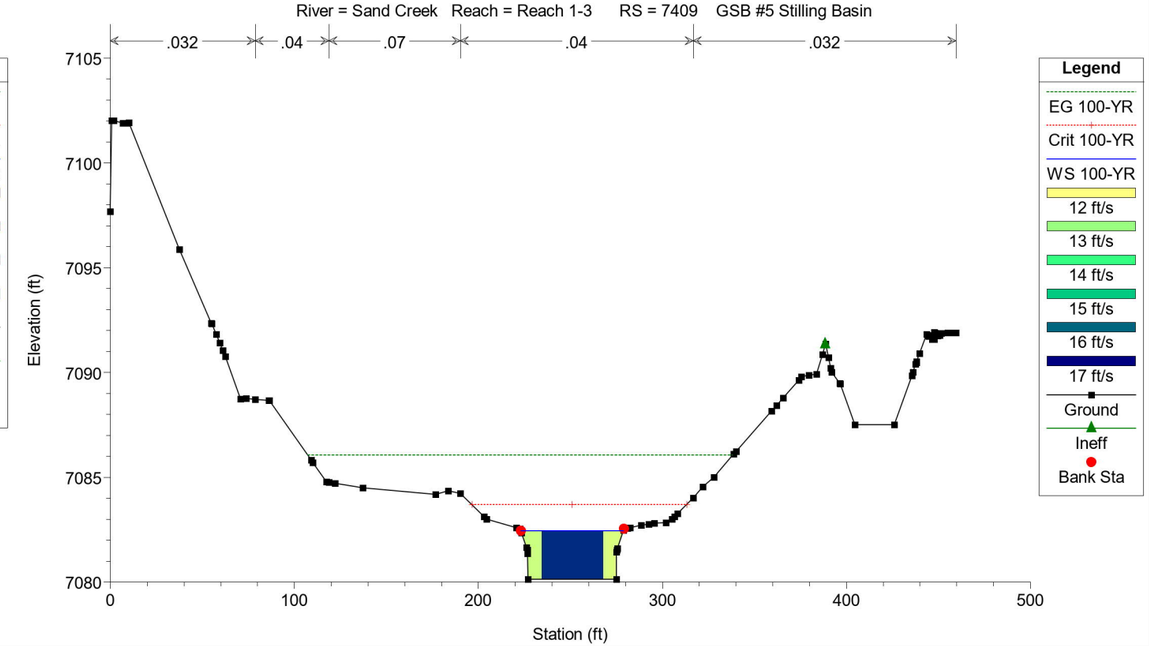
HEC-RAS Model Plan: Proposed Conditions - Shear/Vel 3/31/2023

River = Sand Creek Reach = Reach 1-3 RS = 7422 GSB #5 Toe



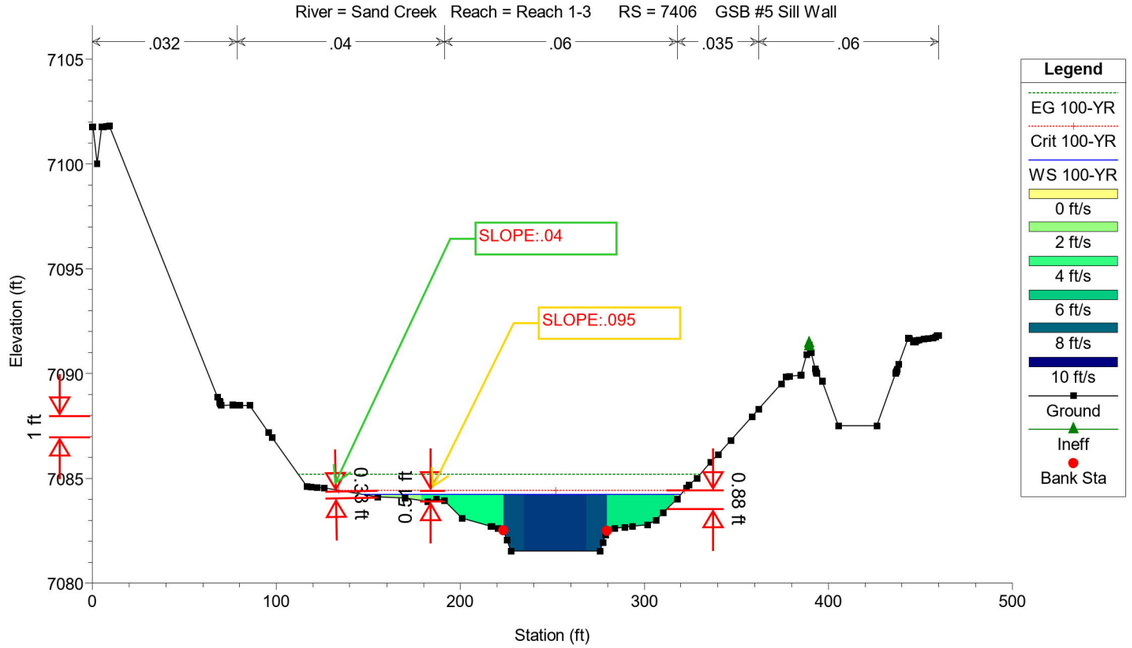
HEC-RAS Model Plan: Proposed Conditions - Shear/Vel 3/31/2023

River = Sand Creek Reach = Reach 1-3 RS = 7409 GSB #5 Stilling Basin



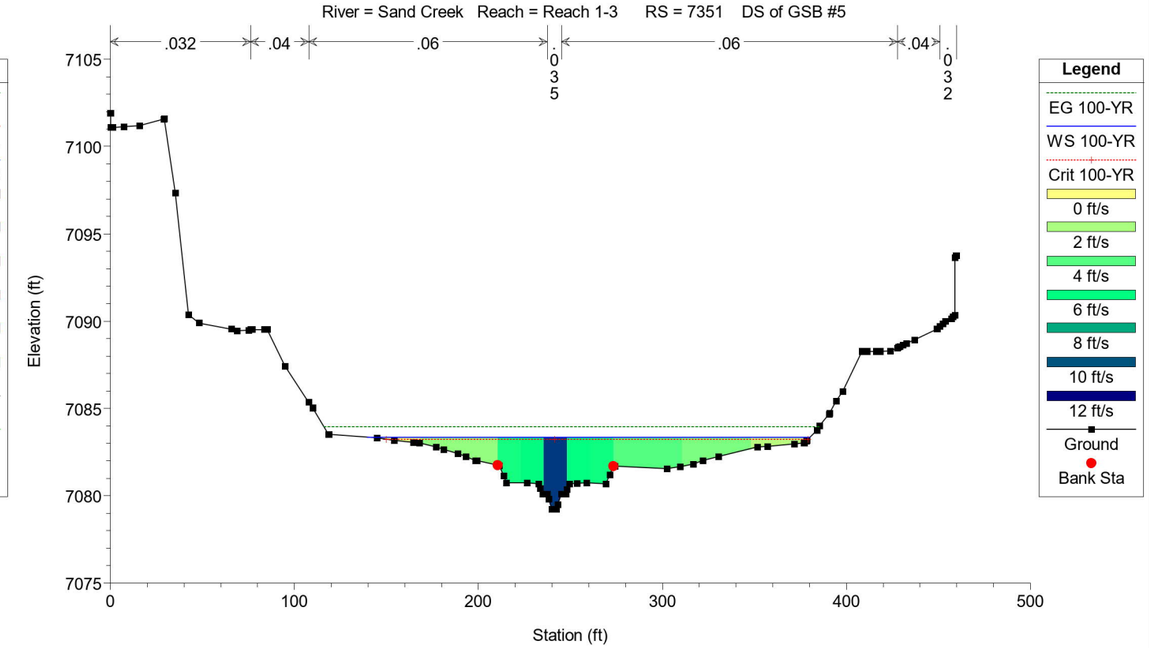
HEC-RAS Model Plan: Proposed Conditions - Shear/Vel 3/31/2023

River = Sand Creek Reach = Reach 1-3 RS = 7406 GSB #5 Sill Wall



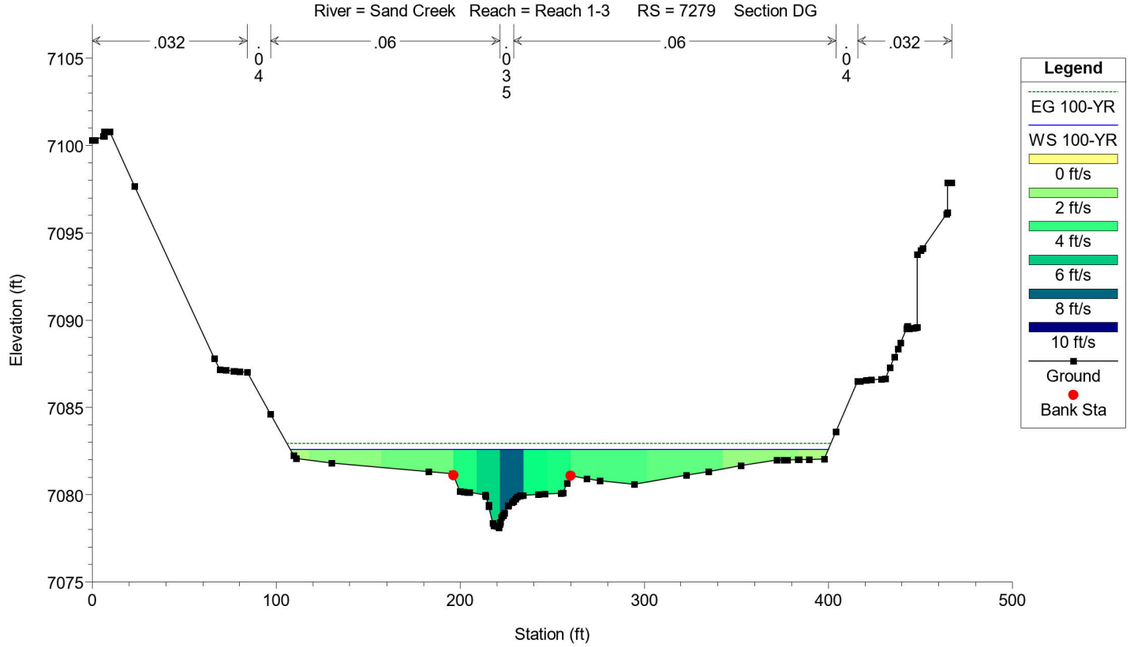
HEC-RAS Model Plan: Proposed Conditions - Shear/Vel 3/31/2023

River = Sand Creek Reach = Reach 1-3 RS = 7351 DS of GSB #5



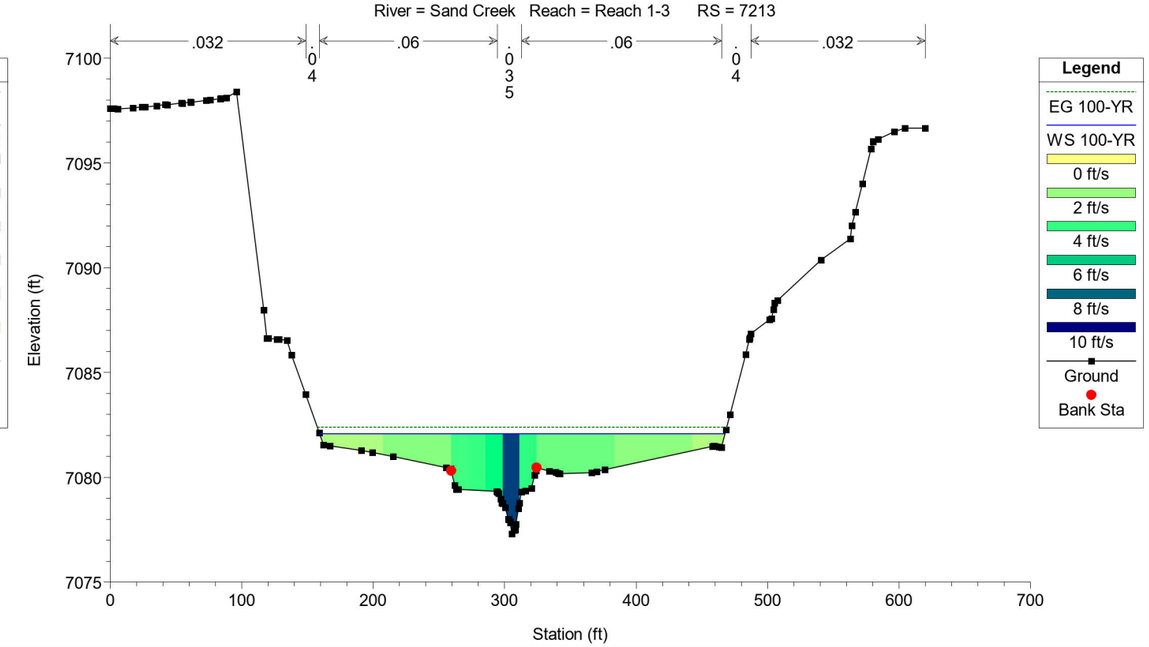
HEC-RAS Model Plan: Proposed Conditions - Shear/Vel 3/31/2023

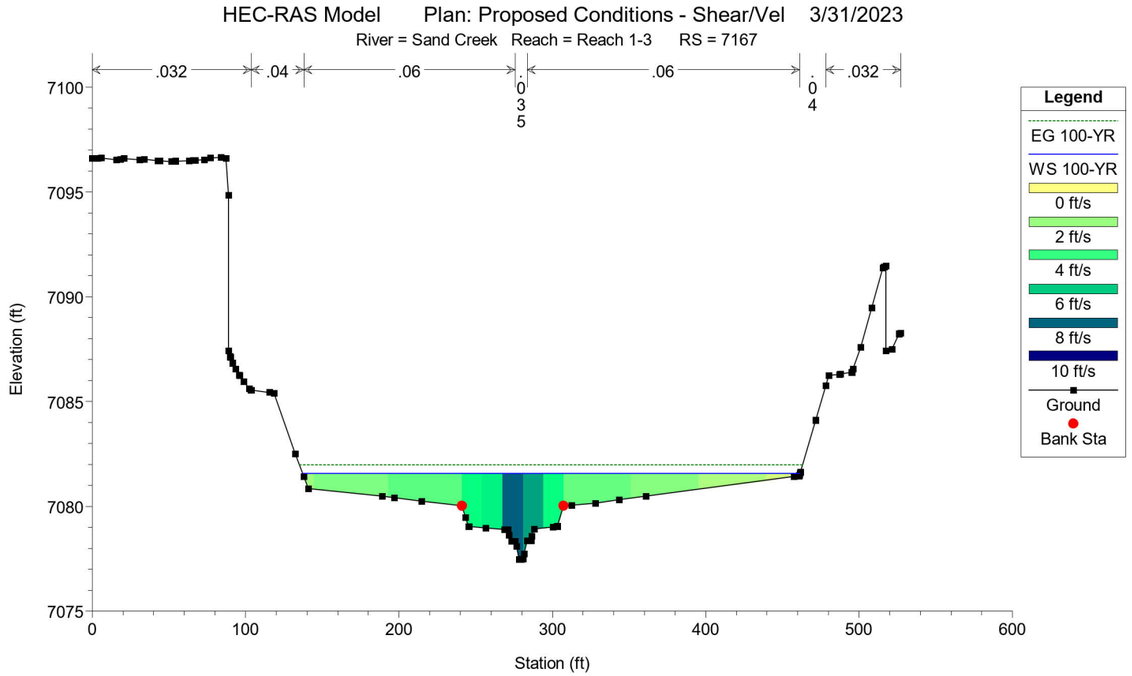
River = Sand Creek Reach = Reach 1-3 RS = 7279 Section DG

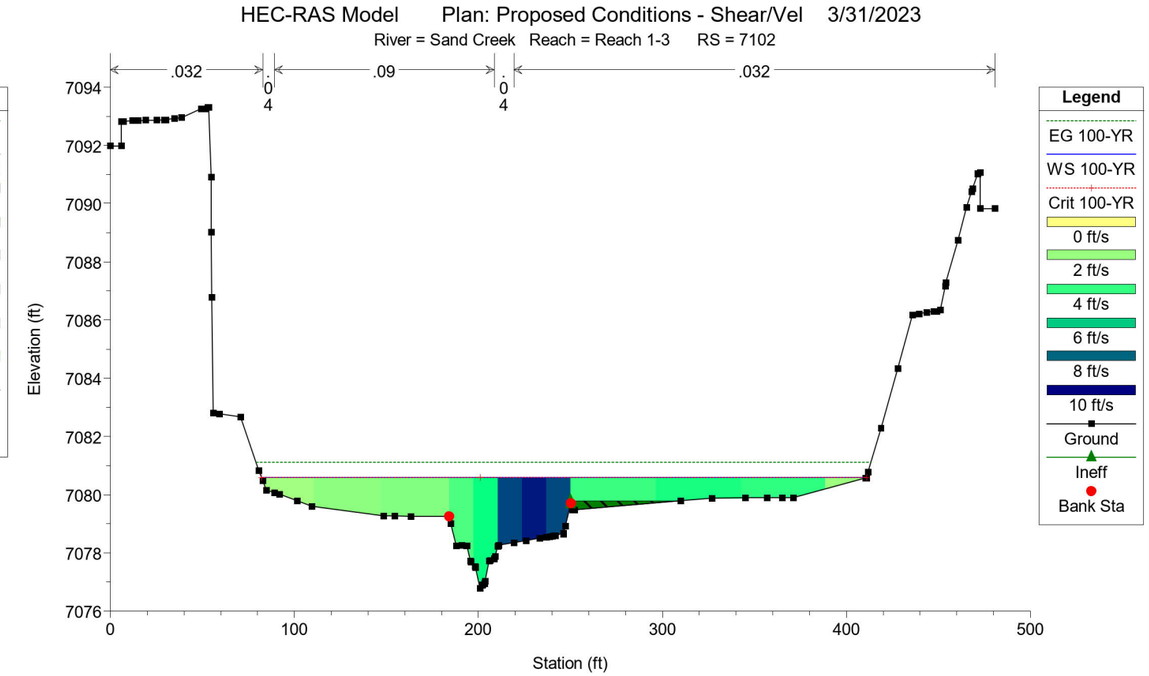


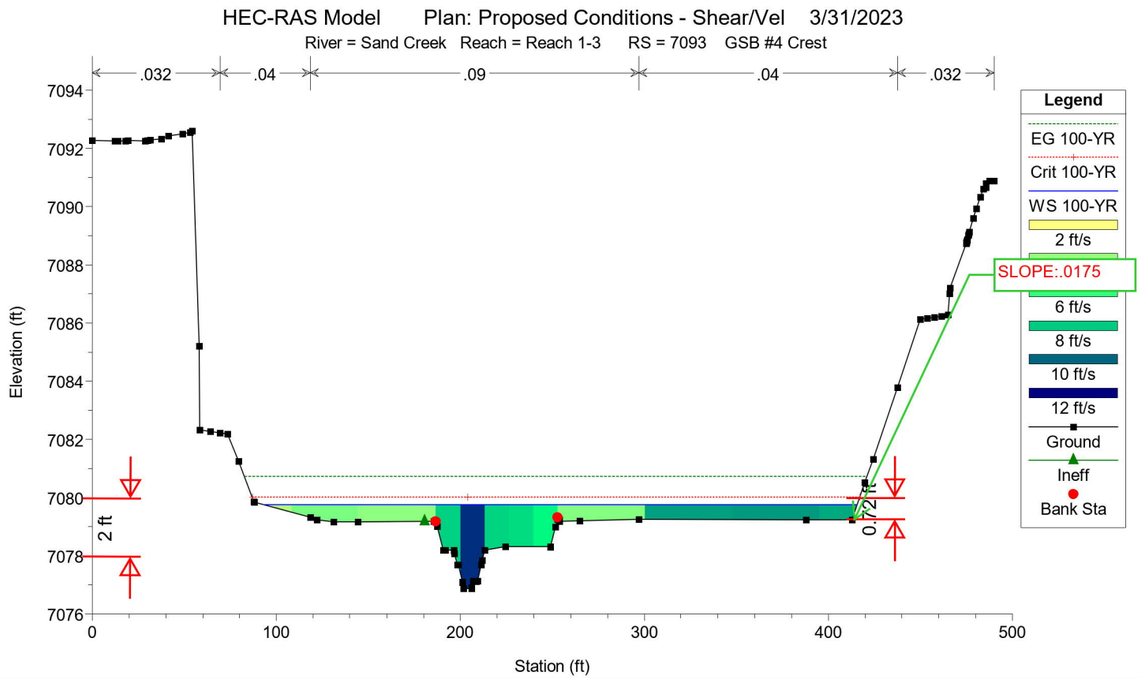
HEC-RAS Model Plan: Proposed Conditions - Shear/Vel 3/31/2023

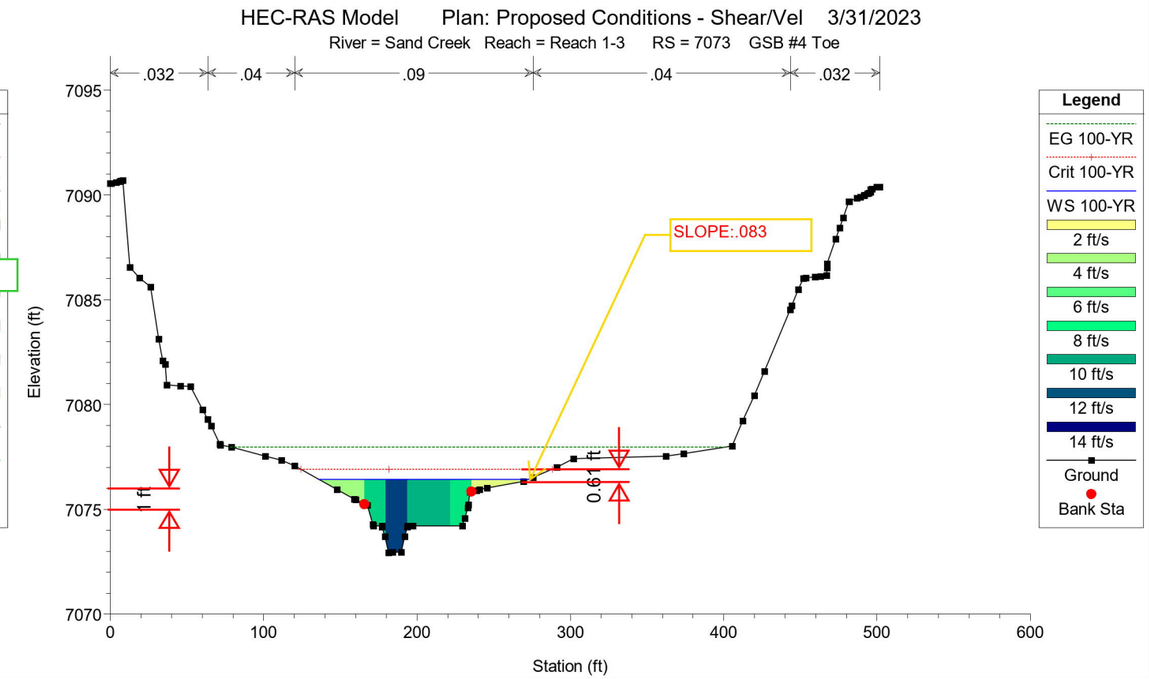
River = Sand Creek Reach = Reach 1-3 RS = 7213




HEC-RAS Model Plan: Proposed Conditions - Shear/Vel 3/31/2023
River = Sand Creek Reach = Reach 1-3 RS = 7167
.032
.04
.06
.035
.06
.04
.032
Legend
EG 100-YR
WS 100-YR
0 ft/s
2 ft/s
4 ft/s
6 ft/s
8 ft/s
10 ft/s
Ground
Bank Sta
Elevation (ft)
Station (ft)

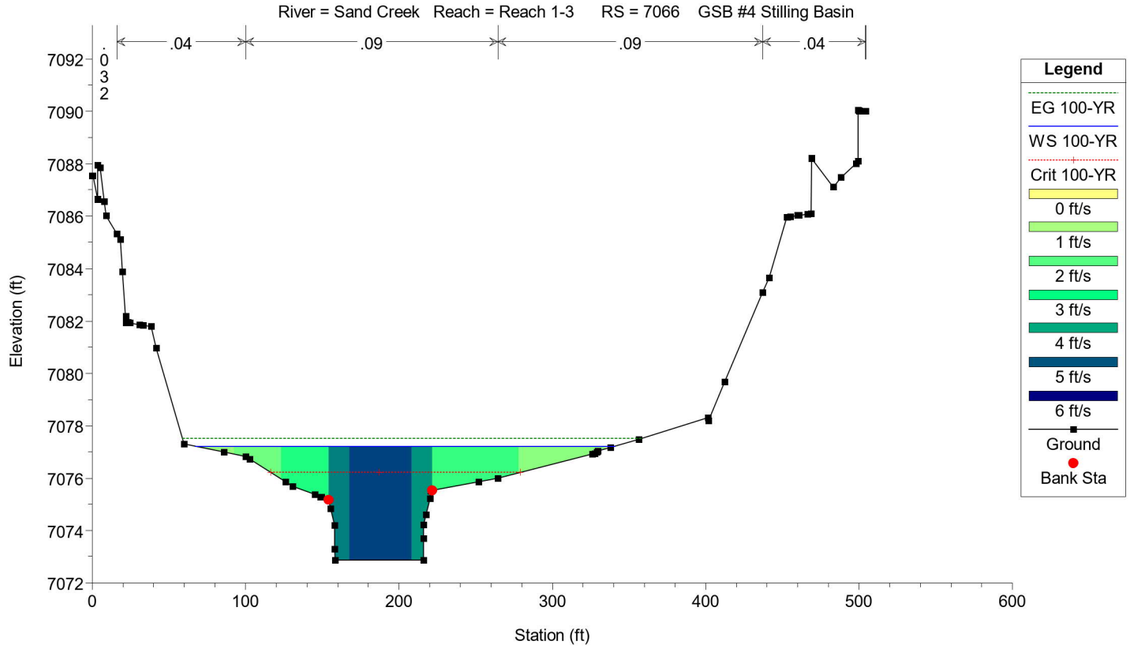

HEC-RAS Model Plan: Proposed Conditions - Shear/Vel 3/31/2023
River = Sand Creek Reach = Reach 1-3 RS = 7102
.032
.04
.09
.04
.032
Legend
EG 100-YR
WS 100-YR
Crit 100-YR
0 ft/s
2 ft/s
4 ft/s
6 ft/s
8 ft/s
10 ft/s
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)


HEC-RAS Model Plan: Proposed Conditions - Shear/Vel 3/31/2023
River = Sand Creek Reach = Reach 1-3 RS = 7093 GSB #4 Crest
.032
.04
.09
.04
.032
SLOPE:.0175
2 ft
0.72 ft
Legend
EG 100-YR
Crit 100-YR
WS 100-YR
2 ft/s
6 ft/s
8 ft/s
10 ft/s
12 ft/s
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)


HEC-RAS Model Plan: Proposed Conditions - Shear/Vel 3/31/2023
River = Sand Creek Reach = Reach 1-3 RS = 7073 GSB #4 Toe
.032
.04
.09
.04
.032
SLOPE:.083
1 ft
0.61 ft
Legend
EG 100-YR
Crit 100-YR
WS 100-YR
2 ft/s
4 ft/s
6 ft/s
8 ft/s
10 ft/s
12 ft/s
14 ft/s
Ground
Bank Sta
Elevation (ft)
Station (ft)

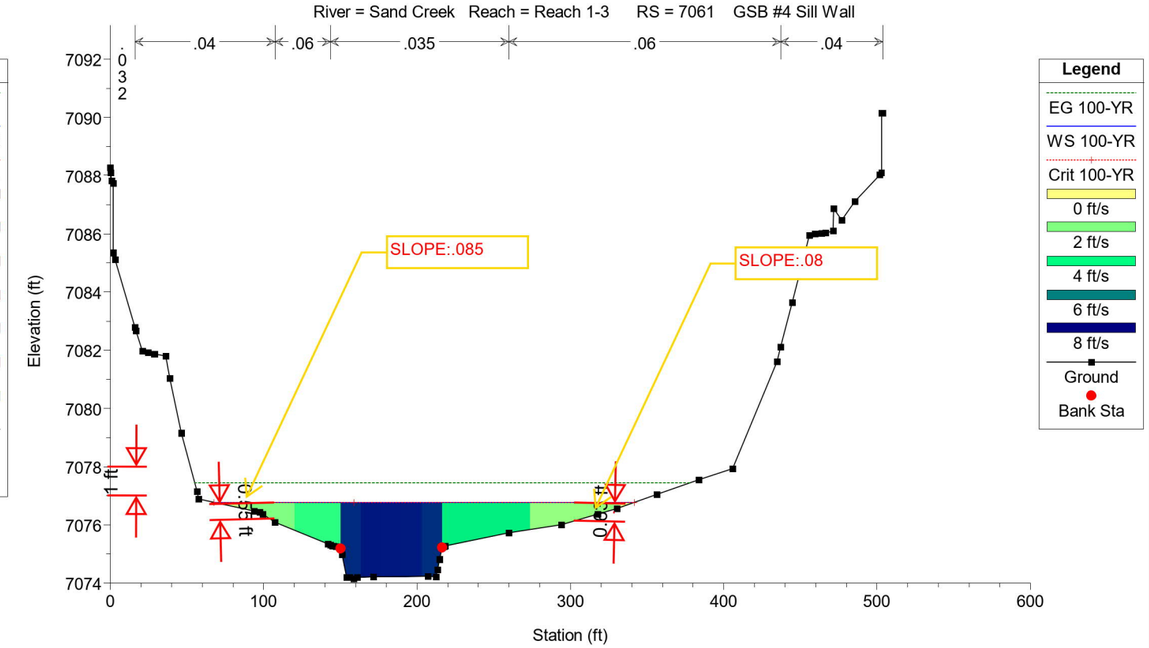
HEC-RAS Model Plan: Proposed Conditions - Shear/Vel 3/31/2023

River = Sand Creek Reach = Reach 1-3 RS = 7066 GSB #4 Stilling Basin



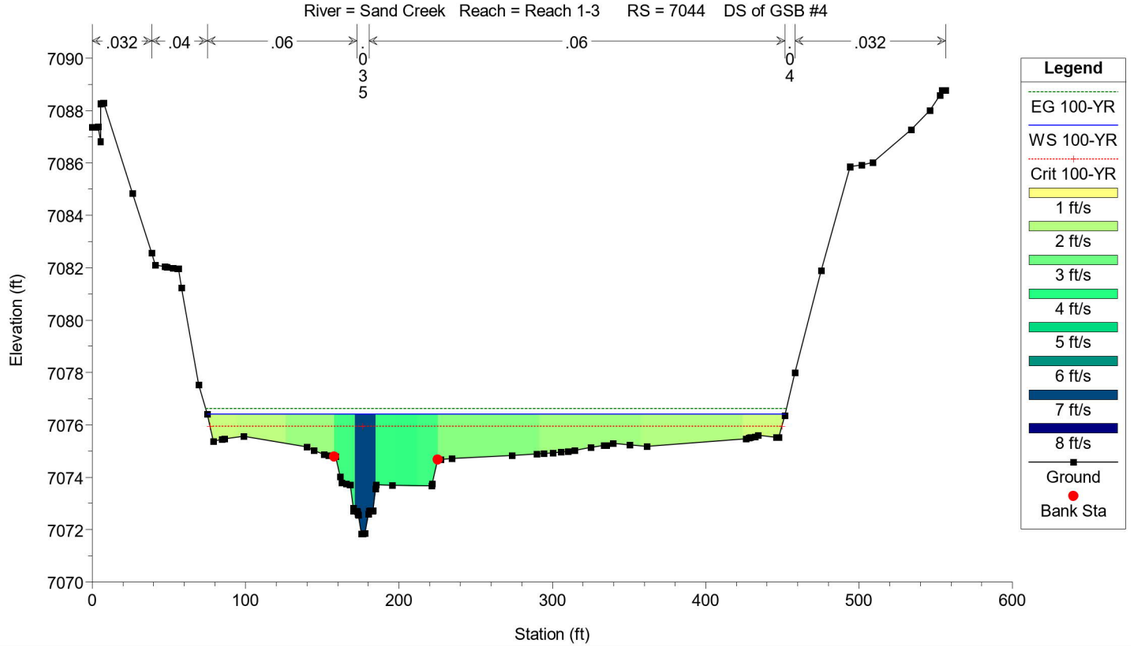
HEC-RAS Model Plan: Proposed Conditions - Shear/Vel 3/31/2023

River = Sand Creek Reach = Reach 1-3 RS = 7061 GSB #4 Sill Wall



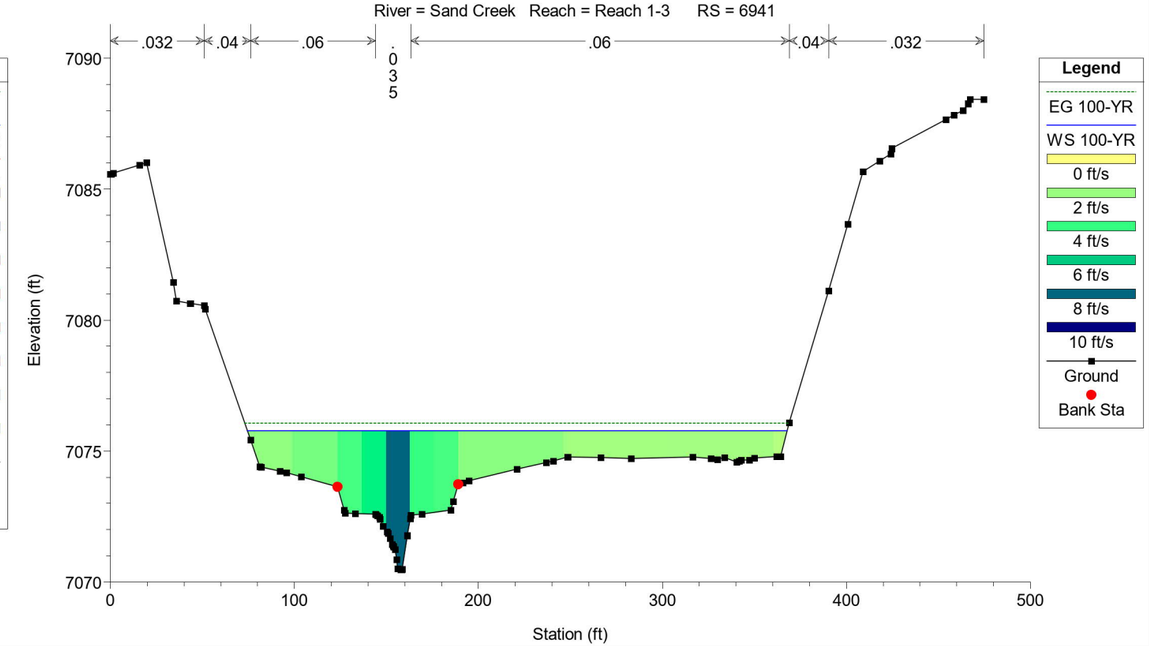
HEC-RAS Model Plan: Proposed Conditions - Shear/Vel 3/31/2023

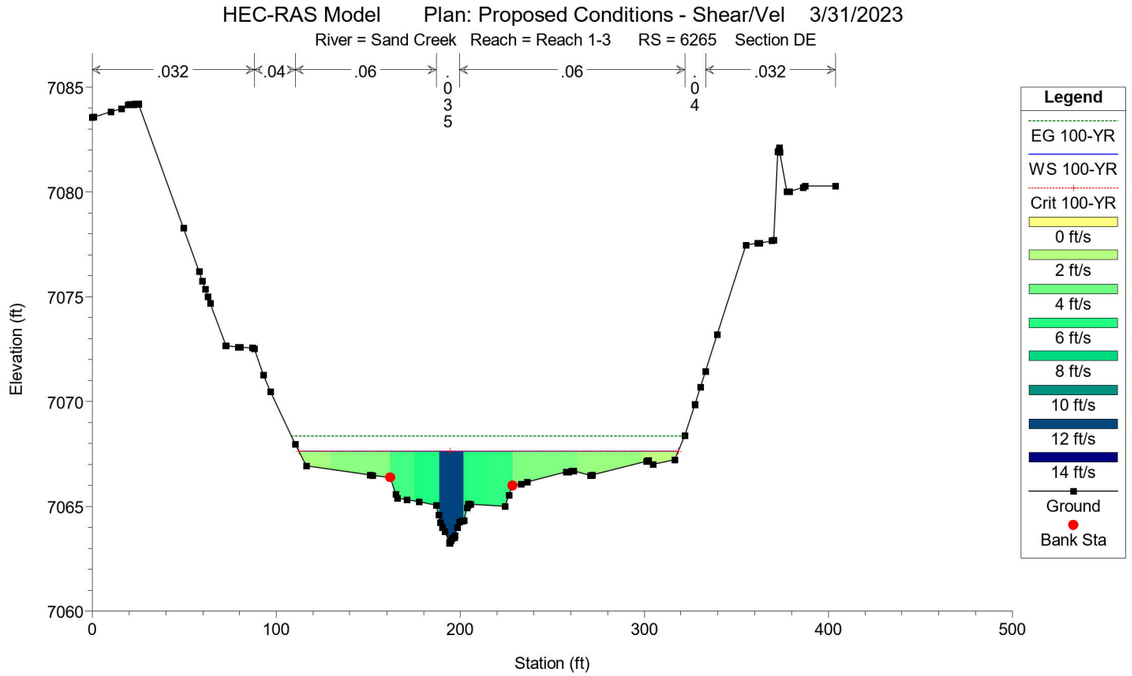
River = Sand Creek Reach = Reach 1-3 RS = 7044 DS of GSB #4

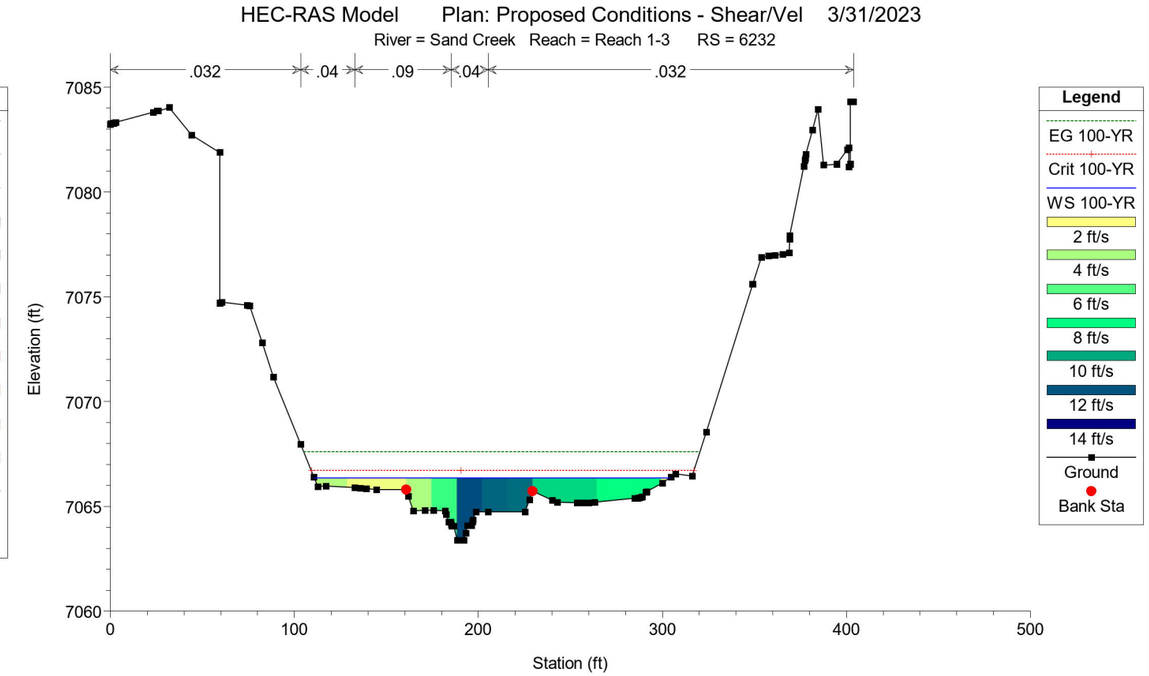


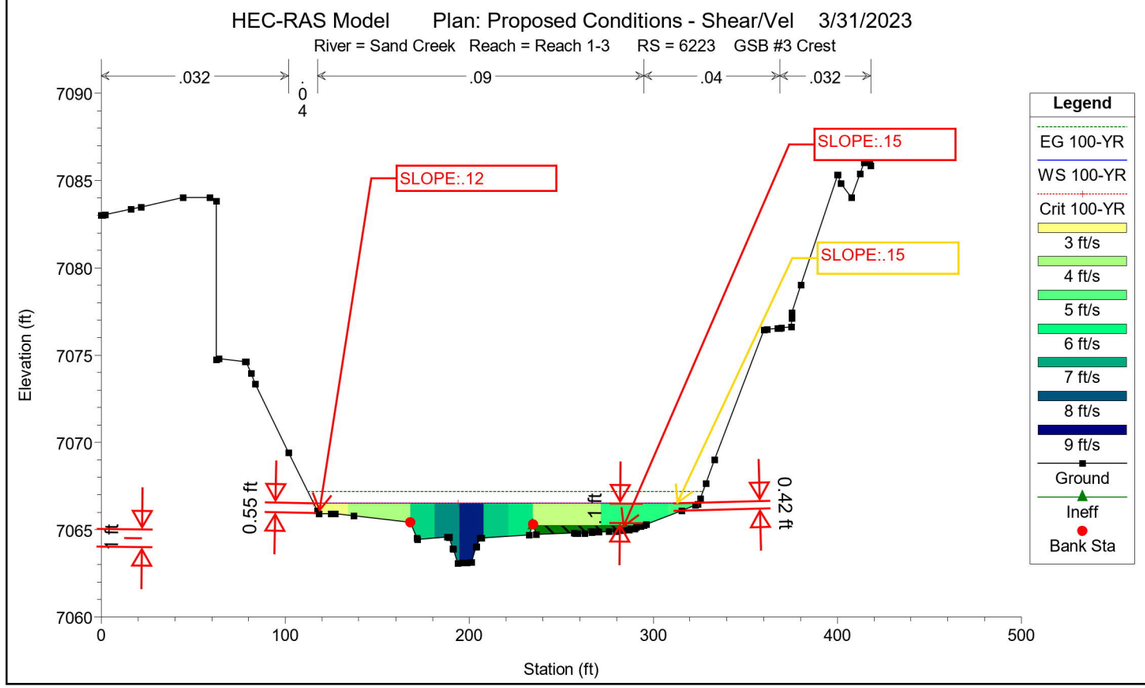
HEC-RAS Model Plan: Proposed Conditions - Shear/Vel 3/31/2023

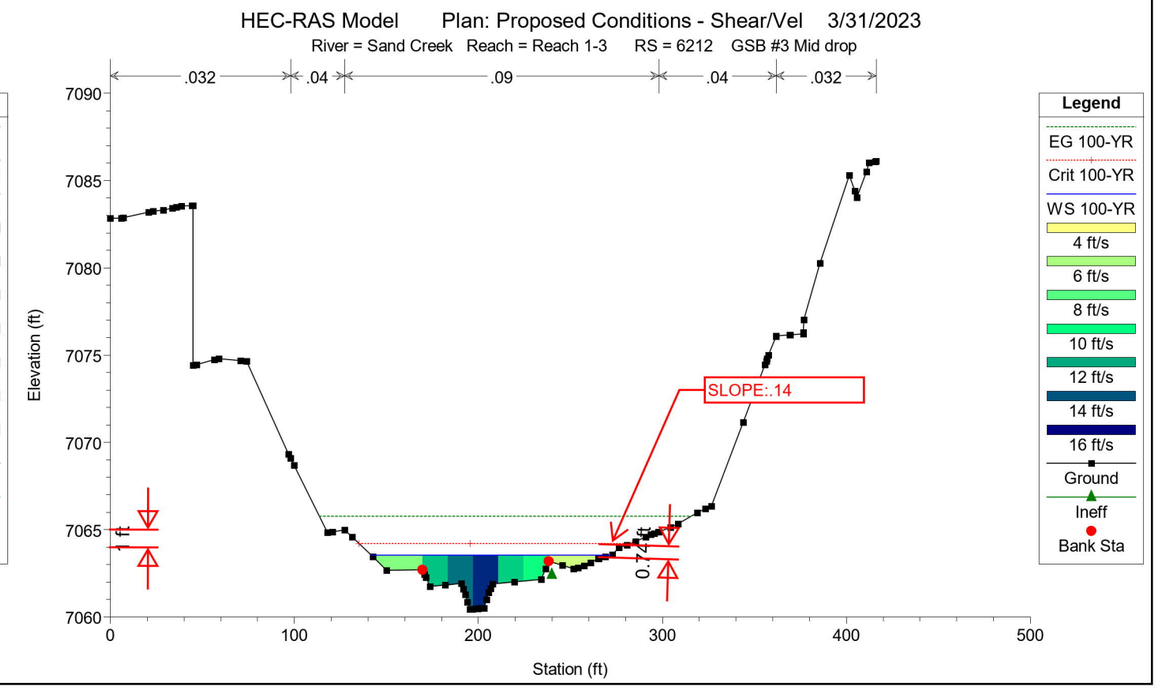
River = Sand Creek Reach = Reach 1-3 RS = 6941




HEC-RAS Model Plan: Proposed Conditions - Shear/Vel 3/31/2023
River = Sand Creek Reach = Reach 1-3 RS = 6265 Section DE
.032
.04
.06
.035
.06
.04
.032
Legend
EG 100-YR
WS 100-YR
Crit 100-YR
0 ft/s
2 ft/s
4 ft/s
6 ft/s
8 ft/s
10 ft/s
12 ft/s
14 ft/s
Ground
Bank Sta
Elevation (ft)
Station (ft)

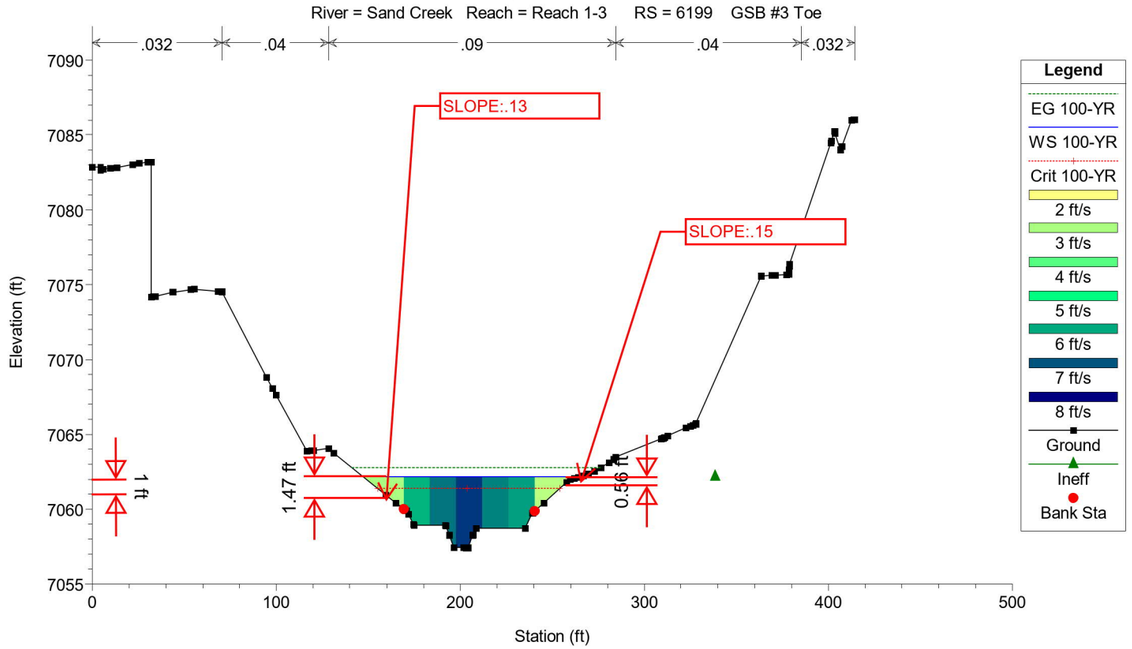

HEC-RAS Model Plan: Proposed Conditions - Shear/Vel 3/31/2023
River = Sand Creek Reach = Reach 1-3 RS = 6232
.032
.04
.09
.04
.032
Legend
EG 100-YR
Crit 100-YR
WS 100-YR
2 ft/s
4 ft/s
6 ft/s
8 ft/s
10 ft/s
12 ft/s
14 ft/s
Ground
Bank Sta
Elevation (ft)
Station (ft)


HEC-RAS Model Plan: Proposed Conditions - Shear/Vel 3/31/2023
River = Sand Creek Reach = Reach 1-3 RS = 6223 GSB #3 Crest
.032
.04
.09
.04
.032
SLOPE:.12
SLOPE:.15
SLOPE:.15
0.55 ft
1 ft
0.42 ft
1 ft
Legend
EG 100-YR
WS 100-YR
Crit 100-YR
3 ft/s
4 ft/s
5 ft/s
6 ft/s
7 ft/s
8 ft/s
9 ft/s
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)


HEC-RAS Model Plan: Proposed Conditions - Shear/Vel 3/31/2023
River = Sand Creek Reach = Reach 1-3 RS = 6212 GSB #3 Mid drop
.032
.04
.09
.04
.032
SLOPE:.14
1 ft
0.42 ft
Legend
EG 100-YR
Crit 100-YR
WS 100-YR
4 ft/s
6 ft/s
8 ft/s
10 ft/s
12 ft/s
14 ft/s
16 ft/s
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)

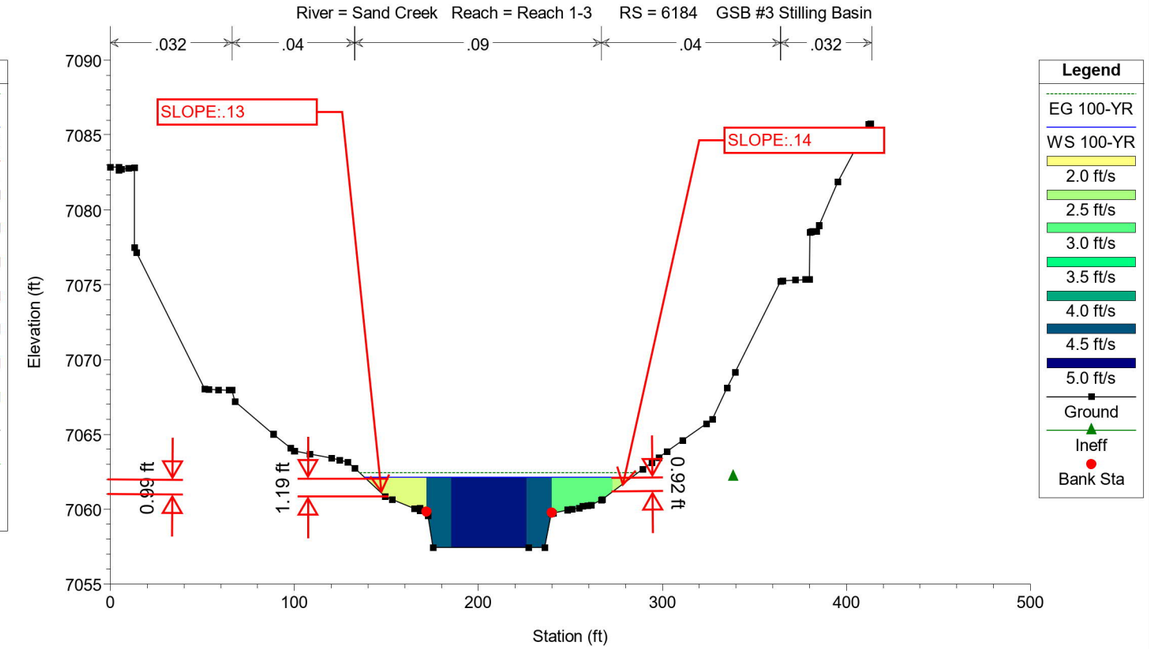
HEC-RAS Model Plan: Proposed Conditions - Shear/Vel 3/31/2023

River = Sand Creek Reach = Reach 1-3 RS = 6199 GSB #3 Toe



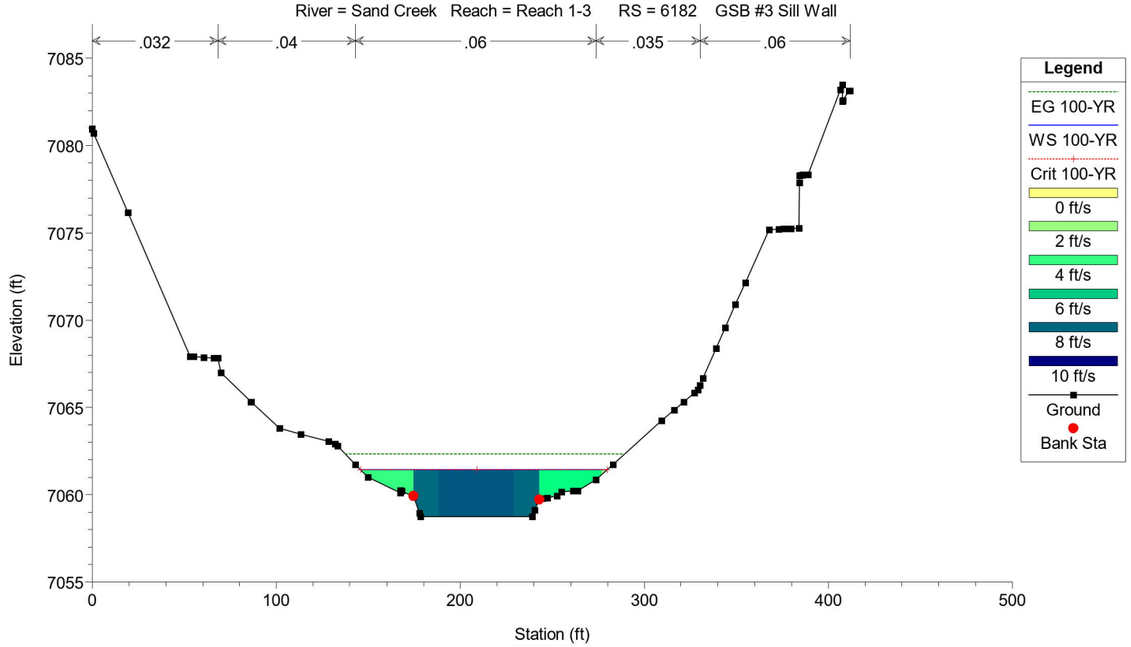
HEC-RAS Model Plan: Proposed Conditions - Shear/Vel 3/31/2023

River = Sand Creek Reach = Reach 1-3 RS = 6184 GSB #3 Stilling Basin



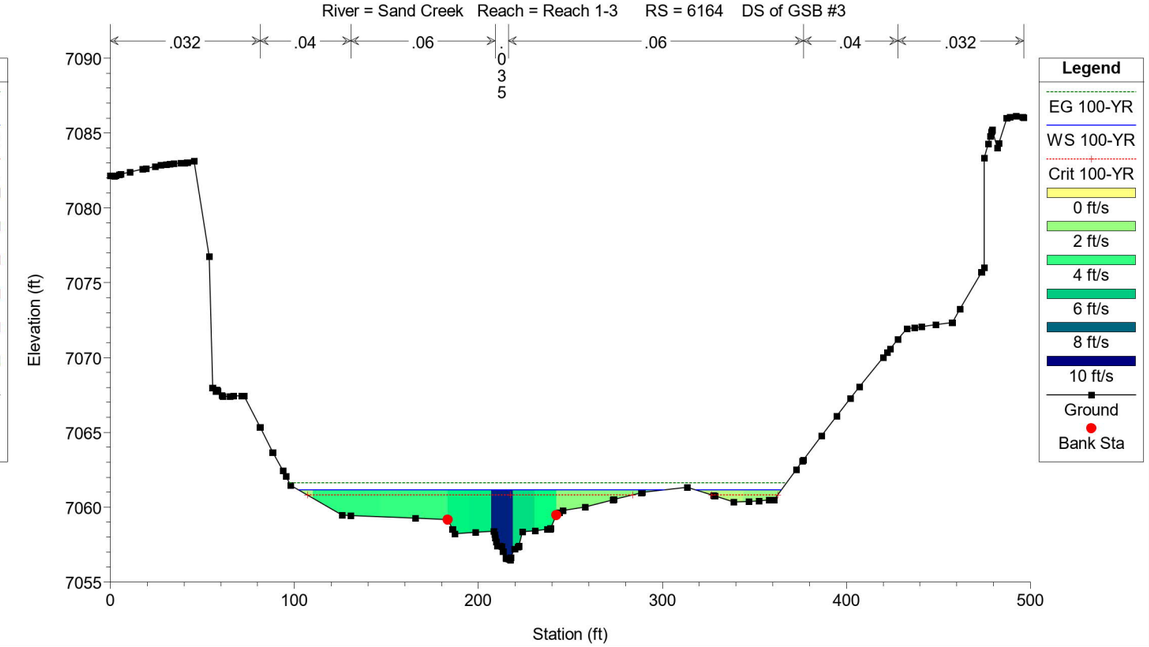
HEC-RAS Model Plan: Proposed Conditions - Shear/Vel 3/31/2023

River = Sand Creek Reach = Reach 1-3 RS = 6182 GSB #3 Sill Wall



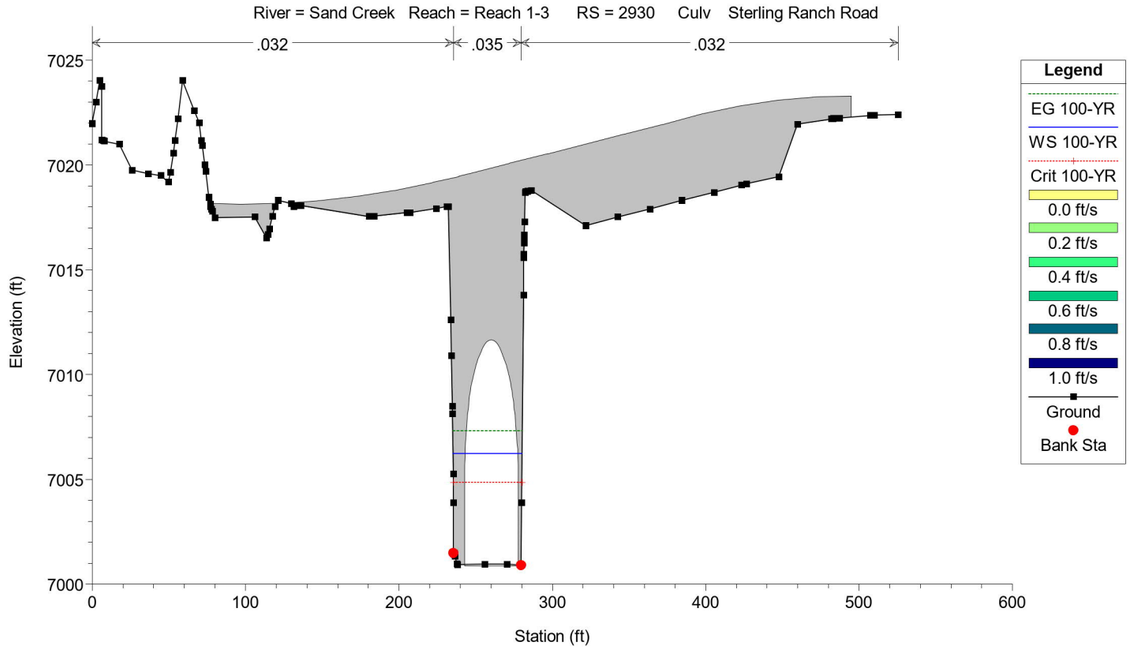
HEC-RAS Model Plan: Proposed Conditions - Shear/Vel 3/31/2023

River = Sand Creek Reach = Reach 1-3 RS = 6164 DS of GSB #3



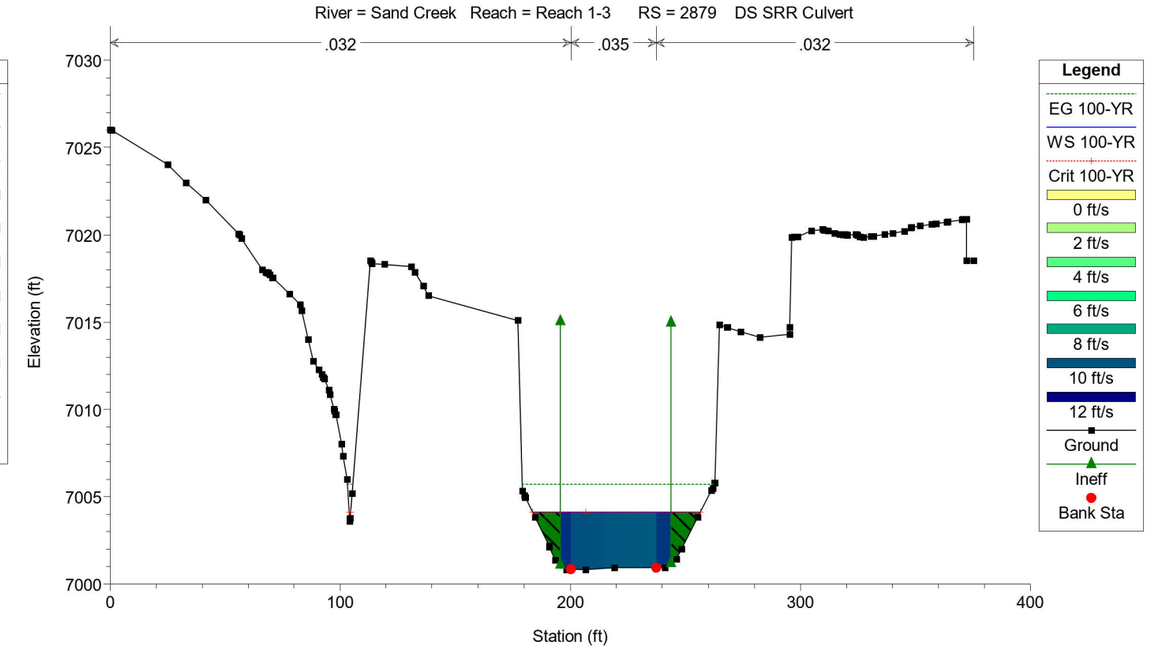
HEC-RAS Model Plan: Proposed Conditions - Shear/Vel 3/31/2023

River = Sand Creek Reach = Reach 1-3 RS = 2930 Culv Sterling Ranch Road



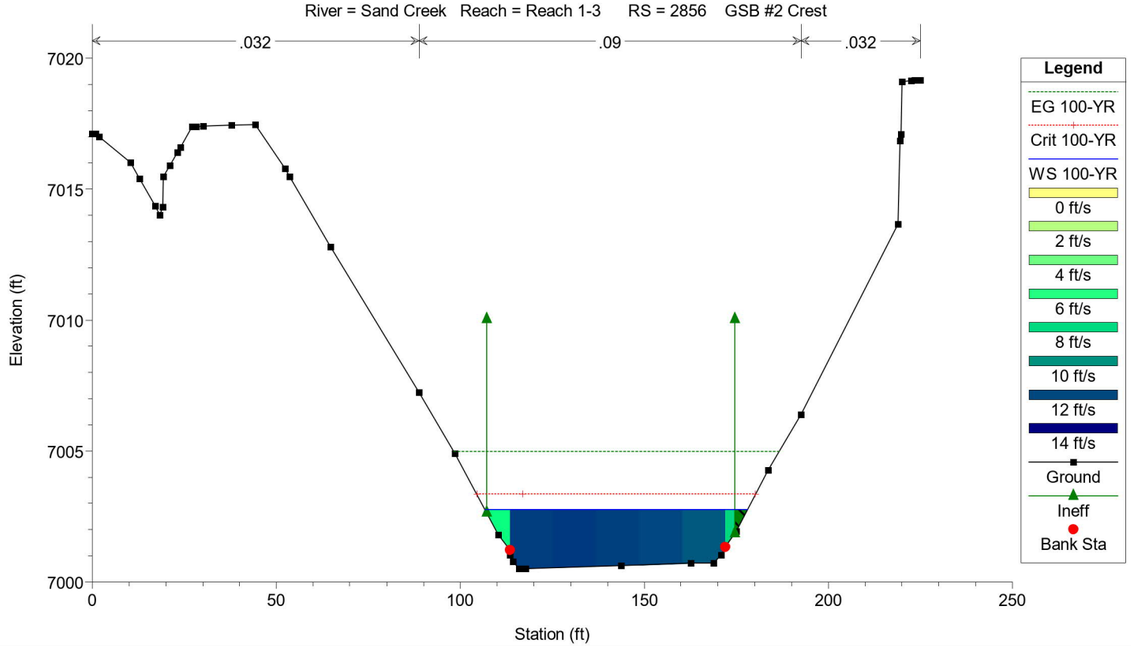
HEC-RAS Model Plan: Proposed Conditions - Shear/Vel 3/31/2023

River = Sand Creek Reach = Reach 1-3 RS = 2879 DS SRR Culvert



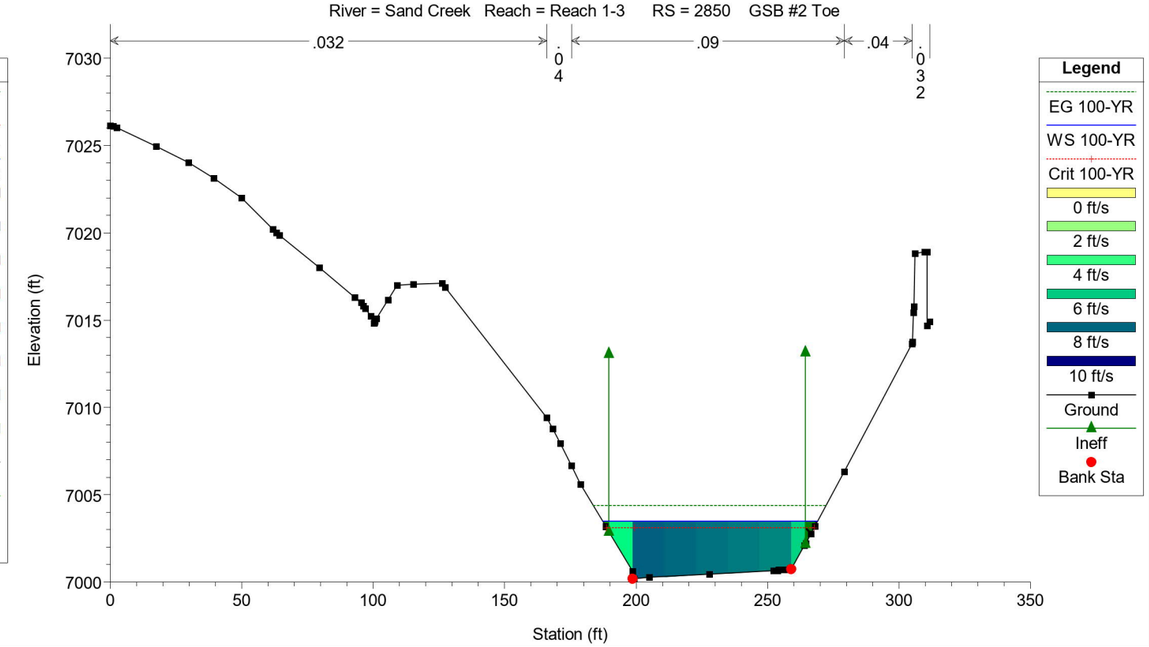
HEC-RAS Model Plan: Proposed Conditions - Shear/Vel 3/31/2023

River = Sand Creek Reach = Reach 1-3 RS = 2856 GSB #2 Crest



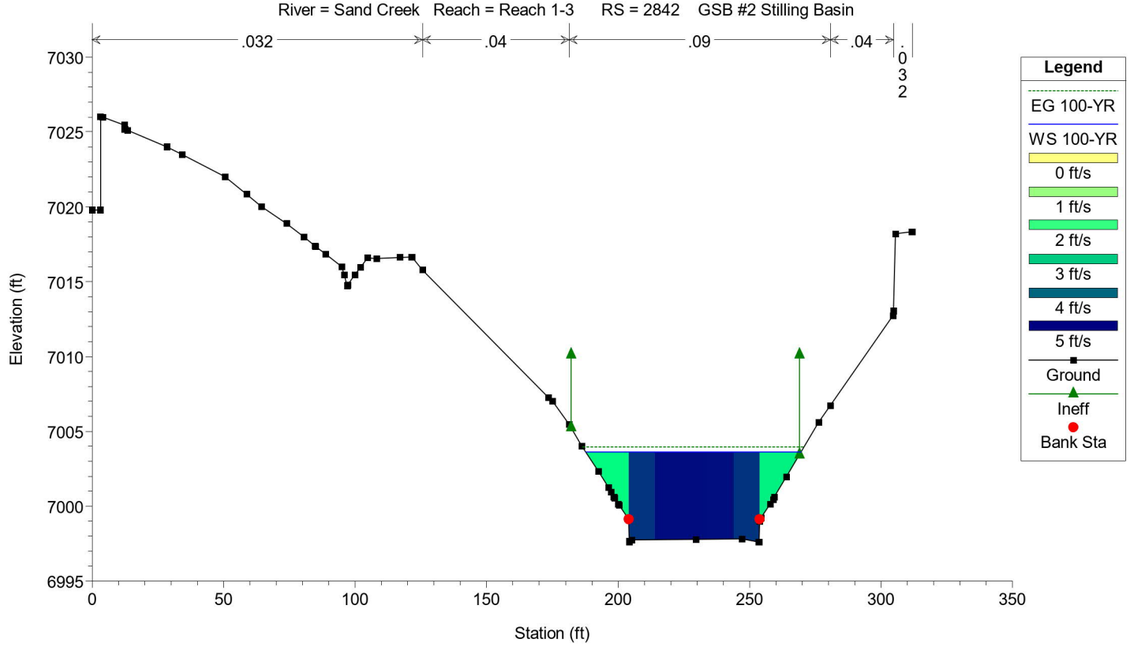
HEC-RAS Model Plan: Proposed Conditions - Shear/Vel 3/31/2023

River = Sand Creek Reach = Reach 1-3 RS = 2850 GSB #2 Toe



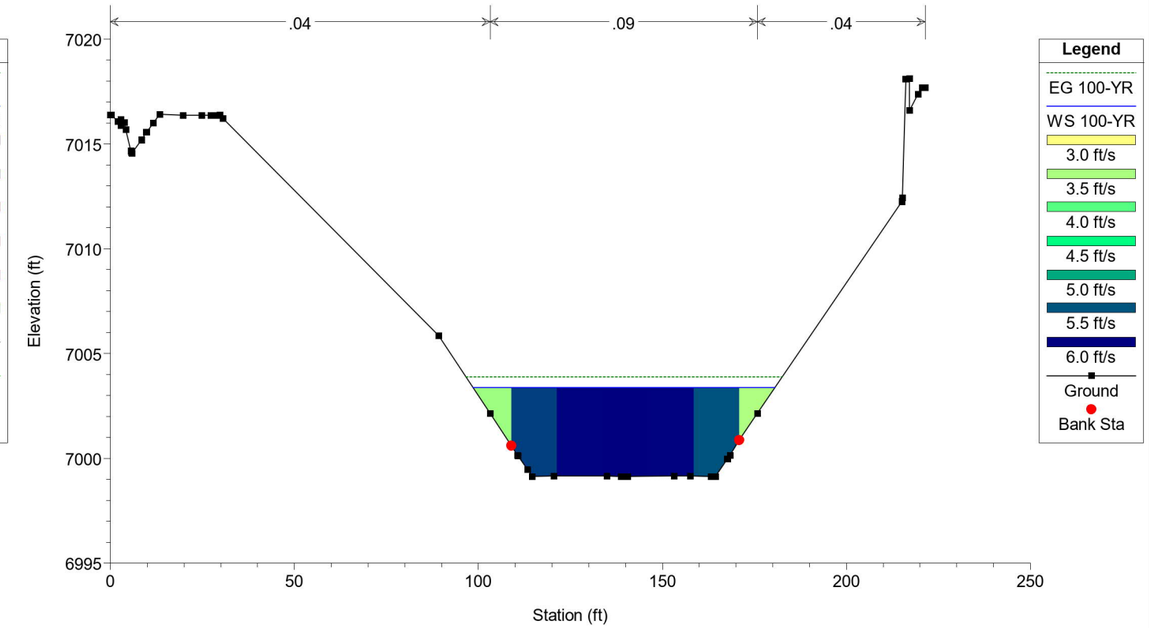
HEC-RAS Model Plan: Proposed Conditions - Shear/Vel 3/31/2023

River = Sand Creek Reach = Reach 1-3 RS = 2842 GSB #2 Stilling Basin



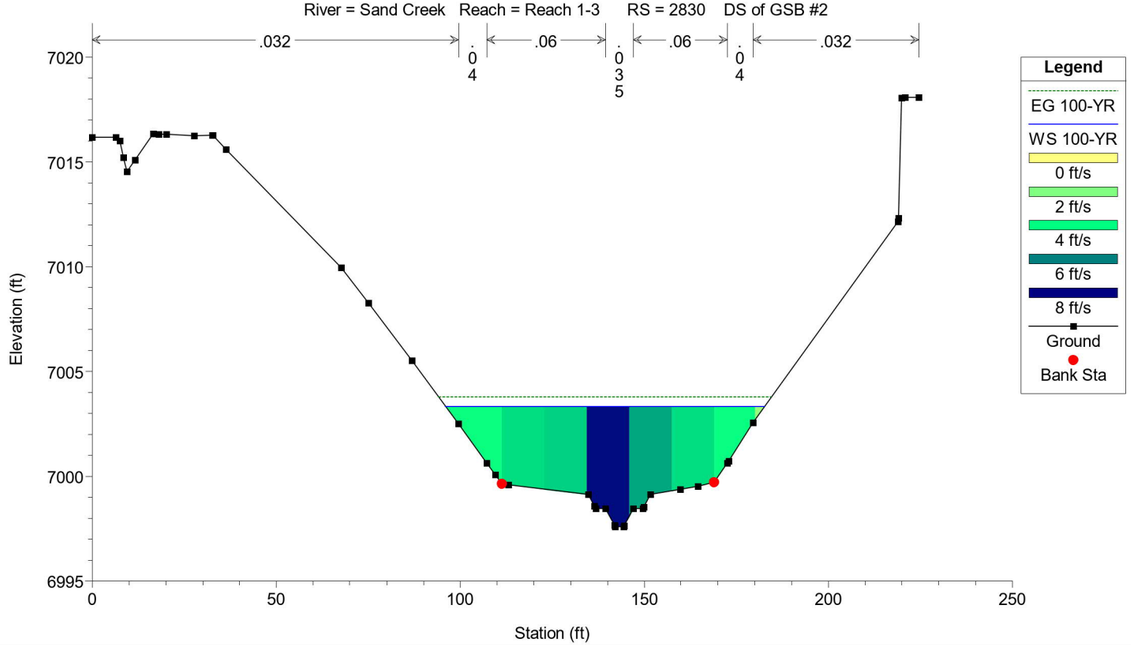
HEC-RAS Model Plan: Proposed Conditions - Shear/Vel 3/31/2023

River = Sand Creek Reach = Reach 1-3 RS = 2838 GSB #2 Sill Wall



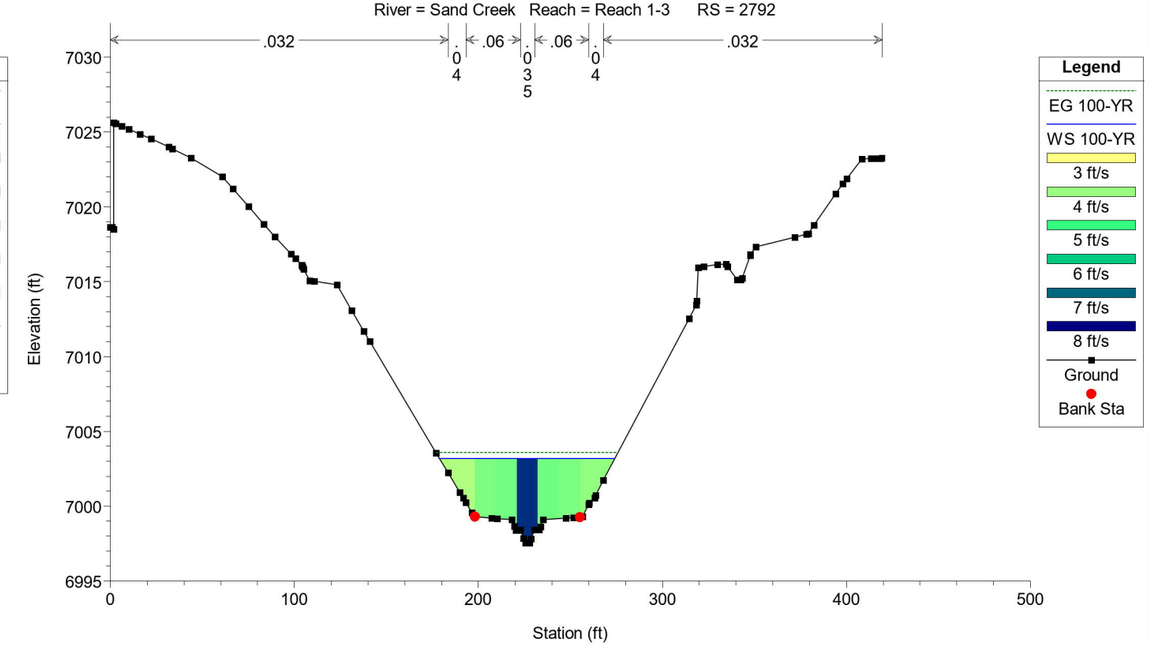
HEC-RAS Model Plan: Proposed Conditions - Shear/Vel 3/31/2023

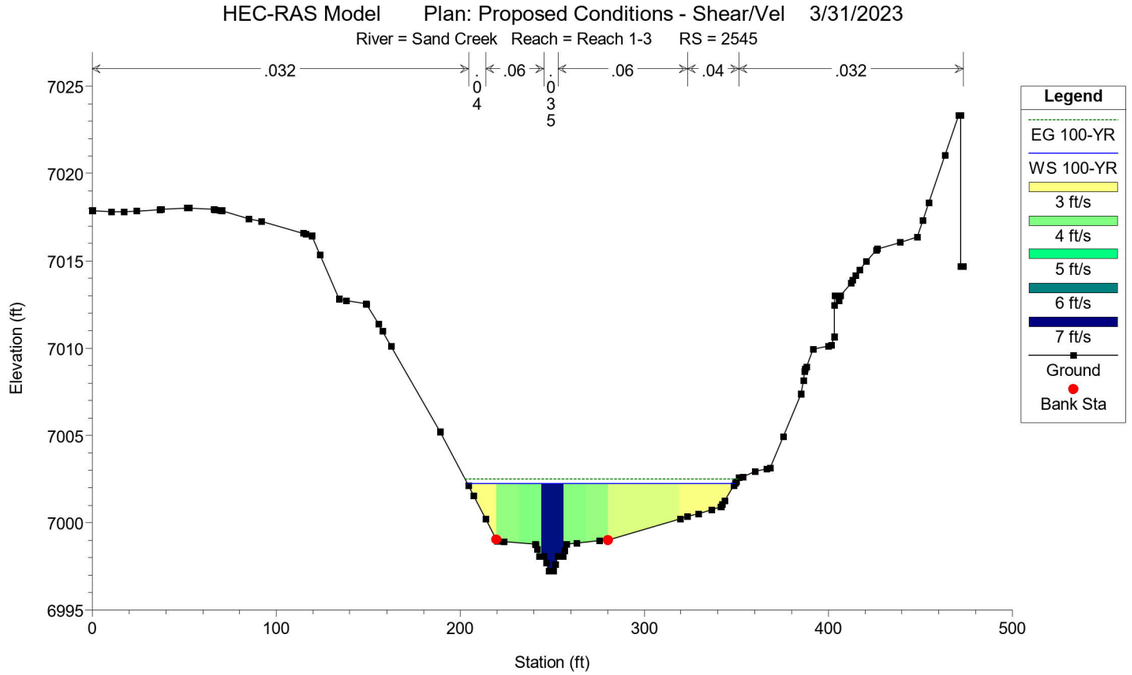
River = Sand Creek Reach = Reach 1-3 RS = 2830 DS of GSB #2

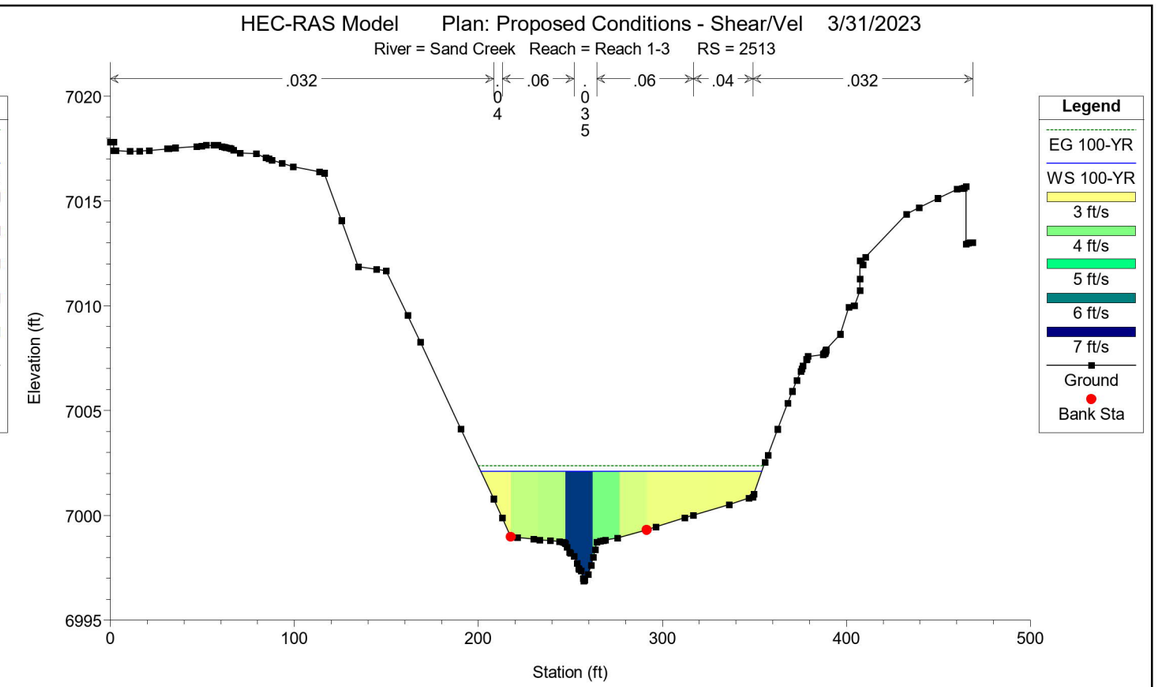


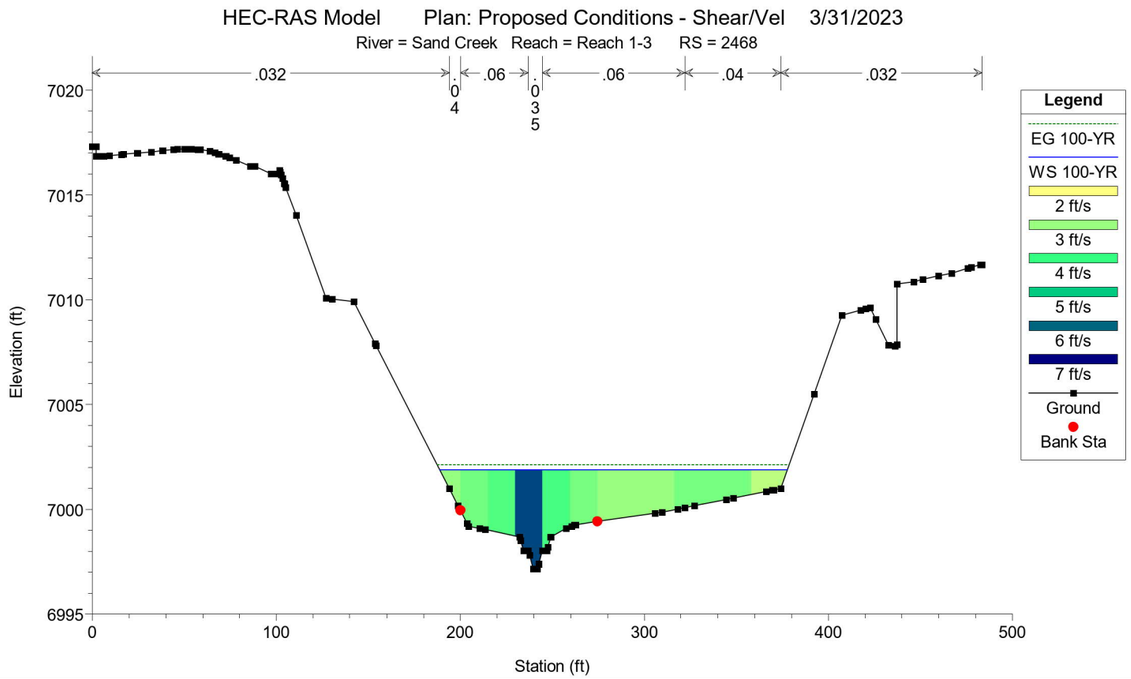
HEC-RAS Model Plan: Proposed Conditions - Shear/Vel 3/31/2023

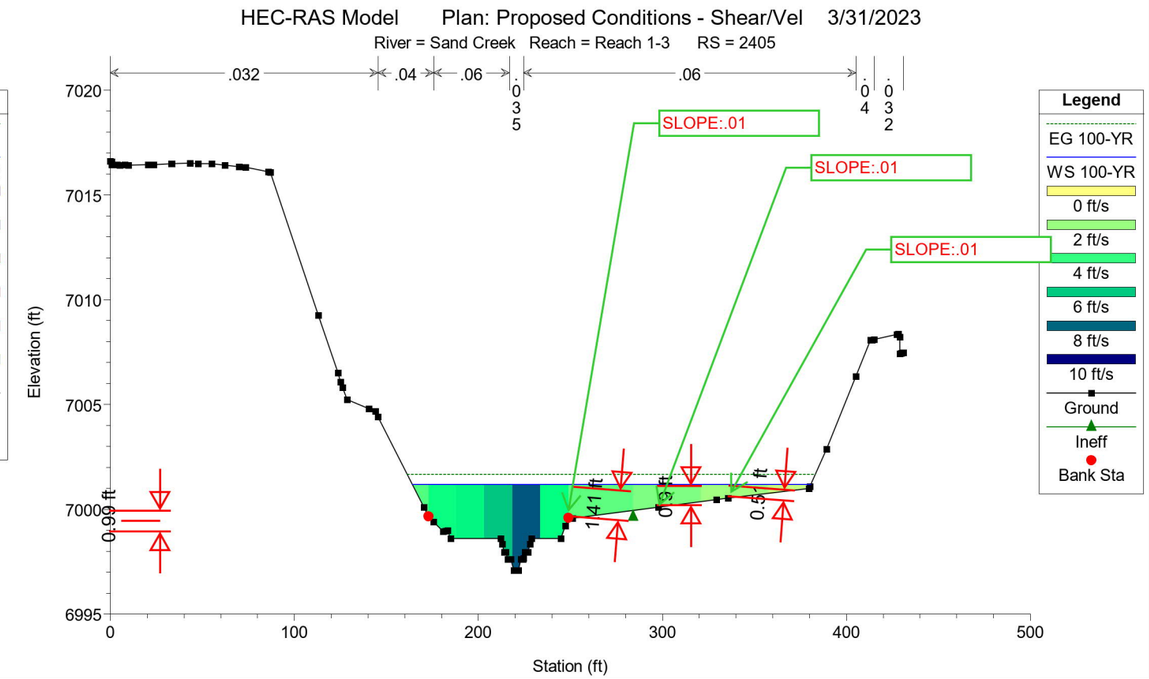
River = Sand Creek Reach = Reach 1-3 RS = 2792

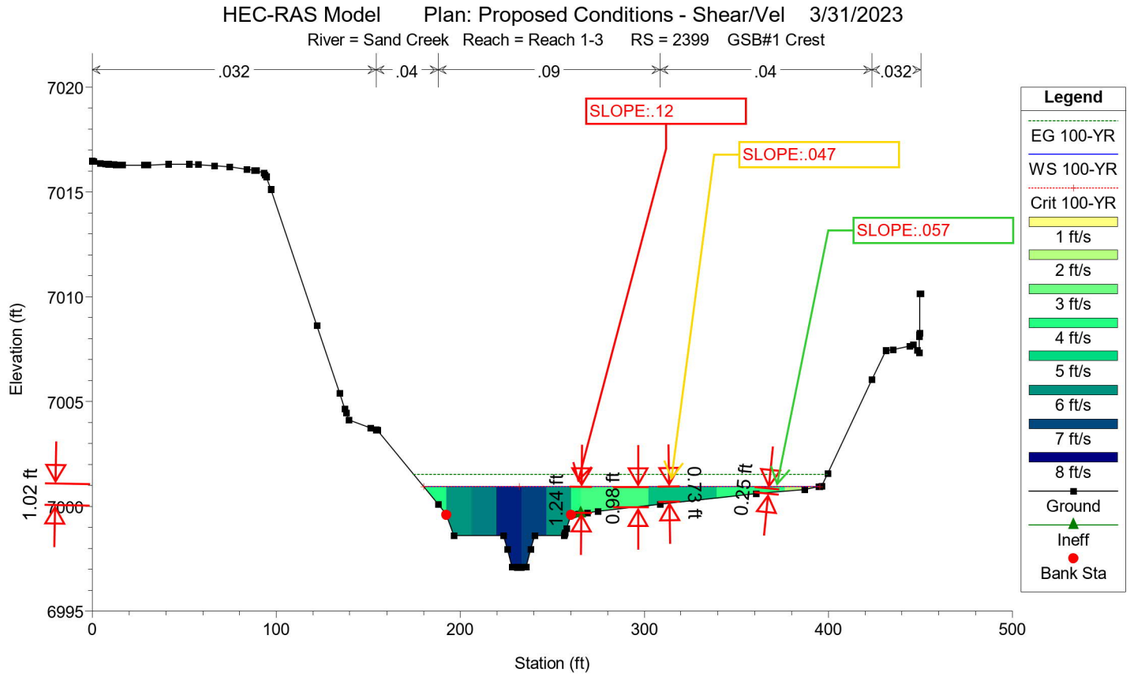


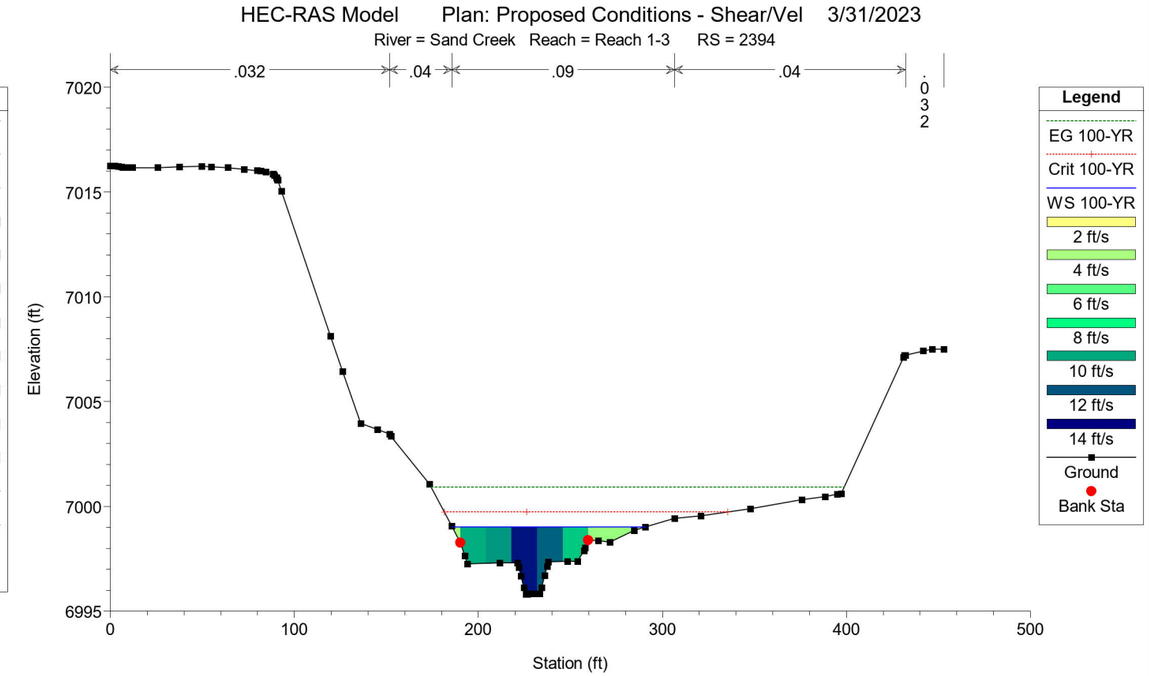

HEC-RAS Model Plan: Proposed Conditions - Shear/Vel 3/31/2023
River = Sand Creek Reach = Reach 1-3 RS = 2545
.032
.04
.06
.035
.06
.04
.032
Legend
EG 100-YR
WS 100-YR
3 ft/s
4 ft/s
5 ft/s
6 ft/s
7 ft/s
Ground
Bank Sta
Elevation (ft)
Station (ft)

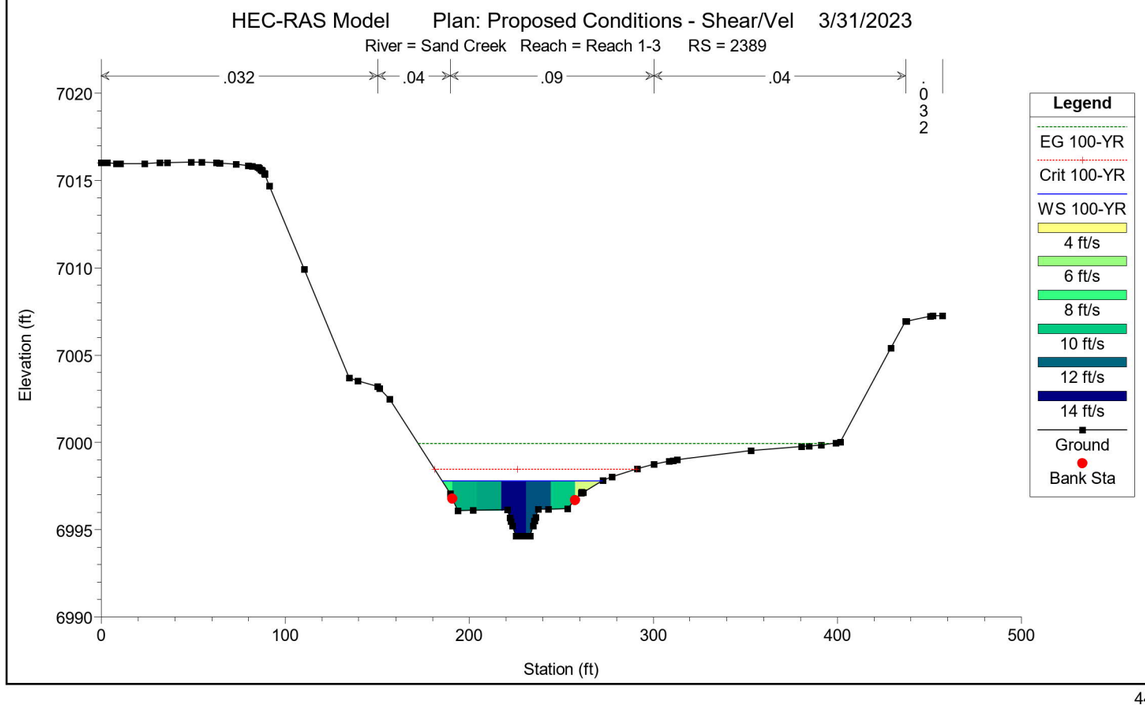

HEC-RAS Model Plan: Proposed Conditions - Shear/Vel 3/31/2023
River = Sand Creek Reach = Reach 1-3 RS = 2513
.032
.04
.06
.035
.06
.04
.032
Legend
EG 100-YR
WS 100-YR
3 ft/s
4 ft/s
5 ft/s
6 ft/s
7 ft/s
Ground
Bank Sta
Elevation (ft)
Station (ft)

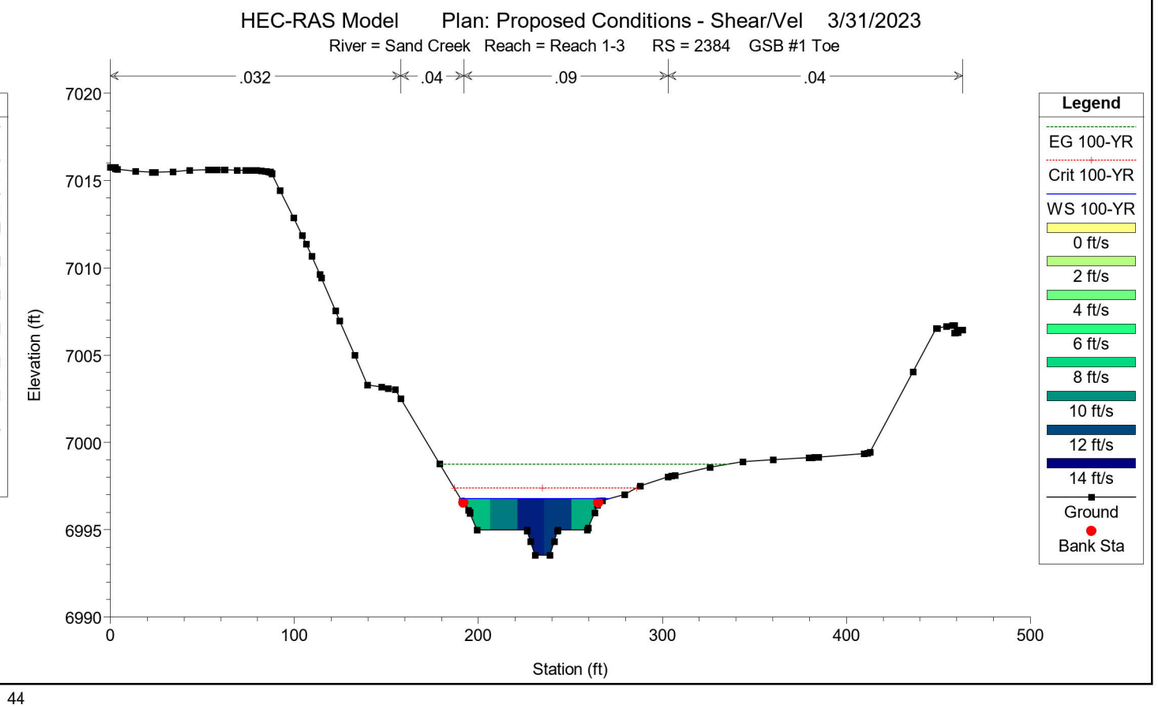

HEC-RAS Model Plan: Proposed Conditions - Shear/Vel 3/31/2023
River = Sand Creek Reach = Reach 1-3 RS = 2468
.032
.04
.06
.035
.06
.04
.032
Legend
EG 100-YR
WS 100-YR
2 ft/s
3 ft/s
4 ft/s
5 ft/s
6 ft/s
7 ft/s
Ground
Bank Sta
Elevation (ft)
Station (ft)

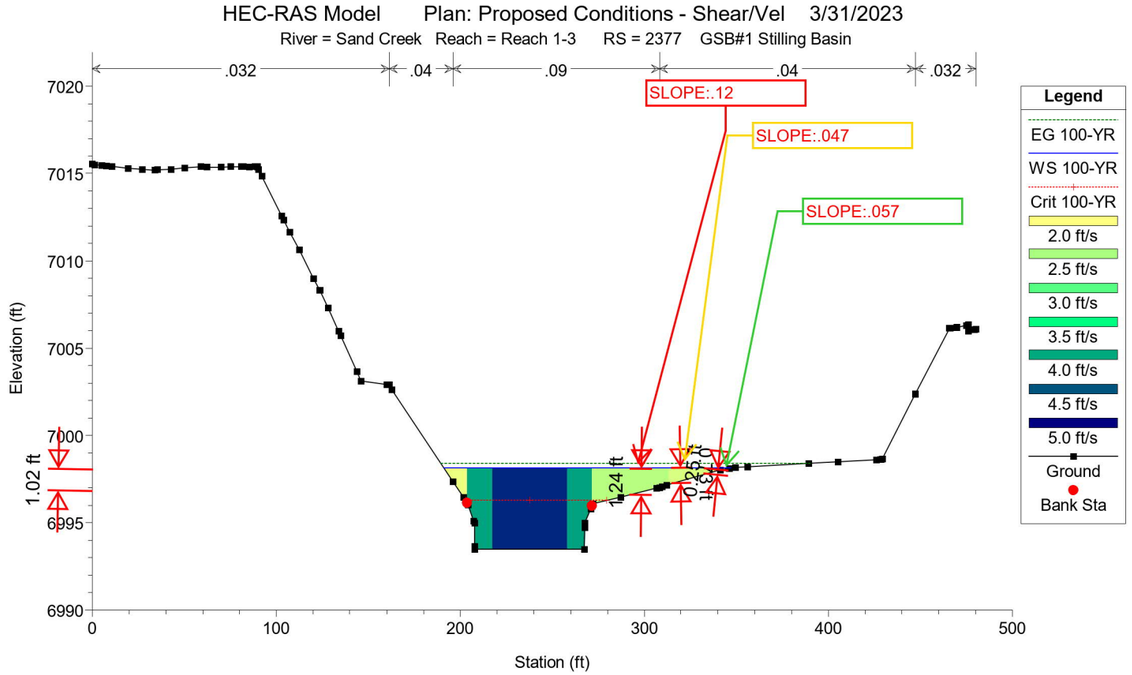

HEC-RAS Model Plan: Proposed Conditions - Shear/Vel 3/31/2023
River = Sand Creek Reach = Reach 1-3 RS = 2405
.032
.04
.06
.035
.06
.04
.032
SLOPE:.01
SLOPE:.01
SLOPE:.01
0.99 ft
1.41 ft
0.91 ft
0.91 ft
Legend
EG 100-YR
WS 100-YR
0 ft/s
2 ft/s
4 ft/s
6 ft/s
8 ft/s
10 ft/s
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)

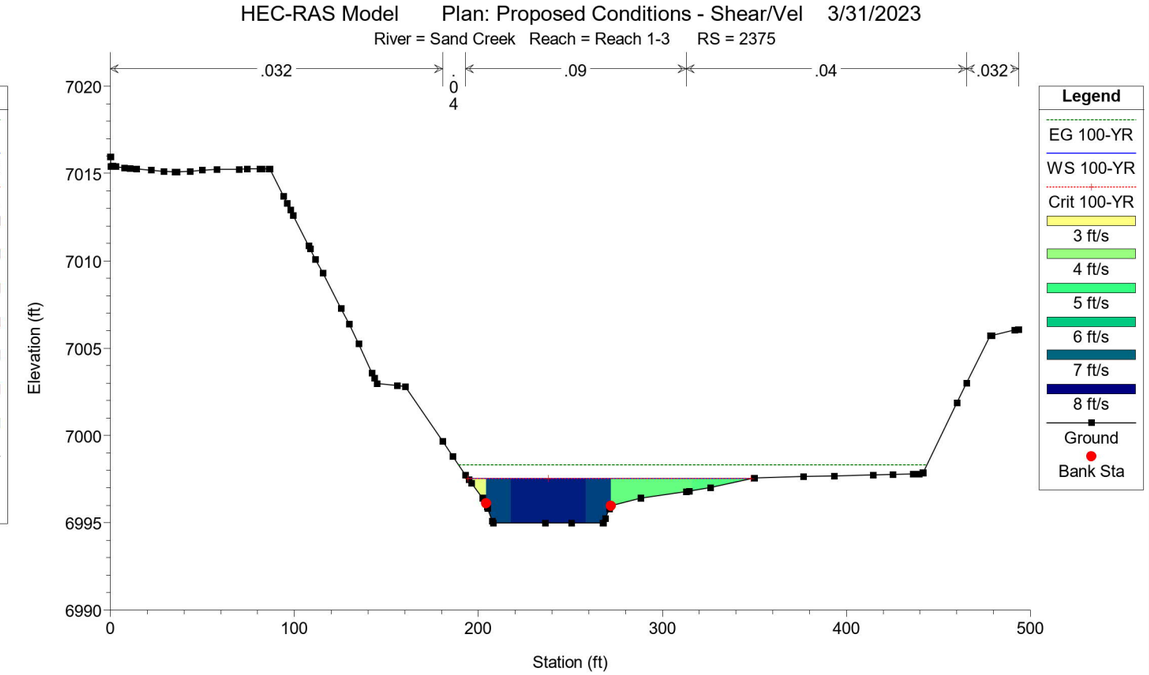

HEC-RAS Model Plan: Proposed Conditions - Shear/Vel 3/31/2023
River = Sand Creek Reach = Reach 1-3 RS = 2399 GSB#1 Crest
.032
.04
.09
.04
.032
SLOPE:.12
SLOPE:.047
SLOPE:.057
1.02 ft
1.24 ft
0.98 ft
0.73 ft
0.25 ft
Elevation (ft)
Station (ft)
Legend
EG 100-YR
WS 100-YR
Crit 100-YR
1 ft/s
2 ft/s
3 ft/s
4 ft/s
5 ft/s
6 ft/s
7 ft/s
8 ft/s
Ground
Ineff
Bank Sta

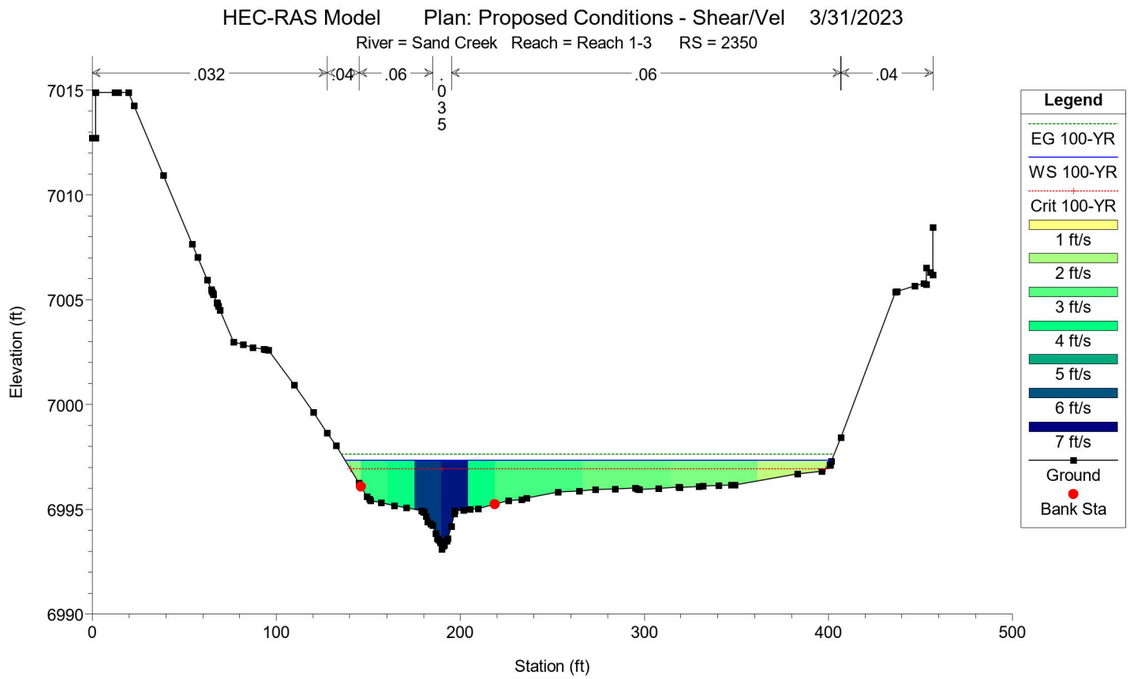

HEC-RAS Model Plan: Proposed Conditions - Shear/Vel 3/31/2023
River = Sand Creek Reach = Reach 1-3 RS = 2394
.032
.04
.09
.04
.032
Elevation (ft)
Station (ft)
Legend
EG 100-YR
Crit 100-YR
WS 100-YR
2 ft/s
4 ft/s
6 ft/s
8 ft/s
10 ft/s
12 ft/s
14 ft/s
Ground
Bank Sta

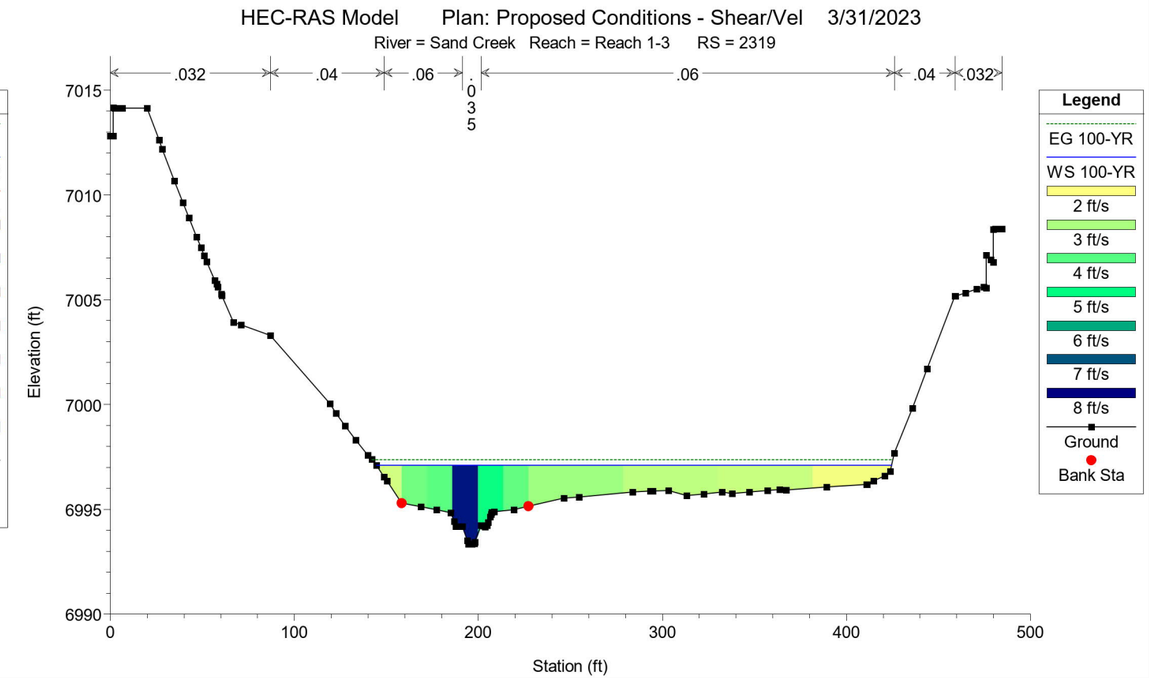

HEC-RAS Model Plan: Proposed Conditions - Shear/Vel 3/31/2023
River = Sand Creek Reach = Reach 1-3 RS = 2389
.032
.04
.09
.04
.032
Elevation (ft)
Station (ft)
Legend
EG 100-YR
Crit 100-YR
WS 100-YR
4 ft/s
6 ft/s
8 ft/s
10 ft/s
12 ft/s
14 ft/s
Ground
Bank Sta


HEC-RAS Model Plan: Proposed Conditions - Shear/Vel 3/31/2023
River = Sand Creek Reach = Reach 1-3 RS = 2384 GSB #1 Toe
.032
.04
.09
.04
Elevation (ft)
Station (ft)
Legend
EG 100-YR
Crit 100-YR
WS 100-YR
0 ft/s
2 ft/s
4 ft/s
6 ft/s
8 ft/s
10 ft/s
12 ft/s
14 ft/s
Ground
Bank Sta


HEC-RAS Model Plan: Proposed Conditions - Shear/Vel 3/31/2023
River = Sand Creek Reach = Reach 1-3 RS = 2377 GSB#1 Stilling Basin
.032
.04
.09
.04
.032
SLOPE:.12
SLOPE:.047
SLOPE:.057
1.02 ft
1.24 ft
0.26 ft
1.31 ft
Elevation (ft)
Station (ft)
Legend
EG 100-YR
WS 100-YR
Crit 100-YR
2.0 ft/s
2.5 ft/s
3.0 ft/s
3.5 ft/s
4.0 ft/s
4.5 ft/s
5.0 ft/s
Ground
Bank Sta


HEC-RAS Model Plan: Proposed Conditions - Shear/Vel 3/31/2023
River = Sand Creek Reach = Reach 1-3 RS = 2375
.032
.04
.09
.04
.032
Elevation (ft)
Station (ft)
Legend
EG 100-YR
WS 100-YR
Crit 100-YR
3 ft/s
4 ft/s
5 ft/s
6 ft/s
7 ft/s
8 ft/s
Ground
Bank Sta


HEC-RAS Model Plan: Proposed Conditions - Shear/Vel 3/31/2023
River = Sand Creek Reach = Reach 1-3 RS = 2350
.032
.04
.06
.06
.04
Elevation (ft)
Station (ft)
Legend
EG 100-YR
WS 100-YR
Crit 100-YR
1 ft/s
2 ft/s
3 ft/s
4 ft/s
5 ft/s
6 ft/s
7 ft/s
Ground
Bank Sta


HEC-RAS Model Plan: Proposed Conditions - Shear/Vel 3/31/2023
River = Sand Creek Reach = Reach 1-3 RS = 2319
.032
.04
.06
.06
.04
.032
Elevation (ft)
Station (ft)
Legend
EG 100-YR
WS 100-YR
2 ft/s
3 ft/s
4 ft/s
5 ft/s
6 ft/s
7 ft/s
8 ft/s
Ground
Bank Sta

Mixed Flow Evaluation for GSB Design

HEC-RAS Plan: PROP - Shear Locations: User Defined

River	Reach	River Sta	Profile	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Flow Area	Top Width	Max Chl Dpth	Mann Wtd Left	Mann Wtd Chnl	Mann Wtd Rght	Froude # XS	Vel Total	Vel Chnl
				(cfs)	(ft)	(ft)	(ft)	(ft)	(ft/ft)	(sq ft)	(ft)	(ft)					(ft/s)	(ft/s)
Sand Creek	Reach 1-3	9955	2-YR	154.80	7135.86	7137.87	7137.62	7138.02	0.010379	49.64	105.93	2.01		0.045		0.61	3.12	3.12
Sand Creek	Reach 1-3	9955	5-YR	475.50	7135.86	7138.52	7138.52	7138.87	0.015806	120.43	254.30	2.66	0.060	0.049	0.060	1.21	3.95	4.88
Sand Creek	Reach 1-3	9955	100-YR	1643.00	7135.86	7139.17	7139.33	7139.89	0.028362	298.12	286.86	3.31	0.060	0.050	0.060	1.18	5.51	8.03
Sand Creek	Reach 1-3	9943	2-YR	154.80	7135.80	7137.42	7137.42	7137.71	0.140070	35.79	132.39	1.62		0.090		0.99	4.33	4.33
Sand Creek	Reach 1-3	9943	5-YR	475.50	7135.80	7138.14	7138.25	7138.53	0.074404	103.24	251.71	2.34	0.076	0.090	0.046	1.36	4.61	5.18
Sand Creek	Reach 1-3	9943	100-YR	1643.00	7135.80	7138.71	7138.84	7139.37	0.071473	260.99	294.12	2.91	0.064	0.090	0.045	1.22	6.30	6.53
Sand Creek	Reach 1-3	9926	2-YR	154.80	7131.59	7134.20	7133.20	7134.24	0.004987	101.20	70.12	2.61	0.090	0.090	0.090	0.23	1.53	1.54
Sand Creek	Reach 1-3	9926	5-YR	475.50	7131.59	7135.21	7133.84	7135.33	0.008203	180.81	92.26	3.62	0.090	0.090	0.090	0.34	2.63	2.77
Sand Creek	Reach 1-3	9926	100-YR	1643.00	7131.59	7136.55	7135.46	7137.01	0.019995	324.87	123.84	4.96	0.090	0.090	0.090	0.60	5.06	5.73
Sand Creek	Reach 1-3	9913	2-YR	154.80	7131.58	7134.19		7134.20	0.001164	160.47	70.60	2.61	0.000	0.090	0.090	0.11	0.96	0.96
Sand Creek	Reach 1-3	9913	5-YR	475.50	7131.58	7135.19		7135.25	0.003170	247.27	111.15	3.61	0.090	0.090	0.089	0.24	1.92	2.03
Sand Creek	Reach 1-3	9913	100-YR	1643.00	7131.58	7136.57		7136.78	0.007808	477.91	246.24	4.99	0.081	0.090	0.058	0.47	3.44	4.01
Sand Creek	Reach 1-3	9910	2-YR	154.80	7132.63	7134.14		7134.19	0.008790	85.66	70.55	1.51	0.090	0.090	0.090	0.29	1.81	1.81
Sand Creek	Reach 1-3	9910	5-YR	475.50	7132.63	7135.08		7135.23	0.011968	167.14	111.78	2.45	0.090	0.090	0.090	0.43	2.84	3.06
Sand Creek	Reach 1-3	9910	100-YR	1643.00	7132.63	7136.46		7136.74	0.014646	402.95	244.56	3.83	0.068	0.090	0.059	0.59	4.08	4.67
Sand Creek	Reach 1-3	9875	2-YR	154.80	7131.85	7133.56	7133.50	7133.81	0.012493	38.27	59.35	1.70		0.037		0.89	4.05	4.05
Sand Creek	Reach 1-3	9875	5-YR	475.50	7131.85	7134.54	7134.17	7134.85	0.008966	112.87	146.19	2.69	0.060	0.042	0.060	0.90	4.21	4.49
Sand Creek	Reach 1-3	9875	100-YR	1643.00	7131.85	7136.20		7136.47	0.004812	480.04	258.88	4.35	0.060	0.045	0.060	0.54	3.42	4.88
Sand Creek	Reach 1-3	9626	2-YR	154.80	7129.34	7130.99	7130.99	7131.27	0.138047	36.28	62.07	1.65		0.090		0.98	4.27	4.27
Sand Creek	Reach 1-3	9626	5-YR	475.50	7129.34	7131.74	7131.74	7132.02	0.055418	116.69	213.48	2.40	0.090	0.090	0.048	0.97	4.07	4.50
Sand Creek	Reach 1-3	9626	100-YR	1643.00	7129.34	7132.48	7132.48	7132.96	0.042216	314.86	331.57	3.14	0.058	0.090	0.049	1.00	5.22	5.35
Sand Creek	Reach 1-3	9614	2-YR	154.80	7126.48	7128.03	7128.18	7128.54	0.355590	27.01	60.37	1.55		0.090		1.51	5.73	5.73
Sand Creek	Reach 1-3	9614	5-YR	475.50	7126.48	7128.29	7128.87	7130.21	0.756662	42.81	62.44	1.81		0.090		2.36	11.11	11.11
Sand Creek	Reach 1-3	9614	100-YR	1643.00	7126.48	7129.32	7130.02	7131.67	0.325567	148.42	159.10	2.84	0.090	0.090	0.089	2.25	11.07	13.01
Sand Creek	Reach 1-3	9600	2-YR	154.80	7123.43	7125.83	7125.05	7125.88	0.008503	86.52	70.84	2.40	0.090	0.090	0.090	0.29	1.79	1.79
Sand Creek	Reach 1-3	9600	5-YR	475.50	7123.43	7126.83	7125.69	7126.95	0.010102	174.17	104.67	3.40	0.049	0.090	0.090	0.38	2.73	2.87
Sand Creek	Reach 1-3	9600	100-YR	1643.00	7123.43	7128.10	7127.21	7128.50	0.018383	333.97	148.39	4.67	0.044	0.090	0.090	0.60	4.92	5.18
Sand Creek	Reach 1-3	9587	2-YR	154.80	7123.38	7125.82		7125.83	0.001463	148.17	74.52	2.44	0.040	0.090	0.090	0.13	1.04	1.05
Sand Creek	Reach 1-3	9587	5-YR	475.50	7123.38	7126.81		7126.87	0.002964	264.62	150.53	3.43	0.040	0.090	0.090	0.25	1.80	1.91
Sand Creek	Reach 1-3	9587	100-YR	1643.00	7123.38	7128.12		7128.31	0.005905	489.18	227.72	4.73	0.040	0.090	0.090	0.39	3.36	3.38
Sand Creek	Reach 1-3	9584	2-YR	154.80	7124.71	7125.72		7125.82	0.023604	63.77	67.88	1.01		0.090		0.44	2.43	2.43
Sand Creek	Reach 1-3	9584	5-YR	475.50	7124.71	7126.73		7126.85	0.021540	177.47	152.36	2.02		0.090		0.44	2.68	2.68
Sand Creek	Reach 1-3	9584	100-YR	1643.00	7124.71	7128.01		7128.28	0.022448	400.37	238.30	3.30	0.040	0.090	0.040	0.51	4.10	4.11
Sand Creek	Reach 1-3	9558	2-YR	154.80	7122.44	7125.18		7125.26	0.017707	67.92	64.13	2.74		0.090		0.39	2.28	2.28
Sand Creek	Reach 1-3	9558	5-YR	475.50	7122.44	7126.18		7126.34	0.016056	146.97	115.42	3.74	0.040	0.090	0.043	0.48	3.24	3.33
Sand Creek	Reach 1-3	9558	100-YR	1643.00	7122.44	7127.44		7127.75	0.016736	371.96	295.93	5.00	0.040	0.090	0.041	0.67	4.42	4.70
Sand Creek	Reach 1-3	9256	2-YR	154.80	7118.36	7120.05	7119.62	7120.07	0.004027	122.21	195.40	1.69	0.060	0.056	0.060	0.28	1.27	1.27
Sand Creek	Reach 1-3	9256	5-YR	475.50	7118.36	7120.60	7119.98	7120.67	0.004937	233.75	205.65	2.24	0.060	0.057	0.060	0.34	2.03	2.07
Sand Creek	Reach 1-3	9256	100-YR	1643.00	7118.36	7122.00	7120.73	7122.15	0.004229	536.43	227.70	3.64	0.058	0.058	0.053	0.36	3.06	3.15
Sand Creek	Reach 1-3	9243	2-YR	154.80	7119.00	7119.38	7119.38	7119.54	0.172959	49.01	158.23	0.38		0.090	0.040	1.00	3.16	3.16
Sand Creek	Reach 1-3	9243	5-YR	475.50	7119.00	7119.73	7119.73	7120.04	0.131026	105.74	169.55	0.73	0.040	0.090	0.040	1.00	4.50	4.49
Sand Creek	Reach 1-3	9243	100-YR	1643.00	7119.00	7121.68		7121.87	0.010410	486.97	215.43	2.68	0.040	0.090	0.040	0.41	3.37	3.19
Sand Creek	Reach 1-3	9216	2-YR	154.80	7114.00	7118.32	7114.26	7118.32	0.000002	942.51	236.53	4.32	0.035	0.032	0.032	0.01	0.16	0.17
Sand Creek	Reach 1-3	9216	5-YR	475.50	7114.00	7118.78	7114.56	7118.78	0.000013	1052.11	240.55	4.78	0.035	0.032	0.032	0.04	0.45	0.47
Sand Creek	Reach 1-3	9216	100-YR	1643.00	7114.00	7121.80		7121.82	0.000027	1831.41	273.88	7.80	0.035	0.032	0.032	0.06	0.90	0.95
Sand Creek	Reach 1-3	7455	2-YR	146.52	7085.01	7087.21		7087.36	0.007531	47.24	53.95	2.20		0.042		0.58	3.10	3.10
Sand Creek	Reach 1-3	7455	5-YR	512.38	7085.01	7088.15		7088.32	0.004929	185.15	232.10	3.14	0.070	0.042	0.032	0.62	2.77	3.68

Mixed Flow Evaluation for GSB Design

HEC-RAS Plan: PROP - Shear Locations: User Defined (Continued)

River	Reach	River Sta	Profile	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Flow Area	Top Width	Max Chl Dpth	Mann Wtd Left	Mann Wtd Chnl	Mann Wtd Rght	Froude # XS	Vel Total	Vel Chnl
				(cfs)	(ft)	(ft)	(ft)	(ft)	(ft/ft)	(sq ft)	(ft)	(ft)					(ft/s)	(ft/s)
Sand Creek	Reach 1-3	7455	100-YR	1763.93	7085.01	7089.00		7089.46	0.008375	367.76	251.31	3.99	0.070	0.042	0.032	0.74	4.80	6.14
Sand Creek	Reach 1-3	7445	2-YR	146.52	7085.12	7086.85	7086.85	7087.16	0.081069	32.79	86.45	1.73		0.070		0.98	4.47	4.47
Sand Creek	Reach 1-3	7445	5-YR	512.38	7085.12	7087.88	7087.88	7088.20	0.029482	135.27	239.63	2.75	0.069	0.070	0.070	1.00	3.79	4.89
Sand Creek	Reach 1-3	7445	100-YR	1763.93	7085.12	7088.67	7088.67	7089.28	0.038885	308.27	259.65	3.55	0.067	0.070	0.070	0.94	5.72	7.37
Sand Creek	Reach 1-3	7430	2-YR	146.52	7081.82	7083.05	7083.58	7084.88	0.316120	13.52	15.26	1.23		0.070		2.03	10.84	10.84
Sand Creek	Reach 1-3	7430	5-YR	512.38	7081.82	7083.68	7084.44	7086.72	0.695591	36.63	51.63	1.86		0.070		2.93	13.99	13.99
Sand Creek	Reach 1-3	7430	100-YR	1763.93	7081.82	7085.07	7085.91	7087.99	0.179042	138.78	121.87	3.25	0.070	0.070	0.070	2.27	12.71	14.18
Sand Creek	Reach 1-3	7422	2-YR	146.52	7080.12	7081.30	7081.85	7083.32	0.120598	12.87	15.16	1.18		0.040		2.18	11.38	11.38
Sand Creek	Reach 1-3	7422	5-YR	512.38	7080.12	7082.05	7082.68	7084.27	0.138369	42.85	52.69	1.93		0.040		2.34	11.96	11.96
Sand Creek	Reach 1-3	7422	100-YR	1763.93	7080.12	7083.25	7084.41	7086.98	0.075843	117.29	75.48	3.13	0.040	0.040	0.040	2.19	15.04	15.66
Sand Creek	Reach 1-3	7409	2-YR	146.52	7080.12	7082.49	7080.78	7082.51	0.000436	118.31	56.18	2.37	0.040	0.040		0.15	1.24	1.24
Sand Creek	Reach 1-3	7409	5-YR	512.38	7080.12	7083.50	7081.64	7083.61	0.001246	212.24	112.44	3.38	0.040	0.040	0.040	0.34	2.41	2.71
Sand Creek	Reach 1-3	7409	100-YR	1763.93	7080.12	7082.45	7083.68	7086.05	0.067594	115.80	55.81	2.32		0.040		1.86	15.23	15.23
Sand Creek	Reach 1-3	7406	2-YR	146.52	7081.53	7082.20	7082.17	7082.48	0.054429	34.32	53.87	0.67		0.060		0.94	4.27	4.27
Sand Creek	Reach 1-3	7406	5-YR	512.38	7081.53	7083.06	7083.06	7083.56	0.033673	97.36	104.85	1.53	0.060	0.060	0.060	1.04	5.26	5.84
Sand Creek	Reach 1-3	7406	100-YR	1763.93	7081.53	7084.22	7084.41	7085.19	0.034244	243.17	173.02	2.69	0.058	0.060	0.060	1.17	7.25	8.70
Sand Creek	Reach 1-3	7351	2-YR	146.52	7079.22	7081.38		7081.50	0.008121	51.45	59.46	2.15		0.046		0.54	2.85	2.85
Sand Creek	Reach 1-3	7351	5-YR	512.38	7079.22	7082.24		7082.51	0.010699	139.79	138.31	3.02	0.060	0.051	0.060	0.73	3.67	4.36
Sand Creek	Reach 1-3	7351	100-YR	1763.93	7079.22	7083.34	7083.23	7083.94	0.015970	343.17	240.45	4.12	0.060	0.052	0.060	0.91	5.14	7.08
Sand Creek	Reach 1-3	7093	2-YR	146.52	7076.86	7078.58	7078.58	7078.86	0.148429	34.11	60.93	1.72		0.090		1.01	4.30	4.30
Sand Creek	Reach 1-3	7093	5-YR	512.38	7076.86	7079.48	7079.48	7079.70	0.040238	154.76	305.84	2.62	0.088	0.090	0.048	0.92	3.31	4.11
Sand Creek	Reach 1-3	7093	100-YR	1763.93	7076.86	7079.74	7080.02	7080.72	0.144097	235.74	322.35	2.88	0.083	0.090	0.048	1.63	7.48	8.70
Sand Creek	Reach 1-3	7073	2-YR	146.52	7072.92	7075.08	7074.52	7075.15	0.014880	69.89	65.23	2.16		0.090		0.36	2.10	2.10
Sand Creek	Reach 1-3	7073	5-YR	512.38	7072.92	7074.63	7075.25	7077.05	0.995374	41.00	61.59	1.70		0.090		2.70	12.50	12.50
Sand Creek	Reach 1-3	7073	100-YR	1763.93	7072.92	7076.42	7076.91	7077.96	0.126848	191.74	137.24	3.50	0.090	0.090	0.090	1.48	9.20	10.22
Sand Creek	Reach 1-3	7066	2-YR	146.52	7072.86	7075.09		7075.11	0.001842	132.38	65.26	2.23		0.090		0.14	1.11	1.11
Sand Creek	Reach 1-3	7066	5-YR	512.38	7072.86	7076.07	7074.20	7076.16	0.005663	228.37	148.68	3.21	0.090	0.090	0.090	0.35	2.24	2.48
Sand Creek	Reach 1-3	7066	100-YR	1763.93	7072.86	7077.22	7076.22	7077.52	0.014342	464.22	273.65	4.36	0.087	0.090	0.090	0.60	3.80	4.92
Sand Creek	Reach 1-3	7061	2-YR	146.52	7074.14	7074.77	7074.77	7075.06	0.022658	34.33	62.77	0.63		0.035		1.02	4.27	4.27
Sand Creek	Reach 1-3	7061	5-YR	512.38	7074.14	7075.57	7075.57	7076.08	0.012979	95.39	115.56	1.43	0.040	0.035	0.035	1.11	5.37	5.77
Sand Creek	Reach 1-3	7061	100-YR	1763.93	7074.14	7076.77	7076.77	7077.43	0.009219	330.83	274.11	2.63	0.050	0.035	0.041	1.05	5.33	7.50
Sand Creek	Reach 1-3	7044	2-YR	146.52	7071.83	7073.71	7073.94	7074.52	0.035598	20.23	53.23	1.88		0.038		2.07	7.24	7.24
Sand Creek	Reach 1-3	7044	5-YR	512.38	7071.83	7074.31	7074.67	7075.57	0.067823	56.92	63.50	2.48		0.045		1.68	9.00	9.00
Sand Creek	Reach 1-3	7044	100-YR	1763.93	7071.83	7076.53	7075.95	7076.70	0.004947	625.04	377.98	4.70	0.060	0.052	0.060	0.46	2.82	4.22
Sand Creek	Reach 1-3	6232	2-YR	146.52	7063.38	7065.23		7065.40	0.012936	44.96	90.78	1.85		0.042	0.032	0.83	3.26	3.33
Sand Creek	Reach 1-3	6232	5-YR	512.38	7063.38	7065.98	7065.73	7066.20	0.008641	142.50	184.98	2.60	0.081	0.044	0.032	0.76	3.60	3.98
Sand Creek	Reach 1-3	6232	100-YR	1763.93	7063.38	7066.34	7066.71	7067.59	0.036706	210.95	193.07	2.96	0.064	0.044	0.032	1.51	8.36	9.44
Sand Creek	Reach 1-3	6223	2-YR	146.52	7063.07	7064.83	7064.83	7065.11	0.148335	34.50	94.19	1.76		0.090		1.01	4.25	4.25
Sand Creek	Reach 1-3	6223	5-YR	512.38	7063.07	7065.61	7065.61	7066.00	0.075480	111.22	152.15	2.54	0.090	0.090	0.085	1.04	4.61	5.30
Sand Creek	Reach 1-3	6223	100-YR	1763.93	7063.07	7066.52	7066.52	7067.18	0.068421	285.78	209.31	3.45	0.089	0.090	0.076	0.98	6.17	7.23
Sand Creek	Reach 1-3	6212	2-YR	146.52	7060.43	7061.99	7062.19	7062.65	0.409740	22.58	46.48	1.56		0.090		1.64	6.49	6.49
Sand Creek	Reach 1-3	6212	5-YR	512.38	7060.43	7062.43	7062.98	7064.15	0.595070	48.75	64.48	2.00		0.090		2.13	10.51	10.51
Sand Creek	Reach 1-3	6212	100-YR	1763.93	7060.43	7063.53	7064.21	7065.76	0.269324	158.78	130.36	3.10	0.090	0.090	0.090	1.91	11.11	12.57
Sand Creek	Reach 1-3	6199	2-YR	146.52	7057.41	7059.59	7059.10	7059.66	0.017564	67.06	66.57	2.18		0.090		0.38	2.19	2.19
Sand Creek	Reach 1-3	6199	5-YR	512.38	7057.41	7060.62	7059.81	7060.82	0.020155	143.86	84.42	3.21	0.090	0.090	0.090	0.49	3.56	3.64
Sand Creek	Reach 1-3	6199	100-YR	1763.93	7057.41	7062.15	7061.38	7062.77	0.030034	296.15	117.54	4.74	0.090	0.090	0.090	0.70	5.96	6.54

Mixed Flow Evaluation for GSB Design

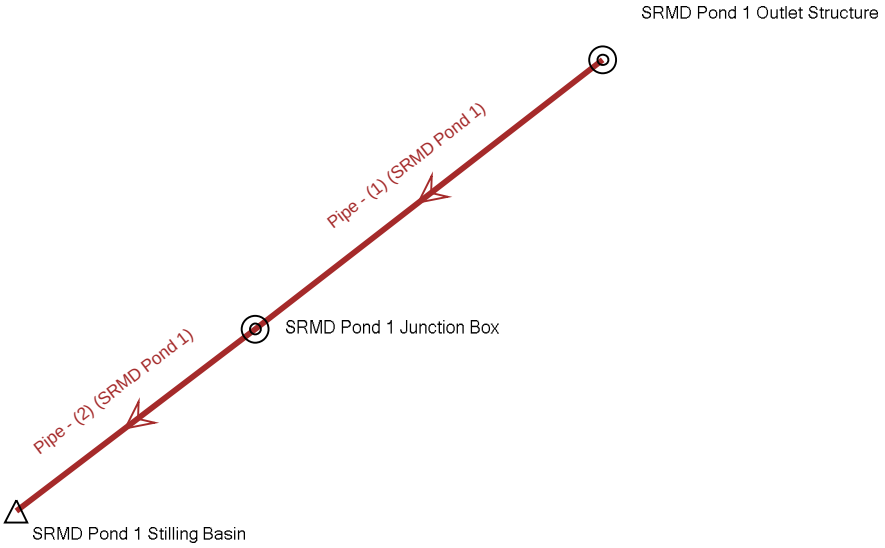
HEC-RAS Plan: PROP - Shear Locations: User Defined (Continued)

River	Reach	River Sta	Profile	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Flow Area	Top Width	Max Chl Dpth	Mann Wtd Left	Mann Wtd Chnl	Mann Wtd Rght	Froude # XS	Vel Total	Vel Chnl
				(cfs)	(ft)	(ft)	(ft)	(ft)	(ft/ft)	(sq ft)	(ft)	(ft)					(ft/s)	(ft/s)
Sand Creek	Reach 1-3	6184	2-YR	146.52	7057.42	7059.57		7059.59	0.001662	136.78	66.79	2.15		0.090		0.13	1.07	1.07
Sand Creek	Reach 1-3	6184	5-YR	512.38	7057.42	7060.56		7060.65	0.005209	223.72	111.45	3.14	0.090	0.090	0.090	0.30	2.29	2.44
Sand Creek	Reach 1-3	6184	100-YR	1763.93	7057.42	7062.12		7062.42	0.011156	425.24	145.16	4.70	0.090	0.090	0.079	0.46	4.15	4.72
Sand Creek	Reach 1-3	6182	2-YR	146.52	7058.72	7059.28	7059.28	7059.55	0.064778	35.01	64.57	0.56		0.060		1.00	4.18	4.18
Sand Creek	Reach 1-3	6182	5-YR	512.38	7058.72	7060.01	7060.01	7060.58	0.045857	86.08	81.93	1.29	0.060	0.060	0.060	1.04	5.95	6.06
Sand Creek	Reach 1-3	6182	100-YR	1763.93	7058.72	7061.41	7061.41	7062.33	0.030039	245.65	133.77	2.69	0.060	0.060	0.059	1.00	7.18	8.15
Sand Creek	Reach 1-3	6164	2-YR	146.52	7056.45	7058.88	7058.63	7059.03	0.011062	46.00	55.84	2.43		0.047		0.62	3.19	3.19
Sand Creek	Reach 1-3	6164	5-YR	512.38	7056.45	7059.80	7059.57	7060.10	0.012330	129.24	126.76	3.35	0.058	0.051	0.060	0.77	3.96	4.63
Sand Creek	Reach 1-3	6164	100-YR	1763.93	7056.45	7061.13	7060.80	7061.61	0.011792	369.81	244.89	4.68	0.056	0.053	0.060	0.79	4.77	6.33
Sand Creek	Reach 1-3	2856	2-YR	101.60	7000.50	7001.39		7001.47	0.029128	43.93	59.73	0.89	0.090	0.090	0.090	0.48	2.31	2.32
Sand Creek	Reach 1-3	2856	5-YR	398.70	7000.50	7002.18		7002.47	0.038527	94.37	67.04	1.68	0.090	0.090	0.090	0.63	4.22	4.32
Sand Creek	Reach 1-3	2856	100-YR	1562.40	7000.50	7002.75	7003.36	7004.98	0.199976	132.42	71.30	2.25	0.090	0.090	0.090	1.51	11.80	12.12
Sand Creek	Reach 1-3	2850	2-YR	101.60	7000.17	7000.90	7000.90	7001.12	0.153404	27.11	62.22	0.72	0.090	0.090	0.090	1.01	3.75	3.77
Sand Creek	Reach 1-3	2850	5-YR	398.70	7000.17	7001.55	7001.55	7002.07	0.111722	69.37	67.25	1.38	0.090	0.090	0.090	1.01	5.75	5.87
Sand Creek	Reach 1-3	2850	100-YR	1562.40	7000.17	7003.47	7003.09	7004.37	0.050787	208.98	81.81	3.30	0.090	0.090	0.090	0.80	7.48	7.78
Sand Creek	Reach 1-3	2842	2-YR	101.60	6997.59	7000.19	6998.26	7000.20	0.000829	125.46	58.25	2.60	0.090	0.090	0.090	0.10	0.81	0.83
Sand Creek	Reach 1-3	2842	5-YR	398.70	6997.59	7001.50	6999.01	7001.56	0.002796	207.56	67.18	3.91	0.090	0.090	0.090	0.20	1.92	2.03
Sand Creek	Reach 1-3	2842	100-YR	1562.40	6997.59	7003.61		7003.93	0.008315	364.60	81.98	6.02	0.090	0.090	0.090	0.38	4.29	4.72
Sand Creek	Reach 1-3	2838	2-YR	101.60	6999.13	7000.14		7000.19	0.014543	53.75	57.87	1.01		0.090		0.35	1.89	1.89
Sand Creek	Reach 1-3	2838	5-YR	398.70	6999.13	7001.40		7001.54	0.012715	132.12	66.96	2.27	0.090	0.090	0.090	0.38	3.02	3.05
Sand Creek	Reach 1-3	2838	100-YR	1562.40	6999.13	7003.36		7003.87	0.019350	278.48	82.02	4.23	0.080	0.090	0.077	0.55	5.61	5.83
Sand Creek	Reach 1-3	2830	2-YR	101.60	6997.58	7000.11		7000.15	0.002135	61.58	61.21	2.53	0.060	0.046	0.060	0.29	1.65	1.67
Sand Creek	Reach 1-3	2830	5-YR	398.70	6997.58	7001.36		7001.49	0.003085	144.56	71.10	3.78	0.057	0.051	0.057	0.35	2.76	2.87
Sand Creek	Reach 1-3	2830	100-YR	1562.40	6997.58	7003.33		7003.77	0.005548	299.22	86.69	5.74	0.049	0.053	0.049	0.51	5.22	5.52
Sand Creek	Reach 1-3	2405	2-YR	101.60	6997.08	6998.99		6999.09	0.008004	39.57	66.34	1.91		0.044		0.59	2.57	2.57
Sand Creek	Reach 1-3	2405	5-YR	398.70	6997.08	6999.86		7000.09	0.010282	108.10	107.24	2.78	0.040	0.050	0.060	0.67	3.69	3.84
Sand Creek	Reach 1-3	2405	100-YR	1562.40	6997.08	7001.18		7001.65	0.012297	330.06	216.73	4.10	0.040	0.053	0.060	0.79	4.73	6.05
Sand Creek	Reach 1-3	2399	2-YR	101.60	6997.08	6998.73	6998.73	6998.96	0.161676	26.69	60.97	1.65		0.090		1.01	3.81	3.81
Sand Creek	Reach 1-3	2399	5-YR	398.70	6997.08	6999.38	6999.38	6999.91	0.124367	67.81	66.14	2.30		0.090		1.02	5.88	5.88
Sand Creek	Reach 1-3	2399	100-YR	1562.40	6997.08	7000.93	7000.93	7001.51	0.047494	271.58	215.32	3.85	0.068	0.090	0.067	0.96	5.75	6.67
Sand Creek	Reach 1-3	2394	2-YR	101.60	6995.80	6997.30	6997.45	6997.77	0.317914	18.44	40.02	1.50		0.090		1.43	5.51	5.51
Sand Creek	Reach 1-3	2394	5-YR	398.70	6995.80	6997.81	6998.11	6998.83	0.353806	49.18	64.99	2.00		0.090		1.64	8.11	8.11
Sand Creek	Reach 1-3	2394	100-YR	1562.40	6995.80	6999.01	6999.72	7000.92	0.201643	148.31	105.44	3.21	0.090	0.090	0.090	1.65	10.53	11.29
Sand Creek	Reach 1-3	2389	2-YR	101.60	6994.62	6996.23	6996.27	6996.50	0.209568	24.67	60.85	1.61		0.090		1.14	4.12	4.12
Sand Creek	Reach 1-3	2389	5-YR	398.70	6994.62	6996.76	6996.91	6997.48	0.205702	58.47	67.21	2.14		0.090	0.090	1.29	6.82	6.82
Sand Creek	Reach 1-3	2389	100-YR	1562.40	6994.62	6997.80	6998.46	6999.91	0.218676	137.31	87.14	3.18	0.057	0.090	0.090	1.64	11.38	11.82
Sand Creek	Reach 1-3	2384	2-YR	101.60	6993.53	6995.77	6995.12	6995.80	0.007992	68.04	66.20	2.24		0.090		0.26	1.49	1.49
Sand Creek	Reach 1-3	2384	5-YR	398.70	6993.53	6996.73	6995.76	6996.86	0.014166	135.88	79.23	3.19	0.040	0.090	0.090	0.40	2.93	2.94
Sand Creek	Reach 1-3	2384	100-YR	1562.40	6993.53	6996.77	6997.38	6998.74	0.200807	139.44	81.04	3.24	0.040	0.090	0.090	1.51	11.21	11.25
Sand Creek	Reach 1-3	2377	2-YR	101.60	6993.46	6995.77		6995.78	0.000738	140.71	65.85	2.31		0.090		0.09	0.72	0.72
Sand Creek	Reach 1-3	2377	5-YR	398.70	6993.46	6996.74		6996.80	0.003243	216.10	98.15	3.28	0.090	0.090	0.090	0.23	1.84	1.91
Sand Creek	Reach 1-3	2377	100-YR	1562.40	6993.46	6998.12	6996.27	6998.40	0.010895	390.59	155.77	4.66	0.083	0.090	0.076	0.48	4.00	4.50
Sand Creek	Reach 1-3	2375	2-YR	101.60	6994.97	6995.69		6995.77	0.030806	44.98	65.15	0.72		0.090		0.48	2.26	2.26
Sand Creek	Reach 1-3	2375	5-YR	398.70	6994.97	6996.54		6996.76	0.031436	109.14	96.66	1.57	0.090	0.090	0.090	0.63	3.65	3.83
Sand Creek	Reach 1-3	2375	100-YR	1562.40	6994.97	6997.52	6997.52	6998.30	0.062814	233.96	153.78	2.54	0.090	0.090	0.077	1.01	6.68	7.56

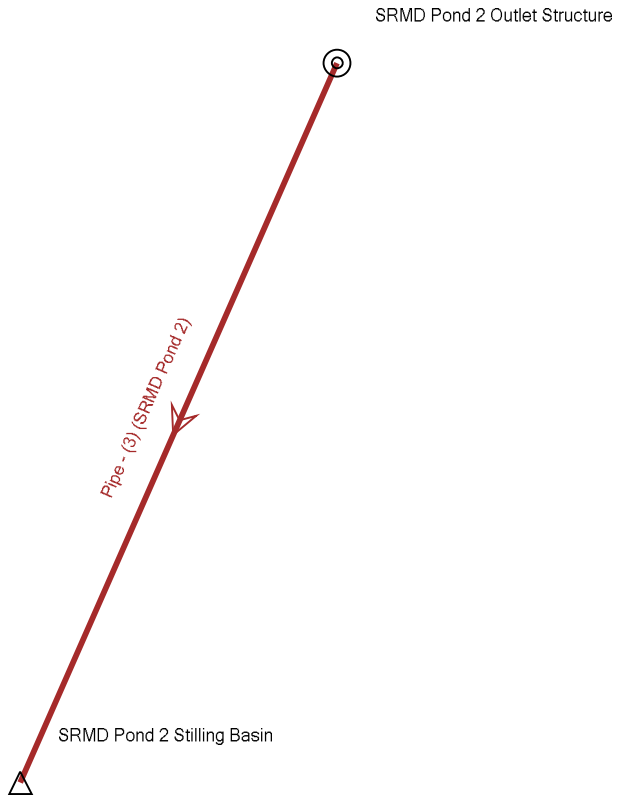
Appendix E

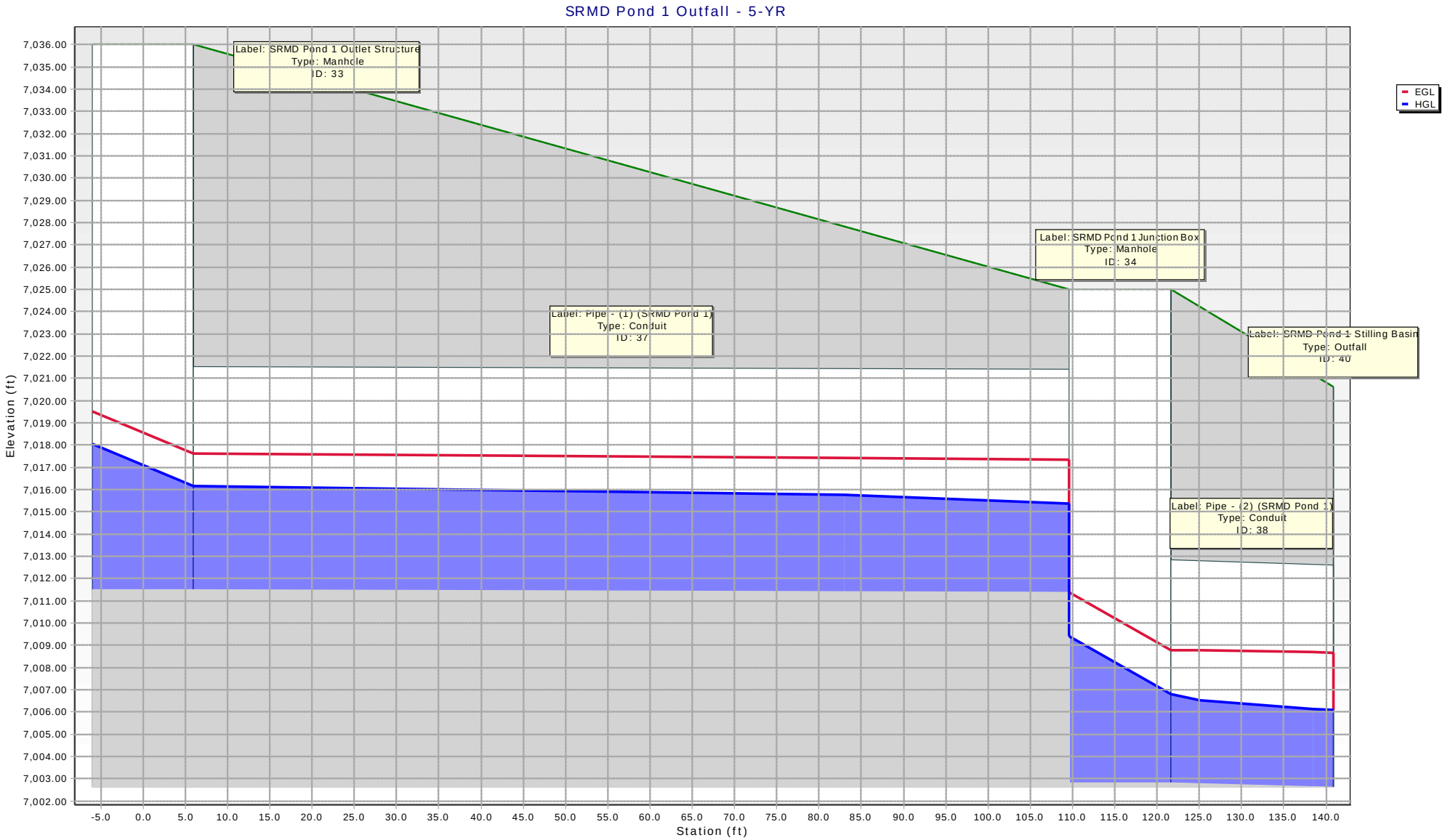
Detention Pond Design Calculations

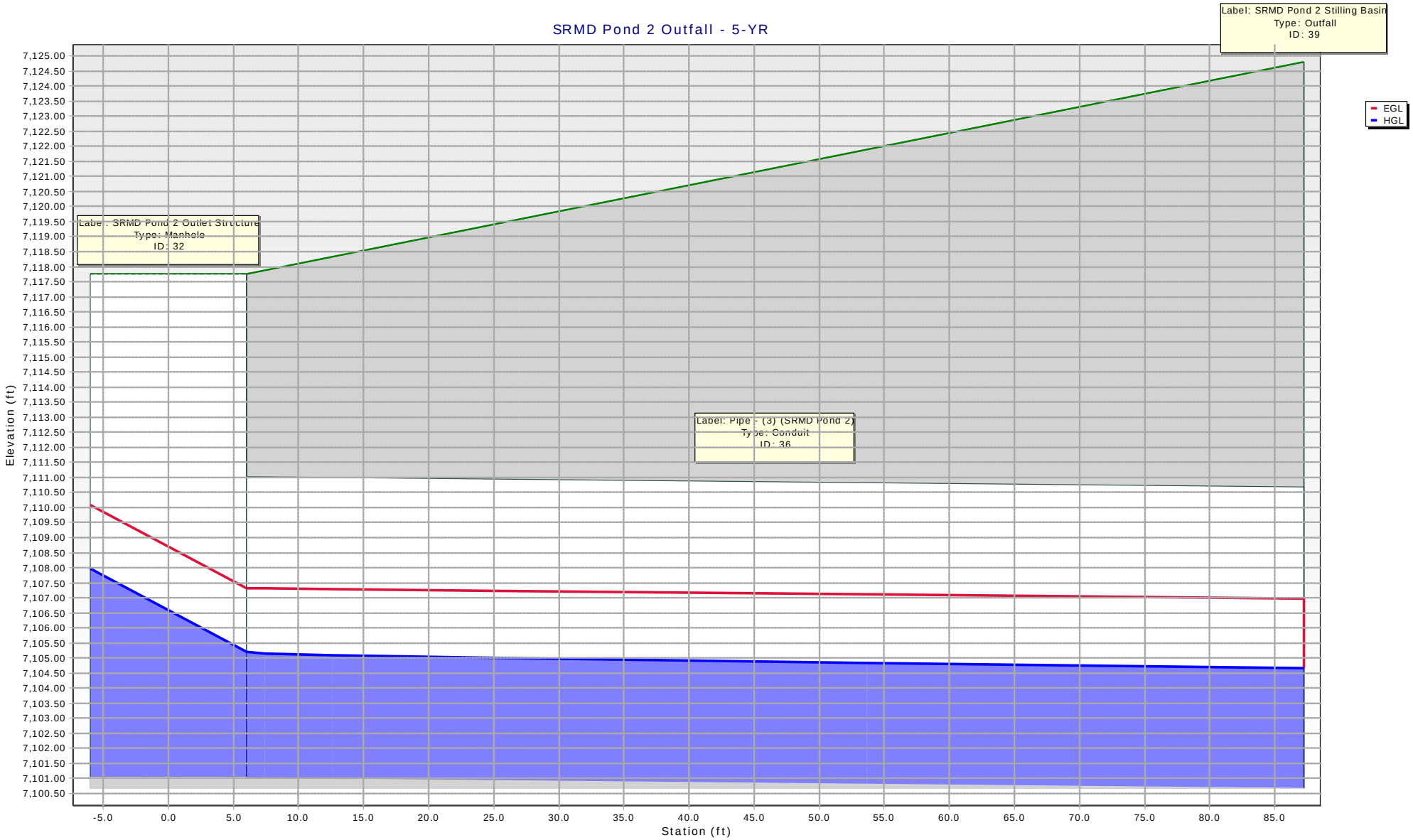
Scenario: 100-YR



Scenario: 100-YR



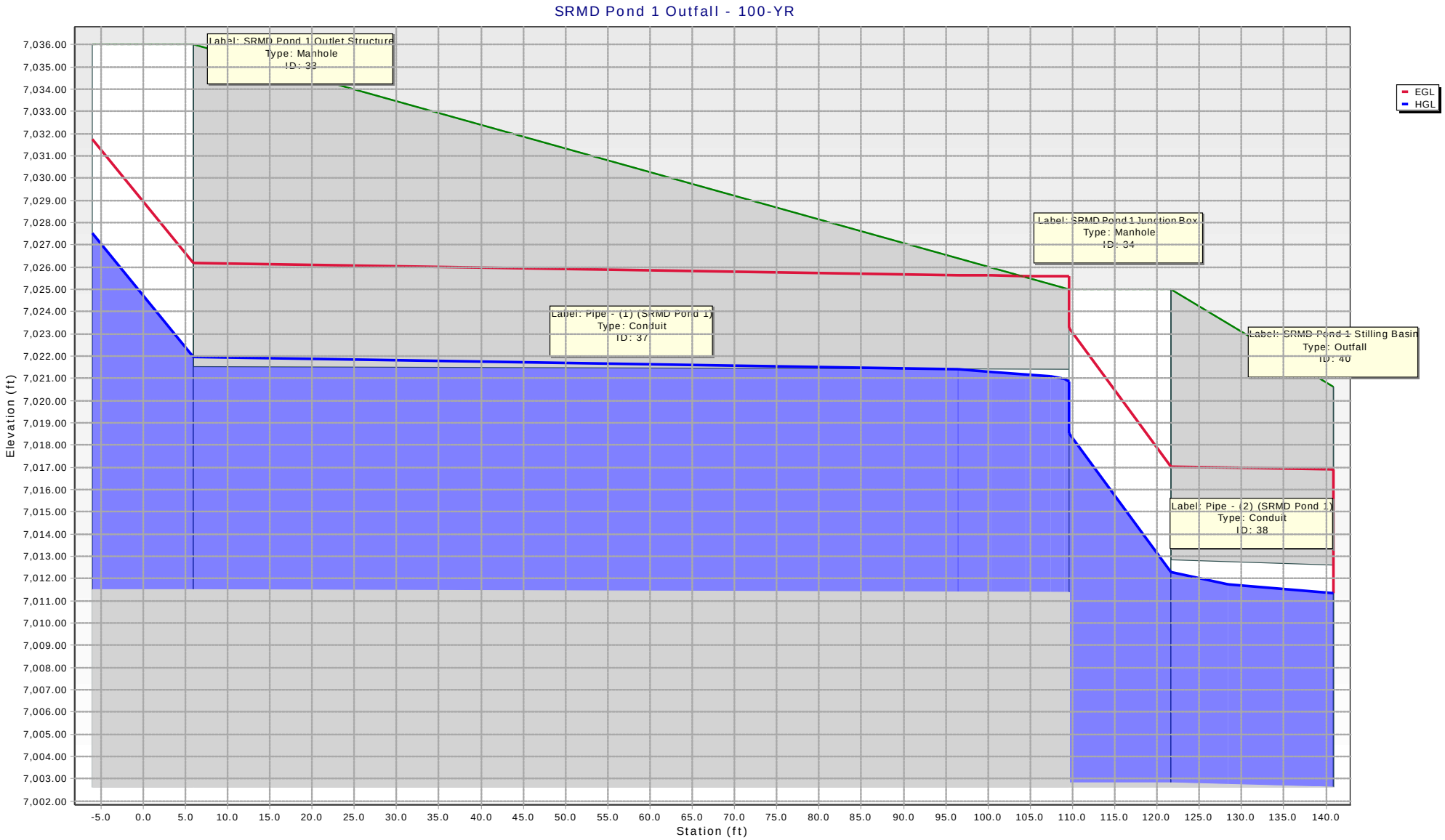

SRMD Pond 1 Outfall - 5-YR
Label: SRMD Pond 1 Outlet Structure
Type: Manhole
ID: 33
Label: SRMD Pond 1 Junction Box
Type: Manhole
ID: 34
Label: Pipe - (1) (SRMD Pond 1)
Type: Conduit
ID: 37
Label: SRMD Pond 1 Stilling Basin
Type: Outfall
ID: 40
Label: Pipe - (2) (SRMD Pond 1)
Type: Conduit
ID: 38
EGL
HGL
Elevation (ft)
Station (ft)

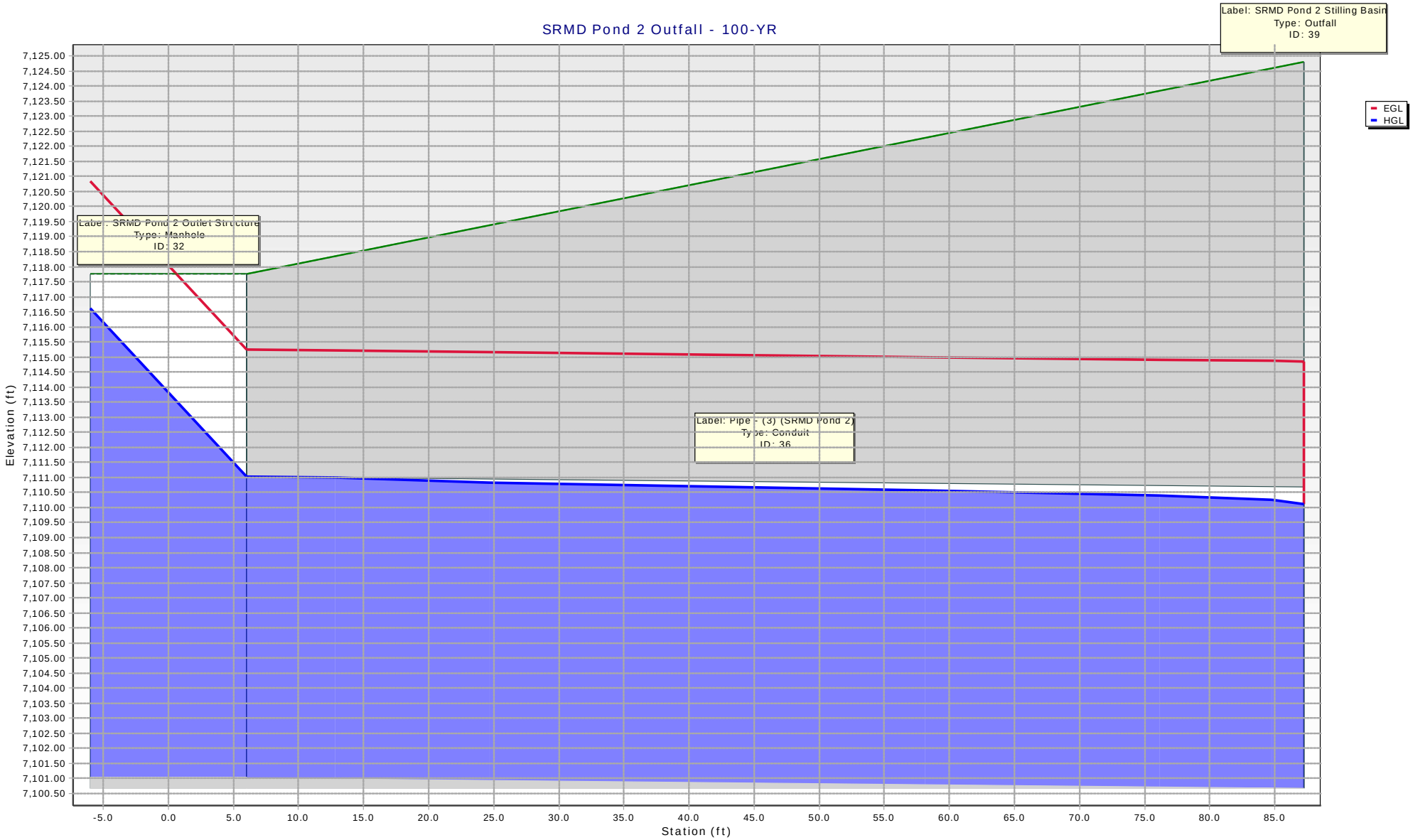

SRMD Pond 2 Outfall - 5-YR
Label: SRMD Pond 2 Stilling Basin
Type: Outfall
ID: 39
Label: SRMD Pond 2 Outlet Structure
Type: Manhole
ID: 32
Label: Pipe - (3) (SRMD Pond 2)
Type: Conduit
ID: 36
EGL
HGL
Elevation (ft)
Station (ft)
7,125.00
7,124.50
7,124.00
7,123.50
7,123.00
7,122.50
7,122.00
7,121.50
7,121.00
7,120.50
7,120.00
7,119.50
7,119.00
7,118.50
7,118.00
7,117.50
7,117.00
7,116.50
7,116.00
7,115.50
7,115.00
7,114.50
7,114.00
7,113.50
7,113.00
7,112.50
7,112.00
7,111.50
7,111.00
7,110.50
7,110.00
7,109.50
7,109.00
7,108.50
7,108.00
7,107.50
7,107.00
7,106.50
7,106.00
7,105.50
7,105.00
7,104.50
7,104.00
7,103.50
7,103.00
7,102.50
7,102.00
7,101.50
7,101.00
7,100.50
-5.0
0.0
5.0
10.0
15.0
20.0
25.0
30.0
35.0
40.0
45.0
50.0
55.0
60.0
65.0
70.0
75.0
80.0
85.0

Scenario: 5-YR
Current Time Step: 0.000 h
Conduit FlexTable: Combined Pipe/Node Report

Upstream Structure	Label	Flow (cfs)	Capacity (Full Flow) (cfs)	Rise (ft)	Span (ft)	Length (User Defined) (ft)	Slope (Calculated) (ft/ft)	Invert (Start) (ft)	Invert (Stop) (ft)	Elevation Ground (Start) (ft)	Elevation Ground (Stop) (ft)	HGL (In) (ft)	HGL (Out) (ft)	Energy Grade Line (In) (ft)	Energy Grade Line (Out) (ft)	Velocity (ft/s)	Manning's n	Upstream Structure Headloss Coefficient
SRMD Pond 1 Outlet Structure	Pipe - (1) (SRMD Pond 1)	537.00	860.07	10.0	12.0	115.6	0.001	7,011.52	7,011.40	7,036.02	7,025.01	7,016.18	7,015.37	7,017.61	7,017.35	7.59	0.013	1.320
SRMD Pond 1 Junction Box	Pipe - (2) (SRMD Pond 1)	537.00	2,450.71	10.0	12.0	25.3	0.008	7,002.83	7,002.62	7,025.01	7,020.64	7,006.80	7,006.09	7,008.78	7,008.68	16.06	0.013	1.320
SRMD Pond 2 Outlet Structure	Pipe - (3) (SRMD Pond 2)	487.00	1,333.67	10.0	10.0	87.2	0.004	7,101.02	7,100.67	7,117.76	7,124.81	7,105.21	7,104.66	7,107.31	7,106.98	12.29	0.013	1.320

X:\2510000.all\2518804\StormCAD\2518804 StormCAD.stsw


SRMD Pond 1 Outfall - 100-YR
Label: SRMD Pond 1 Outlet Structure
Type: Manhole
ID: 33
Label: SRMD Pond 1 Junction Box
Type: Manhole
ID: 34
Label: Pipe - (1) (SRMD Pond 1)
Type: Conduit
ID: 37
Label: SRMD Pond 1 Stilling Basin
Type: Outfall
ID: 40
Label: Pipe - (2) (SRMD Pond 1)
Type: Conduit
ID: 38
EGL
HGL
Elevation (ft)
Station (ft)


SRMD Pond 2 Outfall - 100-YR
Label: SRMD Pond 2 Stilling Basin
Type: Outfall
ID: 39
Label: SRMD Pond 2 Outlet Structure
Type: Manhole
ID: 32
Label: Pipe - (3) (SRMD Pond 2)
Type: Conduit
ID: 36
EGL
HGL
Elevation (ft)
Station (ft)
7,125.00
7,124.50
7,124.00
7,123.50
7,123.00
7,122.50
7,122.00
7,121.50
7,121.00
7,120.50
7,120.00
7,119.50
7,119.00
7,118.50
7,118.00
7,117.50
7,117.00
7,116.50
7,116.00
7,115.50
7,115.00
7,114.50
7,114.00
7,113.50
7,113.00
7,112.50
7,112.00
7,111.50
7,111.00
7,110.50
7,110.00
7,109.50
7,109.00
7,108.50
7,108.00
7,107.50
7,107.00
7,106.50
7,106.00
7,105.50
7,105.00
7,104.50
7,104.00
7,103.50
7,103.00
7,102.50
7,102.00
7,101.50
7,101.00
7,100.50
-5.0
0.0
5.0
10.0
15.0
20.0
25.0
30.0
35.0
40.0
45.0
50.0
55.0
60.0
65.0
70.0
75.0
80.0
85.0

Scenario: 100-YR
Current Time Step: 0.000 h
Conduit FlexTable: Combined Pipe/Node Report

Upstream Structure	Label	Flow (cfs)	Capacity (Full Flow) (cfs)	Rise (ft)	Span (ft)	Length (User Defined) (ft)	Slope (Calculated) (ft/ft)	Invert (Start) (ft)	Invert (Stop) (ft)	Elevation Ground (Start) (ft)	Elevation Ground (Stop) (ft)	HGL (In) (ft)	HGL (Out) (ft)	Energy Grade Line (In) (ft)	Energy Grade Line (Out) (ft)	Velocity (ft/s)	Manning's n	Upstream Structure Headloss Coefficient
SRMD Pond 1 Outlet Structure	Pipe - (1) (SRMD Pond 1)	1,978.00	860.07	10.0	12.0	115.6	0.001	7,011.52	7,011.40	7,036.02	7,025.01	7,021.97	7,020.85	7,026.19	7,025.58	16.48	0.013	1.320
SRMD Pond 1 Junction Box	Pipe - (2) (SRMD Pond 1)	1,978.00	2,450.71	10.0	12.0	25.3	0.008	7,002.83	7,002.62	7,025.01	7,020.64	7,012.29	7,011.35	7,017.01	7,016.89	23.02	0.013	1.320
SRMD Pond 2 Outlet Structure	Pipe - (3) (SRMD Pond 2)	1,649.00	1,333.67	10.0	10.0	87.2	0.004	7,101.02	7,100.67	7,117.76	7,124.81	7,111.04	7,110.12	7,115.26	7,114.85	16.49	0.013	1.320

X:\2510000.all\2518804\StormCAD\2518804 StormCAD.stsw

HY-8 Culvert Analysis Report

Crossing Discharge Data

Discharge Selection Method: Specify Minimum, Design, and Maximum Flow

Minimum Flow: 0 cfs

Design Flow: 1550 cfs

Maximum Flow: 2600 cfs

Table 1 - Summary of Culvert Flows at Crossing: SRR (separate berm)

Headwater Elevation (ft)	Total Discharge (cfs)	Culvert 1 Discharge (cfs)	Culvert 2 (low flow) Discharge (cfs)	Roadway Discharge (cfs)	Iterations
7000.88	0.00	0.00	0.00	0.00	0
7003.13	260.00	151.32	108.64	0.00	3
7004.37	520.00	339.63	180.32	0.00	4
7005.52	780.00	552.62	227.38	0.00	4
7006.71	1040.00	773.45	266.59	0.00	4
7008.18	1300.00	994.87	305.19	0.00	4
7009.91	1550.00	1205.48	344.57	0.00	4
7011.14	1820.00	1333.23	369.90	115.89	7
7011.40	2080.00	1359.45	375.23	344.67	5
7011.62	2340.00	1380.22	379.47	580.03	5
7011.81	2600.00	1398.22	383.17	817.61	4
7010.88	1672.34	1307.58	364.76	0.00	Overtopping

Rating Curve Plot for Crossing: SRR (separate berm)

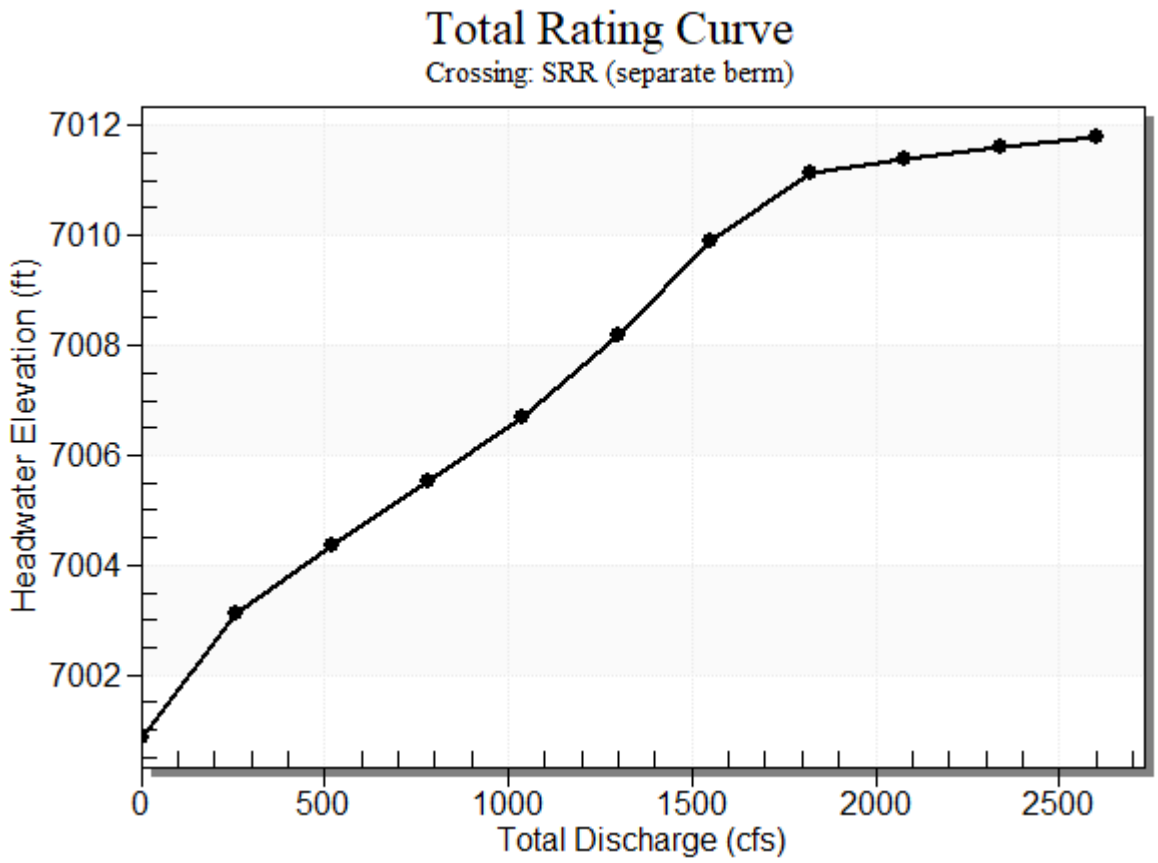


Table 2 - Culvert Summary Table: Culvert 1

Total Discharge (cfs)	Culvert Discharge (cfs)	Headwater Elevation (ft)	Inlet Control Depth (ft)	Outlet Control Depth (ft)	Flow Type	Normal Depth (ft)	Critical Depth (ft)	Outlet Depth (ft)	Tailwater Depth (ft)	Outlet Velocity (ft/s)	Tailwater Velocity (ft/s)
0.00	0.00	7000.88	0.000	0.000	0-NF	0.000	0.000	0.000	0.000	0.000	0.000
260.00	151.32	7003.13	1.745	1.751	3-M2t	1.225	1.017	1.177	1.738	4.944	2.537
520.00	339.63	7004.37	2.954	2.998	3-M2t	2.077	1.743	2.032	2.593	6.429	3.216
780.00	552.62	7005.52	4.097	4.143	3-M2t	2.886	2.412	2.703	3.264	7.863	3.673
1040.00	773.45	7006.71	5.326	5.184	3-M2t	3.644	3.018	3.274	3.835	9.085	4.027
1300.00	994.87	7008.18	6.800	6.142	7-M2t	4.000	3.569	3.780	4.341	10.124	4.318
1550.00	1205.48	7009.91	8.531	4.111	5-M2t	4.000	4.000	3.780	4.781	0.000	4.558
1820.00	1333.23	7011.14	9.756	4.548	5-M2t	4.000	4.000	3.780	5.218	10.124	4.786
2080.00	1359.45	7011.40	10.024	4.939	5-M2t	4.000	4.000	3.780	5.609	10.124	4.982
2340.00	1380.22	7011.62	10.241	5.306	5-M2t	4.000	4.000	3.780	5.976	10.124	5.159
2600.00	1398.22	7011.81	10.431	5.652	5-M2t	4.000	4.000	3.780	6.322	10.124	5.322

****

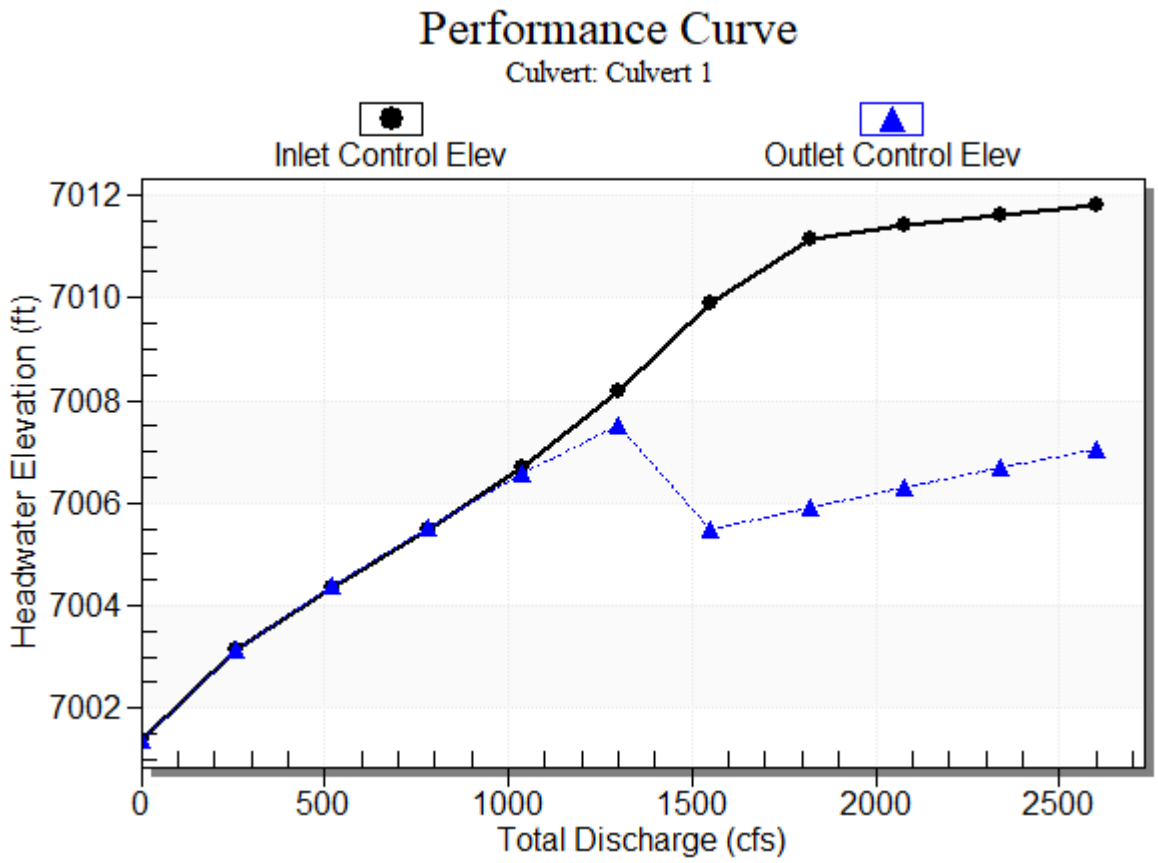
Straight Culvert

Inlet Elevation (invert): 7001.38 ft, Outlet Elevation (invert): 7001.27 ft

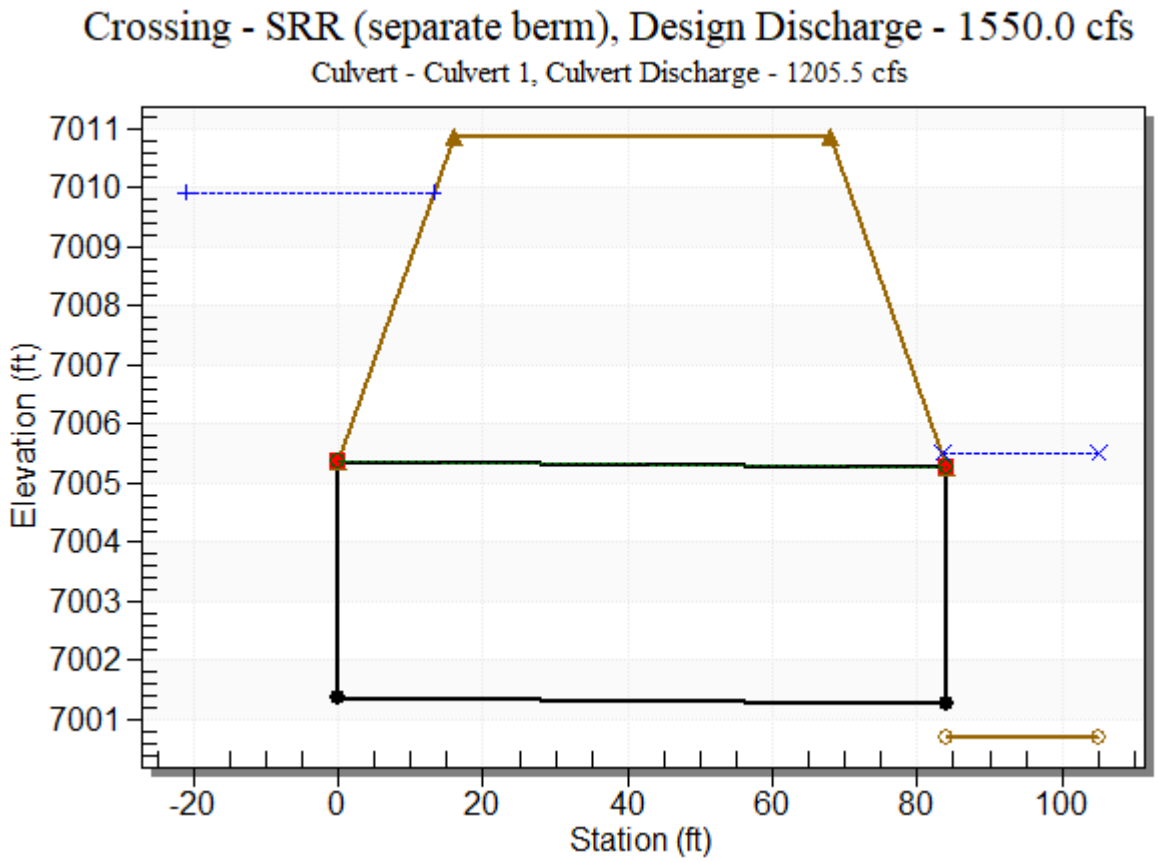
Culvert Length: 84.00 ft, Culvert Slope: 0.0013

****

Culvert Performance Curve Plot: Culvert 1



Water Surface Profile Plot for Culvert: Culvert 1



Site Data - Culvert 1

Site Data Option: Culvert Invert Data

Inlet Station: 0.00 ft

Inlet Elevation: 7001.38 ft

Outlet Station: 84.00 ft

Outlet Elevation: 7001.27 ft

Number of Barrels: 2

Culvert Data Summary - Culvert 1

Barrel Shape: Concrete Box

Barrel Span: 13.00 ft

Barrel Rise: 4.00 ft

Barrel Material: Concrete

Embedment: 0.00 in

Barrel Manning's n: 0.0120

Culvert Type: Straight

Inlet Configuration: Square Edge (90º) Headwall

Inlet Depression: None

Table 3 - Culvert Summary Table: Culvert 2 (low flow)

Total Discharge (cfs)	Culvert Discharge (cfs)	Headwater Elevation (ft)	Inlet Control Depth (ft)	Outlet Control Depth (ft)	Flow Type	Normal Depth (ft)	Critical Depth (ft)	Outlet Depth (ft)	Tailwater Depth (ft)	Outlet Velocity (ft/s)	Tailwater Velocity (ft/s)
0.00	0.00	7000.88	0.000	0.000	0-NF	0.000	0.000	0.000	0.000	0.000	0.000
260.00	108.64	7003.13	2.213	2.235	7-M1t	1.340	1.294	1.738	1.738	4.808	2.537
520.00	180.32	7004.37	3.494	3.860	4-FFf	1.865	1.815	2.000	2.593	6.935	3.216
780.00	227.38	7005.52	4.644	5.380	4-FFf	2.000	2.000	2.000	3.264	8.745	3.673
1040.00	266.59	7006.71	5.825	6.807	4-FFf	2.000	2.000	2.000	3.835	10.253	4.027
1300.00	305.19	7008.18	7.300	8.288	4-FFf	2.000	2.000	2.000	4.341	11.738	4.318
1550.00	344.57	7009.91	9.031	9.860	4-FFf	2.000	2.000	2.000	4.781	13.253	4.558
1820.00	369.90	7011.14	10.255	11.097	4-FFf	2.000	2.000	2.000	5.218	14.227	4.786
2080.00	375.23	7011.40	10.524	11.663	4-FFf	2.000	2.000	2.000	5.609	14.432	4.982
2340.00	379.47	7011.62	10.740	12.172	4-FFf	2.000	2.000	2.000	5.976	14.595	5.159
2600.00	383.17	7011.81	10.931	12.642	4-FFf	2.000	2.000	2.000	6.322	14.737	5.322

****

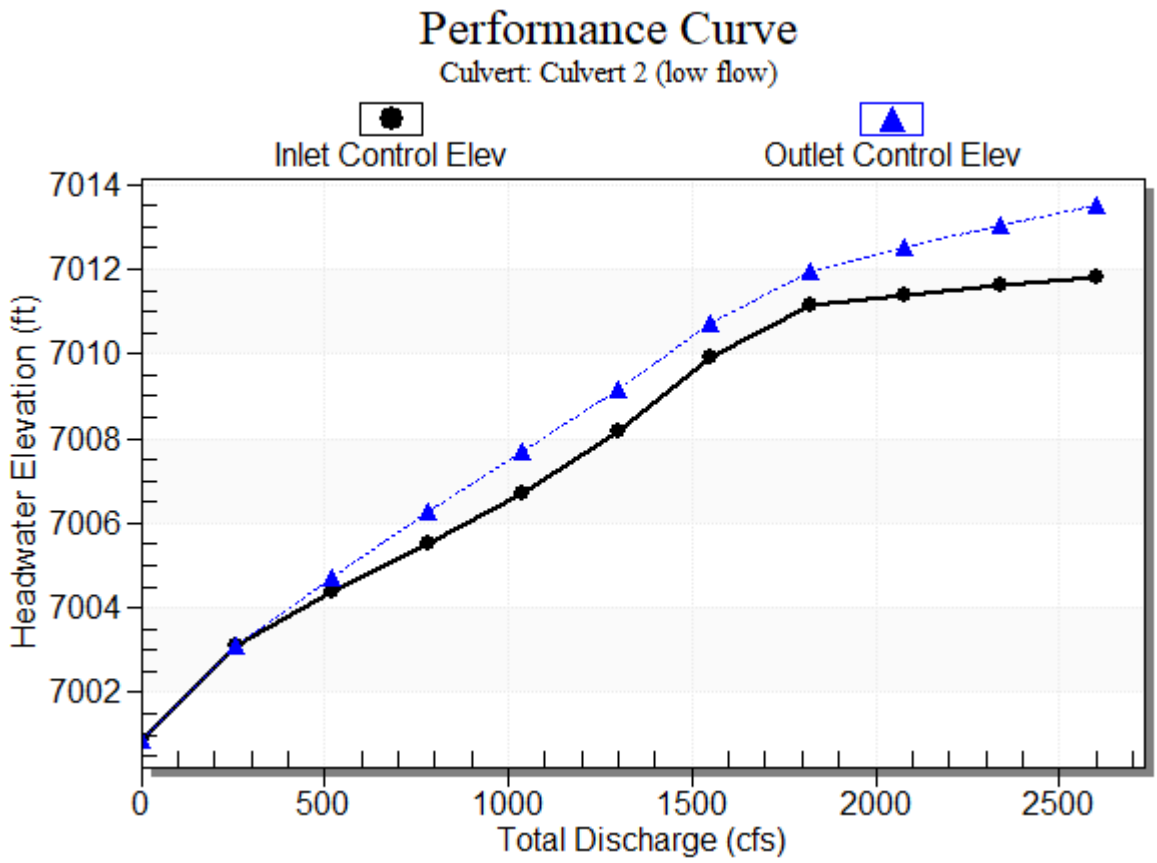
Straight Culvert

Inlet Elevation (invert): 7000.88 ft, Outlet Elevation (invert): 7000.71 ft

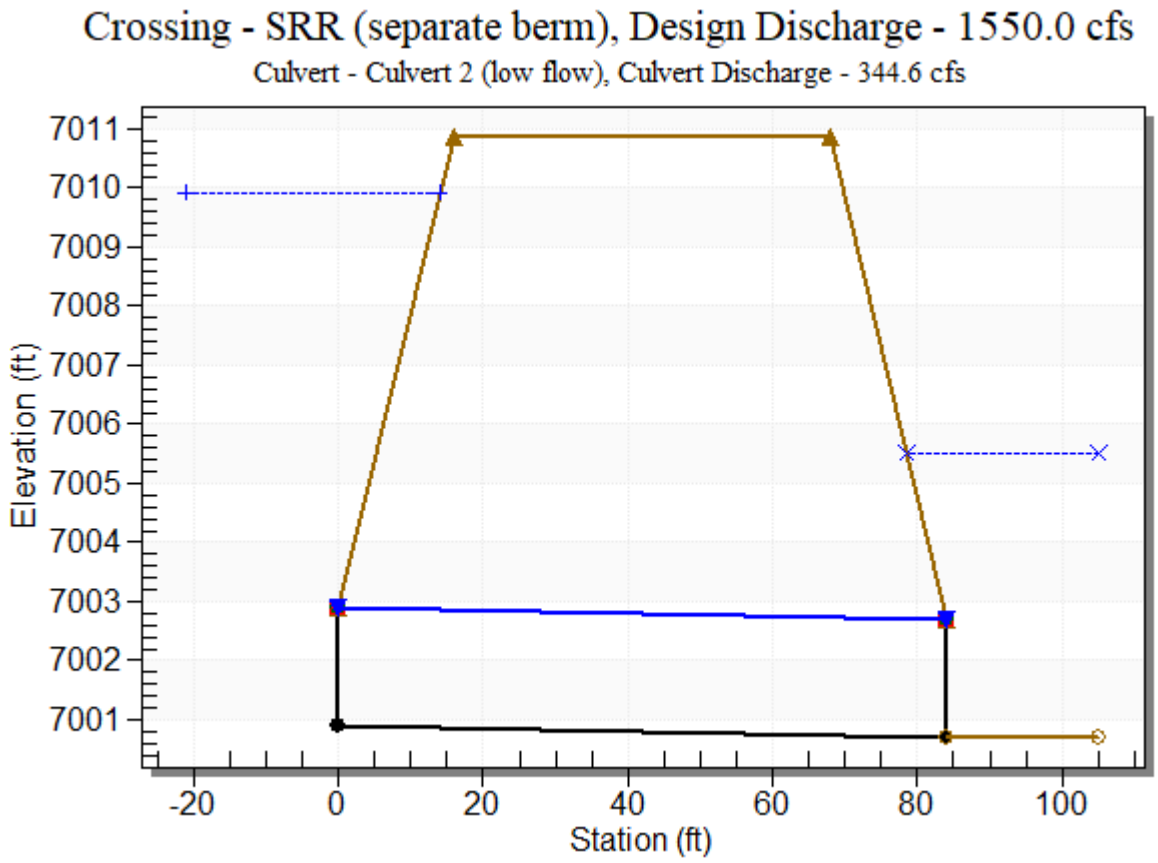
Culvert Length: 84.00 ft, Culvert Slope: 0.0020

****

Culvert Performance Curve Plot: Culvert 2 (low flow)



Water Surface Profile Plot for Culvert: Culvert 2 (low flow)



Site Data - Culvert 2 (low flow)

Site Data Option: Culvert Invert Data

Inlet Station: 0.00 ft

Inlet Elevation: 7000.88 ft

Outlet Station: 84.00 ft

Outlet Elevation: 7000.71 ft

Number of Barrels: 1

Culvert Data Summary - Culvert 2 (low flow)

Barrel Shape: Concrete Box

Barrel Span: 13.00 ft

Barrel Rise: 2.00 ft

Barrel Material: Concrete

Embedment: 0.00 in

Barrel Manning's n: 0.0120

Culvert Type: Straight

Inlet Configuration: Square Edge (90º) Headwall

Inlet Depression: None

Table 4 - Downstream Channel Rating Curve (Crossing: SRR (separate berm))

Flow (cfs)	Water Surface Elev (ft)	Depth (ft)	Velocity (ft/s)	Shear (psf)	Froude Number
0.00	7000.71	0.00	0.00	0.00	0.00
260.00	7002.45	1.74	2.54	0.22	0.36
520.00	7003.30	2.59	3.22	0.32	0.38
780.00	7003.97	3.26	3.67	0.41	0.39
1040.00	7004.55	3.84	4.03	0.48	0.40
1300.00	7005.05	4.34	4.32	0.54	0.41
1550.00	7005.49	4.78	4.56	0.60	0.41
1820.00	7005.93	5.22	4.79	0.65	0.42
2080.00	7006.32	5.61	4.98	0.70	0.42
2340.00	7006.69	5.98	5.16	0.75	0.43
2600.00	7007.03	6.32	5.32	0.79	0.43

Tailwater Channel Data - SRR (separate berm)

Tailwater Channel Option: Trapezoidal Channel

Bottom Width: 52.00 ft

Side Slope (H:V): 4.00 (_:1)

Channel Slope: 0.0020

Channel Manning's n: 0.0350

Channel Invert Elevation: 7000.71 ft

Roadway Data for Crossing: SRR (separate berm)

Roadway Profile Shape: Constant Roadway Elevation

Crest Length: 300.00 ft

Crest Elevation: 7010.88 ft

Roadway Surface: Paved

Roadway Top Width: 52.00 ft

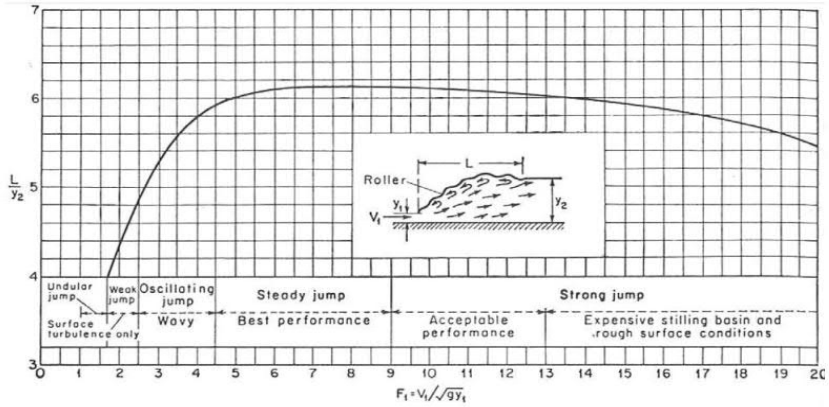
Grouted Boulder Stilling Basin Calculations for SRMD Pond #1 & 2 Outfalls

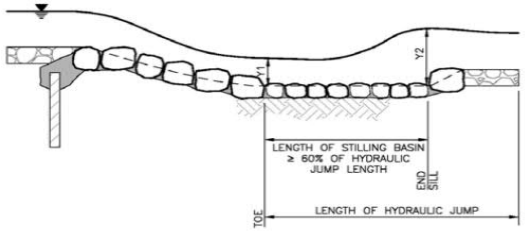
Pond 1 (Lower)

	Q	Froude (From StormCAD)	Velocity (from StormCAD)	Y2 (from HEC)	L (from chart)	Y1(from HEC)	L (from calc)
2-Yr	142	1.68	10.24	1.2	4.8	0.59	4.010722837
5-Yr	513	1.699	15.83	3.06	12.24	1.17	8.175549096
10-Yr	560	1.694	16.27	4.21	16.84	1.6	11.10031821
25-Yr	1155	1.62	20.1	4.97	19.88	1.91	11.83886596
50-Yr	1591	1.563	21.85	6.34	25.36	2.37	13.34018799
100-Yr	1875	1.529	22.73	7.17	28.68	2.68	14.17446829

Pond 2 (Upper)

	Q	Froude (From StormCAD)	Velocity (from StormCAD)	Y2 (from HEC)	L (from chart)	Y1(from HEC)	L (from calc)
2-Yr	155	1.501	10.4	0.89	3.56	0.64	3.205845838
5-Yr	480	1.524	15.38	1.58	6.32	1.3	6.81071213
10-Yr	783	1.395	16.99	2	8	1.52	6.003354922
25-Yr	1036	1.345	18.21	2.3	9.2	1.62	5.588541897
50-Yr	1409	1.281	19.52	2.74	10.96	1.72	4.832937184
100-Yr	1665	1.309	20.87	3.03	12.12	1.78	5.499838345





Length of hydraulic jump [edit]

Length of a hydraulic jump is often hard to measure in the field and during laboratory investigations due to the sudden changes in surface turbulence, in addition to the formation of roller and eddies.[9] The length of a hydraulic jump is often an important factor to know when considering the design of structures like settling basins. Comprehensive studies are applying six-legged components for the bed lining of stilling basins. The results imply that appropriate settings of the elements can decrease the length of the hydraulic jump, the length of stilling basin, the conjugated depth, and consequently reduce the scour depth downstream of the basin.[10] The equation derived for length is based on experimental data, and relates the length to the upstream Froude number.

$$(1)\ L = 220 \times y_1 \times \tanh \frac{Fr_1 - 1}{22}$$ [11]

Existing Stock Pond 1 Proposed Outlet Structure

width	25	area	625	open area x 70%	218.75	0.25
length	25	blockage	0.5			
perimeter	100	blockage	0	avail perm.	100	

Elev (ft)	Head (ft)	Orifice	Weir
7036	0	0	0
7036.25	0.25	526.6381	38.75
7036.5	0.5	744.7787	109.6016
7036.75	0.75	912.1639	201.3509
7037	1	1053.276	310
7037.25	1.25	1177.599	433.2382
7037.5	1.5	1289.995	569.5064
7037.75	1.75	1393.353	717.66
7038	2	1489.557	876.8124
7038.25	2.25	1579.914	1046.25
7038.5	2.5	1665.376	1225.383
7038.75	2.75	1746.661	1413.711
7039	3	1824.328	1610.807
7039.25	3.25	1898.821	1816.296
7039.5	3.5	1970.499	2029.849
7039.75	3.75	2039.66	2251.172
7040	4	2106.552	2480
7040.25	4.25	2171.384	2716.096
7040.5	4.5	2234.336	2959.242
7040.75	4.75	2295.562	3209.239
7041	5	2355.197	3465.905
7041.25	5.25	2413.359	3729.071
7041.5	5.5	2470.152	3998.579
7041.75	5.75	2525.667	4274.285
7042	6	2579.989	4556.051
7042.25	6.25	2633.19	4843.75
7042.5	6.5	2685.338	5137.262
7042.75	6.75	2736.492	5436.474
7043	7	2786.707	5741.28
7043.25	7.25	2836.033	6051.579
7043.5	7.5	2884.516	6367.275
7043.75	7.75	2932.197	6688.277
7044	8	2979.115	7014.499
7044.25	8.25	3025.305	7345.859
7044.5	8.5	3070.801	7682.279
7044.75	8.75	3115.633	8023.683
7045	9	3159.828	8370
7045.25	9.25	3203.414	8721.161
7045.5	9.5	3246.415	9077.1
7045.75	9.75	3288.854	9437.753
7046	10	3330.752	9803.061
7046.25	10.25	3372.129	10172.96
7046.5	10.5	3413.005	10547.41
7046.75	10.75	3453.397	10926.33
7047	11	3493.322	11309.69
7047.25	11.25	3532.796	11697.43
7047.5	11.5	3571.833	12089.5
7047.75	11.75	3610.449	12485.86
7048	12	3648.656	12886.46

Existing Stock Pond 2 Proposed Outlet Structure

width	25	area	625	open area x 70%	218.75
length	25	blockage	0.5		
perimeter	100	blockage	0	avail perm.	100

Elev (ft)	Head (ft)	Orifice	Weir
7117.75	0	0	0
7118	0.25	526.6381	38.75
7118.25	0.5	744.7787	109.6016
7118.5	0.75	912.1639	201.3509
7118.75	1	1053.276	310
7119	1.25	1177.599	433.2382
7119.25	1.5	1289.995	569.5064
7119.5	1.75	1393.353	717.66
7119.75	2	1489.557	876.8124
7120	2.25	1579.914	1046.25
7120.25	2.5	1665.376	1225.383
7120.5	2.75	1746.661	1413.711
7120.75	3	1824.328	1610.807
7121	3.25	1898.821	1816.296
7121.25	3.5	1970.499	2029.849
7121.5	3.75	2039.66	2251.172
7121.75	4	2106.552	2480
7122	4.25	2171.384	2716.096
7122.25	4.5	2234.336	2959.242
7122.5	4.75	2295.562	3209.239
7122.75	5	2355.197	3465.905
7123	5.25	2413.359	3729.071
7123.25	5.5	2470.152	3998.579
7123.5	5.75	2525.667	4274.285
7123.75	6	2579.989	4556.051
7124	6.25	2633.19	4843.75
7124.25	6.5	2685.338	5137.262
7124.5	6.75	2736.492	5436.474
7124.75	7	2786.707	5741.28
7125	7.25	2836.033	6051.579
7125.25	7.5	2884.516	6367.275
7125.5	7.75	2932.197	6688.277
7125.75	8	2979.115	7014.499
7126	8.25	3025.305	7345.859
7126.25	8.5	3070.801	7682.279
7126.5	8.75	3115.633	8023.683
7126.75	9	3159.828	8370
7127	9.25	3203.414	8721.161
7127.25	9.5	3246.415	9077.1
7127.5	9.75	3288.854	9437.753
7127.75	10	3330.752	9803.061
7128	10.25	3372.129	10172.96
7128.25	10.5	3413.005	10547.41
7128.5	10.75	3453.397	10926.33
7128.75	11	3493.322	11309.69
7129	11.25	3532.796	11697.43
7129.25	11.5	3571.833	12089.5
7129.5	11.75	3610.449	12485.86
7129.75	12	3648.656	12886.46

Appendix F

Excerpts From Reference Material

5 | SMOOTH STONES RESTORATION PLLC

To: Tristin Bonser, PE JR Engineering

From: David Bidelspach, 5 Smooth Stones Restoration, PLLC

CC:

Date: April 6th, 2021

Re: Sand Creek Channel Stabilization Project; El Paso County - General Guidelines for Geomorphic Assessment / Design and Performance Standards

Five Smooth Stones Restoration (5SSR) was tasked with developing general guidelines for geomorphic assessment and conceptual design for the drainage referred to as Sand Creek adjacent to the current private development within El Paso County, Colorado. The location of Sand Creek limits and development is shown below in Error! Reference source not found.. This memo discusses the geomorphic findings from field survey and site visit along with general guidelines used to develop the suggested parameters for the reaches within the Sand Creek.

Background

Development is currently on going adjacent to the site. Most of the infrastructure for the development is near completion and it also appears most development drainage systems to Sand Creek, such as culverts and detention basins have been installed.

Development flows were provided to 5SSR from JR Engineering from The Sand Creek Basing Planning Study of Q_{10} = 700cfs and Q_{100} = 2,620 cfs and used for the evaluation of performance standards for the site.

Drainage Areas and current watershed uses using USGS StreamStats (https://streamstats.usgs.gov) and used for initial investigation for regional curve comparisons and existing conditions evaluation.

Project Objectives

5SSR identified five objectives to direct the project study for Sand Creek channels. The objectives of the study are:

1. Preform geomorphic assessment of current conditions
2. Identify potential future conditions
3. Provide MCDA Alternative Analysis for Design Options
4. Provide design dimensions (Performance Standards) for a multi-stage channel to handle proposed development flows for different Alternatives.
5. Improve the riparian functions of stability, habitat, and aesthetics.

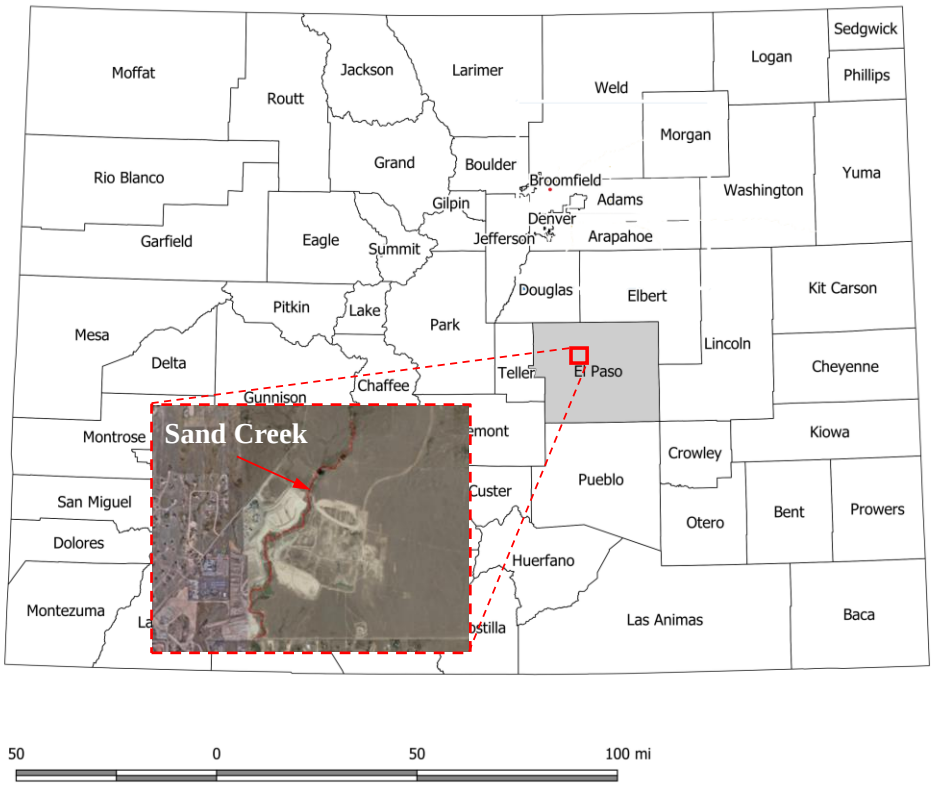


Figure 1 – Project Location Map

Figure 2 – Project Site Location Map

Geomorphic Assessment

A geomorphic survey and assessment were performed in March 10th, 2021 on approximately 9000ft of Sand Creek. Data collection consisted of visual inspection, photo documentation, profile, pattern and cross-sections for the entire length of the project of Sand Creek, Error! Reference source not found.. Data from this assessment were used to evaluate existing conditions of the project area, informing stable slope angles, channel dimensions, trajectory and current function. Existing dimension, pattern, and profile data was analyzed and provided as separate items attached to this memo.

The site consists of multiple ponds and detection structures that have impacted stream function and process. Vegetation is very limited on the project other than presence of willows in the lower laying areas with the typical shrubs on the upper riparian zones. The upper section of the reach (Figure 3, Figure 6) has good floodplain connection leading into the ponds with minimal erosion impacts in a more of a semi confined valley with low bank heights being in the 2-3ft range. Downstream of the second pond, there is a significate change in bed elevation and we start to see the valley become more confined with more upper terrace erosion and down valley migration tendencies, Figure 4, Figure 7. It is theorized that at one point the steam had an active head cut and incision occurred, then over time the channel carved new floodplain to balance equilibrium. And some point the ponds were installed and changed the how the valley functioned to how it sits today. Near the Development a blockage of a road, Figure 5, has affected the hydrology and downstream there is another large pond. Towards the end of the reach, we still see channel migration into high terrace banks but do appear to have more floodplain access and less confinement.

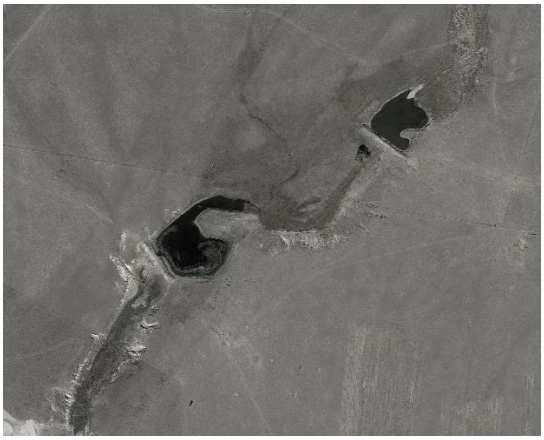


Figure 3, 4 – Upper Reach Ponds and Down Valley Migration Example

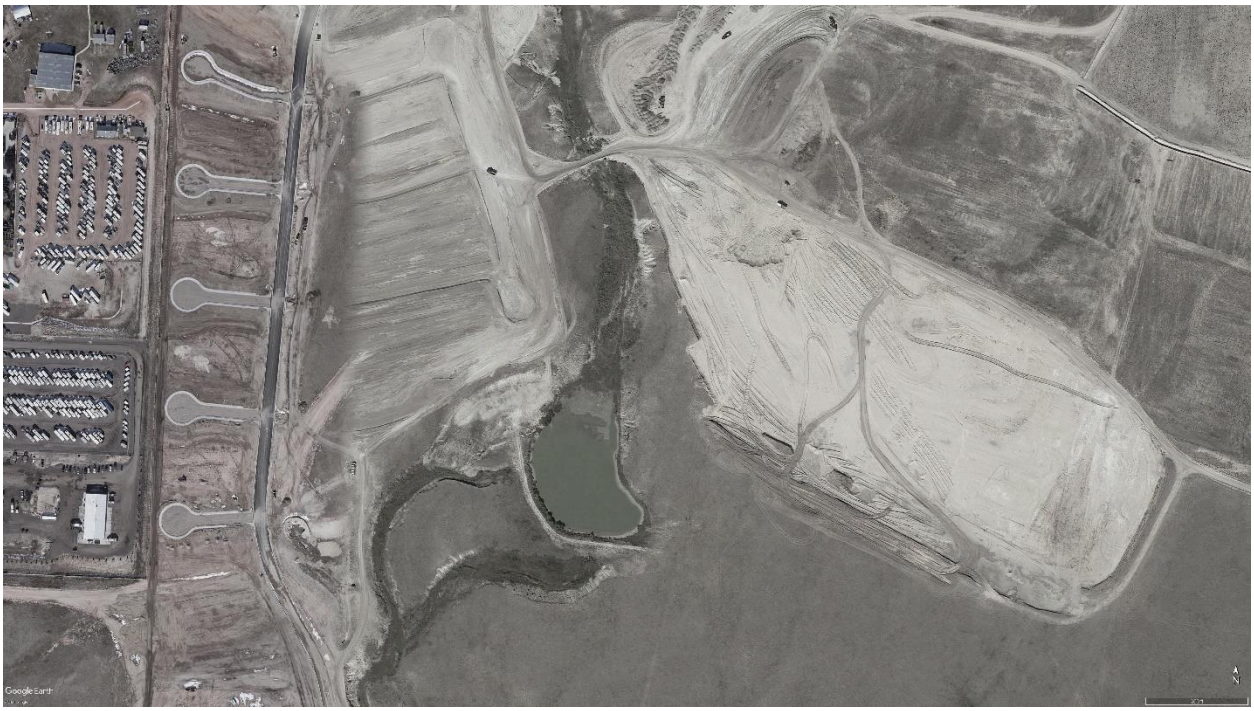


Figure 5 – Road Detention and Pond #3

Existing cross-sections though the site show increased channel incision (disconnection from floodplains) and low bank heights reaching as high as 12ft. the average slope thought the reach is 0.016 ft/ft. The existing channel sinuosity, or stream length/valley length, is nearly 1.2.

Figure 6 – Start of Reach – Unconfined

Figure 7 – DW Pond #2 Confined Valley

Figure 8 – Willows in Riparian Zone

Figure 9 – Confined Valley, Limited Bank Erosion

Figure 10 – Down Valley Migration

Figure 11 – Headcut

Figure 12 – High Terrace with open floodplain towards end of project

Bankfull Channel Dimensions

USGS StreamStats (https://streamstats.usgs.gov) was used to evaluate the drainage area, in square miles (A) and mean annual rainfall, in inches per year, for the reaches. The mean annual rainfall and drainage area used for upper and lower limits are 19.84 inches/year and 2.6 square miles at the start and 3.4 square miles at the end of the project reach. From the existing conditions survey, cross-sections were analyzed using in field bankfull calls thought the reach and are listed in the table below:

Table 1 - Existing Bankfull Dimensions

	XS STA	Area (sq mi)	WBKF (ft)	DBKF	ABKF (sq ft)	W/D	Entrenchment Ratio	Stream Type
1	97	2.62	15.6	0.58	9	27	1.46	B
6	927	2.75	24.9	0.33	8.09	75	<5	C
7	1725	2.86	16.7	0.59	9.84	28	1.61	B
13	4770	3.21	20.5	0.62	12.7	33	1.52	B
17	6612	3.35	29.2	0.36	10.6	81.11	1.72	B
21	9940	3.48	22.2	0.71	15.9	31.27	2.78	C

From this data, a local mini-regional curve was also used to evaluate the validity of 1) compared to expected watershed response factor (WRF) using the Southwest Regional Curve intercept graph and 2) compared to other local curves collected thought the front range for suggested bankfull areas. Typically, there is a high correlation between the bankfull cross-sectional area and the associated drainage area. This is evident for this mini-regional curve.

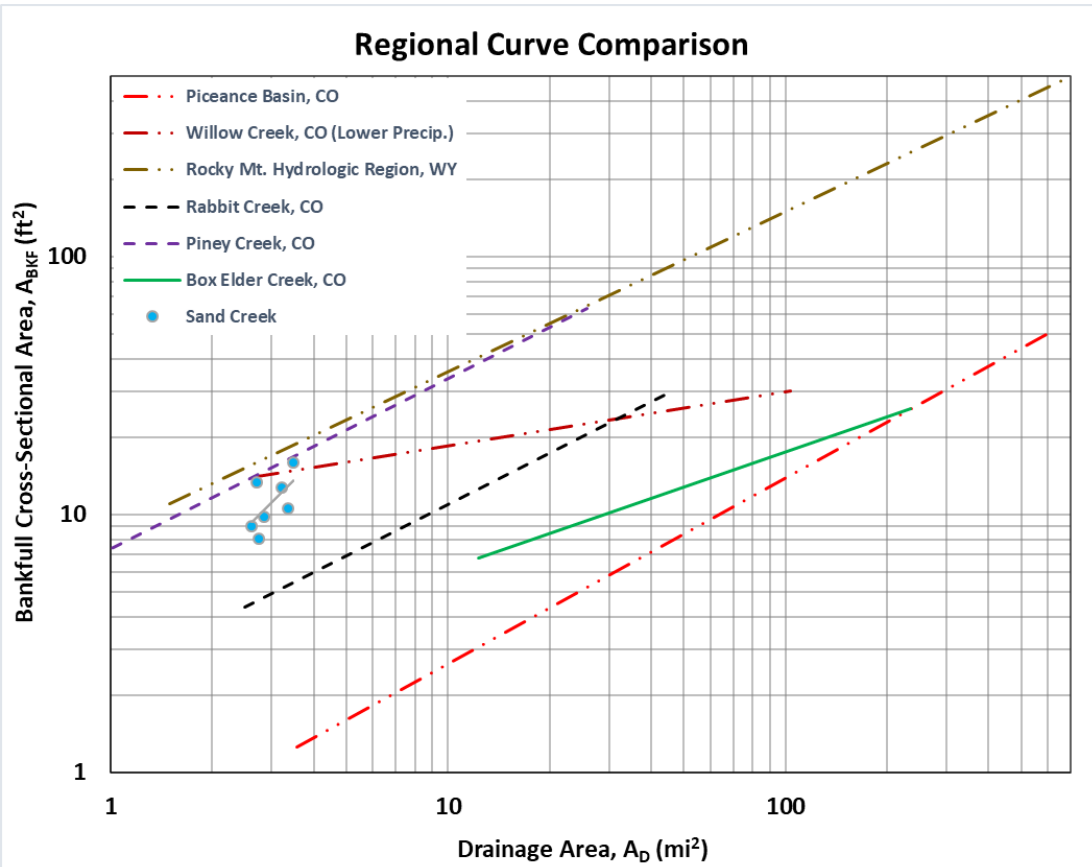


Figure 13 – Regional Curve Comparison.

Using the Southwest Regional Curve Intercept graph (Error! Reference source not found.) to relate the mean annual rainfall to the cross-sectional area y-intercept, a.k.a. watershed response factor (WRF), along with field observations and measurements, a WRF of 7.9 was used to calculate the recommended bankfull cross-sectional area, A_{BKF}, for the reaches.

$$A_{BKF} = WRF * DA^{0.67}$$

Reference design bankfull width-to-depth ratios (WDR_{BKF}) between 18 and 22 should be evaluated for the channel design. The WDR is defined as the bankfull width (W_{BKF}) divided by the mean depth of the bankfull cross-section d_{BKF}.

$$WDR = \frac{W_{BKF}}{d_{BKF}}$$

Using the WDR the recommended design bankfull widths can be calculated using:

$$W_{BKF} = \sqrt{WDR * A_{BKF}}$$

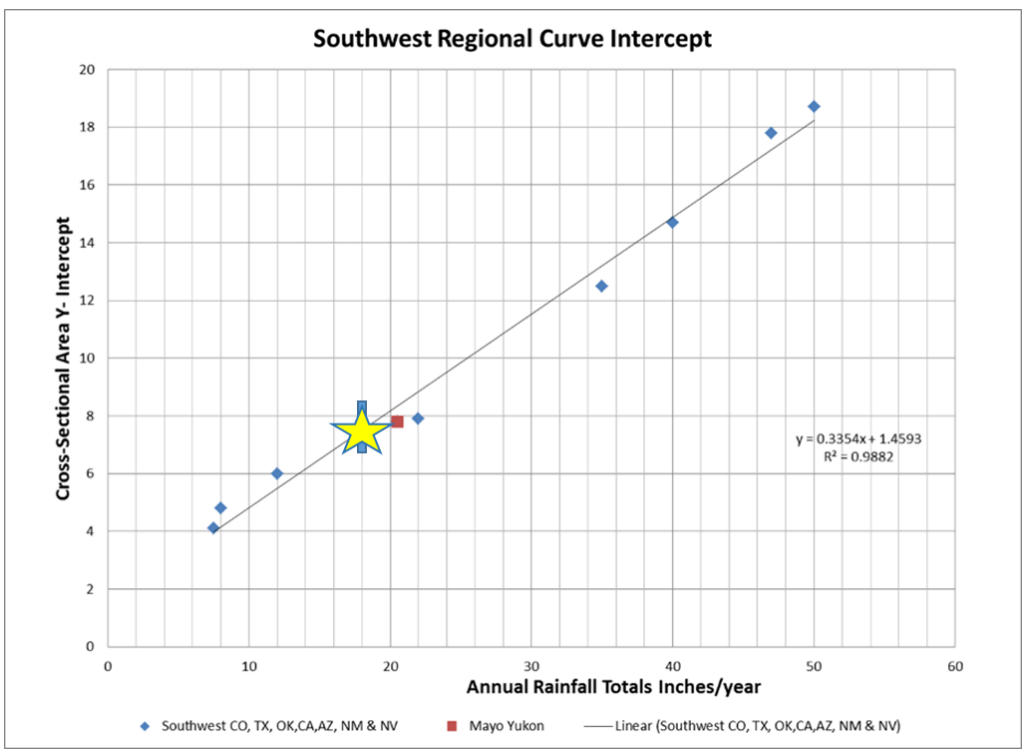


Figure 14 – Southwest Regional Curve Intercept.

Bankfull cross-sectional areas ranging from approximately 8 to 15 square feet were observed on-site with a degree of uncertainty, but for the most part fell within range of what we would expect.

MCDA Alternative Analysis

Design Alternatives Analysis

The design alternative analysis was done using the Multi-Criterial Decision Analysis (MCDA), the MCDA is a scoring system that compares the different design alternatives based on the goals and objectives of the project. For Sand Creek the goals are to reduce maintenance, enhance ecosystem and habitat, reduce sediment transport, and increase channel stability while reducing the risk of further degradation. For this project four alternatives are considered:

Alternative 1: Do nothing

The do-nothing alternative sees what is going to happen if no action it is taken for stream restoration, for Sand Creek these means further erosion of the banks, movement of the channel trajectory overtime, and increase in risk of damaging private property with increased flows dure to the proposed development. The initial capital cost for this alternative is nothing but the maintenance cost would be the maximum potential cost.

Alternative 2: Priority II restauration with 700ft with floodplain

The priority II restoration main objective is to widen the floodplain at the existing channel elevation to reduce shear stress. For Sand Creek this means that the channel width/floodplain would be about 700ft in order maintain shear stress to about 1.2 lbf/ft^2, the increase of the channel width will happen in 4 stages (Inner berm, Bankfull, Flood Terrace, and Floodplain) (Figure 5). Priority II restauration produces very stable streams however it requires more floodplain grading, some structures and periodic maintenance making this this alternative more expensive compared to priority I or II. Priority III restoration for Sand Creek comes with a few challenges, one of them being the confinement of the channel between two urban areas, limiting the channel width to about 200 to 300 ft, making the shear stress grader than 1.2 lbf/ft^2, due to the higher shear stress the channel restauration would requiring more structures to stabilize the banks to reduce the risk of bank erosion. The initial capital construction, design and permitting cost for this 10,800ft reach would be 4.9 Million dollars with the low maintenance cost of less $2,000/year.

Alternative 3: Priority II four stages channel with 1-2ft floodplain drops.

Alternative 3 restoration for Sand Creek it is the same as alternative 2 with the difference that instead of increasing the floodplain width to 700ft, alternative 3 will take into consideration the current channel dimensions and fit the channel design with 4 stages with 1 – 2 ft drops, however, due to the constrains of the channel dimensions, more structure would be needed to stabilize banks. 5SSR's assumption is that is some areas the available floodplain width may only be 200ft. With an approximate 200ft floodplain this would require channel slope of .006 ft/ft to obtain 1.2lb/ft and would also require around 100 - 1ft riffle drops to make up for the project reach. The design could have a riffle/drop structure as close as every 100ft. This alternative also has assumed 2 smaller stock ponds and 1 larger pond online with Sand Creek will remain with the proposed development. This alternative requires less floodplain grading than Alternative 2 but will be more costly due to importing more boulders for structures and

grade control. The initial capital construction, design and permitting cost for this 10,800ft reach would be 6.3 Million dollars with the low maintenance cost of less $2,500/year.

Alternative 4: Priority II/III channel realignment as needed and rip rap floodplain protection and bank stabilization.

This alternative prioritizes the most vulnerable places along the channel and proposes realignment of the channel where bank erosion could be a risk for private property. In places where stabilization its needed, the banks would be stabilized using sill joint planted rip rap, coir and transplants. This alternative is not ideal however address the main issues of bank erosion of the channel. This alternative would allow the maximum floodplain slope to increase to .016 ft/ft average slope with ~200ft flood width and no drop structures. The applied shear of less than 3psf for this alternative would be higher than the natural stable reference threshold shear for vegetated floodplains in the region. The initial capital construction, design and permitting cost for this 10,800ft reach would be 9.1 Million dollars with the low maintenance cost of less $3,600/year.

Table 2: MCDA matrix table

			Option #1	Option #2	Option #3	Option #4
			Do nothing	Priority II - Stabilize Banks with Coir, River NCD Structures and Regrade Floddplain to 700ft	Priority II - Stabilize Banks with Coir, River NCD Structures and Regrade Floodplain 1-2ft drops to fit into design	Priority III - Realignment as needed stabilize banks with sill joint planted rip rap, coir and transplants
		Concept Option Description				
Reduce Maintenance	Sustainability and Robustness	2	4	1	2	3
	Minimize the need for future maintenance	1	4	1	2	3
Ecosystem and Habitat Enhancements	Habiatat Improvements	2	5	2	2	3
	Ecological Resiliency	3	5	1	3	3
	Floodplain Restoration and Connectivity	3	4	1	3	4
Sediment Reduction and Stabilization	Reduction of Bank Erosion and Lateral Bank Migration	1	4	1	3	3
	Minimize Vertical Instabilty by adding needed grade control	2	5	1	3	3
	Sustainable Sediment Transport Balance	2	4	1	2	2
Risk Reduction	No Increase in Liability to Funders	2	3	1	3	3
	No Rise in Flood Stage or Flood Stage Reduction (No CLOMR and LOMR project requirements)	4	1	1	2	1
	Protect and not disturb the cultural resource area.	5	1	3	2	2
	Engineering Design Life Spand and Risk Reduction	5	5	1	3	4
	Minimize disturbance as required by permit conditions of the existing USACE NWP 27 and the Preble's Mouse	4	1	4	3	2
	MCDA Matrix Score		115	60	92	97
	MCDA RANKING		4	1	2	3

Performance Standards and Design Recommendations

Reference dimensionless ratios, based on the valley type, channel slopes, and region, informed the recommended pattern design of each of the reaches based on the proposed bankfull width. Pool-to-pool spacing recommended to be between 4.5 to 6.0 times the W_{BKF}. Radius of curvatures are recommended to be 2.5 to 3.5 times W_{BKF}. Riffle lengths are recommended to be between 1.5 to 2.5 times W_{BKF}. Meander wavelengths are recommended to be between 9 and 12 times W_{BKF}. Channel belt widths are recommended to be between 2 and 3.5 times W_{BKF}. For Sand Creek, it is recommended that a multi stage channel be designed that includes an Inner Berm feature, Bankfull Feature, Floodplain Terrace, and a 10 and 100-year bench to handle flood flows and reducing shear stresses to around 1.2 lb/sqft.

Bankfull Design

Using the existing conditions site values as well as regional curve information from other locations it is determined to size the channel with a bankfull area of 14sq ft, bankfull width of 17ft and mean depth of 0.71 ft. The low flow should account for 33% of the bankfull area.

Floodplain Design

The area for flood terraces for each of the reaches is recommended to be designed to approximately 300% of the A_{BKF}. The flood terrace width-to-depth ratio (WDR_{FLTR}) is recommended to be three times that of the WDR_{BKF}.

JRE provided 100-year flows for each of the reaches for the ultimate buildout condition. Floodplain widths and depths were designed to accommodate the estimated 100-year peak flood assuming a 100-year design shear stress not to exceed 1.2 pounds per square foot. Discharge and velocity estimates were calculated assuming a manning's "n" of 0.055. Width required for this alternative would require close to 700ft of floodplain, which is most likely not an option. Other design alternatives such as using drop structures to manage the slope was evaluated to keep the shear at 1.2 assuming a maximum width of 200ft. The alterative of looking at the max shear based on a 200ft floodplain width was also evaluated for consideration of design for a steeper slope.

Drop Structures Evaluation

The use of drop structures maybe required to reduce channel slope where proposed corridor widths make it implausible to construct a floodplain wide enough to convey the 100-year discharge while staying below the 100-year design shear stress. The concepts evaluated for using drops in each of these reaches will need to be further evaluated to ensure that the channel designs fit the landscape. The concepts should also be optimized, potentially reducing the required channel/floodplain corridor.

Design Considerations

100-year floodplain design assumes that vegetation at each of the reaches can provide stability up to an applied shear stress of 1.2 psf. Bank stabilization can be used to reduce risk to areas that the applied shear stress nears, exceeds, or is expected to exceed 1.2 psf.

Common treatment methods based on shear are listed as follows:

- 0 – 1 psf - Treatment Seed and Straw with Riparian Plantings
- 1 –1.4 psf – Treatment Floodplain Coir Matting / Seed and Straw with Riparian Plantings
- 1.5 – 2.5 psf - Treatment Floodplain Boulder/ Log Sills, Floodplain Coir Matting / Seed and Straw with Riparian Plantings
- 2.6 – 4.0 psf - Treatment Floodplain Vegetated Rip-Rap, Floodplain Coir Matting / Seed and Straw with Riparian Plantings

Riffle grade control structures are being recommended to stabilize channel grade throughout the design. Where cascade riffles are not utilized, augmenting each of the riffles with 4 to 8-inch riprap is recommended to reduce the risk of scour at the riffles. This is particularly important at regions downstream of "clear water" discharge points or where threshold riffle design, a riffle with minimal movement, is required. The 4-8-inch riprap will be stable in-place for all design discharges that have an applied shear stress less than 1.2 psf. **Figure 15** shows the Shield's/Rosgen Entrainment Function used for sizing particles for applied shear stress.

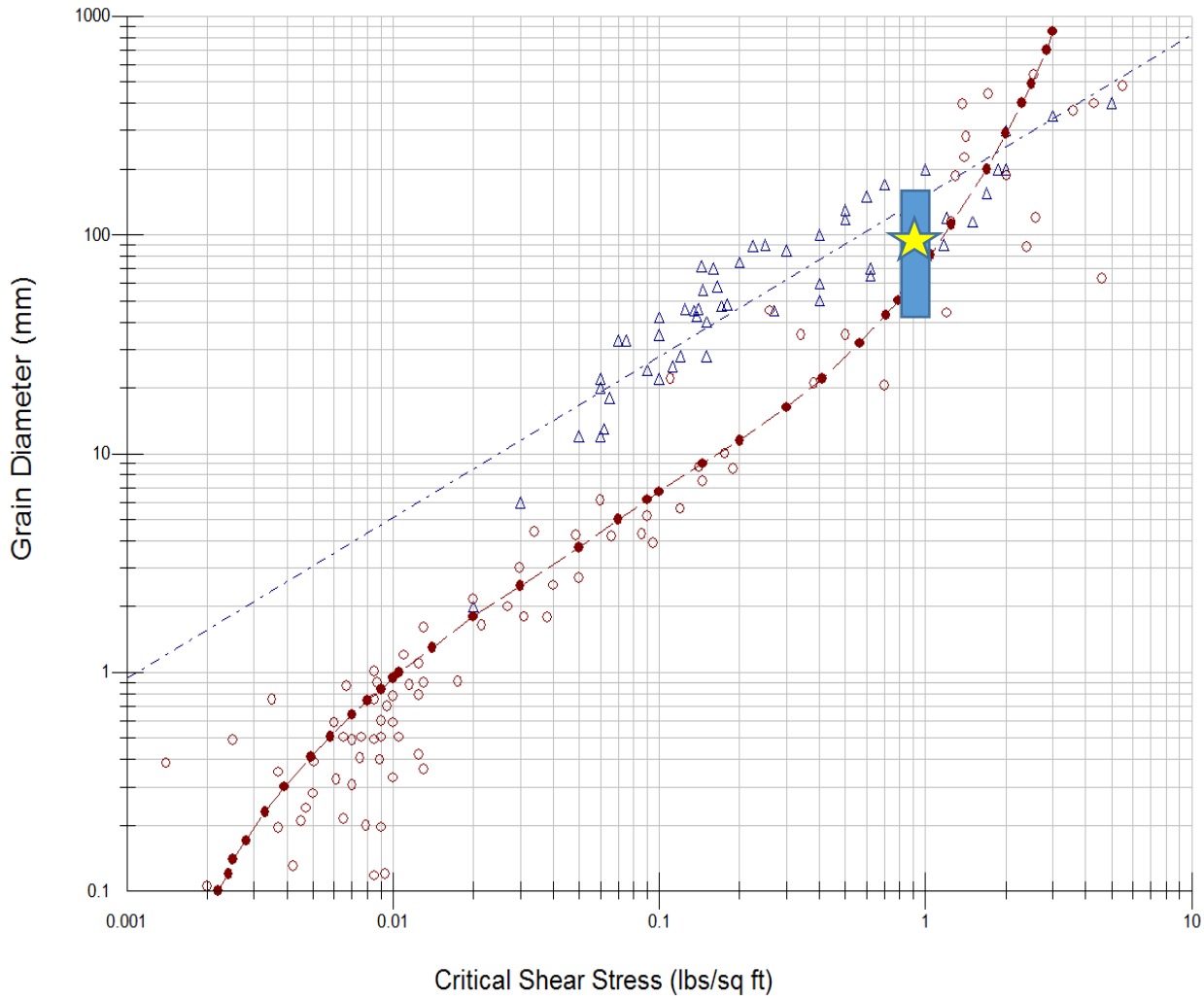


Figure 15: Shield's/Rosgen Entrainment Function. The red trendline shows the Shields function, while the blue trendline shows Rosgen function.

Joint planted riprap is recommended at the terminus of the project reach for scour protection at the catchment pond. The in-line pond outlet structure design required for the successful implementation of Alternatives 2-4 has not been investigated at this time. This report is to serve as a conceptual reconnaissance level geomorphic assessment. The later design process will require a greater detail of investigation and analysis. The 5SSR team has assumed that the

Potential Structures In-streams Structures

Gravel Constructed Riffle

Gravel constructed riffles utilize immobile gravel in the riffle section of the channel. Gravel armors the channel, increases channel roughness, provides grade control, and promotes macroinvertebrate habitat. Gravel augmented riffles promote channel stability in high shear stress situations within perennial channels. All gravel riffles would designed to a threshold shear of 1.2psf with gravel having a D50 exceeding 100mm and a D84 exceeding 180mm.

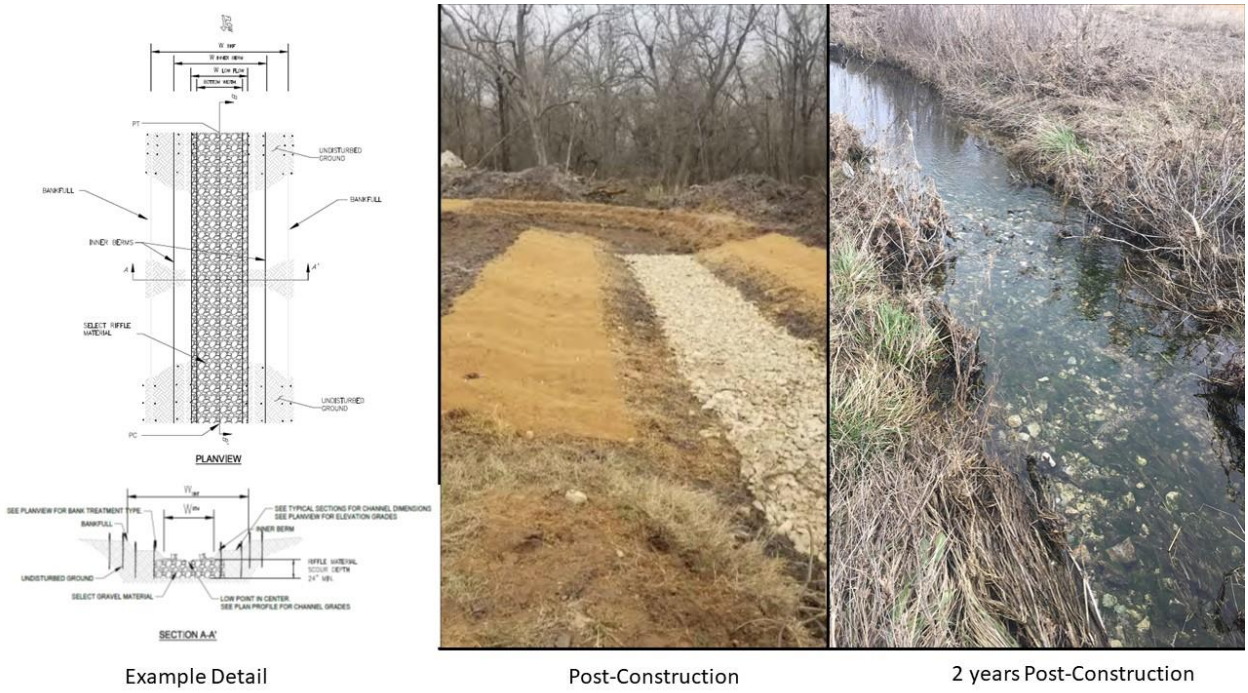
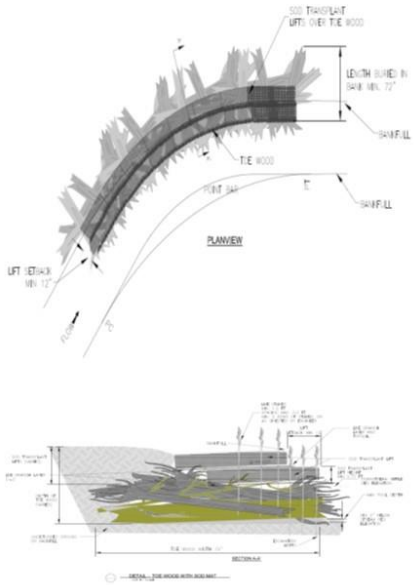


Figure 1: Gravel Constructed Riffle

Toe wood Bank Stabilization

Toe wood structures incorporate native woody material into a submerged undercut bank to replicate natural stream banks. The structure consists of large woody debris such as logs, branches, brush, and roots buried at the bankfull bench. The bottom layer consists of woody debris and soil as fill. Root wads are placed to cantilever foundation logs; the root wads protrude from the stream bank, protecting it from the shearing force of flow. Filler materials such as small logs, limbs, and tree branches are placed on the second layer. The top layer consists of backfill with overlying coir-wrapped soil lifts and live stakes. Toe

wood can be placed along the geomorphic channel streambanks. When placed in the outside meander bank, toe wood helps protect it from lateral migration and subsequent bank erosion while promoting revegetation. Toe wood is also a cost-effective stream stabilization method, as it reuses woody material harvested from site clearing. There is a possibility with later design phases that the wood toe stabilization could be substituted by hay bales for cost reduction or coir lifts if wood is unavailable.



Example Detail

Post-Construction

2 years Post-Construction

Figure 2: Toe Wood and Bank Stabilization

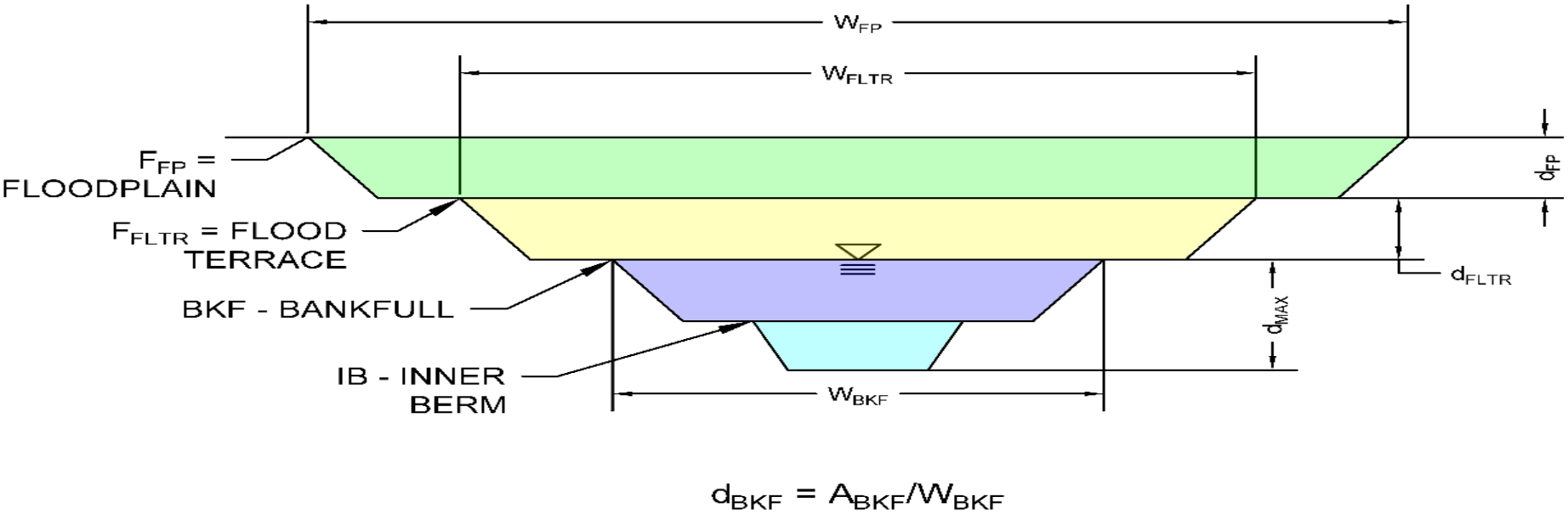


Figure 18 Typical riffle (tangent section) channel cross-section and channel acronyms.

Table 3: Performance Standard

Reach #	Rainfall	Reach Name	Watershed Area	Existing Reach Drop	Existing Reach Length	Existing Reach Slope	Regional Relationship	Assumed Bankfull Velocity	Design Bankfull XS Area	Design Bankfull WDR	Design Bankfull XS Width	Design Pool-Pool Spacing Ratio	Design Pool-Pool Spacing	% Flood Terrace Channel	Design Flood Terrace Area	Design Flood Terrace WDR	Design Flood Terrace Width	Depth for Offset	% Low Flow Channel	Design Inner Berm	Design Inner Berm WDR	Design Inner Berm Width	100-yr Design Discharge	100-yr Design Shear Stress	100-yr Design Average Depth	100-yr Floodplain Velocity	100-yr Floodplain Area	100-yr Floodplain Width	Min Riffle Substrate D84	Min Riffle Substrate D50	Min. Design Scour Depth of Riffles
1	19.84	R1	2.4	46.47	2286	0.020	8.11	3	14.59	20	17.08	4	68.32	3	43.76	60	51.24	0.85	0.3	4.38	16	8.37	2620	1.2	0.95	3.41	768.01	811.83	6.84	3.71	17.11
2	19.84	R2	2.9	59.51	3840	0.015	8.11	3	16.56	20	18.20	4	72.79	3	49.68	60	54.59	0.91	0.3	4.97	16	8.92	2620	1.2	1.24	3.57	733.39	591.01	6.84	3.71	17.11
3	19.84	R3	3.4	43	3600	0.012	8.11	3	18.42	20	19.19	4	76.78	3	55.26	60	57.58	0.96	0.3	7.74	16	11.13	2620	1.2	1.61	3.73	701.63	435.79	6.84	3.71	17.11
ALT 1	19.84	ALT 3	2.4	43	3600	0.016	8.11	3	14.59	20	17.08	5	85.40	3	43.76	60	51.24	0.85	0.3	4.38	16	8.37	2620	1.2	1.20	3.55	737.38	613.50	6.84	3.71	17.11
ALT 3	19.84	ALT 3	2.4	43	3600	0.006	8.11	3	14.59	20	17.08	5	85.40	3	43.76	60	51.24	0.85	0.3	4.38	16	8.37	2620	1.2	3.13	4.18	626.56	200.00	6.84	3.71	17.11
ALT 4	19.84	ALT 4	2.4	43	3600	0.016	8.11	3	14.59	20	17.08	4	68.32	3	43.76	60	51.24	0.85	0.3	4.38	16	8.37	2620	2.26	2.26	5.43	482.49	213.15	10.90	7.18	27.24

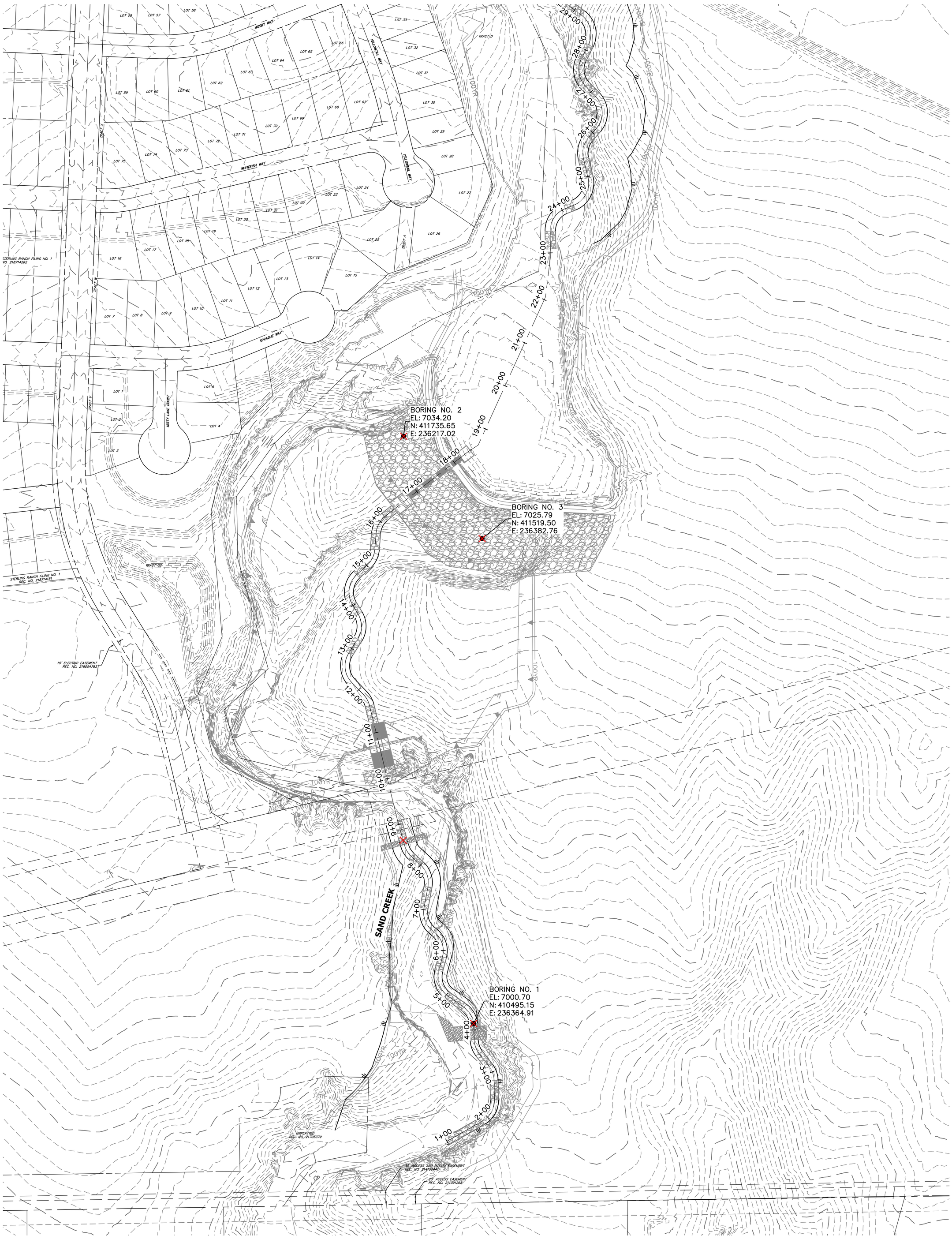
Table 4: Channel alternatives

WS (ft)	Depth Y (ft)	XS Area (ft2)	Top Width (ft)	V (ft/s)	Hydraulic Depth (ft)	Hydraulic Radius (ft)	Shear Stress	Stream Power	Slope (ft/ft)	Q (cfs)	Alternative
97.33	0.68	4.32	12.90	1.01	0.33	0.33	0.13	0.13	0.006	4.36	IB-ALT3
98.00	1.35	14.29	16.85	1.85	0.85	0.83	0.32	0.59	0.006	26.44	BKF-ALT3
98.96	2.31	66.83	57.62	2.30	1.16	1.15	0.43	1.00	0.006	153.52	FLD TERRACE ALT3
100.03	3.38	267.60	191.36	2.62	1.40	1.39	0.52	1.37	0.006	700.00	Q10 - ALT3
101.74	5.09	603.92	201.55	4.34	3.00	2.97	1.12	4.87	0.006	2620.00	Q100 -ALT3
99.66	3.02	198.45	189.28	3.53	1.05	1.04	1.05	3.69	0.016	700.00	Q10 - ALT4
100.94	4.30	445.58	196.98	5.88	2.26	2.25	2.26	13.28	0.016	2620.00	Q100 - ALT4
99.38	2.73	313.05	593.57	2.24	0.53	0.53	0.53	1.18	0.016	700.00	Q10 - Alt 2
100.01	3.37	692.92	597.18	3.78	1.16	1.16	1.16	4.38	0.016	2620.00	Q100 Alt 2

SAND CREEK RESTORATION

STERLING RANCH, CO

GEOTECHNICAL BORING LOCATIONS



N

100 50 0 100

ORIGINAL SCALE: 1" = 100'

GEOTECHNICAL BORING
LOCATIONS
SAND CREEK RESTORATION
JOB NO. 25188.04
1/28/22
SHEET 1 OF 3

J·R ENGINEERING
A Westrian Company

Centennial 303-740-9393 • Colorado Springs 719-593-2593
Fort Collins 970-491-9888 • www.jrengineering.com

SAND CREEK RESTORATION

STERLING RANCH, CO

GEOTECHNICAL BORING LOCATIONS

GEOTECHNICAL BORING
LOCATIONS
SAND CREEK RESTORATION
JOB NO. 25188.04
1/28/22
SHEET 2 OF 3

100 50 0 100
ORIGINAL SCALE: 1" = 100'

J·R ENGINEERING
A Westrian Company

Centennial 303-740-9393 • Colorado Springs 719-593-2593
Fort Collins 970-491-9888 • www.jrengineering.com

SAND CREEK RESTORATION

STERLING RANCH, CO

GEOTECHNICAL BORING LOCATIONS

N

100 50 0 100

ORIGINAL SCALE: 1" = 100'

GEOTECHNICAL BORING
LOCATIONS
SAND CREEK RESTORATION
JOB NO. 25188.04
1/28/22
SHEET 3 OF 3

J·R ENGINEERING
A Westrian Company

Centennial 303-740-9393 • Colorado Springs 719-593-2593
Fort Collins 970-491-9888 • www.jrengineering.com

ENTECH
ENGINEERING, INC.
505 ELKTON DRIVE
COLORADO SPRINGS, CO 80907
PHONE (719) 531-5599
FAX (719) 531-5238

SUBSURFACE SOIL INVESTIGATION
STERLING RANCH
SAND CREEK CHANNEL IMPROVEMENTS
COLORADO SPRINGS, COLORADO

Prepared for

C&C Land
20 Boulder Crescent 2nd Floor
Colorado Springs, Colorado 80903

Attn: Chaz Collins

April 5, 2022

Respectfully Submitted,

ENTECH ENGINEERING, INC.

Stuart Wood
Geologist

Reviewed by:

COLORADO LICENSED
AUSTIN M. NOSSOKOFF
53477
4-5-22
PROFESSIONAL ENGINEER

Austin M. Nossokoff P.E.

AMN/el

Encl.

Entech Job No. 211647
AAprojects/2021/211647 ssi

Table of Contents

1.0 INTRODUCTION 1
2.0 PROJECT AND SITE DESCRIPTION 2
3.0 SUBSURFACE EXPLORATIONS AND LABORATORY TESTING 2
4.0 SUBSURFACE CONDITIONS 3
4.1 Soil and Rock 3
4.2 Groundwater 4
5.0 GEOTECHNICAL EVALUATION AND RECOMMENDATIONS 5
5.1 Shallow Foundation Parameters 5
5.2 Bearing Capacity/Lateral Pressures 6
5.3 Concrete 7
5.4 Structural Fill 7
5.5 Winter Construction 7
5.6 Construction Observations 8
6.0 CLOSURE 8

TABLE

Table 1: Summary of Laboratory Test Results

FIGURES

Figure 1: Site Vicinity Map
Figure 2A: Site Plan/Test Boring Map
Figure 2B: Site Plan/Test Boring Map
Figure 2C: Site Plan/Test Boring Map

APPENDICES

Appendix A: Test Boring Logs
Appendix B: Laboratory Test Results

SUBSURFACE SOIL INVESTIGATION
STERLING RANCH
SAND CREEK CHANNEL IMPROVEMENTS
COLORADO SPRINGS, COLORADO

1.0 INTRODUCTION

C&C Land is planning the construction of four drop structures and improvements to two pond embankments along Sand Creek in the Sterling Ranch Subdivision. The project site is located east of Vollmer Road and northeast of the proposed Marksheffel Drive in Colorado Springs, Colorado. A Vicinity Map is presented in Figure 1. The Site Plan/Test Boring Location Map, Figure 2 indicates the approximate project location and test boring locations.

This report describes the subsurface conditions encountered in test borings drilled in the vicinity of the proposed drop structures and embankment dams and provides recommendations for design and construction. The subsurface investigation for the channel improvements consisted of drilling eight borings placed along the channel, one in the vicinity of each drop structure and two at each proposed embankment location, collecting samples of soil from the borings, performing laboratory tests on selected samples and conducting a geotechnical evaluation of the investigation findings. Drilling and subsurface investigation activities for the test borings were performed by Entech Engineering, Inc. (Entech). The contents of this report, including the geotechnical evaluation and recommendations, are subject to the limitations and assumptions presented in Section 6.

2.0 PROJECT AND SITE DESCRIPTION

It is Entech's understanding that the project will consist of the construction of four drop structures and pond embankment improvements for 2 holding ponds and associated channel improvements. Adjacent properties consist of future residential parcels and existing residential parcels. At the time of drilling, water was flowing in the channel. The channel flows to the southwest towards Colorado Springs.

3.0 SUBSURFACE EXPLORATIONS AND LABORATORY TESTING

The subsurface conditions on this site were investigated by drilling eight exploratory test borings. Four of the test borings were placed adjacent to the proposed location of each drop structure and two were placed adjacent to two separate pond embankment locations. The locations of the test borings are indicated on the Site/Test Boring Location Map, Figure 2. Test boring locations were staked by JR Engineering. Test Boring No. 6 was moved to the top of the embankment. The test borings were advanced with a power-driven continuous-flight auger-drilling rig to depths of 15 to 30 feet. Samples were obtained during drilling using the Standard Penetration Test, ASTM D-1586, utilizing a California sampler. Results of the Standard Penetration Testing (SPT) are included on the boring logs in terms of N-values expressed in blows per foot (bpf). Soil samples recovered from the borings were visually classified in the field and described on the boring logs. The field classifications were later verified using laboratory testing and grouped by soil type. The soil types (identified by number) are included on the boring logs. The Test Boring Logs are presented in Appendix A.

Water content testing (ASTM D-2216) was performed on samples recovered from the borings and the results are shown on the boring logs. Grain-Size Analysis (ASTM D-422) and Atterberg Limits testing (ASTM D-4318) were performed on selected samples to assist in classifying the materials encountered in the borings. Volume change testing was performed on selected samples using Swell/Consolidation and FHA swell tests in order to evaluate potential expansion/compression characteristics of the soil. Soluble sulfate testing was performed on samples of soil to evaluate the potential for below grade degradation of concrete due to sulfate attack. The laboratory testing results are summarized on Table 1 and are presented in Appendix B.

4.0 SUBSURFACE CONDITIONS

Two soil types and one bedrock type were encountered in the borings drilled for the proposed drop structures and embankments: Soil Type 1: native slightly silty to silty to clayey sand and silty to very silty sand fill (SM, SM-SW, SC), Soil Type 2: native sandy to very sandy clay (CL), and Soil Type 3: slightly silty to very silty sandstone bedrock (SM, SM-SW). The soil was classified using the results of the laboratory testing and the Unified Soil Classification System (USCS). Observations for groundwater presence were made in each of the boreholes following completion of drilling.

4.1 Soil and Rock

Soil Type 1 classifies as native slightly silty to silty to clayey sand and silty to very silty sand fill (SM, SM-SW, SC). The fill soils are from an existing earthen dam at Test Boring No. 6. The sand was encountered in all of the test borings from the existing ground surface and at 3 feet bgs in Test Boring No. 3 and extending to depths of 4 to 19 feet below ground surface (bgs). Standard Penetration Testing resulted in N-values of 4 to 26 bpf, indicating loose to medium dense states. Water content and grain size testing resulted in approximately 6 to 20 percent water content and approximately 11 to 40 percent of the soil size particles passing the No. 200 sieve. Atterberg Limits testing on the sand resulted in no values. Swell/Consolidation Testing on a sample of silty sand from Test Boring No. 1 and 8 at depths of 10 and 15 feet resulted in volume changes of 0.1 and 0.0 percent, respectively, indicating a low potential for expansion or consolidation. FHA swell testing on a sample of the very clayey sand resulted in a swell pressure of 120 psf, indicating low expansion potential. Sulfate testing performed on samples of the sand resulted in less than 0.01 percent sulfate by weight, indicating the sand exhibits negligible potential for concrete degradation due to below grade sulfate attack.

Soil Type 2 classifies as a native sandy to very sandy clay (CL). The clay was encountered in Test Boring Nos.3 and 6 at the ground surface in Test Boring No. 3 and 19 feet bgs in Test Boring No. 6 and extending to 3 or up to 24 feet bgs. Standard Penetration Testing resulted in N-values of 9 and 14, indicating firm consistencies. Water content and grain size testing resulted in approximately 18 to 25 percent water content and 52.5 to 76.5 percent of the soil size particles passing the No. 200 sieve.

Soil Type 3 classifies as slightly silty to very silty sandstone bedrock (SM, SM-SW). The sandstone was encountered in all of the test borings at a depth of 4 to 24 feet bgs and extended to the termination of borings at 15 to 30 feet bgs. Standard Penetration Testing resulted in N-values of 36 to greater than 50 bpf, indicating dense to very dense states. Water content and grain size testing resulted in approximately 11 to 16.5 percent water content and approximately 6 to 24.5 percent of the soil size particles passing the No. 200 sieve. Atterberg Limits testing on the sandstone resulted in no values. Swell/Consolidation Testing on the sandstone resulted in volume changes of 0.00 to 0.10 percent indicating a low expansion/consolidation potential.

Additional soil descriptions can be seen on the enclosed drill logs. (Appendix A). A summary of the laboratory test results is presented in Table 1. Laboratory results are presented in Appendix B. It should be noted that the soil classification shown on the logs is based on the engineer's visual classification of the samples at the depths indicated. The soil types may vary between samples and locations tested. Also, stratification lines shown on the logs represent the approximate boundary between soil types and the actual transition may be gradual and vary with location.

4.2 Groundwater

Groundwater was encountered in all of the test borings at depths ranging from 2.5 to 9 feet bgs, during and subsequent to drilling. Groundwater will impact construction of the channel improvements and excavations during installation of drop structures and embankment improvements. Dewatering techniques will be required. Creek flow will vary due to variations in rainfall, drainage and other factors not readily apparent at this time. It should be noted that groundwater levels observed at the time of the subsurface investigation could change due to seasonal variations, changes in land runoff characteristics, and future development of nearby areas.

5.0 GEOTECHNICAL EVALUATION AND RECOMMENDATIONS

The following discussion is based on the subsurface conditions encountered in the borings drilled for the channel improvements to be constructed at the location previously described. If subsurface conditions different from those described herein are encountered during construction or if the project elements change from those described, Entech Engineering, Inc. should be notified so that the evaluation and recommendations presented below can be reviewed and revised if necessary.

Subsurface conditions in the channel improvement area consist of silty and clayey sands with some clay lenses overlying silty sandstone bedrock. The bedrock was encountered at 4 to 24 feet bgs in the test borings. It should be noted that Test Boring No. 6 was drilled on top of the existing embankment, which is where the bedrock was encountered at 24 feet. Water was encountered between 2.5 and 9 feet in the test borings. Water was flowing in the channel at the time of the investigation. SPT N-values measured in the soils and bedrock indicated overall medium dense to very dense states with some loose pockets generally encountered near the groundwater table.

Any newly placed fill should be placed according to the “Structural Fill” paragraph. Prior to placing the structural fill, the surface should be scarified, moisture-conditioned and compacted. The structural fill should be moisture-conditioned to within ± 2% of its optimum moisture content to aid in compaction. Density tests should be performed to verify compaction with the first density test performed at subgrade and then when 12 to 18 inches of fill have been placed.

Sheet pile walls constructed in the channel should extend into the bedrock. Concrete cutoff walls should extend into bedrock or be installed over stabilized subgrade.

5.1 Shallow Foundation Parameters

Structures associated with the channel improvements can be supported with shallow foundations resting on native medium dense sand soils, imported structural fill, and sandstone bedrock. It should be noted that due to the shallow groundwater on this site, extensive subgrade improvements are anticipated to support shallow foundations, if installed. The drop structure walls should bear on native medium dense sand soils, imported structural fill, and undisturbed sandstone. Provided the above recommendations are followed an allowable bearing pressure of

2400 for the native medium dense sand soils and imported structural fill and 3500 psf is recommended for the sandstone bedrock.

Entech should observe excavated subgrades to evaluate if the exposed conditions are consistent with those described in this report. Entech should also provide recommendations for overexcavation depth and other subgrade improvements, if necessary, and the need for drain systems and stabilization methods based on the excavation conditions observed at that time.

5.2 Bearing Capacity/Lateral Pressures

The following values are recommended for use in designing below grade foundation walls subjected to unbalanced lateral loads and/or retaining walls that may be associate with this project.

Recommended Design Values – Lateral Loading*

Equivalent fluid density for lateral earth pressure (active case), pcf (sand)	45
Equivalent fluid density for lateral earth pressure (active case), pcf (saturated)	110
Equivalent fluid density for lateral earth pressure (passive case), pcf	250
Soil density (loose sand and gravel), psf	115
Soil density (compacted sand and gravel), psf	125
Angle of Internal Friction (loose sand), degrees	28
Angle of Internal Friction (compacted sand), degrees	34
Coefficient of sliding between concrete and sand/gravel	0.35

*Note: The passive pressure should be evaluated for site-specific conditions. The above lateral loading design values are for non-expansive, granular backfill conditions with level backslope angles and no surcharge loads. If wall backfill is submerged, water pressures must be taken into account as additional wall loading. If the backfill slope angles are greater than zero degrees, if the backfill is surcharged, or if the backfill is not free draining, the design values must be adjusted to account for additional lateral loading.

Site granular materials should be approved prior to hauling or placement. Granular backfill material should be compacted to a minimum of 95% of its maximum Modified Proctor Dry Density (ASTM D-1557). Granular backfill should be placed at a moisture content of ±2% of its optimum

moisture content. Density tests should be taken on the backfill to verify compaction, at 1-foot intervals.

5.3 Concrete

Type II cement is recommended for concrete at this site. To further avoid concrete degradation during construction it is recommended that concrete not be placed on frozen or wet ground. Care should be taken to prevent the accumulation or ponding of water in the foundation excavation prior to the placement of concrete. If standing water is present in the foundation excavation, it should be removed by ditching to sumps and pumping the water away from the foundation area prior to concrete placement. If concrete is placed during periods of cold temperatures, the concrete must be kept from freezing. This may require covering the concrete with insulated blankets and adding heat to prohibit freezing.

5.4 Structural Fill

Areas to receive fill should have all topsoil, organic material or debris removed. Fill must be properly benched. The surface should be scarified and moisture conditioned to within ±2 percent of its optimum moisture content and compacted to 95 percent of its maximum Modified Proctor Dry Density (ASTM D-1557) for granular soils and 95 percent of its maximum Standard Proctor Dry Density (ASTM D-698) prior to placing new fill. New fill should be placed in thin lifts not to exceed 6 inches after compaction while maintaining at least 95 percent (95 percent for cohesive) of its maximum Modified Proctor Dry Density (ASTM D-1557). Standard (ASTM D-698 cohesive) fill materials should be placed at a moisture content conducive to compaction, usually ±2 percent of Proctor optimum moisture content. The placement and compaction of fill should be observed and tested by Entech Engineering, Inc. Any imported soils should be approved by Entech Engineering, Inc. prior to being hauled to the site.

5.5 Winter Construction

In the event construction of the planned facility occurs during winter, foundations and subgrades should be protected from freezing conditions. Concrete should not be placed on frozen soil and once concrete has been placed, it should not be allowed to freeze. Similarly, once exposed, the subgrade should not be allowed to freeze. During site grading and subgrade preparation, care should be taken to avoid burial of snow, ice or frozen material within the planned construction area.

5.6 Construction Observations

It is recommended that Entech observe and document the following activities during construction.

- Excavated subgrades and subgrade preparation.
- Placement of drains (if installed).
- Placement/compaction of fill material.

6.0 CLOSURE

The subsurface investigation, geotechnical evaluation and recommendations presented in this report are intended for use by C&C Land with application to the planned channel improvements in Sand Creek northeast of proposed Markheffel Road in northeastern Colorado Springs, Colorado. In conducting the subsurface investigation, laboratory testing, engineering evaluation and reporting, Entech Engineering, Inc. endeavored to work in accordance with generally accepted professional geotechnical and geologic practices and principles consistent with the level of care and skill ordinarily exercised by members of the geotechnical profession currently practicing in same locality and under similar conditions. No other warranty, expressed or implied is made. During final design and/or construction, if conditions are encountered which appear different from those described in this report, Entech Engineering, Inc. requests that it be notified so that the evaluation and recommendations presented herein can be reviewed and modified as appropriate.

If there are any questions regarding the information provided herein or if Entech Engineering, Inc. can be of further assistance, please do not hesitate to contact us.

TABLE

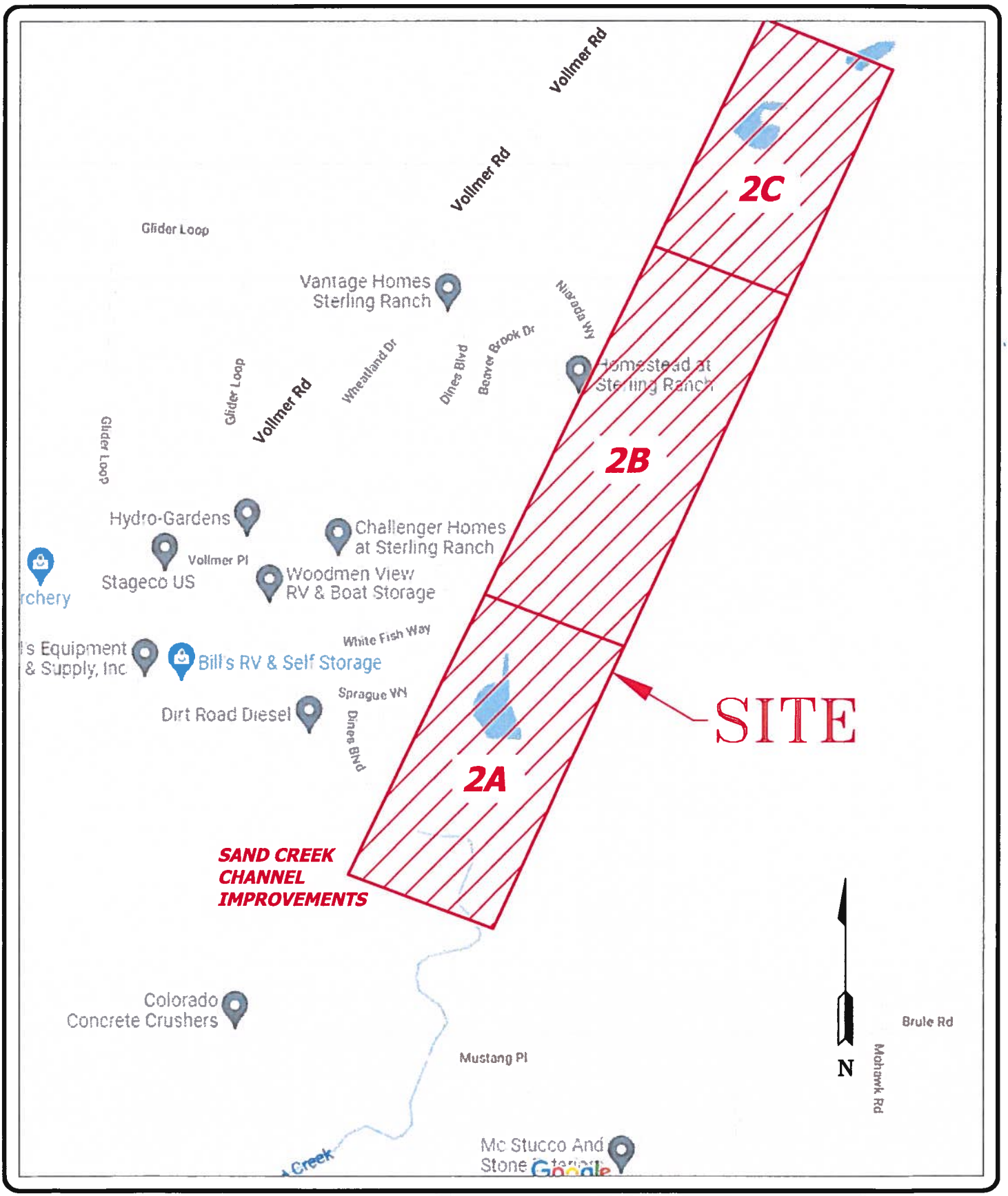
TABLE 1

SUMMARY OF LABORATORY TEST RESULTS

CLIENT C&C LAND
PROJECT CHANNEL IMPROVEMENTS
JOB NO. 211647

SOIL TYPE	TEST BORING NO.	DEPTH (FT)	WATER (%)	DRY DENSITY (PCF)	PASSING NO. 200 SIEVE (%)	LIQUID LIMIT (%)	PLASTIC INDEX (%)	SULFATE (WT %)	FHA SWELL (PSF)	SWELL/ CONSOL (%)	UNIFIED CLASSIFICATION	SOIL DESCRIPTION
1	1	10	12.3	109.3	34.9	NV	NP			-0.1	SM	SAND, SILTY
1	2	5			33.5				120		SM	SAND, SILTY
1	5	2-3			40.1	NV	NP	<0.01			SM	SAND, VERY SILTY
2	3	2-3			76.5						CL	CLAY, SANDY
2	6	20			52.5						CL	CLAY, VERY SANDY
3	1	15			41.4	NV	NP				SM	SANDSTONE, VERY SILTY
3	4	20			24.5	NV	NP				SM	SANDSTONE, SILTY
3	6	25	16.5	112.3	11.8					0.1	SM-SW	SANDSTONE, SLIGHTLY SILTY
3	7	5			6.0						SM-SW	SANDSTONE, SLIGHTLY SILTY
3	8	15	8.3	119.1	10.0					0.0	SM-SW	SANDSTONE, SLIGHTLY SILTY

FIGURES



ENTECH ENGINEERING, INC.
505 ELKTON DRIVE
COLORADO SPRINGS, CO. 80907 (719) 531-5599

VICINITY MAP
SAND CREEK CHANNEL IMPROVEMENTS
EL PASO COUNTY, CO
FOR: C & C LAND

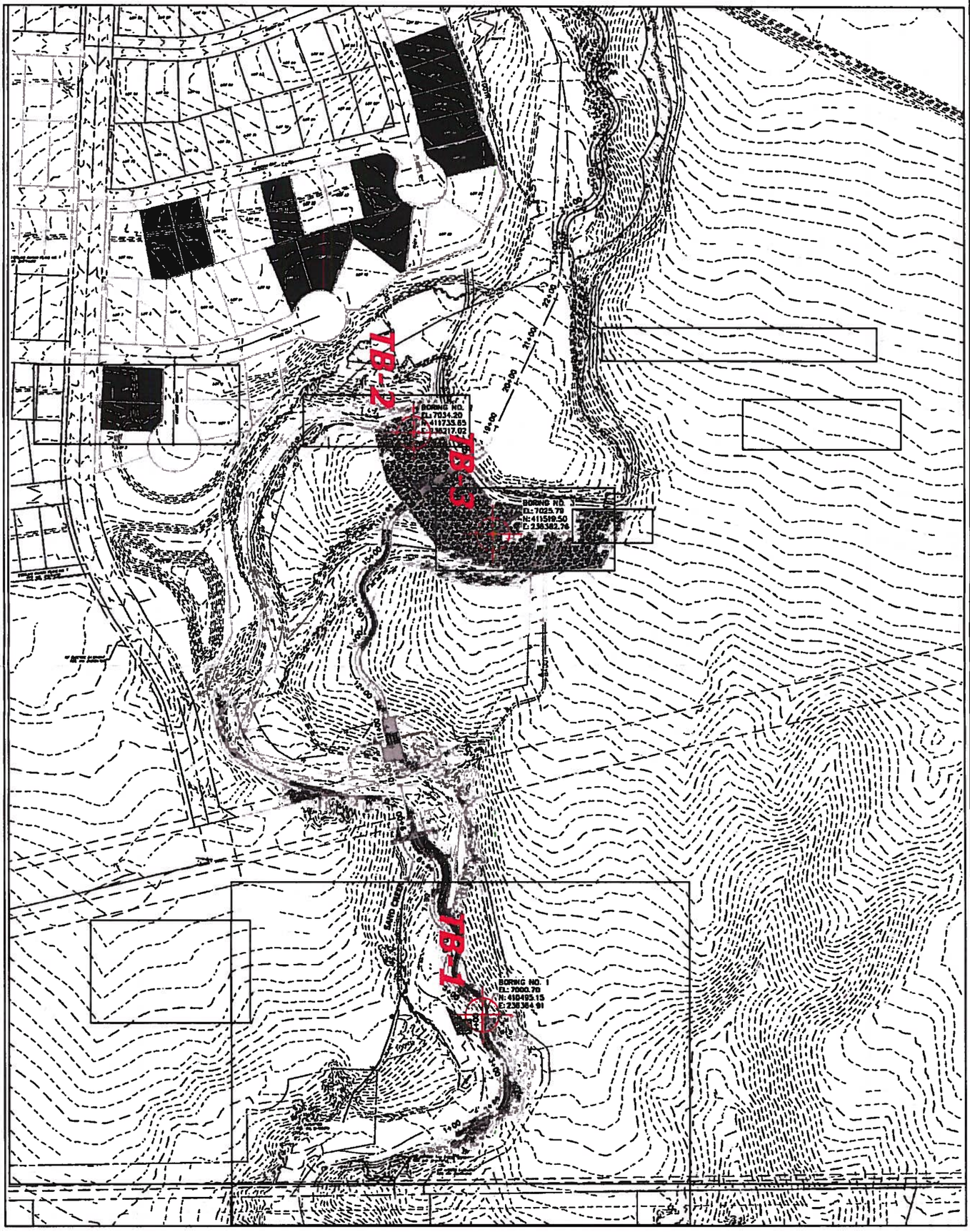
DRAWN:	DATE:	CHECKED:	DATE:
JHR	3/28/22	AMN	3-31-22

JOB NO.: 211647

FIG NO.: 1

STERLING RANCH, CO

GEOTECHNICAL BORING LOCATIONS



TB-2- APPROXIMATE TEST BORING LOCATION AND NUMBER

N

DRAWN BY: JKB	
REVIEWED BY: AMH	
CHECKED BY:	
DATE: 9/24/2022	
SCALE: AS SHOWN	
JOB NO.: 211047	
FIGURE NO.: 2A	

SITE PLAN/TEST BORING MAP
SAND CREEK CHANNEL IMPROVEMENTS
EL PASO COUNTY, CO
FOR: C & C LAND

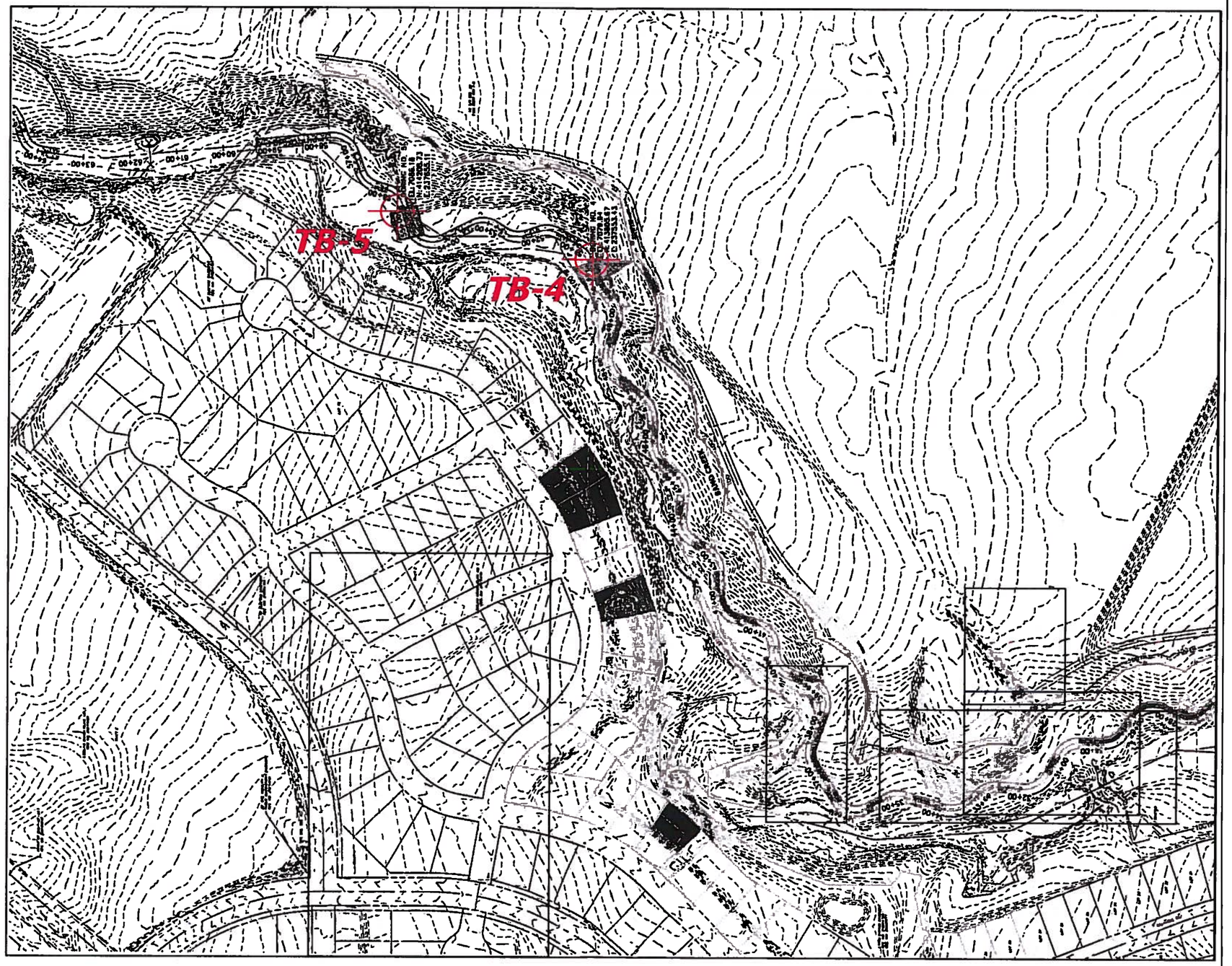
ENTECH ENGINEERING, INC.
505 ELKTON DRIVE
COLORADO SPRINGS, CO. 80907 (719) 531-5599

REVISIONS	BY

SAND CREEK RESTORATION

STERLING RANCH, CO

GEOTECHNICAL BORING LOCATIONS



TB-2- APPROXIMATE TEST BORING LOCATION AND NUMBER

N

REVISIONS	BY:

ENTECH ENGINEERING, INC.
505 ELKTON DRIVE
COLORADO SPRINGS, CO. 80907 (719) 531-5599

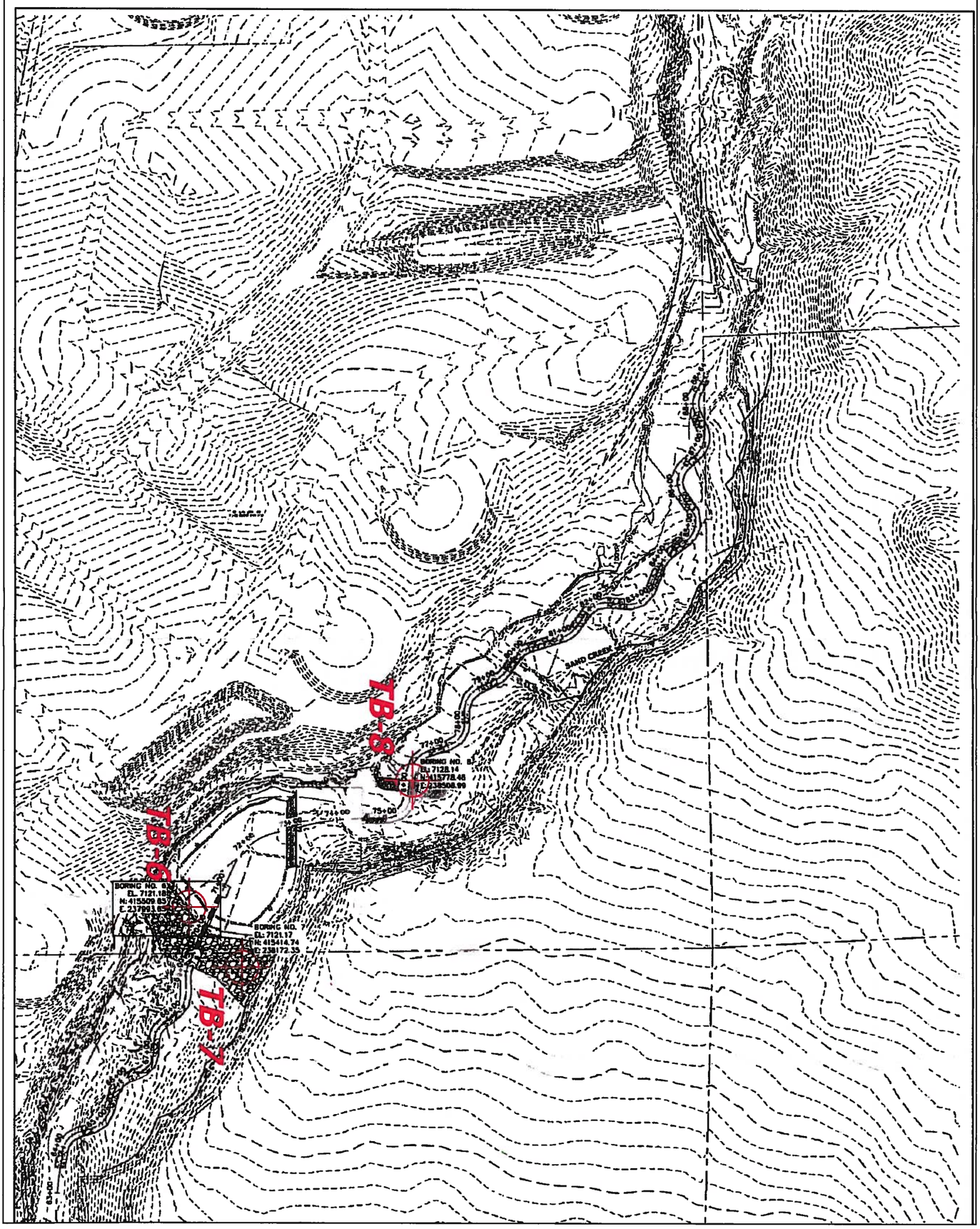
SITE PLAN/TEST BORING MAP
SAND CREEK CHANNEL IMPROVEMENTS
EL PASO COUNTY, CO
FOR: C & C LAND

DRAWN BY:	JRR
DESIGNED BY:	AMN
CHECKED BY:	
DATE:	3/24/2022
SCALE:	AS SHOWN
JOB NO.:	211647
FIGURE NO.:	2B

SAND CREEK RESTORATION

STERLING RANCH, CO

GEOTECHNICAL BORING LOCATIONS



TB-2- APPROXIMATE TEST BORING LOCATION AND NUMBER

N

DRAWN BY: JEB	
DESIGNED BY: AMH	
CHECKED BY:	
DATE: 9/24/2002	
SCALE: AS SHOWN	
JOB NO.: 211047	
FIGURE NO.: 2C	

SITE PLAN/TEST BORING MAP
SAND CREEK CHANNEL IMPROVEMENTS
EL PASO COUNTY, CO
FOR: C & C LAND

ENTECH ENGINEERING, INC.
505 ELKTON DRIVE
COLORADO SPRINGS, CO. 80907 (719) 531-5599

REVISIONS	BY

APPENDIX A: Test Boring Logs

TEST BORING NO. 1
DATE DRILLED 2/26/2022
Job # 211647

REMARKS

WATER @ 5', 2/28/22

Depth (ft)	Symbol	Samples	Blows per foot	Watercontent %	Soil Type
			9	7.1	1
5			7	12.8	1
10			36	10.6	3
15			50 / 7"	12.5	3
20			50 / 4"	11.6	3

SAND, SLIGHTLY SILTY TO SILTY, FINE TO COARSE GRAINED, TAN TO GRAY BROWN, LOOSE TO DENSE, MOIST

WEATHERED TO FORMATIONAL SANDSTONE, VERY SILTY, FINE GRAINED, GRAY BROWN, VERY DENSE, MOIST

TEST BORING NO. 2
DATE DRILLED 2/26/2022
CLIENT C&C LAND
LOCATION CHANNEL IMPROVEMENTS

REMARKS

WATER @ 9', 2/28/22

Depth (ft)	Symbol	Samples	Blows per foot	Watercontent %	Soil Type
			22	3.5	1
5			22	11.4	1
10			29	2.4	1
15			50 / 3"	12.2	3
20			50 / 4"	16.5	3

SAND, SILTY, FINE TO COARSE GRAINED, BROWN, MEDIUM DENSE, MOIST

SANDSTONE, SILTY, FINE TO COARSE GRAINED, TAN, VERY DENSE, MOIST

ENTECH
ENGINEERING, INC.
505 ELKTON DRIVE
COLORADO SPRINGS, COLORADO 80907

TEST BORING LOG

DRAWN:	DATE:	CHECKED:	DATE:

JOB NO.: 211647
FIG NO.: A- 1

TEST BORING NO. 3
DATE DRILLED 2/26/2022
Job # 211647

REMARKS

WATER @ 2.5', 2/28/22

Depth (ft)	Samples	Blows per foot	Watercontent %	Soil Type
		9	17.6	2
5		7	20.1	1
10		50/4"	12.8	3
15		50/3"	12.9	3
20				

CLAY, SANDY WITH ORGANICS, BLACK, FIRM, MOIST

SAND, VERY SILTY, FINE GRAINED, BROWN, LOOSE, MOIST

SANDSTONE, SILTY, FINE TO COARSE GRAINED, GRAY BROWN, VERY DENSE, MOIST

TEST BORING NO. 4
DATE DRILLED 2/26/2022
CLIENT C&C LAND
LOCATION CHANNEL IMPROVEMENTS

REMARKS

WATER @ 4', 2/28/22

Depth (ft)	Samples	Blows per foot	Watercontent %	Soil Type
		11	6.7	1
5		13	10.6	1
10		10	10.3	1
15		8	12.5	1
20		50/3"	18.9	3
25		50/3"	11.4	3

SAND, SILTY, FINE TO COARSE GRAINED, TAN, MEDIUM DENSE TO LOOSE, MOIST

SANDSTONE, SILTY, FINE TO COARSE GRAINED, BROWN, VERY DENSE, MOIST

ENTECH
ENGINEERING, INC.
505 ELKTON DRIVE
COLORADO SPRINGS, COLORADO 80907

TEST BORING LOG

DRAWN:	DATE:	CHECKED:	DATE:

JOB NO.: 211647
FIG NO.: A- 2

TEST BORING NO. 5
DATE DRILLED 2/26/2022
Job # 211647

REMARKS

WATER @ 2.5', 2/28/22

Depth (ft)	Samples	Blows per foot	Watercontent %	Soil Type	REMARKS
		9	29.2	1	SAND, VERY SILTY, FINE TO MEDIUM GRAINED, GRAY BROWN, LOOSE TO MEDIUM DENSE, MOIST
5		50/5"	15.6	3	SANDSTONE, SILTY, FINE TO COARSE GRAINED, GRAY BROWN, VERY DENSE, MOIST
10		50/2"	13.2	3	
15		50/5"	11.3	3	
20					

TEST BORING NO. 6
DATE DRILLED 2/26/2022
CLIENT C&C LAND
LOCATION CHANNEL IMPROVEMENTS

REMARKS

WATER @ 7', 2/28/22

Depth (ft)	Samples	Blows per foot	Watercontent %	Soil Type	REMARKS
		21	9.0	1A	FILL 0-14', SAND, SILTY TO VERY SILTY, FINE TO COARSE GRAINED, BROWN TO BLACK, MEDIUM DENSE TO LOOSE, MOIST
5		20	11.9	1A	
10		6	15.7	1A	
15		11	8.7	1	BLACK LENS SAND, SILTY, FINE TO COARSE GRAINED, BROWN, MEDIUM DENSE, MOIST
20		14	24.9	2	CLAY, VERY SANDY, BLACK, FIRM, MOIST
25		50/7"	15.8	3	SANDSTONE, SLIGHTLY SILTY, FINE TO COARSE GRAINED, GRAY BROWN, VERY DENSE, MOIST
30		50/1"	10.6	3	

ENTECH
ENGINEERING, INC.
505 ELKTON DRIVE
COLORADO SPRINGS, COLORADO 80907

TEST BORING LOG

DRAWN:	DATE:	CHECKED:	DATE:

JOB NO.: 211647
FIG NO.: A- 3

TEST BORING NO. 7
DATE DRILLED 2/26/2022
Job # 211647

REMARKS

WATER @ 3.5', 2/28/22

Depth (ft)	Symbol	Samples	Blows per foot	Watercontent %	Soil Type
			16	14.0	1
5			50 / 7"	11.9	3
10			50 / 6"	11.4	3
15			50 / 4"	14.7	3
20					

SAND, SILTY, FINE TO COARSE GRAINED, TAN, MEDIUM DENSE, MOIST

SANDSTONE, SLIGHTLY SILTY, FINE TO COARSE GRAINED, TAN, VERY DENSE, MOIST

TEST BORING NO. 8
DATE DRILLED 2/26/2022
CLIENT C&C LAND
LOCATION CHANNEL IMPROVEMENTS

REMARKS

WATER @ 4.5', 2/28/22

Depth (ft)	Symbol	Samples	Blows per foot	Watercontent %	Soil Type
			12	22.2	1
5			6	10.8	1
10					
15			50 / 4"	11.4	3
20			50 / 5"	11.2	3

SAND, SILTY TO CLAYEY, FINE TO COARSE GRAINED, TAN, MEDIUM DENSE, MOIST

SANDSTONE, SLIGHTLY SILTY, FINE TO COARSE GRAINED, TAN, VERY DENSE, MOIST

ENTECH
ENGINEERING, INC.
505 ELKTON DRIVE
COLORADO SPRINGS, COLORADO 80907

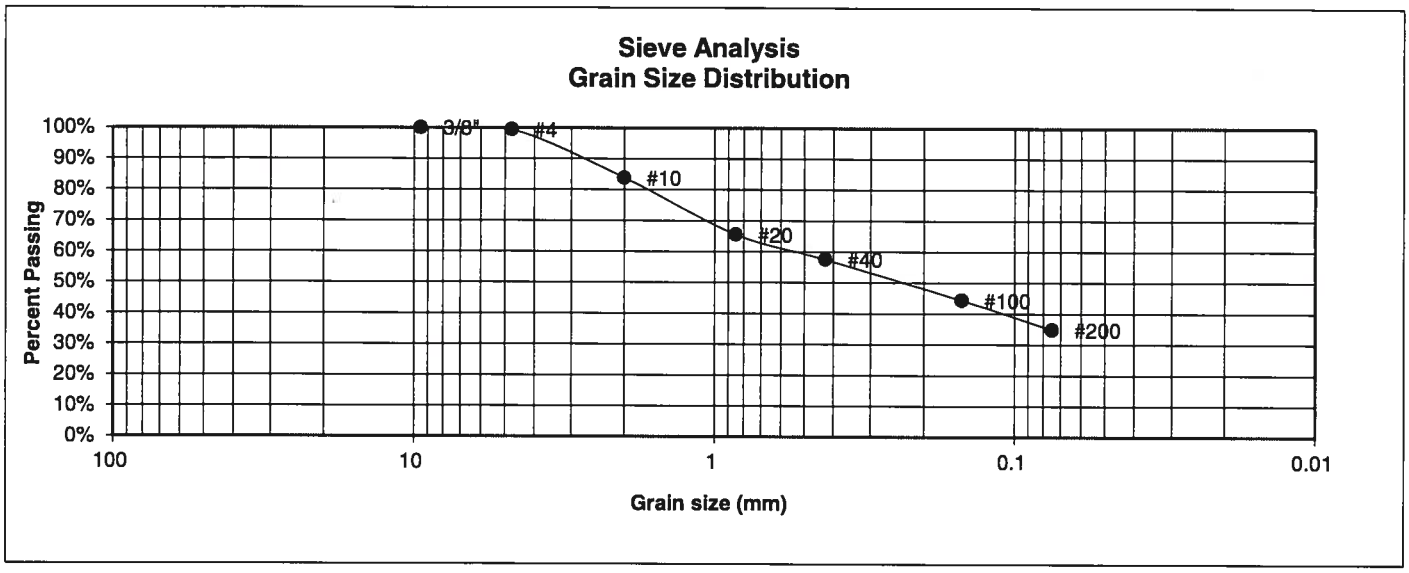
TEST BORING LOG

DRAWN:	DATE:	CHECKED:	DATE:

JOB NO.: 211647
FIG NO.: A- 4

APPENDIX B: Laboratory Test Results

UNIFIED CLASSIFICATION	SM	CLIENT	C&C LAND
SOIL TYPE #	1	PROJECT	CHANNEL IMPROVEMENTS
TEST BORING #	1	JOB NO.	211647
DEPTH (FT)	10	TEST BY	BL



U.S. Sieve #	Percent Finer
3"	
1 1/2"	
3/4"	
1/2"	
3/8"	100.0%
4	99.3%
10	83.9%
20	65.5%
40	57.5%
100	44.4%
200	34.9%

Atterberg Limits	
Plastic Limit	NP
Liquid Limit	NV
Plastic Index	NP

Swell	
Moisture at start	
Moisture at finish	
Moisture increase	
Initial dry density (pcf)	
Swell (psf)	

ENTECH
ENGINEERING, INC.
505 ELKTON DRIVE
COLORADO SPRINGS, COLORADO 80907

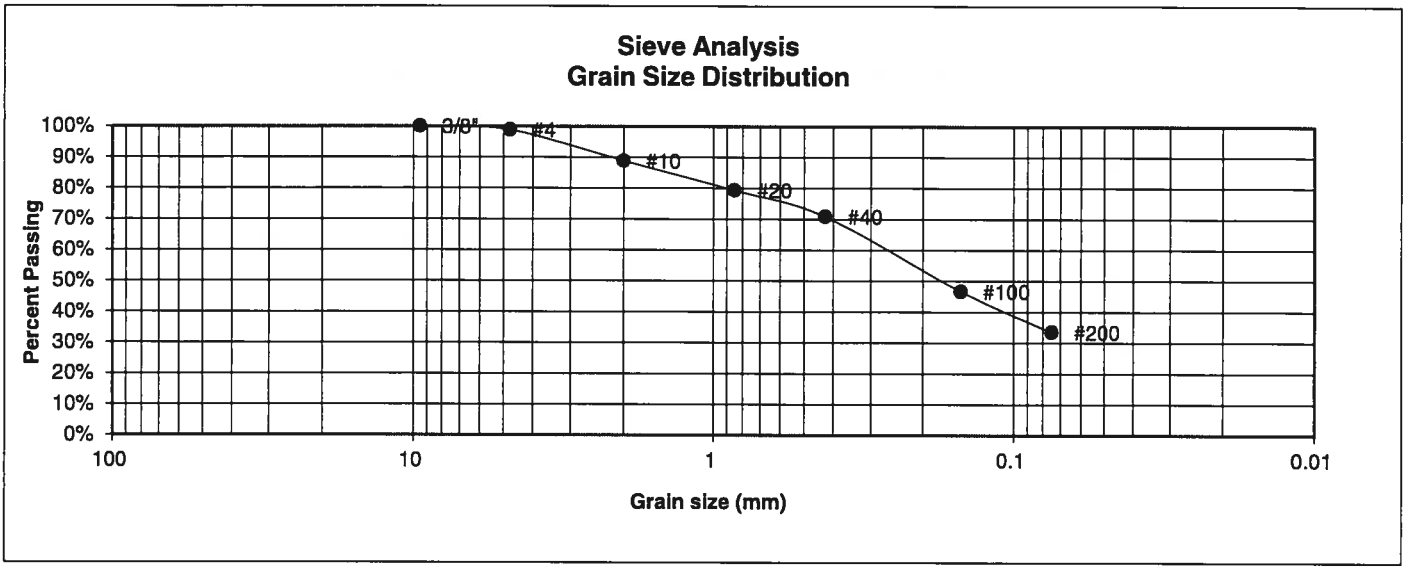
LABORATORY TEST RESULTS

DRAWN:	DATE:	CHECKED: SW	DATE: 4-1-22

JOB NO.: 211647

FIG NO.: B-1

UNIFIED CLASSIFICATION	SM	CLIENT	C&C LAND
SOIL TYPE #	1	PROJECT	CHANNEL IMPROVEMENTS
TEST BORING #	2	JOB NO.	211647
DEPTH (FT)	5	TEST BY	BL



U.S. Sieve #	Percent Finer
3"	
1 1/2"	
3/4"	
1/2"	
3/8"	100.0%
4	98.9%
10	88.8%
20	79.3%
40	70.8%
100	46.7%
200	33.5%

Atterberg Limits	
Plastic Limit	
Liquid Limit	
Plastic Index	

Swell	
Moisture at start	12.2%
Moisture at finish	19.7%
Moisture increase	7.6%
Initial dry density (pcf)	104
Swell (psf)	120

ENTECH
ENGINEERING, INC.
505 ELKTON DRIVE
COLORADO SPRINGS, COLORADO 80907

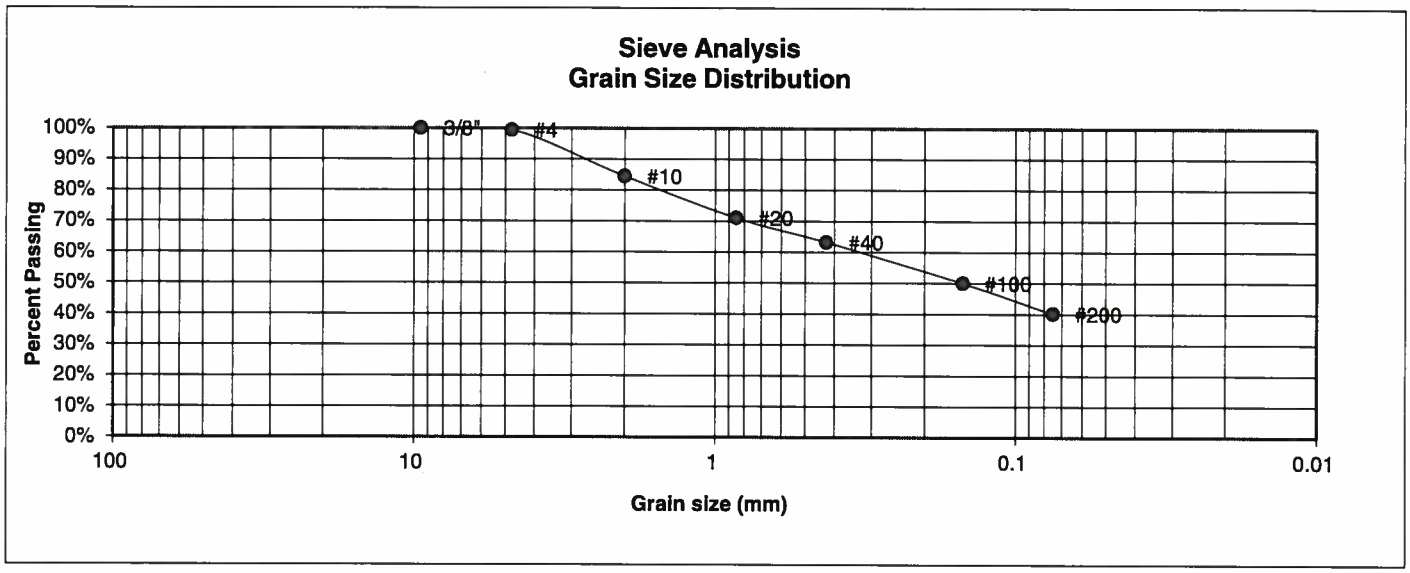
LABORATORY TEST RESULTS

DRAWN:	DATE:	CHECKED: SW	DATE: 4-1-22

JOB NO.: 211647

FIG NO.: B-2

UNIFIED CLASSIFICATION	SM	CLIENT	C&C LAND
SOIL TYPE #	1	PROJECT	CHANNEL IMPROVEMENTS
TEST BORING #	5	JOB NO.	211647
DEPTH (FT)	2-3	TEST BY	BL



U.S. Sieve #	Percent Finer
3"	
1 1/2"	
3/4"	
1/2"	
3/8"	100.0%
4	99.4%
10	84.5%
20	71.0%
40	63.2%
100	50.0%
200	40.1%

Atterberg Limits

Plastic Limit	NP
Liquid Limit	NV
Plastic Index	NP

Swell

Moisture at start	
Moisture at finish	
Moisture increase	
Initial dry density (pcf)	
Swell (psf)	

ENTECH ENGINEERING, INC.
505 ELKTON DRIVE
COLORADO SPRINGS, COLORADO 80907

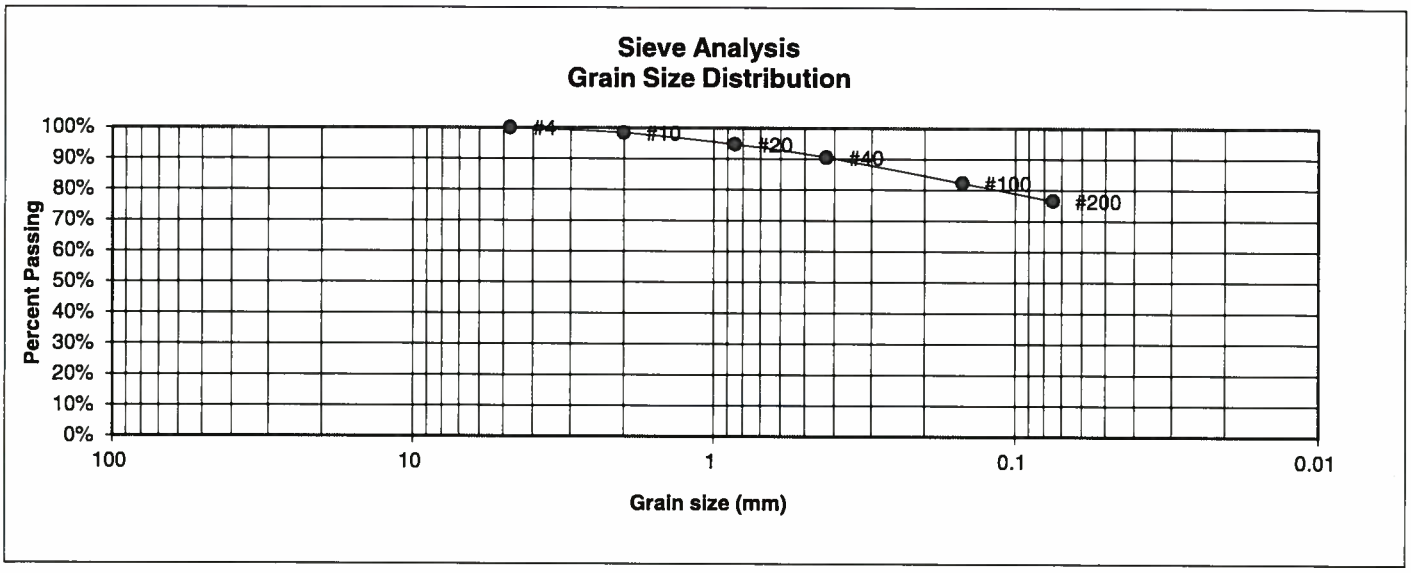
LABORATORY TEST RESULTS

DRAWN:	DATE:	CHECKED: SW	DATE: 4-1-22

JOB NO.: 211647

FIG NO.: B-3

UNIFIED CLASSIFICATION	CL	CLIENT	C&C LAND
SOIL TYPE #	2	PROJECT	CHANNEL IMPROVEMENTS
TEST BORING #	3	JOB NO.	211647
DEPTH (FT)	2-3	TEST BY	BL



U.S. Sieve #	Percent Finer
3"	
1 1/2"	
3/4"	
1/2"	
3/8"	
4	100.0%
10	98.4%
20	94.7%
40	90.5%
100	82.3%
200	76.5%

Atterberg Limits
Plastic Limit
Liquid Limit
Plastic Index

Swell
Moisture at start
Moisture at finish
Moisture increase
Initial dry density (pcf)
Swell (psf)

ENTECH ENGINEERING, INC.
505 ELKTON DRIVE
COLORADO SPRINGS, COLORADO 80907

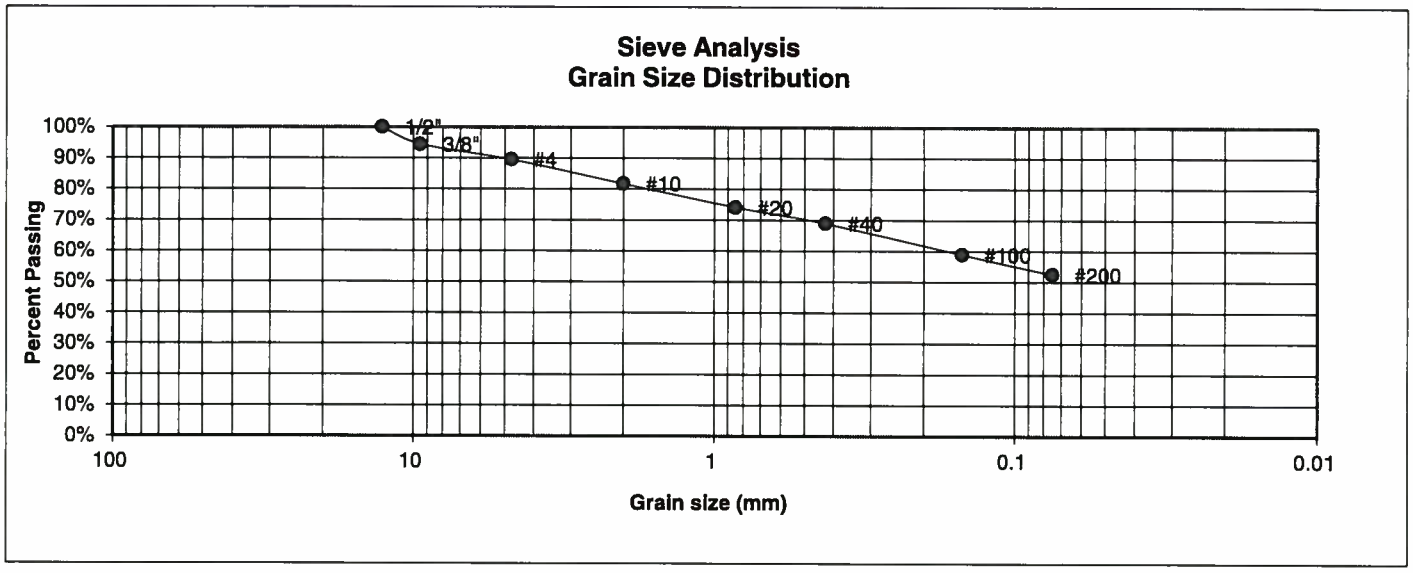
LABORATORY TEST RESULTS

DRAWN:	DATE:	CHECKED: SW	DATE: 4-1-22

JOB NO.: 211647

FIG NO.: B-4

UNIFIED CLASSIFICATION	CL	CLIENT	C&C LAND
SOIL TYPE #	2	PROJECT	CHANNEL IMPROVEMENTS
TEST BORING #	6	JOB NO.	211647
DEPTH (FT)	20	TEST BY	BL



U.S. Sieve #	Percent Finer
3"	
1 1/2"	
3/4"	
1/2"	100.0%
3/8"	94.4%
4	89.5%
10	81.7%
20	74.1%
40	69.0%
100	59.0%
200	52.5%

Atterberg Limits
Plastic Limit
Liquid Limit
Plastic Index

Swell
Moisture at start
Moisture at finish
Moisture increase
Initial dry density (pcf)
Swell (psf)

ENTECH ENGINEERING, INC.
505 ELKTON DRIVE
COLORADO SPRINGS, COLORADO 80907

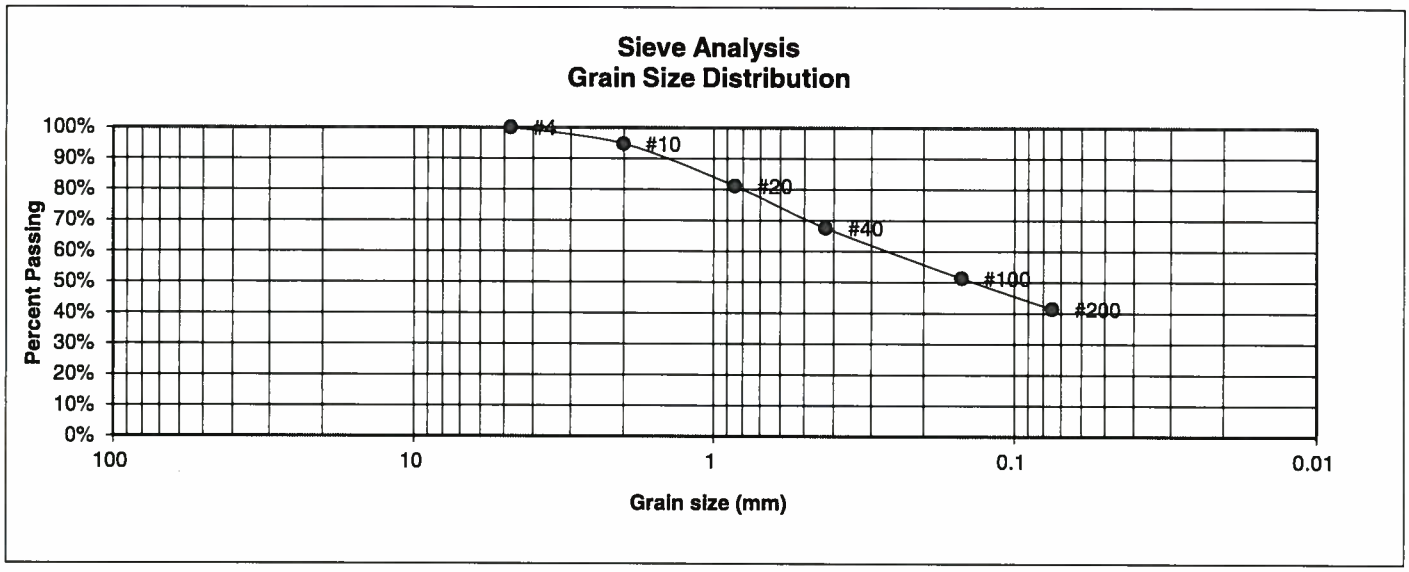
LABORATORY TEST RESULTS

DRAWN:	DATE:	CHECKED: SW	DATE: 4-1-22

JOB NO.: 211647

FIG NO.: B-5

UNIFIED CLASSIFICATION	SM	CLIENT	C&C LAND
SOIL TYPE #	3	PROJECT	CHANNEL IMPROVEMENTS
TEST BORING #	1	JOB NO.	211647
DEPTH (FT)	15	TEST BY	BL



U.S. Sieve #	Percent Finer
3"	
1 1/2"	
3/4"	
1/2"	
3/8"	
4	100.0%
10	94.7%
20	81.1%
40	67.5%
100	51.4%
200	41.4%

Atterberg Limits	
Plastic Limit	NP
Liquid Limit	NV
Plastic Index	NP

Swell	
Moisture at start	
Moisture at finish	
Moisture increase	
Initial dry density (pcf)	
Swell (psf)	

ENTECH ENGINEERING, INC.
505 ELKTON DRIVE
COLORADO SPRINGS, COLORADO 80907

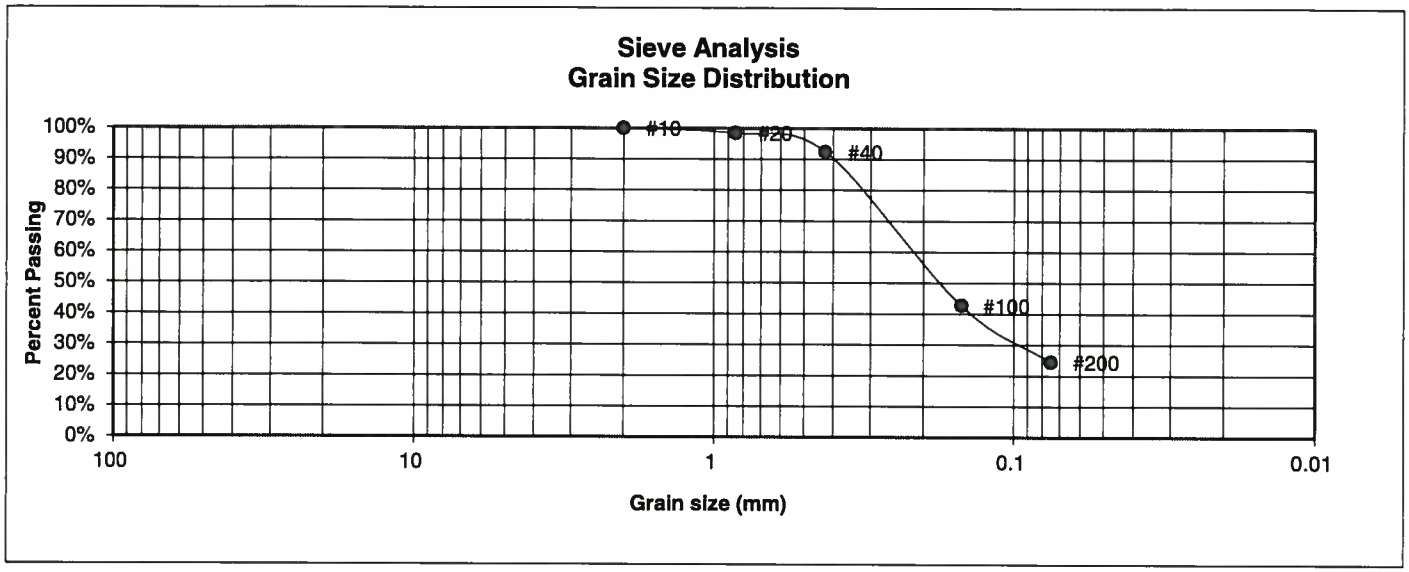
LABORATORY TEST RESULTS

DRAWN:	DATE:	CHECKED: SW	DATE: 4-1-22

JOB NO.: 211647

FIG NO.: B-6

UNIFIED CLASSIFICATION	SM	CLIENT	C&C LAND
SOIL TYPE #	3	PROJECT	CHANNEL IMPROVEMENTS
TEST BORING #	4	JOB NO.	211647
DEPTH (FT)	20	TEST BY	BL



U.S. Sieve #	Percent Finer
3"	
1 1/2"	
3/4"	
1/2"	
3/8"	
4	
10	100.0%
20	98.4%
40	92.4%
100	42.7%
200	24.5%

Atterberg Limits	
Plastic Limit	NP
Liquid Limit	NV
Plastic Index	NP

Swell	
Moisture at start	
Moisture at finish	
Moisture increase	
Initial dry density (pcf)	
Swell (psf)	

ENTECH
ENGINEERING, INC.
505 ELKTON DRIVE
COLORADO SPRINGS, COLORADO 80907

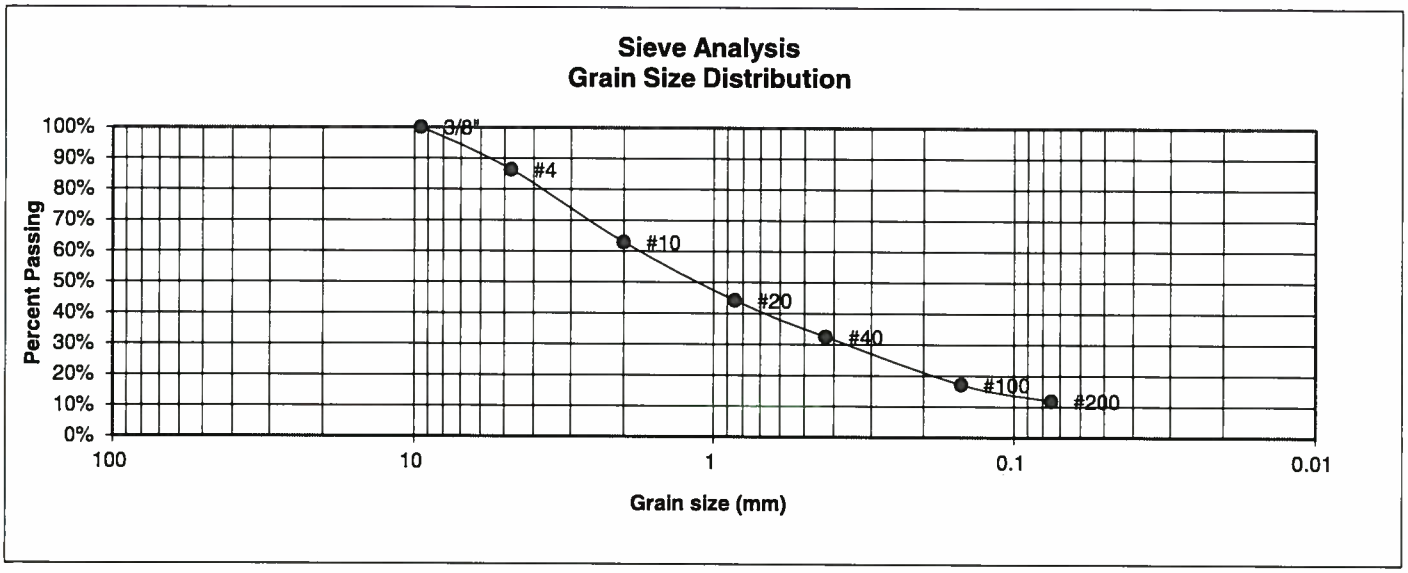
LABORATORY TEST RESULTS

DRAWN:	DATE:	CHECKED: SW	DATE: 4-1-22

JOB NO.: 211647

FIG NO.: B-7

UNIFIED CLASSIFICATION	SM-SW	CLIENT	C&C LAND
SOIL TYPE #	3	PROJECT	CHANNEL IMPROVEMENTS
TEST BORING #	6	JOB NO.	211647
DEPTH (FT)	25	TEST BY	BL



U.S. Sieve #	Percent Finer
3"	
1 1/2"	
3/4"	
1/2"	
3/8"	100.0%
4	86.4%
10	62.9%
20	44.2%
40	32.5%
100	17.1%
200	11.8%

Atterberg Limits
Plastic Limit
Liquid Limit
Plastic Index

Swell
Moisture at start
Moisture at finish
Moisture increase
Initial dry density (pcf)
Swell (psf)

ENTECH ENGINEERING, INC.
505 ELKTON DRIVE
COLORADO SPRINGS, COLORADO 80907

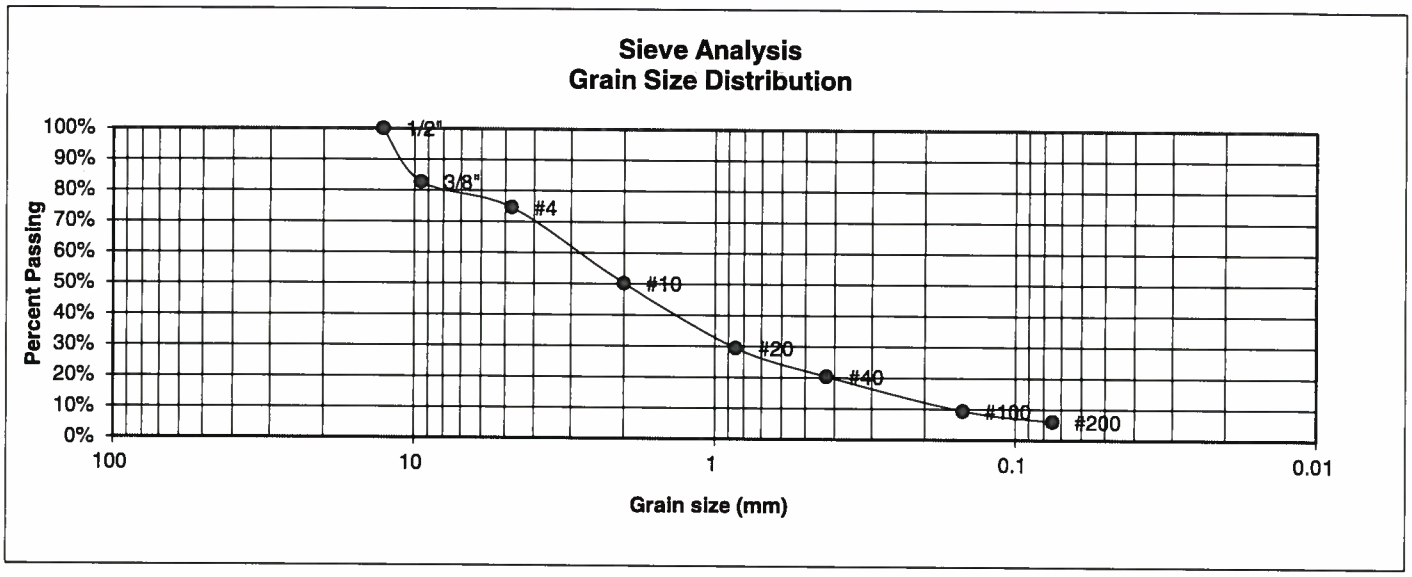
LABORATORY TEST RESULTS

DRAWN:	DATE:	CHECKED: SW	DATE: 4-1-22

JOB NO.: 211647

FIG NO.: B-8

UNIFIED CLASSIFICATION	SM-SW	CLIENT	C&C LAND
SOIL TYPE #	3	PROJECT	CHANNEL IMPROVEMENTS
TEST BORING #	7	JOB NO.	211647
DEPTH (FT)	5	TEST BY	BL



U.S. Sieve #	Percent Finer
3"	
1 1/2"	
3/4"	
1/2"	100.0%
3/8"	82.7%
4	74.5%
10	50.2%
20	29.4%
40	20.4%
100	9.3%
200	6.0%

Atterberg Limits
Plastic Limit
Liquid Limit
Plastic Index

Swell
Moisture at start
Moisture at finish
Moisture increase
Initial dry density (pcf)
Swell (psf)

ENTECH ENGINEERING, INC.
505 ELKTON DRIVE
COLORADO SPRINGS, COLORADO 80907

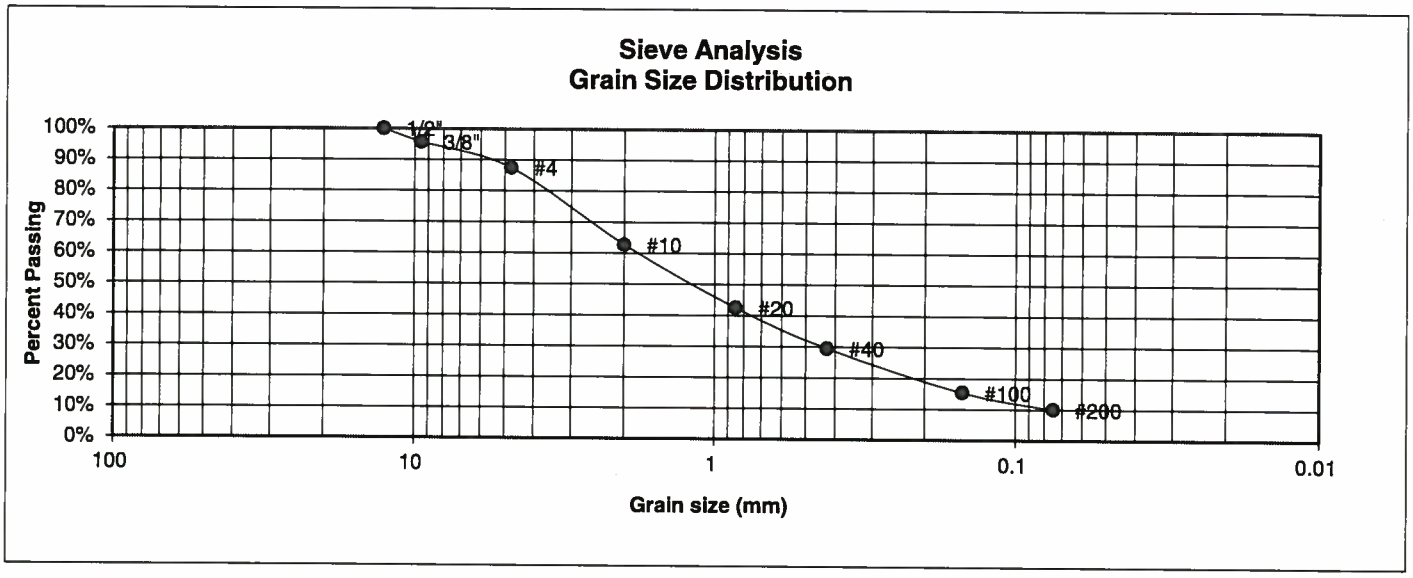
LABORATORY TEST RESULTS

DRAWN:	DATE:	CHECKED: SW	DATE: 4-12-22

JOB NO.: 211647

FIG NO.: B-9

UNIFIED CLASSIFICATION	SM-SW	CLIENT	C&C LAND
SOIL TYPE #	3	PROJECT	CHANNEL IMPROVEMENTS
TEST BORING #	8	JOB NO.	211647
DEPTH (FT)	15	TEST BY	BL



U.S. Sieve #	Percent Finer
3"	
1 1/2"	
3/4"	
1/2"	100.0%
3/8"	95.7%
4	87.4%
10	62.7%
20	42.5%
40	29.5%
100	15.4%
200	10.0%

Atterberg Limits
Plastic Limit
Liquid Limit
Plastic Index

Swell
Moisture at start
Moisture at finish
Moisture increase
Initial dry density (pcf)
Swell (psf)

ENTECH ENGINEERING, INC.
505 ELKTON DRIVE
COLORADO SPRINGS, COLORADO 80907

LABORATORY TEST RESULTS

DRAWN:	DATE:	CHECKED: SW	DATE: 4-1-22

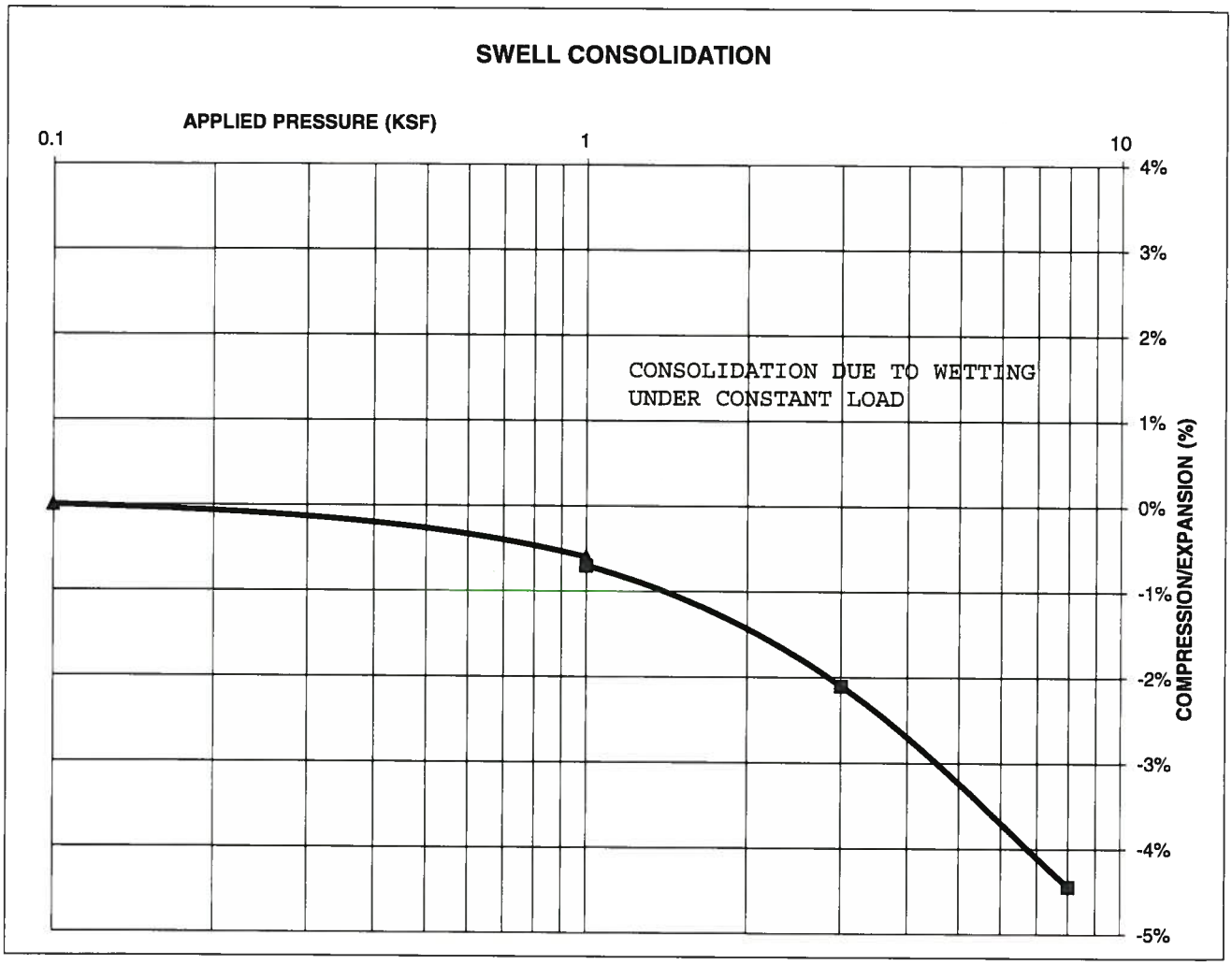
JOB NO.: 211647

FIG NO.: B-10

CONSOLIDATION TEST RESULTS

TEST BORING #	1	DEPTH(ft)	10
DESCRIPTION	SM	SOIL TYPE	1
NATURAL UNIT DRY WEIGHT (PCF)			109
NATURAL MOISTURE CONTENT			12.3%
SWELL/CONSOLIDATION (%)			-0.1%

JOB NO. 211647
CLIENT C&C LAND
PROJECT CHANNEL IMPROVEMENTS



ENTECH
ENGINEERING, INC.
505 ELKTON DRIVE
COLORADO SPRINGS, COLORADO 80907

SWELL CONSOLIDATION
TEST RESULTS

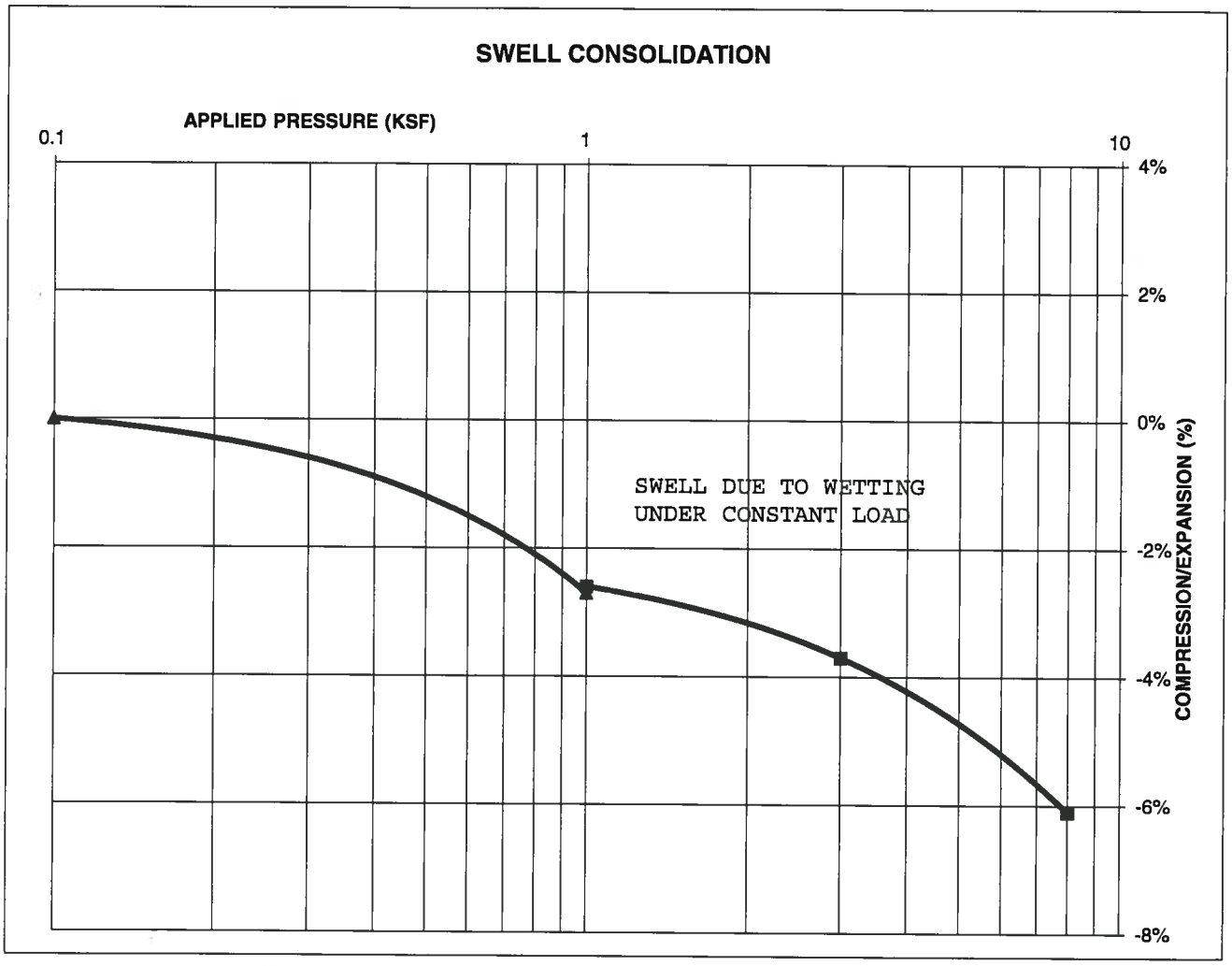
DRAWN:	DATE:	CHECKED: SW	DATE: 4-1-22

JOB NO.: 211647
FIG NO.: B-11

CONSOLIDATION TEST RESULTS

TEST BORING #	6	DEPTH(ft)	25
DESCRIPTION	SM-SW	SOIL TYPE	3
NATURAL UNIT DRY WEIGHT (PCF)			112
NATURAL MOISTURE CONTENT			16.5%
SWELL/CONSOLIDATION (%)			0.1%

JOB NO. 211647
CLIENT C&C LAND
PROJECT CHANNEL IMPROVEMENTS



ENTECH
ENGINEERING, INC.
505 ELKTON DRIVE
COLORADO SPRINGS, COLORADO 80907

SWELL CONSOLIDATION
TEST RESULTS

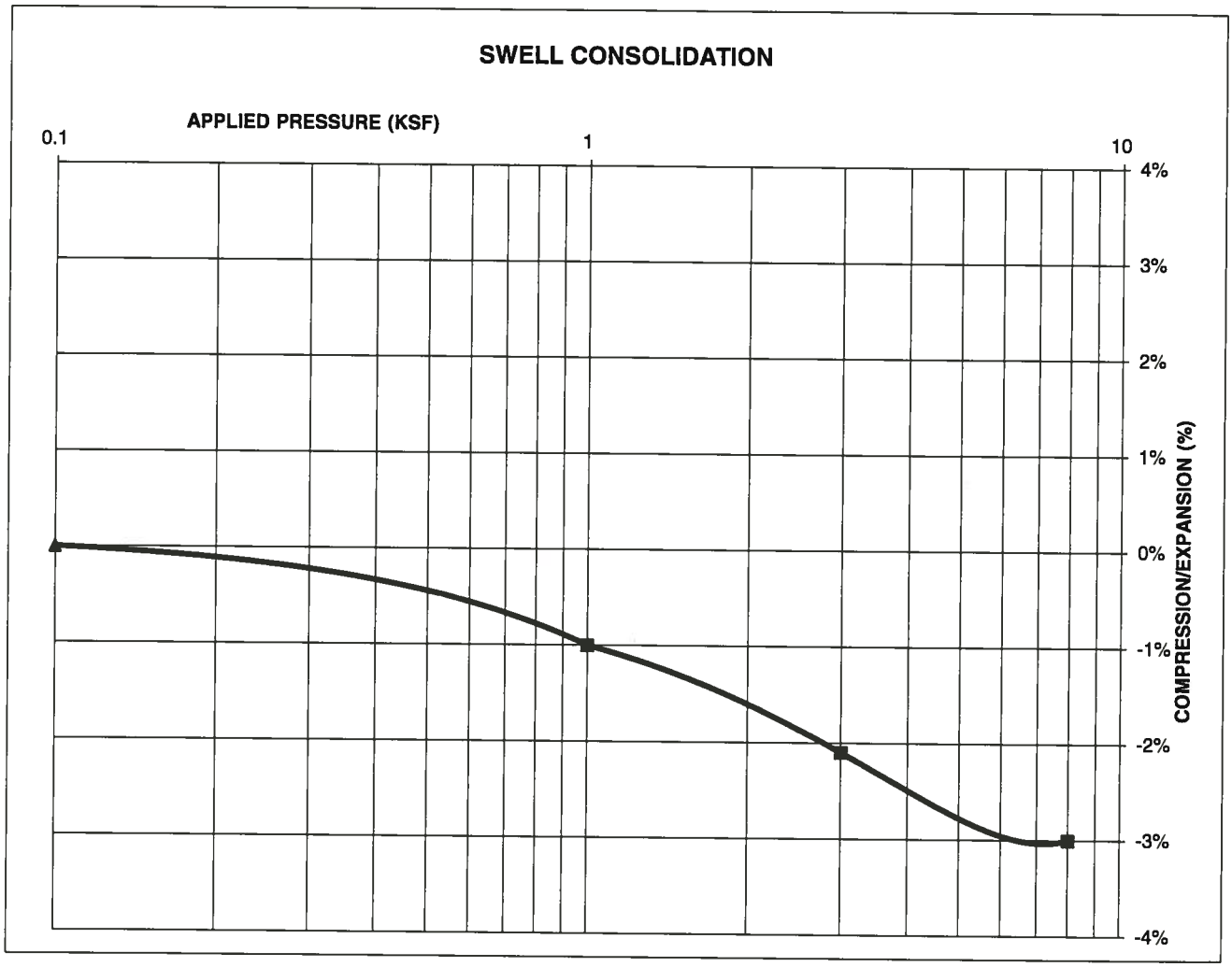
DRAWN:	DATE:	CHECKED: SW	DATE: 4-1-22

JOB NO.: 211647
FIG NO.: B-12

CONSOLIDATION TEST RESULTS

TEST BORING #	8	DEPTH(ft)	15
DESCRIPTION	SM-SW	SOIL TYPE	1
NATURAL UNIT DRY WEIGHT (PCF)			119
NATURAL MOISTURE CONTENT			8.3%
SWELL/CONSOLIDATION (%)			0.0%

JOB NO. 211647
CLIENT C&C LAND
PROJECT CHANNEL IMPROVEMENTS



ENTECH
ENGINEERING, INC.
505 ELKTON DRIVE
COLORADO SPRINGS, COLORADO 80907

SWELL CONSOLIDATION
TEST RESULTS

DRAWN:	DATE:	CHECKED: SW	DATE: 4-1-22

JOB NO.: 211647
FIG NO.: B-13

CLIENT	C&C LAND	JOB NO.	211647
PROJECT	CHANNEL IMPROVEMENTS	DATE	3/4/2022
LOCATION	CHANNEL IMPROVEMENTS	TEST BY	BL

BORING NUMBER	DEPTH, (ft)	SOIL TYPE NUMBER	UNIFIED CLASSIFICATION	WATER SOLUBLE SULFATE, (wt%)
TB-1	10	1	SM	0.00
TB-4	20	3	SM	0.00
TB-5	2-3	1	SM	<0.01

QC BLANK PASS

ENTECH
ENGINEERING, INC.
505 ELKTON DRIVE
COLORADO SPRINGS, COLORADO 80907

LABORATORY TEST
SULFATE RESULTS

DRAWN:	DATE:	CHECKED: SW	DATE: 4-1-22

JOB NO.: 211647

FIG NO.: B-14

Channel Design Report

Sand Creek Stabilization at Aspen Meadows Subdivision Filing No. 1

Prepared on behalf of:

COLA
Colorado Land Acquisition
7910 Gateway Boulevard, Ste 102
El Paso, TX 79915

Prepared by:

Matrix
Excellence by Design

2435 Research Parkway, Suite 300
Colorado Springs, Colorado 80920
Phone: 719.575.0100
Fax: 719.575.0208
matrixdesigngroup.com

February 11, 2020

wetland and riparian vegetation within and adjacent to the channel. Upland vegetation is included for the more upland areas extending into and out of the floodplain. Minor realignment of the channel will take place in three sections along the project reach: Sta. 85+31 to 88+98, Sta. 103+00 to 104+10, and Sta. 108+00 to 110+20. The project seeks to preserve the existing stable reaches of Sand Creek. To maintain a stable slope in the channel, a series of drop structures are proposed.

E. Variances

Variances are required for some proposed improvements as described in Section V of this report. A variance request is submitted to the City under separate cover.

F. Maintenance and Access

It is anticipated that proposed channel improvements will be conveyed to the City for ownership and maintenance upon completion and acceptance. Permanent access for maintenance is shown in the Design Plans on the overall drainage plan (DR01). Access routes are shown to all nine grouted boulder drop structures and to both sheet pile cutoff walls.

G. Tributary Stormwater Facilities

Not applicable.

V. Channel, Structure and Utility Crossing Design

A. Variances to DBPS

Design hydrology was taken from the "Sand Creek Channel Study (North of Woodman Road) Hydrologic Analysis" prepared by M&S Civil in October 2016.

B. Hydrologic and Hydraulic Criteria

Flows in the project reach have been estimated from various sources, including the FEMA Flood Insurance Study dated December 7, 2018, (FIS) and LOMRs, the Sand Creek Drainage Basin Planning Study (Kiowa, 1996), the Upper Sand Creek Hydrologic Analysis (Wilson, 2011) and USGS and CWCB regression equations. Results from these sources are discussed and summarized in a Technical Memorandum entitled Sand Creek Channel Study (North of Woodmen Road) Hydrologic Analysis) by MS Civil Consultants, Inc. (MS Civil) dated October 2016. The technical memorandum includes an analysis of the upstream watershed based on the newly adopted DCM, which changed the design storm distribution and other hydrologic modeling parameters.

Design flows were based on a combination of sources:

- Major flood flows (10-, 50-, and 100-year) come from the FEMA hydrology
- Minor flood flows are based on the M&S hydrologic study, referencing the existing conditions (2016) for a design point just upstream of Regional Pond 3
- The low flow was determined to be Q= 40 cfs based on a survey of existing conditions, since the design aims to preserve existing healthy conditions. The calculations of the low flow discharge are included in the appendix.

A summary of the design flows are given in the following table:

Return Period	Low Flow	2-Year	5-Year	10-Year	50-Year	100-Year
Flow (cfs)	40	262	454	1200	2100	2600
Source	Matrix	M&S	M&S	FEMA	FEMA	FEMA

Table 1- Design Hydrology (cfs)

The primary source of design criteria is the DCM. However, additional criteria provided in the USDCM was also applied.

C. Site Constraints

Several constraints were identified for the project including, but not limited to:

- The proposed Marksheffel Road Crossing – The proposed channel improvements must tie in to the proposed upstream and downstream extents of the Marksheffel Road Crossing
- Utility crossings between Stations 89+50 and 91+50- The design avoids placing drop structures over the utilities.
- Existing concrete drop structure at Station 85+40 – The channel improvements tie into the invert of this structure.
- Delineated wetlands – Disturbance in these areas is to be minimized.

D. Major Channel Components/Attributes

The channel improvements consist primarily of grade control drop structures (boulder cross vanes and grouted boulder), earthwork grading, and revegetation. The approach considers two distinct perspectives from the City and from the USACE. Early in the design process the USACE indicated a Regional Permit 37 would be adequate if disturbances were limited, while the City has indicated long-term potential degradation is a high priority. The design components meet the objectives of both the USACE and City by limiting permanent disturbance using small structures and protecting existing vegetation as well as preparing for long-term degradation by burying larger structures. By completely burying the structures, disturbance is considered temporary.

Given the general healthy condition of the channel a design is preferred that provides immediate stabilization as well as protection from perceived long-term channel degradation. To this point, drop structures are proposed at or near existing channel elevations, as well as at anticipated long-term degraded elevations. In order to maintain the current ecological integrity of the project area seven smaller boulder vane drops are recommended for limited disturbance. Nine grouted boulder structures are proposed to be installed, but only five will be placed to address current conditions. Four of the grouted drop structures will be buried in anticipation of long-term degradation.

FINAL DRAINAGE REPORT
For
Aspen Meadows

Sand Creek
Drainage Basin

Prepared for:
City of Colorado Springs
Engineering Development Review Division Team
30 North Nevada Avenue, Suite 401
Colorado Springs, CO 80903

On Behalf of:

COLA, LLC.
7910 Gateway Boulevard, Suite 102
El Paso, TX 79915

Prepared by:

Matrix DESIGN GROUP
2435 Research Parkway, Suite 300
Colorado Springs, CO 80920
(719) 575-0100
fax (719) 572-0208

January 2019

Project No. 17.886.004

D. Four-Step Process

Per the DCM Chapter 1, Section 4, the City of Colorado Springs require the UDFCD Four Step Process for receiving water protection that focuses on reducing runoff volumes, treating the water quality capture volume (WQCV), stabilizing draingeways, and implementing long-term source controls. Stonebridge Development complies with this process in the following ways:

1. Reducing runoff volumes – the runoff reduction worksheet has been completed and can be found in Appendix C. An example of this step would be to provide landscaping in the available open space areas. Majority of runoff generated from this site area is being released/conveyed through overland flow and grassed swales which help to eliminate unnecessary impervious area.
2. These flows eventually discharge into Pond 1 which has been designed to treat the runoff for water quality and release flows at historic rates.
3. The runoff is routed through proposed storm sewer into proposed Pond 1. Downstream from Pond 1, treated release runoff enters existing Sand Creek Channel that conveys flows approximately 2,875 feet downstream, to another existing Detention Facility “Pond 3”.
4. Implementing long-term source controls – source control BMP’s such as temporary sedimentation basins, covering storage/handling areas and implementing containment/control measures, particularly around vehicular activities should be utilized to control potential source contaminants. The specific location(s) of source control areas will be identified within the SWMP as determined by the site superintendent.

E. Detention and Water Quality

Development of the site requires that full spectrum detention be provided to reduce the fully developed flows from the site to pre-project levels. This is due in part to the master planning of the area, as well as consideration of environmental impacts to existing downstream facilities. A full spectrum extended detention basin is proposed to treat the full spectrum of runoff from the single-family development and an extended water quality control volume detention area is proposed to treat runoff to Marksheffel Road. Please refer to Appendix C for UD-detention spreadsheet calculations for Pond 1 and the Marksheffel WQCV treatment pond.

To effectively treat the water quality runoff volume, each pond utilizes a small outlet structure to extend the time required to discharge the full volume of runoff. Treating the water quality volume requires an extended discharge time of 40 hours. This is the time required to achieve removal of a significant amount of total suspended solids (TSS). The ponds will also have low flow trickle channels which drain to a micro pool at the outlet structure, which is in place to promote biological uptake. Pond 1 was designed with a total watershed area of 21.45 Acres and 55.9% imperviousness. The WQCV treatment pond for Marksheffel Road was designed with a watershed of 8.09 Acres (including 5.7 Acres from Sub-basins A12 through A17 and 2.49 Acres from Sub-basins

Matrix Design Group, Inc., 2019©

RP-7C and RP-7D), and 91.2% watershed imperviousness. The basins and their structures are sized based on pre-development peak flows as calculated by the UD-Detention spreadsheet from UDFCD. The spreadsheets can be found in Appendix C.

The overall volume requirement calculated for the full spectrum EDB, which includes the water quality control volume, the excess urban runoff volume, and detention for storms from the 5-year (20% probability) to the 100-year (1% probability) is 2.32 acre-ft or 101,234 cubic feet. This total detention volume is slightly higher than the value indicated by UD-Detention (2.25 Acre-ft) in order to account for additional flows to Marksheffel Drive from portions of the development along Marksheffel Drive which cannot be diverted to Pond 1. The EURV volume in the lower portion of the detention volume will allow for low and high probability storms to be released to Sand Creek at rates which approximate pre-development conditions. This also reduces the higher probability storms (i.e. less than 2-year (50% probability)) to a level which is at or near the sediment carrying threshold value for the downstream drainageways. The proposed storm sewer drainage facilities will be publicly owned and maintained by the metro district.

The proposed outfall for Pond 1 must discharge the Q100 (1% probability flow) at 90% of the pre-development rate of 7.2 cfs for the development to comply with city requirements. The peak discharge rate is further decreased (overdetained) to 3.7 cfs to account for the portion of Aspen Meadows which adds a flow of approximately 3.5 cfs over the UD-Detention calculation for pre-development flows to Marksheffel Drive. This is a reduction from the pre-project Q100 discharge for the site which is estimated to be approximately 46 cfs.

The emergency overflow for the pond will be at the 5’ stage and will discharge directly to Sand Creek.

Channel Improvements

Sand Creek runs directly adjacent to the proposed Aspen Meadows development, running from the northeast to the southwest. Improvements to this channel are one of the conditions of development and Matrix Design Group, Inc. is designing these improvements under a different project and which will be covered under a separate submittal. Based on previous similar rehabilitation projects a rough estimate of stream rehabilitation for Sand Creek ranges from $705 to $1,340 per linear foot of channel improvement. For the 4,250-foot proposed project this means a range of $2,996,250 to $5,695,000 in projected construction costs. In the future, as the designs are refined, we will be able to narrow the cost estimate window.

VIII. Erosion Control Plan

Per the city of Colorado Springs Drainage Criteria Manual Volume 1, an erosion control plan is required to be included with the drainage analysis. At this time, it is respectfully

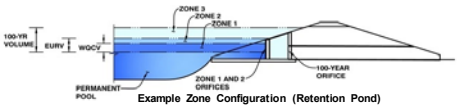
Matrix Design Group, Inc., 2019©

DETENTION BASIN STAGE-STORAGE TABLE BUILDER

UD-Detention, Version 3.07 (February 2017)

Project: Aspen Meadows

Basin ID: SINGLE FAMILY AREA OF 21.45 ACRES



Example Zone Configuration (Retention Pond)

Required Volume Calculation

Selected BMP Type =	**EDB**	
Watershed Area =	21.45	acres
Watershed Length =	1,988	ft
Watershed Slope =	0.010	ft/ft
Watershed Imperviousness =	55.90%	percent
Percentage Hydrologic Soil Group A =	95.3%	percent
Percentage Hydrologic Soil Group B =	4.7%	percent
Percentage Hydrologic Soil Groups C/D =	0.0%	percent
Desired WQCV Drain Time =	40.0	hours
Location for 1-hr Rainfall Depths =	User Input	
Water Quality Capture Volume (WQCV) =	0.399	acre-feet
Excess Urban Runoff Volume (EURV) =	1.420	acre-feet
2-yr Runoff Volume (P1 = 0.95 in.) =	0.782	acre-feet
5-yr Runoff Volume (P1 = 1.23 in.) =	1.055	acre-feet
10-yr Runoff Volume (P1 = 1.49 in.) =	1.348	acre-feet
25-yr Runoff Volume (P1 = 1.88 in.) =	1.842	acre-feet
50-yr Runoff Volume (P1 = 2.21 in.) =	2.350	acre-feet
100-yr Runoff Volume (P1 = 2.57 in.) =	2.959	acre-feet
500-yr Runoff Volume (P1 = 3.52 in.) =	4.557	acre-feet
Approximate 2-yr Detention Volume =	0.738	acre-feet
Approximate 5-yr Detention Volume =	0.997	acre-feet
Approximate 10-yr Detention Volume =	1.262	acre-feet
Approximate 25-yr Detention Volume =	1.682	acre-feet
Approximate 50-yr Detention Volume =	1.945	acre-feet
Approximate 100-yr Detention Volume =	2.246	acre-feet

Optional User Override 1-hr Precipitation	
0.95	inches
1.23	inches
1.49	inches
1.88	inches
2.21	inches
2.57	inches
3.52	inches

Stage-Storage Calculation

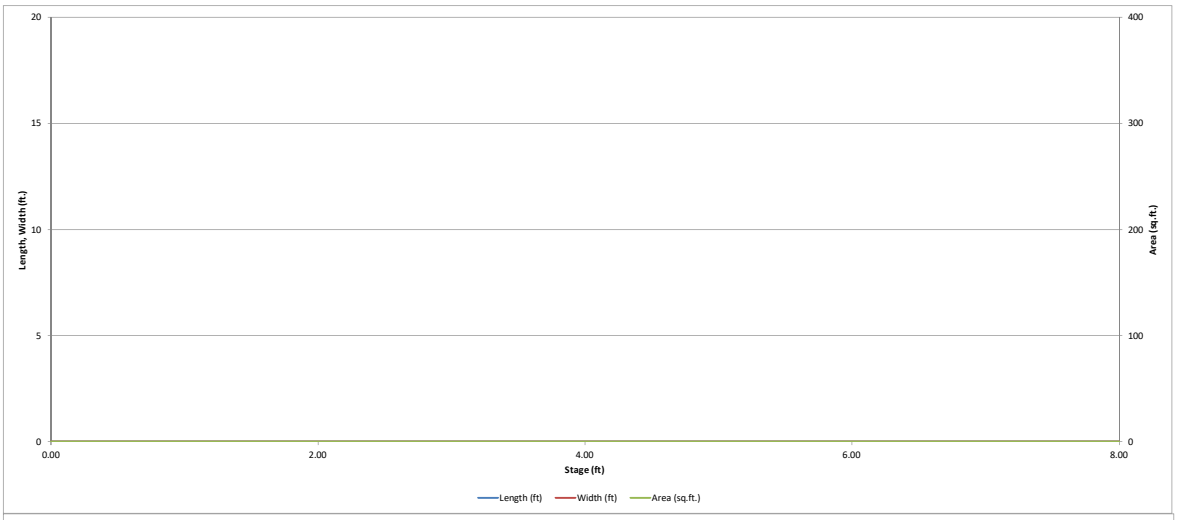
Zone 1 Volume (WQCV) =	0.399	acre-feet
Zone 2 Volume (EURV - Zone 1) =	1.021	acre-feet
Zone 3 Volume (100-year - Zones 1 & 2) =	0.825	acre-feet
Total Detention Basin Volume =	2.246	acre-feet
Initial Surcharge Volume (ISV) =	user	ft^3
Initial Surcharge Depth (ISD) =	user	ft
Total Available Detention Depth (H_{total}) =	user	ft
Depth of Trickle Channel (H_{TC}) =	user	ft
Slope of Trickle Channel (S_{TC}) =	user	ft/ft
Slopes of Main Basin Sides (S_{main}) =	user	H:V
Basin Length-to-Width Ratio ($R_{L/W}$) =	user	
Initial Surcharge Area (A_{ISV}) =	user	ft^2
Surcharge Volume Length (L_{ISV}) =	user	ft
Surcharge Volume Width (W_{ISV}) =	user	ft
Depth of Basin Floor (H_{FLOOR}) =	user	ft
Length of Basin Floor (L_{FLOOR}) =	user	ft
Width of Basin Floor (W_{FLOOR}) =	user	ft
Area of Basin Floor (A_{FLOOR}) =	user	ft^2
Volume of Basin Floor (V_{FLOOR}) =	user	ft^3
Depth of Main Basin (H_{MAIN}) =	user	ft
Length of Main Basin (L_{MAIN}) =	user	ft
Width of Main Basin (W_{MAIN}) =	user	ft
Area of Main Basin (A_{MAIN}) =	user	ft^2
Volume of Main Basin (V_{MAIN}) =	user	ft^3
Calculated Total Basin Volume (V_{total}) =	**user**	acre-feet

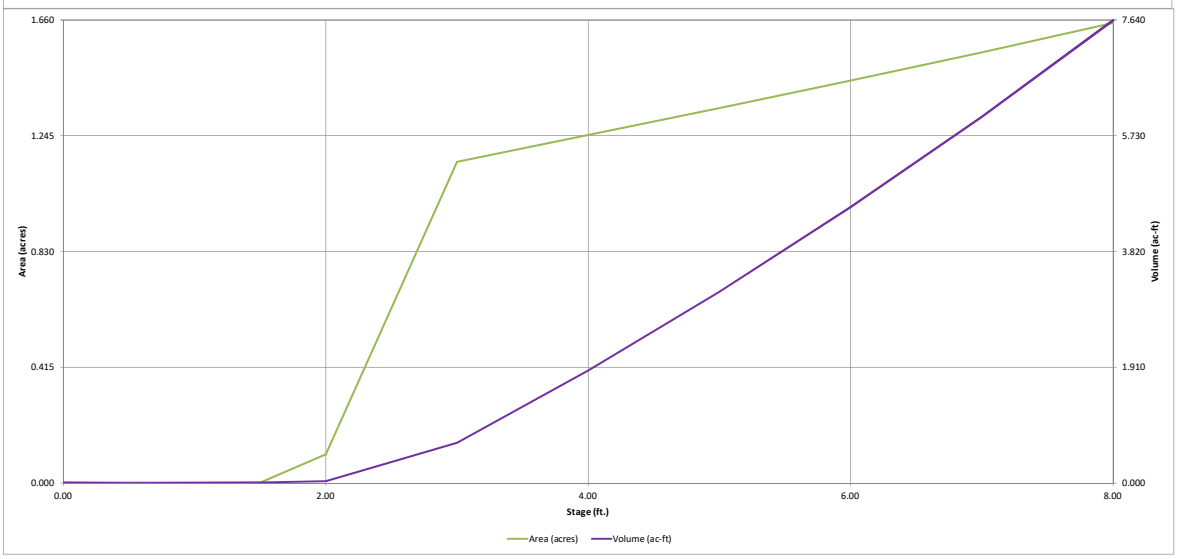
Depth Increment = 0.1 ft

Stage - Storage Description	Stage (ft)	Optional Override Stage (ft)	Length (ft)	Width (ft)	Area (ft^2)	Optional Override Area (ft^2)	Area (acre)	Volume (ft^3)	Volume (ac-ft)
Top of Micropool	--	0.00	--	--	--	77	0.002		
	--	0.50	--	--	--	77	0.002	38	0.001
	--	1.50	--	--	--	77	0.002	115	0.003
	--	2.00	--	--	--	4,494	0.103	1,214	0.028
	--	3.00	--	--	--	50,208	1.153	28,609	0.657
	--	4.00	--	--	--	54,337	1.247	80,881	1.857
	--	5.00	--	--	--	58,563	1.344	137,331	3.153
	--	6.00	--	--	--	62,889	1.444	198,057	4.547
	--	7.00	--	--	--	67,315	1.545	263,159	6.041
	--	8.00	--	--	--	71,840	1.649	332,737	7.639

DETENTION BASIN STAGE-STORAGE TABLE BUILDER

UD-Detention, Version 3.07 (February 2017)



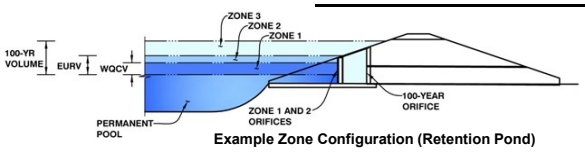


Detention Basin Outlet Structure Design

UD-Detention, Version 3.07 (February 2017)

Project: Aspen Meadows

Basin ID: SINGLE FAMILY AREA OF 21.45 ACRES



Example Zone Configuration (Retention Pond)

	Stage (ft)	Zone Volume (ac-ft)	Outlet Type
Zone 1 (WQCV)	2.75	0.399	Orifice Plate
Zone 2 (EURV)	3.65	1.021	Rectangular Orifice
Zone 3 (100-year)	4.31	0.825	Weir&Pipe (Circular)
		2.246	Total

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

Underdrain Orifice Invert Depth =	N/A	ft (distance below the filtration media surface)
Underdrain Orifice Diameter =	N/A	inches

Calculated Parameters for Underdrain

Underdrain Orifice Area =	N/A	ft^2
Underdrain Orifice Centroid =	N/A	feet

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

Invert of Lowest Orifice =	0.00	ft (relative to basin bottom at Stage = 0 ft)
Depth at top of Zone using Orifice Plate =	2.73	ft (relative to basin bottom at Stage = 0 ft)
Orifice Plate: Orifice Vertical Spacing =	10.90	inches
Orifice Plate: Orifice Area per Row =	1.00	sq. inches (diameter = 1-1/8 inches)

Calculated Parameters for Plate

WQ Orifice Area per Row =	6.944E-03	ft^2
Elliptical Half-Width =	N/A	feet
Elliptical Slot Centroid =	N/A	feet
Elliptical Slot Area =	N/A	ft^2

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

	Row 1 (required)	Row 2 (optional)	Row 3 (optional)	Row 4 (optional)	Row 5 (optional)	Row 6 (optional)	Row 7 (optional)	Row 8 (optional)
Stage of Orifice Centroid (ft)	0.00	0.91	1.82					
Orifice Area (sq. inches)	1.00	1.00	1.00					

	Row 9 (optional)	Row 10 (optional)	Row 11 (optional)	Row 12 (optional)	Row 13 (optional)	Row 14 (optional)	Row 15 (optional)	Row 16 (optional)
Stage of Orifice Centroid (ft)								
Orifice Area (sq. inches)								

User Input: Vertical Orifice (Circular or Rectangular)

	Zone 2 Rectangular	Not Selected	
Invert of Vertical Orifice =	2.75	N/A	ft (relative to basin bottom at Stage = 0 ft)
Depth at top of Zone using Vertical Orifice =	3.65	N/A	ft (relative to basin bottom at Stage = 0 ft)
Vertical Orifice Height =	2.00	N/A	inches
Vertical Orifice Width =	6.67		inches

Calculated Parameters for Vertical Orifice

	Zone 2 Rectangular	Not Selected	
Vertical Orifice Area =	0.09	N/A	ft^2
Vertical Orifice Centroid =	0.08	N/A	feet

User Input: Overflow Weir (Dropbox) and Grate (Flat or Sloped)

	Zone 3 Weir	Not Selected	
Overflow Weir Front Edge Height, Ho =	3.54	N/A	ft (relative to basin bottom at Stage = 0 ft)
Overflow Weir Front Edge Length =	3.00	N/A	feet
Overflow Weir Slope =	0.00	N/A	H:V (enter zero for flat grate)
Horiz. Length of Weir Sides =	3.00	N/A	feet
Overflow Grate Open Area % =	70%	N/A	%, grate open area/total area
Debris Clogging % =	50%	N/A	%

Calculated Parameters for Overflow Weir

	Zone 3 Weir	Not Selected	
Height of Grate Upper Edge, H_t =	3.54	N/A	feet
Over Flow Weir Slope Length =	3.00	N/A	feet
Grate Open Area / 100-yr Orifice Area =	16.97	N/A	should be $\geq$ 4
Overflow Grate Open Area w/o Debris =	6.30	N/A	ft^2
Overflow Grate Open Area w/ Debris =	3.15	N/A	ft^2

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

	Zone 3 Circular	Not Selected	
Depth to Invert of Outlet Pipe =	0.30	N/A	ft (distance below basin bottom at Stage = 0 ft)
Circular Orifice Diameter =	8.25	N/A	inches

Calculated Parameters for Outlet Pipe w/ Flow Restriction Plate

	Zone 3 Circular	Not Selected	
Outlet Orifice Area =	0.37	N/A	ft^2
Outlet Orifice Centroid =	0.34	N/A	feet
Half-Central Angle of Restrictor Plate on Pipe =	N/A	N/A	radians

User Input: Emergency Spillway (Rectangular or Trapezoidal)

Spillway Invert Stage=	5.00	ft (relative to basin bottom at Stage = 0 ft)
Spillway Crest Length =	11.00	feet
Spillway End Slopes =	4.00	H:V
Freeboard above Max Water Surface =	1.00	feet

Calculated Parameters for Spillway

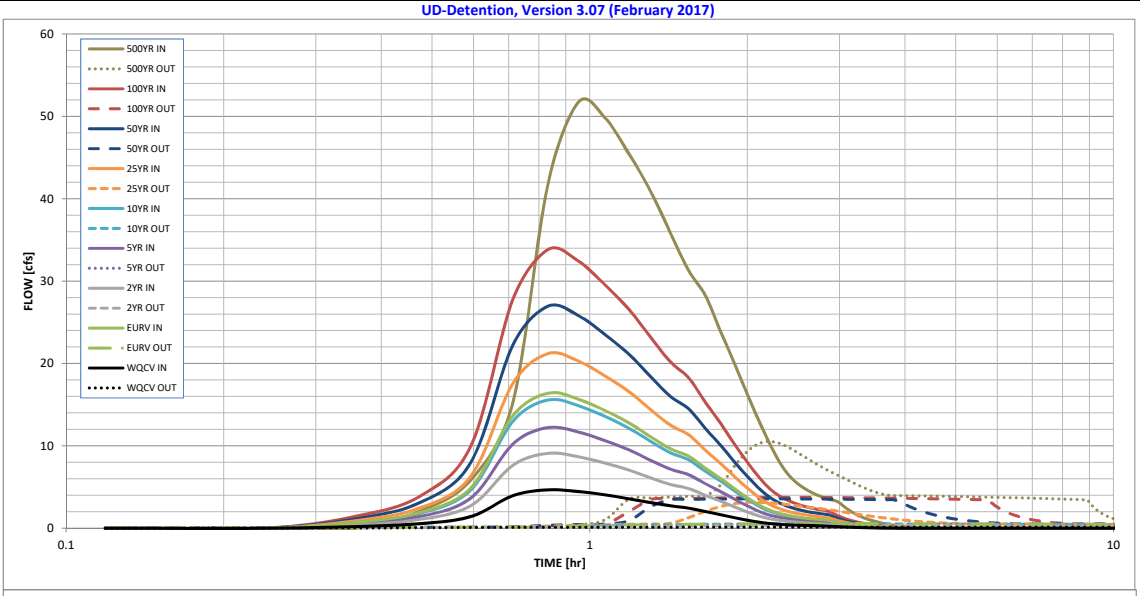
Spillway Design Flow Depth=	0.84	feet
Stage at Top of Freeboard =	6.84	feet
Basin Area at Top of Freeboard =	1.53	acres

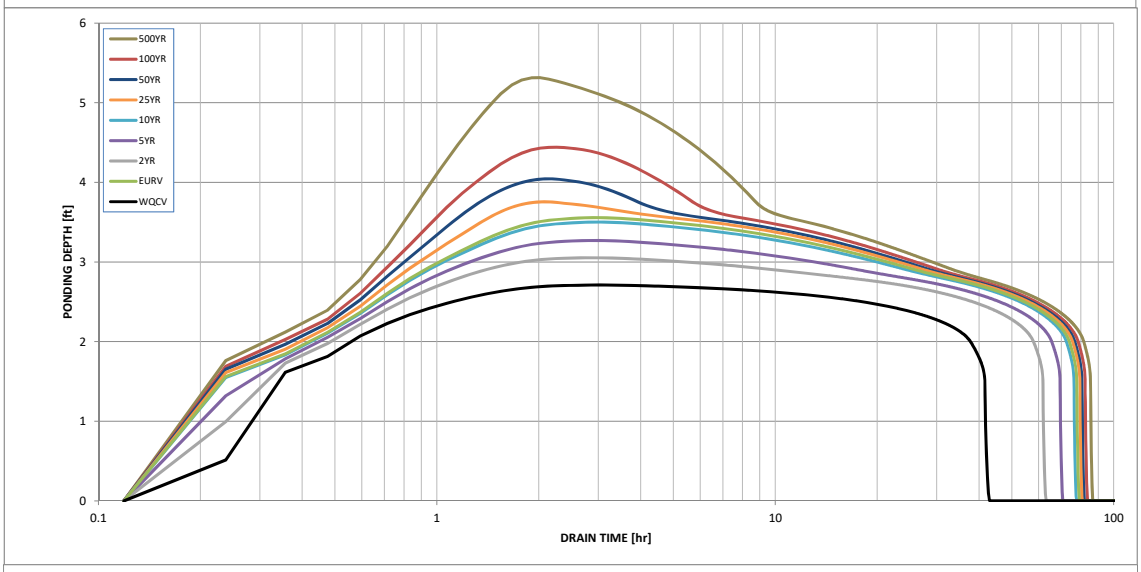
Routed Hydrograph Results

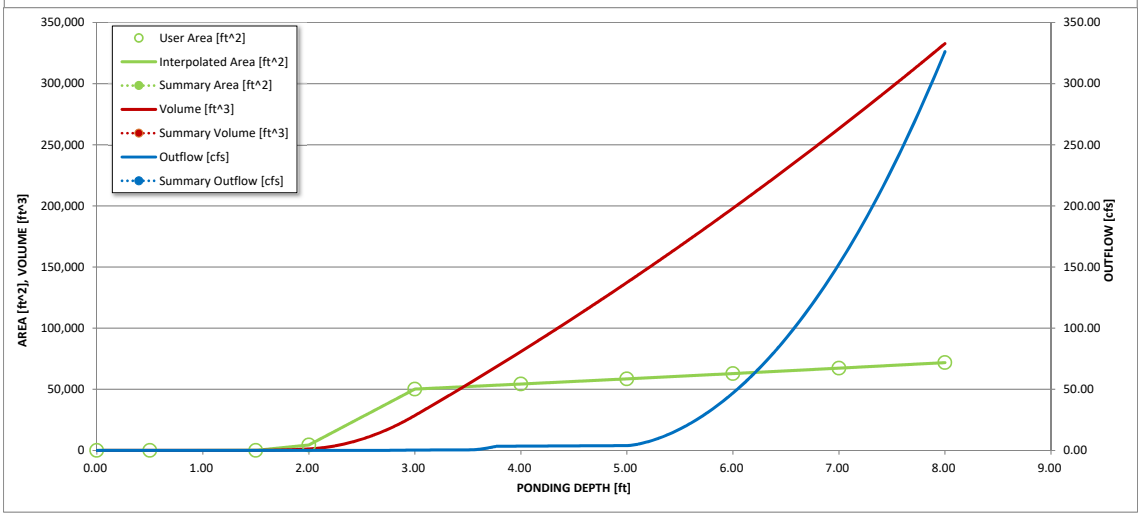
Design Storm Return Period =	WQCV	EURV	2 Year	5 Year	10 Year	25 Year	50 Year	100 Year	500 Year
One-Hour Rainfall Depth (in) =	0.53	1.07	0.95	1.23	1.49	1.88	2.21	2.57	3.52
Calculated Runoff Volume (acre-ft) =	0.399	1.420	0.782	1.055	1.348	1.842	2.350	2.959	4.557
OPTIONAL Override Runoff Volume (acre-ft) =									
Inflow Hydrograph Volume (acre-ft) =	0.399	1.421	0.783	1.056	1.349	1.843	2.352	2.961	4.560
Predevelopment Unit Peak Flow, q (cfs/acre) =	0.00	0.00	0.00	0.00	0.01	0.03	0.14	0.33	0.82
Predevelopment Peak Q (cfs) =	0.0	0.0	0.0	0.1	0.2	0.7	3.1	7.1	17.6
Peak Inflow Q (cfs) =	4.7	16.4	9.1	12.2	15.6	21.2	27.0	33.8	51.7
Peak Outflow Q (cfs) =	0.1	0.6	0.4	0.4	0.5	3.2	3.6	3.7	10.5
Ratio Peak Outflow to Predevelopment Q =	N/A	N/A	N/A	6.9	2.2	4.3	1.2	0.5	0.6
Structure Controlling Flow =	Plate	Overflow Grate 1	Vertical Orifice 1	Vertical Orifice 1	Vertical Orifice 1	Overflow Grate 1	Outlet Plate 1	Outlet Plate 1	Spillway
Max Velocity through Grate 1 (fps) =	N/A	0.01	N/A	N/A	N/A	0.4	0.5	0.5	0.5
Max Velocity through Grate 2 (fps) =	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Time to Drain 97% of Inflow Volume (hours) =	40	72	59	65	71	73	72	72	70
Time to Drain 99% of Inflow Volume (hours) =	**42**	76	61	68	75	77	78	78	80
Maximum Ponding Depth (ft) =	2.71	3.56	3.05	3.27	3.50	3.75	4.04	4.44	5.31
Area at Maximum Ponding Depth (acres) =	0.85	1.20	1.16	1.18	1.20	1.22	1.25	1.29	1.38
Maximum Volume Stored (acre-ft) =	0.367	1.305	0.715	0.971	1.245	1.548	1.907	2.415	3.574

Detention Basin Outlet Structure Design

UD-Detention, Version 3.07 (February 2017)







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

Detention Basin Outlet Structure Design

Outflow Hydrograph Workbook Filename: _____

Storm Inflow Hydrographs **UD-Detention, Version 3.07 (February 2017)**

The user can override the calculated inflow hydrographs from this workbook with inflow hydrographs developed in a separate program.

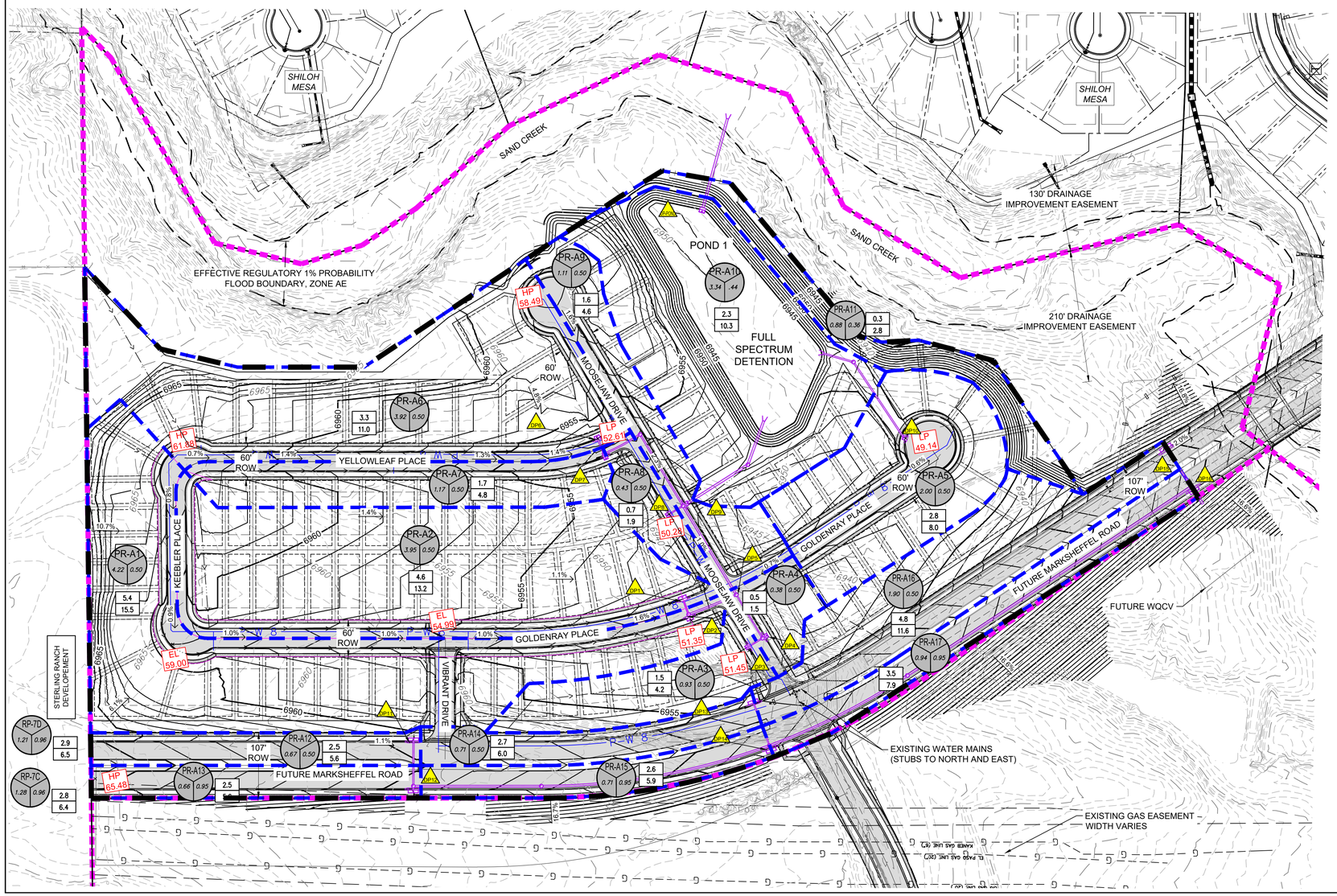
	SOURCE	WORKBOOK	WORKBOOK	WORKBOOK	WORKBOOK	WORKBOOK	WORKBOOK	WORKBOOK	WORKBOOK	WORKBOOK
Time Interval	TIME	WQCV [cfs]	EURV [cfs]	2 Year [cfs]	5 Year [cfs]	10 Year [cfs]	25 Year [cfs]	50 Year [cfs]	100 Year [cfs]	500 Year [cfs]
7.13 min	0:00:00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	0:07:08	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Hydrograph	0:14:16	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Constant	0:21:23	0.21	0.71	0.40	0.54	0.68	0.91	1.15	1.43	2.13
0.702	0:28:31	0.56	1.94	1.08	1.45	1.84	2.49	3.16	3.94	5.94
	0:35:39	1.44	4.97	2.78	3.72	4.73	6.40	8.11	10.13	15.25
	0:42:47	3.96	13.65	7.64	10.23	12.98	17.58	22.25	27.79	41.79
	0:49:55	4.67	16.39	9.10	12.22	15.57	21.20	26.96	33.83	51.71
	0:57:02	4.45	15.68	8.68	11.68	14.89	20.30	25.83	32.45	49.83
	1:04:10	4.05	14.27	7.91	10.63	13.56	18.48	23.51	29.53	45.41
	1:11:18	3.61	12.80	7.07	9.52	12.15	16.58	21.12	26.57	40.92
	1:18:26	3.10	11.10	6.11	8.25	10.54	14.41	18.39	23.18	35.82
	1:25:34	2.71	9.65	5.32	7.17	9.16	12.51	16.00	20.19	31.28
	1:32:41	2.45	8.75	4.82	6.50	8.31	11.35	14.49	18.27	28.22
	1:39:49	2.01	7.28	3.99	5.39	6.90	9.46	12.10	15.27	23.68
	1:46:57	1.64	5.98	3.26	4.42	5.67	7.80	9.99	12.63	19.63
	1:54:05	1.25	4.67	2.52	3.43	4.42	6.10	7.85	9.95	15.57
	2:01:13	0.92	3.53	1.88	2.58	3.34	4.65	6.00	7.65	12.05
	2:08:20	0.67	2.58	1.36	1.87	2.44	3.41	4.43	5.67	9.01
	2:15:28	0.52	1.97	1.05	1.44	1.86	2.59	3.35	4.28	6.75
	2:22:36	0.43	1.61	0.86	1.18	1.52	2.11	2.72	3.46	5.42
	2:29:44	0.37	1.36	0.73	1.00	1.29	1.78	2.30	2.91	4.56
	2:36:52	0.32	1.19	0.64	0.88	1.13	1.56	2.00	2.54	3.96
	2:43:59	0.29	1.07	0.58	0.79	1.01	1.40	1.80	2.28	3.54
	2:51:07	0.27	0.98	0.53	0.73	0.93	1.28	1.65	2.09	3.24
	2:58:15	0.20	0.72	0.39	0.53	0.69	0.95	1.22	1.55	2.42
	3:05:23	0.14	0.53	0.29	0.39	0.50	0.69	0.89	1.12	1.75
	3:12:31	0.11	0.39	0.21	0.29	0.37	0.51	0.65	0.83	1.30
	3:19:38	0.08	0.29	0.16	0.21	0.27	0.38	0.48	0.62	0.97
	3:26:46	0.06	0.21	0.11	0.15	0.20	0.27	0.35	0.45	0.71
	3:33:54	0.04	0.15	0.08	0.11	0.14	0.19	0.25	0.32	0.51
	3:41:02	0.03	0.11	0.06	0.08	0.10	0.14	0.18	0.23	0.37
	3:48:10	0.02	0.07	0.04	0.05	0.07	0.10	0.13	0.16	0.26
	3:55:17	0.01	0.04	0.02	0.03	0.04	0.06	0.08	0.10	0.17
	4:02:25	0.00	0.02	0.01	0.02	0.02	0.03	0.04	0.06	0.10
	4:09:33	0.00	0.01	0.00	0.01	0.01	0.01	0.02	0.03	0.04
	4:16:41	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.01
	4:23:49	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:30:56	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:38:04	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:45:12	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:52:20	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	4:59:28	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:06:35	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:13:43	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:20:51	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:27:59	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:35:07	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:42:14	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:49:22	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	5:56:30	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	6:03:38	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	6:10:46	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	6:17:53	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	6:25:01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	6:32:09	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	6:39:17	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	6:46:25	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	6:53:32	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	7:00:40	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	7:07:48	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	7:14:56	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	7:22:04	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	7:29:11	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	7:36:19	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	7:43:27	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	7:50:35	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	7:57:43	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	8:04:50	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	8:11:58	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	8:19:06	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	8:26:14	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	8:33:22	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

ASPEN MEADOWS

COLORADO SPRINGS, CO

PROPOSED CONDITIONS MAP

Design Point Summary Table									
Design Point	Upstream Area (Acres)	Upstream Q5 (cfs)	Upstream Q100 (cfs)	Subbasins Included	Inlet Name	Inlet Type	Inlet Size (ft)	Outlet Pipe Size/Type	Downstream Design Point
DP1	4.22	4.6	13.2	A2	A2	D 10 R	8	24" RCP/HP	D2
DP2	8.17	10.0	28.7	A1,A2	A1	D 10 R	8	30" RCP/HP	D5
DP3	0.93	1.5	4.2	A3	A3	D 10 R	6	18" RCP/HP	D4
DP4	1.31	2.0	5.7	A3,A4	A4	D 10 R	6	18" RCP/HP	D5
DP5	9.48	12.0	34.4	A1,A2,A3,A4	D5	MH	6	30" RCP/HP	D9
DP6	3.92	3.3	11.0	A6	A6	D 10 R	8	24" RCP/HP	D7
DP7	5.08	5.0	15.9	A6,A7	A5	D 10 R	6	24" RCP/HP	D9
DP8	0.43	0.7	1.9	A8	A7	D 10 R	6	18" RCP/HP	D9
DP9	16.10	19.3	56.8	A1,A2,A3,A4,A6, A7,A8,A9	A8	D 10 R	8	36" RCP/HP	D10
DP10	2.00	2.8	8.0	A5	A5	D 10 R	0	0	0
DP Pond	21.45	24.4	75.1	A1,A2,A3,A4,A5, A6,A7,A8,A9,A10	A9	Detention Outlet Structure	Orifice Plate: 1.02 Sq. In. (Stage 0', .9' & 1.06') Overflow Weir/Grate: L=2', W=2' w/ slope: 0 Overflow Weir/Grate: (Stage: 4' to 6') Structure Outlet Pipe: 18" RCP/HP (10.5" Orifice Plate.		-
Detention Discharge	-	0.4	3.7						Sand Creek
DP11	1.88	5.4	12.1	A12	A12	D 10 R	16	18" RCP/HP	D12
DP12	3.82	10.7	24.0	A12,A13	A13	D 10 R	16	24" RCP/HP	D14
DP13	0.71	2.7	6.0	A14	A14	D 10 R	16	18" RCP/HP	D14
DP14	5.24	16.0	36.0	A12,A13, A14,A15	A15	D 10 R	16	30" RCP/HP	D16
DP15	1.90	4.8	11.6	A16	A16	D 10 R	20	18" RCP/HP	D16
DP16	8.09	24.3	55.4	A12,A13, A14, A15,A16,A17	A17	D 10 R	16	30" RCP/HP	Sand Creek



Basin Summary Table			
Aspen Meadows			
Area ID	Area (Acres)	Q5 (cfs)	Q100 (cfs)
RP-7C	1.28	2.8	6.4
RP-7D	1.21	2.9	6.5
A1	4.22	5.4	15.5
A2	3.95	4.6	13.2
A3	0.93	1.5	4.2
A4	0.38	0.5	1.5
A5	2.00	2.8	8.0
A6	3.92	3.3	11.0
A7	1.17	1.7	4.8
A8	0.43	0.7	1.9
A9	1.11	1.6	4.6
A10	3.34	2.3	10.3
A11	0.88	0.3	2.8
A12	0.67	2.5	5.6
A13	0.66	2.5	5.6
A14	0.71	2.7	6.0
A15	0.71	2.6	5.9
A16	1.90	4.8	11.6
A17	0.94	3.5	7.9

NOTES:

1. Spot elevations subject to change with final grading design and construction.

LEGEND

- SUB-BASIN BOUNDARY
- EXISTING CONTOUR (4900)
- PROPOSED CONTOUR (6970)
- FLOW DIRECTION (XXX)
- LOW POINT AND ELEVATION (LP XX)
- HIGH POINT AND ELEVATION (HP XX)
- SPOT ELEVATION (95.71)
- SWALE
- DESIGN POINT (x)
- SUB BASIN DESIGNATION (XX)
- SUB BASIN RUNOFF COEFFICIENT (XX)
- SUB BASIN AREA (AC.) (X.XX)
- 5-YEAR STORM EVENT PEAK FLOW (CFS) (0.0)
- 100-YEAR STORM EVENT PEAK FLOW (CFS) (0.0)
- PROPERTY LINE
- STORM PIPE

GRAPHIC SCALE

100' 0' 100' 200'

(IN FEET)
1 inch = 100 ft.

Know what's below. Call before you dig.

CONSULTANT:

CIVIL ENGINEER:

Matrix DESIGN GROUP
2435 Research Parkway, Suite 300
Colorado Springs, CO 80920
Phone 719-575-0100
Fax 719-575-0208

LANDSCAPE ARCHITECT:

Thomas & Thomas Planning-Urban
614 N. Tejon Street
Colorado Springs, CO 80903
Phone (719)578-8777

PROJECT:

ASPEN MEADOWS
FILING NO.1
DEVELOPMENT PLAN
CITY OF COLORADO SPRINGS
JANUARY 2019

OWNER:

COLA, LLC
555 MIDDLE PARKWAY
COLORADO SPRINGS, CO 80921
(719)459-0807

DEVELOPER:

COLA, LLC
555 MIDDLE PARKWAY
COLORADO SPRINGS, CO 80921
(719)459-0807

CITY PLANNING FILE NO: AR DP XXXXXXXXX

ISSUE: JANUARY, 2019

DRAWING INFORMATION:	
PROJECT NO:	17.886.004.000
DRAWN BY:	CRAIG DOLD
CHECKED BY:	JEFF ODOR
APPROVED BY:	JEFF ODOR
SHEET TITLE:	

DRAINAGE REPORT MAP

DR02

SHEET 2 OF 3

INNOVATIVE DESIGN. **CLASSIC RESULTS.**

FINAL DRAINAGE REPORT
FOR
RETREAT AT TIMBERRIDGE
FILING NO. 1

Prepared for:
TIMBERRIDGE DEVELOPMENT GROUP, LLC
2138 FLYING HORSE CLUB DRIVE
COLORADO SPRINGS CO 80921
(719) 592-9333

Prepared by:
CLASSIC CONSULTING
619 N. CASCADE AVE SUITE 200
COLORADO SPRINGS CO 80903
(719) 785-0790

Job No. 1185.00

PCD Project No. SF-19-009

Basin S (Q_2 = 0.2 cfs Q_5 = 1 cfs, Q_{100} = 7 cfs) represents a portion of Sand Creek that will be platted with this Filing. No residential development is proposed within this basin other than the proposed channel improvements as recommended in the DBPS and proposed with this specific Filing.

DETENTION / STORMWATER QUALITY FACILITES

As required, storm water quality measures will be utilized in order to reduce the amount of sediment, debris and pollutants that are allowed to enter Sand Creek. These features include but are not limited to the multiple Full Spectrum Detention Basins, Rain Gardens and permanent sediment basins. Site Planning and design techniques for the large lot, rural areas should help limit impervious area, minimize directly impervious area, lengthen time of travel and increase infiltration in order to decrease the rate and volume of stormwater runoff. Urban areas that require detention will provide a Water Quality Capture Volume (WQCV) and Excess Urban Runoff Volume (EURV) in the lower portion of the facility storage volume that will release the more frequent storms at a slower rate to help minimize the effects of development of the property. The proposed detention/SWQ facilities are to be private facilities with ownership and maintenance by the TimberRidge Metropolitan District. After completion of construction and upon the Board of County Commissioners acceptance, the Sand Creek channel will be owned and maintained by the El Paso County along with all drainage facilities within the public Right of Way.

SAND CREEK CHANNEL IMPROVEMENTS

As stated in the Sand Creek DBPS, this Reach SC-9 is recommended as a floodplain preservation design concept. Given the fact of the current requirements for detention/SWQ facilities planned for the property with designed release at or below pre-development flows, the existing Sand Creek drainageway is expected to remain stable. Existing FEMA FIS channel velocities as found in the LOMR 08-080541P seem to exceed recommended allowable velocities. Although, based on the findings from the CORE Consultants, Inc. Impact Identification Report, no significant erosion or channel degradation through this property currently exists at this time. Specifically

located grade control structures (See Appendix) were specified in the DBPS through this reach in order to slow the cannel velocity to the DBPS recommended 7 feet per second and to prevent localized and long-term stream degradation affecting channel linings and overbanks. The allowable velocity and shear stress will vary depending upon the existing riparian vegetation/wetlands found within the channel and overbank floodplain terrace areas. A HEC-RAS hydraulic analysis for this portion of Reach SC-9 has been provided in order to determine the necessary channel improvements for the proposed Filing No. 1 development and future Filings. A separate wetland impact report along with the Section 404 permitting, prepared by CORE Consultants, has been developed based on these proposed channel improvements and submitted directly to the U.S. Army Corps of Engineers with necessary consult with U.S. Fish and Wildlife for their review and approval. This report and documentation can be found in the Appendix for El Paso County staff review.

HEC-RAS MODELING

HEC-RAS ver. 5.0.6 was used to perform a one-dimensional, steady flow hydraulic model of a portion of Reach SC-9 from Arroya Lane to approximately 650 feet downstream of the TimberRidge south property line. HEC-RAS was used to define the stream centerline, overbanks, cross-sections and manning's n values. The stream centerline follows the channel thalweg to define the reach network. Cross-section topography data was obtained by using the generated surface from the 2-ft. flown contours utilized for all site design. This data was then exported from AutoCAD containing three-dimensional coordinates for the stream centerline, cross-sections, reach stations, overbank stations, reach lengths and imported into HEC-RAS. Two separate models defining the existing condition and proposed condition were prepared using the same centerline stationing. The proposed model included the introduction of the ineffective flow area for the culvert added for the Poco Road crossing. Different Manning's n values were applied across the various channel cross-sections to reflect the changes in vegetative cover within the channel and overbanks. The selected Manning's n values for the channel and overbanks were determined using Tables 10-1 and 10-2 from the DCM and Table 3 from the USGS Guide for

selecting Manning's Roughness Coefficients based on numerous site visits in an effort to photograph and document each cross-section. (See Appendix) The following table summarizes the selected Manning's n values:

Table 1 Manning's n Values

Feature	Manning's n Value
Main Channel	0.03 – 0.10
Overbank Floodplain Terraces	0.12 – 0.16

Steady flow data was entered starting at Arroya Lane, channel station 55+32.95, with a flow change location at station 15+07.91 representing the Sand Creek DBPS segment change from 171 to 170. Steady flow data corresponding to recurrence intervals of 10 Yr. and 100 Yr. for the FEMA, DBPS and Sterling Ranch MDDP conditions was entered. The models were run in subcritical mode to evaluate hydraulic conditions. Boundary conditions for the entire reach were based on normal depth calculations for the upstream and downstream channel slopes. The following table summarizes the flows used in the models:

Table 2 Model Flow Values

Flood Event / Location	Flow Value (cfs)
Arroya Lane (Sta: 55+32.95)	
FEMA 100 Yr.	2600
DBPS 100 Yr.	2170
DBPS 10 Yr.	630
Sterling MDDP 100 Yr.	1487
Sterling MDDP 10 Yr.	430

DBPS Segment 170 (Sta: 15+07.91)	
FEMA 100 Yr.	2600
DBPS 100 Yr.	2260
DBPS 10 Yr.	670
Sterling MDDP 100 Yr.	1520
Sterling MDDP 10 Yr.	450

Per the approved DBPS, the anticipated developed flows just upstream of this project are Q_{10} = 630 cfs and Q_{100} = 2170 cfs as depicted within DBPS segment no. 171. The anticipated developed flows exiting this property are Q_{10} = 670 cfs and Q_{100} = 2260 cfs as depicted within DBPS segment no. 170. As discussed earlier, the FEMA FIS flows appear to be significantly higher than both those presented in the DBPS and the Sterling Ranch MDDP. We understand that Sterling Ranch may be processing a CLOMR/LOMR in the near future, however, we have continued to utilize the significantly larger flows as determined by the FEMA FIS (2600 cfs) in the channel improvement designs and the Poco Road culvert crossing calculations. The proposed culvert calculations meet the criteria found in the DCM Vol. 1 6.4.2. which provides the 2 feet freeboard within the structure based on the flow of 2600 cfs.

The proposed public roadway crossing of Sand Creek is planned for this site. (Extension of Poco Road) Upon development of Filing No. 1, the proposed crossing will consist of a two cell multi-plate steel single radius arch (24' x 10.33') with concrete headwalls to facilitate the conveyance of the 100 yr. flow. (See Appendix) This facility allows for 2.2' of freeboard within the structure utilizing the 2600 cfs FEMA flows. The proposed structure is made from heavy gage corrugated steel plates with 3 oz. per square foot galvanized coating (both sides) capable of providing a service life of 75 years or longer. Soils testing provide further design information related to wall thickness to account for corrosion and abrasion requirements per County standards.

Based on recent site visits during May and July of 2019, the entire Sand Creek drainage corridor through the Retreat at TimberRidge development was walked and photographed for documentation purposes and aide in the HEC-RAS modeling. (See Appendix) As discovered in the field and documented in the photos taken both up-stream and down-stream at each HES-RAS station, this reach of the Sand Creek channel appears very stable with no signs of erosion within the main channel or channel overbanks. This is mainly due to the significant vegetal cover throughout the reach. The classification of the vegetal cover seems to have a range from Retardance Class A-C as defined by HEC-15 chart (See Appendix) This type of vegetation retardance significantly increases the allowable shear stress within the channel while reducing the velocity. The following table defines the retardance level based on the vegetation class:

Table 3

Vegetal Retardance Curve Index by SCS Retardance Class

SCS Retardance Class	Retardance Curve Index
A	10.0
B	7.64
C	5.60
D	4.44
E	2.88

Based on this information, the maximum allowable sheer stress is found by the flowing equation:

$$\tau = 0.75\text{Curve Index}$$

Thus, the range of shear stress for this reach of Sand Creek equals 4.2 – 7.5 (lb/ft^2).

Referencing the HES-RAS model calculations in the Appendix shows that only a few stations showed shear stress exceeding this limit. (Sta: 33+34.27, 20+83.66 and 18+79.67) All three of these stations are within the Filing 1 development area and with the proposed channel

improvements and selective embankment lining, the shear stress at those locations will be reduced to the allowable range.

The proposed channel improvements within this Filing consist of five check structures located approximately 600 feet apart. Two of them will be constructed north of the Poco Road crossing and three south of the road crossing. The DBPS only depicts one structure along this stretch of channel but additional ones are being planned to further limit degradation and help control the elevation of the channel invert. These check structures are designed to be sheet piling with a concrete cap per Urban Drainage Vol. 2 Figures 9-27 thru 9-28. The intent of these structures is to hold grade so if the stream wants to flatten its equilibrium slope, the incision is limited. Thus, the plan is for these structures to eventually become drop structures as dictated by future channel characteristics.

The DBPS also recommended to provide selective rip-rap channel stabilization located at culvert crossings, pipe outlets and outside bends of the channel. Based on the mean channel slope and maximum allowable velocity of 7.0 fps, Type L Rip-Rap stabilization will be provided at select locations within Filing No. 1. (See Appendix for tables describing slope, velocity, shear, Froude No., etc.) The existing channel slope throughout this reach ranges from 0.6% to 7.3%. These steeper slopes seem to represent numerous areas with isolated shallow pools within the main channel which help support the growth of the wetlands. These isolated areas will remain with only minimal disturbance taking place at the locations of the proposed improvements (i.e. check structures and culvert crossing). Per the HEC-RAS model, the proposed channel velocities range from 2.7 ft./sec. to 6.0 ft./sec. All stations are within the allowable velocity of 7.0 ft./sec. In conjunction with the installation of the rip-rap stabilization, the selected stretches of channel with the higher velocities have also been widened 15’-20’ to create and extend the floodplain terraces, better stabilize the steeper natural slopes outside the floodplain area, as recommended in the soils report. These extended terraces assist in reducing flow velocities and provide adequate capacity for larger storm events. The proposed widening of the floodplain terraces

takes place outside of the wetland delineations. (Reference the wetland mitigation plan prepared by CORE Consultants found in the Appendix)

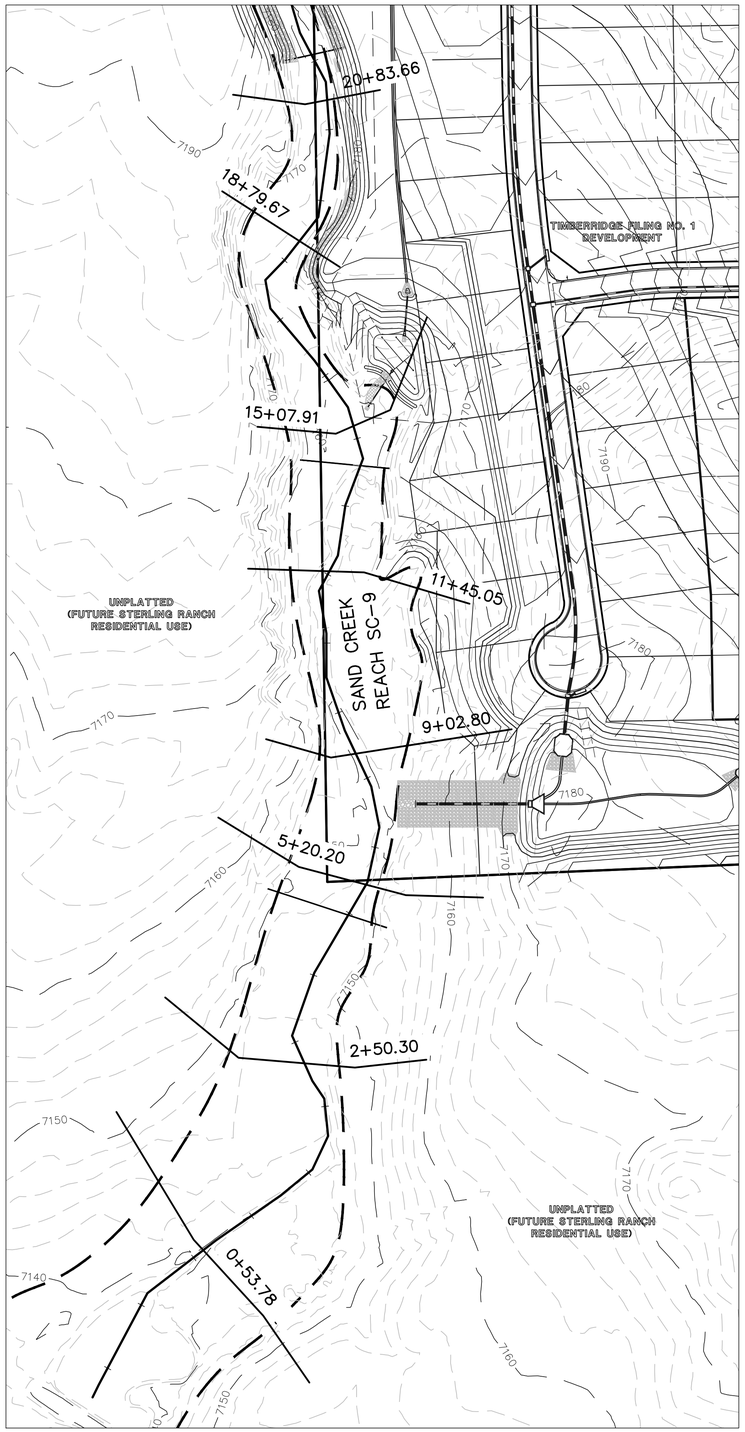
The HEC-RAS model calculations also shows only one station with Froude No. over 1.0. This location is Sta: 29+60.10, at the entrance to the proposed culvert crossing where the channel has been narrowed up to help facilitate efficiently routing the flow under the roadway. However, the supercritical flow at this location is handled with rip-rap bank stabilization and concrete headwall and wingwalls at the culvert crossing. The Froude No. at all other stations remains less than 1.0, with subcritical flow characteristics.

DRAINAGE CRITERIA

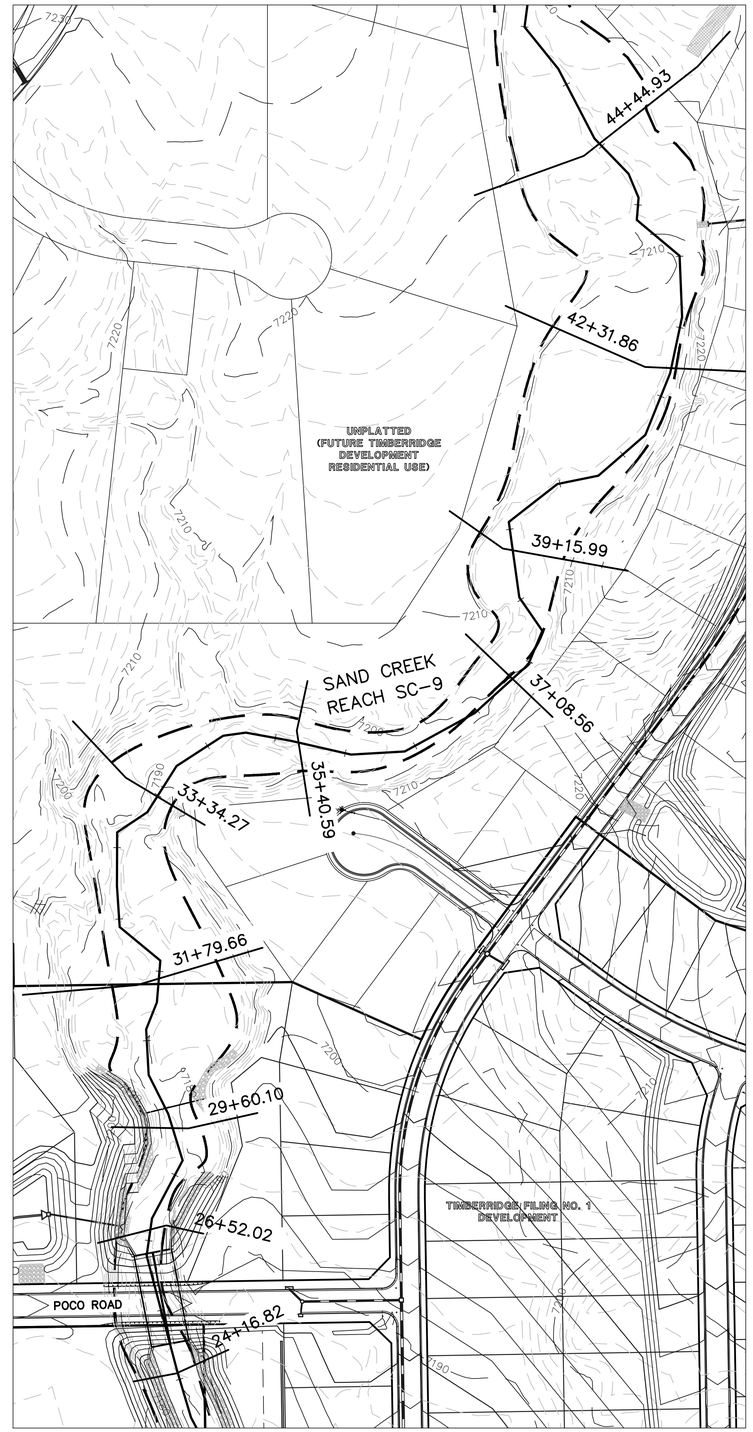
Hydrologic calculations were performed using the City of Colorado Springs/El Paso County Drainage Criteria Manual, as revised in November 1991 and October 1994 with County adopted Chapter 6 and Section 3.2.1 of Chapter 13 of the City of Colorado Springs/El Paso County Drainage Criteria Manual as revised in May 2014. The overall pre-development design model was calculated using PondPack V8i with time of concentrations estimated using NRCS Unit Hydrograph procedures described in the DCM based upon the hydrologic soil type and runoff ARC II curve numbers (CN) chart (Table 6-10) with a 24 hour NRCS Type II distribution. Individual on-site developed basin design used for detention/SWQ basin sizing, inlet sizing and storm system routing was calculated using the Rational Method. Runoff Coefficients are based on the imperviousness of the particular land use and the hydrologic soil type in accordance with Table 6-6. The average rainfall intensity, by recurrence interval found in the Intensity-Duration-Frequency (IDF) curves in Figure 6-5. (See Appendix)

The City of Colorado Springs/El Paso County DCM requires the Four Step Process for receiving water protection that focuses on reducing runoff volumes, treating the water quality capture volume (WQCV), stabilizing drainage ways, and implementing long-term source controls. The Four Step Process pertains to management of smaller, frequently occurring storm events, as

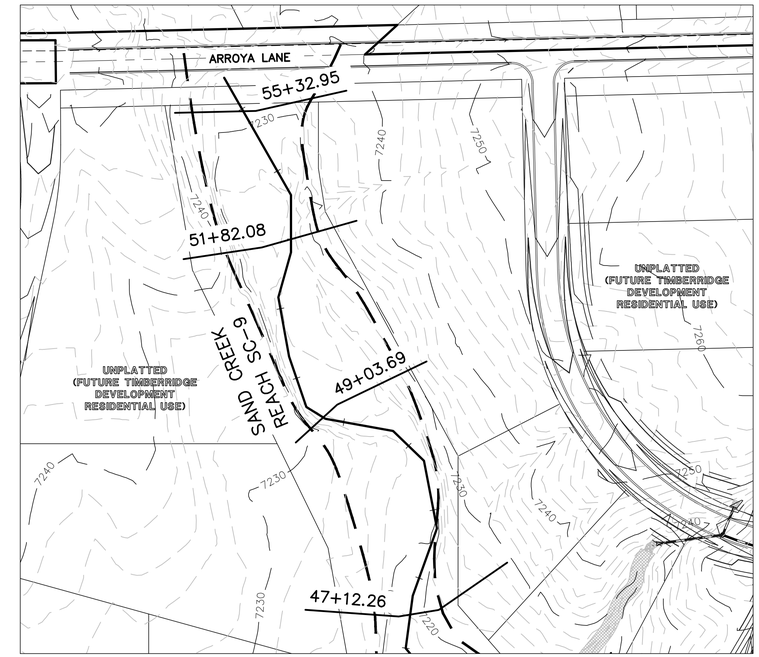
SEE RIGHT



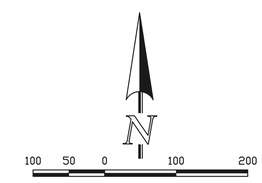
SEE RIGHT



SEE LEFT



SEE LEFT



SCALE: 1" = 100'

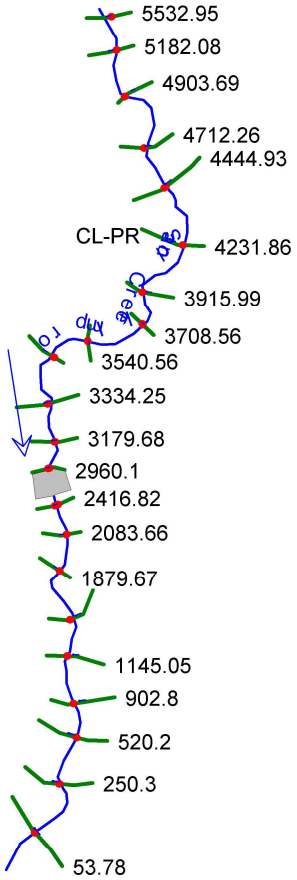
CLASSIC CONSULTING

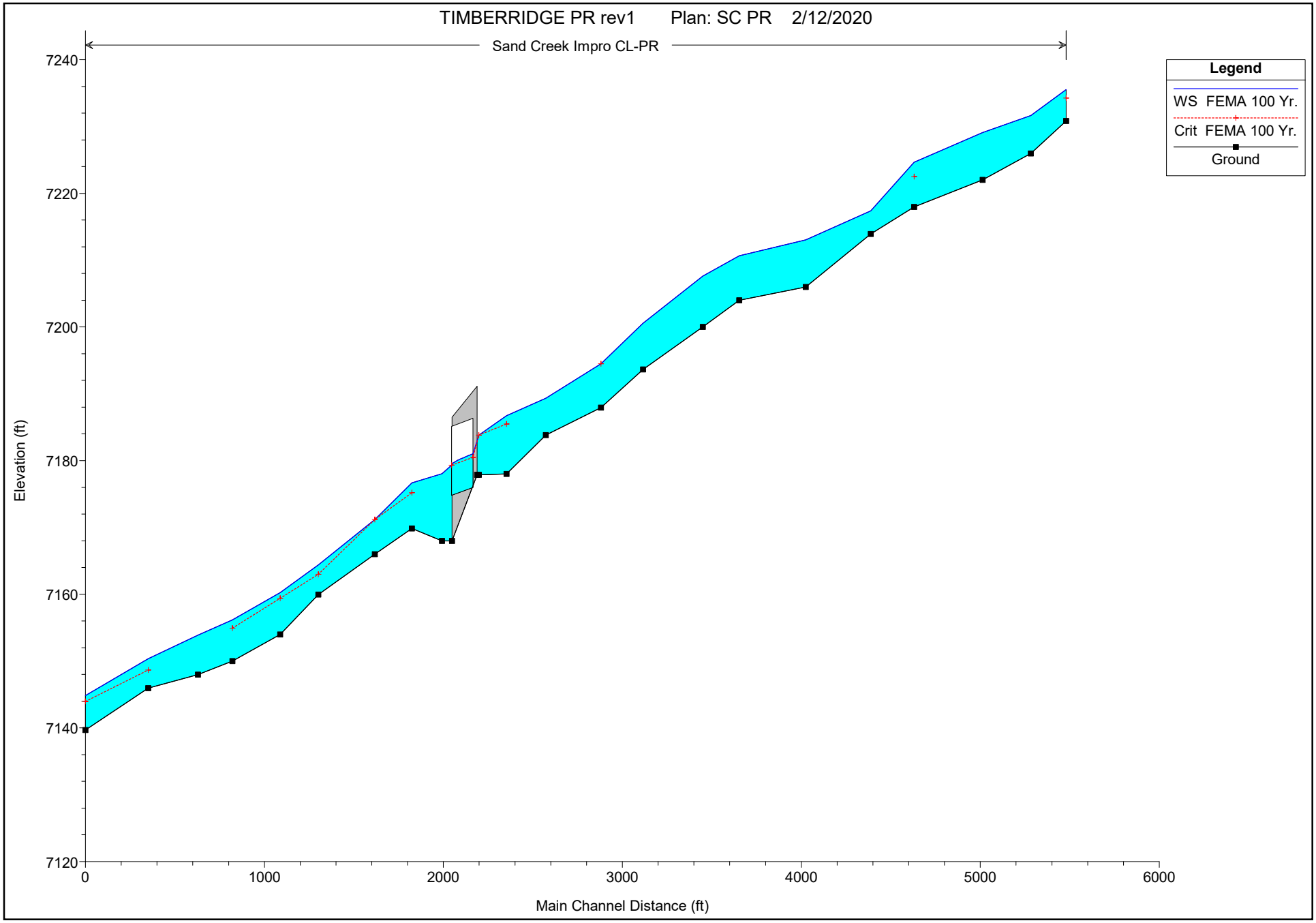
619 N. Cascade Avenue, Suite 200
Colorado Springs, Colorado 80903
(719)785-0790
(719)785-0799 (Fax)

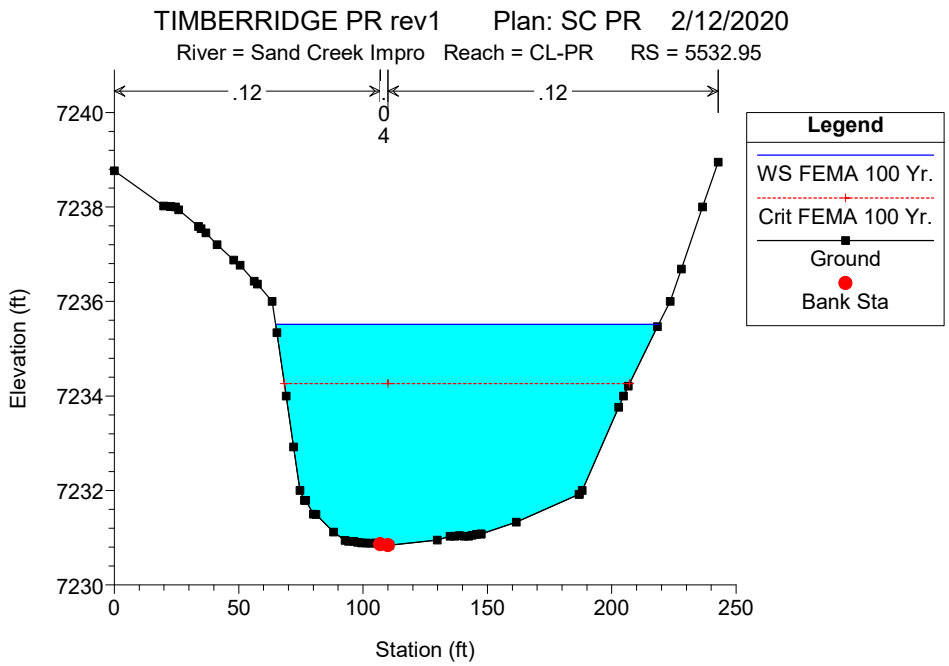
RETREAT AT TIMBERRIDGE FILING NO. 1
CONSTRUCTION PLANS
HEC-RAS ANALYSIS
CHANNEL STATIONING EXHIBIT

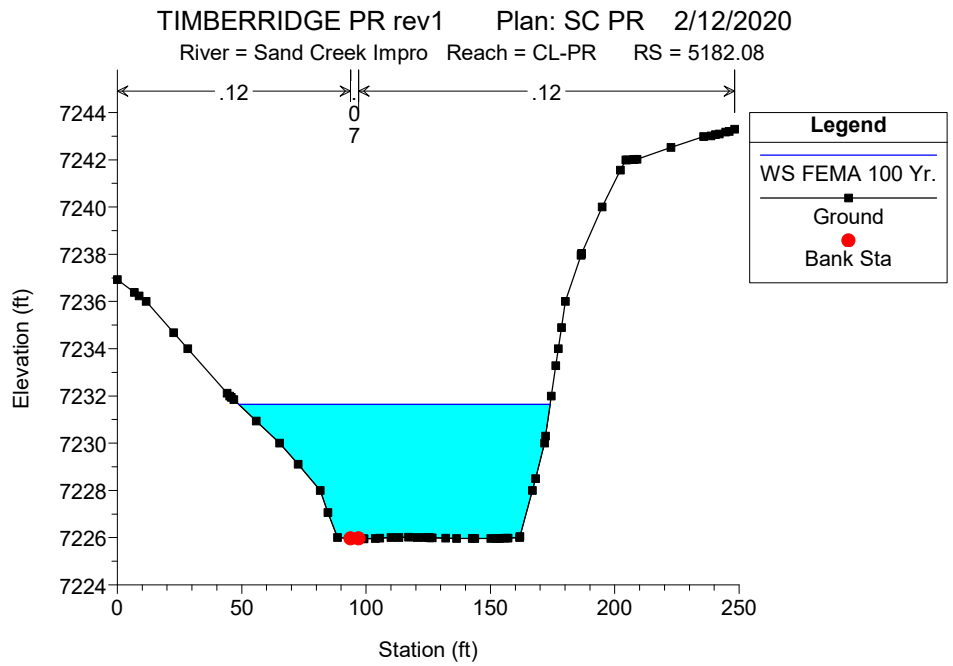
DESIGNED BY	MAW	SCALE	DATE	7/22/19
DRAWN BY	MAW	(H) 1"= 100'	SHEET 1	OF 1
CHECKED BY		(V) 1"= N/A	JOB NO.	1185.00

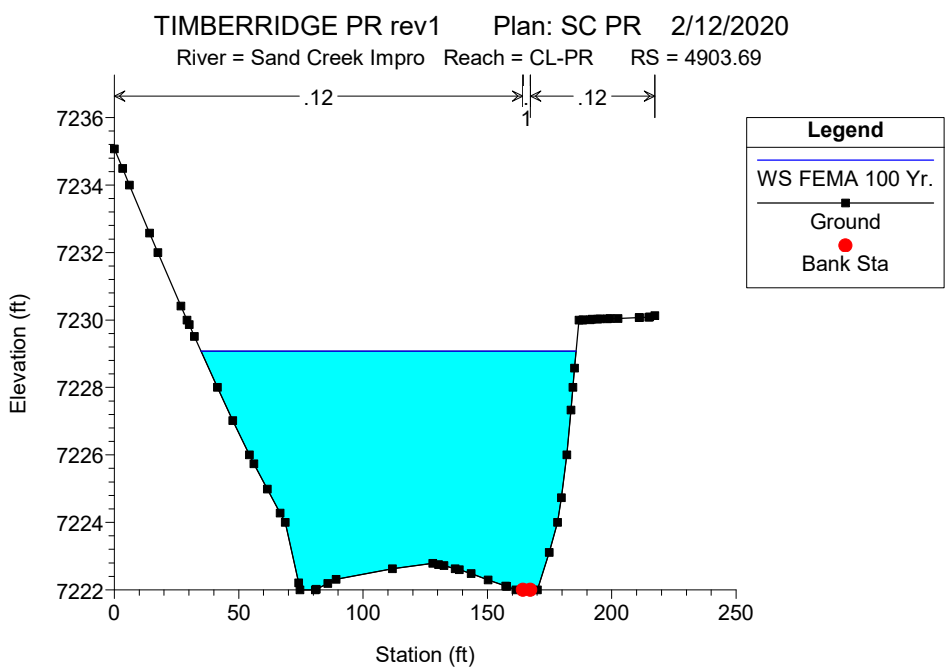
N:\1185001\DRAWINGS\SURFACES\HECRAS\HECRAS MODEL EXHIBIT.dwg, 8/1/2019 4:41:31 PM, 1:1

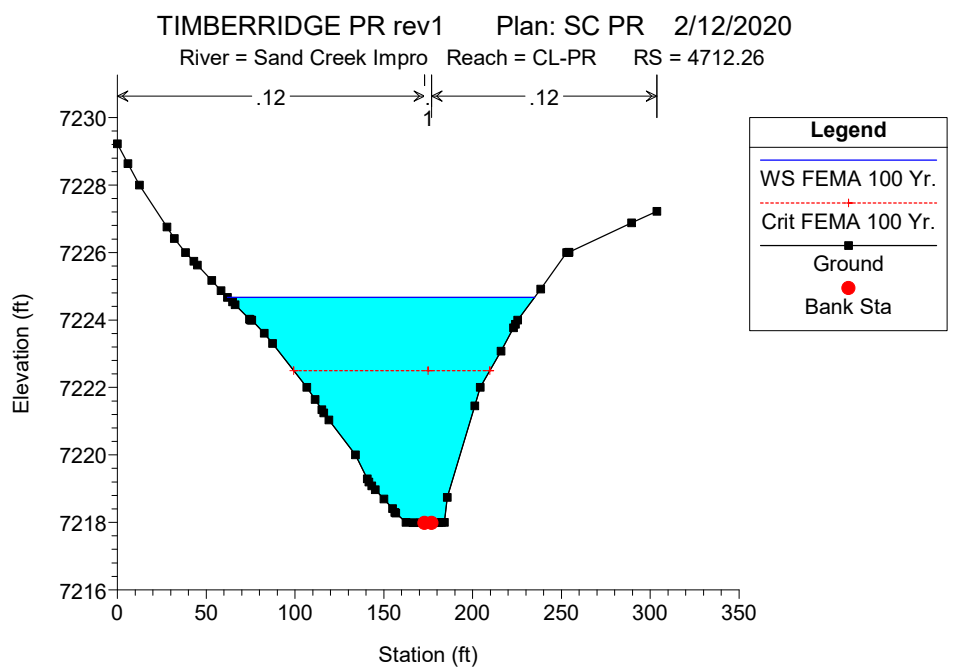

5532.95
5182.08
4903.69
4712.26
4444.93
CL-PR
4231.86
3915.99
3708.56
3540.56
3334.25
3179.68
2960.1
2416.82
2083.66
1879.67
1145.05
902.8
520.2
250.3
53.78

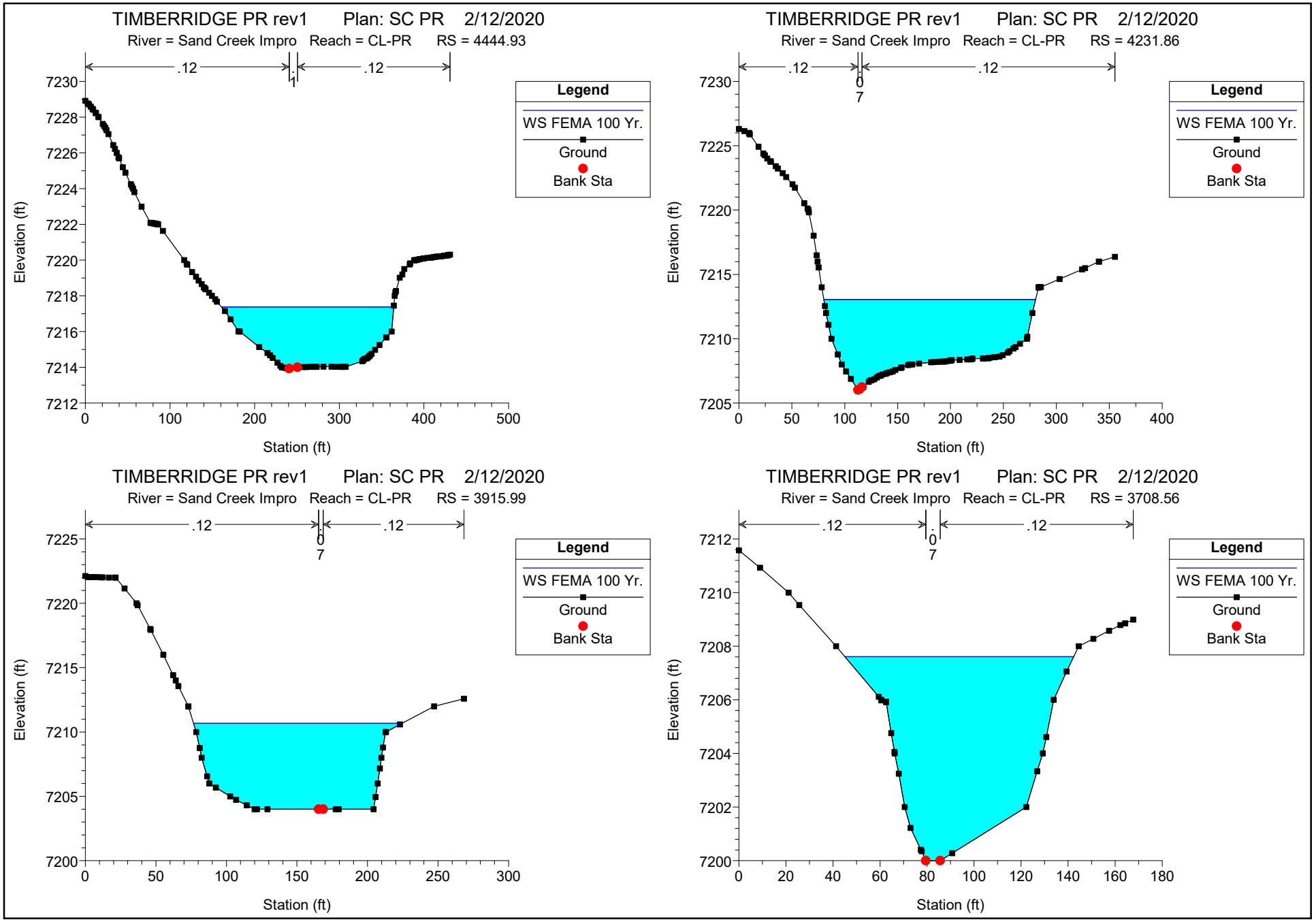

TIMBERRIDGE PR rev1 Plan: SC PR 2/12/2020
Sand Creek Impro CL-PR
Legend
WS FEMA 100 Yr.
Crit FEMA 100 Yr.
Ground
Elevation (ft)
7240
7220
7200
7180
7160
7140
7120
0
1000
2000
3000
4000
5000
6000
Main Channel Distance (ft)

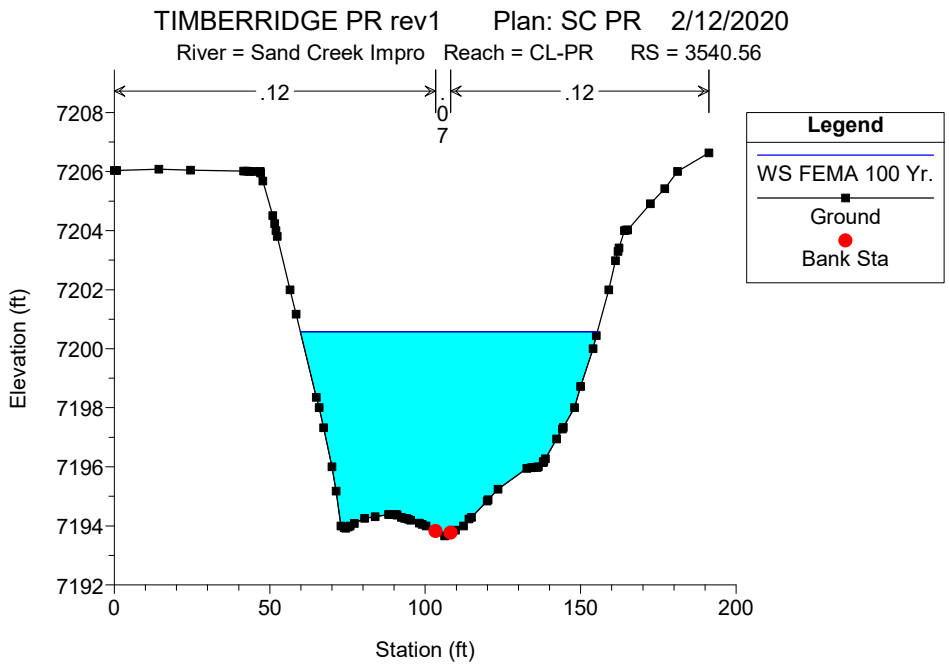

TIMBERRIDGE PR rev1 Plan: SC PR 2/12/2020
River = Sand Creek Impro Reach = CL-PR RS = 5532.95
.12
.12
0
4
Legend
WS FEMA 100 Yr.
Crit FEMA 100 Yr.
Ground
Bank Sta
Elevation (ft)
Station (ft)

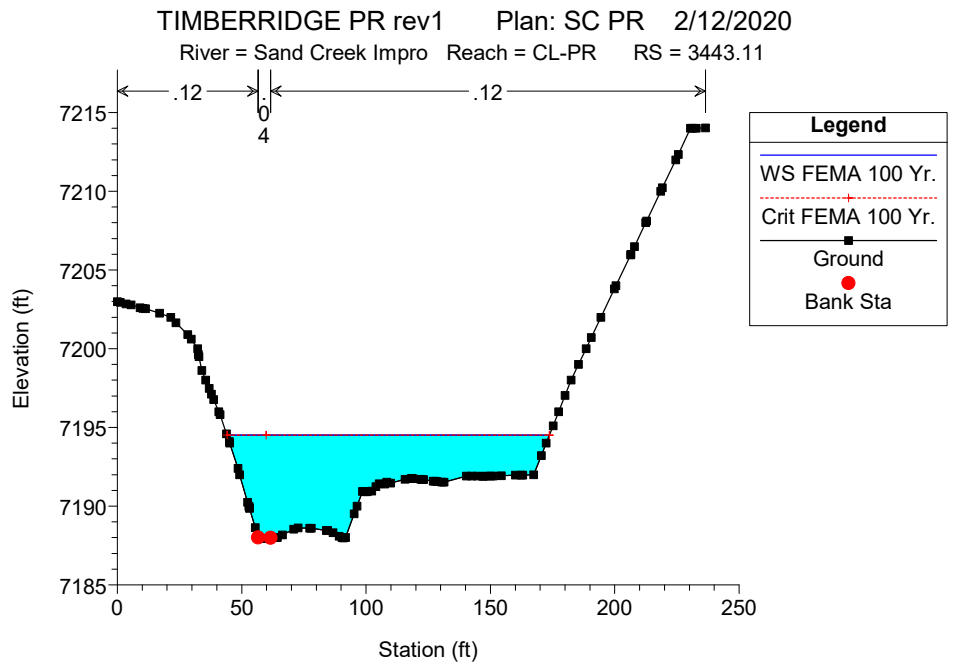

TIMBERRIDGE PR rev1 Plan: SC PR 2/12/2020
River = Sand Creek Impro Reach = CL-PR RS = 5182.08
.12
.12
0
7
Legend
WS FEMA 100 Yr.
Ground
Bank Sta
Elevation (ft)
Station (ft)

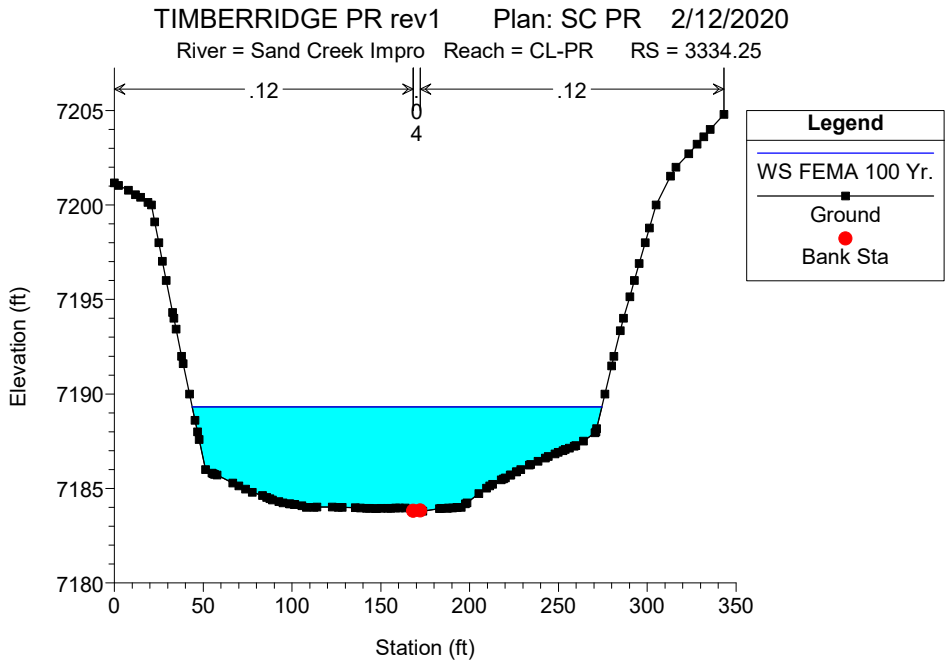

TIMBERRIDGE PR rev1 Plan: SC PR 2/12/2020
River = Sand Creek Impro Reach = CL-PR RS = 4903.69
.12
.12
1
Legend
WS FEMA 100 Yr.
Ground
Bank Sta
Elevation (ft)
Station (ft)

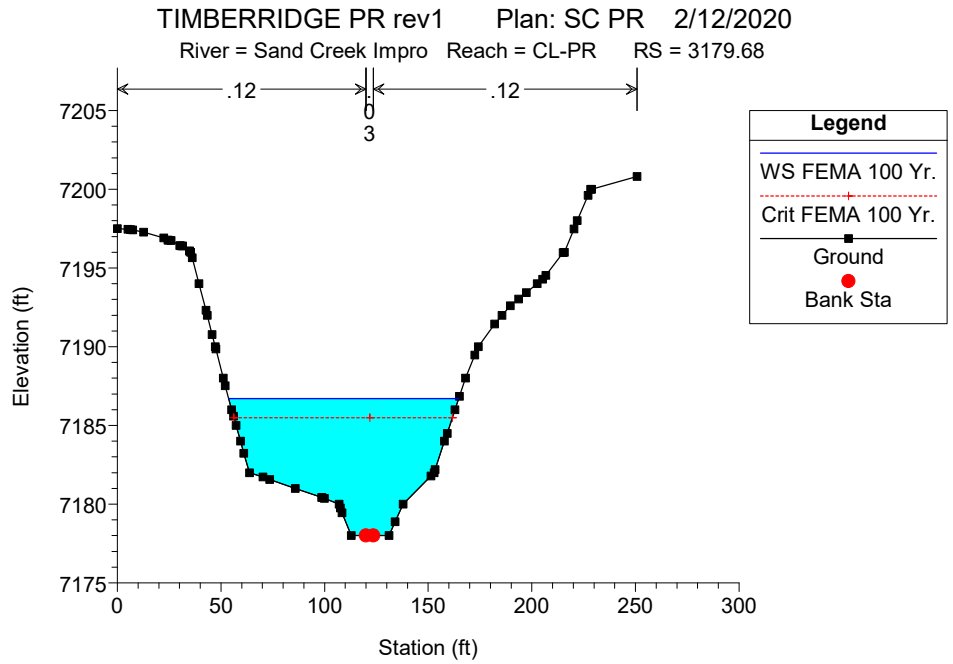

TIMBERRIDGE PR rev1 Plan: SC PR 2/12/2020
River = Sand Creek Impro Reach = CL-PR RS = 4712.26
.12
.12
1
Legend
WS FEMA 100 Yr.
Crit FEMA 100 Yr.
Ground
Bank Sta
Elevation (ft)
Station (ft)

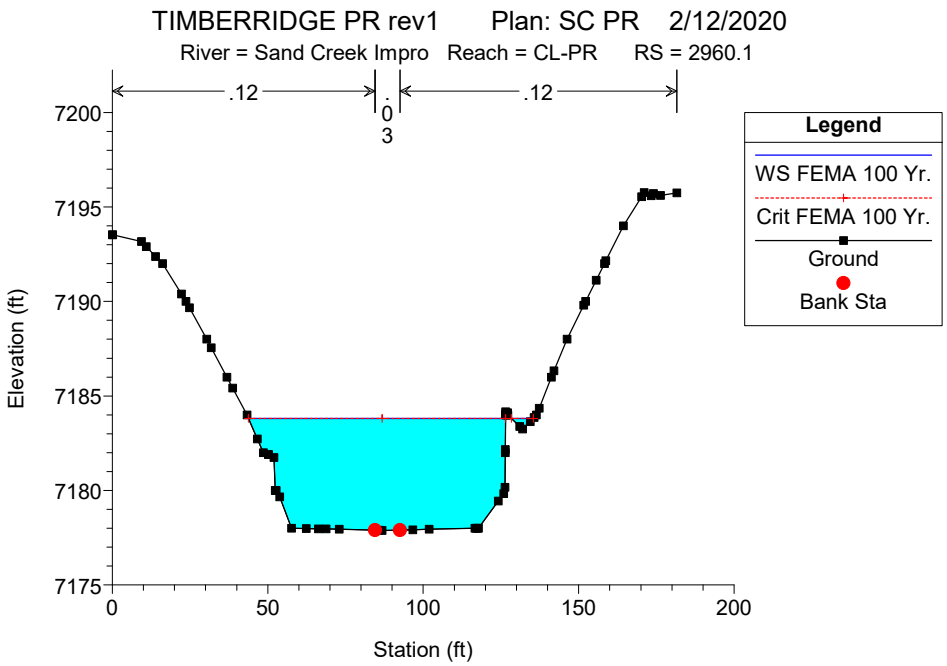

TIMBERRIDGE PR rev1 Plan: SC PR 2/12/2020
River = Sand Creek Impro Reach = CL-PR RS = 4444.93
.12
.1
.12
Legend
WS FEMA 100 Yr.
Ground
Bank Sta
Elevation (ft)
Station (ft)
TIMBERRIDGE PR rev1 Plan: SC PR 2/12/2020
River = Sand Creek Impro Reach = CL-PR RS = 4231.86
.12
.07
.12
Legend
WS FEMA 100 Yr.
Ground
Bank Sta
Elevation (ft)
Station (ft)
TIMBERRIDGE PR rev1 Plan: SC PR 2/12/2020
River = Sand Creek Impro Reach = CL-PR RS = 3915.99
.12
.07
.12
Legend
WS FEMA 100 Yr.
Ground
Bank Sta
Elevation (ft)
Station (ft)
TIMBERRIDGE PR rev1 Plan: SC PR 2/12/2020
River = Sand Creek Impro Reach = CL-PR RS = 3708.56
.12
.07
.12
Legend
WS FEMA 100 Yr.
Ground
Bank Sta
Elevation (ft)
Station (ft)

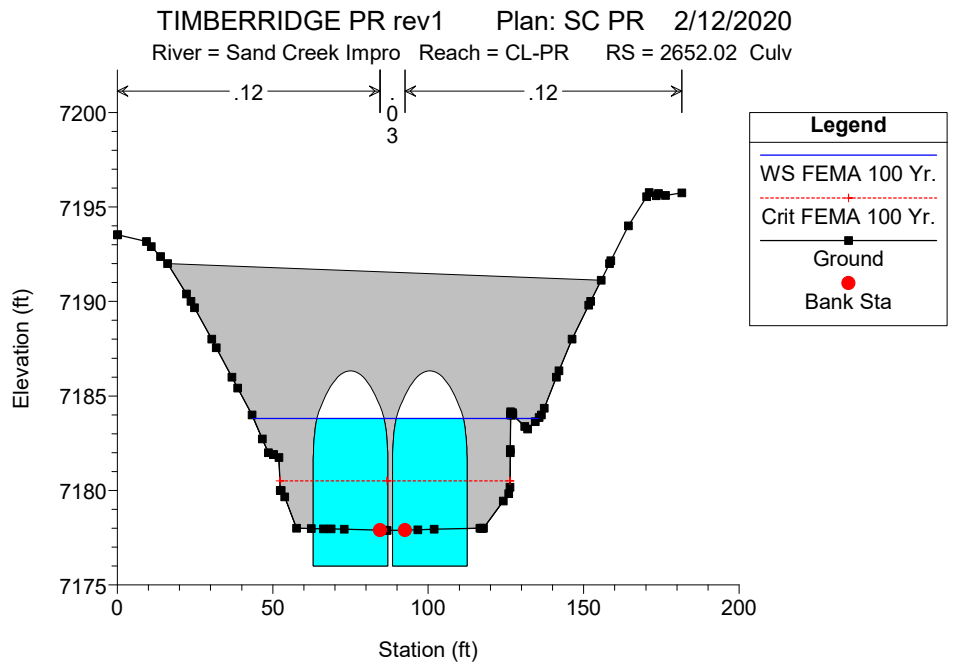

TIMBERRIDGE PR rev1 Plan: SC PR 2/12/2020
River = Sand Creek Impro Reach = CL-PR RS = 3540.56
.12
.07
.12
Legend
WS FEMA 100 Yr.
Ground
Bank Sta
Elevation (ft)
Station (ft)

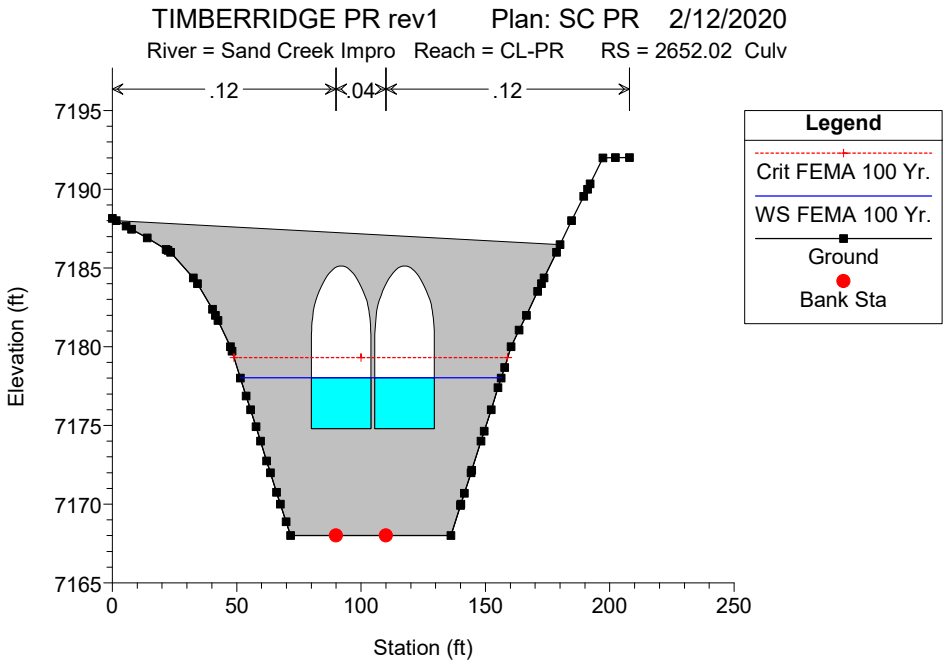

TIMBERRIDGE PR rev1 Plan: SC PR 2/12/2020
River = Sand Creek Impro Reach = CL-PR RS = 3443.11
.12
.04
.12
Legend
WS FEMA 100 Yr.
Crit FEMA 100 Yr.
Ground
Bank Sta
Elevation (ft)
Station (ft)

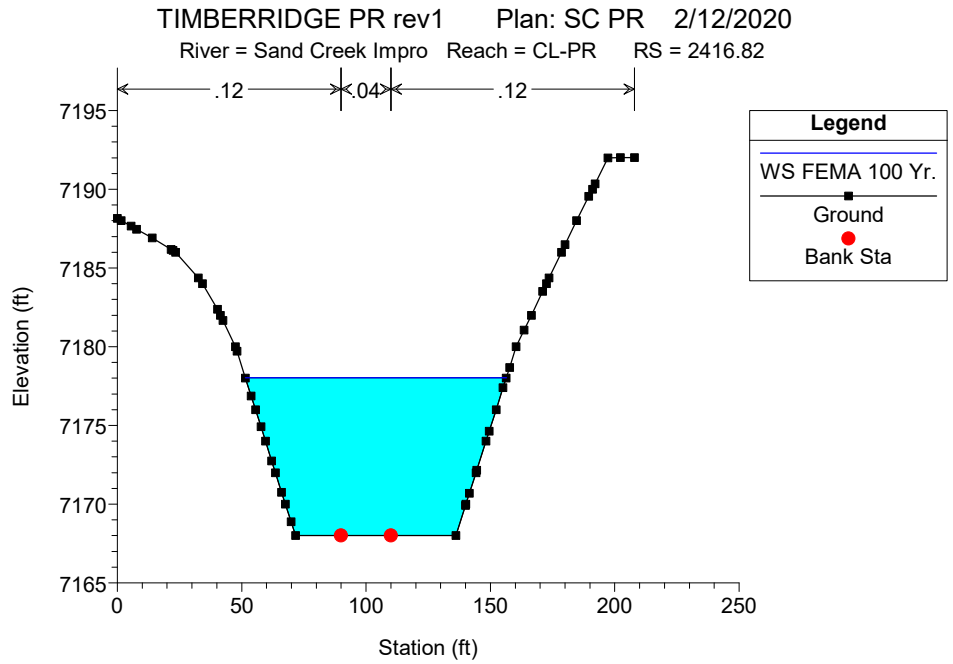

TIMBERRIDGE PR rev1 Plan: SC PR 2/12/2020
River = Sand Creek Impro Reach = CL-PR RS = 3334.25
.12
.04
.12
Legend
WS FEMA 100 Yr.
Ground
Bank Sta
Elevation (ft)
Station (ft)

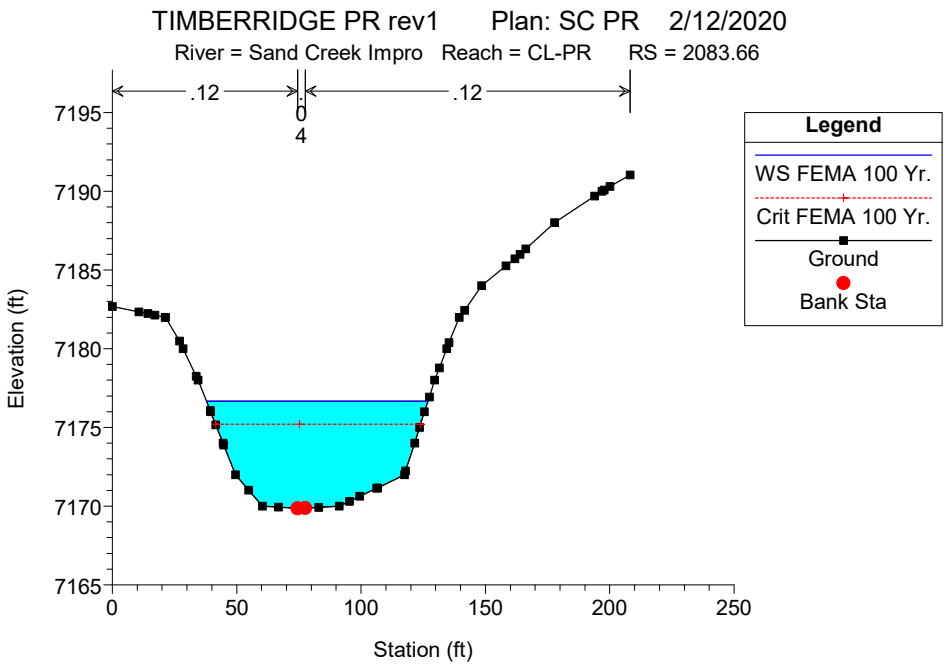

TIMBERRIDGE PR rev1 Plan: SC PR 2/12/2020
River = Sand Creek Impro Reach = CL-PR RS = 3179.68
.12
.03
.12
Legend
WS FEMA 100 Yr.
Crit FEMA 100 Yr.
Ground
Bank Sta
Elevation (ft)
Station (ft)

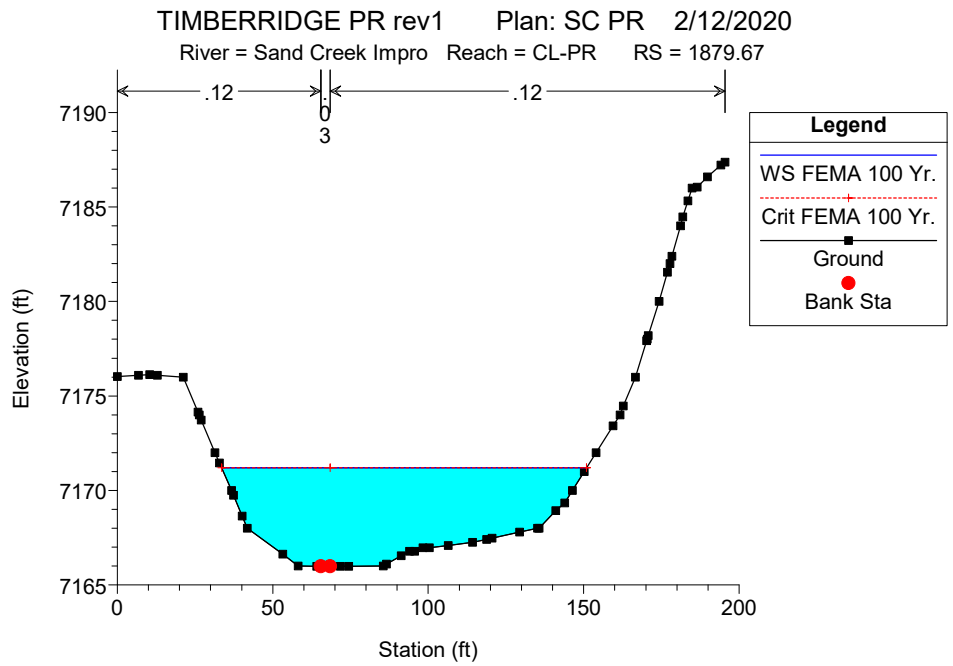

TIMBERRIDGE PR rev1 Plan: SC PR 2/12/2020
River = Sand Creek Impro Reach = CL-PR RS = 2960.1
.12
.03
.12
Legend
WS FEMA 100 Yr.
Crit FEMA 100 Yr.
Ground
Bank Sta
Elevation (ft)
Station (ft)

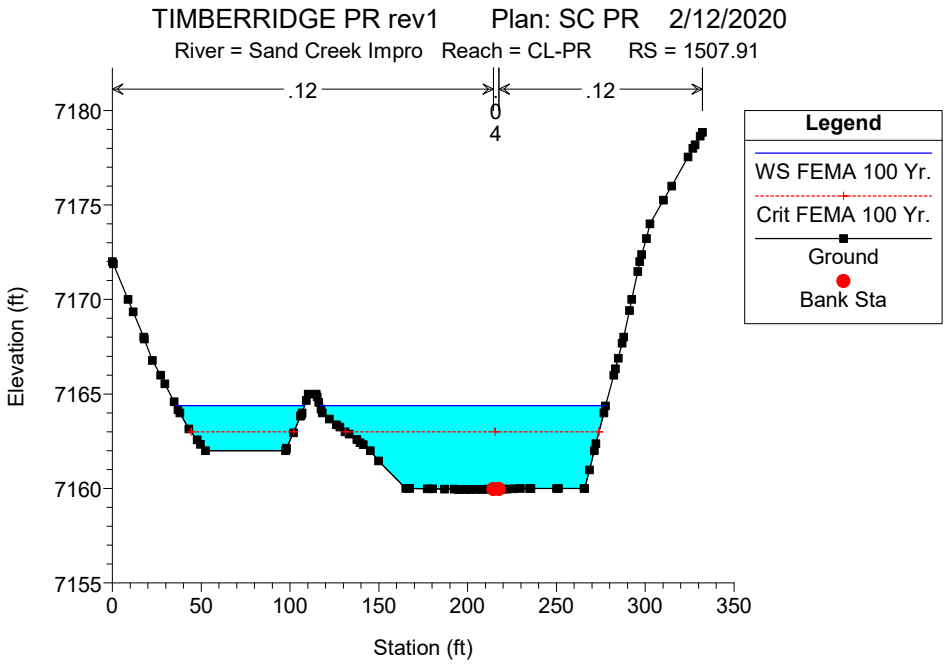

TIMBERRIDGE PR rev1 Plan: SC PR 2/12/2020
River = Sand Creek Impro Reach = CL-PR RS = 2652.02 Culv
.12
.03
.12
Legend
WS FEMA 100 Yr.
Crit FEMA 100 Yr.
Ground
Bank Sta
Elevation (ft)
Station (ft)

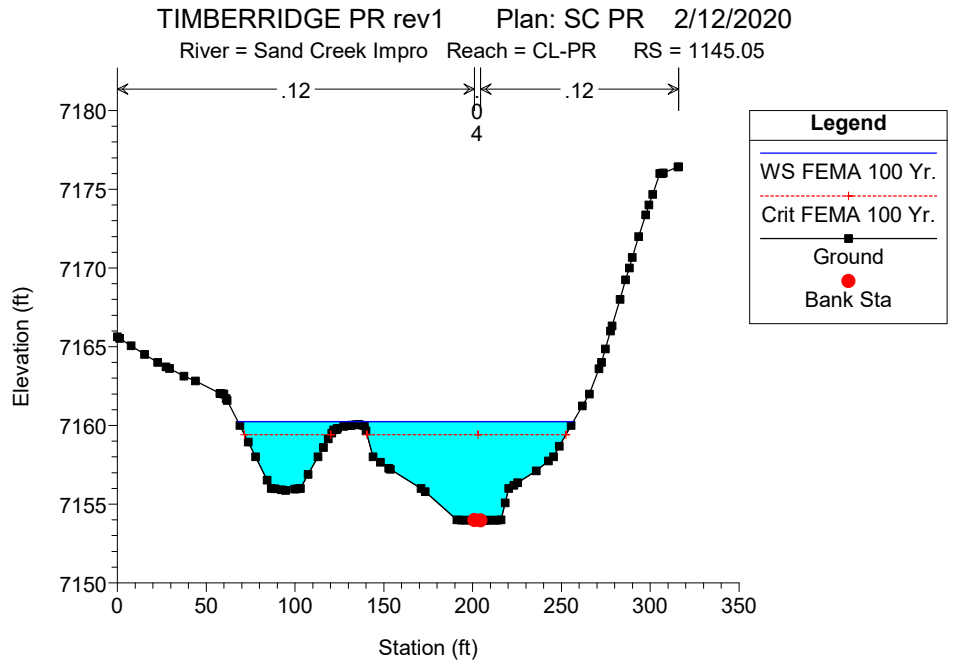

TIMBERRIDGE PR rev1 Plan: SC PR 2/12/2020
River = Sand Creek Impro Reach = CL-PR RS = 2652.02 Culv
.12
.04
.12
Legend
Crit FEMA 100 Yr.
WS FEMA 100 Yr.
Ground
Bank Sta
Elevation (ft)
Station (ft)

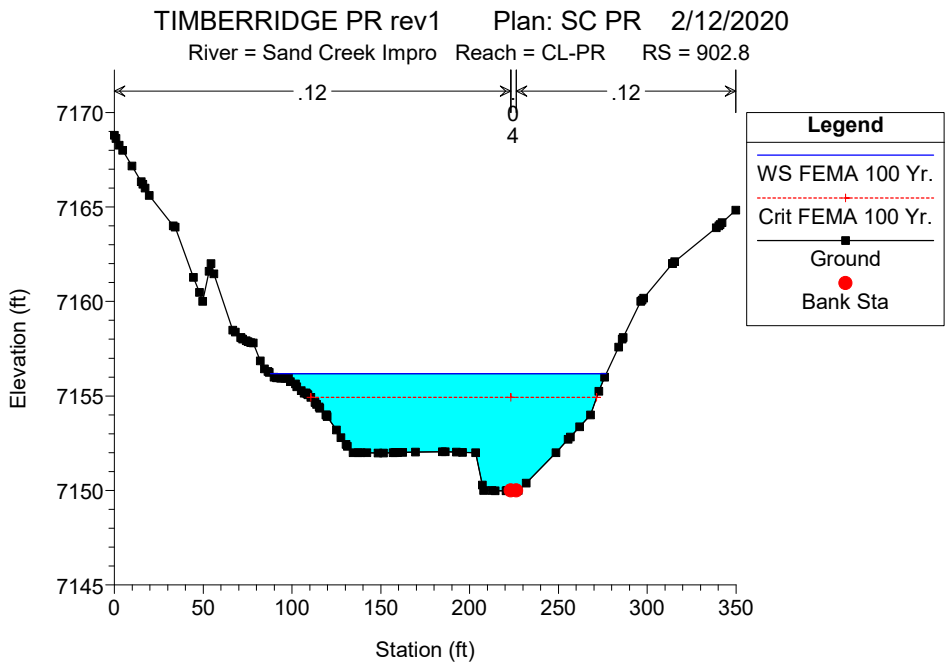

TIMBERRIDGE PR rev1 Plan: SC PR 2/12/2020
River = Sand Creek Impro Reach = CL-PR RS = 2416.82
.12
.04
.12
Legend
WS FEMA 100 Yr.
Ground
Bank Sta
Elevation (ft)
Station (ft)

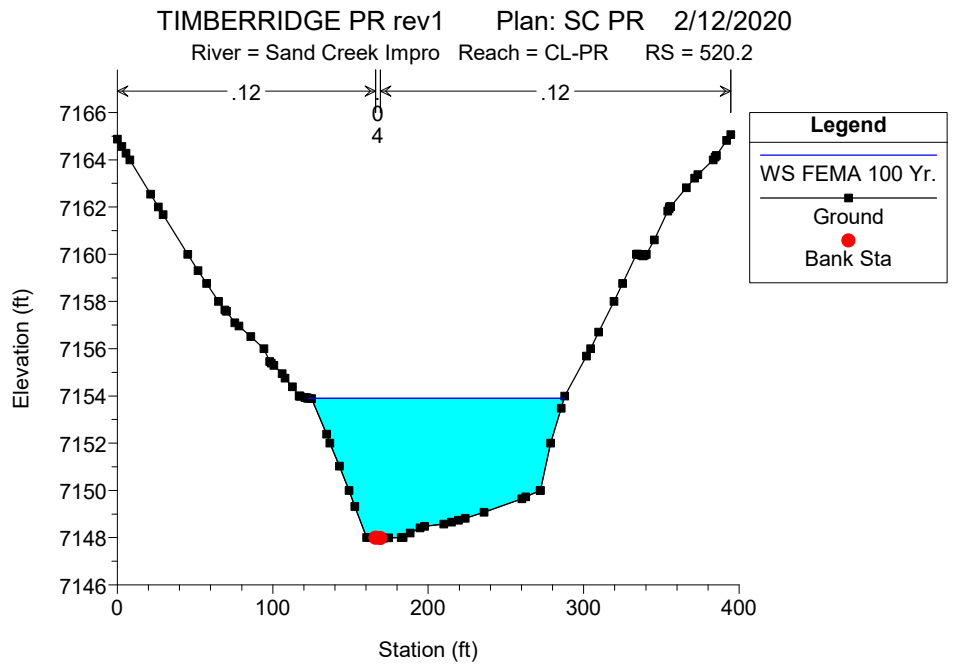

TIMBERRIDGE PR rev1 Plan: SC PR 2/12/2020
River = Sand Creek Impro Reach = CL-PR RS = 2083.66
.12
0
4
.12
Legend
WS FEMA 100 Yr.
Crit FEMA 100 Yr.
Ground
Bank Sta
Elevation (ft)
Station (ft)

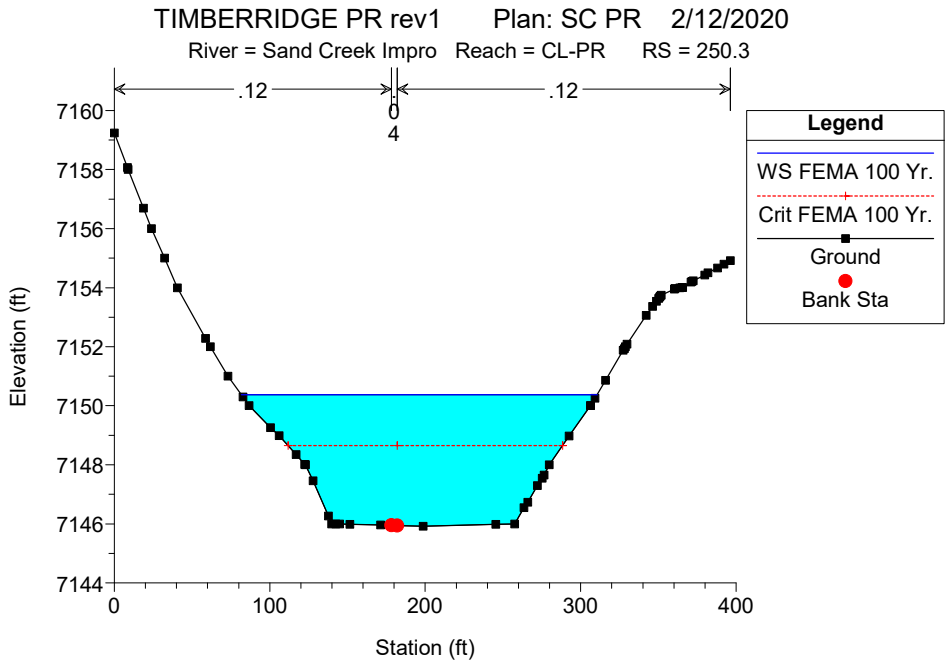

TIMBERRIDGE PR rev1 Plan: SC PR 2/12/2020
River = Sand Creek Impro Reach = CL-PR RS = 1879.67
.12
0
3
.12
Legend
WS FEMA 100 Yr.
Crit FEMA 100 Yr.
Ground
Bank Sta
Elevation (ft)
Station (ft)

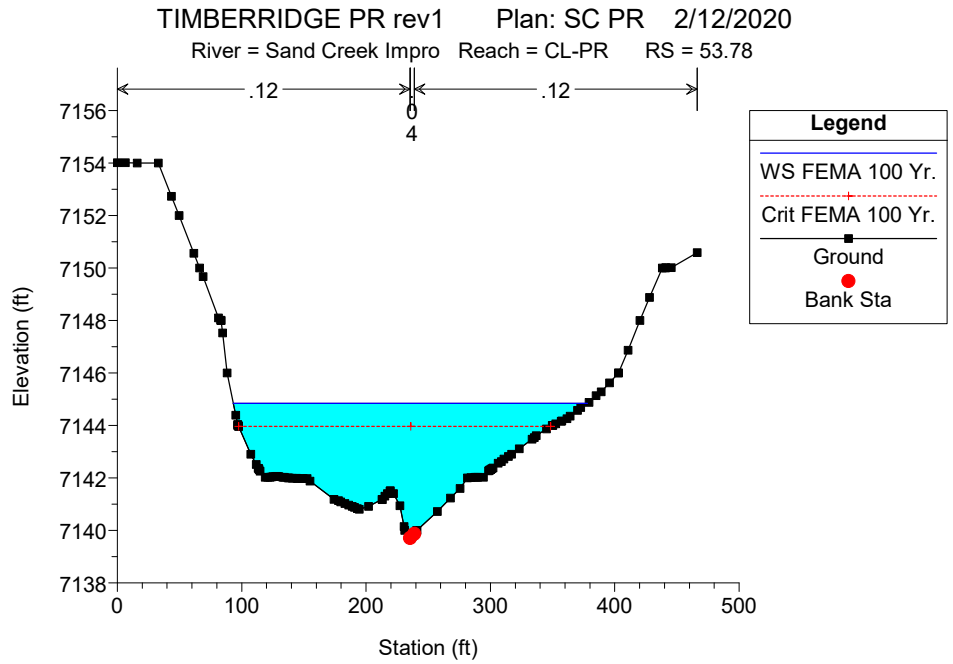

TIMBERRIDGE PR rev1 Plan: SC PR 2/12/2020
River = Sand Creek Impro Reach = CL-PR RS = 1507.91
.12
0
4
.12
Legend
WS FEMA 100 Yr.
Crit FEMA 100 Yr.
Ground
Bank Sta
Elevation (ft)
Station (ft)


TIMBERRIDGE PR rev1 Plan: SC PR 2/12/2020
River = Sand Creek Impro Reach = CL-PR RS = 1145.05
.12
0
4
.12
Legend
WS FEMA 100 Yr.
Crit FEMA 100 Yr.
Ground
Bank Sta
Elevation (ft)
Station (ft)


TIMBERRIDGE PR rev1 Plan: SC PR 2/12/2020
River = Sand Creek Impro Reach = CL-PR RS = 902.8
.12
0
4
.12
Legend
WS FEMA 100 Yr.
Crit FEMA 100 Yr.
Ground
Bank Sta
Elevation (ft)
Station (ft)


TIMBERRIDGE PR rev1 Plan: SC PR 2/12/2020
River = Sand Creek Impro Reach = CL-PR RS = 520.2
.12
0
4
.12
Legend
WS FEMA 100 Yr.
Ground
Bank Sta
Elevation (ft)
Station (ft)


TIMBERRIDGE PR rev1 Plan: SC PR 2/12/2020
River = Sand Creek Impro Reach = CL-PR RS = 250.3
.12
0
4
.12
Legend
WS FEMA 100 Yr.
Crit FEMA 100 Yr.
Ground
Bank Sta
Elevation (ft)
Station (ft)


TIMBERRIDGE PR rev1 Plan: SC PR 2/12/2020
River = Sand Creek Impro Reach = CL-PR RS = 53.78
.12
0
4
.12
Legend
WS FEMA 100 Yr.
Crit FEMA 100 Yr.
Ground
Bank Sta
Elevation (ft)
Station (ft)

HEC-RAS Plan: SC PR River: Sand Creek Impro Reach: CL-PR

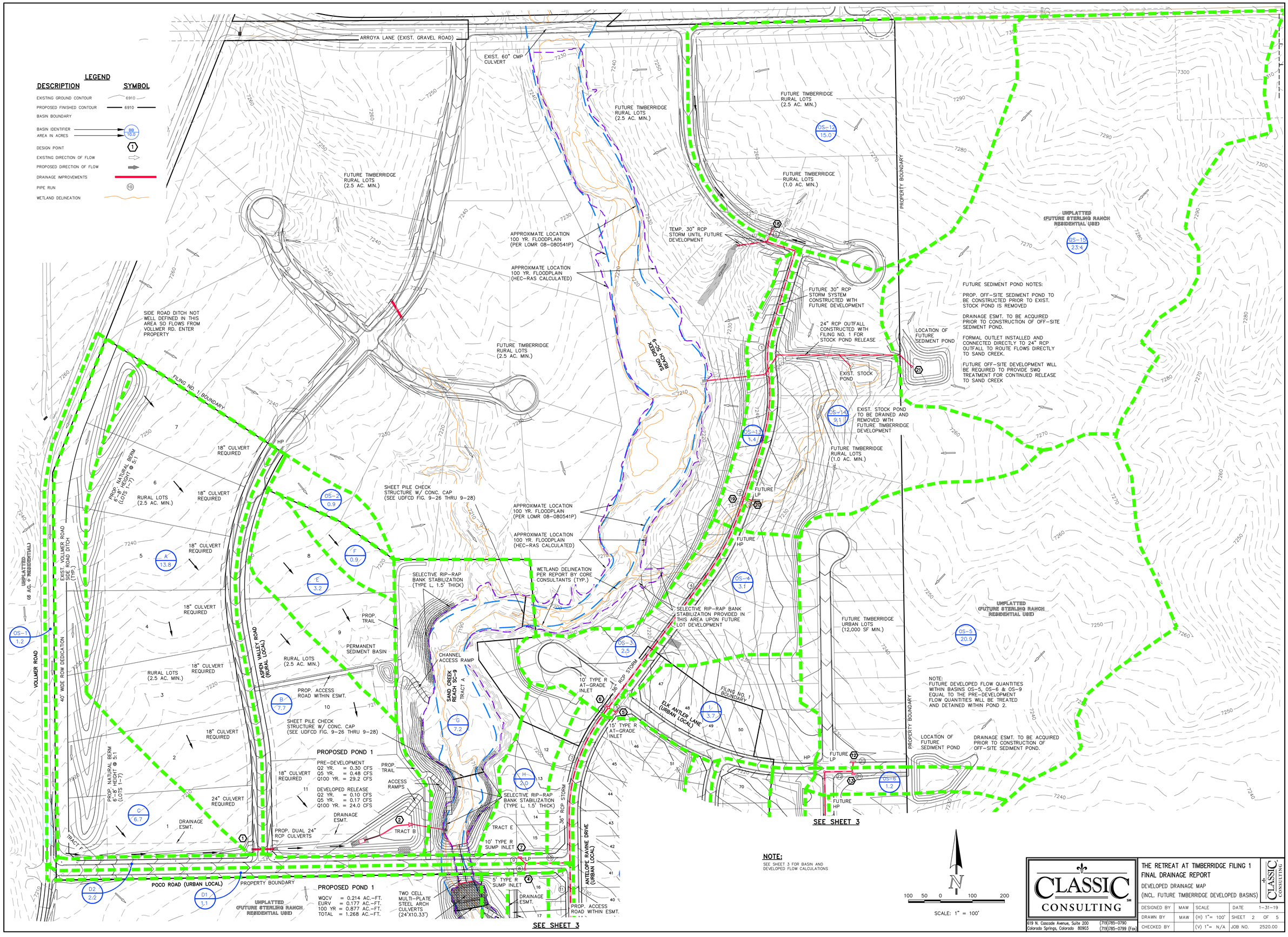
Reach	River Sta	Profile	Q Total	Min Ch El	W.S. Elev	Crit W.S.	Max Chl Dpth	Hydr Radius	E.G. Elev	E.G. Slope	Vel Total	Shear Total	Flow Area	Top Width	Froude # XS
			(cfs)	(ft)	(ft)	(ft)	(ft)	(ft)	(ft)	(ft/ft)	(ft/s)	(lb/sq ft)	(sq ft)	(ft)	
CL-PR	5532.95	FEMA 100 Yr.	2600	7230.84	7235.52	7234.26	4.68	3.61	7236.12	0.022532	4.65	5.08	559.31	154.07	0.57
CL-PR	5532.95	DBPS 100 Yr.	2170	7230.84	7235.07	7233.95	4.23	3.29	7235.61	0.022905	4.41	4.71	491.77	148.65	0.57
CL-PR	5532.95	DBPS 10 Yr.	630	7230.84	7233.06	7232.50	2.22	1.73	7233.31	0.023035	2.91	2.48	216.54	125.20	0.54
CL-PR	5532.95	Sterling MDDP 10	1487	7230.84	7234.29	7233.38	3.45	2.71	7234.72	0.023299	3.92	3.95	379.06	139.17	0.56
CL-PR	5532.95	Sterling MDDP 10	430	7230.84	7232.68	7232.24	1.84	1.40	7232.87	0.022857	2.53	2.00	169.66	120.97	0.53
CL-PR	5182.08	FEMA 100 Yr.	2600	7225.96	7231.65		5.70	4.27	7232.07	0.018615	4.79	4.96	542.74	125.32	0.44
CL-PR	5182.08	DBPS 100 Yr.	2170	7225.96	7231.06		5.11	3.92	7231.45	0.019462	4.61	4.76	470.87	118.58	0.44
CL-PR	5182.08	DBPS 10 Yr.	630	7225.96	7228.29		2.34	2.08	7228.49	0.026314	3.41	3.41	185.01	88.36	0.44
CL-PR	5182.08	Sterling MDDP 10	1487	7225.96	7229.99		4.04	3.26	7230.32	0.021471	4.24	4.37	351.05	106.45	0.44
CL-PR	5182.08	Sterling MDDP 10	430	7225.96	7227.79		1.84	1.68	7227.95	0.027798	3.02	2.92	142.22	84.05	0.43
CL-PR	4903.69	FEMA 100 Yr.	2600	7222.00	7229.08		7.08	5.44	7229.24	0.006504	3.12	2.21	834.06	150.85	0.24
CL-PR	4903.69	DBPS 100 Yr.	2170	7222.00	7228.49		6.48	5.01	7228.62	0.006323	2.91	1.98	745.50	146.47	0.23
CL-PR	4903.69	DBPS 10 Yr.	630	7222.00	7225.44		3.44	2.71	7225.50	0.005992	1.88	1.01	334.88	122.66	0.20
CL-PR	4903.69	Sterling MDDP 10	1487	7222.00	7227.37		5.37	4.19	7227.47	0.006083	2.53	1.59	586.67	138.19	0.22
CL-PR	4903.69	Sterling MDDP 10	430	7222.00	7224.81		2.81	2.20	7224.85	0.006187	1.66	0.85	258.54	116.93	0.20
CL-PR	4712.26	FEMA 100 Yr.	2600	7217.98	7224.67	7222.49	6.69	3.43	7225.00	0.022684	4.36	4.86	596.20	172.82	0.44
CL-PR	4712.26	DBPS 100 Yr.	2170	7217.98	7224.21	7222.08	6.23	3.29	7224.51	0.022022	4.17	4.52	520.04	157.47	0.43
CL-PR	4712.26	DBPS 10 Yr.	630	7217.98	7221.75	7220.15	3.76	2.32	7221.89	0.016998	2.91	2.46	216.66	92.87	0.35
CL-PR	4712.26	Sterling MDDP 10	1487	7217.98	7223.35	7221.41	5.37	2.98	7223.60	0.020224	3.75	3.77	396.37	132.21	0.40
CL-PR	4712.26	Sterling MDDP 10	430	7217.98	7221.22	7219.76	3.24	2.03	7221.33	0.015199	2.52	1.93	170.41	83.30	0.33
CL-PR	4444.93	FEMA 100 Yr.	2600	7213.93	7217.38		3.45	2.59	7217.78	0.041470	4.92	6.71	528.48	203.56	0.56
CL-PR	4444.93	DBPS 100 Yr.	2170	7213.93	7217.10		3.17	2.37	7217.45	0.040993	4.61	6.07	470.76	198.02	0.54
CL-PR	4444.93	DBPS 10 Yr.	630	7213.93	7215.68		1.75	1.26	7215.83	0.040995	3.03	3.23	207.63	164.62	0.49
CL-PR	4444.93	Sterling MDDP 10	1487	7213.93	7216.56		2.63	1.93	7216.83	0.041638	4.06	5.02	366.53	189.42	0.53
CL-PR	4444.93	Sterling MDDP 10	430	7213.93	7215.34		1.41	1.04	7215.47	0.044949	2.78	2.90	154.49	149.20	0.50
CL-PR	4231.86	FEMA 100 Yr.	2600	7206.00	7213.05		7.05	4.68	7213.18	0.005951	2.75	1.74	944.92	200.18	0.24
CL-PR	4231.86	DBPS 100 Yr.	2170	7206.00	7212.39		6.39	4.11	7212.52	0.006602	2.66	1.69	815.09	196.97	0.25
CL-PR	4231.86	DBPS 10 Yr.	630	7206.00	7209.91		3.91	1.87	7209.99	0.008531	1.84	0.99	341.65	182.71	0.29
CL-PR	4231.86	Sterling MDDP 10	1487	7206.00	7211.38		5.38	3.21	7211.49	0.007400	2.40	1.48	618.74	191.90	0.26
CL-PR	4231.86	Sterling MDDP 10	430	7206.00	7209.48		3.48	1.52	7209.55	0.008382	1.63	0.80	264.61	173.44	0.30
CL-PR	3915.99	FEMA 100 Yr.	2600	7203.99	7210.67		6.67	5.37	7210.84	0.006819	3.22	2.28	807.78	147.59	0.25
CL-PR	3915.99	DBPS 100 Yr.	2170	7203.99	7209.92		5.93	5.14	7210.08	0.006714	3.09	2.16	702.67	133.86	0.25
CL-PR	3915.99	DBPS 10 Yr.	630	7203.99	7206.76		2.77	2.41	7206.84	0.008606	2.12	1.29	297.60	122.40	0.25
CL-PR	3915.99	Sterling MDDP 10	1487	7203.99	7208.64		4.65	4.07	7208.77	0.007426	2.78	1.88	535.10	129.53	0.25
CL-PR	3915.99	Sterling MDDP 10	430	7203.99	7206.17		2.17	1.87	7206.23	0.009769	1.91	1.14	225.47	119.97	0.26
CL-PR	3708.56	FEMA 100 Yr.	2600	7200.00	7207.61		7.61	4.48	7208.47	0.022675	5.84	6.34	445.42	97.38	0.61
CL-PR	3708.56	DBPS 100 Yr.	2170	7200.00	7207.00		7.00	4.31	7207.76	0.022077	5.59	5.94	388.08	88.02	0.59
CL-PR	3708.56	DBPS 10 Yr.	630	7200.00	7203.76		3.76	2.53	7204.15	0.022567	3.98	3.57	158.43	61.66	0.55
CL-PR	3708.56	Sterling MDDP 10	1487	7200.00	7205.80		5.80	4.06	7206.39	0.020504	5.07	5.19	293.58	70.55	0.53
CL-PR	3708.56	Sterling MDDP 10	430	7200.00	7203.33		3.33	2.21	7203.60	0.017709	3.25	2.44	132.37	59.09	0.49
CL-PR	3540.56	FEMA 100 Yr.	2600	7193.66	7200.57		6.91	4.85	7201.18	0.020761	5.47	6.29	474.94	95.52	0.49
CL-PR	3540.56	DBPS 100 Yr.	2170	7193.66	7199.95		6.29	4.40	7200.51	0.021210	5.21	5.83	416.82	92.51	0.50
CL-PR	3540.56	DBPS 10 Yr.	630	7193.66	7197.31		3.65	2.46	7197.55	0.017340	3.28	2.66	191.88	76.96	0.43
CL-PR	3540.56	Sterling MDDP 10	1487	7193.66	7198.86		5.20	3.61	7199.31	0.021767	4.66	4.91	319.14	86.58	0.50

HEC-RAS Plan: SC PR River: Sand Creek Impro Reach: CL-PR (Continued)

Reach	River Sta	Profile	Q Total	Min Ch El	W.S. Elev	Crit W.S.	Max Chl Dpth	Hydr Radius	E.G. Elev	E.G. Slope	Vel Total	Shear Total	Flow Area	Top Width	Froude # XS
			(cfs)	(ft)	(ft)	(ft)	(ft)	(ft)	(ft)	(ft/ft)	(ft/s)	(lb/sq ft)	(sq ft)	(ft)	
CL-PR	3540.56	Sterling MDDP 10	430	7193.66	7196.50		2.84	1.84	7196.75	0.024145	3.26	2.77	131.95	70.93	0.51
CL-PR	3443.11	FEMA 100 Yr.	2600	7187.94	7194.51	7194.51	6.56	3.73	7196.07	0.021671	5.27	5.04	492.98	129.56	0.91
CL-PR	3443.11	DBPS 100 Yr.	2170	7187.94	7194.15	7194.15	6.21	3.42	7195.54	0.020111	4.85	4.30	447.03	127.88	0.89
CL-PR	3443.11	DBPS 10 Yr.	630	7187.94	7191.36	7190.82	3.42	2.37	7192.50	0.025903	4.74	3.84	132.80	54.41	0.96
CL-PR	3443.11	Sterling MDDP 10	1487	7187.94	7193.45	7193.45	5.51	2.83	7194.60	0.017805	4.14	3.14	359.38	124.76	0.89
CL-PR	3443.11	Sterling MDDP 10	430	7187.94	7190.91	7190.56	2.97	2.24	7191.62	0.019329	3.94	2.70	109.12	47.34	0.79
CL-PR	3334.25	FEMA 100 Yr.	2600	7183.81	7189.32		5.52	4.23	7189.51	0.005907	2.65	1.56	981.23	230.65	0.30
CL-PR	3334.25	DBPS 100 Yr.	2170	7183.81	7188.66		4.86	3.64	7188.85	0.006937	2.61	1.58	830.90	227.52	0.32
CL-PR	3334.25	DBPS 10 Yr.	630	7183.81	7186.03		2.23	1.57	7186.19	0.015218	2.24	1.50	280.91	178.27	0.45
CL-PR	3334.25	Sterling MDDP 10	1487	7183.81	7187.56		3.76	2.68	7187.75	0.009702	2.55	1.62	582.77	217.08	0.38
CL-PR	3334.25	Sterling MDDP 10	430	7183.81	7185.57	7185.03	1.77	1.27	7185.72	0.017980	2.12	1.42	202.82	159.92	0.48
CL-PR	3179.68	FEMA 100 Yr.	2600	7178.00	7186.71	7185.49	8.71	5.63	7187.94	0.007518	4.06	2.64	639.85	110.97	0.65
CL-PR	3179.68	DBPS 100 Yr.	2170	7178.00	7185.75	7184.94	7.75	4.91	7187.04	0.008743	4.05	2.68	535.16	106.58	0.72
CL-PR	3179.68	DBPS 10 Yr.	630	7178.00	7182.53	7182.53	4.53	2.33	7183.49	0.009626	2.92	1.40	215.73	91.59	0.91
CL-PR	3179.68	Sterling MDDP 10	1487	7178.00	7184.63	7184.05	6.63	4.06	7185.70	0.008282	3.55	2.10	418.93	101.39	0.72
CL-PR	3179.68	Sterling MDDP 10	430	7178.00	7181.91	7181.80	3.91	1.84	7182.82	0.009671	2.68	1.11	160.58	86.43	0.99
CL-PR	2960.1	FEMA 100 Yr.	2600	7177.88	7183.81	7183.81	5.93	4.52	7186.24	0.015014	6.00	4.24	433.01	89.70	1.00
CL-PR	2960.1	DBPS 100 Yr.	2170	7177.88	7183.62	7183.62	5.74	4.49	7185.43	0.011742	5.22	3.29	415.72	86.85	0.87
CL-PR	2960.1	DBPS 10 Yr.	630	7177.88	7180.25	7180.25	2.37	2.07	7181.27	0.020692	4.06	2.68	155.15	73.90	0.99
CL-PR	2960.1	Sterling MDDP 10	1487	7177.88	7181.69	7181.69	3.81	3.37	7183.66	0.021780	5.67	4.58	262.04	74.31	1.06
CL-PR	2960.1	Sterling MDDP 10	430	7177.88	7179.69	7179.69	1.81	1.59	7180.56	0.024632	3.75	2.45	114.63	71.48	1.04
CL-PR	2652.02		Culvert												
CL-PR	2416.82	FEMA 100 Yr.	2600	7168.00	7178.03		10.03	7.75	7178.46	0.001610	3.06	0.78	850.03	104.94	0.32
CL-PR	2416.82	DBPS 100 Yr.	2170	7168.00	7177.34		9.34	7.31	7177.69	0.001441	2.79	0.66	778.14	102.14	0.30
CL-PR	2416.82	DBPS 10 Yr.	630	7168.00	7173.86		5.86	4.92	7173.94	0.000608	1.41	0.19	447.31	88.13	0.18
CL-PR	2416.82	Sterling MDDP 10	1487	7168.00	7176.06		8.06	6.46	7176.28	0.001131	2.29	0.46	650.59	96.97	0.26
CL-PR	2416.82	Sterling MDDP 10	430	7168.00	7173.14		5.14	4.39	7173.19	0.000445	1.12	0.12	384.42	85.21	0.15
CL-PR	2083.66	FEMA 100 Yr.	2600	7169.86	7176.67	7175.20	6.81	5.12	7177.75	0.018458	5.56	5.90	467.69	89.07	0.64
CL-PR	2083.66	DBPS 100 Yr.	2170	7169.86	7176.09	7174.72	6.23	4.72	7177.04	0.017970	5.20	5.29	417.06	86.40	0.63
CL-PR	2083.66	DBPS 10 Yr.	630	7169.86	7173.17	7172.49	3.31	2.49	7173.62	0.017534	3.42	2.72	183.97	73.27	0.59
CL-PR	2083.66	Sterling MDDP 10	1487	7169.86	7175.02	7173.85	5.16	3.93	7175.75	0.017320	4.55	4.25	327.03	81.60	0.60
CL-PR	2083.66	Sterling MDDP 10	430	7169.86	7172.54	7172.09	2.68	1.96	7172.93	0.019196	3.10	2.35	138.88	70.36	0.62
CL-PR	1879.67	FEMA 100 Yr.	2600	7165.99	7171.19	7171.19	5.21	3.81	7172.98	0.028576	5.75	6.80	451.84	117.40	0.96
CL-PR	1879.67	DBPS 100 Yr.	2170	7165.99	7170.77	7170.77	4.79	3.48	7172.37	0.028116	5.39	6.11	402.44	114.64	0.96
CL-PR	1879.67	DBPS 10 Yr.	630	7165.99	7168.82	7168.76	2.84	1.90	7169.55	0.021750	3.29	2.58	191.77	100.63	0.88
CL-PR	1879.67	Sterling MDDP 10	1487	7165.99	7170.01	7170.01	4.03	2.87	7171.29	0.026838	4.68	4.82	317.64	109.73	0.94
CL-PR	1879.67	Sterling MDDP 10	430	7165.99	7168.47	7168.38	2.49	1.60	7169.02	0.018443	2.74	1.84	156.86	97.71	0.83
CL-PR	1507.91	FEMA 100 Yr.	2600	7159.96	7164.39	7162.99	4.45	3.06	7164.73	0.016308	3.62	3.12	718.84	233.19	0.47
CL-PR	1507.91	DBPS 100 Yr.	2260	7159.96	7164.01	7162.75	4.07	2.77	7164.36	0.017902	3.57	3.09	633.11	227.58	0.50
CL-PR	1507.91	DBPS 10 Yr.	670	7159.96	7161.95	7161.23	2.01	1.78	7162.17	0.024174	2.99	2.68	224.05	125.58	0.50
CL-PR	1507.91	Sterling MDDP 10	1520	7159.96	7163.22	7162.20	3.28	2.22	7163.52	0.019435	3.30	2.69	460.79	206.84	0.51
CL-PR	1507.91	Sterling MDDP 10	450	7159.96	7161.46	7160.95	1.52	1.36	7161.65	0.029371	2.75	2.49	163.35	120.10	0.52

HEC-RAS Plan: SC PR River: Sand Creek Impro Reach: CL-PR (Continued)

Reach	River Sta	Profile	Q Total	Min Ch El	W.S. Elev	Crit W.S.	Max Chl Dpth	Hydr Radius	E.G. Elev	E.G. Slope	Vel Total	Shear Total	Flow Area	Top Width	Froude # XS
			(cfs)	(ft)	(ft)	(ft)	(ft)	(ft)	(ft)	(ft/ft)	(ft/s)	(lb/sq ft)	(sq ft)	(ft)	
CL-PR	1145.05	FEMA 100 Yr.	2600	7153.97	7160.24	7159.42	6.27	3.31	7161.05	0.017947	4.11	3.71	632.55	188.76	0.69
CL-PR	1145.05	DBPS 100 Yr.	2260	7153.97	7159.81	7159.12	5.84	3.25	7160.55	0.017500	4.07	3.55	555.47	169.09	0.67
CL-PR	1145.05	DBPS 10 Yr.	670	7153.97	7157.71	7157.23	3.74	1.89	7158.17	0.014848	2.76	1.75	242.44	127.39	0.69
CL-PR	1145.05	Sterling MDDP 10	1520	7153.97	7158.97	7158.47	5.00	2.72	7159.61	0.017020	3.61	2.89	420.96	153.05	0.68
CL-PR	1145.05	Sterling MDDP 10	450	7153.97	7157.22		3.25	1.64	7157.59	0.013306	2.45	1.36	183.48	111.09	0.67
CL-PR	902.8	FEMA 100 Yr.	2600	7149.99	7156.18	7154.92	6.20	3.63	7156.73	0.014153	3.77	3.20	689.09	188.94	0.55
CL-PR	902.8	DBPS 100 Yr.	2260	7149.99	7155.77	7154.69	5.79	3.47	7156.29	0.014206	3.68	3.08	614.39	175.99	0.54
CL-PR	902.8	DBPS 10 Yr.	670	7149.99	7153.42	7153.18	3.44	1.75	7153.84	0.017659	2.74	1.93	244.17	139.03	0.69
CL-PR	902.8	Sterling MDDP 10	1520	7149.99	7154.82	7154.13	4.84	2.83	7155.28	0.015070	3.35	2.66	454.21	159.68	0.57
CL-PR	902.8	Sterling MDDP 10	450	7149.99	7152.94	7152.85	2.96	1.36	7153.37	0.019105	2.51	1.62	179.34	131.19	0.79
CL-PR	520.2	FEMA 100 Yr.	2600	7147.98	7153.90		5.92	4.25	7154.31	0.011062	3.70	2.94	703.30	164.34	0.44
CL-PR	520.2	DBPS 100 Yr.	2260	7147.98	7153.53		5.55	4.04	7153.90	0.010733	3.51	2.71	643.97	158.44	0.42
CL-PR	520.2	DBPS 10 Yr.	670	7147.98	7151.16		3.18	2.22	7151.33	0.009612	2.25	1.33	297.97	134.05	0.39
CL-PR	520.2	Sterling MDDP 10	1520	7147.98	7152.61		4.63	3.37	7152.89	0.010142	3.03	2.13	502.24	148.41	0.41
CL-PR	520.2	Sterling MDDP 10	450	7147.98	7150.66		2.68	1.79	7150.80	0.009375	1.94	1.05	231.82	129.26	0.39
CL-PR	250.3	FEMA 100 Yr.	2600	7145.95	7150.37	7148.65	4.45	3.22	7150.71	0.015150	3.52	3.05	738.50	228.86	0.46
CL-PR	250.3	DBPS 100 Yr.	2260	7145.95	7150.08	7148.41	4.16	3.03	7150.39	0.014919	3.36	2.82	673.05	221.77	0.45
CL-PR	250.3	DBPS 10 Yr.	670	7145.95	7148.12		2.20	1.85	7148.24	0.012952	2.25	1.50	297.75	160.58	0.37
CL-PR	250.3	Sterling MDDP 10	1520	7145.95	7149.33	7147.88	3.41	2.59	7149.56	0.014206	2.95	2.30	514.46	198.14	0.42
CL-PR	250.3	Sterling MDDP 10	450	7145.95	7147.68		1.76	1.53	7147.78	0.012593	1.95	1.20	230.66	150.96	0.35
CL-PR	53.78	FEMA 100 Yr.	2600	7139.68	7144.84	7143.96	5.16	2.74	7145.25	0.016008	3.33	2.74	781.65	284.79	0.55
CL-PR	53.78	DBPS 100 Yr.	2260	7139.68	7144.58	7143.81	4.90	2.56	7144.97	0.016007	3.19	2.56	708.62	276.00	0.55
CL-PR	53.78	DBPS 10 Yr.	670	7139.68	7142.89	7142.65	3.21	1.43	7143.19	0.016011	2.24	1.42	298.70	209.26	0.64
CL-PR	53.78	Sterling MDDP 10	1520	7139.68	7143.92	7143.35	4.24	2.14	7144.27	0.016001	2.85	2.14	534.10	249.07	0.57
CL-PR	53.78	Sterling MDDP 10	450	7139.68	7142.52	7142.40	2.84	1.15	7142.81	0.016008	2.01	1.15	224.09	193.76	0.70



CLASSIC CONSULTING

619 N. Cascade Avenue, Suite 200
Colorado Springs, Colorado 80903
(719)785-0790
(719)785-0799 (Fax)

THE RETREAT AT TIMBERRIDGE FILING 1
FINAL DRAINAGE REPORT
DEVELOPED DRAINAGE MAP
(INCL. FUTURE TIMBERRIDGE DEVELOPED BASINS)

DESIGNED BY	MAW	SCALE	DATE	1-31-19
DRAWN BY	MAW	(H) 1"= 100'	SHEET 2 OF 5	
CHECKED BY		(V) 1"= N/A	JOB NO.	2520.00

FINAL DRAINAGE REPORT ~ SURFACE ROUTING SUMMARY

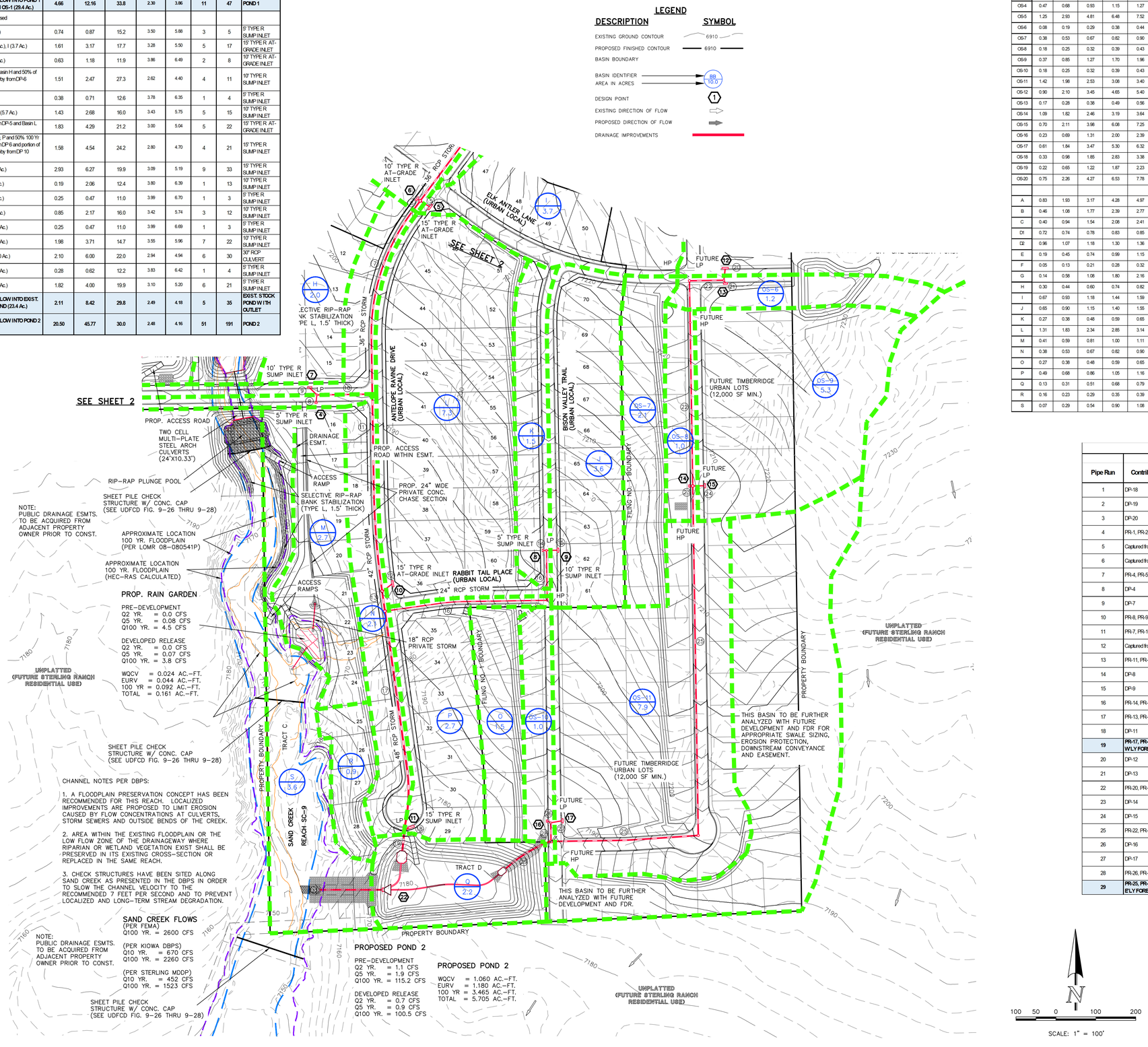
Design Point(s)	Contributing Basins	Equivalent CA(5)	Equivalent CA(100)	Maximum Tc	Intensity I(5)	Intensity I(100)	Flow Q(5)	Flow Q(100)	Inlet Size
1	A (13.8 Ac.), OS-1 (1.2 Ac.) and C (6.7 Ac.)	3.58	9.08	31.8	2.39	4.02	9	36	DUAL 24" RCP CULVERTS
2	**TOTAL INFLOW INTO POND 1 A, B, C and OS-1 (29.4 Ac.)**	**4.66**	**12.16**	**33.8**	**2.30**	**3.86**	**11**	**47**	**POND 1**
3	No longer used								
4	D1 (1.1 Ac.)	0.74	0.87	15.2	3.50	5.88	3	5	5' TYPE R SUMP INLET
5	OS-4 (3.1 Ac.), I (3.7 Ac.)	1.61	3.17	17.7	3.28	5.50	5	17	15' TYPE R AT-GRADE INLET
6	OS-3 (2.5 Ac.)	0.63	1.18	11.9	3.86	6.49	2	8	10' TYPE R AT-GRADE INLET
7	Basin D2, Basin H and 50% of 100 yr Flowby from DP-6 (5.5 Ac)	1.51	2.47	27.3	2.62	4.40	4	11	10' TYPE R SUMP INLET
8	K (1.5 Ac.)	0.38	0.71	12.6	3.78	6.35	1	4	5' TYPE R SUMP INLET
9	J and OS-7 (5.7 Ac.)	1.43	2.68	16.0	3.43	5.75	5	15	10' TYPE R SUMP INLET
10	Flowby from DP-5 and Basin L (7.3 Ac)	1.83	4.29	21.2	3.00	5.04	5	22	15' TYPE R AT-GRADE INLET
11	Basins N, O, P and 50% 100 Yr. Flowby from DP 6 and portion of 100 Yr Flowby from DP 10 (13.6 Ac)	1.58	4.54	24.2	2.80	4.70	4	21	15' TYPE R SUMP INLET
12	OS-5 (20.9Ac.)	2.93	6.27	19.9	3.09	5.19	9	33	15' TYPE R SUMP INLET
13	OS-6 (1.2Ac.)	0.19	2.06	12.4	3.80	6.39	1	13	10' TYPE R SUMP INLET
14	OS-8 (1.0Ac.)	0.25	0.47	11.0	3.99	6.70	1	3	5' TYPE R SUMP INLET
15	OS-9 (5.3 Ac.)	0.85	2.17	16.0	3.42	5.74	3	12	10' TYPE R SUMP INLET
16	OS-10 (1.0 Ac.)	0.25	0.47	11.0	3.99	6.69	1	3	5' TYPE R SUMP INLET
17	OS-11 (7.9 Ac.)	1.98	3.71	14.7	3.55	5.96	7	22	10' TYPE R SUMP INLET
18	OS-12 (15.0 Ac.)	2.10	6.00	22.0	2.94	4.94	6	30	30" RCP CULVERT
19	OS-13 (1.4 Ac.)	0.28	0.62	12.2	3.83	6.42	1	4	5' TYPE R SUMP INLET
20	OS-14 (9.1 Ac.)	1.82	4.00	19.9	3.10	5.20	6	21	5' TYPE R SUMP INLET
21	**TOTAL INFLOW INTO EXIST. STOCK POND (23.4 Ac.)**	**2.11**	**8.42**	**29.8**	**2.49**	**4.18**	**5**	**35**	**EXIST. STOCK POND WITH OUTLET**
22	**TOTAL INFLOW INTO POND 2 (104.8 Ac.)**	**20.50**	**45.77**	**30.0**	**2.48**	**4.16**	**51**	**191**	**POND 2**

FINAL DRAINAGE REPORT ~ BASIN RUNOFF SUMMARY

BASIN	CA(2)	CA(5)	CA(10)	CA(25)	CA(50)	CA(100)	C(5)	Overland Length (ft)	Overland Height (ft)	Overland Tc (min)	Street / Channel Flow Length (ft)	Slope (%)	Velocity (fps)	Tc (min)	Tc TOTAL (min)	I(2) (in/hr)	I(5) (in/hr)	I(10) (in/hr)	I(25) (in/hr)	I(50) (in/hr)	I(100) (in/hr)	Q(2) (cfs)	Q(5) (cfs)	Q(100) (cfs)
OS-1	0.68	0.71	0.76	0.82	0.85	0.88	0.08	10	0.2	4.6	1700	3.5%	1.9	15.1	19.8	2.48	3.11	3.62	4.14	4.66	5.21	2	2	5
OS-2	0.02	0.07	0.14	0.23	0.27	0.32	0.08	300	10.5	21.1					21.1	2.41	3.01	3.51	4.01	4.51	5.05	0.0	0.2	1.6
OS-3	0.45	0.63	0.80	0.98	1.08	1.18	0.25	55	1.1	9.1	600	3.0%	3.5	2.9	11.9	3.08	3.86	4.51	5.15	5.80	6.49	1	2	8
OS-4	0.47	0.68	0.93	1.15	1.27	1.43	0.22	200	6	15.6	400	3.0%	3.5	1.9	17.6	2.62	3.28	3.83	4.38	4.93	5.51	1	2	8
OS-5	1.25	2.93	4.81	6.48	7.52	8.36	0.14	200	8	15.5	750	2.0%	2.8	4.4	19.9	2.47	3.09	3.61	4.13	4.64	5.19	3	9	43
OS-6	0.08	0.19	0.29	0.38	0.44	0.49	0.16	55	1.1	10.0	500	3.0%	3.5	2.4	12.4	3.04	3.80	4.44	5.07	5.71	6.39	0.3	1	3
OS-7	0.38	0.53	0.67	0.82	0.90	0.99	0.25	100	10	7.2					7.2	3.69	4.63	5.40	6.17	6.94	7.77	1	2	8
OS-8	0.18	0.25	0.32	0.39	0.43	0.47	0.25	55	1.1	9.1	400	3.0%	3.5	1.9	11.0	3.18	3.99	4.65	5.32	5.98	6.70	1	1	3
OS-9	0.37	0.85	1.27	1.70	1.96	2.17	0.16	200	10	14.1	400	3.0%	3.5	1.9	16.0	2.73	3.42	3.99	4.56	5.13	5.74	1	3	12
OS-10	0.18	0.25	0.32	0.39	0.43	0.47	0.25	55	1.1	9.1	450	3.8%	3.9	1.9	11.0	3.18	3.99	4.65	5.32	5.98	6.69	1	1	3
OS-11	1.42	1.98	2.53	3.08	3.40	3.71	0.25	200	10	12.8	450	3.8%	3.9	1.9	14.7	2.84	3.55	4.14	4.74	5.33	5.96	4	7	22
OS-12	0.90	2.10	3.45	4.65	5.40	6.00	0.14	300	13	18.5	600	2.0%	2.8	3.5	22.0	2.35	2.94	3.43	3.93	4.42	4.94	2	6	30
OS-13	0.17	0.28	0.38	0.49	0.56	0.62	0.20	55	1.1	9.6	450	2.0%	2.8	2.7	12.2	3.05	3.83	4.46	5.10	5.74	6.42	0.5	1	4
OS-14	1.09	1.82	2.46	3.19	3.64	4.00	0.20	300	12	17.8	350	2.0%	2.8	2.1	19.9	2.48	3.10	3.62	4.13	4.65	5.20	3	6	21
OS-15	0.70	2.11	3.98	6.08	7.25	8.42	0.09	300	16	18.2	1300	3.5%	1.9	11.6	29.8	2.00	2.49	2.91	3.32	3.74	4.18	1	5	35
OS-16	0.23	0.69	1.31	2.00	2.39	2.77	0.09	300	10	21.2	600	3.5%	1.9	5.3	26.6	2.13	2.66	3.11	3.55	4.00	4.47	0.5	2	12
OS-17	0.61	1.84	3.47	5.30	6.32	7.34	0.09	300	9.5	21.6	650	3.5%	1.9	5.8	27.4	2.10	2.62	3.05	3.49	3.93	4.39	1.3	5	32
OS-18	0.33	0.98	1.85	2.83	3.38	3.92	0.09	300	10	21.2	700	3.5%	1.9	6.2	27.5	2.09	2.61	3.05	3.49	3.92	4.39	0.7	3	17
OS-19	0.22	0.65	1.22	1.87	2.23	2.59	0.09	300	10	21.2	400	3.5%	1.9	3.6	24.8	2.21	2.77	3.23	3.69	4.15	4.64	0.5	2	12
OS-20	0.75	2.26	4.27	6.53	7.78	9.04	0.09	300	16	18.2	1300	3.5%	1.9	11.6	29.8	2.00	2.49	2.91	3.32	3.74	4.18	2	6	38
A	0.83	1.93	3.17	4.28	4.97	5.52	0.14	300	10.5	19.9	1280	3.2%	1.8	11.9	31.8	1.92	2.39	2.79	3.19	3.59	4.02	2	5	22
B	0.46	1.08	1.77	2.39	2.77	3.08	0.14	300	10.5	19.9	400	2.0%	1.4	4.7	24.6	2.23	2.78	3.24	3.71	4.17	4.67	1	3	14
C	0.40	0.94	1.54	2.08	2.41	2.68	0.14	300	10.5	19.9	1100	1.5%	2.4	7.5	27.3	2.10	2.62	3.06	3.49	3.93	4.40	1	2	12
D1	0.72	0.74	0.78	0.83	0.85	0.87	0.08	15	0.3	5.7	1400	1.5%	2.4	9.5	15.2	2.80	3.50	4.08	4.67	5.25	5.88	2	3	5
D2	0.96	1.07	1.18	1.30	1.36	1.43	0.25	55	1.1	9.1	500	2.5%	3.2	2.6	11.7	3.11	3.89	4.54	5.19	5.84	6.54	3	4	9
E	0.19	0.45	0.74	0.99	1.15	1.28	0.14	300	10.5	19.9	300	2.0%	1.4	3.5	23.4	2.28	2.85	3.33	3.81	4.28	4.79	0.4	1	6
F	0.05	0.13	0.21	0.28	0.32	0.36	0.14	300	10.5	19.9					19.9	2.48	3.10	3.62	4.13	4.65	5.20	0.1	0.4	1.9
G	0.14	0.58	1.08	1.80	2.16	2.52	0.08	70	14	5.7	900	2.0%	1.4	10.6	16.3	2.71	3.39	3.96	4.52	5.09	5.70	0.4	2	14
H	0.30	0.44	0.60	0.74	0.82	0.92	0.22	100	4	10.1	300	3.0%	3.5	1.4	11.5	3.13	3.92	4.57	5.23	5.88	6.58	1	2	6
I	0.67	0.93	1.18	1.44	1.59	1.74	0.25	120	3	12.4	550	3.5%	3.7	2.4	14.9	2.82	3.53	4.12	4.71	5.30	5.93	2	3	10
J	0.65	0.90	1.15	1.40	1.55	1.69	0.25	120	3	12.4	600	2.0%	2.8	3.5	16.0	2.74	3.43	4.00	4.57	5.14	5.75	2	3	10
K	0.27	0.38	0.48	0.59	0.65	0.71	0.25	55	1.1	9.1	600	2.0%	2.8	3.5	12.6	3.02	3.78	4.41	5.05	5.68	6.35	0.8	1	4
L	1.31	1.83	2.34	2.85	3.14	3.43	0.25	150	4.5	13.1	850	2.5%	3.2	4.5	17.6	2.62	3.28	3.83	4.38	4.93	5.51	3	6	19
M	0.41	0.59	0.81	1.00	1.11	1.24	0.22	100	4	10.1	400	2.0%	2.8	2.4	12.4	3.04	3.80	4.44	5.07	5.71	6.39	1	2	8
N	0.38	0.53	0.67	0.82	0.90	0.99	0.25	55	1.1	9.1	1050	2.0%	2.8	6.2	15.2	2.79	3.50	4.08	4.66	5.25	5.87	1	2	6
O	0.27	0.38	0.48	0.59	0.65	0.71	0.25	80	5	7.5					7.5	3.64	4.56	5.32	6.08	6.84	7.66	1	2	5
P	0.49	0.68	0.86	1.05	1.16	1.27	0.25	120	3	12.4	450	1.5%	2.4	3.1	15.5	2.77	3.47	4.05	4.63	5.21	5.83	1	2	7
Q	0.13	0.31	0.51	0.68	0.79	0.86	0.14	90	22	5.7	300	1.5%	1.2	4.1	9.8	3.32	4.16	4.85	5.54	6.24	6.98	0.4	1	6
R	0.16	0.23	0.29	0.35	0.39	0.42	0.25	90	6	7.8					7.8	3.59	4.50	5.26	6.01	6.76	7.56	1	1	3
S	0.07	0.29	0.54	0.90	1.08	1.26	0.08	140	14	10.2	750	1.5%	2.4	5.1	15.3	2.79	3.49	4.07	4.66	5.24	5.86	0.2	1.0	7

FINAL DRAINAGE REPORT ~ PIPE ROUTING SUMMARY

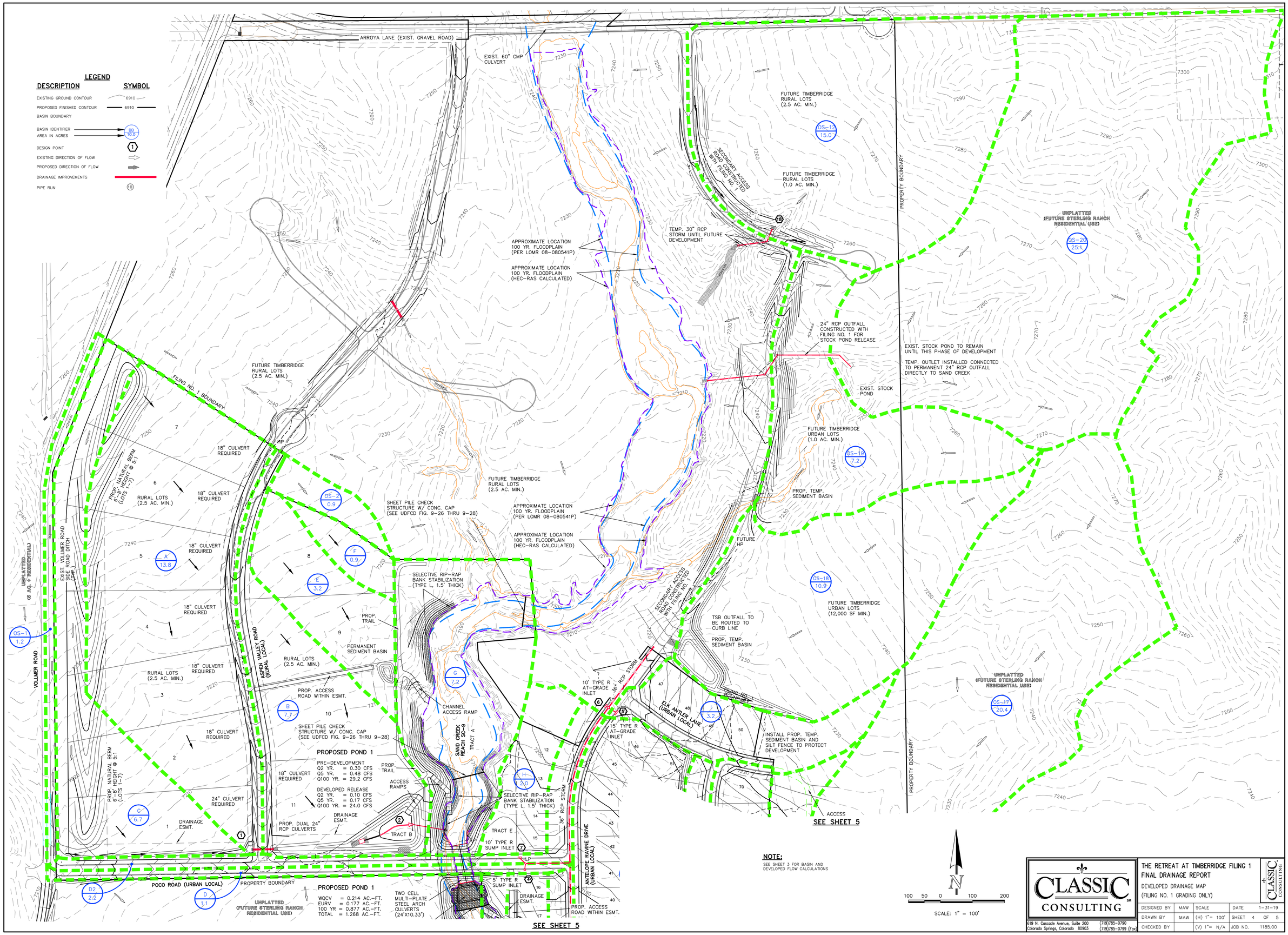
Pipe Run	Contributing Basins	Equivalent CA(5)	Equivalent CA(100)	Maximum Tc	Intensity I(5)	Intensity I(100)	Flow Q(5)	Flow Q(100)	Pipe Size*
1	DP-18	2.10	6.00	23.2	2.86	4.81	6	29	30" RCP
2	DP-19	0.28	0.62	12.2	3.83	6.42	1	4	18" RCP
3	DP-20	1.82	4.00	19.9	3.10	5.20	6	21	24" RCP
4	PR-1, PR-2, PR-3	4.20	10.62	23.9	2.82	4.73	12	50	36" RCP
5	Captured from DP-5	1.61	2.31	17.7	3.28	5.50	5	13	24" RCP
6	Captured from DP-6	0.63	0.93	11.9	3.86	6.49	2	6	18" RCP
7	PR-4, PR-5, PR-6	6.43	13.86	24.4	2.79	4.68	18	65	36" RCP
8	DP-4	0.74	0.87	15.2	3.50	5.88	3	5	18" RCP
9	DP-7	1.51	2.47	27.3	2.62	4.40	4	11	24" RCP
10	PR-8, PR-9	2.25	3.34	27.5	2.61	4.38	6	15	30" RCP
11	PR-7, PR-10	8.69	17.20	28.0	2.58	4.33	22	75	42" RCP
12	Captured from DP-10	1.83	2.83	21.2	3.00	5.04	5	14	24" RCP
13	PR-11, PR-12	10.51	20.03	28.1	2.58	4.33	27	87	42" RCP
14	DP-8	0.38	0.71	12.6	3.78	6.35	1	4	18" RCP
15	DP-9	1.43	2.68	16.0	3.43	5.75	5	15	24" RCP
16	PR-14, PR-15	1.80	3.38	16.4	3.39	5.69	6	19	24" RCP
17	PR-13, PR-16	12.31	23.41	28.6	2.55	4.28	31	100	48" RCP
18	DP-11	1.58	4.54	24.2	2.80	4.70	4	21	30" RCP
19	**PR-17, PR-18 W'LY FOREBAY OUTFALL**	**13.89**	**27.96**	**28.8**	**2.54**	**4.26**	**35**	**119**	**48" RCP**
20	DP-12	2.93	6.27	19.9	3.09	5.19	9	33	30" RCP
21	DP-13	0.19	2.06	12.4	3.80	6.39	1	13	24" RCP
22	PR-20, PR-21	3.12	8.33	20.7	3.04	5.10	9	42	30" RCP
23	DP-14	0.25	0.47	11.0	3.99	6.70	1	3	18" RCP
24	DP-15	0.85	2.17	16.0	3.42	5.74	3	12	24" RCP
25	PR-22, PR-23, PR-24	4.22	10.97	22.0	2.94	4.94	12	54	36" RCP
26	DP-16	0.25	0.47	11.0	3.99	6.69	1	3	18" RCP
27	DP-17	1.98	3.71	14.7	3.55	5.96	7	22	30" RCP
28	PR-26, PR-27	2.23	4.18	14.9	3.53	5.93	8	25	30" RCP
29	**PR-25, PR-28 E'LY FOREBAY OUTFALL**	**6.44**	**15.16**	**22.3**	**2.92**	**4.91**	**19**	**74**	**42" RCP**



CLASSIC CONSULTING
619 N. Cascoda Avenue, Suite 200
Colorado Springs, Colorado 80903
(719)785-0790
(719)785-0799 (Fax)

THE RETREAT AT TIMBERRIDGE FILING 1
FINAL DRAINAGE REPORT
DEVELOPED DRAINAGE MAP
(INCL. FUTURE DEVELOPED TIMBERRIDGE BASINS)

DESIGNED BY	MAW	SCALE		DATE	1-31-19
DRAWN BY	MAW	(H) 1"= 100'		SHEET	3 OF 5
CHECKED BY		(V) 1"= N/A		JOB NO.	2520.00



CLASSIC CONSULTING

619 N. Cascade Avenue, Suite 200
Colorado Springs, Colorado 80903
(719)785-0790
(719)785-0799 (Fax)

THE RETREAT AT TIMBERRIDGE FILING 1
FINAL DRAINAGE REPORT
DEVELOPED DRAINAGE MAP
(FILING NO. 1 GRADING ONLY)

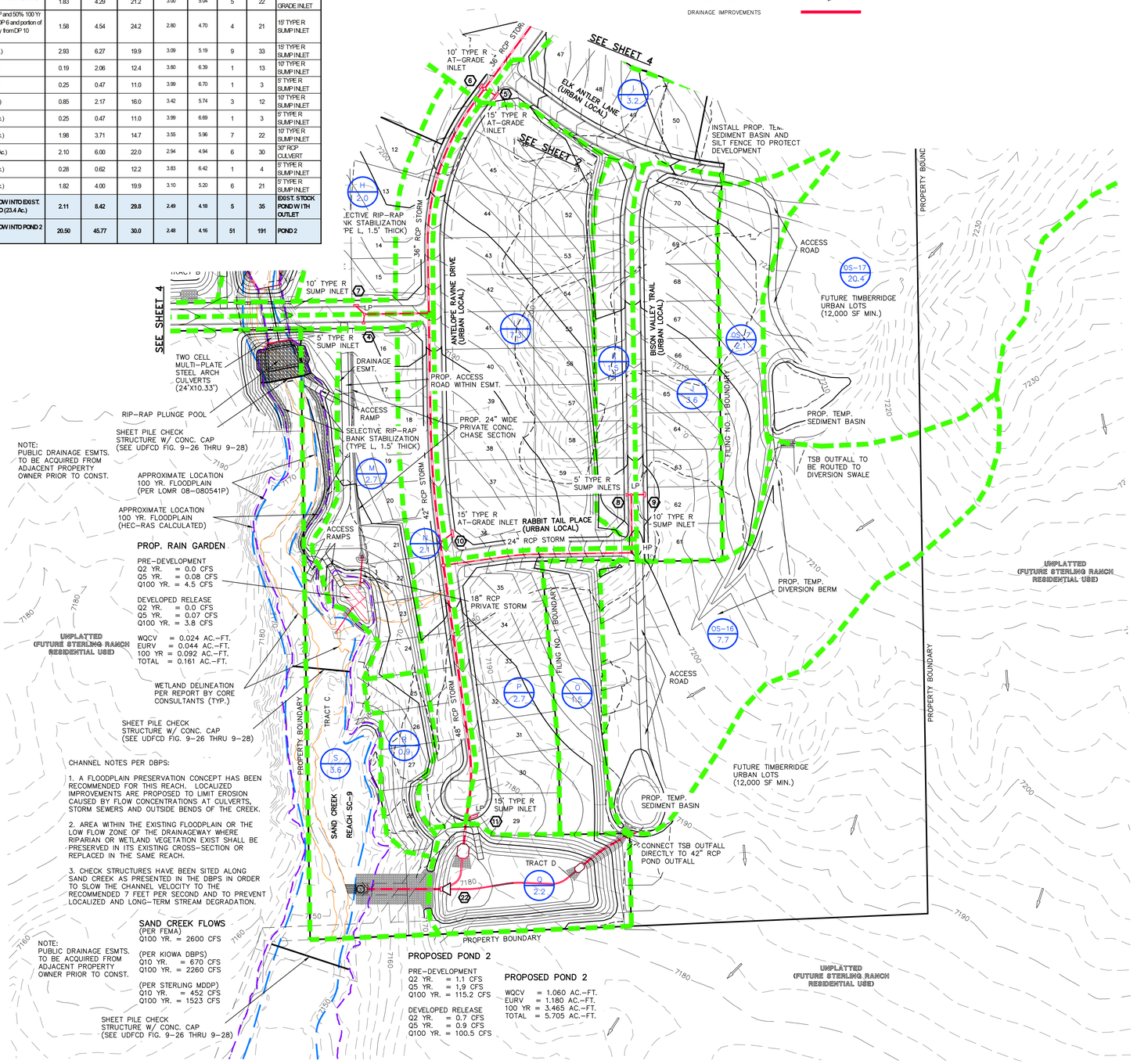
DESIGNED BY	MAW	SCALE	DATE	1-31-19
DRAWN BY	MAW	(H) 1"= 100'	SHEET	4 OF 5
CHECKED BY		(V) 1"= N/A	JOB NO.	1185.00

FINAL DRAINAGE REPORT ~ SURFACE ROUTING SUMMARY

Design Point(s)	Contributing Basins	Equivalent CA(5)	Equivalent CA(100)	Maximum Tc	Intensity I(5)	Intensity I(100)	Flow Q(5)	Flow Q(100)	Inlet Size
1	A (13.8 Ac.), OS-1 (1.2 Ac.) and C (6.7 Ac.)	3.58	9.08	31.8	2.39	4.02	9	36	DUAL 24" RCP CULVERTS
2	**TOTAL INFLOW INTO POND 1 A, B, C and OS-1 (29.4 Ac.)**	**4.66**	**12.16**	**33.8**	**2.30**	**3.86**	**11**	**47**	**POND 1**
3	No longer used								
4	D1 (1.1 Ac.)	0.74	0.87	15.2	3.50	5.88	3	5	5' TYPE R SUMP INLET
5	OS-4 (3.1 Ac.), I (3.7 Ac.)	1.61	3.17	17.7	3.28	5.50	5	17	15' TYPE R AT-GRADE INLET
6	OS-3 (2.5 Ac.)	0.63	1.18	11.9	3.86	6.49	2	8	10' TYPE R AT-GRADE INLET
7	Basin D2, Basin H and 50% of 100 yr Flowby from DP-6 (5.5 Ac)	1.51	2.47	27.3	2.62	4.40	4	11	10' TYPE R SUMP INLET
8	K (1.5 Ac.)	0.38	0.71	12.6	3.78	6.35	1	4	5' TYPE R SUMP INLET
9	J and OS-7 (5.7 Ac.)	1.43	2.68	16.0	3.43	5.75	5	15	10' TYPE R SUMP INLET
10	Flowby from DP-5 and Basin L (7.3 Ac)	1.83	4.29	21.2	3.00	5.04	5	22	15' TYPE R AT-GRADE INLET
11	Basins N, O, P and 50% 100 Yr. Flowby from DP-6 and portion of 100 Yr Flowby from DP-10 (13.6 Ac)	1.58	4.54	24.2	2.80	4.70	4	21	15' TYPE R SUMP INLET
12	OS-5 (20.9Ac.)	2.93	6.27	19.9	3.09	5.19	9	33	15' TYPE R SUMP INLET
13	OS-6 (1.2Ac.)	0.19	2.06	12.4	3.80	6.39	1	13	10' TYPE R SUMP INLET
14	OS-8 (1.0Ac.)	0.25	0.47	11.0	3.99	6.70	1	3	5' TYPE R SUMP INLET
15	OS-9 (5.3 Ac.)	0.85	2.17	16.0	3.42	5.74	3	12	10' TYPE R SUMP INLET
16	OS-10 (1.0 Ac.)	0.25	0.47	11.0	3.99	6.69	1	3	5' TYPE R SUMP INLET
17	OS-11 (7.9 Ac.)	1.98	3.71	14.7	3.55	5.96	7	22	10' TYPE R SUMP INLET
18	OS-12 (15.0 Ac.)	2.10	6.00	22.0	2.94	4.94	6	30	30" RCP CULVERT
19	OS-13 (1.4 Ac.)	0.28	0.62	12.2	3.83	6.42	1	4	5' TYPE R SUMP INLET
20	OS-14 (9.1 Ac.)	1.82	4.00	19.9	3.10	5.20	6	21	5' TYPE R SUMP INLET
21	**TOTAL INFLOW INTO EXIST. STOCK POND (23.4 Ac.)**	**2.11**	**8.42**	**29.8**	**2.49**	**4.18**	**5**	**35**	**EXIST. STOCK POND WITH OUTLET**
22	**TOTAL INFLOW INTO POND 2 (104.8 Ac.)**	**20.50**	**45.77**	**30.0**	**2.48**	**4.16**	**51**	**191**	**POND 2**

LEGEND

DESCRIPTION	SYMBOL
EXISTING GROUND CONTOUR	6910
PROPOSED FINISHED CONTOUR	6910
BASIN BOUNDARY	
BASIN IDENTIFIER / AREA IN ACRES	BB / 10.0
DESIGN POINT	1
EXISTING DIRECTION OF FLOW	
PROPOSED DIRECTION OF FLOW	
DRAINAGE IMPROVEMENTS	



FINAL DRAINAGE REPORT ~ BASIN RUNOFF SUMMARY

BASIN	WEIGHTED CA(2)	CA(5)	CA(10)	CA(25)	CA(50)	CA(100)	OVERLAND C(5)	Length (ft)	Height (ft)	Tc (min)	STREET / CHANNEL FLOW Length (ft)	Slope (%)	Velocity (fps)	Tc (min)	Tc TOTAL (min)	INTENSITY I(2) (in/hr)	I(5) (in/hr)	I(10) (in/hr)	I(25) (in/hr)	I(50) (in/hr)	I(100) (in/hr)	TOTAL FLOWS Q(2) (cfs)	Q(5) (cfs)	Q(100) (cfs)
OS-1	0.68	0.71	0.76	0.82	0.85	0.88	0.08	10	0.2	4.6	1700	3.5%	1.9	15.1	19.8	2.48	3.11	3.52	4.14	4.66	5.21	2	**2**	**5**
OS-2	0.02	0.07	0.14	0.23	0.27	0.32	0.08	300	10.5	21.1					21.1	2.41	3.01	3.51	4.01	4.51	5.05	0.0	**0.2**	**1.6**
OS-3	0.45	0.63	0.80	0.98	1.08	1.18	0.25	55	1.1	9.1	600	3.0%	3.5	2.9	11.9	3.08	3.86	4.51	5.15	5.80	6.49	1	**2**	**8**
OS-4	0.47	0.68	0.93	1.15	1.27	1.43	0.22	200	6	15.6	400	3.0%	3.5	1.9	17.6	2.62	3.28	3.83	4.38	4.93	5.51	1	**2**	**8**
OS-5	1.25	2.93	4.81	6.48	7.52	8.36	0.14	200	8	15.5	750	2.0%	2.8	4.4	19.9	2.47	3.09	3.61	4.13	4.64	5.19	3	**9**	**43**
OS-6	0.08	0.19	0.29	0.38	0.44	0.49	0.16	55	1.1	10.0	500	3.0%	3.5	2.4	12.4	3.04	3.80	4.44	5.07	5.71	6.39	0.3	**1**	**3**
OS-7	0.38	0.53	0.67	0.82	0.90	0.99	0.25	100	10	7.2					7.2	3.69	4.63	5.40	6.17	6.94	7.77	1	**2**	**8**
OS-8	0.18	0.25	0.32	0.39	0.43	0.47	0.25	55	1.1	9.1	400	3.0%	3.5	1.9	11.0	3.18	3.99	4.65	5.32	5.98	6.70	1	**1**	**3**
OS-9	0.37	0.85	1.27	1.70	1.96	2.17	0.16	200	10	14.1	400	3.0%	3.5	1.9	16.0	2.73	3.42	3.99	4.56	5.13	5.74	1	**3**	**12**
OS-10	0.18	0.25	0.32	0.39	0.43	0.47	0.25	55	1.1	9.1	450	3.8%	3.9	1.9	11.0	3.18	3.99	4.65	5.32	5.98	6.69	1	**1**	**3**
OS-11	1.42	1.98	2.53	3.08	3.40	3.71	0.25	200	10	12.8	450	3.8%	3.9	1.9	14.7	2.84	3.55	4.14	4.74	5.33	5.96	4	**7**	**22**
OS-12	0.90	2.10	3.45	4.65	5.40	6.00	0.14	300	13	18.5	600	2.0%	2.8	3.5	22.0	2.35	2.94	3.43	3.93	4.42	4.94	2	**6**	**30**
OS-13	0.17	0.28	0.38	0.49	0.56	0.62	0.20	55	1.1	9.6	400	2.0%	2.8	2.7	12.2	3.05	3.83	4.46	5.10	5.74	6.42	0.5	**1**	**4**
OS-14	1.09	1.82	2.46	3.19	3.64	4.00	0.20	300	12	17.8	350	2.0%	2.8	2.1	19.9	2.48	3.10	3.62	4.13	4.65	5.20	3	**6**	**21**
OS-15	0.70	2.11	3.98	6.08	7.25	8.42	0.09	300	16	18.2	1300	3.5%	1.9	11.6	29.8	2.00	2.49	2.91	3.32	3.74	4.18	1	**5**	**35**
OS-16	0.23	0.69	1.31	2.00	2.39	2.77	0.09	300	10	21.2	600	3.5%	1.9	5.3	26.6	2.13	2.66	3.11	3.55	4.00	4.47	0.5	**2**	**12**
OS-17	0.61	1.84	3.47	5.30	6.32	7.34	0.09	300	9.5	21.6	650	3.5%	1.9	5.8	27.4	2.10	2.62	3.05	3.49	3.93	4.39	1.3	**5**	**32**
OS-18	0.33	0.98	1.85	2.83	3.38	3.92	0.09	300	10	21.2	700	3.5%	1.9	6.2	27.5	2.09	2.61	3.05	3.49	3.92	4.39	0.7	**3**	**17**
OS-19	0.22	0.65	1.22	1.87	2.23	2.59	0.09	300	10	21.2	400	3.5%	1.9	3.6	24.8	2.21	2.77	3.23	3.69	4.15	4.64	0.5	**2**	**12**
OS-20	0.75	2.26	4.27	6.53	7.78	9.04	0.09	300	16	18.2	1300	3.5%	1.9	11.6	29.8	2.00	2.49	2.91	3.32	3.74	4.18	2	**6**	**38**
A	0.83	1.93	3.17	4.28	4.97	5.52	0.14	300	10.5	19.9	1280	3.2%	1.8	11.9	31.8	1.92	2.39	2.79	3.19	3.59	4.02	2	**5**	**22**
B	0.46	1.08	1.77	2.39	2.77	3.08	0.14	300	10.5	19.9	400	2.0%	1.4	4.7	24.6	2.23	2.78	3.24	3.71	4.17	4.67	1	**3**	**14**
C	0.40	0.94	1.54	2.08	2.41	2.68	0.14	300	10.5	19.9	1100	1.5%	2.4	7.5	27.3	2.10	2.62	3.06	3.49	3.93	4.40	1	**2**	**12**
D1	0.72	0.74	0.78	0.83	0.85	0.87	0.08	15	0.3	5.7	1400	1.5%	2.4	9.5	15.2	2.80	3.50	4.08	4.67	5.25	5.88	2	**3**	**5**
D2	0.96	1.07	1.18	1.30	1.36	1.43	0.25	55	1.1	9.1	500	2.5%	3.2	2.6	11.7	3.11	3.89	4.54	5.19	5.84	6.54	3	**4**	**9**
E	0.19	0.45	0.74	0.99	1.15	1.28	0.14	300	10.5	19.9	300	2.0%	1.4	3.5	23.4	2.28	2.85	3.33	3.81	4.28	4.79	0.4	**1**	**6**
F	0.05	0.13	0.21	0.28	0.32	0.36	0.14	300	10.5	19.9					19.9	2.48	3.10	3.62	4.13	4.65	5.20	0.1	**0.4**	**1.9**
G	0.14	0.58	1.08	1.80	2.16	2.52	0.08	70	14	5.7	900	2.0%	1.4	10.6	16.3	2.71	3.39	3.96	4.52	5.09	5.70	0.4	**2**	**14**
H	0.30	0.44	0.60	0.74	0.82	0.92	0.22	100	4	10.1	300	3.0%	3.5	1.4	11.5	3.13	3.92	4.57	5.23	5.88	6.58	1	**2**	**6**
I	0.67	0.93	1.18	1.44	1.59	1.74	0.25	120	3	12.4	550	3.5%	3.7	2.4	14.9	2.82	3.53	4.12	4.71	5.30	5.93	2	**3**	**10**
J	0.65	0.90	1.15	1.40	1.55	1.69	0.25	120	3	12.4	600	2.0%	2.8	3.5	16.0	2.74	3.43	4.00	4.57	5.14	5.75	2	**3**	**10**
K	0.27	0.38	0.48	0.59	0.65	0.71	0.25	55	1.1	9.1	600	2.0%	2.8	3.5	12.6	3.02	3.78	4.41	5.05	5.68	6.35	0.8	**1**	**4**
L	1.31	1.83	2.34	2.85	3.14	3.43	0.25	150	4.5	13.1	850	2.5%	3.2	4.5	17.6	2.62	3.28	3.83	4.38	4.93	5.51	3	**6**	**19**
M	0.41	0.59	0.81	1.00	1.11	1.24	0.22	100	4	10.1	400	2.0%	2.8	2.4	12.4	3.04	3.80	4.44	5.07	5.71	6.39	1	**2**	**8**
N	0.38	0.53	0.67	0.82	0.90	0.99	0.25	55	1.1	9.1	1050	2.0%	2.8	6.2	15.2	2.79	3.50	4.08	4.66	5.25	5.87	1	**2**	**6**
O	0.27	0.38	0.48	0.59	0.65	0.71	0.25	80	5	7.5					7.5	3.64	4.56	5.32	6.08	6.84	7.66	1	**2**	**5**
P	0.49	0.68	0.86	1.05	1.16	1.27	0.25	120	3	12.4	450	1.5%	2.4	3.1	15.5	2.77	3.47	4.05	4.63	5.21	5.83	1	**2**	**7**
Q	0.13	0.31	0.51	0.68	0.79	0.88	0.14	90	22	5.7	300	1.5%	1.2	4.1	9.8	3.32	4.16	4.85	5.54	6.24	6.98	0.4	**1**	**6**
R	0.16	0.23	0.29	0.35	0.39	0.42	0.25	90	6	7.8					7.8	3.59	4.50	5.26	6.01	6.76	7.56	1	**1**	**3**
S	0.07	0.29	0.54	0.90	1.08	1.26	0.08	140	14	10.2	750	1.5%	2.4	5.1	15.3	2.79	3.49	4.07	4.66	5.24	5.86	0.2	**1.0**	**7**

FINAL DRAINAGE REPORT ~ PIPE ROUTING SUMMARY

Pipe Run	Contributing Basins	Equivalent CA(5)	Equivalent CA(100)	Maximum Tc	Intensity I(5)	Intensity I(100)	Flow Q(5)	Flow Q(100)	Pipe Size*
1	DP-18	2.10	6.00	23.2	2.86	4.81	6	29	30" RCP
2	DP-19	0.28	0.62	12.2	3.83	6.42	1	4	18" RCP
3	DP-20	1.82	4.00	19.9	3.10	5.20	6	21	24" RCP
4	PR-1, PR-2, PR-3	4.20	10.62	23.9	2.82	4.73	12	50	36" RCP
5	Captured from DP-5	1.61	2.31	17.7	3.28	5.50	5	13	24" RCP
6	Captured from DP-6	0.63	0.93	11.9	3.86	6.49	2	6	18" RCP
7	PR-4, PR-5, PR-6	6.43	13.86	24.4	2.79	4.68	18	65	36" RCP
8	DP-4	0.74	0.87	15.2	3.50	5.88	3	5	18" RCP
9	DP-7	1.51	2.47	27.3	2.62	4.40	4	11	24" RCP
10	PR-8, PR-9	2.25	3.34	27.5	2.61	4.38	6	15	30" RCP
11	PR-7, PR-10	8.69	17.20	28.0	2.58	4.33	22	75	42" RCP
12	Captured from DP-10	1.83	2.83	21.2	3.00	5.04	5	14	24" RCP
13	PR-11, PR-12	10.51	20.03	28.1	2.58	4.33	27	87	42" RCP
14	DP-8	0.38	0.71	12.6	3.78	6.35	1	4	18" RCP
15	DP-9	1.43	2.68	16.0	3.43	5.75	5	15	24" RCP
16	PR-14, PR-15	1.80	3.38	16.4	3.39	5.69	6	19	24" RCP
17	PR-13, PR-16	12.31	23.41	28.6	2.55	4.28	31	100	48" RCP
18	DP-11	1.58	4.54	24.2	2.80	4.70	4	21	30" RCP
19	**PR-17, PR-18 W'LY FOREBAY OUTFALL**	**13.89**	**27.96**	**28.8**	**2.54**	**4.26**	**35**	**119**	**48" RCP**
20	DP-12	2.93	6.27	19.9	3.09	5.19	9	33	30" RCP
21	DP-13	0.19	2.06	12.4	3.80	6.39	1	13	24" RCP
22	PR-20, PR-21	3.12	8.33	20.7	3.04	5.10	9	42	30" RCP
23	DP-14	0.25	0.47	11.0	3.99	6.70	1	3	18" RCP
24	DP-15	0.85	2.17	16.0	3.42	5.74	3	12	24" RCP
25	PR-22, PR-23, PR-24	4.22	10.97	22.0	2.94	4.94	12	54	36" RCP
26	DP-16	0.25	0.47	11.0	3.99	6.69	1	3	18" RCP
27	DP-17	1.98	3.71	14.7	3.55	5.96	7	22	30" RCP
28	PR-26, PR-27	2.23	4.18	14.9	3.53	5.93	8	25	30" RCP
29	**PR-25, PR-28 E'LY FOREBAY OUTFALL**	**6.44**	**15.16**	**22.3**	**2.92**	**4.91**	**19**	**74**	**42" RCP**

CLASSIC CONSULTING
619 N. Cascade Avenue, Suite 200
Colorado Springs, Colorado 80903
(719)785-0790
(719)785-0799 (Fax)

THE RETREAT AT TIMBERRIDGE FILING 1
FINAL DRAINAGE REPORT
DEVELOPED DRAINAGE MAP
(FILING NO. 1 GRADING ONLY)

DESIGNED BY	MAW	SCALE		DATE	1-31-19
DRAWN BY	MAW	(H) 1"= 100'		SHEET	5 OF 5
CHECKED BY		(V) 1"= N/A		JOB NO.	1185.00

MASTER DEVELOPMENT DRAINAGE PLAN AMENDMENT FOR STERLING RANCH

Prepared For:
SR Land, LLC
20 Boulder Crescent, 2nd Floor
Colorado Springs, CO 80903
(719) 491-3024

January 20th, 2023
Project No. 25188.04

Prepared By:
JR Engineering, LLC
5475 Tech Center Drive
Colorado Springs, CO 80919
(303)-267-6240
Contact: Mike Bramlett, PE

Detention spreadsheet's stage-area and stage-discharge curves from the Retreat at Timber Ridge Filing 1 Final Drainage Report.

- Pond FSD21 now outfalls directly into DP-73 instead of going through Pond FSD27. Based on the Drainage Report for The Retreat at Timber Ridge, flows from Sub-Basin SC3-21 drain to a future full spectrum detention pond that outfalls directly into Sand Creek.

  A table summarizing the changes in the Full Spectrum Detention Pond's sizing and release rates can be found in **Appendix C**.

The second stated purpose of this MDDP Amendment is to document the differences between the MDDP and this MDDP Amendment. Comparing the MDDP Amendment's proposed conditions model to the MDDP, the median difference in Sub-basin peak flow rates between the two is a 6% decrease in the basin runoff. With the basin parameters carried over as much as possible, some of the differences is due to how the hydrographs were generated in HEC-HMS and SWMM respectively. The MDDP used curve number while the MDDP Amendment used CUHP. The MDDP Amendment also took into account changes basin parameters based on the various accepted Final Drainage Reports. The differences in Sub-basin peak flow rates were not universally higher in CUHP-SWMM, with there being a range from 100% higher to 100% lower. A table comparing the peak flow rates of the Sub-basins can be found in **Appendix C**.

The comparison between the routed hydrographs at the design points of the MDDP Amendment proposed conditions model and MDDP proposed conditions model shows a more consistent change. Peak runoff rates along the main fork are mostly a few percent higher, with a handful further downstream the reach 14 to 16% higher. The East Fork saw a reduction of peak runoff rates around 60% from the previous model. The total volume of water is consistently 10 to 25% lower than the previous model with a exception of a few places. This is due in part to the changes in detention release rates as well as the previously mentioned differences in how the hydrographs were created. The differences between the two models of when peak runoff occurs were typically within 10 to 15 minutes in each basin and at each node. Tables comparing the MDDP Amendment proposed conditions model with the previous one from the MDDP can be found in **Appendix C.**

The last and most crucial comparison is between the updated existing conditions model and the updated proposed conditions model. As seen in Table 1, all of the online and offline detention shows a clear reduction in flows along Sand Creek. The total volume of runoff is very similar in the undeveloped upper portion of the reach at Design Points 74, 75, and 78. As runoff accumulates downstream at Design Points 73, 71, 69, and 63 the volume of runoff drastically increases due to the increased imperviousness of the adjacent developments, but the peak flow rates remain lower than existing due to all of the full spectrum detention ponds along the reach.

As seen in Table 1, Pond W-3 reduces peak flow rates downstream of it at Design Points 60A and 53A to below the pre-development rates seen in the updated existing conditions model. Flows have been reduced from 1969.2 and 2197.2 cfs, respectively, to 1882.2 and 1887.5 cfs. A table comparing the peak runoff rates and the total volume of runoff at the design points can be found in **Appendix C**.

DRAINAGE FACILITY DESIGN

General Concept

The third stated purpose of this MDDP Amendment is an evaluation of the required volume for on-line detention at Sterling Ranch Road (Pond W-3). Along with an on-line detention pond, new culverts are proposed at Sterling Ranch Road and Briargate Parkway being designed by others. The amendment also includes revisions to the existing stock pond north of Sterling Ranch Road, the stock ponds north of Briargate Parkway, and improvements to Sand Creek channel.

Specific Details

Compared to the previous preliminary design of Pond W-3 from the 2018 MDDP, the amount of storage volume has decreased from 78.2 ac-ft. to 50.5 ac-ft. In order to avoid classification as a jurisdictional dam, the maximum ponding depth is 10 feet. The peak release rate has been increased from 1350.6 cfs to 1585.2 cfs. Despite the increase in release rate, peak flow rates along Sand Creek downstream of the pond are lower than existing. The previous MDDP model outfalls at DP 53A, which is defined as the Full Spectrum Pond at Woodmen Drive, and so does the MDDP Amendment SWMM model. The MDDP model over-detains at Pond W-3 in order to reduce flows downstream well below those in the existing conditions. With the goal being to simply reduce flows to less than predevelopment rates, this amount of detention is unnecessary, hence the reduced storage volume and the increased release rate. A complete comparison between existing and proposed conditions of design flows along Sand Creek can be seen below.

Table 1.

Design Point Comparison Summary						
Location	Design Point ID	Existing (Updated)	Proposed (MDDP)	Proposed (Amendment)	% Difference Amend vs. MDDP	% Difference Amend vs. EX
		Q100 (cfs)				
	DP-74	352.3	262.8	293.8	12%	-17%
	DP-75	970.5	950.5	887.9	-7%	-9%
	DP-78	497.7	385.3	422.1	10%	-15%
	DP-73	1672	1506.7	1497.1	-1%	-10%
Sterling Ranch N BNDY	DP-71	1734.9	1612.2	1644.1	2%	-5%
Briargate Pkwy X'ing	DP-69	1988.4	1775.7	1763.9	-1%	-11%
Sterling Ranch S BNDY	DP-63	1980.7	1385.1	1585.2	14%	-20%
Marksheffel X'ing	DP-60A	1969.2	1661.8	1882.2	13%	-4%
Sand Creek and Pond 3	DP-53A	2197.7	1668.9	1887.5	13%	-14%
Near SE Prop Corner	DP-56	242.9	196.4	136.2	-31%	-44%

Conceptually, the current preliminary design for Pond W-3 is similar to what was previously shown in the MDDP. Ponding occurs adjacent to Sterling Ranch Road and pass through a 3 barrel box culvert before entering the roadway culvert and continuing downstream. The Sterling Ranch Road culvert is currently proposed to be a Bridgecor arch with a 38’-1” span x 11’x11” rise (by others).

The existing stock pond upstream of Sterling Ranch Road will remain in place, with flows passing through the pond and leaving through an outlet structure. The major change in how the pond functions is the new design does not have a diversion structure along Sand Creek that routes flows around the existing pond. Due the narrow space between the proposed development and the existing stock pond, this portion of channel would require extensive reinforcement due to high shears and velocities. In order to maintain the water right for the pond, an outlet orifice structure maintains a static water surface of 7038 ft and all flows above that elevation pass undetained through the orifice structure and outfall into Pond W-3. An Agridrain system adjacent to the outlet structure controls flows below the static water surface and allow flows to be impounded or released as needed. Adding the existing stock pond as online storage directly upstream of Pond W-3 made a drastic difference in peak flows. The time of peak concentration at Sterling Ranch Road was only about 20 minutes greater, but the additional storage volume attributed to the stock ponds reduced peak flows by 160 cfs and reduced the maximum volume of runoff flowing into Pond W-3 by 1.3 ac-ft.

The proposed channel improvements begin just north of the Sterling Ranch southern property boundary and run north roughly two miles to the northern property boundary. The horizontal

Existing Conditions Design Point Peak Flow Rate Summary

Design Point	MDDP						MDDP Amendment						% Difference					
	Q_2 (cfs)	Q_5 (cfs)	Q_{10} (cfs)	Q_{25} (cfs)	Q_{50} (cfs)	Q_{100} (cfs)	Q_2 (cfs)	Q_5 (cfs)	Q_{10} (cfs)	Q_{25} (cfs)	Q_{50} (cfs)	Q_{100} (cfs)	Q_2	Q_5	Q_{10}	Q_{25}	Q_{50}	Q_{100}
DP-73	225.9	380.7	618	957	1260.4	1582.3	171.2	503.09	791.79	1033.04	1414.41	1672.0	-32%	24%	22%	7%	11%	5%
DP-71	229.3	388.9	629.7	978.8	1277.3	1637.9	175	518.37	818.24	1068.91	1466.2	1734.9	-31%	25%	23%	8%	13%	6%
DP-69	253	434.8	707.7	1100	1453.3	1870.4	189.69	579.88	923.83	1213.68	1675.53	1988.4	-33%	25%	23%	9%	13%	6%
DP-63	251.4	430.7	713.1	1113.2	1496.2	1911.5	175.18	557.4	899.71	1192.36	1661.58	1980.7	-44%	23%	21%	7%	10%	3%
DP-10	36.5	56	106.4	162.9	220.6	287.2	32.32	93.36	146.19	189.33	255.2	300.1	-13%	40%	27%	14%	14%	4%
DP-9A	55.3	94.3	150.3	227.7	299.5	380.5	31.89	101.87	173.68	232.21	321.39	381.1	-73%	7%	13%	2%	7%	0%
DP-9	52.8	88.8	142.1	214.2	281	351.4	28.73	93.68	160.49	215.19	297.14	351.7	-84%	5%	11%	0%	5%	0%
DP-8A	7.7	15.2	27.1	44.2	60.5	78.4	0.56	17.3	31.43	42.65	59.34	70.5	-1275%	12%	14%	-4%	-2%	-11%
DP-8	24.2	45.1	77.8	124.4	169.5	220.9	1.97	50.28	115.07	167.23	245.12	297.4	-1128%	10%	32%	26%	31%	26%
DP-7	32.4	57.1	97.3	156.1	213.8	277.9	22.38	82.23	143.62	194.75	273.43	326.3	-45%	31%	32%	20%	22%	15%
DP-6	12.2	23.9	43.1	70.9	97	125.2	7.82	24.38	46.12	63.58	89.43	106.6	-56%	2%	7%	-12%	-8%	-17%
DP-5	0.5	1.7	4.5	9.4	14.5	20.5	1.18	9.36	20.8	29.82	42.58	50.9	58%	82%	78%	68%	66%	60%
DP-4	11.6	21.5	37.5	60.9	83.1	107.4	12.95	35.87	65.46	89.09	123.98	147.0	10%	40%	43%	32%	33%	27%
DP-3	1.1	1.8	2.8	4.3	5.6	7.1	0.0	0.69	1.71	2.52	3.71	4.5	-10900%	-161%	-64%	-71%	-51%	-57%
DP-2	4.8	7.9	12.4	18.7	24.5	30.9	0.0	4.41	10.85	15.93	23.17	27.9	-47900%	-79%	-14%	-17%	-6%	-11%
DP-1	5	8.2	13	19.6	25.7	32.2	0.0	4.88	11.82	17.63	25.97	31.5	-49900%	-68%	-10%	-11%	1%	-2%
DP-60A	247.7	430.2	707.1	1113	1496.6	1913.5	167.91	546.35	886.79	1179	1649.04	1969.2	-48%	21%	20%	6%	9%	3%
DP-56	23.2	42.5	71.9	115.6	157.4	202.9	0.35	40.19	96.37	141.51	207.98	242.9	-6529%	-6%	25%	18%	24%	16%
DP-53A	262.1	454	763.2	1196.5	1609.8	2061.5	182.68	602.01	983.58	1311.23	1837.86	2197.7	-43%	25%	22%	9%	12%	6%

Existing Conditions Design Point Total Runoff Volume Summary

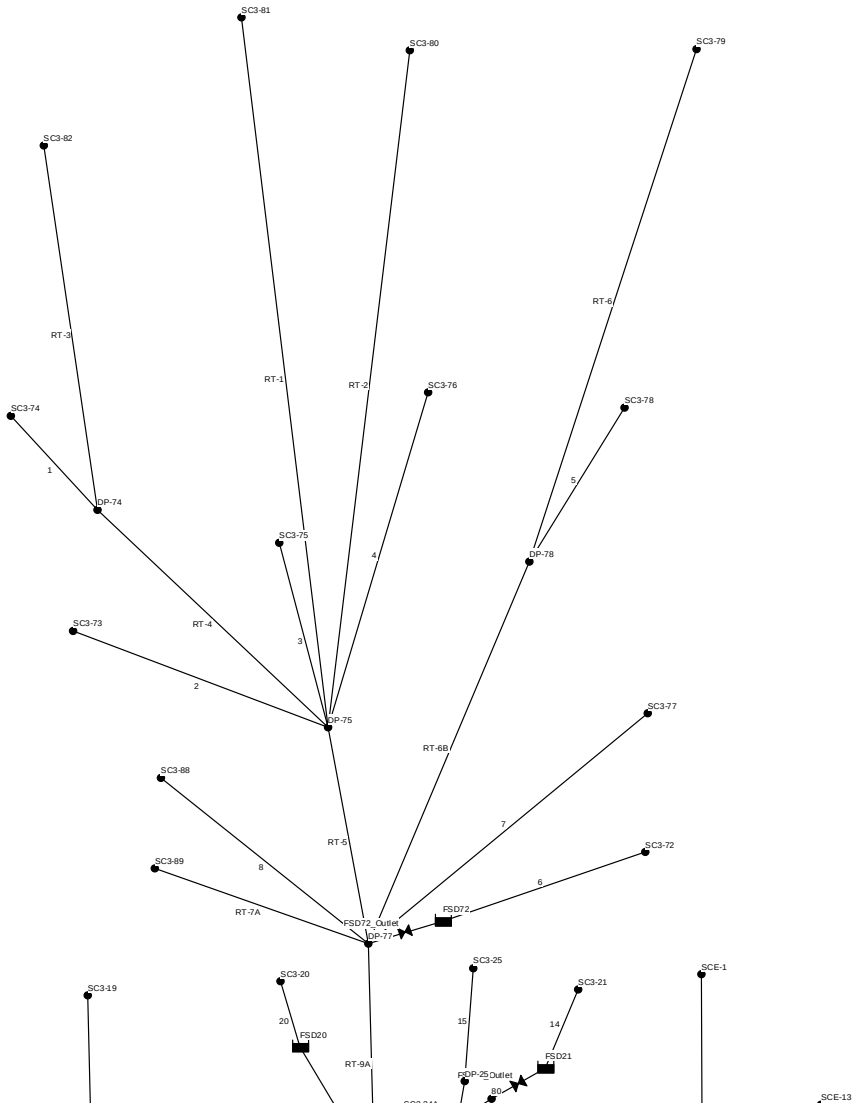
Design Point	MDDP						MDDP Amendment						% Difference					
	V_2 (ac-ft)	V_5 (ac-ft)	V_{10} (ac-ft)	V_{25} (ac-ft)	V_{50} (ac-ft)	V_{100} (ac-ft)	V_2 (ac-ft)	V_5 (ac-ft)	V_{10} (ac-ft)	V_{25} (ac-ft)	V_{50} (ac-ft)	V_{100} (ac-ft)	V_2	V_5	V_{10}	V_{25}	V_{50}	V_{100}
DP-73	40.4	61.5	92.1	134.3	173.1	214.9	19.9	51.9	78.6	101.0	136.3	159.9	-103%	-19%	-17%	-33%	-27%	-34%
DP-71	42.5	64.9	97.1	141.6	182.5	226.6	20.7	54.6	82.6	106.2	143.6	168.5	-105%	-19%	-18%	-33%	-27%	-34%
DP-69	50.7	77.4	116.1	169.4	218.6	271.4	24.0	64.4	98.2	126.4	171.2	201.0	-111%	-20%	-18%	-34%	-28%	-35%
DP-63	54.1	82.5	123.8	180.8	233.3	289.9	25.9	69.7	105.9	136.3	184.4	216.4	-109%	-18%	-17%	-33%	-26%	-34%
DP-10	7.6	11.7	17.6	25.8	33.4	41.6	5.4	12.2	17.9	22.5	29.6	34.4	-41%	4%	1%	-15%	-13%	-21%
DP-9A	9.3	14.1	21.1	30.7	39.4	48.8	3.6	9.4	15.2	20.0	27.5	32.5	-159%	-50%	-39%	-53%	-43%	-50%
DP-9	8.4	12.7	19	27.6	35.5	44	3.0	8.1	13.4	17.7	24.4	28.9	-181%	-56%	-42%	-56%	-45%	-52%
DP-8A	1.3	2.1	3.4	5.2	7	8.9	0.1	1.7	3.2	4.3	6.0	7.1	-2153%	-21%	-8%	-22%	-17%	-25%
DP-8	4.4	7	11.1	16.8	22.3	28.4	0.2	4.9	10.3	14.5	21.0	25.3	-2483%	-43%	-8%	-15%	-6%	-12%
DP-7	6.1	10	15.9	24.3	32.4	41.3	3.1	10.3	17.6	23.6	32.8	39.0	-99%	3%	10%	-3%	1%	-6%
DP-6	2.4	4	6.3	9.6	12.7	16	1.0	2.7	4.8	6.5	9.2	10.9	-142%	-51%	-31%	-47%	-38%	-46%
DP-5	0.2	0.4	0.8	1.4	1.9	2.6	0.1	0.5	1.2	1.7	2.6	3.1	-160%	26%	34%	20%	26%	16%
DP-4	2.6	4.2	6.7	10.2	13.5	17.2	1.6	3.7	6.5	8.7	12.0	14.2	-64%	-12%	-3%	-17%	-12%	-21%
DP-3	0.1	0.2	0.3	0.5	0.6	0.8	0.0	0.1	0.2	0.2	0.3	0.4	-9900%	-231%	-98%	-123%	-79%	-97%
DP-2	0.6	0.9	1.4	2.1	2.7	3.4	0.0	0.3	0.7	1.0	1.5	1.8	-59900%	-236%	-108%	-111%	-82%	-88%
DP-1	0.6	0.9	1.3	1.9	2.5	3.1	0.0	0.2	0.6	0.9	1.4	1.7	-59900%	-263%	-110%	-106%	-83%	-86%
DP-60A	55.3	84.4	126.4	184.8	238.5	296.6	26.1	71.2	108.6	139.6	189.0	221.9	-112%	-19%	-16%	-32%	-26%	-34%
DP-56	4	6.3	9.9	14.9	19.8	25.1	0.1	4.0	8.7	12.6	18.2	22.0	-6352%	-58%	-13%	-19%	-9%	-14%
DP-53A	63	96.4	144.7	211.8	273.9	340.9	31.6	84.1	128.0	164.5	221.9	260.5	-99%	-15%	-13%	-29%	-23%	-31%

APPENDIX C

PROPOSED CONDITIONS HYDRAULIC CALCULATIONS

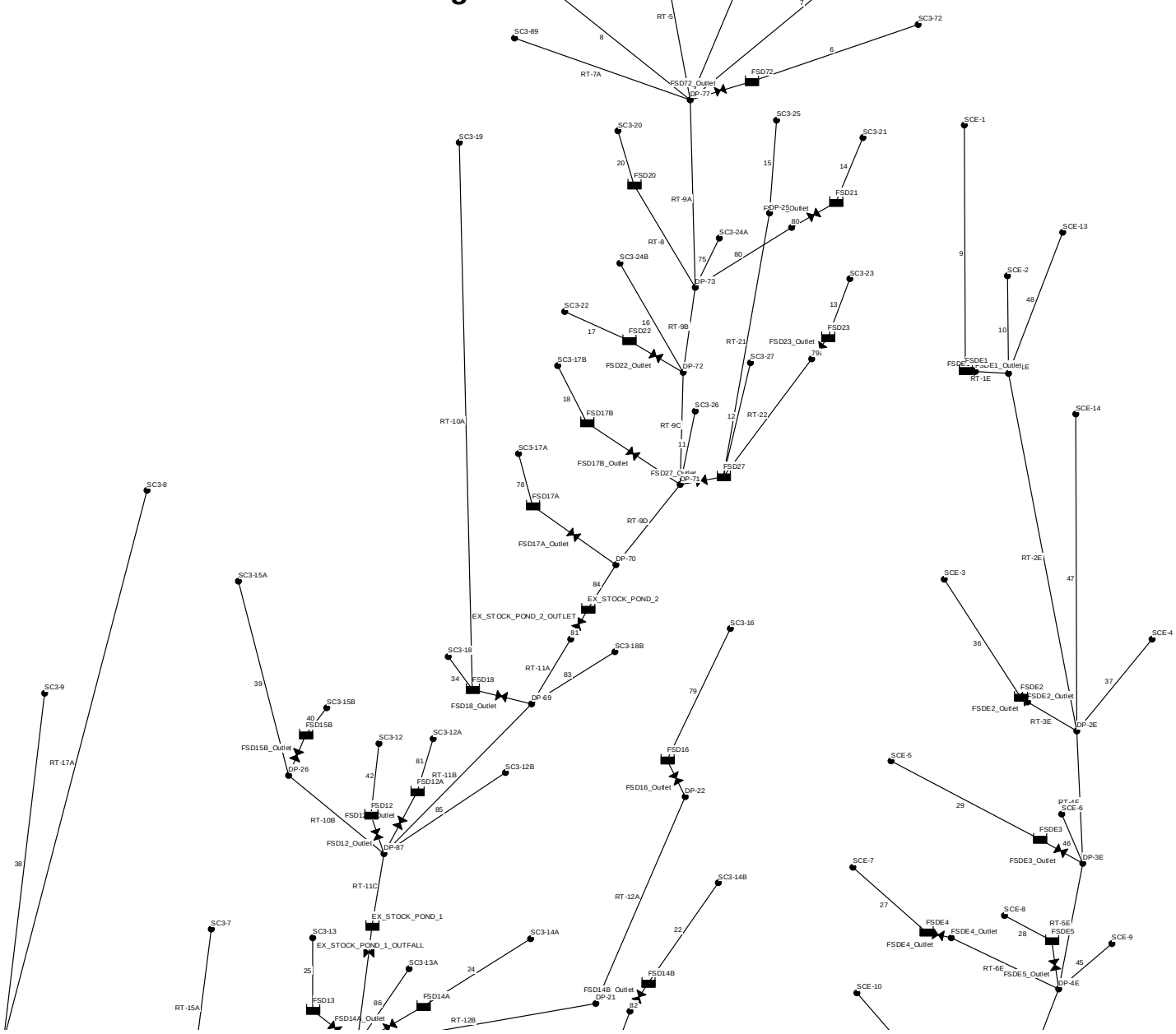
Sterling Ranch 2021 MDDP Amendment

01/01/2005 00:05:0



Sterling Ranch 2021 MDDP Amendment

01/01/2005 00:05:00



Existing vs. Proposed Peak Flow Rate Design Point Summary

Design Point	Existing Q_2 (cfs)	Proposed Q_2 (cfs)	% Difference	Existing Q_5 (cfs)	Proposed Q_5 (cfs)	% Difference	Existing Q_{10} (cfs)	Proposed Q_{10} (cfs)	% Difference	Existing Q_{25} (cfs)	Proposed Q_{25} (cfs)	% Difference	Existing Q_{50} (cfs)	Proposed Q_{50} (cfs)	% Difference	Existing Q_{100} (cfs)	Proposed Q_{100} (cfs)	% Difference
DP-73	171.20	147.28	-14%	503.09	442.59	-12%	791.79	703.56	-11%	1033.04	919.81	-11%	1414.41	1257.44	-11%	1672.0	1497.12	-10%
DP-71	175.00	149.28	-15%	518.37	472.6	-9%	818.24	771.35	-6%	1068.91	1012.75	-5%	1466.2	1386.32	-5%	1734.9	1644.06	-5%
DP-69	189.69	146.52	-23%	579.88	512.38	-12%	923.83	847.5	-8%	1213.68	1108.89	-9%	1675.53	1497.55	-11%	1988.4	1763.93	-11%
DP-63	175.18	128.57	-27%	557.4	480.38	-14%	899.71	763.81	-15%	1192.36	1005.42	-16%	1661.58	1368.28	-18%	1980.7	1585.19	-20%
DP-60A	167.91	135.75	-19%	546.35	544.14	0%	886.79	863.88	-3%	1179	1138.24	-3%	1649.04	1569.79	-5%	1969.2	1882.17	-4%
DP-53A	182.68	135.8	-26%	602.01	545.87	-9%	983.58	866.46	-12%	1311.23	1141.24	-13%	1837.86	1573.95	-14%	2197.7	1887.54	-14%
DP-56	0.35	24.04	6769%	40.19	43.91	9%	96.37	62.31	-35%	141.51	79.42	-44%	207.98	106.6	-49%	242.9	136.21	-44%
DP-8	1.97	26.31	1236%	50.28	47.57	-5%	115.07	67.39	-41%	167.23	84.03	-50%	245.12	107.24	-56%	297.4	137.04	-54%

Existing vs. Proposed Total Runoff Volume Design Point Summary

Design Point	Existing V_2 (ac-ft)	Proposed V_2 (ac-ft)	% Difference	Existing V_5 (ac-ft)	Proposed V_5 (ac-ft)	% Difference	Existing V_{10} (ac-ft)	Proposed V_{10} (ac-ft)	% Difference	Existing V_{25} (ac-ft)	Proposed V_{25} (ac-ft)	% Difference	Existing V_{50} (ac-ft)	Proposed V_{50} (ac-ft)	% Difference	Existing V_{100} (ac-ft)	Proposed V_{100} (ac-ft)	% Difference
DP-73	19.9	20.62	4%	51.9	52.17	1%	78.6	78.56	0%	101.0	100.66	0%	136.3	135.64	0%	159.9	158.97	-1%
DP-71	20.7	26.36	27%	54.6	62.30	14%	82.6	92.07	12%	106.2	117.23	10%	143.6	156.82	9%	168.5	183.52	9%
DP-69	24.0	28.66	19%	64.4	70.58	10%	98.2	105.26	7%	126.4	133.19	5%	171.2	177.07	3%	201.0	205.92	2%
DP-63	25.9	70.28	172%	69.7	134.11	93%	105.9	187.20	77%	136.3	230.78	69%	184.4	297.99	62%	216.4	343.71	59%
DP-60A	26.1	98.20	276%	71.2	180.14	153%	108.6	249.19	129%	139.6	305.05	118%	189.0	392.82	108%	221.9	448.06	102%
DP-53A	31.6	98.82	213%	84.1	181.06	115%	128.0	250.42	96%	164.5	306.89	87%	221.9	392.82	77%	260.5	451.12	73%
DP-56	0.1	29.15	46929%	4.0	42.96	977%	8.7	55.85	539%	12.6	66.59	431%	18.2	83.17	357%	22.0	94.21	328%
DP-8	0.2	30.23	17648%	4.9	45.11	825%	10.3	58.62	472%	14.5	69.97	381%	21.0	87.46	317%	25.3	98.82	290%

MDDP Proposed vs. Amendment Proposed Peak Flow Rate Basin Summary

Basin	MDDP Q_2 (cfs)	Amend Q_2 (cfs)	% Difference	MDDP Q_5 (cfs)	Amend Q_5 (cfs)	% Difference	MDDP Q_{10} (cfs)	Amend Q_{10} (cfs)	% Difference	MDDP Q_{25} (cfs)	Amend Q_{25} (cfs)	% Difference	MDDP Q_{50} (cfs)	Amend Q_{50} (cfs)	% Difference	MDDP Q_{100} (cfs)	Amend Q_{100} (cfs)	% Difference
SC3-1A	16.3	15.4	-6%	23.3	32.05	38%	33	44.63	35%	45.8	54.22	18%	57.1	68.02	19%	68.9	77.21	12%
SC3-5A	40.6	48.38	19%	53.7	75.2	40%	71	95.88	35%	92.4	112.35	22%	110.6	135.5	23%	129.1	150.82	17%
SC3-5B	53.8	60.26	12%	73	97.13	33%	98.5	126.36	28%	130.8	149	14%	158.6	181.48	14%	187	203.13	9%
SC3-6A	61.4	59.98	-2%	79.3	84.21	6%	102.2	106.32	4%	130.1	123.77	-5%	153.6	149.06	-3%	177.1	165.69	-6%
SC3-6B	32.9	30	-9%	43.4	47.16	9%	57	60.52	6%	73.9	70.92	-4%	88.2	85.96	-3%	102.7	95.97	-7%
SC3-6C	53.9	52.26	-3%	72.5	84.02	16%	97.1	115.61	19%	128	140.03	9%	154.5	174.32	13%	181.5	196.64	8%
SC3-7	54	60.94	13%	69.9	87.91	26%	90.3	109.28	21%	115.2	126.05	9%	136.2	150.45	10%	157.2	166.71	6%
SC3-8	25.4	12.18	-52%	42.1	56.41	34%	66.7	93.96	41%	100.7	122.75	22%	132.3	166.13	26%	166.2	195.44	18%
SC3-9	45.8	24.66	-46%	71.5	73.44	3%	108.6	114.01	5%	158.9	146.06	-8%	204.9	193.77	-5%	254	225.81	-11%
SC3-10	7.6	2.94	-61%	12.3	14.36	17%	19.4	23.62	22%	29.1	30.77	6%	38	41.33	9%	47.7	48.66	2%
SC3-11A	5.3	1.99	-62%	7.8	5.36	-31%	11.3	8.05	-29%	15.9	10.06	-37%	20	13.08	-35%	24.3	15.09	-38%
SC3-11B	59.4	68	14%	81.3	99.65	23%	110.8	126.13	14%	148.1	146.85	-1%	180.5	176.93	-2%	213.7	196.96	-8%
SC3-11C		1.37			5.83			9.3			11.93			15.66			18.16	
SC3-12	77.8	47.61	-39%	105.6	71.53	-32%	142.5	91.34	-36%	189.1	106.54	-44%	229.1	129.44	-44%	270	144.67	-46%
SC3-12A		15.01			24.03			31.22			36.66			44.86			50.3	
SC3-12B		2.17			6.35			9.82			12.6			16.83			19.66	
SC3-13	43.9	56.24	28%	57.8	80.96	40%	76.5	100.72	32%	98.5	115.86	18%	117.6	138.53	18%	136.9	153.6	12%
SC3-13A		2.61			7.62			11.81			15.18			20.28			23.7	
SC3-14A	127.6	110.65	-13%	175.4	160.22	-9%	239.8	203.13	-15%	321.9	237.5	-26%	393.2	287.18	-27%	466.3	320.18	-31%
SC3-14B	24.6	63.13	157%	34.3	90	162%	47.4	115.58	144%	64.2	136.1	112%	79	165.72	110%	94.1	185.1	97%
SC3-15A	21.6	13.21	-39%	35.5	38.41	8%	56.3	59.28	5%	85.3	76.32	-11%	112.1	102.43	-9%	141	119.86	-15%
SC3-15B	10.8	8.38	-22%	14	12.29	-12%	18.2	15.45	-15%	23.3	17.9	-23%	27.6	21.56	-22%	31.9	24	-25%
SC3-16		180.7			266.34			343.24			404.73			493.4			552.27	
SC3-16A	84.4		46%	120.4		53%	170		41%	234.8		21%	292.2		19%	351.8		11%
SC3-16B	39		46%	53.7		53%	73.6		41%	99		21%	121.1		19%	143.8		11%
SC3-17A	41.8	25.63	-39%	59.6	39.59	-34%	85.2	50.91	-40%	119	59.5	-50%	149.1	72.46	-51%	180.6	81.07	-55%
SC3-17B		20.59			32.3			41.97			49.43			60.7			68.19	
SC3-18	49.3	22.75	-54%	67.1	32.96	-51%	91	41.34	-55%	121.2	47.83	-61%	147.3	57.56	-61%	174	64.05	-63%
SC3-18B		1.53			4.45			6.89			8.86			11.91			13.95	
SC3-19	28.8	28	-3%	47.7	78.96	66%	75.7	120.84	60%	114.4	154.22	35%	150.2	205.45	37%	188.8	239.67	27%
SC3-20	9.9	9.29	-6%	15.5	21.02	36%	23.8	30.73	29%	35.1	38.5	10%	45.5	50.17	10%	56.6	57.99	2%
SC3-21	7	9.77	40%	10.8	20.68	91%	16.3	29.45	81%	23.7	36.03	52%	30.4	45.92	51%	37.5	52.53	40%
SC3-22	9.4	7.15	-24%	14.8	16.35	10%	22.5	24.05	7%	32.9	30.08	-9%	42.5	39.14	-8%	52.6	45.22	-14%
SC3-23	5.5	10.92	99%	8.3	22.1	166%	12.4	31.23	152%	18	38.2	112%	23	48.72	112%	28.4	55.73	96%
SC3-24A	13	6.43	-51%	20.4	15.26	-25%	31.1	22.51	-28%	45.7	28.3	-38%	59	37.09	-37%	73.2	42.98	-41%
SC3-24B	3.4	1.95	-43%	5.3	4.78	-10%	8.1	7.12	-12%	11.8	8.98	-24%	15.2	11.76	-23%	18.9	13.62	-28%
SC3-25	5.8	5.58	-4%	8.9	12.02	35%	13.4	17.2	28%	19.5	21.1	8%	25.1	26.97	7%	31	30.9	0%
SC3-26	2.5	1.66	-34%	4	4.37	9%	6.2	6.61	7%	9.2	8.4	-9%	12.1	11.13	-8%	15.1	12.95	-14%
SC3-27	35.1	14.49	-59%	51.2	27.87	-46%	73.8	39.1	-47%	103.7	48.09	-54%	130.3	61.8	-53%	158.3	70.95	-55%
SC3-61	13.7	5.61	-59%	22	22.4	2%	34.4	36.4	6%	51.6	47.4	-8%	67.6	63.67	-6%	84.8	74.61	-12%
SC3-72	12.8	9.55	-25%	20.2	23.84	18%	31.4	35.61	13%	46.7	44.98	-4%	60.9	59.19	-3%	76	68.7	-10%
SC3-73	16.4	12.16	-26%	26.4	33.03	25%	41.3	50.14	21%	62.1	63.84	3%	81.3	84.94	4%	102	99.04	-3%
SC3-74	22.3	22.51	1%	36.5	53.27	46%	57.3	79.1	38%	85.9	99.77	16%	112.3	131.03	17%	140.7	151.94	8%
SC3-75	13.1	11.12	-15%	21.5	26.37	23%	33.7	38.98	16%	50.5	49.21	-3%	66.1	64.91	-2%	82.8	75.41	-9%
SC3-76	14.2	10.85	-24%	23.1	27.09	17%	36.4	40.54	11%	54.6	51.45	-6%	71.4	68.18	-5%	89.6	79.38	-11%
SC3-77	16.6	8.93	-46%	27.6	27.11	-2%	43.8	42.16	-4%	66.2	54.46	-18%	87	73.59	-15%	109.4	86.36	-21%
SC3-78	28.1	32.29	15%	45.3	77.46	71%	70.6	114.83	63%	106.2	144.42	36%	139.1	189.21	36%	174.5	219.17	26%
SC3-79	34.9	32.26	-8%	57	82.54	45%	89.5	123.52	38%	134.3	156.01	16%	175.6	205.95	17%	220.1	239.34	9%
SC3-80	27.3	22.36	-18%	44.3	57.34	29%	69.6	86.09	24%	104.5	109.14	4%	136.8	144.5	6%	171.4	168.15	-2%
SC3-81	42.6	26.67	-37%	70.2	81	15%	111	125.85	13%	167.4	162.22	-3%	219.6	218.65	0%	275.7	256.32	-7%
SC3-82	20	17.01	-15%	33.2	50.83	53%	52.8	79.48	51%	80	102.02	28%	105.1	136.18	30%	132.3	158.98	20%
SC3-88	10.5	6.28	-40%	17.4	18.99	9%	27.6	29.44	7%	41.8	37.84	-9%	54.9	50.8	-7%	69	59.46	-14%
SC3-89	6.1	2.86	-53%	10	8.64	-14%	15.7	13.39	-15%	23.6	17.14	-27%	30.8	22.87	-26%	38.6	26.69	-31%
SCE-1	23.3	9.82	-58%	35.9	21.3	-41%	53.8	30.85	-43%	79.1	38.58	-51%	102.4	50.51	-51%	127.4	58.52	-54%
SCE-2	4.4	1.42	-68%	7	3.35	-52%	10.8	4.95	-54%	15.9	6.27	-61%	20.7	8.3	-60%	25.7	9.66	-62%
SCE-3	30.6	8.5	-72%	45.2	16.95	-63%	65.9	25.2	-62%	93.3	31.78	-66%	118	41.56	-65%	143.9	48.16	-67%
SCE-4	13.3	4.16	-69%	19.6	7.52	-62%	28.6	10.35	-64%	40.6	12.67	-69%	257.8	16.29	-94%	62.6	18.71	-70%
SCE-5	100.4	71.73	-29%	130.6	99.51	-24%	169.6	125.72	-26%	217.4	146.92	-32%	257.8	177.83	-31%	298.4	198.17	-34%
SCE-6	1.6	0.18	-89%	2.5	0.55	-78%	3.7	1.03	-72%	5.4	1.42	-74%	7	2	-71%	8.6	2.39	-72%
SCE-7	58.9	33.06	-44%	75.5	46.14	-39%	96.6	56.71	-41%	122.2	64.87	-47%	143.7	77.06	-46%	165.2	85.19	-48%
SCE-8	38.6	47.1	22%	48.4	61.37	27%	60.7	73.41	21%	75.4	82.94	10%	87.7	97.16	11%	99.9	106.61	7%
SCE-9	1.5	0.22	-85%	2.4	0.68	-72%	3.6	1.27	-65%	5.3	1.75	-67%	6.8	2.46	-64%	8.5	2.94	-65%
SCE-10	7.6	106.33	1299%	189.4	165.76	-12%	19.4	230.7	1089%	29.1	283.77	875%	398.9	358.46	-10%	467.5	407.13	-13%
SCE-11	2.3	0.77	-67%	3.6	2.52	-30%	5.5	4.75	-14%	8	6.5	-19%	10.3	8.93	-13%	12.8	10.51	-18%
SCE-13	19.6	10.9	-44%	31.3	25.85	-17%	48.7	38.21	-22%	73.1	48.24	-34%	95.7	63.64	-34%	120	73.94	-38%
SCE-14	13.2	8	-39%	21.2	19.04	-10%	33.3	28.21	-15%	49.9	35.59	-29%	65.2	46.77	-28%	81.7	54.26	-34%
SCE-15	2.2	13.6	518%	5.1	27.2	433%	10.1	38.53	281%	17.7	47.35	168%	25.1	60.67	142%	35.4	69.54	96%

MDDP Proposed vs. Amendment Proposed Peak Flow Rate Design Point Summary

Design Point	MDDP Q_2 (cfs)	Amend Q_2 (cfs)	% Difference	MDDP Q_5 (cfs)	Amend Q_5 (cfs)	% Difference	MDDP Q_{10} (cfs)	Amend Q_{10} (cfs)	% Difference	MDDP Q_{25} (cfs)	Amend Q_{25} (cfs)	% Difference	MDDP Q_{50} (cfs)	Amend Q_{50} (cfs)	% Difference	MDDP Q_{100} (cfs)	Amend Q_{100} (cfs)	% Difference
DP-74	39.3	33.68	-14%	65.3	94.55	45%	104.8	145.74	39%	158.9	187.2	18%	209.1	251.03	20%	262.8	293.76	12%
DP-75	141.2	95.13	-33%	235.1	274.57	17%	376.6	427.98	14%	566.6	555.2	-2%	750.9	754.29	0%	950.5	887.87	-7%
DP-77	209.9	144.08	-31%	351.9	426.57	21%	580.6	672.84	16%	886.6	877.81	-1%	1168.4	1201.19	3%	1467.7	1423.89	-3%
DP-78	59.7	52.82	-12%	98.4	138.33	41%	154	210.37	37%	232.6	269.64	16%	306.2	360.98	18%	385.3	422.09	10%
DP-73	207.5	147.28	-29%	354.3	442.59	25%	588.5	703.56	20%	897.1	919.81	3%	1187.2	1257.44	6%	1506.7	1497.12	-1%
DP-72	206.2	148.02	-28%	352.5	450.59	28%	586.7	718.2	22%	897.2	939.53	5%	1195.3	1285.42	8%	1518.6	1527.18	1%
DP-71	205.9	149.28	-27%	349.3	472.6	35%	610.5	771.35	26%	932.4	1012.75	9%	1226.9	1386.32	13%	1612.2	1644.06	2%
DP-70	205.3	149.57	-27%	349.8	477.23	36%	614	780.47	27%	940.1	1025.79	9%	1260.6	1405.32	11%	1636.7	1666.98	2%
DP-69	212.7	146.52	-31%	366.6	512.38	40%	653.7	847.5	30%	1010.6	1108.89	10%	1364.1	1497.55	10%	1775.7	1763.93	-1%
DP-87	216.9	143.88	-34%	374.6	533.15	42%	681.9	890.76	31%	1072.1	1170.95	9%	1471.5	1589.82	8%	1905.9	1880.39	-1%
DP-68	214.6	126.27	-41%	374.5	579.69	55%	714.9	994.15	39%	1187.6	1327.63	12%	1674.9	1837.13	10%	2204.1	2160.43	-2%
DP-64	85.9	89.76	4%	112.1	133.15	19%	145.9	167.21	15%	187.5	194.25	4%	222.6	233.42	5%	258	259.48	1%
DP-63	154.4	128.57	-17%	201	480.38	139%	375.7	763.81	103%	815.9	1005.42	23%	1112.1	1368.28	23%	1385.1	1585.19	14%
DP-61	156.6	132.9	-15%	223.9	535.22	139%	428	851.44	99%	928.2	1123.05	21%	1287.3	1549.17	20%	1620.1	1859.67	15%
DP-60A	161.6	135.75	-16%	224.8	544.14	142%	439.1	863.88	97%	950.4	1138.24	20%	1320.5	1569.79	19%	1661.8	1882.17	13%
DP-53A	161.6	135.8	-16%	225.7	545.87	142%	441.8	866.46	96%	951.1	1141.24	20%	1326	1573.95	19%	1668.9	1887.54	13%
DP-1E	23.9	12.41	-48%	38.3	29.33	-23%	70.1	43.32	-38%	132.8	54.71	-59%	173	72.19	-58%	220.9	83.88	-62%
DP-2E	48.9	24.93	-49%	76.8	56.12	-27%	123	81.89	-33%	228.7	103.16	-55%	319.7	135.52	-58%	419.4	157.2	-63%
DP-3E	48.5	26.73	-45%	75.7	59.28	-22%	122.2	86.63	-29%	271.1	109.01	-60%	387.1	143.9	-63%	500.1	176.03	-65%
DP-4E	48.1	28.34	-41%	76.2	61.94	-19%	122.4	91.01	-26%	286.9	114.79	-60%	407.3	152.57	-63%	534.8	184.7	-65%
DP-56	23.1	24.04	4%	35.3	43.91	24%	71.5	62.31	-13%	108.3	79.42	-27%	152.1	106.6	-30%	196.4	136.21	-31%
DP-8	24.1	26.31	9%	37.2	47.57	28%	73.5	67.39	-8%	111.3	84.03	-25%	155.4	107.24	-31%	200.7	137.04	-32%
DP-21	0.6	8.07	1245%	8.8	45.76	420%	17.8	92.48	420%	57.1	128.9	126%	116.8	153.87	32%	174.9	200.93	15%
DP-22	0.6	8.07	1245%	8.8	45.78	420%	17.6	92.52	426%	56.8	128.94	127%	105.1	153.88	46%	156.4	191.38	22%
DP-25	5.9	5.58	-5%	9.1	12.02	32%	16.3	17.2	6%	35.1	21.1	-40%	46.4	26.97	-42%	58.2	30.9	-47%
DP-26	0.1	13.62	13520%	1.1	38.87	3434%	3.2	59.76	1768%	7.3	76.84	953%	9.5	102.99	984%	12	120.45	904%
EX_STOCK_POND_1		133.68			512.29			863.82			1143.6			1561.29			1848.83	
EX_STOCK_POND_2		149.57			477.23			780.47			1025.79			1405.32			1666.98	
FSD14B_Outfall		2.57			20.53			44.05			64.95			98.12			116.66	
PNDE7	46.5	31.92	-31%	75.4	68.33	-9%	121.2	100.59	-17%	285.2	126.9	-56%	402.4	176	-56%	548	222.77	-59%
PNDW3	214.6	126.27	-41%	374.5	579.69	55%	714.9	994.15	39%	1187.6	1327.63	12%	1674.9	1837.12	10%	2204.1	2160.43	-2%

MDDP Proposed vs. Amendment Total Runoff Volume Proposed Design Point Summary																		
Design Point	MDDP V_2 (ac-ft)	Amend V_2 (ac-ft)	% Difference	MDDP V_5 (ac-ft)	Amend V_5 (ac-ft)	% Difference	MDDP V_{10} (ac-ft)	Amend V_{10} (ac-ft)	% Difference	MDDP V_{25} (ac-ft)	Amend V_{25} (ac-ft)	% Difference	MDDP V_{50} (ac-ft)	Amend V_{50} (ac-ft)	% Difference	MDDP V_{100} (ac-ft)	Amend V_{100} (ac-ft)	% Difference
DP-74	5.9	3.03	-49%	9	7.67	-15%	13.6	11.57	-15%	19.8	14.82	-25%	25.5	20.04	-21%	31.6	23.51	-26%
DP-75	22.7	11.05	-51%	34.5	28.82	-16%	51.7	43.58	-16%	75.4	56.16	-26%	97.1	75.80	-22%	120.5	89.00	-26%
DP-77	37.7	18.84	-50%	57.4	48.49	-16%	85.9	73.04	-15%	125.1	93.91	-25%	161.1	126.74	-21%	199.9	148.53	-26%
DP-78	8.9	4.91	-45%	13.5	11.69	-13%	20.1	17.40	-13%	29.3	22.25	-24%	37.7	29.86	-21%	46.7	34.99	-25%
DP-73	40	20.62	-48%	60.8	52.17	-14%	91	78.56	-14%	132.5	100.66	-24%	170.7	135.64	-21%	211.7	158.97	-25%
DP-72	41.3	21.30	-48%	62.9	53.71	-15%	94	80.71	-14%	136.8	103.42	-24%	176.2	139.33	-21%	218.5	163.26	-25%
DP-71	46.3	26.36	-43%	70	62.30	-11%	104.3	92.07	-12%	151.3	117.23	-23%	194.5	156.82	-19%	240.8	183.52	-24%
DP-70	49.5	28.45	-43%	74.5	65.06	-13%	110.6	95.75	-13%	160.1	121.53	-24%	205.4	162.04	-21%	254	189.35	-25%
DP-69	57.5	28.66	-50%	86.1	70.58	-18%	127.4	105.26	-17%	183.8	133.19	-28%	235.3	177.07	-25%	290.6	205.92	-29%
DP-87	66.5	35.29	-47%	98.9	82.55	-17%	145.6	121.53	-17%	209.1	153.75	-26%	267.1	203.16	-24%	329.1	236.30	-28%
DP-68	81.8	65.37	-20%	123.7	126.74	2%	183.9	177.99	-3%	264.9	219.73	-17%	338	284.79	-16%	415.8	328.37	-21%
DP-64	7	7.46	7%	9.1	10.10	11%	11.8	12.34	5%	15.2	14.12	-7%	18.1	16.79	-7%	21.1	18.57	-12%
DP-63	85.6	70.28	-18%	129.5	134.11	4%	192.3	187.20	-3%	276.7	230.78	-17%	352.8	297.99	-16%	433.5	343.71	-21%
DP-61	103.7	89.61	-14%	157.8	166.95	6%	235.1	232.31	-1%	338.4	285.10	-16%	431.3	368.26	-15%	529.8	420.44	-21%
DP-60A	111	98.20	-12%	168.6	180.14	7%	250.4	249.19	0%	359.5	305.05	-15%	457.7	392.82	-14%	561.5	448.06	-20%
DP-53A	112	98.82	-12%	170	181.06	7%	252.6	250.42	-1%	362.6	306.89	-15%	461.7	392.82	-15%	566.5	451.12	-20%
DP-1E	3.1	2.48	-20%	5.2	5.19	0%	8.4	7.73	-8%	12.7	10.00	-21%	16.6	13.56	-18%	20.9	15.96	-24%
DP-2E	6.1	6.01	-1%	10.4	11.66	12%	16.9	16.85	0%	25.7	21.27	-17%	33.7	28.17	-16%	42.2	32.84	-22%
DP-3E	7	13.35	91%	13.7	21.45	57%	23.4	28.85	23%	36.1	34.99	-3%	47.4	44.81	-5%	59.3	51.25	-14%
DP-4E	7.6	19.27	154%	15.6	29.15	87%	27.2	38.05	40%	43	45.73	6%	57.2	57.39	0%	72	65.06	-10%
DP-56	7.7	29.15	279%	16.1	42.96	167%	28.6	55.85	95%	51.3	66.59	30%	71.7	83.17	16%	92.9	94.21	1%
DP-8	8	30.23	278%	16.7	45.11	170%	26.6	58.62	120%	53	69.97	32%	74	87.46	18%	95.9	98.82	3%
DP-21	6.3	20.50	225%	11.3	28.39	151%	18.3	35.29	93%	27.5	40.82	48%	35.6	49.10	38%	44	54.93	25%
DP-22	6.3	20.53	226%	10.7	28.42	166%	16.7	35.29	111%	24.6	40.82	66%	31.5	49.41	57%	38.7	54.93	42%
DP-25	1.3	0.31	-76%	1.9	0.61	-68%	2.8	0.87	-69%	4.1	1.08	-74%	5.2	1.42	-73%	6.4	1.65	-74%
DP-26	0.7	2.01	188%	0.9	4.73	425%	1.2	7.03	486%	1.5	8.93	495%	1.8	11.97	565%	2.1	13.99	566%

Summary of Peak Discharges						
Design Point 75						
Storm Event (YR)	2	5	10	25	50	100
2016 Existing Cond. (cfs)	141	235	377	567	751	951
2021 Existing Cond. (cfs)						971
2018 Developed Cond. (cfs)	141	235	377	567	751	951
2022 Developed Cond. (cfs)	95	275	428	555	754	888
Design Point 77						
Storm Event (YR)	2	5	10	25	50	100
2016 Existing Cond. (cfs)	n/a	n/a	n/a	n/a	n/a	n/a
2021 Existing Cond. (cfs)						
2018 Developed Cond. (cfs)	210	352	581	887	1168	1468
2022 Developed Cond. (cfs)	144	427	673	878	1201	1424
1996 DBPS Existing Cond. (cfs)						2193
1996 DBPS Developed Cond. (cfs)						2262
Design Point 73						
Storm Event (YR)	2	5	10	25	50	100
2016 Existing Cond. (cfs)	226	381	618	957	1260	1582
2021 Existing Cond. (cfs)						1672
2018 Developed Cond. (cfs)	208	354	589	897	1187	1507
2022 Developed Cond. (cfs)	147	443	704	920	1257	1497
Design Point 71						
Storm Event (YR)	2	5	10	25	50	100
2016 Existing Cond. (cfs)	229	389	630	979	1277	1638
2021 Existing Cond. (cfs)						1735
2018 Developed Cond. (cfs)	206	349	611	932	1227	1612
2022 Developed Cond. (cfs)	149	473	771	1013	1386	1644
Design Point 69						
Storm Event (YR)	2	5	10	25	50	100
2016 Existing Cond. (cfs)	253	435	708	1100	1453	1870
2021 Existing Cond. (cfs)						1988
2018 Developed Cond. (cfs)	213	367	654	1011	1364	1776
2022 Developed Cond. (cfs)	147	512	848	1109	1498	1764
Design Point 68						
Storm Event (YR)	2	5	10	25	50	100
2016 Existing Cond. (cfs)	n/a	n/a	n/a	n/a	n/a	n/a
2021 Existing Cond. (cfs)						
2018 Developed Cond. w/o Pnd (cfs)	215	375	715	1188	1675	2204
2018 Developed w/Pnd (cfs) Pnd W3	154	200	367	800	1086	1351
2022 Developed Cond. w/ Pnd(cfs)	126	580	994	1328	1837	2160
Design Point 63						
Storm Event (YR)	2	5	10	25	50	100
2016 Existing Cond. (cfs)	251	431	713	1113	1496	1912
2021 Existing Cond. (cfs)						1981
2018 Developed Cond. w/o Pnd (cfs)	213	373	721	1198	1705	2237
2018 Developed w/Pnd (cfs)	154	201	376	816	1112	1385
2021 Developed Cond. w/ Pnd(cfs)	129	480	764	1005	1368	1585
2011 Wilson (cfs)			1066			1791
1996 DBPS Existing Cond. (cfs)						2508
1996 DBPS Developed Cond. (cfs)						2689
Design Point 61						
Storm Event (YR)	2	5	10	25	50	100
2016 Existing Cond. (cfs)	n/a	n/a	n/a	n/a	n/a	n/a
2018 Developed Cond. w/o Pnd (cfs)	214	375	783	1370	1967	2607
2018 Developed w/Pnd (cfs)	157	224	428	928	1287	1620
2022 Developed Cond. w/ Pnd(cfs)	133	535	851	1123	1549	1860
2011 Wilson (cfs)			1232			2087
Design Point 60a						
Storm Event (YR)	2	5	10	25	50	100
2016 Existing Cond. (cfs)	248	430	707	1113	1497	1914
2021 Existing Cond. (cfs)						1969
2018 Developed Cond. w/o Pnd (cfs)	216	378	795	1395	2004	2645
2018 Developed w/Pnd (cfs)	162	225	439	950	1321	1662
2022 Developed Cond. w/ Pnd(cfs)	136	544	864	1138	1570	1882
2011 Wilson (cfs)			1265			2133
1996 DBPS Existing Cond. (cfs)						2629
1996 DBPS Developed Cond. (cfs)						3295
Design Point 53a						
Storm Event (YR)	2	5	10	25	50	100
2016 Existing Cond. (cfs)	262	454	763	1197	1610	2062
2021 Existing Cond. (cfs)						2198
2018 Developed Cond. w/o Pnd (cfs)	215	378	792	1392	2009	2657
2018 Developed w/Pnd (cfs)	162	226	442	951	1326	1669
2022 Developed Cond. w/ Pnd(cfs)	136	546	866	1141	1574	1888

APPENDIX D

REFERENCE MATERIAL

STERLING RANCH
RETENTION POND VOLUME

(Pond Volume Calculation)

BIG POND

Elevation	SF	CF	Storage AF	Storage Sum
7028	0.00	-		0
7030	53,785.00	53,785.00	1.23	1.23
7032	70,507.00	124,292.00	2.85	4.09
7034	87,672.00	158,179.00	3.63	7.72
7036	109,612.00	197,284.00	4.53	12.25

Total = 533,540 CF

Total = 12.25 Ac-ft

At Elevation 7035, the Storage is 9.98 Ac-ft.
At Elevation 7034, the Storage is 7.72 Ac-ft.

Calculated by: VAS
Date: 4/21/2016
Checked by: VAS

STERLING RANCH

"BIG POND"

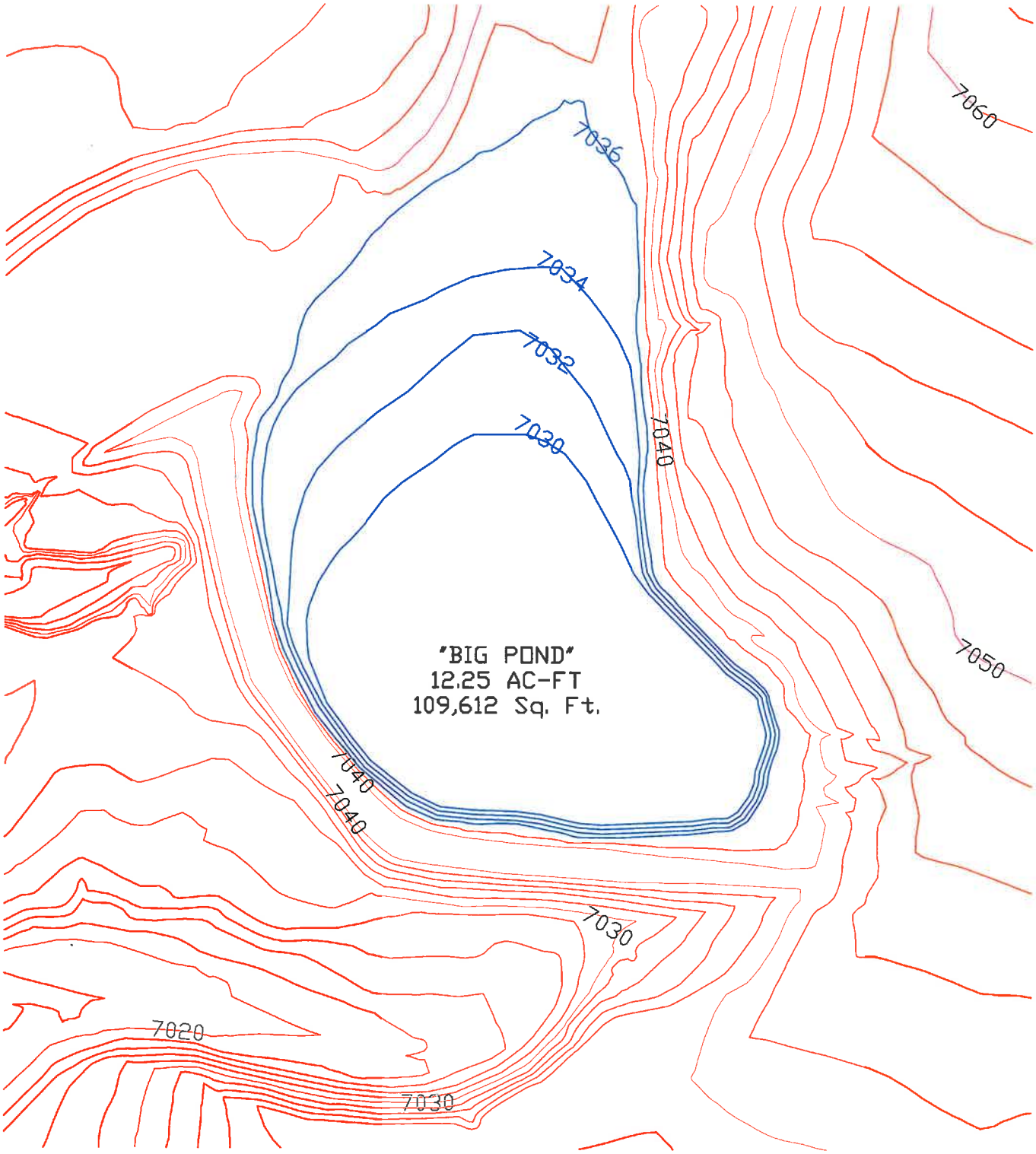


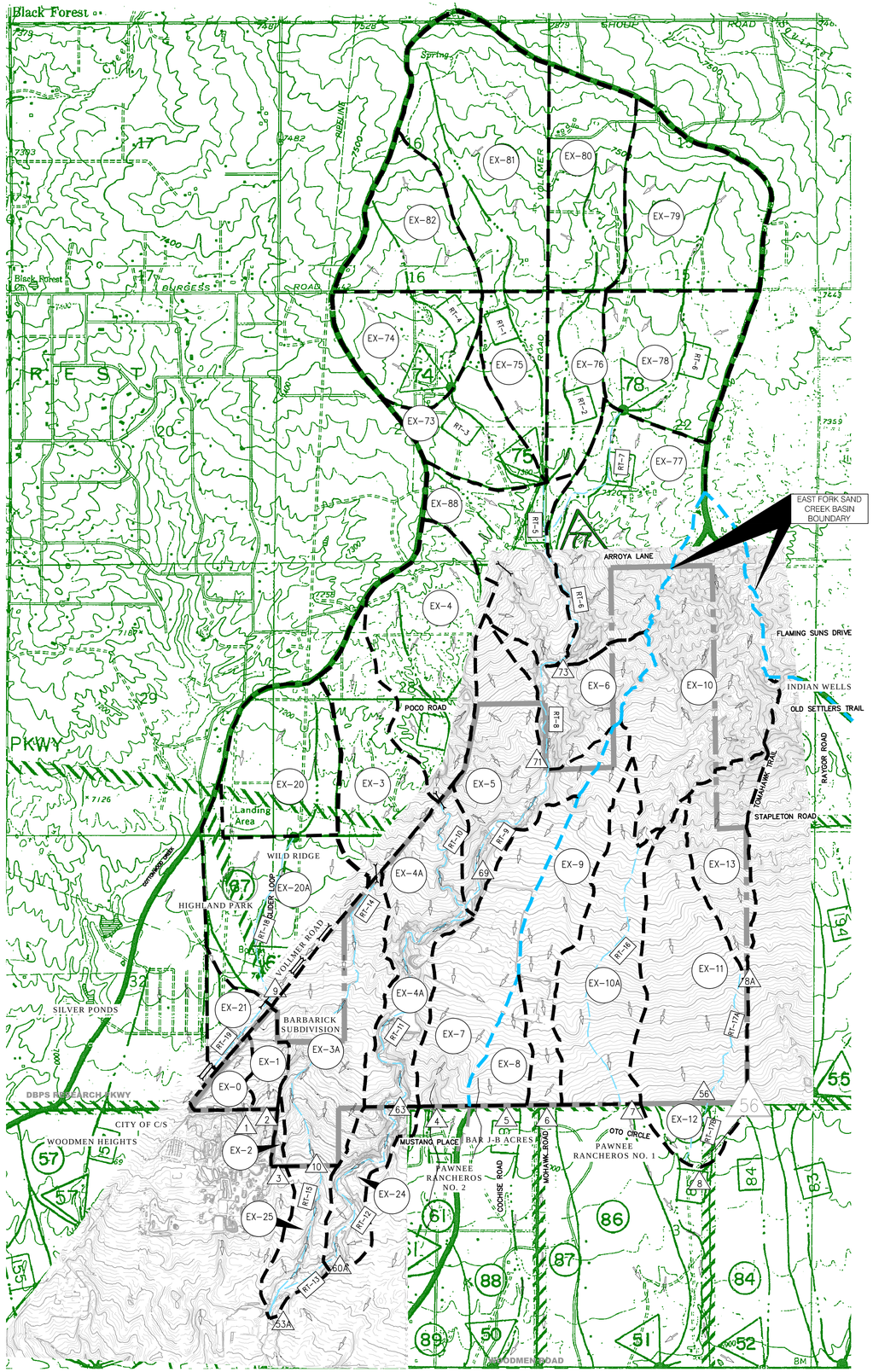
EXHIBIT
STERLING RANCH
JOB NO. 09-001
DATE PREPARED: 4-25-16
DATE REVISED:

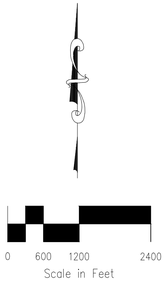
M&S CIVIL CONSULTANTS, INC.
20 BOULDER CRESCENT, STE. 110
COLORADO SPRINGS,
COLORADO 80903
v 719.955.5485
f 719.444.8427

SHEET 1 OF 1

APPENDIX E

DRAINAGE MAPS





LEGEND

BASIN ID – SC3–77

DESIGN POINT – 87

REACH IDENTIFIER – RT–17A

BASIN BOUNDARY –

EAST FORK SAND CREEK BASIN BOUNDARY –

FLOW DIRECTION –

BASIN SUMMARY

BASIN	CN	AREA (ACRES)	AREA (SQ MI)	Q_2 (CFS)	Q_5 (CFS)	Q_{10} (CFS)	Q_{25} (CFS)	Q_{50} (CFS)	Q_{100} (CFS)
EX–0	62	23.8	0.037	5.0	8.2	13.0	19.6	25.7	32.2
EX–1	62	25.7	0.040	4.8	7.9	12.4	18.7	24.5	30.9
EX–2	62	5.5	0.009	1.1	1.8	2.8	4.3	5.6	7.1
EX–3	62	136.8	0.214	22.0	36.4	57.6	86.9	114.0	143.1
EX–3A	61	188.1	0.294	28.3	47.4	75.7	115.1	152.2	192.6
EX–4	62	192.0	0.300	30.1	49.9	79.1	119.5	157.0	197.3
EX–4A	62	151.5	0.237	24.7	40.8	64.4	97.0	127.2	160.1
EX–5	62	153.9	0.240	24.2	40.0	63.4	95.9	125.9	158.2
EX–6	62	90.2	0.141	15.3	25.5	40.1	60.7	79.9	100.5
EX–7	56	165.0	0.258	11.6	21.5	37.5	60.9	83.1	107.4
EX–8	45	42.0	0.066	0.5	1.7	4.5	9.4	14.5	20.5
EX–9	54	131.9	0.206	12.2	23.9	43.1	70.9	97.0	125.2
EX–10	60	270.7	0.423	32.7	56.0	91.1	140.1	185.9	236.1
EX–10A	41	179.3	0.280	0.6	2.2	7.3	17.4	29.1	43.1
EX–11	43	209.3	0.327	18.0	29.8	47.7	73.4	98.3	126.1
EX–12	51	39.5	0.062	2.2	5.1	10.1	17.7	25.1	33.3
EX–13	55	89.3	0.139	7.7	15.2	27.1	44.2	60.5	78.4
EX–20	62	143.4	0.224	25.4	42.1	66.7	100.7	132.3	166.2
EX–20A	64	179.7	0.281	32.2	51.9	80.5	119.8	155.9	194.6
EX–21	65	33.3	0.052	8.6	13.5	20.7	30.5	39.4	49.0
EX–24	59	63.1	0.099	9.5	16.6	27.5	42.9	57.4	73.0
EX–25	43	54.4	0.085	0.3	1.5	4.8	10.7	17.2	25.1
EX–73	63	90.0	0.141	16.4	26.4	41.3	62.1	81.3	102.0
EX–74	63	119.7	0.187	22.3	36.5	57.3	85.9	112.3	140.7
EX–75	63	79.3	0.124	13.1	21.5	33.7	50.5	66.1	82.8
EX–76	63	86.4	0.135	14.2	23.1	36.4	54.6	71.4	89.6
EX–77	62	230.6	0.360	34.7	56.9	90.6	137.5	180.9	227.7
EX–78	63	155.6	0.243	28.1	45.3	70.6	106.2	139.1	174.5
EX–79	63	189.0	0.295	34.9	57.0	89.5	134.3	175.6	220.1
EX–80	63	147.7	0.231	27.3	44.3	69.6	104.5	136.8	171.4
EX–81	62	262.9	0.411	42.6	70.2	111.0	167.4	219.6	275.7
EX–82	62	117.8	0.184	20.0	33.2	52.8	80.0	105.1	132.3
EX–88	62	139.2	0.217	22.2	36.7	58.0	87.6	115.0	144.4

DESIGN POINT SUMMARY (PEAK FLOW)

DESIGN POINT	AREA (SQ MI)	Q_2 (CFS)	Q_5 (CFS)	Q_{10} (CFS)	Q_{25} (CFS)	Q_{50} (CFS)	Q_{100} (CFS)	LOCATION
DP–74	0.371	39.3	65.3	104.8	158.9	209.1	262.8	
DP–75	1.413	141.2	235.1	376.6	566.6	750.9	950.5	
DP–78	0.538	59.7	98.4	154.0	232.6	306.2	385.3	
DP–73	2.528	225.9	380.7	618.0	957.0	1260.4	1582.3	
DP–71	2.669	229.3	388.9	629.7	978.8	1277.3	1637.9	STERLING RANCH NORTHERN BNDRY
DP–69	3.209	253.0	434.8	707.7	1100.0	1453.3	1870.4	
DP–63	3.446	251.4	430.7	713.1	1113.2	1496.2	1911.5	STERLING RANCH SOUTHERN BNDRY
DP–10	0.508	36.5	56.0	106.4	162.9	220.6	287.2	COLORADO SPRINGS/EL PASO BNDRY
DP–9A	0.557	55.3	94.3	150.3	227.7	299.5	380.5	VOLLMER/TAHITI DRIVE
DP–9	0.505	52.8	88.8	142.1	214.2	281.0	351.4	VOLLMER/LOCHWINNOCH LN
DP–8A	0.139	7.7	15.2	27.1	44.2	60.5	78.4	D/S STERLING RANCH EASTERN BNDRY
DP–8	0.528	24.2	45.1	77.8	124.4	169.5	220.9	D/S STERLING RANCH SOUTHERN BNDRY
DP–7	0.703	32.4	57.1	97.3	156.1	213.8	277.9	STERLING RANCH SOUTHERN BNDRY
DP–6	0.206	12.2	23.9	43.1	70.9	97.0	125.2	STERLING RANCH SOUTHERN BNDRY
DP–5	0.066	0.5	1.7	4.5	9.4	14.5	20.5	STERLING RANCH SOUTHERN BNDRY
DP–4	0.258	11.6	21.5	37.5	60.9	83.1	107.4	STERLING RANCH SOUTHERN BNDRY
DP–3	0.009	1.1	1.8	2.8	4.3	5.6	7.1	STERLING RANCH SOUTHERN BNDRY
DP–2	0.040	4.8	7.9	12.4	18.7	24.5	30.9	STERLING RANCH SOUTHERN BNDRY
DP–1	0.037	5.0	8.2	13.0	19.6	25.7	32.2	STERLING RANCH SOUTHERN BNDRY
DP–60A	3.545	247.7	430.2	707.1	1113.0	1496.6	1913.5	FUTURE MARKSHEFFEL X–ING
DP–56	0.466	23.2	42.5	71.9	115.6	157.4	202.9	STERLING RANCH SOUTHERN BNDRY
DP–53A	4.138	262.1	454.0	763.2	1196.5	1609.8	2061.5	SAND CREEK AND POND 3

DESIGN POINT SUMMARY (VOLUME)

DESIGN POINT	AREA (SQ MI)	V_2 (AC–FT)	V_5 (AC–FT)	V_{10} (AC–FT)	V_{25} (AC–FT)	V_{50} (AC–FT)	V_{100} (AC–FT)	LOCATION
DP–74	0.371	5.9	9.0	13.6	19.8	25.5	31.6	
DP–75	1.413	22.7	34.5	51.7	75.4	97.1	120.5	
DP–78	0.538	8.9	13.5	20.1	29.3	37.7	46.7	
DP–73	2.528	40.4	61.5	92.1	134.3	173.1	214.9	
DP–71	2.669	42.5	64.9	97.1	141.6	182.5	226.6	STERLING RANCH NORTHERN BNDRY
DP–69	3.209	50.7	77.4	116.1	169.4	218.6	271.4	
DP–63	3.446	54.1	82.5	123.8	180.8	233.3	289.9	STERLING RANCH SOUTHERN BNDRY
DP–10	0.508	7.6	11.7	17.6	25.8	33.4	41.6	COLORADO SPRINGS/EL PASO BNDRY
DP–9A	0.557	9.3	14.1	21.1	30.7	39.4	48.8	VOLLMER/TAHITI DRIVE
DP–9	0.505	8.4	12.7	19.0	27.6	35.5	44.0	VOLLMER/LOCHWINNOCH LN
DP–8A	0.139	1.3	2.1	3.4	5.2	7.0	8.9	D/S STERLING RANCH EASTERN BNDRY
DP–8	0.528	4.4	7.0	11.1	16.8	22.3	28.4	D/S STERLING RANCH SOUTHERN BNDRY
DP–7	0.703	6.1	10.0	15.9	24.3	32.4	41.3	STERLING RANCH SOUTHERN BNDRY
DP–6	0.206	2.4	4.0	6.3	9.6	12.7	16.0	STERLING RANCH SOUTHERN BNDRY
DP–5	0.066	0.2	0.4	0.8	1.4	1.9	2.6	STERLING RANCH SOUTHERN BNDRY
DP–4	0.258	2.6	4.2	6.7	10.2	13.5	17.2	STERLING RANCH SOUTHERN BNDRY
DP–3	0.009	0.1	0.2	0.3	0.5	0.6	0.8	STERLING RANCH SOUTHERN BNDRY
DP–2	0.040	0.6	0.9	1.4	2.1	2.7	3.4	STERLING RANCH SOUTHERN BNDRY
DP–1	0.037	0.6	0.9	1.3	1.9	2.5	3.1	STERLING RANCH SOUTHERN BNDRY
DP–60A	3.545	55.3	84.4	126.4	184.8	238.5	296.6	FUTURE MARKSHEFFEL X–ING
DP–56	0.466	4.0	6.3	9.9	14.9	19.8	25.1	SAND CREEK AND POND 3
DP–53A	4.138	63.0	96.4	144.7	211.8	273.9	340.9	SAND CREEK AND POND 3

EFSC DBPS DESIGN POINT SUMMARY (PEAK FLOW)

DBPS DESIGN POINT	AREA (SQ MI)	Q_{10} (CFS)	Q_{100} (CFS)
DP–50	0.32	47.0	195.7
DP–51 (BASIN 86)	0.33	17.7	74.1
DP–52	1.67	80.5	456.5
DP–56	0.79	63.6	265.0

Values reported from SCDBPS
(DP 50, 51, 52 Not analyzed as a part of this study)
DBPS Reach 85(Basin91)=Q10=28.8cfs Q100=115.2cfs

M&S CIVIL CONSULTANTS, INC.
20 BOULDER CRESCENT, SUITE 110
COLORADO SPRINGS, CO 80903
PHONE: 719.955.5485

2018 STERLING RANCH MDDP

EXISTING HYDROLOGIC CONDITIONS MAP

PROJECT NO. 09–002 | FILE: \dwg\Eng Exhibits\2018–MDDP–ExistCondWSWrkMap.dwg

DESIGNED BY: DLM
DRAWN BY: DLM
CHECKED BY: VAS

SCALE
HORIZ: NTS
VERT: NTS

DATE: 08–22–18

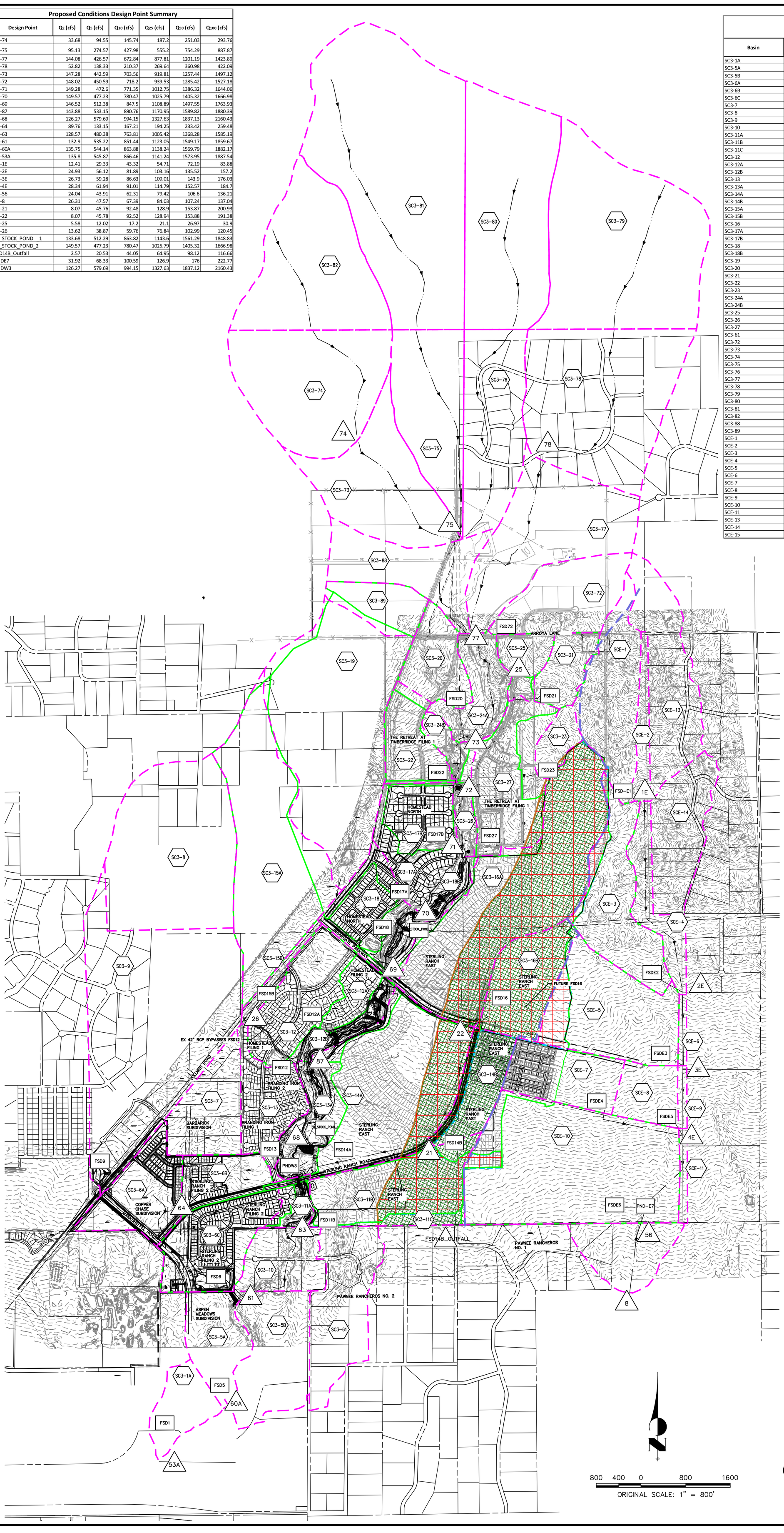
DM1

FOR LOCATING & MARKING GAS, ELECTRIC, WATER & TELEPHONE LINES
FOR BURIED UTILITY INFORMATION
48 HRS BEFORE YOU DIG
CALL 1–800–922–1987

File: D:\09002A\Sterling Ranch District\dwg\Eng Exhibits\2018 MDDP\2018-MDDP-ExistCondWSWrkMap.dwg Photostamp: 11/13/2018 1:52 PM

Proposed Conditions Design Point Summary						
Design Point	Q_2 (cfs)	Q_5 (cfs)	Q_{10} (cfs)	Q_{25} (cfs)	Q_{50} (cfs)	Q_{100} (cfs)
DP-74	33.68	94.55	145.74	187.2	251.03	293.76
DP-75	95.13	274.57	427.98	555.2	754.29	887.87
DP-77	144.08	426.57	672.84	877.81	1201.19	1423.89
DP-78	52.82	138.33	210.37	269.64	360.98	422.09
DP-73	147.28	442.59	703.56	919.81	1257.44	1497.12
DP-72	148.02	450.59	718.2	939.53	1285.42	1527.18
DP-71	149.28	472.6	771.35	1012.75	1386.32	1644.06
DP-70	149.57	477.23	780.47	1025.79	1405.32	1666.98
DP-69	146.52	512.38	847.5	1108.89	1497.55	1763.93
DP-87	143.88	533.15	890.76	1170.95	1589.82	1880.39
DP-68	126.27	579.69	994.15	1327.63	1837.13	2160.43
DP-64	89.76	133.15	167.21	194.25	233.42	259.48
DP-63	128.57	480.38	763.81	1005.42	1368.28	1585.19
DP-61	132.9	535.22	851.44	1123.05	1549.17	1859.67
DP-60A	135.75	544.14	863.88	1138.24	1569.79	1882.17
DP-53A	135.8	545.87	866.46	1141.24	1573.95	1887.54
DP-1E	12.41	29.33	43.32	54.71	72.19	83.88
DP-2E	24.93	56.12	81.89	103.16	135.52	157.2
DP-3E	26.73	59.28	86.63	109.01	143.9	176.03
DP-4E	28.34	61.94	91.01	114.79	152.57	184.7
DP-56	24.04	43.91	62.31	79.42	106.6	136.21
DP-8	26.31	47.57	67.39	84.03	107.24	137.04
DP-21	8.07	45.76	92.48	128.9	153.87	200.93
DP-22	8.07	45.78	92.52	128.94	153.88	191.38
DP-25	5.58	12.02	17.2	21.1	26.97	30.9
DP-26	13.62	38.87	59.76	76.84	102.99	120.45
EX_STOCK_POND _1	133.68	512.29	863.82	1143.6	1561.29	1848.83
EX_STOCK_POND_2	149.57	477.23	780.47	1025.79	1405.32	1666.98
FSD14B_Outfall	2.57	20.53	44.05	64.95	98.12	116.66
PNDE7	31.92	68.33	100.59	126.9	176	222.77
PNDW3	126.27	579.69	994.15	1327.63	1837.12	2160.43

Proposed Conditions Basin Summary						
Basin	Q_2 (cfs)	Q_5 (cfs)	Q_{10} (cfs)	Q_{25} (cfs)	Q_{50} (cfs)	Q_{100} (cfs)
SC3-1A	15.4	32.05	44.63	54.22	68.02	77.21
SC3-5A	48.38	75.2	95.88	112.35	135.5	150.82
SC3-5B	60.26	97.13	126.36	149	181.48	203.13
SC3-6A	59.98	84.21	106.32	123.77	149.06	165.69
SC3-6B	30	47.16	60.52	70.92	85.96	95.97
SC3-6C	52.26	84.02	115.61	140.03	174.32	196.64
SC3-7	60.94	87.91	109.28	126.05	150.45	166.71
SC3-8	12.18	56.41	93.96	122.75	166.13	195.44
SC3-9	24.66	73.44	114.01	146.06	193.77	225.81
SC3-10	2.94	14.36	23.62	30.77	41.33	48.66
SC3-11A	1.99	5.36	8.05	10.06	13.08	15.09
SC3-11B	68	99.65	126.13	146.85	176.93	196.96
SC3-11C	1.37	5.83	9.3	11.93	15.66	18.16
SC3-12	47.61	71.53	91.34	106.54	129.44	144.67
SC3-12A	15.01	24.03	31.22	36.66	44.86	50.3
SC3-12B	2.17	6.35	9.82	12.6	16.83	19.66
SC3-13	56.24	80.96	100.72	115.86	138.53	153.6
SC3-13A	2.61	7.62	11.81	15.18	20.28	23.7
SC3-14A	110.65	160.22	203.13	237.5	287.18	320.18
SC3-14B	63.13	90	115.58	136.1	165.72	185.1
SC3-15A	13.21	38.41	59.28	76.32	102.43	119.86
SC3-15B	8.38	12.29	15.45	17.9	21.56	24
SC3-16	180.7	266.34	343.24	404.73	493.4	552.27
SC3-17A	25.63	39.59	50.91	59.5	72.46	81.07
SC3-17B	20.59	32.3	41.97	49.43	60.7	68.19
SC3-18	22.75	32.96	41.34	47.83	57.56	64.05
SC3-18B	1.53	4.45	6.89	8.86	11.91	13.95
SC3-19	28	78.96	120.84	154.22	205.45	239.67
SC3-20	9.29	21.02	30.73	38.5	50.17	57.99
SC3-21	9.77	20.68	29.45	36.03	45.92	52.53
SC3-22	7.15	16.35	24.05	30.08	39.14	45.22
SC3-23	10.92	22.1	31.23	38.2	48.72	55.73
SC3-24A	6.43	15.26	22.51	28.3	37.09	42.98
SC3-24B	1.95	4.78	7.12	8.98	11.76	13.62
SC3-25	5.58	12.02	17.2	21.1	26.97	30.9
SC3-26	1.66	4.37	6.61	8.4	11.13	12.95
SC3-27	14.49	27.87	39.1	48.09	61.8	70.95
SC3-61	5.61	22.4	36.4	47.4	63.67	74.61
SC3-72	9.55	23.84	35.61	44.98	59.19	68.7
SC3-73	12.16	33.03	50.14	63.84	84.94	99.04
SC3-74	22.51	53.27	79.1	99.77	131.03	151.94
SC3-75	11.12	26.37	38.98	49.21	64.91	75.41
SC3-76	10.85	27.09	40.54	51.45	68.18	79.38
SC3-77	8.93	27.11	42.16	54.46	73.59	86.36
SC3-78	32.29	77.46	114.83	144.42	189.21	219.17
SC3-79	32.26	82.54	123.52	156.01	205.95	239.34
SC3-80	22.36	57.34	86.09	109.14	144.5	168.15
SC3-81	26.67	81	125.85	162.22	218.65	256.32
SC3-82	17.01	50.83	79.48	102.02	136.18	158.98
SC3-88	6.28	18.99	29.44	37.84	50.8	59.46
SC3-89	2.86	8.64	13.39	17.14	22.87	26.69
SCE-1	9.82	21.3	30.85	38.58	50.51	58.52
SCE-2	1.42	3.35	4.95	6.27	8.3	9.66
SCE-3	8.5	16.95	25.2	31.78	41.56	48.16
SCE-4	4.16	7.52	10.35	12.67	16.29	18.71
SCE-5	71.73	99.51	125.72	146.92	177.83	198.17
SCE-6	0.18	0.55	1.03	1.42	2	2.39
SCE-7	33.06	46.14	56.71	64.87	77.06	85.19
SCE-8	47.1	61.37	73.41	82.94	97.16	106.61
SCE-9	0.22	0.68	1.27	1.75	2.46	2.94
SCE-10	106.33	165.76	230.7	283.77	358.46	407.13
SCE-11	0.77	2.52	4.75	6.5	8.93	10.51
SCE-13	10.9	25.85	38.21	48.24	63.64	73.94
SCE-14	8	19.04	28.21	35.59	46.77	54.26
SCE-15	13.6	27.2	38.53	47.35	60.67	69.54



PROPOSED DRAINAGE MAP
SAND CREEK MDDP AMENDMENT
JOB NO. 25188.04
01/17/23
SHEET 1 OF 1

J·R ENGINEERING
A Westrian Company

Centennial 303-740-9393 • Colorado Springs 719-593-2593
Fort Collins 970-491-9888 • www.jrengineering.com

Appendix G

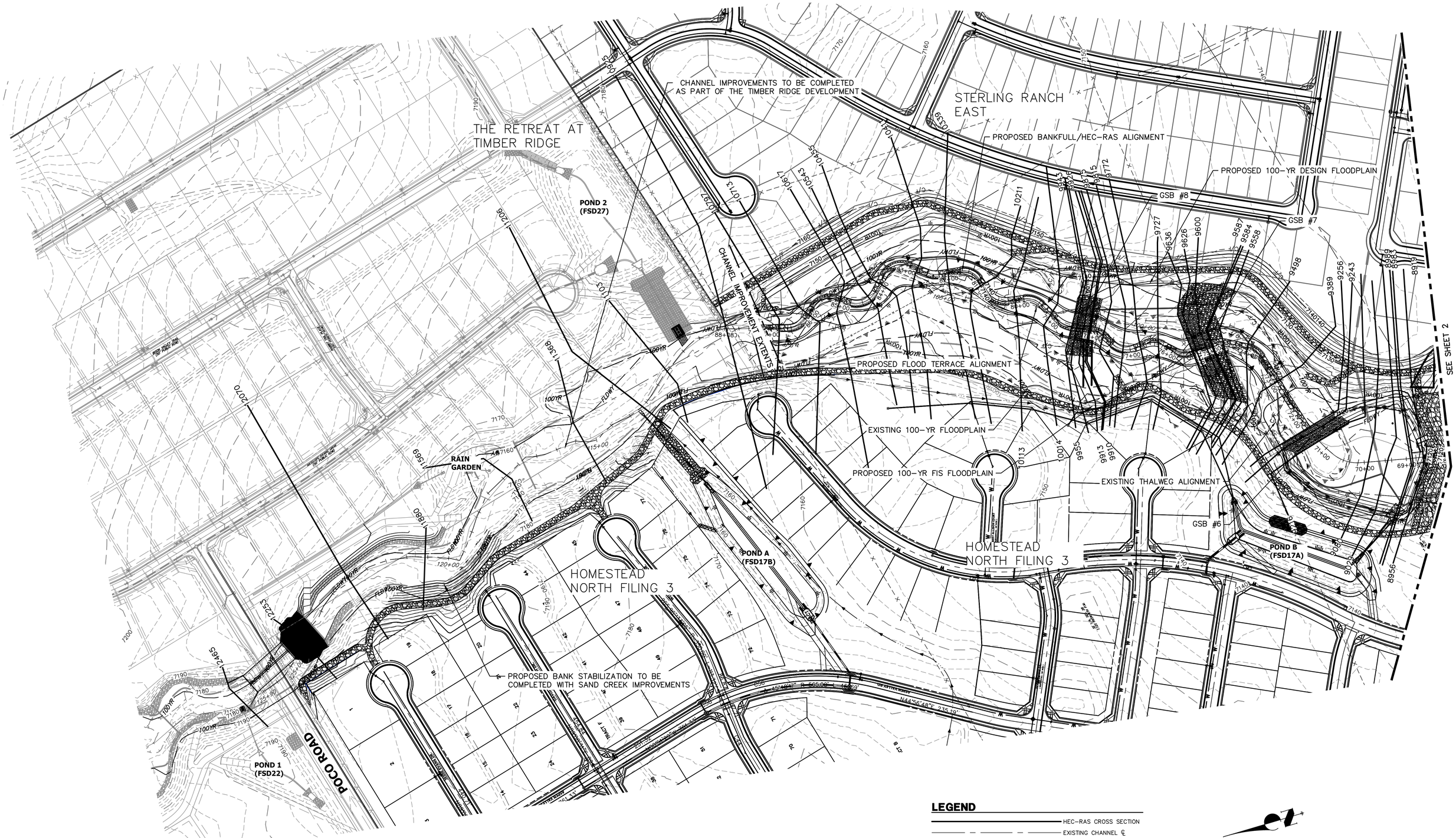
HEC-RAS Work Map

SAND CREEK PLAN & PROFILE

SAND CREEK MASTER BANKFULL ALIGNMENT PROFILE
STA -2+95.01 TO 88+07.73

BANKFULL PLAN & PROFILE
SAND CREEK RESTORATION
PROJECT NO: 25188.04
DATE: 06/30/2023
SHEET 1 OF 1

SAND CREEK RESTORATION WORK MAP



LEGEND

- HEC-RAS CROSS SECTION
- EXISTING CHANNEL ℄
- PROPOSED CHANNEL ℄
- 100YR — 100-YR FIS
- 100YR — 100-YR DESIGN WSEL
- 100YR — 100-YR EXISTING WSEL

100 50 0 100 200

ORIGINAL SCALE: 1" = 100'

HEC-RAS WORK MAP
SAND CREEK RESTORATION
PROJECT NO: 25188.04
DATE: 11/20/23
SHEET 1 OF 3

X:\2510000.all\2518804\HEC-RAS\HEC-RASE Base Files\2022-04-08-Sand Creek HEC Work Map.dwg, Layout1 (3), 13/6/2023 1:57:02 PM, VaughnD

SAND CREEK RESTORATION WORK MAP

LEGEND

- HEC-RAS CROSS SECTION
- EXISTING CHANNEL ℄
- PROPOSED CHANNEL ℄
- 100YR — 100-YR FIS
- 100YR — 100-YR DESIGN WSEL
- 100YR — 100-YR EXISTING WSEL

100 50 0 100 200

ORIGINAL SCALE: 1" = 100'

HEC-RAS WORK MAP
SAND CREEK RESTORATION
PROJECT NO: 25188.04
DATE: 11/20/23
SHEET 2 OF 3

X:\2510000.all\2518804\HEC-RAS\HEC-RASE Base Files\2022-04-08-Sand Creek HEC Work Map.dwg, Layout1 (4), 12/6/2023 1:57:23 PM, VaughnD

SAND CREEK RESTORATION WORK MAP

LEGEND

- HEC-RAS CROSS SECTION
- EXISTING CHANNEL ℄
- PROPOSED CHANNEL ℄
- 100YR — 100-YR FIS
- 100YR — 100-YR DESIGN WSEL
- 100YR — 100-YR EXISTING WSEL

100 50 0 100 200

ORIGINAL SCALE: 1" = 100'

HEC-RAS WORK MAP
SAND CREEK RESTORATION
PROJECT NO: 25188.04
DATE: 11/20/23
SHEET 3 OF 3

X:\2510000.all\25188\HHEC-RAS\HEC RASE Base Files\2022-04-08-Sand Creek HEC Work Map.dwg, Layout1 (5), 12/6/2023 1:57:42 PM, VaughtD

Appendix H

Wetlands Mitigation Plan

SAND CREEK RESTORATION – WETLANDS EXHIBIT

LEGEND

- PERMANENT LOSSES FROM CHANNEL
- PERMANENT LOSSES FROM BRIDGE
- MITIGATION AREAS
- PRESERVED WETLANDS

Sand Creek Wetlands Disturbances		
Totals	Sq Ft	Acres
Total Existing Onsite Wetland	709,592	16.29
Reach 1 Permanent Loss	53,030	1.2174
Reach 2 Permanent Loss	203,081	4.6621
Reach 3 Permanent Loss	208,940	4.7966
Permanent Loss Total	465,051	10.6761
Reach 1 Wetlands Preserved	-	0
Reach 2 Wetlands Preserved	100,676	2.3112
Reach 3 Wetlands Preserved	-	0
Total Wetlands Preserved	100,676	2.3112
Reach 1 Mitigation	117,747	2.7031
Reach 2 Mitigation	1,151,914	26.4443
Reach 3 Mitigation	484,540	11.1235
Mitigation Total	1,754,200	40.2709
Total (Mitigation less Permanent Loss)	1,289,149	29.5948
Mitigation to Permanent Loss Ratio	3.77	

FINAL GRADING TOTALS:

REACH 1 –30,764 CY CUT
4,603 CY FILL
26,162 NET

REACH 2 –646,436 CY CUT
24,522 CY FILL
621,913 CY NET

REACH 3 –129,691 CY CUT
3,462 CY FILL
126,229 CY NET

TOTAL– 806,8911 CY CUT
32,587 CY FILL
774,304 CY NET

Wetlands Impacts Summary	
Total Permanent Loss	10.6761
Total Re-Establishment	7.0579
Total Establishment	26.1728
Total Enhancement	4.729
Total Preservation	2.3112
Total Mitigation	**40.2709**
Mitigation to Permanent Loss Ratio	**3.77**

Permanent Impacts	
Impact Area	Area (ac)
1	0.004
2	0.6592
3	0.0268
4	0.5274
5	0.3427
6	0.0124
7	0.6318
8	0.136
9	0.4761
10	0.543
11	0.0639
12	0.0485
13	0.2452
14	0.0767
15	0.0755
16	0.1361
17	0.4612
18	0.0208
19	0.6157
20	0.0838
21	0.0537
22	0.6390
23	0.0409
24	0.0066
25	0.0632
26	0.0116
27	0.0185
28	0.0131
29	0.1061
30	0.0032
31	0.0584
32	0.0509
33	0.8142
34	0.3847
35	0.0334
36	1.6645
37	0.0068
38	0.4397
39	0.2038
40	0.0058
41	0.0084
42	0.3796
43	0.1225
44	0.0985
45	0.0898
46	0.1026
47	0.0698
Total	10.6761

Enhancement	
Mitigation Area	Area (ac)
1	0.6776
24	0.9247
27	0.8238
32	0.3407
47	0.6028
67	0.0682
73	1.2912
Total	4.729

Preservation	
Mitigation Area	Area (ac)
19	2.3112
Total	2.3112

Total Mitigation		
Mitigation Area	Area (ac)	Designation
1	0.6776	Enhancement
2	0.0269	Re-Establish
3	0.299	Re-Establish
4	0.0041	Establish
5	0.0986	Establish
6	0.0151	Re-Establish
7	0.9905	Establish
8	0.2136	Establish
9	0.1462	Establish
10	0.1556	Establish
11	0.0444	Re-Establish
12	0.0315	Establish
13	2.4557	Establish
14	1.2728	Establish
15	0.3427	Re-Establish
16	1.4399	Establish
17	0.016	Establish
18	0.136	Re-Establish
19	2.3112	Preservation
20	0.0094	Re-Establish
21	0.0463	Establish
22	0.0639	Re-Establish
23	0.2452	Re-Establish
24	0.9247	Enhancement
25	4.4623	Establish
26	0.0767	Re-Establish
27	0.8238	Enhancement
28	0.0755	Re-Establish
29	5.8293	Establish
30	0.446	Re-Establish
31	1.1086	Establish
32	0.3407	Enhancement
33	0.9171	Establish
34	0.0208	Re-Establish
35	0.0323	Establish
36	0.1138	Re-Establish
37	1.0739	Establish
38	0.9171	Establish
39	0.167	Re-Establish
40	0.2395	Establish
41	0.2196	Re-Establish
42	0.0152	Establish
43	0.2375	Establish
44	0.0638	Re-Establish
45	0.0066	Re-Establish
46	0.0632	Re-Establish
47	0.6028	Enhancement
48	0.2801	Establish
49	1.2037	Establish
50	0.0116	Re-Establish
51	0.0185	Re-Establish
52	0.2329	Establish
53	0.0131	Re-Establish
54	0.1061	Re-Establish
55	0.006	Establish
56	0.0083	Establish
57	0.8142	Re-Establish
58	0.1841	Establish
59	0.0101	Establish
60	1.1652	Establish
61	0.006	Establish
62	0.0234	Establish
63	0.0326	Establish
64	1.6376	Re-Establish
65	0.2747	Re-Establish
66	0.1273	Re-Establish
67	0.0682	Enhancement
68	0.4082	Establish
69	0.0084	Re-Establish
70	0.0157	Establish
71	0.3543	Re-Establish
72	0.0913	Establish
73	1.2912	Enhancement
74	0.8016	Establish
75	0.015	Re-Establish
76	1.0691	Re-Establish
77	0.1026	Re-Establish
78	0.0698	Re-Establish
Total	40.2709	

Establishment	
Mitigation Area	Area (ac)
4	0.0041
5	0.0986
7	0.9905
8	0.2136
9	0.1462
10	0.1556
12	0.0315
13	2.4557
14	1.2728
16	1.4399
17	0.016
21	0.0463
25	4.4623
29	5.8293
31	1.1086
33	0.9171
35	0.0323
37	1.0739
38	0.9171
40	0.2395
42	0.0152
43	0.2375
48	0.2801
49	1.2037
52	0.2329
55	0.006
56	0.0083
58	0.1841
59	0.0101
60	1.1652
61	0.006
62	0.0234
63	0.0326
68	0.4082
70	0.0157
72	0.0913
74	0.8016
Total	26.1728

Re-Establishment	
Mitigation Area	Area (ac)
2	0.0269
3	0.299
6	0.0151
11	0.0444
15	0.3427
18	0.136
20	0.0094
22	0.0639
23	0.2452
26	0.0767
28	0.0755
30	0.446
34	0.0208
36	0.1138
39	0.167
41	0.2196
44	0.0638
45	0.0066
46	0.0632
50	0.0116
51	0.0185
53	0.0131
54	0.1061
57	0.8142
64	1.6376
65	0.2747
66	0.1273
69	0.0084
71	0.3543
75	0.015
76	1.0691
77	0.1026
78	0.0698
Total	7.0579

100 50 0 100 200

HORIZONTAL
ORIGINAL SCALE: 1" = 100'
VERTICAL
ORIGINAL SCALE: 1" = 10'

WETLANDS EXHIBIT
SAND CREEK RESTORATION
PROJECT NO: 25188.04
DATE: 11/26/2023
SHEET 1 OF 1