APPENDIX E FLOODPLAIN HYDROLOGY AND HYDRAULICS ANALYSIS

University Boulevard Extension
Floodplain H&H Analysis

Date: September 2025

Prepared For: PRINCE WILLIAM COUNTY
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Introduction

Purpose

The purpose of this flood study is to assess the hydraulic impacts associated with the proposed University Boulevard Extension project in Prince William County, Virginia. This project is being designed to a preliminary level of detail and will then be advertised as a design-build project. See Picture below for Project Location Map. The project involves the construction of a new 2.5-mile roadway segment extending from Devlin Road to Wellington Road along a new alignment that crosses an unnamed tributary to Rocky Branch. This segment of the unnamed tributary to Rocky Branch is within a FEMA-designated Zone AE flood hazard area with an established regulatory floodway, as delineated by LOMR Case No. 20-03-0070P, effective December 3, 2020. Design constraints include maintaining no encroachment within the regulatory floodway and ensuring that the proposed conditions result in no rise (i.e., ≤ 0.00 feet) in the base flood elevation. The hydrologic and hydraulic analysis will evaluate existing and proposed conditions in coordination with the preliminary roadway and bridge designs to ensure compliance with applicable floodplain management criteria. This report and the associated design are not intended for direct use in construction or permitting at this stage. Instead, they serve to inform Prince William County and the future Design-Build team on a feasible bridge crossing solution, with respect to hydraulics, floodplain impacts, easement requirements, and permitting considerations.

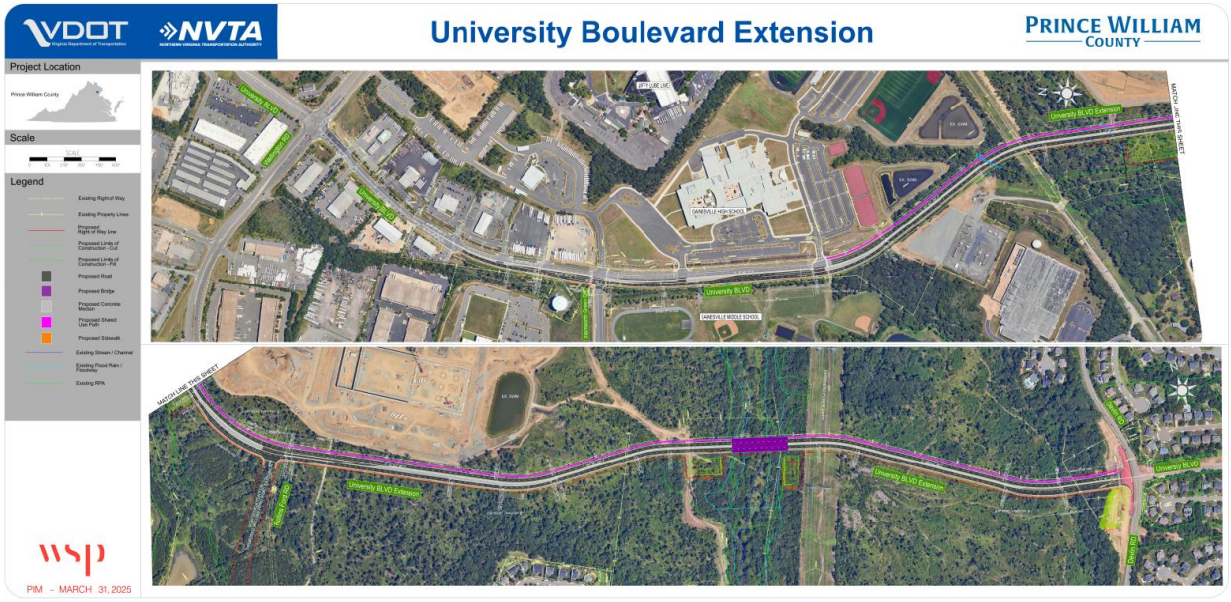


Figure 1: Project Location Map

Effective Studies

The current effective Flood Insurance Study (FIS) for Prince William County, Virginia and Incorporated Areas is dated August 3, 2015 (Community No. 510119). According to this study, no detailed hydrologic or hydraulic analysis was originally provided for the unnamed tributary. However, a subsequent Letter of Map Revision (LOMR Case No. 20-03-0070P), effective December 3, 2020, provided updated hydrologic and hydraulic analyses for the unnamed tributary to Rocky Branch, identified in the LOMR as Piney Branch.

For consistency, this report will refer to the stream as the unnamed tributary to Rocky Branch. The revised study reach extends from approximately 2,870 feet upstream of State Route 619 (Linton Hall Road) to approximately 6,690 feet upstream of the same roadway. At a location approximately 0.57 miles upstream of Linton Hall Road, the drainage area contributing to the unnamed tributary to Rocky Branch is 1.89 square miles, with a 100-year peak discharge of 4,640 cubic feet per second (cfs). The LOMR includes Base Flood Elevations (BFEs) both with and without consideration of the regulatory floodway.

The most recent effective hydraulic model for the unnamed tributary to Rocky Branch (Piney Branch) is associated with LOMR 20-03-0070P (effective date December 3, 2020).

Study Limits

This floodplain study proposes revisions to the hydraulic analysis to evaluate the impacts of the University Boulevard Extension project. The analysis focuses on the area surrounding the proposed bridge crossing of the unnamed tributary to Rocky Branch. Specifically, revisions are limited to updates in cross-sectional geometry at River Stations 6020 and 5881 to reflect the proposed conditions.

Hydrology

The 100-year peak discharge was obtained from the effective hydraulic model associated with LOMR 20-03-0070P, which includes steady flow data developed for FEMA regulatory analysis. Since only the 100-year FEMA discharge is available from the LOMR, additional peak discharge estimates were developed using USGS StreamStats. StreamStats was used to generate flows based on regional regression equations applicable to the project location, which lies within the Mesozoic Basin region of the Piedmont physiographic province. Please refer to the StreamStats Report in Appendix D for further details. The applicable regression equations are summarized in Table 1. Among the available flow types, the Peak-Flow Statistics were selected due to their broader range of applicability. Urban Peak-Flow Statistics were excluded from this analysis as they produced lower discharge estimates. The derived peak flows were used to evaluate Water Surface Elevations (WSELs) under various storm events. The flow rates summary is provided in Table 2.

Table 1: Regional Regression Equations for Estimating Peak Flows of Streams in Virginia – Mesozoic Basin Region (USGS StreamStats)

Recurrence Interval	Regression Equation	Pseudo R^2	Avg. Std. Error of Prediction (%)	Std. Model Error (%)
0.5 peak	Log10(Q) = 2.002 + 0.722 × Log10(DA)	0.85	44	41
0.2 peak	Log10(Q) = 2.416 + 0.660 × Log10(DA)	0.83	44	42
0.1 peak	Log10(Q) = 2.656 + 0.624 × Log10(DA)	0.82	44	41
0.04 peak	Log10(Q) = 2.923 + 0.586 × Log10(DA)	0.81	43	40
0.02 peak	Log10(Q) = 3.081 + 0.561 × Log10(DA)	0.8	42	39
0.01 peak	Log10(Q) = 3.265 + 0.537 × Log10(DA)	0.8	41	37

(Austin, S.H., Krstolic, J.L., and Wiegand, Ute,2011)

Table 2: Flow Rates Summary Table

River	River Station	FEMA Flow Rates (cfs)	USGS StreamStats Flow Rates (cfs)					
		100-yr	100-yr	50-yr	25-yr	10-yr	5-yr	2-yr

The unnamed tributary to Rocky Branch (Piney Branch)	8,920	4,641	2,670	1,840	1,260	698	412	166

Hydraulic Analysis

A hydraulic analysis was conducted using the U.S. Army Corps of Engineers' Hydrologic Engineering Center's River Analysis System (HEC-RAS) Version 6.6 for the unnamed tributary to Rocky Branch to evaluate the 100-year floodplain impacts associated with the proposed bridge and University Boulevard Extension.

Based on the FEMA Effective HEC-RAS Model Files (LOMR 20-03-0070P), the stream centerline was updated based on high-resolution imagery and topographic contours. Cross section 5920 was removed due to overlap with the proposed bridge structure, and cross section 5881 was added to reflect the proposed geometry for accurate comparison. Although the area of revision related to bridge construction is limited to cross sections 6020 and 5881, the full extent of the hydraulic model was retained without truncation for consistency with the effective model.

Datum

The Existing Conditions model from the Letter of Map Revision (LOMR Case No. 20-03-0070P, 2020) was developed in the North American Vertical Datum of 1988 (NAVD88). The current project model was developed directly from this LOMR model and is therefore also referenced to NAVD88.

Two primary datasets were used to develop the project surface:

- LiDAR Surface: State of Virginia, 2024 (https://vgin.vdem.virginia.gov/apps/VGIN::virginia-lidar-download-application/explore?path=)
- Effective Model Surface: FEMA Study Reference 20-03-0070P_Hydraulics, 2020

The effective model channel elevations were retained where appropriate, while overbank elevations were supplemented with LiDAR data to ensure consistency across the NAVD88 datum.

The effective FEMA Flood Insurance Study (FIS) materials, including FIRMs and LOMAs, were originally developed in NGVD29. The effective model elevations were successfully converted to NAVD88 using the National Geodetic Survey (NGS) conversion tool.

Key consistency checks were performed:

- The downstream boundary condition in the current model matches the converted LOMA Map BFE elevation.
- The LiDAR ground surface is consistent with the effective model surface.

Based on these checks, the current hydraulic model accurately reflects the correct vertical datum and ground surface conditions in NAVD88. All floodplain elevation data presented in this report are reported in NAVD 88.

Existing Conditions Model

The most recent effective hydraulic model for the unnamed tributary to Rocky Branch (Piney Branch) is associated with LOMR 20-03-0070P, with an effective date of December 3, 2020. The effective HEC-RAS model was provided by FEMA and was upgraded to HEC-RAS Version 6.6 to develop the Existing model. The model ran successfully without requiring changes to input parameters.

The stream centerline was updated using high-resolution 2024 State LiDAR data accessed from the Virginia FEMA DEM Viewer. The LiDAR dataset, dated September 2024, has a cell resolution of 2.5 ft by 2.5 ft and was verified in ArcMap for accuracy. Reach lengths were adjusted accordingly to match the updated stream centerline, while cross section stationing and elevation data were retained from the FEMA effective model. Comparison with the LiDAR surface confirmed that the original cross section elevations provide a reasonable approximation for use in the Existing model.

A normal depth slope of S = 0.001 was applied as the downstream boundary condition, consistent with the FEMA effective model. Manning's n values of 0.1 for the overbanks and 0.03 for the main channel were used throughout the model to represent flow resistance, matching the parameters used in the FEMA effective model.

Cross section 5920 from the FEMA effective model was removed due to its overlap with the proposed bridge footprint. A new cross section, 5881, was added just downstream of the proposed bridge to facilitate comparison between existing and proposed conditions. The station-elevation data for 5881 were extracted from the 2024 State LiDAR, and no changes were made to other model parameters.

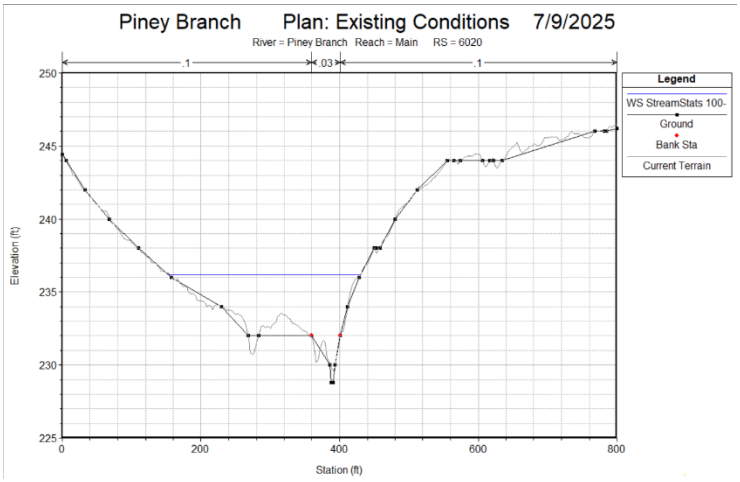


Figure 2: River Station 6020 Existing Geometry (Black) vs Current Terrain (Grey)

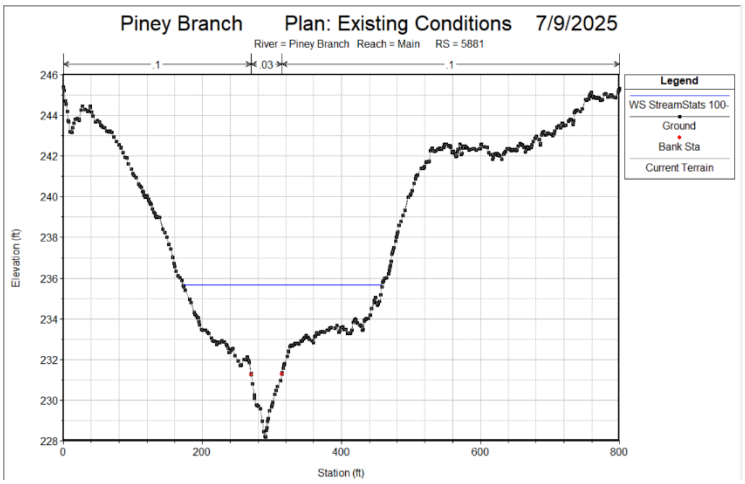


Figure 3: River Station 5881 Geometry from State LiDAR

Proposed Conditions Model

In the proposed conditions HEC-RAS model, the proposed bridge was added between cross sections 6020 and 5881. The internal bridge cross sections were assigned a Manning's n value of 0.07 to reflect the expected maintenance conditions. The area around the bridge abutments is anticipated to be cleared of woody vegetation, with shading from the bridge reducing the potential for vegetative reestablishment. Additionally, the ground will be stabilized using stone riprap or similar scour protection measures. These conditions justify the use of a lower roughness coefficient compared to the surrounding wooded floodplain.

Grading was applied within the bridge opening and extended to the adjacent upstream and downstream cross sections to maintain floodplain continuity and enhance conveyance. The internal bridge geometry was copied to cross sections 6020 and 5881, and the ground elevations were graded to 234 ft, representing the proposed excavation to open the floodplain for unobstructed flow. Internal cross section bottom elevations were aligned with existing ground to maintain consistent longitudinal slope through the bridge.

Ineffective flow areas were defined using a 1:1 contraction and 2:1 expansion ratio at the bridge cross sections, consistent with HEC-RAS guidelines. However, contraction and expansion coefficients of 0.1 and 0.3, respectively, at the cross sections immediately upstream and downstream of the bridge. Due to the wide span and elevated bridge deck, the bridge does not restrict flow or cause contraction. The modeled water surface elevations remain below the bridge deck under all flow conditions. Flow passes beneath the superstructure without contracting around the abutments do not impact the flow. The only impediment that causes energy loss is the pier.

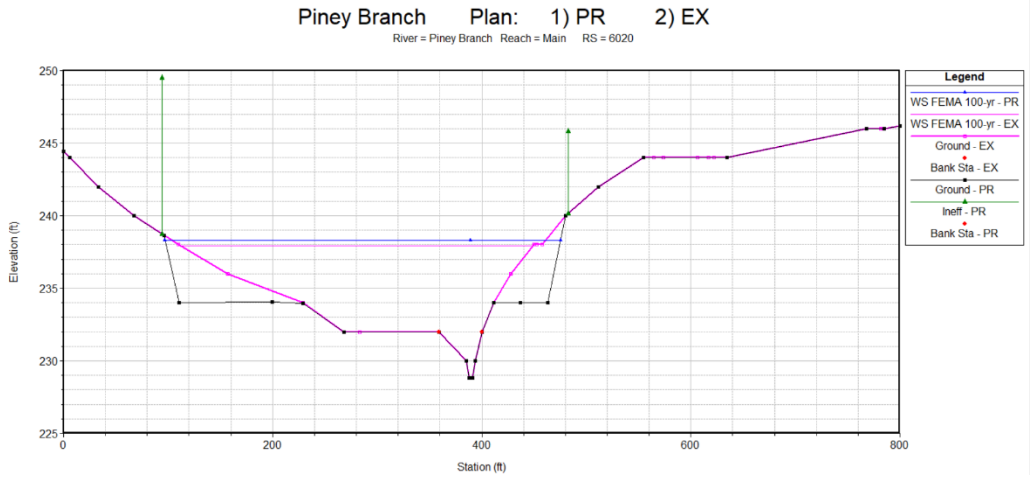


Figure 4: River Station 6020 Proposed Geometry (Black) vs Existing Geometry (Magenta)

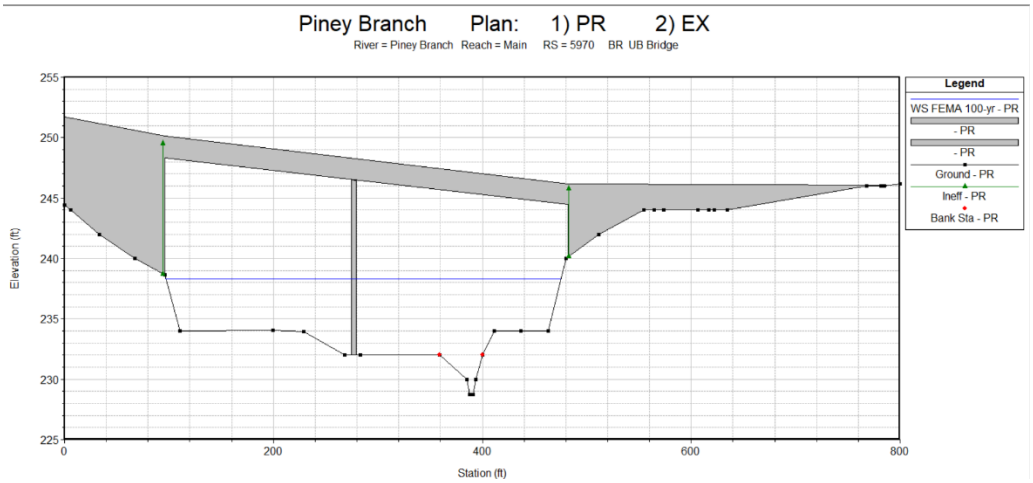


Figure 5: Bridge Upstream Internal Cross Section Proposed Geometry

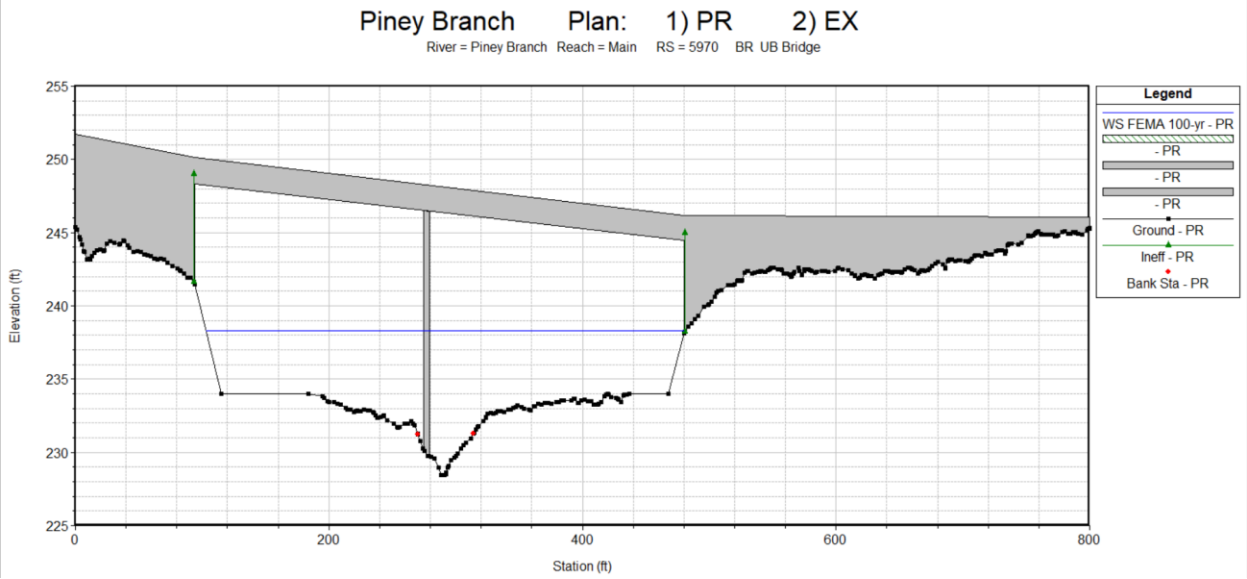


Figure 6: Bridge Downstream Internal Cross Section Proposed Geometry

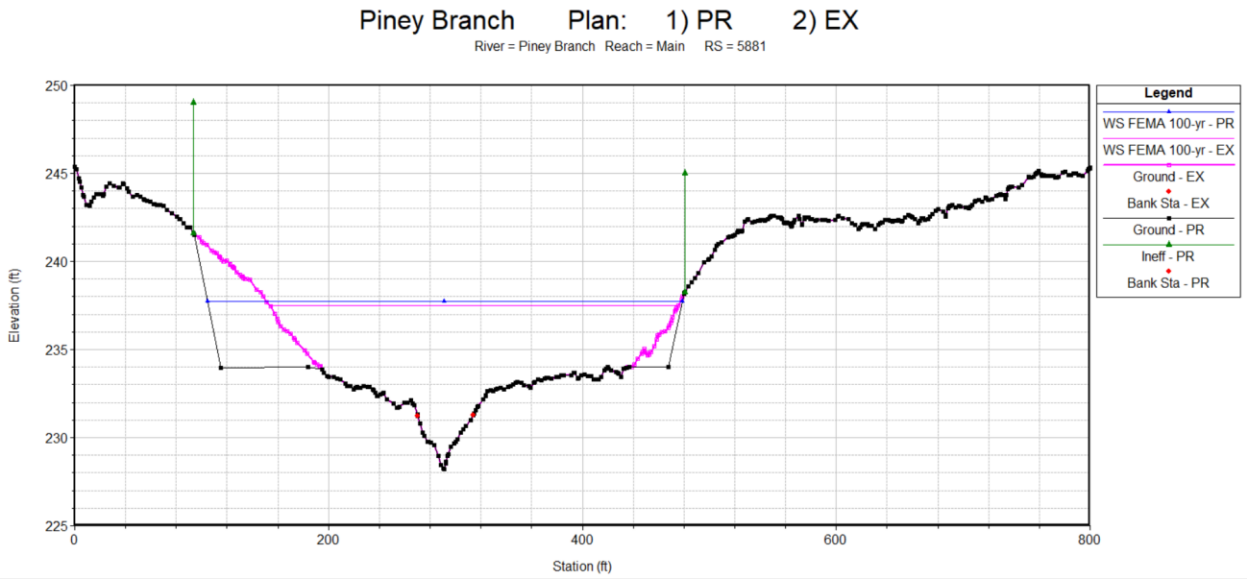


Figure 7: Figure 4: River Station 5881 Proposed Geometry (Black) vs Existing Geometry (Magenta)

Floodplain Model and Mapping

Topographic work maps depicting the regulatory 100-year floodplain under both existing and proposed conditions are included in Appendix A. The maps incorporate 2-foot contour lines generated from the 2024 State LiDAR data.

A localized rise in the Base Flood Elevation (BFE) was identified at cross sections 6020 and 5881 in the proposed model, directly resulting from the grading and geometry associated with the proposed bridge construction. These increases are observed not only for the FEMA 100-year flow but also for the StreamStats 100-year event, as well as the more frequent 50-, 25-, and 10-year storm events. No BFE increases are present elsewhere within the study reach. To reflect these localized changes and maintain

compliance with regulatory requirements, a floodplain easement has been delineated and added to the topographic work map.

Floodway Model

A regulatory floodway was included in the effective FEMA model associated with LOMR 20-03-0070P. A detailed floodway analysis will be developed and submitted when the project advances to a later phase with more refined design information.

Summary

- A practical bridge design will likely require a pier within the FEMA-designated Floodway to maintain feasible span lengths. As a result, the future design-build team will need to pursue a Conditional Letter of Map Revision (CLOMR) and subsequent Letter of Map Revision (LOMR).
- To comply with Prince William County floodplain management criteria, a detailed hydrologic study of the unnamed tributary to Rocky Branch watershed will be required to characterize ultimate build-out conditions.
- The hydraulic model indicates a rise in water surface elevation greater than 0.1 foot for the following scenarios:
  100-year FEMA Flow: 0.39' upstream, 0.25' downstream
  100-year StreamStats: 0.27' upstream, 0.16' downstream
  50-year StreamStats: 0.23' upstream, 0.03' downstream
  10-year StreamStats: 0.29' upstream, 0.15' downstream
- To accommodate the hydraulic impacts, permanent floodplain easements will be required as follows:
  1. NOVA Mango Farms LLC / Stanley Martin Homes LLC: 20,276.23 SF (0.465 ac)
  2. LHR Gainesville LLC / Stanley Martin Homes LLC: 25,494.86 SF (0.585 ac)

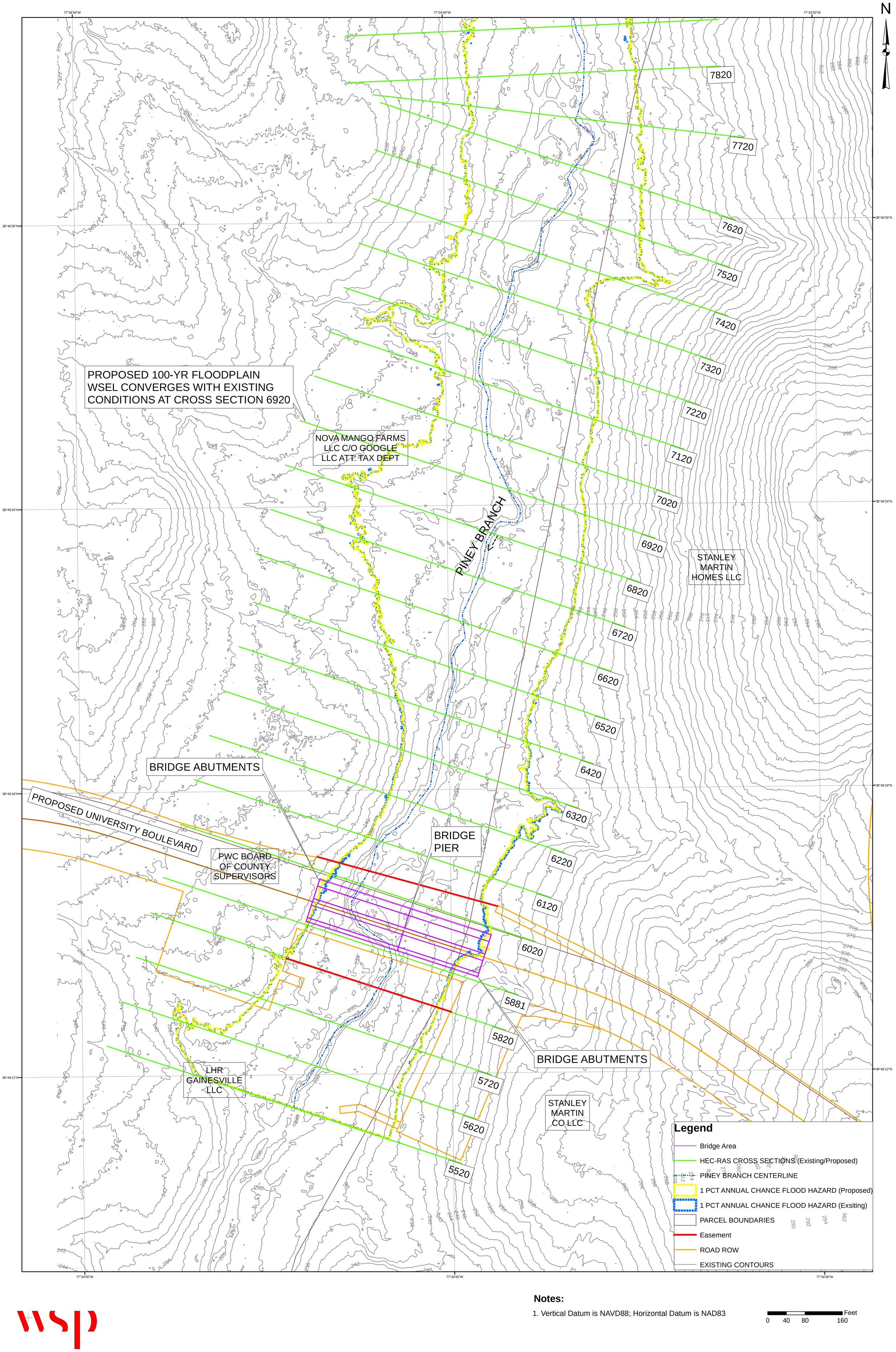
References

1. Federal Emergency Management Agency (FEMA). Flood Insurance Study, Prince William County, Virginia and Incorporated Areas, Revised August 3, 2015.
2. Federal Emergency Management Agency (FEMA). Letter of Map Revision (LOMR) Case No. 20-03-0070P-510119, Effective December 3, 2020.
3. Austin, S.H., Krstolic, J.L., & Wiegand, U. (2011). Peak-Flow Characteristics of Virginia Streams (U.S. Geological Survey Scientific Investigations Report 2011–5144, 106 p., plus 3 tables and 2 appendices on CD). Retrieved from http://pubs.usgs.gov/sir/2011/5144/
4. U.S. Army Corps of Engineers, Hydrologic Engineering Center (HEC). HEC-RAS Hydraulic Reference Manual. Retrieved from https://www.hec.usace.army.mil/confluence/rasdocs/ras1dtechref/latest

APPENDIX A

Floodplain Mapping

University Boulevard Extension Floodplain Map



Notes:

1. Vertical Datum is NAVD88; Horizontal Datum is NAD83

0 40 80 160 Feet

APPENDIX B

Water Surface Elevation Comparison Tables

Table 1: Base Flood Elevation Comparison (FEMA 100-Year Water Surface Elevations) – Existing vs. Proposed Conditions (HEC-RAS Results)

River Station	HEC-RAS Profile	Existing WSE	Proposed WSE	Difference between Proposed and Existing Models	Property Owner Information
		ft	ft	PR - EX	Name
6920	FEMA 100-yr	241.08	241.08	0.00	NOVA MANGO FARMS LLC/STANLEY MARTIN HOMES LLC
6820	FEMA 100-yr	240.60	240.59	-0.01	
6720	FEMA 100-yr	240.58	240.58	0.00	
6620	FEMA 100-yr	239.98	239.98	0.00	
6520	FEMA 100-yr	239.32	239.30	-0.02	
6420	FEMA 100-yr	238.64	238.52	-0.12	
6320	FEMA 100-yr	238.71	238.59	-0.12	
6220	FEMA 100-yr	238.18	237.96	-0.22	
6120	FEMA 100-yr	238.32	238.18	-0.14	
6020	FEMA 100-yr	237.93	238.32	0.39	
5970	Proposed Bridge				PWC BOARD OF COUNTY
5881	FEMA 100-yr	237.50	237.75	0.25	LHR GAINESVILLE LLC/STANLEY MARTIN HOMES LLC
5820	FEMA 100-yr	237.18	237.18	0.00	
5720	FEMA 100-yr	237.14	237.14	0.00	
5620	FEMA 100-yr	236.99	236.99	0.00	
5520	FEMA 100-yr	237.00	237.00	0.00	

Table 2: Comparison of StreamStats 100-Year Water Surface Elevations – Existing vs. Proposed Conditions (HEC-RAS Results)

River Station	HEC-RAS Profile	Existing WSE	Proposed WSE	Difference between Proposed and Existing Models	Property Owner Information
		ft	ft	PR - EX	Name
6920	StreamStats 100-yr	239.89	239.89	0.00	NOVA MANGO FARMS LLC/STANLEY MARTIN HOMES LLC
6820	StreamStats 100-yr	238.66	238.66	0.00	
6720	StreamStats 100-yr	238.99	239.00	0.01	
6620	StreamStats 100-yr	238.22	238.22	0.00	
6520	StreamStats 100-yr	237.73	237.75	0.02	
6420	StreamStats 100-yr	236.93	236.82	-0.11	
6320	StreamStats 100-yr	236.99	236.89	-0.10	
6220	StreamStats 100-yr	236.50	236.29	-0.21	
6120	StreamStats 100-yr	236.62	236.46	-0.16	
6020	StreamStats 100-yr	236.20	236.47	0.27	
5970	Proposed Bridge				PWC BOARD OF COUNTY
5881	StreamStats 100-yr	235.66	235.82	0.16	LHR GAINESVILLE LLC/STANLEY MARTIN HOMES LLC
5820	StreamStats 100-yr	235.32	235.32	0.00	
5720	StreamStats 100-yr	235.31	235.31	0.00	
5620	StreamStats 100-yr	235.12	235.12	0.00	
5520	StreamStats 100-yr	235.10	235.10	0.00	

Table 3: Comparison of StreamStats 50-Year Water Surface Elevations – Existing vs. Proposed Conditions (HEC-RAS Results)

River Station	HEC-RAS Profile	Existing WSE	Proposed WSE	Difference between Proposed and Existing Models	Property Owner Information
		ft	ft	PR - EX	Name
6920	StreamStats 50-yr	239.14	239.14	0.00	NOVA MANGO FARMS LLC/STANLEY MARTIN HOMES LLC
6820	StreamStats 50-yr	237.90	237.90	0.00	
6720	StreamStats 50-yr	238.13	238.13	0.00	
6620	StreamStats 50-yr	237.39	237.39	0.00	
6520	StreamStats 50-yr	236.86	236.89	0.03	
6420	StreamStats 50-yr	236.03	235.97	-0.06	
6320	StreamStats 50-yr	236.06	236.00	-0.06	
6220	StreamStats 50-yr	235.60	235.47	-0.13	
6120	StreamStats 50-yr	235.69	235.59	-0.10	
6020	StreamStats 50-yr	235.30	235.53	0.23	
5970	Proposed Bridge				PWC BOARD OF COUNTY
5881	StreamStats 50-yr	234.68	234.71	0.03	LHR GAINESVILLE LLC/STANLEY MARTIN HOMES LLC
5820	StreamStats 50-yr	234.32	234.32	0.00	
5720	StreamStats 50-yr	234.32	234.32	0.00	
5620	StreamStats 50-yr	234.11	234.11	0.00	
5520	StreamStats 50-yr	234.08	234.08	0.00	

Table 4: Comparison of StreamStats 25-Year Water Surface Elevations – Existing vs. Proposed Conditions (HEC-RAS Results)

River Station	HEC-RAS Profile	Existing WSE	Proposed WSE	Difference between Proposed and Existing Models	Property Owner Information
		ft	ft	PR - EX	Name
6920	StreamStats 25-yr	238.44	238.44	0.00	NOVA MANGO FARMS LLC/STANLEY MARTIN HOMES LLC
6820	StreamStats 25-yr	237.26	237.26	0.00	
6720	StreamStats 25-yr	237.35	237.35	0.00	
6620	StreamStats 25-yr	236.75	236.75	0.00	
6520	StreamStats 25-yr	236.23	236.23	0.00	
6420	StreamStats 25-yr	235.27	235.27	0.00	
6320	StreamStats 25-yr	235.26	235.26	0.00	
6220	StreamStats 25-yr	234.81	234.80	-0.01	
6120	StreamStats 25-yr	234.87	234.88	0.01	
6020	StreamStats 25-yr	234.53	234.74	0.21	
5970	Proposed Bridge				PWC BOARD OF COUNTY
5881	StreamStats 25-yr	233.84	233.84	0.00	LHR GAINESVILLE LLC/STANLEY MARTIN HOMES LLC
5820	StreamStats 25-yr	233.44	233.44	0.00	
5720	StreamStats 25-yr	233.45	233.45	0.00	
5620	StreamStats 25-yr	233.24	233.24	0.00	
5520	StreamStats 25-yr	233.18	233.18	0.00	

Table 5: Comparison of StreamStats 10-Year Water Surface Elevations – Existing vs. Proposed Conditions (HEC-RAS Results)

River Station	HEC-RAS Profile	Existing WSE	Proposed WSE	Difference between Proposed and Existing Models	Property Owner Information
		ft	ft	PR EX	Name
6920	StreamStats 10-yr	237.48	237.48	0.00	NOVA MANGO FARMS LLC/STANLEY MARTIN HOMES LLC
6820	StreamStats 10-yr	236.37	236.37	0.00	
6720	StreamStats 10-yr	236.34	236.34	0.00	
6620	StreamStats 10-yr	235.96	235.96	0.00	
6520	StreamStats 10-yr	235.37	235.37	0.00	
6420	StreamStats 10-yr	234.53	234.53	0.00	
6320	StreamStats 10-yr	234.27	234.31	0.04	
6220	StreamStats 10-yr	233.74	233.88	0.14	
6120	StreamStats 10-yr	233.77	233.91	0.14	
6020	StreamStats 10-yr	233.44	233.73	0.29	
5970	Proposed Bridge				PWC BOARD OF COUNTY
5881	StreamStats 10-yr	232.87	233.02	0.15	LHR GAINESVILLE LLC/STANLEY MARTIN HOMES LLC
5820	StreamStats 10-yr	232.33	232.33	0.00	
5720	StreamStats 10-yr	232.33	232.33	0.00	
5620	StreamStats 10-yr	232.10	232.10	0.00	
5520	StreamStats 10-yr	232.02	232.02	0.00	

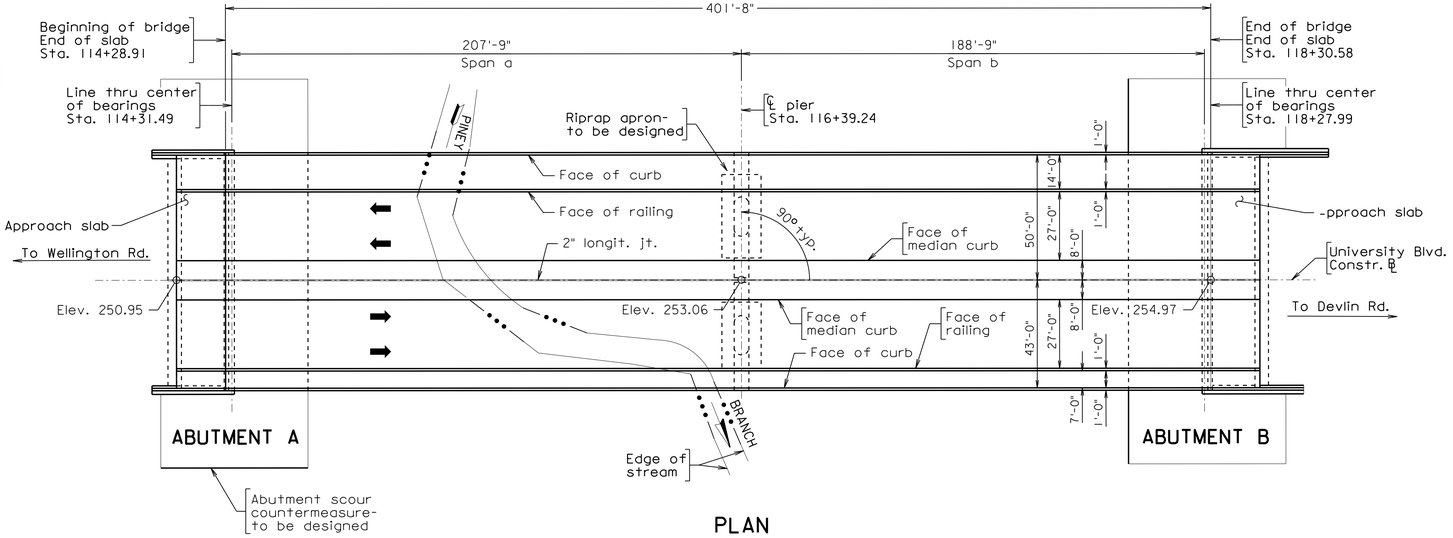
Table 6: Comparison of StreamStats 2-Year Water Surface Elevations – Existing vs. Proposed Conditions (HEC-RAS Results)

River Station	HEC-RAS Profile	Existing WSE	Proposed WSE	Difference between Proposed and Existing Models	Property Owner Information
		ft	ft	PR - EX	Name
6920	StreamStats 2-yr	235.82	235.82	0.00	NOVA MANGO FARMS LLC/STANLEY MARTIN HOMES LLC
6820	StreamStats 2-yr	234.40	234.40	0.00	
6720	StreamStats 2-yr	234.48	234.48	0.00	
6620	StreamStats 2-yr	234.29	234.28	-0.01	
6520	StreamStats 2-yr	233.65	233.64	-0.01	
6420	StreamStats 2-yr	232.88	232.92	0.04	
6320	StreamStats 2-yr	232.49	232.60	0.11	
6220	StreamStats 2-yr	232.08	232.24	0.16	
6120	StreamStats 2-yr	232.05	232.23	0.18	
6020	StreamStats 2-yr	231.68	231.97	0.29	
5970	Proposed Bridge				PWC BOARD OF COUNTY
5881	StreamStats 2-yr	230.83	230.79	-0.04	LHR GAINESVILLE LLC/STANLEY MARTIN HOMES LLC
5820	StreamStats 2-yr	230.56	230.56	0.00	
5720	StreamStats 2-yr	230.40	230.40	0.00	
5620	StreamStats 2-yr	229.98	229.98	0.00	
5520	StreamStats 2-yr	229.87	229.87	0.00	

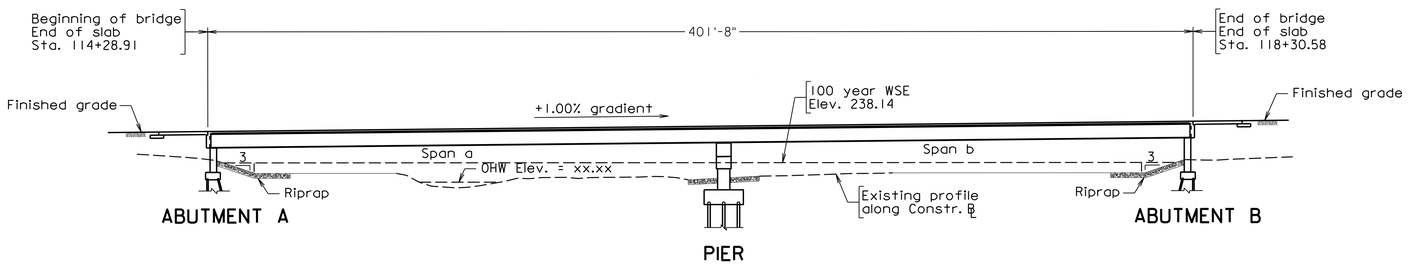
APPENDIX C

Bridge Plans

STATE	FEDERAL AID		STATE		SHEET NO.
	ROUTE	PROJECT	ROUTE	PROJECT	
V-.	—		620	0000-840-000	1
Federal Structure No. 0000000000XXXXX			FHW- Construction and Scour Code:		
Federal Stewardship and Oversight Code:		NFO		UPC No.	



PLAN



DEVELOPED SECTION ALONG CONSTR. ℄

DESIGN EXCEPTION(S):

None

GENERAL NOTES:

Width: 14'-0" shared use path, 12" barrier. 27'-0" roadway, 16'-0" median, 27'-0" roadway, 12" barrier, 7'-0" sidewalk. Overall width: 93'-0" face to face of curbs.

Span layout: 207'-9" - 188'-9"

Capacity: HL-93 loading.

Specifications:

Construction: Virginia Department of Transportation Road and Bridge Specifications, 2020.

Design: A-SHTO LRFD Bridge Design Specifications, 9th Edition, 2020; and VDOT Modifications.

Standards: Virginia Department of Transportation Road and Bridge Standards, 2016; including all current revisions.

These plans are incomplete unless accompanied by the Supplemental Specifications and Special Provisions included in the contract documents.

GP&E.dgn

WSP USA
HERNDON, VA
STRUCTURAL ENGINEER

PL-NS BY:	WSP US-, INC.
COORDINATED:	
SUPERVISED:	MICH-EL MAGYARICS, P.E.
DESIGNED:	MEGAN ZELLNER
DRAWN:	CL-RIS- V. MAYHAY
CHECKED:	MICH-EL MAGYARICS, P.E.

Scale: 1" = 30'

No.	Description	Date
	REVISIONS	
	For Table of Revisions, see Sheet 2.	

VDOT

COMMONWEALTH OF VIRGINIA

DEPARTMENT OF TRANSPORTATION

PROPOSED BRIDGE ON

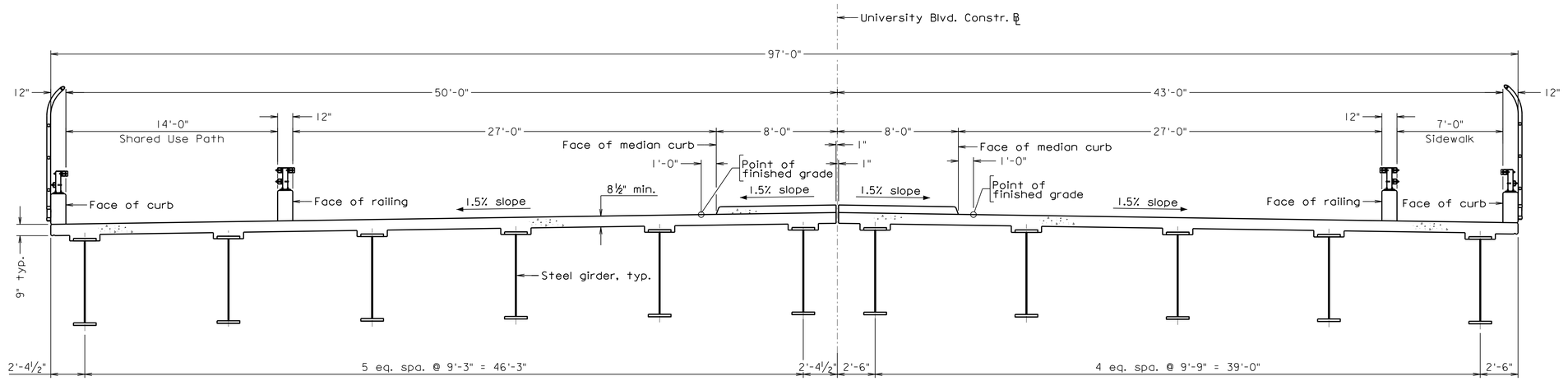
UNIVERSITY BOULEVARD OVER PINEY BRANCH
PRINCE WILLIAM COUNTY - 0.5 MI. RTE. 621
PROJ. 0000-840-000, BXXX

Recommended for Approval: _____ _____
District Project Development Engineer Date

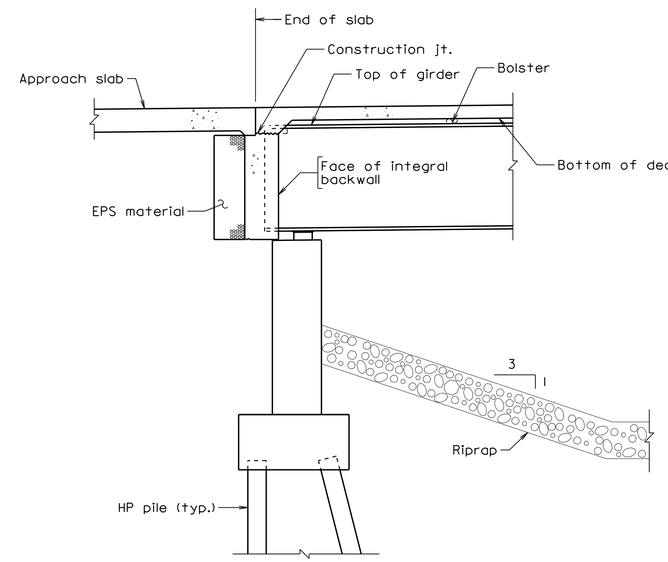
Approved: _____ _____
District Administrator Date

Date: _____

STATE	FEDERAL AID		STATE		SHEET NO.
	ROUTE	PROJECT	ROUTE	PROJECT	
V-.	—		840	0000-840-000	



TRANSVERSE SECTION



SEMI-INTEGRAL ABUTMENT DETAIL

TRANSVERSE SECTION.dgn

WSP USA
HERNDON, VA
STRUCTURAL ENGINEER

Scale: ¼" = 1'-0"

No.	Description	Date
Revisions		

COMMONWE-LTH OF VIRGINIA
DEP-RTMENT OF TR-NSPORT-TION

STRUCTURE -ND BRIDGE DIVISION

TRANSVERSE SECTION AND ABUTMENT DETAIL

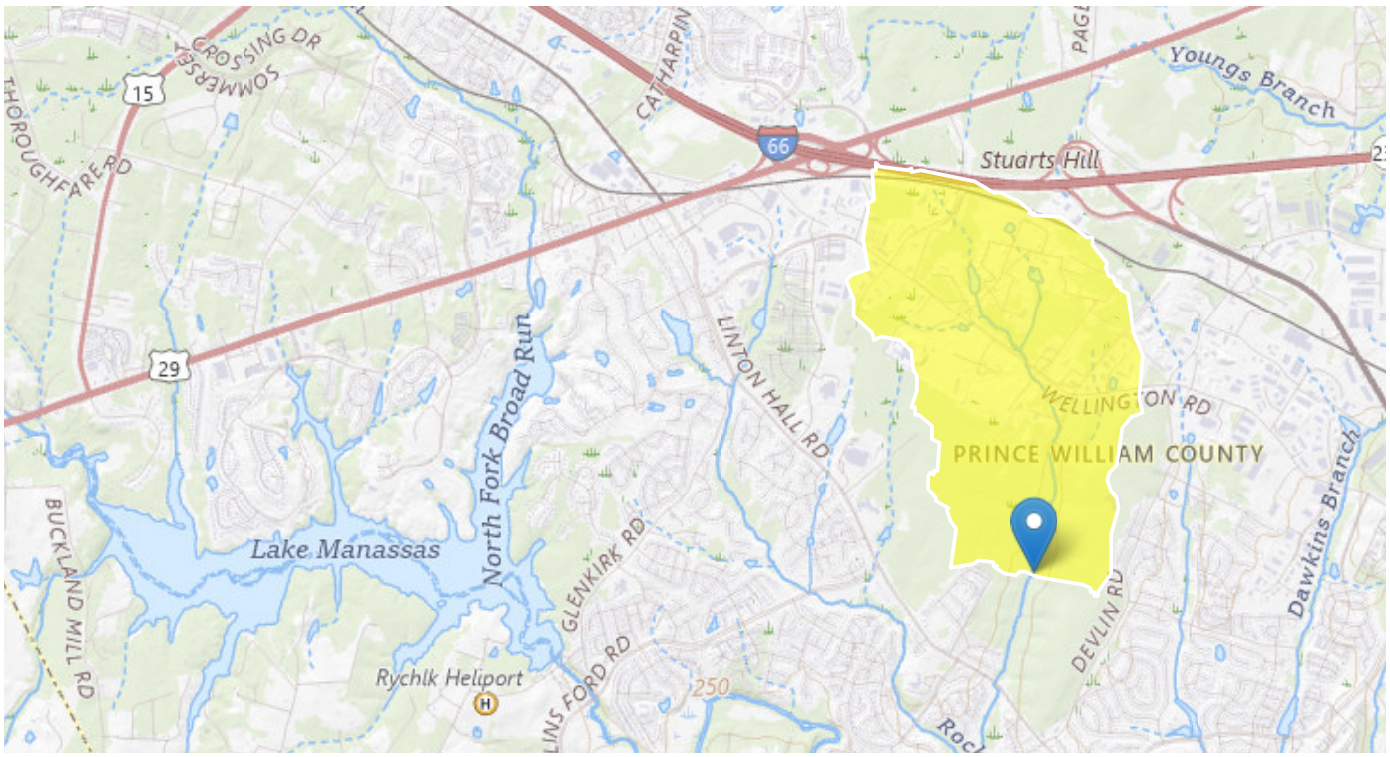
Designed: MZ	Date	Plan No.	Sheet No.
Drawn: CYM	July 2025	XXX-XX	2 of 2
Checked: MM			

APPENDIX D

StreamStats Report

StreamStats Report

Region ID: VA
Workspace ID: VA20250708173842219000
Clicked Point (Latitude, Longitude): 38.76965, -77.57885
NHD Stream GNIS Name of Click Point:
Time: 2025-07-08 13:39:05 -0400



Collapse All

Basin Characteristics

Parameter Code	Parameter Description	Value	Unit
BRMETA	Percent area of metamorphic rocks within the Blue Ridge Physiographic Region	0	percent
CPSED	Percent area of sedimentary rockswithin the Coastal Plain Physiographic Region	0	percent
DRNAREA	Area that drains to a point on a stream	2	square miles
ELEV	Mean Basin Elevation	306.31	feet
ELEVMAX	Maximum basin elevation	369.47	feet

Parameter Code	Parameter Description	Value	Unit
I24H2Y	Maximum 24-hour precipitation that occurs on average once in 2 years - Equivalent to precipitation intensity index	2.999	inches
LC01BARE	Percentage of area barren land, NLCD 2001 category 31	0.06	percent
LC01CRPHAY	Percentage of cultivated crops and hay, classes 81 and 82, from NLCD 2001	3.23	percent
LC01DEV	Percentage of land-use from NLCD 2001 classes 21-24	37.44	percent
LC01FORSHB	Percentage of forests and shrub lands, classes 41 to 52, from NLCD 2001	52.63	percent
LC01HERB	Percentage of herbaceous upland from NLCD 2001 class 71	0	percent
LC01IMP	Percent imperviousness of basin area 2001 NLCD	13.74	percent
LC01WATER	Percentage of open water, class 11, from NLCD 2001	0.45	percent
LC01WETLND	Percentage of wetlands, classes 90 and 95, from NLCD 2001	6.19	percent
LC06BARE	Percent of area covered by barren rock using 2006 NLCD	0.08	percent
LC06CRPHAY	Percentage of cultivated crops and hay, classes 81 and 82, from NLCD 2006	2.16	percent
LC06DEV	Percentage of land-use from NLCD 2006 classes 21-24	44.21	percent
LC06FORSHB	Percentage of forests and shrub lands, classes 41 to 52, from NLCD 2006	48.23	percent
LC06GRASS	Percent of area covered by grassland/herbaceous using 2006 NLCD	0	percent
LC06IMP	Percentage of impervious area determined from NLCD 2006 impervious dataset	17.23	percent
LC06WATER	Percent of open water, class 11, from NLCD 2006	0.45	percent
LC06WETLND	Percent of area covered by wetland using 2006 NLCD	4.88	percent
LC11BARE	Percentage of barren from NLCD 2011 class 31	0	percent
LC11CRPHAY	Percentage of cultivated crops and hay, classes 81 and 82, from NLCD 2011	2.05	percent
LC11DEV	Percentage of developed (urban) land from NLCD 2011 classes 21-24	46.5	percent
LC11FORSHB	Percentage of forests and shrub lands, classes 41 to 52, from NLCD 2011	43.8	percent

Parameter Code	Parameter Description	Value	Unit
LC11GRASS	Percent of area covered by grassland/herbaceous using 2011 NLCD	0.71	percent
LC11IMP	Average percentage of impervious area determined from NLCD 2011 impervious dataset	19.1	percent
LC11WATER	Percent of open water, class 11, from NLCD 2011	0.31	percent
LC11WETLND	Percentage of wetlands, classes 90 and 95, from NLCD 2011	6.61	percent
LFREGNO	Low Flow Region Number	1549	dimensionless
MESZOIC	Percent of area within the Mesozoic Basins	100	percent
MINBELEV	Minimum basin elevation	224.91	feet
PDIGMET	Percent area of igneous and metamorphic within the Piedmont Physiographic Region	0	percent
PKREGNO	Peak Flow Region Number	1552	dimensionless
PRECIP	Mean Annual Precipitation	42.907	inches
RELIEF	Maximum - minimum elevation	145	feet
STATOM19_8	Percentage of soils with greater than 7.3 percent and less than or equal to 19.8 percent organic matter from STATSGO	0	percent
STATOM55_7	Percentage of soils with greater than 19.8 percent and less than or equal to 55.7 percent organic matter from STATSGO	0	percent
STATSCLAY10	Percentage of soils with less than 10 percent clay from STATSGO	0	percent
STATSCLY20	Percentage of soils with greater than 10 percent and less than or equal to 20 percent clay from STATSGO	0	percent
STATSCLY30	Percentage of soils with greater than 20 percent and less than or equal to 30 percent clay from STATSGO	27.41	percent
STATSCLY40	Percentage of soils with greater than 30 percent and less than or equal to 40 percent clay from STATSGO	72.59	percent
STATSCLY50	Percentage of soils with greater than 40 percent and less than or equal to 50 percent clay from STATSGO	0	percent
STATSCLY60	Percentage of soils with greater than 50 percent and less than or equal to 60 percent clay from STATSGO	0	percent
STATSGODEP	Area-weighted average soil depth from NRCS STATSGO database	56.37	inches

Parameter Code	Parameter Description	Value	Unit
STATSOM0_5	Percentage of soils with less than 0.5 percent organic matter from STATSGO	74.29	percent
STATSOM2_6	Percentage of soils with greater than 0.50 percent and less than or equal to 2.60 percent organic matter from STATSGO	25.71	percent
STATSOM7_3	Percentage of soils with greater than 2.6 percent and less than or equal to 7.3 percent organic matter from STATSGO	0	percent
STATSPERM	Area-weighted average soil permeability from NRCS STATSGO database	1.645	inches per hour
STATSWATCP	Available water capacity of the top 60 inches of soil - determined from STATSGO data	0.117	inch per inch
VRCARB	Percent of area of carbonate rocks within the Valley and Ridge Physiographic Region	0	percent
VRPLSLC	Percent of area of siliciclastic rocks witin the Valley and Ridge or Appalachian Plateau Physiographic Regions	0	percent

Peak-Flow Statistics

Peak-Flow Statistics Parameters [Piedmont Mesozoic 2011 5144]

Parameter Code	Parameter Name	Value	Units	Min Limit	Max Limit
DRNAREA	Drainage Area	2	square miles	0.06	7866

Peak-Flow Statistics Flow Report [Piedmont Mesozoic 2011 5144]

PIL: Lower 90% Prediction Interval, PIU: Upper 90% Prediction Interval, ASEp: Average Standard Error of Prediction, SE: Standard Error, PC: Percent Correct, RMSE: Root Mean Squared Error, PseudoR^2: Pseudo R Squared (other -- see report)

Statistic	Value	Unit	ASEp
50-percent AEP flood	166	ft^3/s	41
42.9-percent AEP flood	201	ft^3/s	42
20-percent AEP flood	412	ft^3/s	42
10-percent AEP flood	698	ft^3/s	41
4-percent AEP flood	1260	ft^3/s	40

Statistic	Value	Unit	ASEp
2-percent AEP flood	1840	ft^3/s	39
1-percent AEP flood	2670	ft^3/s	37
0.5-percent AEP flood	3610	ft^3/s	36

Peak-Flow Statistics Citations

Austin, S.H., Krstolic, J.L., and Wiegand, Ute,2011, Peak-flow characteristics of Virginia streams: U.S. Geological Survey Scientific Investigations Report 2011–5144, 106 p. + 3 tables and 2 appendixes on CD. (http://pubs.usgs.gov/sir/2011/5144/)

Low-Flow Statistics

Low-Flow Statistics Parameters [Piedmont Mesozoic 2011 5143]

Parameter Code	Parameter Name	Value	Units	Min Limit	Max Limit
DRNAREA	Drainage Area	2	square miles	0.09	7393

Low-Flow Statistics Flow Report [Piedmont Mesozoic 2011 5143]

PIL: Lower 90% Prediction Interval, PIU: Upper 90% Prediction Interval, ASEp: Average Standard Error of Prediction, SE: Standard Error, PC: Percent Correct, RMSE: Root Mean Squared Error, PseudoR^2: Pseudo R Squared (other -- see report)

Statistic	Value	Unit	ASEp
1 Day 1.11 Year Low Flow	0.123	ft^3/s	70.9
1 Day 1.25 Year Low Flow	0.074	ft^3/s	83.9
1 Day 1.43 Year Low Flow	0.0498	ft^3/s	96.3
1 Day 1.67 Year Low Flow	0.0346	ft^3/s	109
1 Day 2 Year Low Flow	0.0236	ft^3/s	126
1 Day 2.5 Year Low Flow	0.015	ft^3/s	150
4 Day 1.11 Year Low Flow	0.137	ft^3/s	70.4
4 Day 1.25 Year Low Flow	0.0825	ft^3/s	81.4
7 Day 1.11 Year Low Flow	0.183	ft^3/s	67.3
7 Day 1.25 Year Low Flow	0.103	ft^3/s	76.5
7 Day 1.43 Year Low Flow	0.0813	ft^3/s	85.1
7 Day 1.67 Year Low Flow	0.0659	ft^3/s	94
30 Day 1.11 Year Low Flow	0.352	ft^3/s	51.8

Statistic	Value	Unit	ASEp
30 Day 1.25 Year Low Flow	0.227	ft^3/s	59.5
30 Day 1.43 Year Low Flow	0.155	ft^3/s	66.1

Low-Flow Statistics Citations

Austin, S.H., Krstolic, J.L., and Wiegand, Ute,2011, Low-flow characteristics of Virginia streams: U.S. Geological Survey Scientific Investigations Report 2011–5143, 122 p. + 9 tables on CD. (http://pubs.usgs.gov/sir/2011/5143/)

Bankfull Statistics

Bankfull Statistics Parameters [Appalachian Highlands D Bieger 2015]

Parameter Code	Parameter Name	Value	Units	Min Limit	Max Limit
DRNAREA	Drainage Area	2	square miles	0.07722	940.1535

Bankfull Statistics Parameters [Piedmont P Bieger 2015]

Parameter Code	Parameter Name	Value	Units	Min Limit	Max Limit
DRNAREA	Drainage Area	2	square miles	0.289575	939.99906

Bankfull Statistics Parameters [USA Bieger 2015]

Parameter Code	Parameter Name	Value	Units	Min Limit	Max Limit
DRNAREA	Drainage Area	2	square miles	0.07722	59927.7393

Bankfull Statistics Flow Report [Appalachian Highlands D Bieger 2015]

Statistic	Value	Unit
Bieger_D_channel_width	20.3	ft
Bieger_D_channel_depth	1.37	ft
Bieger_D_channel_cross_sectional_area	28.1	ft^2

Bankfull Statistics Flow Report [Piedmont P Bieger 2015]

Statistic	Value	Unit
Bieger_P_channel_width	18.3	ft
Bieger_P_channel_depth	1.42	ft

Statistic	Value	Unit
Bieger_P_channel_cross_sectional_area	26.2	ft^2

Bankfull Statistics Flow Report [USA Bieger 2015]

Statistic	Value	Unit
Bieger_USA_channel_width	15.8	ft
Bieger_USA_channel_depth	1.4	ft
Bieger_USA_channel_cross_sectional_area	24.8	ft^2

Bankfull Statistics Flow Report [Area-Averaged]

Statistic	Value	Unit
Bieger_D_channel_width	20.3	ft
Bieger_D_channel_depth	1.37	ft
Bieger_D_channel_cross_sectional_area	28.1	ft^2
Bieger_P_channel_width	18.3	ft
Bieger_P_channel_depth	1.42	ft
Bieger_P_channel_cross_sectional_area	26.2	ft^2
Bieger_USA_channel_width	15.8	ft
Bieger_USA_channel_depth	1.4	ft
Bieger_USA_channel_cross_sectional_area	24.8	ft^2

Bankfull Statistics Citations

Bieger, Katrin; Rathjens, Hendrik; Allen, Peter M.; and Arnold, Jeffrey G.,2015, Development and Evaluation of Bankfull Hydraulic Geometry Relationships for the Physiographic Regions of the United States, Publications from USDA-ARS / UNL Faculty, 17p. (https://digitalcommons.unl.edu/usdaarsfacpub/1515?utm_source=digitalcommons.unl.edu%2Fusdaarsfacpub%2F1515&utm_medium=PDF&utm_campaign=F

Urban Peak-Flow Statistics

Urban Peak-Flow Statistics Parameters [Peak Urban01 2014 5090]

Parameter Code	Parameter Name	Value	Units	Min Limit	Max Limit
DRNAREA	Drainage Area	2	square miles	0.07	2404

Parameter Code	Parameter Name	Value	Units	Min Limit	Max Limit
LC01DEV	Percent_Developed_from_NLCD2001	37.44	percent	10	96

Urban Peak-Flow Statistics Parameters [Peak Urban06 2014 5090]

Parameter Code	Parameter Name	Value	Units	Min Limit	Max Limit
DRNAREA	Drainage Area	2	square miles	0.07	2404
LC06DEV	Percent Developed from NLCD2006	44.21	percent	10	96

Urban Peak-Flow Statistics Parameters [Peak Urban11 2014 5090]

Parameter Code	Parameter Name	Value	Units	Min Limit	Max Limit
DRNAREA	Drainage Area	2	square miles	0.07	2404
LC11DEV	Percent Developed from NLCD2011	46.5	percent	10	96

Urban Peak-Flow Statistics Flow Report [Peak Urban01 2014 5090]

PIL: Lower 90% Prediction Interval, PIU: Upper 90% Prediction Interval, ASEp: Average Standard Error of Prediction, SE: Standard Error, PC: Percent Correct, RMSE: Root Mean Squared Error, PseudoR^2: Pseudo R Squared (other -- see report)

Statistic	Value	Unit	ASEp
Urban 99.5-percent AEP flood	82.9	ft^3/s	70.4
Urban 99-percent AEP flood	90	ft^3/s	67.8
Urban 95-percent AEP flood	111	ft^3/s	60.5
Urban 90-percent AEP flood	135	ft^3/s	59.3
Urban 80-percent AEP flood	169	ft^3/s	57.5
Urban 66.7-percent AEP flood	199	ft^3/s	57.3
Urban 50-percent AEP flood	241	ft^3/s	57.3
Urban 42.9-percent AEP flood	268	ft^3/s	57.1
Urban 20-Percent AEP flood	403	ft^3/s	60.6
Urban 10-percent AEP flood	558	ft^3/s	64.1
Urban 4-percent AEP flood	827	ft^3/s	74.4
Urban 2-percent AEP flood	1090	ft^3/s	84.8
Urban 1-percent AEP flood	1360	ft^3/s	97.9
Urban 0.5-percent AEP flood	1720	ft^3/s	102
Urban 0.2-percent AEP flood	2540	ft^3/s	134

Urban Peak-Flow Statistics Flow Report [Peak Urban06 2014 5090]

PIL: Lower 90% Prediction Interval, PIU: Upper 90% Prediction Interval, ASEp: Average Standard Error of Prediction, SE: Standard Error, PC: Percent Correct, RMSE: Root Mean Squared Error, PseudoR^2: Pseudo R Squared (other -- see report)

Statistic	Value	Unit	ASEp
Urban 99.5-percent AEP flood	98.1	ft^3/s	70.4
Urban 99-percent AEP flood	106	ft^3/s	67.8
Urban 95-percent AEP flood	129	ft^3/s	60.5
Urban 90-percent AEP flood	154	ft^3/s	59.3
Urban 80-percent AEP flood	191	ft^3/s	57.5
Urban 66.7-percent AEP flood	228	ft^3/s	57.3
Urban 50-percent AEP flood	275	ft^3/s	57.3
Urban 42.9-percent AEP flood	305	ft^3/s	57.1
Urban 20-Percent AEP flood	455	ft^3/s	60.6
Urban 10-percent AEP flood	624	ft^3/s	64.1
Urban 4-percent AEP flood	909	ft^3/s	74.4
Urban 2-percent AEP flood	1190	ft^3/s	84.8
Urban 1-percent AEP flood	1500	ft^3/s	97.9
Urban 0.5-percent AEP flood	1900	ft^3/s	102
Urban 0.2-percent AEP flood	2810	ft^3/s	134

Urban Peak-Flow Statistics Flow Report [Peak Urban11 2014 5090]

PIL: Lower 90% Prediction Interval, PIU: Upper 90% Prediction Interval, ASEp: Average Standard Error of Prediction, SE: Standard Error, PC: Percent Correct, RMSE: Root Mean Squared Error, PseudoR^2: Pseudo R Squared (other -- see report)

Statistic	Value	Unit	ASEp
Urban 99.5-percent AEP flood	104	ft^3/s	70.4
Urban 99-percent AEP flood	112	ft^3/s	67.8
Urban 95-percent AEP flood	135	ft^3/s	60.5
Urban 90-percent AEP flood	162	ft^3/s	59.3
Urban 80-percent AEP flood	200	ft^3/s	57.5
Urban 66.7-percent AEP flood	239	ft^3/s	57.3
Urban 50-percent AEP flood	288	ft^3/s	57.3
Urban 42.9-percent AEP flood	319	ft^3/s	57.1

Statistic	Value	Unit	ASEp
Urban 20-Percent AEP flood	474	ft^3/s	60.6
Urban 10-percent AEP flood	648	ft^3/s	64.1
Urban 4-percent AEP flood	939	ft^3/s	74.4
Urban 2-percent AEP flood	1230	ft^3/s	84.8
Urban 1-percent AEP flood	1550	ft^3/s	97.9
Urban 0.5-percent AEP flood	1970	ft^3/s	102
Urban 0.2-percent AEP flood	2910	ft^3/s	134

Urban Peak-Flow Statistics Citations

Austin, S.H.,2014, Methods and equations for estimating peak streamflow per square mile in Virginia's urban basins: U.S. Geological Survey Scientific Investigations Report 2014–5090, 25 p. (http://pubs.usgs.gov/sir/2014/5090)

Maximum Probable Flood Statistics

Maximum Probable Flood Statistics Parameters [Crippen Bue Region 5]

Parameter Code	Parameter Name	Value	Units	Min Limit	Max Limit
DRNAREA	Drainage Area	2	square miles	0.1	10000

Maximum Probable Flood Statistics Flow Report [Crippen Bue Region 5]

Statistic	Value	Unit
Maximum Flood Crippen Bue Regional	17500	ft^3/s

Maximum Probable Flood Statistics Citations

Crippen, J.R. and Bue, Conrad D.1977, Maximum Floodflows in the Conterminous United States, Geological Survey Water-Supply Paper 1887, 52p. (https://pubs.usgs.gov/wsp/1887/report.pdf)

NHD Features of Delineated Basin

NHD Streams Intersecting Basin Delineation Boundary

This functionality attempts to find the stream name at the delineation point. The name of the nearest intersecting National Hydrography Dataset (NHD) stream is selected by default to appear in the report above. NHD streams do not correspond to the StreamStats stream grid and may not be accurate. If you would like a different stream to

appear in the above section, please make a selection below.

GNIS ID	GNIS Name	Distance from Clicked Point (ft)	Feature Type	Selected Stream Name
		29.02	Perennial	✓

Watershed Boundary Dataset (WBD) HUC 8 Intersecting Basin Delineation Boundary

This functionality attempts to find the intersecting HUC 8 of the delineated watershed. HUC boundaries do not correspond to the StreamStats data and may not be accurate.

HUC 8	Name
02070010	Middle Potomac-Anacostia-Occoquan

NHD Hydrologic Features Citations

U.S. Geological Survey, 2022, USGS TNM - National Hydrography Dataset, accessed July 21, 2022 at URL https://hydro.nationalmap.gov/arcgis/rest/services/nhd/MapServer/6. (https://hydro.nationalmap.gov/arcgis/rest/services/nhd/MapServer/6) U.S. Geological Survey, 2022, USGS TNM - National Hydrography Dataset, accessed July 21, 2022 at URL https://hydro.nationalmap.gov/arcgis/rest/services/wbd/MapServer/4. (https://hydro.nationalmap.gov/arcgis/rest/services/wbd/MapServer/4)

Application Version: 4.29.2
StreamStats Services Version: 1.2.22
NSS Services Version: 2.2.1

APPENDIX E

HEC-RS Input Files

HEC-RAS HEC-RAS 6.6 September 2024
U.S. Army Corps of Engineers
Hydrologic Engineering Center
609 Second Street
Davis, California

```
X     X  XXXXXX    XXXX        XXXX       XX      XXXX
X     X  X        X    X       X   X     X  X    X
X     X  X        X            X   X    X    X   X
XXXXXXX  XXXX     X       XXX  XXXX     XXXXXX    XXXX
X     X  X        X            X  X     X    X        X
X     X  X        X    X       X   X    X    X        X
X     X  XXXXXX    XXXX        X    X   X    X   XXXXX
```

PROJECT DATA
Project Title: Piney Branch
Project File : PineyBranch.prj
Run Date and Time: 7/9/2025 5:34:37 PM

Project in English units

PLAN DATA

Plan Title: Proposed Conditions
Plan File : C:\Users\USLL709941\Desktop\University Blvd VA\hydraulics\HEC-RAS for Report\PineyBranch.p06

Geometry Title: Geometry_ProposedConditions
Geometry File : C:\Users\USLL709941\Desktop\University Blvd VA\hydraulics\HEC-RAS for Report\PineyBranch.g07

Flow Title : Flow Data_FEMA_StreamStats
Flow File : C:\Users\USLL709941\Desktop\University Blvd VA\hydraulics\HEC-RAS for Report\PineyBranch.f03

Plan Description:
Georeferenced cross sections from FEMA GIS data. Stream centerline updated using aerial imagery and contours. 2024 State LiDAR added to RAS Mapper. Bridge 2C added; adjacent downstream XS 5881 adjusted. Bridge internal XS Manning’s n = 0.07. Low Flow Method set to Energy, Momentum, Yarnell and WSPRO. Applied grading for the internal cross sections to open the floodplain, as also extended grading bridge upstream/downstream XS.Copied the internal cross section of bridges to adjacent US/DS, grading the ground to 234 for the bridge internal cross sections, and adjacent US/DS XS. Matched internal cross section

elevations to align with existing ground elevation to maintain the slope.

Plan Summary Information:
Number of: Cross Sections = 35 Multiple Openings = 0
Culverts = 0 Inline Structures = 0
Bridges = 1 Lateral Structures = 0

Computational Information
Water surface calculation tolerance = 0.01
Critical depth calculation tolerance = 0.01
Maximum number of iterations = 20
Maximum difference tolerance = 0.3
Flow tolerance factor = 0.001

Computation Options
Critical depth computed only where necessary
Conveyance Calculation Method: At breaks in n values only
Friction Slope Method: Average Conveyance
Computational Flow Regime: Subcritical Flow

Encroachment Data
Equal Conveyance = True
Left Offset = 0
Right Offset = 0

River = Piney Branch Reach = Main

RS	Profile	Method	Value1	Value2
8920	FEMA FW	1	238	430
8820	FEMA FW	1	290	434
8720	FEMA FW	1	292	422
8620	FEMA FW	1	295	440
8520	FEMA FW	1	204	438
8420	FEMA FW	1	241	445
8320	FEMA FW	1	258	467
8220	FEMA FW	1	261	453
8120	FEMA FW	1	272	445
8020	FEMA FW	1	260	457
7920	FEMA FW	1	254	417
7820	FEMA FW	1	258	436
7720	FEMA FW	1	314	501
7620	FEMA FW	1	310	521
7520	FEMA FW	1	305	512
7420	FEMA FW	1	360	538
7320	FEMA FW	1	365	530
7220	FEMA FW	1	320	535
7120	FEMA FW	1	270	460
7020	FEMA FW	1	257	430
6920	FEMA FW	1	235	409
6820	FEMA FW	1	214	455
6720	FEMA FW	1	193	392

6620	FEMA FW	1	194	410
6520	FEMA FW	1	213	395
6420	FEMA FW	1	230	370
6320	FEMA FW	1	234	346
6220	FEMA FW	1	239	351
6120	FEMA FW	1	223	372
6020	FEMA FW	1	240	401
5920	FEMA FW	1	220	403
5820	FEMA FW	1	213	395
5720	FEMA FW	1	238	439
5620	FEMA FW	1	248	460
5520	FEMA FW	1	248	522

FLOW DATA

Flow Title: Flow Data_FEMA_StreamStats
Flow File : C:\Users\USLL709941\Desktop\University Blvd VA\hydraulics\HEC-RAS for Report\PineyBranch.f03

Flow Data (cfs)

River	Reach	RS	FEMA 100-yr	FEMA FWStreamStats 100-yr Peak Flow	StreamStats 50-yr Peak Flow	StreamStats 25-yr Peak Flow	StreamStats 10-yr Peak Flow	StreamStats 5-yr Peak Flow	StreamStats 2-yr Peak Flow
Piney Branch	Main	8920	4641	4641	2670	1840	1260	698	412
166									

Boundary Conditions

River	Reach	Profile	Upstream	Downstream
Piney Branch	Main	FEMA 100-yr		
Normal S = 0.001				
Piney Branch	Main	FEMA FW		
Normal S = 0.001				

GEOMETRY DATA

Geometry Title: Geometry_ProposedConditions
Geometry File : C:\Users\USLL709941\Desktop\University Blvd VA\hydraulics\HEC-RAS for Report\PineyBranch.g07

CROSS SECTION

RIVER: Piney Branch
REACH: Main RS: 8920

INPUT
Description:
Station Elevation Data num= 26

Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev
0	258	38.55	256	81.42	254	113.39	252	174.53	250
236.19	248	268.11	246	305	245	341.88	244	345	243.5
355	243.5	359.83	244	373	245	385.53	246	433.75	248
473.99	250	524.89	252	553.8	254	582.88	256	608.35	258
629.89	260	664.92	262	691.5	264	725.69	266	758.92	268
800	269.94								

Manning's n Values num= 3

Sta	n Val	Sta	n Val	Sta	n Val
0	.1	305	.03	373	.1

Bank Sta: Left	Right	Lengths: Left Channel	Right	Coeff Contr.	Expan.
305	373	102.3	102.3	.1	.3

CROSS SECTION

RIVER: Piney Branch
REACH: Main RS: 8820

INPUT
Description:
Station Elevation Data num= 26

Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev
0	257.53	39.62	256	93.78	254	152.74	252	202.92	250
271.44	248	307.15	246	329	245	351.94	244	355	243
365	243	371.11	244	384	245	396.33	246	454.18	248
500.95	250	538.52	252	559.09	254	580.93	256	603.4	258
659.37	260	692.15	262	717.37	264	737.85	264	797.72	266
800	266								

Manning's n Values num= 3

Sta	n Val	Sta	n Val	Sta	n Val

```
       0      .1     329     .03     384      .1

Bank Sta: Left   Right    Lengths: Left Channel   Right     Coeff Contr.   Expan.
          329     384            102.6   102.6   102.6             .1       .3

CROSS SECTION


RIVER: Piney Branch
REACH: Main               RS: 8720

INPUT
Description:
Station Elevation Data    num=      21
     Sta    Elev     Sta    Elev     Sta    Elev     Sta    Elev     Sta    Elev
       0  255.54   64.72     254  146.64     252  197.07     250  246.47     248
  293.36     246     349   244.5  369.12     244     380   242.5     390   242.5
  397.48     244   402.5   244.5  418.59     246   454.5     248  512.88     250
  544.82     252  567.21     254  631.04     256  661.57     258  757.56     260
     800  261.94

Manning's n Values        num=       3
     Sta   n Val     Sta   n Val     Sta   n Val
       0      .1     349     .03   402.5      .1

Bank Sta: Left   Right    Lengths: Left Channel   Right     Coeff Contr.   Expan.
          349   402.5            102.7   102.7   102.7             .1       .3

CROSS SECTION


RIVER: Piney Branch
REACH: Main               RS: 8620

INPUT
Description:
Station Elevation Data    num=      20
     Sta    Elev     Sta    Elev     Sta    Elev     Sta    Elev     Sta    Elev
       0  250.07  119.89     250  196.16     248  232.86     248  272.71     246
  352.78     244  365.32     244     385   240.5     395   240.5  403.02     244
  451.46     246  499.98     248  562.28     250  599.32     252  625.43     254
  689.32     256  739.14     258  750.53     258  775.37     260     800   261.3

Manning's n Values        num=       3
     Sta   n Val     Sta   n Val     Sta   n Val
       0      .1  365.32     .03  403.02      .1

Bank Sta: Left   Right    Lengths: Left Channel   Right     Coeff Contr.   Expan.
        365.32  403.02            105.4   105.4   105.4             .1       .3

CROSS SECTION
```

RIVER: Piney Branch
REACH: Main RS: 8520

INPUT
Description:
Station Elevation Data num= 23

Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev
0	252.35	26.31	252	43.7	252	71.13	250	88.92	248
187.75	246	204.49	246	314.39	244	353.19	242	360	239.5
370	239.5	378.2	242	419.88	244	471.66	246	486.93	248
499.03	250	514.25	252	539.59	254	619.42	256	728.7	258
791.57	260	796.54	260	800	259				

Manning's n Values num= 3

Sta	n Val	Sta	n Val	Sta	n Val
0	.1	353.19	.03	378.2	.1

Bank Sta: Left	Right	Lengths: Left Channel	Right	Coeff Contr.	Expan.
353.19	378.2	100.5	100.5	100.5	.1	.3

CROSS SECTION

RIVER: Piney Branch
REACH: Main RS: 8420

INPUT
Description:
Station Elevation Data num= 26

Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev
0	261.92	42.77	260	78.19	258	102.5	256	119.61	254
141.42	252	159.63	250	179.87	248	201.92	246	277.77	244
285.36	242	290.76	242	300	239.3	320	239.3	351.36	242
379.3	242	440.95	244	487.62	246	525.58	248	556.05	250
576.94	252	615.88	254	670.29	256	735.51	258	798.79	260
800	260.1								

Manning's n Values num= 3

Sta	n Val	Sta	n Val	Sta	n Val
0	.1	290.76	.03	351.36	.1

Bank Sta: Left	Right	Lengths: Left Channel	Right	Coeff Contr.	Expan.
290.76	351.36	100.9	100.9	100.9	.1	.3

CROSS SECTION

RIVER: Piney Branch
REACH: Main RS: 8320

INPUT
Description:
Station Elevation Data num= 29

Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev
0	263.73	28.94	262	62.42	260	72.02	258	84.95	256
104.33	254	117.4	254	135.93	252	160.27	250	181.46	248
218.67	246	266.51	244	273.84	244	329.59	242	359.1	242
365	239.1	375	239.1	381.97	242	481.57	244	492.24	246
522.58	248	541.13	250	603.67	252	664.51	254	677.89	254
722.61	256	771.39	258	799.14	260	800	260.06		

Manning's n Values num= 3

Sta	n Val	Sta	n Val	Sta	n Val
0	.1	359.1	.03	381.97	.1

Bank Sta: Left	Right	Lengths: Left Channel	Right	Coeff Contr.	Expan.
359.1	381.97	110.2	110.2	110.2	.1	.3

CROSS SECTION

RIVER: Piney Branch
REACH: Main RS: 8220

INPUT
Description:
Station Elevation Data num= 28

Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev
0	259.23	56.68	258	92.36	256	112.18	254	131.12	252
150.47	250	175.35	248	218.54	246	256.45	244	308.84	242
315.17	240	331.74	240	334	238.9	343	238.9	345.44	240
349.93	242	420.64	242	460.75	244	489.57	246	507.03	248
525.46	250	550.68	252	571.26	252	592.52	254	665.56	256
723.55	258	770.67	258	800	257.55				

Manning's n Values num= 3

Sta	n Val	Sta	n Val	Sta	n Val
0	.1	331.74	.03	345.44	.1

Bank Sta: Left	Right	Lengths: Left Channel	Right	Coeff Contr.	Expan.
331.74	345.44	115.6	115.6	115.6	.1	.3

CROSS SECTION

RIVER: Piney Branch
REACH: Main RS: 8120

INPUT
Description:

Station Elevation Data num= 24

Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev
0	259.82	37.53	258	62.66	256	86.99	254	116.9	252
152.54	250	181.97	248	218.28	246	255.33	244	298.78	242
312.3	240	315	238.7	326	238.7	328.67	240	333.73	242
394.12	242	471.81	244	490.09	246	517.92	248	541.24	250
579.59	252	639.3	252	760.49	254	800	255.9		

Manning's n Values num= 3

Sta	n Val	Sta	n Val	Sta	n Val
0	.1	312.3	.03	328.67	.1

Bank Sta: Left	Right	Lengths: Left Channel	Right	Coeff Contr.	Expan.
312.3	328.67	100.2	100.2	.1	.3

CROSS SECTION

RIVER: Piney Branch
REACH: Main RS: 8020

INPUT
Description:
Station Elevation Data num= 23

Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev
0	260.4	8.8	260	40.89	258	67.56	256	92.58	254
111.56	252	129.3	250	165.14	248	197.7	246	241.26	244
294.27	242	308.26	240	311	238.5	322	238.5	325.87	240
430.31	242	488.93	244	506.47	246	526.93	248	655.14	250
693.52	252	750.38	254	800	255.71				

Manning's n Values num= 3

Sta	n Val	Sta	n Val	Sta	n Val
0	.1	308.26	.03	325.87	.1

Bank Sta: Left	Right	Lengths: Left Channel	Right	Coeff Contr.	Expan.
308.26	325.87	101.2	101.2	.1	.3

CROSS SECTION

RIVER: Piney Branch
REACH: Main RS: 7920

INPUT
Description:
Station Elevation Data num= 25

Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev
0	258.64	11.74	258	40.06	256	78.83	254	105.52	252
126.41	250	149.76	248	183.99	246	212.25	244	257.42	242
286	240.5	293.93	240	296	238.3	310	238.3	313.78	240

```
     338   240.5  410.65     242  478.22     244  548.43     246  598.36     248
  634.08     250  685.75     252  735.23     254  794.65     256     800  256.25

Manning's n Values        num=       3
     Sta   n Val     Sta   n Val     Sta   n Val
       0      .1     286     .03     338      .1

Bank Sta: Left   Right    Lengths: Left Channel   Right     Coeff Contr.   Expan.
           286     338              104     104     104             .1       .3

CROSS SECTION


RIVER: Piney Branch
REACH: Main               RS: 7820

INPUT
Description:
Station Elevation Data    num=      26
     Sta    Elev     Sta    Elev     Sta    Elev     Sta    Elev     Sta    Elev
       0  259.07   10.33     258   39.51     256   68.46     254    99.2     252
  125.93     250  144.38     248  173.97     246  203.53     244  242.21     242
  261.57     242  278.67     240     285   238.1     305   238.1   309.9     240
  408.48     240  452.65     242  521.09     244  556.32     246  585.02     248
  610.48     250  671.76     254  708.13     256  792.99     258  796.33     258
     800  257.99

Manning's n Values        num=       3
     Sta   n Val     Sta   n Val     Sta   n Val
       0      .1  278.67     .03   309.9      .1

Bank Sta: Left   Right    Lengths: Left Channel   Right     Coeff Contr.   Expan.
        278.67   309.9            100.4   100.4   100.4             .1       .3

CROSS SECTION


RIVER: Piney Branch
REACH: Main               RS: 7720

INPUT
Description:
Station Elevation Data    num=      29
     Sta    Elev     Sta    Elev     Sta    Elev     Sta    Elev     Sta    Elev
       0  260.07   11.68     260   29.85     258   61.82     256   81.27     254
  113.78     252  146.88     250  174.54     248  194.64     246  212.56     246
  245.87     244  298.95     242  326.37     240  348.38     238     350     237
     362     237  363.97     238  378.46     240   458.3     240  532.08     242
  575.79     244  603.19     246  641.59     248  674.13     250  693.57     252
  716.06     254  744.25     256  780.63     258     800  258.36
```

Manning's n Values num= 3

Sta	n Val	Sta	n Val	Sta	n Val
0	.1	326.37	.03	378.46	.1

Bank Sta: Left	Right	Lengths: Left Channel	Right	Coeff Contr.	Expan.
326.37	378.46	137.3	137.3	.1	.3

CROSS SECTION

RIVER: Piney Branch
REACH: Main RS: 7620

INPUT
Description:
Station Elevation Data num= 27

Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev
0	257.22	37.65	256	57.11	254	73.32	254	103.22	252
130.81	250	162.64	248	194.87	246	234.37	244	281.3	242
340.96	240	358	238	360	236.2	366	236.2	368.82	238
397.26	240	492.96	240	559.38	242	589.15	244	615.69	246
648.13	248	684.48	250	711.85	252	733.63	254	753.95	256
785.07	258	800	258.71						

Manning's n Values num= 3

Sta	n Val	Sta	n Val	Sta	n Val
0	.1	340.96	.03	397.26	.1

Bank Sta: Left	Right	Lengths: Left Channel	Right	Coeff Contr.	Expan.
340.96	397.26	110.8	110.8	.1	.3

CROSS SECTION

RIVER: Piney Branch
REACH: Main RS: 7520

INPUT
Description:
Station Elevation Data num= 27

Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev
0	254.34	2.26	254	19.56	252	32.39	250	48.83	248
122.75	248	176.18	246	213.85	244	274.42	242	343.71	240
376	238	380	235.8	388	235.8	392.26	238	501	238
527.88	240	549.55	242	578.21	244	630.45	246	669.61	248
703.76	250	724.96	252	744.87	254	759.7	256	777.26	256
796.23	260	800	260						

Manning's n Values num= 3

Sta	n Val	Sta	n Val	Sta	n Val
0	.1	376	.03	392.26	.1

```
Bank Sta: Left   Right    Lengths: Left Channel   Right     Coeff Contr.   Expan.
          376  392.26            106.1   106.1   106.1             .1       .3

CROSS SECTION


RIVER: Piney Branch
REACH: Main               RS: 7420

INPUT
Description:
Station Elevation Data    num=      29
     Sta    Elev     Sta    Elev     Sta    Elev     Sta    Elev     Sta    Elev
       0  262.72    7.92     262   29.26     260   39.68     258   60.41     256
   80.43     254  106.79     252  121.13     250  149.82     248  207.91     246
  255.75     244   320.7     242  355.23     240  409.61     238  424.89     236
     425   235.6     428   235.6  428.32     236  439.47     238  526.28     238
  553.67     240  574.95     242  596.87     244  647.68     246  704.44     248
  743.23     250  766.34     252  788.66     254     800  254.86

Manning's n Values        num=       3
     Sta   n Val     Sta   n Val     Sta   n Val
       0      .1  409.61     .03  439.47      .1

Bank Sta: Left   Right    Lengths: Left Channel   Right     Coeff Contr.   Expan.
        409.61  439.47            120.1   120.1   120.1             .1       .3

CROSS SECTION


RIVER: Piney Branch
REACH: Main               RS: 7320

INPUT
Description:
Station Elevation Data    num=      30
     Sta    Elev     Sta    Elev     Sta    Elev     Sta    Elev     Sta    Elev
       0  266.79    5.25     266   18.22     264   35.97     262    50.9     260
   69.59     258  103.59     256  123.52     254  140.89     252  168.47     250
  200.94     248  230.79     246  268.76     244  301.26     242   351.8     240
  449.07     238  452.53     236     454   235.2     462   235.2  463.22     236
  480.92     236  488.37     238  553.97     240  574.12     242  649.35     244
  690.87     246  736.27     248  768.46     250  795.17     252     800   252.4

Manning's n Values        num=       3
     Sta   n Val     Sta   n Val     Sta   n Val
       0      .1  449.07     .03  488.37      .1

Bank Sta: Left   Right    Lengths: Left Channel   Right     Coeff Contr.   Expan.
        449.07  488.37              102     102     102             .1       .3
```

CROSS SECTION

RIVER: Piney Branch
REACH: Main RS: 7220

INPUT
Description:
Station Elevation Data num= 33

Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev
0	267.59	8.46	266	22.23	264	32.94	262	48.68	260
69.4	258	87.98	256	116.76	254	133.92	252	147.84	250
169.07	248	189.73	246	218.92	244	242.23	242	300.49	240
403.85	238	459.32	238	466.36	236	468	234.8	473	234.8
474.85	236	482.81	238	520.54	238	557.99	240	577.22	242
609.42	244	626.64	244	640.03	242	668.56	242	691.86	244
719.73	246	789.4	248	800	248.65				

Manning's n Values num= 3

Sta	n Val	Sta	n Val	Sta	n Val
0	.1	459.32	.03	482.81	.1

Bank Sta: Left	Right	Lengths: Left Channel	Right	Coeff Contr.	Expan.
459.32	482.81	108	108	108	.1	.3

CROSS SECTION

RIVER: Piney Branch
REACH: Main RS: 7120

INPUT
Description:
Station Elevation Data num= 27

Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev
0	265.18	9.71	264	24.64	262	41.09	260	55.06	258
74.26	256	92.2	254	114.87	252	129.81	250	140.07	248
168.65	246	183.22	244	208.2	242	240.16	240	297.84	238
371.52	236	374	234.4	378	234.4	381.71	236	469.48	236
476.51	238	495.27	240	537.72	242	668.34	244	754.59	246
798.36	246	800	245						

Manning's n Values num= 3

Sta	n Val	Sta	n Val	Sta	n Val
0	.1	371.52	.03	381.71	.1

Bank Sta: Left	Right	Lengths: Left Channel	Right	Coeff Contr.	Expan.
371.52	381.71	111.6	111.6	111.6	.1	.3

CROSS SECTION

RIVER: Piney Branch
REACH: Main RS: 7020

INPUT
Description:
Station Elevation Data num= 24

Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev
0	262.13	.96	262	17.06	260	33.8	258	46.81	256
62.74	254	94.23	250	116.27	248	139.89	246	164.33	244
184.99	242	206.66	240	245.7	238	356.78	236	360	234
370	234	373.23	236	422.61	236	445.47	238	485.02	240
551.71	242	566.88	242	683.86	244	800	245.87		

Manning's n Values num= 3

Sta	n Val	Sta	n Val	Sta	n Val
0	.1	356.78	.03	373.23	.1

Bank Sta: Left	Right	Lengths: Left Channel	Right	Coeff Contr.	Expan.
356.78	373.23	130.9	130.9	130.9	.1	.3

CROSS SECTION

RIVER: Piney Branch
REACH: Main RS: 6920

INPUT
Description:
Station Elevation Data num= 24

Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev
0	259.05	12.61	258	27.01	256	47.72	254	81.94	250
96.98	248	112.35	246	128.16	244	148	242	180.34	240
205.38	238	250.36	236	307.97	236	326.75	234	328	233
329.5	233	330.74	234	367.1	236	432.49	238	492.61	240
642.35	242	719.58	244	761.31	246	800	247.68		

Manning's n Values num= 3

Sta	n Val	Sta	n Val	Sta	n Val
0	.1	307.97	.03	367.1	.1

Bank Sta: Left	Right	Lengths: Left Channel	Right	Coeff Contr.	Expan.
307.97	367.1	146.4	146.4	146.4	.1	.3

CROSS SECTION

RIVER: Piney Branch
REACH: Main RS: 6820

INPUT
Description:
Station Elevation Data num= 20

Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev
0	253.93	21.42	252	40.82	250	64.76	248	80.46	246
102.64	244	121	242	143.29	240	180.28	238	227.7	236
328.89	234	330	232.5	340	232.5	343.69	234	366.73	236
461.68	238	600.91	240	714.73	242	778.94	244	800	245.02

Manning's n Values num= 3

Sta	n Val	Sta	n Val	Sta	n Val
0	.1	328.89	.03	343.69	.1

Bank Sta: Left	Right	Lengths: Left Channel	Right	Coeff Contr.	Expan.
328.89	343.69	101.1	101.1	.1	.3

CROSS SECTION

RIVER: Piney Branch
REACH: Main RS: 6720

INPUT
Description:
Station Elevation Data num= 25

Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev
0	252.27	3.47	252	25.52	250	48.37	248	67.74	246
85.42	244	104.4	242	119.88	240	147.53	238	229.5	236
247.03	234	253.12	234	280	232	282	231.6	288	231.6
290	232	316.6	234	341.52	234	382.84	236	437.01	238
550.34	240	556.49	240	680.54	242	685.58	242	800	243.97

Manning's n Values num= 3

Sta	n Val	Sta	n Val	Sta	n Val
0	.1	253.12	.03	316.6	.1

Bank Sta: Left	Right	Lengths: Left Channel	Right	Coeff Contr.	Expan.
253.12	316.6	102.1	102.1	.1	.3

CROSS SECTION

RIVER: Piney Branch
REACH: Main RS: 6620

INPUT
Description:
Station Elevation Data num= 23

Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev
0	249.94	26.59	248	65	246	82.66	244	102.78	242
128.51	240	149.94	238	197.29	236	273.95	234	284.26	234

```
     295     232     298   231.2     302   231.2     305     232  314.16     234
  340.88     234  364.25     236  461.46     238  524.83     240  566.72     242
  626.28     244  715.55     246  794.34     246

Manning's n Values        num=       3
     Sta   n Val     Sta   n Val     Sta   n Val
       0      .1  284.26     .03  314.16      .1

Bank Sta: Left   Right    Lengths: Left Channel   Right     Coeff Contr.   Expan.
        284.26  314.16            107.9   107.9   107.9             .1       .3

CROSS SECTION


RIVER: Piney Branch
REACH: Main               RS: 6520

INPUT
Description:
Station Elevation Data    num=      22
     Sta    Elev     Sta    Elev     Sta    Elev     Sta    Elev     Sta    Elev
       0  248.42    9.15     248   54.55     246   97.76     244   126.1     242
  157.28     240  180.32     238  215.72     234  341.53     234     343     232
     345   230.8     350   230.8  353.33     232  359.29     234  393.82     236
  432.31     238  519.59     240  608.85     242  672.39     244  730.65     246
  789.58     248     800  248.03

Manning's n Values        num=       3
     Sta   n Val     Sta   n Val     Sta   n Val
       0      .1  341.53     .03  359.29      .1

Bank Sta: Left   Right    Lengths: Left Channel   Right     Coeff Contr.   Expan.
        341.53  359.29            102.9   102.9   102.9             .1       .3

CROSS SECTION


RIVER: Piney Branch
REACH: Main               RS: 6420

INPUT
Description:
Station Elevation Data    num=      23
     Sta    Elev     Sta    Elev     Sta    Elev     Sta    Elev     Sta    Elev
       0   245.6   24.16     244   75.52     242  120.87     240  163.76     238
  214.29     236  252.44     234  301.59     234  316.57     234  321.43     232
     325   230.4     330   230.4  333.81     232  357.69     234  392.16     236
  431.06     238  462.19     240   497.1     242  525.17     244  539.75     244
   679.8     246  758.58     248     800  249.49

Manning's n Values        num=       3
```

```
     Sta   n Val     Sta   n Val     Sta   n Val
       0      .1  301.59     .03  357.69      .1

Bank Sta: Left   Right    Lengths: Left Channel   Right     Coeff Contr.   Expan.
        301.59  357.69            100.4   100.4   100.4             .1       .3

CROSS SECTION


RIVER: Piney Branch
REACH: Main               RS: 6320

INPUT
Description:
Station Elevation Data    num=      21
     Sta    Elev     Sta    Elev     Sta    Elev     Sta    Elev     Sta    Elev
       0  242.04    1.24     242   46.59     240  134.14     238  210.83     236
  253.16     234  311.19     232     315     230     316   229.8     324   229.8
     325     230  332.35     232   341.7     234  378.49     236  393.93     238
   410.2     240  428.51     242  451.38     244  473.54     246  698.08     248
     800     249

Manning's n Values        num=       3
     Sta   n Val     Sta   n Val     Sta   n Val
       0      .1  253.16     .03   341.7      .1

Bank Sta: Left   Right    Lengths: Left Channel   Right     Coeff Contr.   Expan.
        253.16   341.7            103.4   103.4   103.4             .1       .3

CROSS SECTION


RIVER: Piney Branch
REACH: Main               RS: 6220

INPUT
Description:
Station Elevation Data    num=      25
     Sta    Elev     Sta    Elev     Sta    Elev     Sta    Elev     Sta    Elev
       0  244.34    5.29     244   38.99     242   59.61     240  107.68     238
  186.04     236  248.89     234     285     233   322.2     232     326     230
     328   229.6     338   229.6     340     230   344.3     232     351     233
  359.18     234  377.94     236  395.63     238  409.74     240  428.29     242
  451.75     244  469.13     246  506.74     248   685.5     248     800   249.3

Manning's n Values        num=       3
     Sta   n Val     Sta   n Val     Sta   n Val
       0      .1     285     .03     351      .1

Bank Sta: Left   Right    Lengths: Left Channel   Right     Coeff Contr.   Expan.
           285     351            112.1   112.1   112.1             .1       .3
```

CROSS SECTION

RIVER: Piney Branch
REACH: Main RS: 6120

INPUT
Description:
Station Elevation Data num= 25

Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev
0	245.78	29.02	244	59.43	242	97.5	240	134.82	238
168.24	236	216.03	234	287.39	232	298.52	232	348	230
350	229.2	358	229.2	360	230	372.14	232	384.4	232
389.21	234	392.51	236	409.27	238	433.49	240	450.23	242
479.66	244	537.42	246	661.97	246	793.87	248	800	248.18

Manning's n Values num= 3

Sta	n Val	Sta	n Val	Sta	n Val
0	.1	298.52	.03	372.14	.1

Bank Sta: Left	Right	Lengths: Left Channel	Right	Coeff Contr.	Expan.
298.52	372.14	102.4	102.4	102.4	.1	.3

Ineffective Flow num= 0

Sta L	Sta R	Elev	Permanent

CROSS SECTION

RIVER: Piney Branch
REACH: Main RS: 6020

INPUT
Description:
Station Elevation Data num= 25

Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev
0	244.42	6	244	33.24	242	67.3	240	96	238.65
110.38	234.01	199.49	234.04	229.27	233.95	268.24	232	359.44	232
385.56	230	388	228.8	391	228.8	393.8	230	400.55	232
411.6	234	436.96	234.01	463.29	234.01	480.05	240	511.65	242
554.92	244	634.37	244	768.25	246	784.83	246	800	246.19

Manning's n Values num= 3

Sta	n Val	Sta	n Val	Sta	n Val
0	.07	359.44	.03	400.55	.07

Bank Sta: Left	Right	Lengths: Left Channel	Right	Coeff Contr.	Expan.
359.44	400.55	190.7	190.7	190.7	.1	.3

Ineffective Flow num= 2

Sta L	Sta R	Elev	Permanent
0	94.5	249.5	F

```
   482.5     800   245.8       F

BRIDGE


RIVER: Piney Branch
REACH: Main               RS: 5970

INPUT
Description: UB Bridge
Distance from Upstream XS =      17
Deck/Roadway Width        =      96
Weir Coefficient          =     2.6
Upstream  Deck/Roadway Coordinates
    num=       6
     Sta Hi Cord Lo Cord     Sta Hi Cord Lo Cord     Sta Hi Cord Lo Cord
       0 251.716              96 250.134              96 250.134  248.31
     482 246.143  244.45     482 246.143             800  246.04

Upstream Bridge Cross Section Data
Station Elevation Data    num=      32
     Sta    Elev     Sta    Elev     Sta    Elev     Sta    Elev     Sta    Elev
       0  244.42       6     244   33.24     242    67.3     240      96  238.65
  110.38  234.01  199.49  234.04  229.27 233.946  268.24     232  283.43     232
  359.44     232  385.56     230     388228.7461     391228.7461   393.8     230
  400.55     232   411.6     234  436.96  234.01  463.29  234.01  480.05     240
  511.65     242  554.92     244  564.61     244  573.97     244   606.1     244
  616.93     244  621.82     244  634.37     244  768.25     246  781.91     246
  784.83     246     800  246.19

Manning's n Values        num=       3
     Sta   n Val     Sta   n Val     Sta   n Val
       0     .07  359.44     .03  400.55     .07

Bank Sta: Left   Right    Coeff Contr.   Expan.
        359.44  400.55             .1       .3
Ineffective Flow     num=       2
   Sta L   Sta R    Elev  Permanent
       0    94.5   249.5       F
   482.5     800   245.8       F

Downstream  Deck/Roadway Coordinates
    num=       6
     Sta Hi Cord Lo Cord     Sta Hi Cord Lo Cord     Sta Hi Cord Lo Cord
       0 251.716              94 250.134              94 250.134  248.31
     480 246.143  244.45     480 246.143             800  246.04

Downstream Bridge Cross Section Data
Station Elevation Data    num=     379
     Sta    Elev     Sta    Elev     Sta    Elev     Sta    Elev     Sta    Elev
       0   245.4     1.4  245.23     3.2  244.72       4  244.55     5.2   244.2
```

6.6	243.76	7.2	243.69	9.3	243.19	11.1	243.2	11.9	243.18
13.1	243.38	15.1	243.61	17.1	243.81	19.8	243.83	22.4	243.74
23	243.82	25.1	244.26	27.7	244.44	30.9	244.28	34.9	244.2
35.6	244.22	38.2	244.45	38.9	244.39	40.9	244.15	42.8	243.96
46.1	243.68	48.8	243.75	51.4	243.69	54	243.53	54.7	243.5
56.7	243.44	59.3	243.39	61.9	243.24	62.6	243.24	64.6	243.19
67.2	243.23	69.8	243.16	72.5	242.94	76.5	242.72	80.4	242.54
82.4	242.41	83	242.39	85.6	242.18	88.3	241.94	90.9	241.92
93.5	241.62	94	241.5	115.43	233.98	183.68	234	195.2	233.85
196.2	233.7	198.8	233.47	200.2	233.45	204.1	233.44	206.7	233.34
209.4	233.28	213	233.06	214.6	232.93	216.1	232.91	217.3	232.91
219.9	232.73	220.9	232.81	221.8	232.83	222.5	232.87	224.9	232.83
227.8	232.94	230.8	232.87	232	232.86	234.8	232.74	235.7	232.67
236.8	232.55	238.3	232.36	238.7	232.34	240.7	232.44	242.7	232.5
243.6	232.55	246.2	232.17	251.5	231.94	254.1	231.71	254.6	231.7
255.9	231.74	259.4	231.99	262.5	231.99	264.7	232.12	266.5	231.95
267.3	231.85	269.9	231.31	270.4	231.24	272.4	230.79	274.4	230.27
275.2	230.1	277.8	229.77	278.34	229.755	280.3	229.7	283.1	229.59
286.2	228.98	288.4	228.44	290.2	228.44	291	228.44	292.2	228.53
292.5	228.64	293.6	228.95	294.2	229.08	296.2	229.47	298.9	229.66
300.1	229.76	301.5	229.9	304.1	230.29	306	230.48	308	230.66
312	230.97	313.9	231.29	314.7	231.35	315.9	231.57	317.3	231.75
317.9	231.79	321.9	232.15	323.8	232.37	324	232.41	325.2	232.63
327.9	232.71	329.8	232.66	331.8	232.72	333.1	232.79	335.7	232.81
338.4	232.75	341.7	232.9	343.6	232.94	345.6	233.01	347.6	233.1
348.9	233.18	351.6	233.09	354.2	232.98	357.5	232.93	359.4	232.84
361.84	233.129	362.1	233.16	364.7	233.31	367.3	233.25	370	233.35
371.3	233.38	372.6	233.38	375.2	233.34	379.3	233.43	380.5	233.44
381.2	233.45	383	233.53	385.2	233.56	391	233.53	393.1	233.66
393.7	233.66	396.3	233.36	397.1	233.4	399.1	233.56	401.6	233.6
404.2	233.47	407	233.48	408.9	233.29	412.1	233.29	412.9	233.31
414.7	233.45	417.4	233.82	418.8	233.93	420	233.99	420.8	233.92
422.8	233.8	426.8	233.71	427.9	233.67	428.7	233.62	430.5	233.43
430.7	233.46	432.7	233.9	433.2	233.93	434.1	233.96	434.7	233.96
436.66	234	467.66	234	480	238.16	480.2	238.19	480.5	238.26
483.2	238.59	485.8	238.8	488.4	239.08	491.1	239.34	496	239.97
499	240.08	500	240.14	501.6	240.3	504.2	240.64	505.9	240.89
506.9	241.01	509.5	241.08	514.8	241.39	515.8	241.41	517.4	241.41
519	241.44	520	241.5	521.8	241.67	522.7	241.73	525.3	241.71
525.7	241.76	527.9	242.25	529.7	242.37	530.6	242.4	533.6	242.23
535.6	242.25	538.5	242.32	539.6	242.32	540.2	242.35	541.1	242.38
543.5	242.32	543.7	242.33	544.2	242.34	546.4	242.41	547.5	242.5
548.1	242.54	549	242.6	550.9	242.58	554.3	242.49	555.4	242.51
556	242.48	556.9	242.47	557.4	242.42	558.8	242.23	559.4	242.19
559.5	242.18	559.9	242.18	561.3	242.23	563.3	242.15	563.8	242.07
564.8	241.98	565.3	242.02	566.8	242.21	567.4	242.34	570.1	242.58
571.2	242.4	572.7	242.07	573.2	242.13	574.8	242.39	575.2	242.49
575.3	242.5	577.2	242.48	578	242.49	579.5	242.42	581.1	242.39
583.2	242.29	585.1	242.34	589	242.36	591.3	242.35	593.8	242.3
599	242.35	599.2	242.36	600.9	242.55	601.7	242.59	604.9	242.47
609.6	242.42	612.2	242.18	614.8	242.07	614.8	242.06	617.5	241.85

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   618.7  241.95   620.1  242.08   620.7   242.1   622.7  242.13   624.7   242.1
   625.4  242.03   626.6  242.03   626.7  242.03     628  242.01   630.6  241.84
   633.3  242.09   634.6  242.16   635.9  242.22   636.5  242.23   638.5  242.37
   641.2  242.35   642.4  242.33   642.5  242.33   643.8   242.3   644.5  242.27
   646.4  242.31   648.4  242.32   649.1  242.34   651.7  242.25   652.4   242.3
   654.4   242.5     657  242.62   658.3  242.59   659.6  242.55   660.3  242.51
   662.2  242.41   664.3  242.21   664.8  242.19     666  242.32   667.5  242.45
   668.2  242.43   670.1  242.37   672.7  242.41   673.9  242.56   675.4  242.71
   678.4  242.89   680.6  242.98     684  242.82   685.9  242.55   686.4  242.63
     688  243.04   688.5  243.13   689.6  243.16     690  243.18   691.2  243.19
   693.8  243.05   696.4  243.14   697.9  243.11   701.9  243.07   702.3  243.06
   704.3     243   705.8   243.1     707  243.22   709.3   243.4   709.6  243.43
   712.2  243.48   714.9   243.4   717.5  243.62   717.7  243.62   718.2  243.57
   719.7  243.51   720.1   243.5   722.8  243.52   726.2  243.71     728  243.77
   729.6   243.8   730.7  243.77   733.3  243.55   733.5  243.59   734.2  243.75
   735.5  244.12   735.9   244.2   736.8  244.22   737.5  244.24   738.6  244.25
   743.8  244.19   746.5  244.32   751.3  244.77   751.7  244.79   752.5  244.78
   753.3  244.76   755.3   244.8     757  244.95   757.3  244.98   758.1  245.04
   759.2   245.1   759.6  245.12   761.2  244.95   762.3  244.87   763.2  244.89
   764.3  244.86   767.5  244.85   769.1  244.87   770.2  244.86   771.1  244.84
   772.8  244.77   773.1  244.76     774  244.76   775.1  244.79   775.4  244.79
   778.1  245.03   780.7  245.08   783.3  244.91     785  244.92     787  245.01
   788.6  245.01   788.9  244.99   790.9  244.92   793.9  244.88   797.9  245.15
   798.8  245.24   799.1  245.27   799.7  245.29     800  245.31

Manning's n Values        num=       3
     Sta   n Val     Sta   n Val     Sta   n Val
       0     .07   354.2     .03     407     .07

Bank Sta: Left   Right    Coeff Contr.   Expan.
         270.4   313.9             .1       .3
Ineffective Flow     num=       2
   Sta L   Sta R    Elev  Permanent
       0    93.5     249       F
   480.5     800     245       F

Upstream Embankment side slope              =       0 horiz. to 1.0 vertical
Downstream Embankment side slope            =       0 horiz. to 1.0 vertical
Maximum allowable submergence for weir flow =     .98
Elevation at which weir flow begins         =
Energy head used in spillway design         =
Spillway height used in design              =
Weir crest shape                            = Broad Crested

Number of Piers =  1

Pier Data
Pier Station     Upstream=     277    Downstream=     277
Upstream     num=       2
    Width   Elev    Width   Elev
       5     220       5  248.31
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Downstream     num=       2
    Width   Elev    Width   Elev
       5     220       5  248.31

Number of Bridge Coefficient Sets =  1

Low Flow Methods and Data
       Energy
       Momentum               Cd   =     1.2
       Yarnell                KVal =      .9
       W.S. Pro Method

  W.S.Pro Data
    Left Embankment
       El of the top of the embankment = 250
       El of the toe of the abutment   = 238
    Right Embankment
       El of the top of the embankment = 246
       El of the toe of the abutment   = 240
    Abutment Type                      = 2 Vert. abutments and sloping embankments
    Slope of abutments                 =
    Top with of embankment             = 386
    Centroid station of bridge opening =
    Wing Wall Type                     = No wing walls present
       Width                           =
       Angle                           =
       Radius                          =
    Guide Banks Type                   = No Guide Bank present
       Length                          =
       Offset                          =
       Angle                           =

Selected Low Flow Methods = Highest Energy Answer

High Flow Method
       Energy Only

Additional Bridge Parameters
       Do not add Friction component to Momentum
       Do not add Weight component to Momentum
       Class B flow critical depth computations use critical depth
           inside the bridge at the downstream end
       Criteria to check for pressure flow = Upstream water surface

CROSS SECTION


RIVER: Piney Branch
REACH: Main              RS: 5881

INPUT
```

Description:
Station Elevation Data num= 377

Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev
0	245.4	1.4	245.23	3.2	244.72	4	244.55	5.2	244.2
6.6	243.76	7.2	243.69	9.3	243.19	11.1	243.2	11.9	243.18
13.1	243.38	15.1	243.61	17.1	243.81	19.8	243.83	22.4	243.74
23	243.82	25.1	244.26	27.7	244.44	30.9	244.28	34.9	244.2
35.6	244.22	38.2	244.45	38.9	244.39	40.9	244.15	42.8	243.96
46.1	243.68	48.8	243.75	51.4	243.69	54	243.53	54.7	243.5
56.7	243.44	59.3	243.39	61.9	243.24	62.6	243.24	64.6	243.19
67.2	243.23	69.8	243.16	72.5	242.94	76.5	242.72	80.4	242.54
82.4	242.41	83	242.39	85.6	242.18	88.3	241.94	90.9	241.92
93.5	241.62	94	241.5	115.43	233.98	183.68	234	195.2	233.85
196.2	233.7	198.8	233.47	200.2	233.45	204.1	233.44	206.7	233.34
209.4	233.28	213	233.06	214.6	232.93	216.1	232.91	217.3	232.91
219.9	232.73	220.9	232.81	221.8	232.83	222.5	232.87	224.9	232.83
227.8	232.94	230.8	232.87	232	232.86	234.8	232.74	235.7	232.67
236.8	232.55	238.3	232.36	238.7	232.34	240.7	232.44	242.7	232.5
243.6	232.55	246.2	232.17	251.5	231.94	254.1	231.71	254.6	231.7
255.9	231.74	259.4	231.99	262.5	231.99	264.7	232.12	266.5	231.95
267.3	231.85	269.9	231.31	270.4	231.24	272.4	230.79	274.4	230.27
275.2	230.1	277.8	229.77	278.34	229.76	280.3	229.7	283.1	229.59
286.2	228.98	288.4	228.44	290.2	228.24	291	228.19	292.2	228.53
292.5	228.64	293.6	228.95	294.2	229.08	296.2	229.47	298.9	229.66
300.1	229.76	301.5	229.9	304.1	230.29	306	230.48	308	230.66
312	230.97	313.9	231.29	314.7	231.35	315.9	231.57	317.3	231.75
317.9	231.79	321.9	232.15	323.8	232.37	324	232.41	325.2	232.63
327.9	232.71	329.8	232.66	331.8	232.72	333.1	232.79	335.7	232.81
338.4	232.75	341.7	232.9	343.6	232.94	345.6	233.01	347.6	233.1
348.9	233.18	351.6	233.09	354.2	232.98	357.5	232.93	359.4	232.84
361.84	233.13	362.1	233.16	364.7	233.31	367.3	233.25	370	233.35
371.3	233.38	372.6	233.38	375.2	233.34	379.3	233.43	380.5	233.44
381.2	233.45	383	233.53	385.2	233.56	391	233.53	393.1	233.66
393.7	233.66	396.3	233.36	397.1	233.4	399.1	233.56	401.6	233.6
404.2	233.47	407	233.48	408.9	233.29	412.1	233.29	412.9	233.31
414.7	233.45	417.4	233.82	418.8	233.93	420	233.99	420.8	233.92
422.8	233.8	426.8	233.71	427.9	233.67	428.7	233.62	430.5	233.43
430.7	233.46	432.7	233.9	433.2	233.93	434.1	233.96	434.7	233.96
436.66	234	467.66	234	480	238.16	480.2	238.19	480.5	238.26
483.2	238.59	485.8	238.8	488.4	239.08	491.1	239.34	496	239.97
499	240.08	500	240.14	501.6	240.3	504.2	240.64	505.9	240.89
506.9	241.01	509.5	241.08	514.8	241.39	515.8	241.41	517.4	241.41
519	241.44	520	241.5	521.8	241.67	522.7	241.73	525.3	241.71
525.7	241.76	527.9	242.25	529.7	242.37	530.6	242.4	533.6	242.23
535.6	242.25	538.5	242.32	539.6	242.32	540.2	242.35	541.1	242.38
543.5	242.32	543.7	242.33	544.2	242.34	546.4	242.41	547.5	242.5
548.1	242.54	549	242.6	550.9	242.58	554.3	242.49	555.4	242.51
556	242.48	556.9	242.47	557.4	242.42	558.8	242.23	559.4	242.19
559.5	242.18	559.9	242.18	561.3	242.23	563.3	242.15	563.8	242.07
564.8	241.98	565.3	242.02	566.8	242.21	567.4	242.34	570.1	242.58
571.2	242.4	572.7	242.07	573.2	242.13	574.8	242.39	575.2	242.49

575.3	242.5	577.2	242.48	578	242.49	579.5	242.42	581.1	242.39
583.2	242.29	585.1	242.34	589	242.36	591.3	242.35	593.8	242.3
599	242.35	599.2	242.36	600.9	242.55	601.7	242.59	604.9	242.47
609.6	242.42	612.2	242.18	614.8	242.06	617.5	241.85	618.7	241.95
620.1	242.08	620.7	242.1	622.7	242.13	624.7	242.1	625.4	242.03
626.7	242.03	628	242.01	630.6	241.84	633.3	242.09	634.6	242.16
635.9	242.22	636.5	242.23	638.5	242.37	641.2	242.35	642.4	242.33
642.5	242.33	643.8	242.3	644.5	242.27	646.4	242.31	648.4	242.32
649.1	242.34	651.7	242.25	652.4	242.3	654.4	242.5	657	242.62
658.3	242.59	659.6	242.55	660.3	242.51	662.2	242.41	664.3	242.21
664.8	242.19	666	242.32	667.5	242.45	668.2	242.43	670.1	242.37
672.7	242.41	673.9	242.56	675.4	242.71	678.4	242.89	680.6	242.98
684	242.82	685.9	242.55	686.4	242.63	688	243.04	688.5	243.13
689.6	243.16	690	243.18	691.2	243.19	693.8	243.05	696.4	243.14
697.9	243.11	701.9	243.07	702.3	243.06	704.3	243	705.8	243.1
707	243.22	709.3	243.4	709.6	243.43	712.2	243.48	714.9	243.4
717.5	243.62	717.7	243.62	718.2	243.57	719.7	243.51	720.1	243.5
722.8	243.52	726.2	243.71	728	243.77	729.6	243.8	730.7	243.77
733.3	243.55	733.5	243.59	734.2	243.75	735.5	244.12	735.9	244.2
736.8	244.22	737.5	244.24	738.6	244.25	743.8	244.19	746.5	244.32
751.3	244.77	751.7	244.79	752.5	244.78	753.3	244.76	755.3	244.8
757	244.95	757.3	244.98	758.1	245.04	759.2	245.1	759.6	245.12
761.2	244.95	762.3	244.87	763.2	244.89	764.3	244.86	767.5	244.85
769.1	244.87	770.2	244.86	771.1	244.84	772.8	244.77	773.1	244.76
774	244.76	775.1	244.79	775.4	244.79	778.1	245.03	780.7	245.08
783.3	244.91	785	244.92	787	245.01	788.6	245.01	788.9	244.99
790.9	244.92	793.9	244.88	797.9	245.15	798.8	245.24	799.1	245.27
799.7	245.29	800	245.31						

Manning's n Values num= 3

Sta	n Val	Sta	n Val	Sta	n Val
0	.1	270.4	.03	313.9	.1

Bank Sta: Left Right Lengths: Left Channel Right Coeff Contr. Expan.

270.4	313.9		84.5	84.5	84.5	.1	.3

Ineffective Flow num= 2

Sta L	Sta R	Elev	Permanent
0	93.5	249	F
480.5	800	245	F

CROSS SECTION

RIVER: Piney Branch
REACH: Main RS: 5820

INPUT
Description:
Station Elevation Data num= 27

Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev
0	249.57	23.06	248	45.05	246	68.04	244	88.62	242

```
  113.03     240  141.79     238  166.53     236  188.83     234   230.1     232
  273.64     232  281.82     230     285   228.2     300   228.2  303.71     230
  311.85     232  362.13     232  417.89     234  464.69     236  509.03     238
   536.8     238   567.1     240  641.65     242  656.38     242  749.16     244
  785.99     244     800  244.08

Manning's n Values        num=       3
     Sta   n Val     Sta   n Val     Sta   n Val
       0      .1  273.64     .03  311.85      .1

Bank Sta: Left   Right    Lengths: Left Channel   Right     Coeff Contr.   Expan.
        273.64  311.85            114.3   114.3   114.3             .1       .3
Ineffective Flow     num=       2
   Sta L   Sta R    Elev  Permanent
       0      24   248.5       F
     513     800   244.5       F

CROSS SECTION


RIVER: Piney Branch
REACH: Main               RS: 5720

INPUT
Description:
Station Elevation Data    num=      21
     Sta    Elev     Sta    Elev     Sta    Elev     Sta    Elev     Sta    Elev
       0  248.78    8.23     248   30.35     246   55.09     244   81.15     242
  110.73     240  148.55     238  183.88     236  207.92     234  231.39     232
  327.72     230  331.41     228  340.09     228  365.92     230  396.94     232
  466.05     234  506.82     236   535.6     238  583.82     240   780.4     240
     800  240.84

Manning's n Values        num=       3
     Sta   n Val     Sta   n Val     Sta   n Val
       0      .1  327.72     .03  365.92      .1

Bank Sta: Left   Right    Lengths: Left Channel   Right     Coeff Contr.   Expan.
        327.72  365.92            104.5   104.5   104.5             .1       .3

CROSS SECTION


RIVER: Piney Branch
REACH: Main               RS: 5620

INPUT
Description:
Station Elevation Data    num=      22
     Sta    Elev     Sta    Elev     Sta    Elev     Sta    Elev     Sta    Elev
       0  248.49    6.47     248    27.5     246   49.44     244   83.87     242
```

121.65	240	164.56	238	184.9	236	216.06	234	243.49	232
332.13	230	350.82	228	353.55	228	372.62	230	411.56	232
496.65	234	547.01	236	657.83	236	683.8	238	732.28	240
767.08	242	800	243						

Manning's n Values num= 3

Sta	n Val	Sta	n Val	Sta	n Val
0	.1	332.13	.03	372.62	.1

Bank Sta: Left	Right	Lengths: Left Channel	Right	Coeff Contr.	Expan.
332.13	372.62	106.7	106.7	.1	.3

CROSS SECTION

RIVER: Piney Branch
REACH: Main RS: 5520

INPUT
Description:
Station Elevation Data num= 24

Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev
0	247.36	15.86	246	35.51	244	58.5	242	95.19	240
140.6	238	144.12	238	175.7	236	203.07	234	250.85	232
317.43	230	355.65	230	360	227.8	390	227.8	395.65	230
421.86	232	521.55	232	552.73	234	587.61	236	604.34	238
626.43	240	660.2	242	755.68	244	800	245.6		

Manning's n Values num= 3

Sta	n Val	Sta	n Val	Sta	n Val
0	.1	355.65	.03	395.65	.1

Bank Sta: Left	Right	Coeff Contr.	Expan.
355.65	395.65	.1	.3

SUMMARY OF MANNING'S N VALUES

River:Piney Branch

Reach	River Sta.	n1	n2	n3
Main	8920	.1	.03	.1
Main	8820	.1	.03	.1
Main	8720	.1	.03	.1
Main	8620	.1	.03	.1
Main	8520	.1	.03	.1
Main	8420	.1	.03	.1
Main	8320	.1	.03	.1
Main	8220	.1	.03	.1

Main	8120	.1	.03	.1
Main	8020	.1	.03	.1
Main	7920	.1	.03	.1
Main	7820	.1	.03	.1
Main	7720	.1	.03	.1
Main	7620	.1	.03	.1
Main	7520	.1	.03	.1
Main	7420	.1	.03	.1
Main	7320	.1	.03	.1
Main	7220	.1	.03	.1
Main	7120	.1	.03	.1
Main	7020	.1	.03	.1
Main	6920	.1	.03	.1
Main	6820	.1	.03	.1
Main	6720	.1	.03	.1
Main	6620	.1	.03	.1
Main	6520	.1	.03	.1
Main	6420	.1	.03	.1
Main	6320	.1	.03	.1
Main	6220	.1	.03	.1
Main	6120	.1	.03	.1
Main	6020	.07	.03	.07
Main	5970	Bridge		
Main	5881	.1	.03	.1
Main	5820	.1	.03	.1
Main	5720	.1	.03	.1
Main	5620	.1	.03	.1
Main	5520	.1	.03	.1

SUMMARY OF REACH LENGTHS

River: Piney Branch

Reach	River Sta.	Left	Channel	Right
Main	8920	102.3	102.3	102.3
Main	8820	102.6	102.6	102.6
Main	8720	102.7	102.7	102.7
Main	8620	105.4	105.4	105.4
Main	8520	100.5	100.5	100.5
Main	8420	100.9	100.9	100.9
Main	8320	110.2	110.2	110.2
Main	8220	115.6	115.6	115.6
Main	8120	100.2	100.2	100.2
Main	8020	101.2	101.2	101.2
Main	7920	104	104	104
Main	7820	100.4	100.4	100.4
Main	7720	137.3	137.3	137.3

Main	7620	110.8	110.8	110.8
Main	7520	106.1	106.1	106.1
Main	7420	120.1	120.1	120.1
Main	7320	102	102	102
Main	7220	108	108	108
Main	7120	111.6	111.6	111.6
Main	7020	130.9	130.9	130.9
Main	6920	146.4	146.4	146.4
Main	6820	101.1	101.1	101.1
Main	6720	102.1	102.1	102.1
Main	6620	107.9	107.9	107.9
Main	6520	102.9	102.9	102.9
Main	6420	100.4	100.4	100.4
Main	6320	103.4	103.4	103.4
Main	6220	112.1	112.1	112.1
Main	6120	102.4	102.4	102.4
Main	6020	190.7	190.7	190.7
Main	5970	Bridge		
Main	5881	84.5	84.5	84.5
Main	5820	114.3	114.3	114.3
Main	5720	104.5	104.5	104.5
Main	5620	106.7	106.7	106.7
Main	5520			

SUMMARY OF CONTRACTION AND EXPANSION COEFFICIENTS
River: Piney Branch

Reach	River Sta.	Contr.	Expan.
Main	8920	.1	.3
Main	8820	.1	.3
Main	8720	.1	.3
Main	8620	.1	.3
Main	8520	.1	.3
Main	8420	.1	.3
Main	8320	.1	.3
Main	8220	.1	.3
Main	8120	.1	.3
Main	8020	.1	.3
Main	7920	.1	.3
Main	7820	.1	.3
Main	7720	.1	.3
Main	7620	.1	.3
Main	7520	.1	.3
Main	7420	.1	.3
Main	7320	.1	.3
Main	7220	.1	.3

Main	7120		.1	.3
Main	7020		.1	.3
Main	6920		.1	.3
Main	6820		.1	.3
Main	6720		.1	.3
Main	6620		.1	.3
Main	6520		.1	.3
Main	6420		.1	.3
Main	6320		.1	.3
Main	6220		.1	.3
Main	6120		.1	.3
Main	6020		.1	.3
Main	5970	Bridge		
Main	5881		.1	.3
Main	5820		.1	.3
Main	5720		.1	.3
Main	5620		.1	.3
Main	5520		.1	.3

ERRORS WARNINGS AND NOTES
Errors Warnings and Notes for Plan : PR

River: Piney Branch Reach: Main RS: 8920 Profile: FEMA 100-yr
Warning:The velocity head has changed by more than 0.5 ft (0.15 m). This may indicate the need for additional cross sections.
Warning:The conveyance ratio (upstream conveyance divided by downstream conveyance) is less than 0.7 or greater than 1.4.
This may indicate the need for additional cross sections.
River: Piney Branch Reach: Main RS: 8920 Profile: FEMA FW
Warning:The velocity head has changed by more than 0.5 ft (0.15 m). This may indicate the need for additional cross sections.
Warning:The conveyance ratio (upstream conveyance divided by downstream conveyance) is less than 0.7 or greater than 1.4.
This may indicate the need for additional cross sections.
River: Piney Branch Reach: Main RS: 8920 Profile: StreamStats 100-
Warning:The velocity head has changed by more than 0.5 ft (0.15 m). This may indicate the need for additional cross sections.
Warning:The conveyance ratio (upstream conveyance divided by downstream conveyance) is less than 0.7 or greater than 1.4.
This may indicate the need for additional cross sections.
River: Piney Branch Reach: Main RS: 8920 Profile: StreamStats 50-y
Warning:The velocity head has changed by more than 0.5 ft (0.15 m). This may indicate the need for additional cross sections.
Warning:The conveyance ratio (upstream conveyance divided by downstream conveyance) is less than 0.7 or greater than 1.4.
This may indicate the need for additional cross sections.
River: Piney Branch Reach: Main RS: 8920 Profile: StreamStats 25-y
Warning:The conveyance ratio (upstream conveyance divided by downstream

conveyance) is less than 0.7 or greater than 1.4.
This may indicate the need for additional cross sections.
River: Piney Branch Reach: Main RS: 8920 Profile: StreamStats 10-y
Warning:The conveyance ratio (upstream conveyance divided by downstream conveyance) is less than 0.7 or greater than 1.4.
This may indicate the need for additional cross sections.
River: Piney Branch Reach: Main RS: 8920 Profile: StreamStats 5-yr
Warning:The conveyance ratio (upstream conveyance divided by downstream conveyance) is less than 0.7 or greater than 1.4.
This may indicate the need for additional cross sections.
River: Piney Branch Reach: Main RS: 8920 Profile: StreamStats 2-yr
Warning:The conveyance ratio (upstream conveyance divided by downstream conveyance) is less than 0.7 or greater than 1.4.
This may indicate the need for additional cross sections.
River: Piney Branch Reach: Main RS: 8820 Profile: StreamStats 25-y
Warning:The conveyance ratio (upstream conveyance divided by downstream conveyance) is less than 0.7 or greater than 1.4.
This may indicate the need for additional cross sections.
River: Piney Branch Reach: Main RS: 8820 Profile: StreamStats 10-y
Warning:The conveyance ratio (upstream conveyance divided by downstream conveyance) is less than 0.7 or greater than 1.4.
This may indicate the need for additional cross sections.
River: Piney Branch Reach: Main RS: 8820 Profile: StreamStats 5-yr
Warning:The conveyance ratio (upstream conveyance divided by downstream conveyance) is less than 0.7 or greater than 1.4.
This may indicate the need for additional cross sections.
River: Piney Branch Reach: Main RS: 8820 Profile: StreamStats 2-yr
Warning:The conveyance ratio (upstream conveyance divided by downstream conveyance) is less than 0.7 or greater than 1.4.
This may indicate the need for additional cross sections.
River: Piney Branch Reach: Main RS: 8720 Profile: StreamStats 25-y
Warning:The energy equation could not be balanced within the specified number of iterations. The program used critical depth
for the water surface and continued on with the calculations.
Warning:During the standard step iterations, when the assumed water surface was set equal to critical depth, the calculated
water surface came back below critical depth. This indicates that there is not a valid subcritical answer. The
program defaulted to critical depth.
River: Piney Branch Reach: Main RS: 8720 Profile: StreamStats 10-y
Warning:The energy equation could not be balanced within the specified number of iterations. The program used critical depth
for the water surface and continued on with the calculations.
Warning:During the standard step iterations, when the assumed water surface was set equal to critical depth, the calculated
water surface came back below critical depth. This indicates that there is not a valid subcritical answer. The
program defaulted to critical depth.
River: Piney Branch Reach: Main RS: 8720 Profile: StreamStats 5-yr
Warning:The energy equation could not be balanced within the specified number of iterations. The program used critical depth

for the water surface and continued on with the calculations.
Warning:The conveyance ratio (upstream conveyance divided by downstream conveyance) is less than 0.7 or greater than 1.4.
This may indicate the need for additional cross sections.
Warning:The energy loss was greater than 1.0 ft (0.3 m). between the current and previous cross section. This may indicate
the need for additional cross sections.
Warning:During the standard step iterations, when the assumed water surface was set equal to critical depth, the calculated
water surface came back below critical depth. This indicates that there is not a valid subcritical answer. The
program defaulted to critical depth.
River: Piney Branch Reach: Main RS: 8720 Profile: StreamStats 2-yr
Warning:The energy equation could not be balanced within the specified number of iterations. The program used critical depth
for the water surface and continued on with the calculations.
Warning:The energy loss was greater than 1.0 ft (0.3 m). between the current and previous cross section. This may indicate
the need for additional cross sections.
Warning:During the standard step iterations, when the assumed water surface was set equal to critical depth, the calculated
water surface came back below critical depth. This indicates that there is not a valid subcritical answer. The
program defaulted to critical depth.
River: Piney Branch Reach: Main RS: 8620 Profile: FEMA 100-yr
Warning:The energy equation could not be balanced within the specified number of iterations. The program used critical depth
for the water surface and continued on with the calculations.
Warning:The velocity head has changed by more than 0.5 ft (0.15 m). This may indicate the need for additional cross sections.
Warning:During the standard step iterations, when the assumed water surface was set equal to critical depth, the calculated
water surface came back below critical depth. This indicates that there is not a valid subcritical answer. The
program defaulted to critical depth.
River: Piney Branch Reach: Main RS: 8620 Profile: FEMA FW
Warning:The velocity head has changed by more than 0.5 ft (0.15 m). This may indicate the need for additional cross sections.
River: Piney Branch Reach: Main RS: 8620 Profile: StreamStats 5-yr
Warning:The conveyance ratio (upstream conveyance divided by downstream conveyance) is less than 0.7 or greater than 1.4.
This may indicate the need for additional cross sections.
River: Piney Branch Reach: Main RS: 8620 Profile: StreamStats 2-yr
Warning:The conveyance ratio (upstream conveyance divided by downstream conveyance) is less than 0.7 or greater than 1.4.
This may indicate the need for additional cross sections.
River: Piney Branch Reach: Main RS: 8520 Profile: FEMA 100-yr
Warning:The conveyance ratio (upstream conveyance divided by downstream conveyance) is less than 0.7 or greater than 1.4.
This may indicate the need for additional cross sections.
River: Piney Branch Reach: Main RS: 8520 Profile: FEMA FW

Warning:The conveyance ratio (upstream conveyance divided by downstream conveyance) is less than 0.7 or greater than 1.4.
This may indicate the need for additional cross sections.
River: Piney Branch Reach: Main RS: 8520 Profile: StreamStats 100-
Warning:The velocity head has changed by more than 0.5 ft (0.15 m). This may indicate the need for additional cross sections.
Warning:The conveyance ratio (upstream conveyance divided by downstream conveyance) is less than 0.7 or greater than 1.4.
This may indicate the need for additional cross sections.
River: Piney Branch Reach: Main RS: 8520 Profile: StreamStats 50-y
Warning:The velocity head has changed by more than 0.5 ft (0.15 m). This may indicate the need for additional cross sections.
Warning:The conveyance ratio (upstream conveyance divided by downstream conveyance) is less than 0.7 or greater than 1.4.
This may indicate the need for additional cross sections.
River: Piney Branch Reach: Main RS: 8520 Profile: StreamStats 25-y
Warning:The velocity head has changed by more than 0.5 ft (0.15 m). This may indicate the need for additional cross sections.
Warning:The conveyance ratio (upstream conveyance divided by downstream conveyance) is less than 0.7 or greater than 1.4.
This may indicate the need for additional cross sections.
River: Piney Branch Reach: Main RS: 8520 Profile: StreamStats 10-y
Warning:The conveyance ratio (upstream conveyance divided by downstream conveyance) is less than 0.7 or greater than 1.4.
This may indicate the need for additional cross sections.
River: Piney Branch Reach: Main RS: 8520 Profile: StreamStats 5-yr
Warning:The conveyance ratio (upstream conveyance divided by downstream conveyance) is less than 0.7 or greater than 1.4.
This may indicate the need for additional cross sections.
River: Piney Branch Reach: Main RS: 8520 Profile: StreamStats 2-yr
Warning:The conveyance ratio (upstream conveyance divided by downstream conveyance) is less than 0.7 or greater than 1.4.
This may indicate the need for additional cross sections.
River: Piney Branch Reach: Main RS: 8420 Profile: FEMA 100-yr
Warning:The conveyance ratio (upstream conveyance divided by downstream conveyance) is less than 0.7 or greater than 1.4.
This may indicate the need for additional cross sections.
River: Piney Branch Reach: Main RS: 8420 Profile: FEMA FW
Warning:The conveyance ratio (upstream conveyance divided by downstream conveyance) is less than 0.7 or greater than 1.4.
This may indicate the need for additional cross sections.
River: Piney Branch Reach: Main RS: 8420 Profile: StreamStats 100-
Warning:The conveyance ratio (upstream conveyance divided by downstream conveyance) is less than 0.7 or greater than 1.4.
This may indicate the need for additional cross sections.
River: Piney Branch Reach: Main RS: 8420 Profile: StreamStats 50-y
Warning:The conveyance ratio (upstream conveyance divided by downstream conveyance) is less than 0.7 or greater than 1.4.
This may indicate the need for additional cross sections.
River: Piney Branch Reach: Main RS: 8420 Profile: StreamStats 25-y
Warning:The conveyance ratio (upstream conveyance divided by downstream

conveyance) is less than 0.7 or greater than 1.4.
This may indicate the need for additional cross sections.
River: Piney Branch Reach: Main RS: 8420 Profile: StreamStats 10-y
Warning:The conveyance ratio (upstream conveyance divided by downstream conveyance) is less than 0.7 or greater than 1.4.
This may indicate the need for additional cross sections.
River: Piney Branch Reach: Main RS: 8420 Profile: StreamStats 5-yr
Warning:The conveyance ratio (upstream conveyance divided by downstream conveyance) is less than 0.7 or greater than 1.4.
This may indicate the need for additional cross sections.
River: Piney Branch Reach: Main RS: 8420 Profile: StreamStats 2-yr
Warning:The conveyance ratio (upstream conveyance divided by downstream conveyance) is less than 0.7 or greater than 1.4.
This may indicate the need for additional cross sections.
River: Piney Branch Reach: Main RS: 8220 Profile: FEMA 100-yr
Warning:The velocity head has changed by more than 0.5 ft (0.15 m). This may indicate the need for additional cross sections.
Warning:The conveyance ratio (upstream conveyance divided by downstream conveyance) is less than 0.7 or greater than 1.4.
This may indicate the need for additional cross sections.
River: Piney Branch Reach: Main RS: 8220 Profile: FEMA FW
Warning:The velocity head has changed by more than 0.5 ft (0.15 m). This may indicate the need for additional cross sections.
Warning:The conveyance ratio (upstream conveyance divided by downstream conveyance) is less than 0.7 or greater than 1.4.
This may indicate the need for additional cross sections.
River: Piney Branch Reach: Main RS: 8220 Profile: StreamStats 100-
Warning:The velocity head has changed by more than 0.5 ft (0.15 m). This may indicate the need for additional cross sections.
Warning:The conveyance ratio (upstream conveyance divided by downstream conveyance) is less than 0.7 or greater than 1.4.
This may indicate the need for additional cross sections.
River: Piney Branch Reach: Main RS: 8220 Profile: StreamStats 50-y
Warning:The velocity head has changed by more than 0.5 ft (0.15 m). This may indicate the need for additional cross sections.
Warning:The conveyance ratio (upstream conveyance divided by downstream conveyance) is less than 0.7 or greater than 1.4.
This may indicate the need for additional cross sections.
River: Piney Branch Reach: Main RS: 8220 Profile: StreamStats 25-y
Warning:The velocity head has changed by more than 0.5 ft (0.15 m). This may indicate the need for additional cross sections.
Warning:The conveyance ratio (upstream conveyance divided by downstream conveyance) is less than 0.7 or greater than 1.4.
This may indicate the need for additional cross sections.
River: Piney Branch Reach: Main RS: 8220 Profile: StreamStats 10-y
Warning:The velocity head has changed by more than 0.5 ft (0.15 m). This may indicate the need for additional cross sections.
Warning:The conveyance ratio (upstream conveyance divided by downstream conveyance) is less than 0.7 or greater than 1.4.
This may indicate the need for additional cross sections.
River: Piney Branch Reach: Main RS: 8220 Profile: StreamStats 5-yr

Warning:The velocity head has changed by more than 0.5 ft (0.15 m). This may indicate the need for additional cross sections.
Warning:The conveyance ratio (upstream conveyance divided by downstream conveyance) is less than 0.7 or greater than 1.4.
This may indicate the need for additional cross sections.
River: Piney Branch Reach: Main RS: 8120 Profile: FEMA 100-yr
Warning:The energy equation could not be balanced within the specified number of iterations. The program used critical depth
for the water surface and continued on with the calculations.
Warning:The energy loss was greater than 1.0 ft (0.3 m). between the current and previous cross section. This may indicate
the need for additional cross sections.
Warning:During the standard step iterations, when the assumed water surface was set equal to critical depth, the calculated
water surface came back below critical depth. This indicates that there is not a valid subcritical answer. The
program defaulted to critical depth.
River: Piney Branch Reach: Main RS: 8120 Profile: FEMA FW
Warning:The energy equation could not be balanced within the specified number of iterations. The program used critical depth
for the water surface and continued on with the calculations.
Warning:The velocity head has changed by more than 0.5 ft (0.15 m). This may indicate the need for additional cross sections.
Warning:The cross section had to be extended vertically during the critical depth calculations.
Warning:The energy loss was greater than 1.0 ft (0.3 m). between the current and previous cross section. This may indicate
the need for additional cross sections.
Warning:During the standard step iterations, when the assumed water surface was set equal to critical depth, the calculated
water surface came back below critical depth. This indicates that there is not a valid subcritical answer. The
program defaulted to critical depth.
Warning:The parabolic search method failed to converge on critical depth. The program will try the cross section
slice/secant method to find critical depth.
River: Piney Branch Reach: Main RS: 8120 Profile: StreamStats 100-
Warning:The energy equation could not be balanced within the specified number of iterations. The program used critical depth
for the water surface and continued on with the calculations.
Warning:During the standard step iterations, when the assumed water surface was set equal to critical depth, the calculated
water surface came back below critical depth. This indicates that there is not a valid subcritical answer. The
program defaulted to critical depth.
River: Piney Branch Reach: Main RS: 8120 Profile: StreamStats 50-y
Warning:The energy equation could not be balanced within the specified number of iterations. The program used critical depth
for the water surface and continued on with the calculations.
Warning:During the standard step iterations, when the assumed water surface was set equal to critical depth, the calculated

water surface came back below critical depth. This indicates that there is not a valid subcritical answer. The
program defaulted to critical depth.
River: Piney Branch Reach: Main RS: 8120 Profile: StreamStats 25-y
Warning:The energy equation could not be balanced within the specified number of iterations. The program used critical depth
for the water surface and continued on with the calculations.
Warning:During the standard step iterations, when the assumed water surface was set equal to critical depth, the calculated
water surface came back below critical depth. This indicates that there is not a valid subcritical answer. The
program defaulted to critical depth.
River: Piney Branch Reach: Main RS: 8120 Profile: StreamStats 10-y
Warning:The energy equation could not be balanced within the specified number of iterations. The program used critical depth
for the water surface and continued on with the calculations.
Warning:During the standard step iterations, when the assumed water surface was set equal to critical depth, the calculated
water surface came back below critical depth. This indicates that there is not a valid subcritical answer. The
program defaulted to critical depth.
River: Piney Branch Reach: Main RS: 8020 Profile: FEMA 100-yr
Warning:The energy equation could not be balanced within the specified number of iterations. The program used critical depth
for the water surface and continued on with the calculations.
Warning:During the standard step iterations, when the assumed water surface was set equal to critical depth, the calculated
water surface came back below critical depth. This indicates that there is not a valid subcritical answer. The
program defaulted to critical depth.
River: Piney Branch Reach: Main RS: 8020 Profile: FEMA FW
Warning:The cross section had to be extended vertically during the critical depth calculations.
Warning:The parabolic search method failed to converge on critical depth. The program will try the cross section
slice/secant method to find critical depth.
River: Piney Branch Reach: Main RS: 8020 Profile: StreamStats 100-
Warning:The energy equation could not be balanced within the specified number of iterations. The program used critical depth
for the water surface and continued on with the calculations.
Warning:During the standard step iterations, when the assumed water surface was set equal to critical depth, the calculated
water surface came back below critical depth. This indicates that there is not a valid subcritical answer. The
program defaulted to critical depth.
River: Piney Branch Reach: Main RS: 8020 Profile: StreamStats 50-y
Warning:The energy equation could not be balanced within the specified number of iterations. The program used critical depth
for the water surface and continued on with the calculations.
Warning:During the standard step iterations, when the assumed water surface was set equal to critical depth, the calculated

water surface came back below critical depth. This indicates that there is not a valid subcritical answer. The
program defaulted to critical depth.
River: Piney Branch Reach: Main RS: 8020 Profile: StreamStats 25-y
Warning:The energy equation could not be balanced within the specified number of iterations. The program used critical depth
for the water surface and continued on with the calculations.
Warning:During the standard step iterations, when the assumed water surface was set equal to critical depth, the calculated
water surface came back below critical depth. This indicates that there is not a valid subcritical answer. The
program defaulted to critical depth.
River: Piney Branch Reach: Main RS: 8020 Profile: StreamStats 10-y
Warning:The energy equation could not be balanced within the specified number of iterations. The program used critical depth
for the water surface and continued on with the calculations.
Warning:During the standard step iterations, when the assumed water surface was set equal to critical depth, the calculated
water surface came back below critical depth. This indicates that there is not a valid subcritical answer. The
program defaulted to critical depth.
River: Piney Branch Reach: Main RS: 8020 Profile: StreamStats 2-yr
Warning:The conveyance ratio (upstream conveyance divided by downstream conveyance) is less than 0.7 or greater than 1.4.
This may indicate the need for additional cross sections.
River: Piney Branch Reach: Main RS: 7920 Profile: StreamStats 2-yr
Warning:The conveyance ratio (upstream conveyance divided by downstream conveyance) is less than 0.7 or greater than 1.4.
This may indicate the need for additional cross sections.
River: Piney Branch Reach: Main RS: 7820 Profile: StreamStats 2-yr
Warning:The conveyance ratio (upstream conveyance divided by downstream conveyance) is less than 0.7 or greater than 1.4.
This may indicate the need for additional cross sections.
River: Piney Branch Reach: Main RS: 7720 Profile: StreamStats 10-y
Warning:The conveyance ratio (upstream conveyance divided by downstream conveyance) is less than 0.7 or greater than 1.4.
This may indicate the need for additional cross sections.
River: Piney Branch Reach: Main RS: 7720 Profile: StreamStats 5-yr
Warning:The conveyance ratio (upstream conveyance divided by downstream conveyance) is less than 0.7 or greater than 1.4.
This may indicate the need for additional cross sections.
River: Piney Branch Reach: Main RS: 7720 Profile: StreamStats 2-yr
Warning:The conveyance ratio (upstream conveyance divided by downstream conveyance) is less than 0.7 or greater than 1.4.
This may indicate the need for additional cross sections.
River: Piney Branch Reach: Main RS: 7620 Profile: StreamStats 10-y
Warning:The conveyance ratio (upstream conveyance divided by downstream conveyance) is less than 0.7 or greater than 1.4.
This may indicate the need for additional cross sections.
River: Piney Branch Reach: Main RS: 7620 Profile: StreamStats 5-yr
Warning:The conveyance ratio (upstream conveyance divided by downstream

conveyance) is less than 0.7 or greater than 1.4.
This may indicate the need for additional cross sections.
River: Piney Branch Reach: Main RS: 7620 Profile: StreamStats 2-yr
Warning:The conveyance ratio (upstream conveyance divided by downstream conveyance) is less than 0.7 or greater than 1.4.
This may indicate the need for additional cross sections.
River: Piney Branch Reach: Main RS: 7520 Profile: StreamStats 2-yr
Warning:The conveyance ratio (upstream conveyance divided by downstream conveyance) is less than 0.7 or greater than 1.4.
This may indicate the need for additional cross sections.
River: Piney Branch Reach: Main RS: 7420 Profile: StreamStats 5-yr
Warning:The conveyance ratio (upstream conveyance divided by downstream conveyance) is less than 0.7 or greater than 1.4.
This may indicate the need for additional cross sections.
River: Piney Branch Reach: Main RS: 7420 Profile: StreamStats 2-yr
Warning:The conveyance ratio (upstream conveyance divided by downstream conveyance) is less than 0.7 or greater than 1.4.
This may indicate the need for additional cross sections.
River: Piney Branch Reach: Main RS: 7320 Profile: StreamStats 100-
Warning:The conveyance ratio (upstream conveyance divided by downstream conveyance) is less than 0.7 or greater than 1.4.
This may indicate the need for additional cross sections.
River: Piney Branch Reach: Main RS: 7320 Profile: StreamStats 50-y
Warning:The conveyance ratio (upstream conveyance divided by downstream conveyance) is less than 0.7 or greater than 1.4.
This may indicate the need for additional cross sections.
River: Piney Branch Reach: Main RS: 7320 Profile: StreamStats 25-y
Warning:The conveyance ratio (upstream conveyance divided by downstream conveyance) is less than 0.7 or greater than 1.4.
This may indicate the need for additional cross sections.
River: Piney Branch Reach: Main RS: 7320 Profile: StreamStats 10-y
Warning:The conveyance ratio (upstream conveyance divided by downstream conveyance) is less than 0.7 or greater than 1.4.
This may indicate the need for additional cross sections.
River: Piney Branch Reach: Main RS: 7320 Profile: StreamStats 5-yr
Warning:The conveyance ratio (upstream conveyance divided by downstream conveyance) is less than 0.7 or greater than 1.4.
This may indicate the need for additional cross sections.
River: Piney Branch Reach: Main RS: 7320 Profile: StreamStats 2-yr
Warning:The velocity head has changed by more than 0.5 ft (0.15 m). This may indicate the need for additional cross sections.
Warning:The conveyance ratio (upstream conveyance divided by downstream conveyance) is less than 0.7 or greater than 1.4.
This may indicate the need for additional cross sections.
River: Piney Branch Reach: Main RS: 7220 Profile: FEMA 100-yr
Warning:Divided flow computed for this cross-section.
River: Piney Branch Reach: Main RS: 7220 Profile: StreamStats 100-
Warning:The velocity head has changed by more than 0.5 ft (0.15 m). This may indicate the need for additional cross sections.
River: Piney Branch Reach: Main RS: 7220 Profile: StreamStats 50-y
Warning:The energy equation could not be balanced within the specified number

of iterations. The program used critical depth
for the water surface and continued on with the calculations.
Warning:The velocity head has changed by more than 0.5 ft (0.15 m). This may indicate the need for additional cross sections.
Warning:The conveyance ratio (upstream conveyance divided by downstream conveyance) is less than 0.7 or greater than 1.4.
This may indicate the need for additional cross sections.
Warning:During the standard step iterations, when the assumed water surface was set equal to critical depth, the calculated
water surface came back below critical depth. This indicates that there is not a valid subcritical answer. The
program defaulted to critical depth.
River: Piney Branch Reach: Main RS: 7220 Profile: StreamStats 25-y
Warning:The energy equation could not be balanced within the specified number of iterations. The program used critical depth
for the water surface and continued on with the calculations.
Warning:The velocity head has changed by more than 0.5 ft (0.15 m). This may indicate the need for additional cross sections.
Warning:The conveyance ratio (upstream conveyance divided by downstream conveyance) is less than 0.7 or greater than 1.4.
This may indicate the need for additional cross sections.
Warning:During the standard step iterations, when the assumed water surface was set equal to critical depth, the calculated
water surface came back below critical depth. This indicates that there is not a valid subcritical answer. The
program defaulted to critical depth.
River: Piney Branch Reach: Main RS: 7220 Profile: StreamStats 10-y
Warning:The energy equation could not be balanced within the specified number of iterations. The program used critical depth
for the water surface and continued on with the calculations.
Warning:The velocity head has changed by more than 0.5 ft (0.15 m). This may indicate the need for additional cross sections.
Warning:The conveyance ratio (upstream conveyance divided by downstream conveyance) is less than 0.7 or greater than 1.4.
This may indicate the need for additional cross sections.
Warning:During the standard step iterations, when the assumed water surface was set equal to critical depth, the calculated
water surface came back below critical depth. This indicates that there is not a valid subcritical answer. The
program defaulted to critical depth.
River: Piney Branch Reach: Main RS: 7220 Profile: StreamStats 5-yr
Warning:The energy equation could not be balanced within the specified number of iterations. The program used critical depth
for the water surface and continued on with the calculations.
Warning:The conveyance ratio (upstream conveyance divided by downstream conveyance) is less than 0.7 or greater than 1.4.
This may indicate the need for additional cross sections.
Warning:The energy loss was greater than 1.0 ft (0.3 m). between the current and previous cross section. This may indicate
the need for additional cross sections.
Warning:During the standard step iterations, when the assumed water surface was

set equal to critical depth, the calculated
water surface came back below critical depth. This indicates that there is not a valid subcritical answer. The
program defaulted to critical depth.
River: Piney Branch Reach: Main RS: 7220 Profile: StreamStats 2-yr
Warning:The energy equation could not be balanced within the specified number of iterations. The program used critical depth
for the water surface and continued on with the calculations.
Warning:The velocity head has changed by more than 0.5 ft (0.15 m). This may indicate the need for additional cross sections.
Warning:The conveyance ratio (upstream conveyance divided by downstream conveyance) is less than 0.7 or greater than 1.4.
This may indicate the need for additional cross sections.
Warning:During the standard step iterations, when the assumed water surface was set equal to critical depth, the calculated
water surface came back below critical depth. This indicates that there is not a valid subcritical answer. The
program defaulted to critical depth.
River: Piney Branch Reach: Main RS: 7120 Profile: FEMA 100-yr
Warning:The velocity head has changed by more than 0.5 ft (0.15 m). This may indicate the need for additional cross sections.
River: Piney Branch Reach: Main RS: 7120 Profile: FEMA FW
Warning:The velocity head has changed by more than 0.5 ft (0.15 m). This may indicate the need for additional cross sections.
Warning:The conveyance ratio (upstream conveyance divided by downstream conveyance) is less than 0.7 or greater than 1.4.
This may indicate the need for additional cross sections.
River: Piney Branch Reach: Main RS: 7120 Profile: StreamStats 100-
Warning:The velocity head has changed by more than 0.5 ft (0.15 m). This may indicate the need for additional cross sections.
Warning:The conveyance ratio (upstream conveyance divided by downstream conveyance) is less than 0.7 or greater than 1.4.
This may indicate the need for additional cross sections.
River: Piney Branch Reach: Main RS: 7120 Profile: StreamStats 50-y
Warning:The velocity head has changed by more than 0.5 ft (0.15 m). This may indicate the need for additional cross sections.
Warning:The conveyance ratio (upstream conveyance divided by downstream conveyance) is less than 0.7 or greater than 1.4.
This may indicate the need for additional cross sections.
River: Piney Branch Reach: Main RS: 7120 Profile: StreamStats 25-y
Warning:The velocity head has changed by more than 0.5 ft (0.15 m). This may indicate the need for additional cross sections.
Warning:The conveyance ratio (upstream conveyance divided by downstream conveyance) is less than 0.7 or greater than 1.4.
This may indicate the need for additional cross sections.
River: Piney Branch Reach: Main RS: 7120 Profile: StreamStats 10-y
Warning:The velocity head has changed by more than 0.5 ft (0.15 m). This may indicate the need for additional cross sections.
Warning:The conveyance ratio (upstream conveyance divided by downstream conveyance) is less than 0.7 or greater than 1.4.
This may indicate the need for additional cross sections.

River: Piney Branch Reach: Main   RS: 7120   Profile: StreamStats 5-yr
     Warning:The velocity head has changed by more than 0.5 ft (0.15 m). This may indicate the need for additional cross sections.
     Warning:The conveyance ratio (upstream conveyance divided by downstream conveyance) is less than 0.7 or greater than 1.4.
             This may indicate the need for additional cross sections.
River: Piney Branch Reach: Main   RS: 7120   Profile: StreamStats 2-yr
     Warning:The conveyance ratio (upstream conveyance divided by downstream conveyance) is less than 0.7 or greater than 1.4.
             This may indicate the need for additional cross sections.
River: Piney Branch Reach: Main   RS: 7020   Profile: FEMA 100-yr
     Warning:The velocity head has changed by more than 0.5 ft (0.15 m). This may indicate the need for additional cross sections.
     Warning:The conveyance ratio (upstream conveyance divided by downstream conveyance) is less than 0.7 or greater than 1.4.
             This may indicate the need for additional cross sections.
River: Piney Branch Reach: Main   RS: 7020   Profile: FEMA FW
     Warning:The velocity head has changed by more than 0.5 ft (0.15 m). This may indicate the need for additional cross sections.
     Warning:The conveyance ratio (upstream conveyance divided by downstream conveyance) is less than 0.7 or greater than 1.4.
             This may indicate the need for additional cross sections.
     Warning:The cross section had to be extended vertically during the critical depth calculations.
     Warning:The parabolic search method failed to converge on critical depth. The program will try the cross section
             slice/secant method to find critical depth.
River: Piney Branch Reach: Main   RS: 7020   Profile: StreamStats 100-
     Warning:The velocity head has changed by more than 0.5 ft (0.15 m). This may indicate the need for additional cross sections.
     Warning:The conveyance ratio (upstream conveyance divided by downstream conveyance) is less than 0.7 or greater than 1.4.
             This may indicate the need for additional cross sections.
River: Piney Branch Reach: Main   RS: 7020   Profile: StreamStats 50-y
     Warning:The velocity head has changed by more than 0.5 ft (0.15 m). This may indicate the need for additional cross sections.
     Warning:The conveyance ratio (upstream conveyance divided by downstream conveyance) is less than 0.7 or greater than 1.4.
             This may indicate the need for additional cross sections.
River: Piney Branch Reach: Main   RS: 7020   Profile: StreamStats 25-y
     Warning:The energy equation could not be balanced within the specified number of iterations. The program used critical depth
             for the water surface and continued on with the calculations.
     Warning:The velocity head has changed by more than 0.5 ft (0.15 m). This may indicate the need for additional cross sections.
     Warning:The conveyance ratio (upstream conveyance divided by downstream conveyance) is less than 0.7 or greater than 1.4.
             This may indicate the need for additional cross sections.
     Warning:During the standard step iterations, when the assumed water surface was set equal to critical depth, the calculated
             water surface came back below critical depth. This indicates that

there is not a valid subcritical answer. The
program defaulted to critical depth.
River: Piney Branch Reach: Main RS: 7020 Profile: StreamStats 10-y
Warning:The energy equation could not be balanced within the specified number of iterations. The program used critical depth
for the water surface and continued on with the calculations.
Warning:The velocity head has changed by more than 0.5 ft (0.15 m). This may indicate the need for additional cross sections.
Warning:The conveyance ratio (upstream conveyance divided by downstream conveyance) is less than 0.7 or greater than 1.4.
This may indicate the need for additional cross sections.
Warning:During the standard step iterations, when the assumed water surface was set equal to critical depth, the calculated
water surface came back below critical depth. This indicates that there is not a valid subcritical answer. The
program defaulted to critical depth.
River: Piney Branch Reach: Main RS: 7020 Profile: StreamStats 5-yr
Warning:The energy equation could not be balanced within the specified number of iterations. The program used critical depth
for the water surface and continued on with the calculations.
Warning:The conveyance ratio (upstream conveyance divided by downstream conveyance) is less than 0.7 or greater than 1.4.
This may indicate the need for additional cross sections.
Warning:During the standard step iterations, when the assumed water surface was set equal to critical depth, the calculated
water surface came back below critical depth. This indicates that there is not a valid subcritical answer. The
program defaulted to critical depth.
River: Piney Branch Reach: Main RS: 6920 Profile: StreamStats 100-
Warning:The velocity head has changed by more than 0.5 ft (0.15 m). This may indicate the need for additional cross sections.
Warning:The conveyance ratio (upstream conveyance divided by downstream conveyance) is less than 0.7 or greater than 1.4.
This may indicate the need for additional cross sections.
River: Piney Branch Reach: Main RS: 6920 Profile: StreamStats 50-y
Warning:The velocity head has changed by more than 0.5 ft (0.15 m). This may indicate the need for additional cross sections.
Warning:The conveyance ratio (upstream conveyance divided by downstream conveyance) is less than 0.7 or greater than 1.4.
This may indicate the need for additional cross sections.
River: Piney Branch Reach: Main RS: 6920 Profile: StreamStats 25-y
Warning:The velocity head has changed by more than 0.5 ft (0.15 m). This may indicate the need for additional cross sections.
Warning:The conveyance ratio (upstream conveyance divided by downstream conveyance) is less than 0.7 or greater than 1.4.
This may indicate the need for additional cross sections.
River: Piney Branch Reach: Main RS: 6920 Profile: StreamStats 10-y
Warning:The velocity head has changed by more than 0.5 ft (0.15 m). This may indicate the need for additional cross sections.
Warning:The conveyance ratio (upstream conveyance divided by downstream conveyance) is less than 0.7 or greater than 1.4.

This may indicate the need for additional cross sections.
River: Piney Branch Reach: Main RS: 6920 Profile: StreamStats 5-yr
Warning:The velocity head has changed by more than 0.5 ft (0.15 m). This may indicate the need for additional cross sections.
Warning:The conveyance ratio (upstream conveyance divided by downstream conveyance) is less than 0.7 or greater than 1.4.
This may indicate the need for additional cross sections.
River: Piney Branch Reach: Main RS: 6920 Profile: StreamStats 2-yr
Warning:The velocity head has changed by more than 0.5 ft (0.15 m). This may indicate the need for additional cross sections.
Warning:The conveyance ratio (upstream conveyance divided by downstream conveyance) is less than 0.7 or greater than 1.4.
This may indicate the need for additional cross sections.
River: Piney Branch Reach: Main RS: 6820 Profile: FEMA 100-yr
Warning:The conveyance ratio (upstream conveyance divided by downstream conveyance) is less than 0.7 or greater than 1.4.
This may indicate the need for additional cross sections.
River: Piney Branch Reach: Main RS: 6820 Profile: FEMA FW
Warning:The conveyance ratio (upstream conveyance divided by downstream conveyance) is less than 0.7 or greater than 1.4.
This may indicate the need for additional cross sections.
River: Piney Branch Reach: Main RS: 6820 Profile: StreamStats 100-
Warning:The velocity head has changed by more than 0.5 ft (0.15 m). This may indicate the need for additional cross sections.
Warning:The conveyance ratio (upstream conveyance divided by downstream conveyance) is less than 0.7 or greater than 1.4.
This may indicate the need for additional cross sections.
River: Piney Branch Reach: Main RS: 6820 Profile: StreamStats 50-y
Warning:The energy equation could not be balanced within the specified number of iterations. The program used critical depth
for the water surface and continued on with the calculations.
Warning:The velocity head has changed by more than 0.5 ft (0.15 m). This may indicate the need for additional cross sections.
Warning:The conveyance ratio (upstream conveyance divided by downstream conveyance) is less than 0.7 or greater than 1.4.
This may indicate the need for additional cross sections.
Warning:During the standard step iterations, when the assumed water surface was set equal to critical depth, the calculated
water surface came back below critical depth. This indicates that there is not a valid subcritical answer. The
program defaulted to critical depth.
River: Piney Branch Reach: Main RS: 6820 Profile: StreamStats 25-y
Warning:The energy equation could not be balanced within the specified number of iterations. The program used critical depth
for the water surface and continued on with the calculations.
Warning:The velocity head has changed by more than 0.5 ft (0.15 m). This may indicate the need for additional cross sections.
Warning:The conveyance ratio (upstream conveyance divided by downstream conveyance) is less than 0.7 or greater than 1.4.
This may indicate the need for additional cross sections.
Warning:During the standard step iterations, when the assumed water surface was

set equal to critical depth, the calculated
water surface came back below critical depth. This indicates that there is not a valid subcritical answer. The
program defaulted to critical depth.
River: Piney Branch Reach: Main RS: 6820 Profile: StreamStats 10-y
Warning:The energy equation could not be balanced within the specified number of iterations. The program used critical depth
for the water surface and continued on with the calculations.
Warning:The velocity head has changed by more than 0.5 ft (0.15 m). This may indicate the need for additional cross sections.
Warning:The conveyance ratio (upstream conveyance divided by downstream conveyance) is less than 0.7 or greater than 1.4.
This may indicate the need for additional cross sections.
Warning:During the standard step iterations, when the assumed water surface was set equal to critical depth, the calculated
water surface came back below critical depth. This indicates that there is not a valid subcritical answer. The
program defaulted to critical depth.
River: Piney Branch Reach: Main RS: 6820 Profile: StreamStats 5-yr
Warning:The energy equation could not be balanced within the specified number of iterations. The program used critical depth
for the water surface and continued on with the calculations.
Warning:The velocity head has changed by more than 0.5 ft (0.15 m). This may indicate the need for additional cross sections.
Warning:The conveyance ratio (upstream conveyance divided by downstream conveyance) is less than 0.7 or greater than 1.4.
This may indicate the need for additional cross sections.
Warning:During the standard step iterations, when the assumed water surface was set equal to critical depth, the calculated
water surface came back below critical depth. This indicates that there is not a valid subcritical answer. The
program defaulted to critical depth.
River: Piney Branch Reach: Main RS: 6820 Profile: StreamStats 2-yr
Warning:The energy equation could not be balanced within the specified number of iterations. The program used critical depth
for the water surface and continued on with the calculations.
Warning:The velocity head has changed by more than 0.5 ft (0.15 m). This may indicate the need for additional cross sections.
Warning:The conveyance ratio (upstream conveyance divided by downstream conveyance) is less than 0.7 or greater than 1.4.
This may indicate the need for additional cross sections.
Warning:During the standard step iterations, when the assumed water surface was set equal to critical depth, the calculated
water surface came back below critical depth. This indicates that there is not a valid subcritical answer. The
program defaulted to critical depth.
River: Piney Branch Reach: Main RS: 6720 Profile: FEMA 100-yr
Warning:The conveyance ratio (upstream conveyance divided by downstream conveyance) is less than 0.7 or greater than 1.4.
This may indicate the need for additional cross sections.
River: Piney Branch Reach: Main RS: 6720 Profile: FEMA FW

Warning:The conveyance ratio (upstream conveyance divided by downstream conveyance) is less than 0.7 or greater than 1.4.
This may indicate the need for additional cross sections.
River: Piney Branch Reach: Main RS: 6720 Profile: StreamStats 100-
Warning:The velocity head has changed by more than 0.5 ft (0.15 m). This may indicate the need for additional cross sections.
Warning:The conveyance ratio (upstream conveyance divided by downstream conveyance) is less than 0.7 or greater than 1.4.
This may indicate the need for additional cross sections.
River: Piney Branch Reach: Main RS: 6720 Profile: StreamStats 50-y
Warning:The velocity head has changed by more than 0.5 ft (0.15 m). This may indicate the need for additional cross sections.
Warning:The conveyance ratio (upstream conveyance divided by downstream conveyance) is less than 0.7 or greater than 1.4.
This may indicate the need for additional cross sections.
River: Piney Branch Reach: Main RS: 6720 Profile: StreamStats 25-y
Warning:The conveyance ratio (upstream conveyance divided by downstream conveyance) is less than 0.7 or greater than 1.4.
This may indicate the need for additional cross sections.
River: Piney Branch Reach: Main RS: 6720 Profile: StreamStats 10-y
Warning:The conveyance ratio (upstream conveyance divided by downstream conveyance) is less than 0.7 or greater than 1.4.
This may indicate the need for additional cross sections.
River: Piney Branch Reach: Main RS: 6720 Profile: StreamStats 5-yr
Warning:The conveyance ratio (upstream conveyance divided by downstream conveyance) is less than 0.7 or greater than 1.4.
This may indicate the need for additional cross sections.
River: Piney Branch Reach: Main RS: 6720 Profile: StreamStats 2-yr
Warning:The conveyance ratio (upstream conveyance divided by downstream conveyance) is less than 0.7 or greater than 1.4.
This may indicate the need for additional cross sections.
River: Piney Branch Reach: Main RS: 6620 Profile: StreamStats 10-y
Warning:The conveyance ratio (upstream conveyance divided by downstream conveyance) is less than 0.7 or greater than 1.4.
This may indicate the need for additional cross sections.
River: Piney Branch Reach: Main RS: 6620 Profile: StreamStats 5-yr
Warning:The conveyance ratio (upstream conveyance divided by downstream conveyance) is less than 0.7 or greater than 1.4.
This may indicate the need for additional cross sections.
River: Piney Branch Reach: Main RS: 6620 Profile: StreamStats 2-yr
Warning:The conveyance ratio (upstream conveyance divided by downstream conveyance) is less than 0.7 or greater than 1.4.
This may indicate the need for additional cross sections.
River: Piney Branch Reach: Main RS: 6520 Profile: StreamStats 10-y
Warning:The conveyance ratio (upstream conveyance divided by downstream conveyance) is less than 0.7 or greater than 1.4.
This may indicate the need for additional cross sections.
River: Piney Branch Reach: Main RS: 6520 Profile: StreamStats 5-yr
Warning:The conveyance ratio (upstream conveyance divided by downstream conveyance) is less than 0.7 or greater than 1.4.
This may indicate the need for additional cross sections.

River: Piney Branch Reach: Main   RS: 6420   Profile: FEMA 100-yr
     Warning:The velocity head has changed by more than 0.5 ft (0.15 m). This may indicate the need for additional cross sections.
     Warning:The conveyance ratio (upstream conveyance divided by downstream conveyance) is less than 0.7 or greater than 1.4.
             This may indicate the need for additional cross sections.
River: Piney Branch Reach: Main   RS: 6420   Profile: FEMA FW
     Warning:The conveyance ratio (upstream conveyance divided by downstream conveyance) is less than 0.7 or greater than 1.4.
             This may indicate the need for additional cross sections.
River: Piney Branch Reach: Main   RS: 6420   Profile: StreamStats 100-
     Warning:The velocity head has changed by more than 0.5 ft (0.15 m). This may indicate the need for additional cross sections.
     Warning:The conveyance ratio (upstream conveyance divided by downstream conveyance) is less than 0.7 or greater than 1.4.
             This may indicate the need for additional cross sections.
River: Piney Branch Reach: Main   RS: 6420   Profile: StreamStats 50-y
     Warning:The velocity head has changed by more than 0.5 ft (0.15 m). This may indicate the need for additional cross sections.
     Warning:The conveyance ratio (upstream conveyance divided by downstream conveyance) is less than 0.7 or greater than 1.4.
             This may indicate the need for additional cross sections.
River: Piney Branch Reach: Main   RS: 6420   Profile: StreamStats 25-y
     Warning:The velocity head has changed by more than 0.5 ft (0.15 m). This may indicate the need for additional cross sections.
     Warning:The conveyance ratio (upstream conveyance divided by downstream conveyance) is less than 0.7 or greater than 1.4.
             This may indicate the need for additional cross sections.
River: Piney Branch Reach: Main   RS: 6420   Profile: StreamStats 10-y
     Warning:The energy equation could not be balanced within the specified number of iterations. The program used critical depth
             for the water surface and continued on with the calculations.
     Warning:The conveyance ratio (upstream conveyance divided by downstream conveyance) is less than 0.7 or greater than 1.4.
             This may indicate the need for additional cross sections.
     Warning:During the standard step iterations, when the assumed water surface was set equal to critical depth, the calculated
             water surface came back below critical depth. This indicates that there is not a valid subcritical answer. The
             program defaulted to critical depth.
River: Piney Branch Reach: Main   RS: 6420   Profile: StreamStats 5-yr
     Warning:The velocity head has changed by more than 0.5 ft (0.15 m). This may indicate the need for additional cross sections.
     Warning:The conveyance ratio (upstream conveyance divided by downstream conveyance) is less than 0.7 or greater than 1.4.
             This may indicate the need for additional cross sections.
River: Piney Branch Reach: Main   RS: 6420   Profile: StreamStats 2-yr
     Warning:The conveyance ratio (upstream conveyance divided by downstream conveyance) is less than 0.7 or greater than 1.4.
             This may indicate the need for additional cross sections.
River: Piney Branch Reach: Main   RS: 6220   Profile: FEMA 100-yr

Warning:The velocity head has changed by more than 0.5 ft (0.15 m). This may indicate the need for additional cross sections.
Warning:The conveyance ratio (upstream conveyance divided by downstream conveyance) is less than 0.7 or greater than 1.4.
This may indicate the need for additional cross sections.
River: Piney Branch Reach: Main RS: 6220 Profile: FEMA FW
Warning:The velocity head has changed by more than 0.5 ft (0.15 m). This may indicate the need for additional cross sections.
Warning:The conveyance ratio (upstream conveyance divided by downstream conveyance) is less than 0.7 or greater than 1.4.
This may indicate the need for additional cross sections.
River: Piney Branch Reach: Main RS: 6220 Profile: StreamStats 100-
Warning:The velocity head has changed by more than 0.5 ft (0.15 m). This may indicate the need for additional cross sections.
Warning:The conveyance ratio (upstream conveyance divided by downstream conveyance) is less than 0.7 or greater than 1.4.
This may indicate the need for additional cross sections.
River: Piney Branch Reach: Main RS: 6220 Profile: StreamStats 50-y
Warning:The conveyance ratio (upstream conveyance divided by downstream conveyance) is less than 0.7 or greater than 1.4.
This may indicate the need for additional cross sections.
River: Piney Branch Reach: Main RS: 6220 Profile: StreamStats 25-y
Warning:The conveyance ratio (upstream conveyance divided by downstream conveyance) is less than 0.7 or greater than 1.4.
This may indicate the need for additional cross sections.
River: Piney Branch Reach: Main RS: 6220 Profile: StreamStats 10-y
Warning:The conveyance ratio (upstream conveyance divided by downstream conveyance) is less than 0.7 or greater than 1.4.
This may indicate the need for additional cross sections.
River: Piney Branch Reach: Main RS: 6220 Profile: StreamStats 5-yr
Warning:The conveyance ratio (upstream conveyance divided by downstream conveyance) is less than 0.7 or greater than 1.4.
This may indicate the need for additional cross sections.
River: Piney Branch Reach: Main RS: 6220 Profile: StreamStats 2-yr
Warning:The conveyance ratio (upstream conveyance divided by downstream conveyance) is less than 0.7 or greater than 1.4.
This may indicate the need for additional cross sections.
River: Piney Branch Reach: Main RS: 6120 Profile: StreamStats 10-y
Warning:The conveyance ratio (upstream conveyance divided by downstream conveyance) is less than 0.7 or greater than 1.4.
This may indicate the need for additional cross sections.
River: Piney Branch Reach: Main RS: 6120 Profile: StreamStats 5-yr
Warning:The conveyance ratio (upstream conveyance divided by downstream conveyance) is less than 0.7 or greater than 1.4.
This may indicate the need for additional cross sections.
River: Piney Branch Reach: Main RS: 6120 Profile: StreamStats 2-yr
Warning:The conveyance ratio (upstream conveyance divided by downstream conveyance) is less than 0.7 or greater than 1.4.
This may indicate the need for additional cross sections.
River: Piney Branch Reach: Main RS: 6020 Profile: FEMA 100-yr
Note: Multiple critical depths were found at this location. The critical

depth with the lowest, valid, water surface was
used.
River: Piney Branch Reach: Main RS: 6020 Profile: FEMA FW
Note: Multiple critical depths were found at this location. The critical depth with the lowest, valid, water surface was
used.
River: Piney Branch Reach: Main RS: 6020 Profile: StreamStats 100-
Note: Multiple critical depths were found at this location. The critical depth with the lowest, valid, water surface was
used.
River: Piney Branch Reach: Main RS: 6020 Profile: StreamStats 50-y
Note: Multiple critical depths were found at this location. The critical depth with the lowest, valid, water surface was
used.
River: Piney Branch Reach: Main RS: 6020 Profile: StreamStats 25-y
Note: Multiple critical depths were found at this location. The critical depth with the lowest, valid, water surface was
used.
River: Piney Branch Reach: Main RS: 6020 Profile: StreamStats 10-y
Note: Multiple critical depths were found at this location. The critical depth with the lowest, valid, water surface was
used.
River: Piney Branch Reach: Main RS: 6020 Profile: StreamStats 5-yr
Note: Multiple critical depths were found at this location. The critical depth with the lowest, valid, water surface was
used.
River: Piney Branch Reach: Main RS: 6020 Profile: StreamStats 2-yr
Note: Multiple critical depths were found at this location. The critical depth with the lowest, valid, water surface was
used.
River: Piney Branch Reach: Main RS: 5970 Profile: FEMA 100-yr
Warning:The Yarnell method gave an invalid answer. The upstream energy was less than the downstream energy. The program
defaulted to the next valid (user selected) method. If the Yarnell method was the only one selected, the program
will default to an energy based solution.
Warning:For the final momentum answer at the bridge, the upstream energy was computed lower than the downstream energy. This
is not physically possible, the momentum answer has been disregarded.
River: Piney Branch Reach: Main RS: 5970 Profile: FEMA 100-yr Upstream
Note: Multiple critical depths were found at this location. The critical depth with the lowest, valid, water surface was
used.
River: Piney Branch Reach: Main RS: 5970 Profile: FEMA 100-yr Downstream
Note: Multiple critical depths were found at this location. The critical depth with the lowest, valid, water surface was
used.
River: Piney Branch Reach: Main RS: 5970 Profile: FEMA FW
Warning:Momentum balance could not converge within 100 trials during bridge computations. The program used the trial with
the minimum error.

Warning:For the final momentum answer at the bridge, the upstream energy was computed lower than the downstream energy. This is not physically possible, the momentum answer has been disregarded.
River: Piney Branch Reach: Main RS: 5970 Profile: FEMA FW Upstream
Warning:The velocity head has changed by more than 0.5 ft (0.15 m). This may indicate the need for additional cross sections.
Note: Multiple critical depths were found at this location. The critical depth with the lowest, valid, water surface was used.
River: Piney Branch Reach: Main RS: 5970 Profile: FEMA FW Downstream
Note: Multiple critical depths were found at this location. The critical depth with the lowest, valid, water surface was used.
River: Piney Branch Reach: Main RS: 5970 Profile: StreamStats 100-
Warning:The Yarnell method gave an invalid answer. The upstream energy was less than the downstream energy. The program defaulted to the next valid (user selected) method. If the Yarnell method was the only one selected, the program will default to an energy based solution.
Warning:For the final momentum answer at the bridge, the upstream energy was computed lower than the downstream energy. This is not physically possible, the momentum answer has been disregarded.
River: Piney Branch Reach: Main RS: 5970 Profile: StreamStats 100- Upstream
Note: Multiple critical depths were found at this location. The critical depth with the lowest, valid, water surface was used.
River: Piney Branch Reach: Main RS: 5970 Profile: StreamStats 100- Downstream
Note: Multiple critical depths were found at this location. The critical depth with the lowest, valid, water surface was used.
River: Piney Branch Reach: Main RS: 5970 Profile: StreamStats 50-y
Warning:The Yarnell method gave an invalid answer. The upstream energy was less than the downstream energy. The program defaulted to the next valid (user selected) method. If the Yarnell method was the only one selected, the program will default to an energy based solution.
Warning:For the final momentum answer at the bridge, the upstream energy was computed lower than the downstream energy. This is not physically possible, the momentum answer has been disregarded.
River: Piney Branch Reach: Main RS: 5970 Profile: StreamStats 50-y Upstream
Note: Multiple critical depths were found at this location. The critical depth with the lowest, valid, water surface was used.
River: Piney Branch Reach: Main RS: 5970 Profile: StreamStats 50-y Downstream
Warning:The velocity head has changed by more than 0.5 ft (0.15 m). This may indicate the need for additional cross sections.
Note: Multiple critical depths were found at this location. The critical depth with the lowest, valid, water surface was used.

River: Piney Branch Reach: Main   RS: 5970   Profile: StreamStats 25-y
     Warning:The Yarnell method gave an invalid answer. The upstream energy was less than the downstream energy. The program
             defaulted to the next valid (user selected) method. If the Yarnell method was the only one selected, the program
             will default to an energy based solution.
River: Piney Branch Reach: Main   RS: 5970   Profile: StreamStats 25-y Upstream
     Warning:The conveyance ratio (upstream conveyance divided by downstream conveyance) is less than 0.7 or greater than 1.4.
             This may indicate the need for additional cross sections.
     Note: Multiple critical depths were found at this location. The critical depth with the lowest, valid, water surface was
             used.
River: Piney Branch Reach: Main   RS: 5970   Profile: StreamStats 25-y Downstream
     Note: Multiple critical depths were found at this location. The critical depth with the lowest, valid, water surface was
             used.
River: Piney Branch Reach: Main   RS: 5970   Profile: StreamStats 10-y Upstream
     Warning:The conveyance ratio (upstream conveyance divided by downstream conveyance) is less than 0.7 or greater than 1.4.
             This may indicate the need for additional cross sections.
     Note: Multiple critical depths were found at this location. The critical depth with the lowest, valid, water surface was
             used.
River: Piney Branch Reach: Main   RS: 5970   Profile: StreamStats 10-y Downstream
     Warning:The conveyance ratio (upstream conveyance divided by downstream conveyance) is less than 0.7 or greater than 1.4.
             This may indicate the need for additional cross sections.
     Note: Multiple critical depths were found at this location. The critical depth with the lowest, valid, water surface was
             used.
River: Piney Branch Reach: Main   RS: 5970   Profile: StreamStats 5-yr
     Warning:The water surface upstream of the bridge computed by the Yarnell method was below critical depth. The Yarnell
             solution has been disregarded.
     Note: Yarnell answer is not valid if the water surface is above the low chord or if there is weir flow. The Yarnell answer
             has been disregarded.
River: Piney Branch Reach: Main   RS: 5970   Profile: StreamStats 5-yr Upstream
     Warning:The conveyance ratio (upstream conveyance divided by downstream conveyance) is less than 0.7 or greater than 1.4.
             This may indicate the need for additional cross sections.
     Note: Multiple critical depths were found at this location. The critical depth with the lowest, valid, water surface was
             used.
River: Piney Branch Reach: Main   RS: 5970   Profile: StreamStats 5-yr Downstream
     Warning:The conveyance ratio (upstream conveyance divided by downstream conveyance) is less than 0.7 or greater than 1.4.

This may indicate the need for additional cross sections.
Note: Multiple critical depths were found at this location. The critical depth with the lowest, valid, water surface was used.
River: Piney Branch Reach: Main RS: 5970 Profile: StreamStats 2-yr
Warning:The flow regime calculated by the momentum equation shows class B flow. For the best solution, this profile should be run as a mixed flow problem.
Warning:The water surface upstream of the bridge computed by the Yarnell method was below critical depth. The Yarnell solution has been disregarded.
Note: Yarnell answer is not valid if the water surface is above the low chord or if there is weir flow. The Yarnell answer has been disregarded.
River: Piney Branch Reach: Main RS: 5970 Profile: StreamStats 2-yr Upstream
Warning:The conveyance ratio (upstream conveyance divided by downstream conveyance) is less than 0.7 or greater than 1.4. This may indicate the need for additional cross sections.
Note: Multiple critical depths were found at this location. The critical depth with the lowest, valid, water surface was used.
River: Piney Branch Reach: Main RS: 5970 Profile: StreamStats 2-yr Downstream
Warning:The conveyance ratio (upstream conveyance divided by downstream conveyance) is less than 0.7 or greater than 1.4. This may indicate the need for additional cross sections.
Note: Multiple critical depths were found at this location. The critical depth with the lowest, valid, water surface was used.
River: Piney Branch Reach: Main RS: 5881 Profile: FEMA 100-yr
Note: Multiple critical depths were found at this location. The critical depth with the lowest, valid, water surface was used.
River: Piney Branch Reach: Main RS: 5881 Profile: FEMA FW
Warning:The velocity head has changed by more than 0.5 ft (0.15 m). This may indicate the need for additional cross sections.
Warning:The conveyance ratio (upstream conveyance divided by downstream conveyance) is less than 0.7 or greater than 1.4. This may indicate the need for additional cross sections.
Note: Multiple critical depths were found at this location. The critical depth with the lowest, valid, water surface was used.
River: Piney Branch Reach: Main RS: 5881 Profile: StreamStats 100-
Note: Multiple critical depths were found at this location. The critical depth with the lowest, valid, water surface was used.
River: Piney Branch Reach: Main RS: 5881 Profile: StreamStats 50-y
Note: Multiple critical depths were found at this location. The critical depth with the lowest, valid, water surface was used.
River: Piney Branch Reach: Main RS: 5881 Profile: StreamStats 25-y

Warning:Divided flow computed for this cross-section.
Note: Multiple critical depths were found at this location. The critical depth with the lowest, valid, water surface was used.
River: Piney Branch Reach: Main RS: 5881 Profile: StreamStats 10-y
Note: Multiple critical depths were found at this location. The critical depth with the lowest, valid, water surface was used.
River: Piney Branch Reach: Main RS: 5881 Profile: StreamStats 5-yr
Note: Multiple critical depths were found at this location. The critical depth with the lowest, valid, water surface was used.
River: Piney Branch Reach: Main RS: 5881 Profile: StreamStats 2-yr
Note: Multiple critical depths were found at this location. The critical depth with the lowest, valid, water surface was used.
River: Piney Branch Reach: Main RS: 5820 Profile: FEMA FW
Note: Multiple critical depths were found at this location. The critical depth with the lowest, valid, energy was used.
River: Piney Branch Reach: Main RS: 5820 Profile: StreamStats 50-y
Warning:The conveyance ratio (upstream conveyance divided by downstream conveyance) is less than 0.7 or greater than 1.4. This may indicate the need for additional cross sections.
River: Piney Branch Reach: Main RS: 5820 Profile: StreamStats 25-y
Warning:The conveyance ratio (upstream conveyance divided by downstream conveyance) is less than 0.7 or greater than 1.4. This may indicate the need for additional cross sections.
River: Piney Branch Reach: Main RS: 5820 Profile: StreamStats 10-y
Warning:The conveyance ratio (upstream conveyance divided by downstream conveyance) is less than 0.7 or greater than 1.4. This may indicate the need for additional cross sections.
Note: Multiple critical depths were found at this location. The critical depth with the lowest, valid, energy was used.
River: Piney Branch Reach: Main RS: 5820 Profile: StreamStats 5-yr
Warning:The conveyance ratio (upstream conveyance divided by downstream conveyance) is less than 0.7 or greater than 1.4. This may indicate the need for additional cross sections.
River: Piney Branch Reach: Main RS: 5820 Profile: StreamStats 2-yr
Note: Multiple critical depths were found at this location. The critical depth with the lowest, valid, energy was used.
River: Piney Branch Reach: Main RS: 5720 Profile: StreamStats 2-yr
Warning:The conveyance ratio (upstream conveyance divided by downstream conveyance) is less than 0.7 or greater than 1.4. This may indicate the need for additional cross sections.
River: Piney Branch Reach: Main RS: 5620 Profile: StreamStats 5-yr
Warning:The conveyance ratio (upstream conveyance divided by downstream conveyance) is less than 0.7 or greater than 1.4. This may indicate the need for additional cross sections.
River: Piney Branch Reach: Main RS: 5620 Profile: StreamStats 2-yr
Warning:The conveyance ratio (upstream conveyance divided by downstream conveyance) is less than 0.7 or greater than 1.4.

This may indicate the need for additional cross sections.
River: Piney Branch Reach: Main RS: 5520 Profile: FEMA FW
Warning:The cross section had to be extended vertically during the critical depth calculations.
Warning:The parabolic search method failed to converge on critical depth. The program will try the cross section
slice/secant method to find critical depth.

APPENDIX E

HEC-RAS Standard Tables

HEC-RAS River: Piney Branch Reach: Main

Reach	River Sta	Profile	Plan	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl
				(cfs)	(ft)	(ft)	(ft)	(ft)	(ft/ft)	(ft/s)	(sq ft)	(ft)	
Main	8920	FEMA 100-yr	EX	4641.00	243.50	251.27		251.91	0.001654	7.37	1380.21	370.61	0.49
Main	8920	FEMA 100-yr	PR	4641.00	243.50	251.27		251.91	0.001654	7.37	1380.21	370.61	0.49
Main	8920	StreamStats 100-	EX	2670.00	243.50	249.58		250.05	0.001611	6.05	833.80	278.13	0.46
Main	8920	StreamStats 100-	PR	2670.00	243.50	249.58		250.05	0.001611	6.05	833.80	278.13	0.46
Main	8920	StreamStats 50-y	EX	1840.00	243.50	248.64		249.01	0.001601	5.30	594.33	230.13	0.45
Main	8920	StreamStats 50-y	PR	1840.00	243.50	248.64		249.01	0.001601	5.30	594.33	230.13	0.45
Main	8920	StreamStats 25-y	EX	1260.00	243.50	247.85		248.14	0.001561	4.58	428.58	191.57	0.43
Main	8920	StreamStats 25-y	PR	1260.00	243.50	247.85		248.14	0.001561	4.58	428.58	191.57	0.43
Main	8920	StreamStats 10-y	EX	698.00	243.50	246.85		247.05	0.001573	3.70	257.19	151.54	0.41
Main	8920	StreamStats 10-y	PR	698.00	243.50	246.85		247.05	0.001573	3.70	257.19	151.54	0.41
Main	8920	StreamStats 5-yr	EX	412.00	243.50	246.18		246.32	0.001604	3.05	164.32	124.59	0.39
Main	8920	StreamStats 5-yr	PR	412.00	243.50	246.18		246.32	0.001604	3.05	164.32	124.59	0.39
Main	8920	StreamStats 2-yr	EX	166.00	243.50	245.38		245.46	0.001666	2.17	79.62	86.92	0.36
Main	8920	StreamStats 2-yr	PR	166.00	243.50	245.38		245.46	0.001666	2.17	79.62	86.92	0.36
Main	8820	FEMA 100-yr	EX	4641.00	243.00	249.92	249.65	251.54	0.005064	11.42	853.88	293.63	0.83
Main	8820	FEMA 100-yr	PR	4641.00	243.00	249.92	249.65	251.54	0.005064	11.42	853.88	293.63	0.83
Main	8820	StreamStats 100-	EX	2670.00	243.00	248.49	248.11	249.70	0.005096	9.50	491.32	210.76	0.80
Main	8820	StreamStats 100-	PR	2670.00	243.00	248.49	248.11	249.70	0.005096	9.50	491.32	210.76	0.80
Main	8820	StreamStats 50-y	EX	1840.00	243.00	247.78	247.32	248.70	0.004647	8.08	357.31	172.64	0.74
Main	8820	StreamStats 50-y	PR	1840.00	243.00	247.78	247.32	248.70	0.004647	8.08	357.31	172.64	0.74
Main	8820	StreamStats 25-y	EX	1260.00	243.00	247.18	246.61	247.85	0.004217	6.84	261.19	144.26	0.68
Main	8820	StreamStats 25-y	PR	1260.00	243.00	247.18	246.61	247.85	0.004217	6.84	261.19	144.26	0.68
Main	8820	StreamStats 10-y	EX	698.00	243.00	246.35		246.79	0.003906	5.36	158.11	105.67	0.62
Main	8820	StreamStats 10-y	PR	698.00	243.00	246.35		246.79	0.003906	5.36	158.11	105.67	0.62
Main	8820	StreamStats 5-yr	EX	412.00	243.00	245.78		246.07	0.003665	4.29	105.27	81.79	0.58
Main	8820	StreamStats 5-yr	PR	412.00	243.00	245.78		246.07	0.003665	4.29	105.27	81.79	0.58
Main	8820	StreamStats 2-yr	EX	166.00	243.00	245.06		245.20	0.003712	3.01	55.19	57.15	0.53
Main	8820	StreamStats 2-yr	PR	166.00	243.00	245.06		245.20	0.003712	3.01	55.19	57.15	0.53
Main	8720	FEMA 100-yr	EX	4641.00	242.50	249.45	249.09	251.01	0.004999	11.36	875.38	286.27	0.83
Main	8720	FEMA 100-yr	PR	4641.00	242.50	249.45	249.09	251.01	0.004999	11.36	875.38	286.27	0.83
Main	8720	StreamStats 100-	EX	2670.00	242.50	247.77	247.62	249.11	0.006187	10.09	469.40	198.43	0.87
Main	8720	StreamStats 100-	PR	2670.00	242.50	247.77	247.62	249.11	0.006187	10.09	469.40	198.43	0.87
Main	8720	StreamStats 50-y	EX	1840.00	242.50	246.91	246.84	248.09	0.007028	9.22	314.17	162.85	0.89
Main	8720	StreamStats 50-y	PR	1840.00	242.50	246.91	246.84	248.09	0.007028	9.22	314.17	162.85	0.89
Main	8720	StreamStats 25-y	EX	1260.00	242.50	246.17	246.17	247.22	0.008383	8.52	204.85	132.17	0.93
Main	8720	StreamStats 25-y	PR	1260.00	242.50	246.17	246.17	247.22	0.008383	8.52	204.85	132.17	0.93
Main	8720	StreamStats 10-y	EX	698.00	242.50	245.35	245.35	246.14	0.009985	7.22	111.98	94.14	0.96
Main	8720	StreamStats 10-y	PR	698.00	242.50	245.35	245.35	246.14	0.009985	7.22	111.98	94.14	0.96
Main	8720	StreamStats 5-yr	EX	412.00	242.50	244.82	244.82	245.41	0.011932	6.21	68.54	68.62	0.98
Main	8720	StreamStats 5-yr	PR	412.00	242.50	244.82	244.82	245.41	0.011932	6.21	68.54	68.62	0.98
Main	8720	StreamStats 2-yr	EX	166.00	242.50	244.02	244.02	244.52	0.013222	5.66	29.31	29.30	1.00

HEC-RAS River: Piney Branch Reach: Main (Continued)

Reach	River Sta	Profile	Plan	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl
				(cfs)	(ft)	(ft)	(ft)	(ft)	(ft/ft)	(ft/s)	(sq ft)	(ft)	
Main	8720	StreamStats 2-yr	PR	166.00	242.50	244.02	244.02	244.52	0.013222	5.66	29.31	29.30	1.00
Main	8620	FEMA 100-yr	EX	4641.00	240.50	248.73	248.73	250.47	0.005027	12.55	996.80	354.05	0.84
Main	8620	FEMA 100-yr	PR	4641.00	240.50	248.73	248.73	250.47	0.005027	12.55	996.80	354.05	0.84
Main	8620	StreamStats 100-	EX	2670.00	240.50	247.15	247.02	248.54	0.005008	10.54	546.73	229.46	0.80
Main	8620	StreamStats 100-	PR	2670.00	240.50	247.15	247.02	248.54	0.005008	10.54	546.73	229.46	0.80
Main	8620	StreamStats 50-y	EX	1840.00	240.50	246.35	246.12	247.49	0.004748	9.22	377.65	194.19	0.76
Main	8620	StreamStats 50-y	PR	1840.00	240.50	246.35	246.12	247.49	0.004748	9.22	377.65	194.19	0.76
Main	8620	StreamStats 25-y	EX	1260.00	240.50	245.56	245.22	246.53	0.004835	8.20	240.37	150.62	0.74
Main	8620	StreamStats 25-y	PR	1260.00	240.50	245.56	245.22	246.53	0.004835	8.20	240.37	150.62	0.74
Main	8620	StreamStats 10-y	EX	698.00	240.50	244.53	243.98	245.21	0.004903	6.67	119.01	84.21	0.71
Main	8620	StreamStats 10-y	PR	698.00	240.50	244.53	243.98	245.21	0.004903	6.67	119.01	84.21	0.71
Main	8620	StreamStats 5-yr	EX	412.00	240.50	243.65		244.18	0.005569	5.82	70.83	34.95	0.72
Main	8620	StreamStats 5-yr	PR	412.00	240.50	243.65		244.18	0.005569	5.82	70.83	34.95	0.72
Main	8620	StreamStats 2-yr	EX	166.00	240.50	242.35		242.77	0.007914	5.17	32.08	24.65	0.80
Main	8620	StreamStats 2-yr	PR	166.00	240.50	242.35		242.77	0.007914	5.17	32.08	24.65	0.80
Main	8520	FEMA 100-yr	EX	4641.00	239.50	248.92		249.72	0.002499	10.23	1601.79	411.78	0.61
Main	8520	FEMA 100-yr	PR	4641.00	239.50	248.92		249.72	0.002499	10.23	1601.81	411.78	0.61
Main	8520	StreamStats 100-	EX	2670.00	239.50	247.06		247.98	0.003108	9.71	880.24	344.44	0.66
Main	8520	StreamStats 100-	PR	2670.00	239.50	247.06		247.98	0.003108	9.71	880.24	344.44	0.66
Main	8520	StreamStats 50-y	EX	1840.00	239.50	246.03	245.60	247.01	0.003538	9.29	555.05	285.54	0.68
Main	8520	StreamStats 50-y	PR	1840.00	239.50	246.03	245.60	247.01	0.003538	9.29	555.05	285.54	0.68
Main	8520	StreamStats 25-y	EX	1260.00	239.50	245.29	244.59	246.07	0.003126	7.96	376.56	209.37	0.63
Main	8520	StreamStats 25-y	PR	1260.00	239.50	245.29	244.59	246.07	0.003126	7.96	376.56	209.37	0.63
Main	8520	StreamStats 10-y	EX	698.00	239.50	244.30		244.81	0.002454	6.10	208.90	129.34	0.53
Main	8520	StreamStats 10-y	PR	698.00	239.50	244.30		244.81	0.002454	6.10	208.90	129.34	0.53
Main	8520	StreamStats 5-yr	EX	412.00	239.50	243.42		243.78	0.002205	4.91	119.87	82.16	0.49
Main	8520	StreamStats 5-yr	PR	412.00	239.50	243.42		243.78	0.002205	4.91	119.87	82.16	0.49
Main	8520	StreamStats 2-yr	EX	166.00	239.50	242.04		242.25	0.002699	3.71	44.76	26.57	0.49
Main	8520	StreamStats 2-yr	PR	166.00	239.50	242.04		242.25	0.002699	3.71	44.76	26.57	0.49
Main	8420	FEMA 100-yr	EX	4641.00	239.30	249.07		249.47	0.000808	6.00	1831.60	372.91	0.36
Main	8420	FEMA 100-yr	PR	4641.00	239.30	249.07		249.47	0.000808	6.00	1831.62	372.91	0.36
Main	8420	StreamStats 100-	EX	2670.00	239.30	247.40		247.66	0.000640	4.64	1245.21	327.80	0.31
Main	8420	StreamStats 100-	PR	2670.00	239.30	247.40		247.66	0.000640	4.64	1245.21	327.80	0.31
Main	8420	StreamStats 50-y	EX	1840.00	239.30	246.47		246.66	0.000540	3.89	951.98	299.76	0.27
Main	8420	StreamStats 50-y	PR	1840.00	239.30	246.47		246.66	0.000540	3.89	951.98	299.76	0.27
Main	8420	StreamStats 25-y	EX	1260.00	239.30	245.64		245.78	0.000449	3.23	717.12	263.92	0.24
Main	8420	StreamStats 25-y	PR	1260.00	239.30	245.64		245.78	0.000449	3.23	717.12	263.92	0.24
Main	8420	StreamStats 10-y	EX	698.00	239.30	244.52		244.60	0.000336	2.39	459.75	195.25	0.20
Main	8420	StreamStats 10-y	PR	698.00	239.30	244.52		244.60	0.000336	2.39	459.75	195.25	0.20
Main	8420	StreamStats 5-yr	EX	412.00	239.30	243.57		243.62	0.000294	1.90	298.61	148.21	0.18

HEC-RAS River: Piney Branch Reach: Main (Continued)

Reach	River Sta	Profile	Plan	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl
				(cfs)	(ft)	(ft)	(ft)	(ft)	(ft/ft)	(ft/s)	(sq ft)	(ft)	
Main	8420	StreamStats 5-yr	PR	412.00	239.30	243.57		243.62	0.000294	1.90	298.61	148.21	0.18
Main	8420	StreamStats 2-yr	EX	166.00	239.30	242.09		242.12	0.000376	1.46	116.93	96.89	0.19
Main	8420	StreamStats 2-yr	PR	166.00	239.30	242.09		242.12	0.000376	1.46	116.93	96.89	0.19
Main	8320	FEMA 100-yr	EX	4641.00	239.10	248.69		249.32	0.002222	9.59	1652.27	354.89	0.57
Main	8320	FEMA 100-yr	PR	4641.00	239.10	248.69		249.32	0.002222	9.59	1652.29	354.89	0.57
Main	8320	StreamStats 100-	EX	2670.00	239.10	247.04		247.53	0.002014	7.94	1098.74	308.65	0.52
Main	8320	StreamStats 100-	PR	2670.00	239.10	247.04		247.53	0.002014	7.94	1098.74	308.65	0.52
Main	8320	StreamStats 50-y	EX	1840.00	239.10	246.14		246.55	0.001831	6.92	833.99	278.17	0.49
Main	8320	StreamStats 50-y	PR	1840.00	239.10	246.14		246.55	0.001831	6.92	833.99	278.17	0.49
Main	8320	StreamStats 25-y	EX	1260.00	239.10	245.33		245.68	0.001705	6.09	619.85	253.99	0.46
Main	8320	StreamStats 25-y	PR	1260.00	239.10	245.33		245.68	0.001705	6.09	619.85	253.99	0.46
Main	8320	StreamStats 10-y	EX	698.00	239.10	244.20		244.51	0.001728	5.24	351.08	220.87	0.45
Main	8320	StreamStats 10-y	PR	698.00	239.10	244.20		244.51	0.001728	5.24	351.08	220.87	0.45
Main	8320	StreamStats 5-yr	EX	412.00	239.10	243.23		243.53	0.001984	4.73	170.77	147.88	0.46
Main	8320	StreamStats 5-yr	PR	412.00	239.10	243.23		243.53	0.001984	4.73	170.77	147.88	0.46
Main	8320	StreamStats 2-yr	EX	166.00	239.10	241.78		242.02	0.002684	3.88	42.83	21.91	0.49
Main	8320	StreamStats 2-yr	PR	166.00	239.10	241.78		242.02	0.002684	3.88	42.83	21.91	0.49
Main	8220	FEMA 100-yr	EX	4641.00	238.90	248.36		249.04	0.002846	11.39	1597.51	339.39	0.66
Main	8220	FEMA 100-yr	PR	4641.00	238.90	248.36		249.04	0.002846	11.39	1597.52	339.39	0.66
Main	8220	StreamStats 100-	EX	2670.00	238.90	246.74		247.28	0.002512	9.42	1084.21	293.48	0.60
Main	8220	StreamStats 100-	PR	2670.00	238.90	246.74		247.28	0.002512	9.42	1084.21	293.48	0.60
Main	8220	StreamStats 50-y	EX	1840.00	238.90	245.87		246.32	0.002238	8.20	839.58	266.60	0.56
Main	8220	StreamStats 50-y	PR	1840.00	238.90	245.87		246.32	0.002238	8.20	839.58	266.60	0.56
Main	8220	StreamStats 25-y	EX	1260.00	238.90	245.11		245.48	0.001953	7.07	646.38	241.21	0.51
Main	8220	StreamStats 25-y	PR	1260.00	238.90	245.11		245.48	0.001953	7.07	646.38	241.21	0.51
Main	8220	StreamStats 10-y	EX	698.00	238.90	244.01		244.32	0.001752	5.86	402.57	204.73	0.47
Main	8220	StreamStats 10-y	PR	698.00	238.90	244.01		244.32	0.001752	5.86	402.57	204.73	0.47
Main	8220	StreamStats 5-yr	EX	412.00	238.90	242.99		243.31	0.002038	5.41	216.79	157.47	0.48
Main	8220	StreamStats 5-yr	PR	412.00	238.90	242.99		243.31	0.002038	5.41	216.79	157.47	0.48
Main	8220	StreamStats 2-yr	EX	166.00	238.90	241.51		241.74	0.002348	4.22	64.19	38.41	0.48
Main	8220	StreamStats 2-yr	PR	166.00	238.90	241.51		241.74	0.002348	4.22	64.19	38.41	0.48
Main	8120	FEMA 100-yr	EX	4641.00	238.70	246.72	246.72	248.45	0.006796	15.69	1073.93	294.98	0.99
Main	8120	FEMA 100-yr	PR	4641.00	238.70	246.72	246.72	248.45	0.006796	15.69	1073.91	294.97	0.99
Main	8120	StreamStats 100-	EX	2670.00	238.70	245.46	245.46	246.78	0.005664	12.74	726.25	256.85	0.88
Main	8120	StreamStats 100-	PR	2670.00	238.70	245.46	245.46	246.78	0.005664	12.74	726.25	256.85	0.88
Main	8120	StreamStats 50-y	EX	1840.00	238.70	244.75	244.75	245.88	0.005046	11.13	550.08	237.11	0.81
Main	8120	StreamStats 50-y	PR	1840.00	238.70	244.75	244.75	245.88	0.005046	11.13	550.08	237.11	0.81
Main	8120	StreamStats 25-y	EX	1260.00	238.70	244.11	244.11	245.09	0.004488	9.73	405.84	219.64	0.75
Main	8120	StreamStats 25-y	PR	1260.00	238.70	244.11	244.11	245.09	0.004488	9.73	405.84	219.64	0.75
Main	8120	StreamStats 10-y	EX	698.00	238.70	242.99	242.99	243.94	0.004853	8.60	193.51	155.43	0.75

HEC-RAS River: Piney Branch Reach: Main (Continued)

Reach	River Sta	Profile	Plan	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl
				(cfs)	(ft)	(ft)	(ft)	(ft)	(ft/ft)	(ft/s)	(sq ft)	(ft)	
Main	8120	StreamStats 10-y	PR	698.00	238.70	242.99	242.99	243.94	0.004853	8.60	193.51	155.43	0.75
Main	8120	StreamStats 5-yr	EX	412.00	238.70	241.94	241.63	242.87	0.006096	7.91	67.17	34.43	0.80
Main	8120	StreamStats 5-yr	PR	412.00	238.70	241.94	241.63	242.87	0.006096	7.91	67.17	34.43	0.80
Main	8120	StreamStats 2-yr	EX	166.00	238.70	241.11		241.42	0.003060	4.52	41.74	26.70	0.54
Main	8120	StreamStats 2-yr	PR	166.00	238.70	241.11		241.42	0.003060	4.52	41.74	26.70	0.54
Main	8020	FEMA 100-yr	EX	4641.00	238.50	245.82	245.82	247.42	0.007557	15.42	1059.10	303.16	1.03
Main	8020	FEMA 100-yr	PR	4641.00	238.50	245.82	245.82	247.42	0.007557	15.42	1059.10	303.16	1.03
Main	8020	StreamStats 100-	EX	2670.00	238.50	244.60	244.60	245.86	0.006585	12.68	712.80	265.99	0.93
Main	8020	StreamStats 100-	PR	2670.00	238.50	244.60	244.60	245.86	0.006585	12.68	712.80	265.99	0.93
Main	8020	StreamStats 50-y	EX	1840.00	238.50	243.84	243.84	245.00	0.006479	11.46	519.46	238.63	0.90
Main	8020	StreamStats 50-y	PR	1840.00	238.50	243.84	243.84	245.00	0.006479	11.46	519.46	238.63	0.90
Main	8020	StreamStats 25-y	EX	1260.00	238.50	243.14	243.14	244.17	0.006269	10.21	367.28	199.90	0.86
Main	8020	StreamStats 25-y	PR	1260.00	238.50	243.14	243.14	244.17	0.006269	10.21	367.28	199.90	0.86
Main	8020	StreamStats 10-y	EX	698.00	238.50	242.19	242.19	243.06	0.006289	8.67	201.45	146.45	0.83
Main	8020	StreamStats 10-y	PR	698.00	238.50	242.19	242.19	243.06	0.006289	8.67	201.45	146.45	0.83
Main	8020	StreamStats 5-yr	EX	412.00	238.50	241.53	241.40	242.21	0.005683	7.15	118.09	108.42	0.76
Main	8020	StreamStats 5-yr	PR	412.00	238.50	241.53	241.40	242.21	0.005683	7.15	118.09	108.42	0.76
Main	8020	StreamStats 2-yr	EX	166.00	238.50	240.83		241.10	0.003125	4.35	56.22	66.53	0.54
Main	8020	StreamStats 2-yr	PR	166.00	238.50	240.83		241.10	0.003125	4.35	56.22	66.53	0.54
Main	7920	FEMA 100-yr	EX	4641.00	238.30	245.48	244.90	246.68	0.004333	10.49	1068.91	339.05	0.76
Main	7920	FEMA 100-yr	PR	4641.00	238.30	245.48	244.90	246.68	0.004333	10.49	1068.93	339.06	0.76
Main	7920	StreamStats 100-	EX	2670.00	238.30	244.01	243.58	245.00	0.004701	9.02	622.91	266.53	0.76
Main	7920	StreamStats 100-	PR	2670.00	238.30	244.01	243.58	245.00	0.004701	9.02	622.91	266.53	0.76
Main	7920	StreamStats 50-y	EX	1840.00	238.30	243.24	242.84	244.07	0.004813	8.03	434.04	223.14	0.74
Main	7920	StreamStats 50-y	PR	1840.00	238.30	243.24	242.84	244.07	0.004813	8.03	434.04	223.14	0.74
Main	7920	StreamStats 25-y	EX	1260.00	238.30	242.58	242.23	243.27	0.004951	7.12	298.58	185.79	0.73
Main	7920	StreamStats 25-y	PR	1260.00	238.30	242.58	242.23	243.27	0.004951	7.12	298.58	185.79	0.73
Main	7920	StreamStats 10-y	EX	698.00	238.30	241.74	241.42	242.25	0.005279	5.90	163.38	135.82	0.71
Main	7920	StreamStats 10-y	PR	698.00	238.30	241.74	241.42	242.25	0.005279	5.90	163.38	135.82	0.71
Main	7920	StreamStats 5-yr	EX	412.00	238.30	241.17	240.87	241.54	0.005684	4.97	96.24	96.88	0.70
Main	7920	StreamStats 5-yr	PR	412.00	238.30	241.17	240.87	241.54	0.005684	4.97	96.24	96.88	0.70
Main	7920	StreamStats 2-yr	EX	166.00	238.30	240.35		240.62	0.008057	4.19	39.60	42.27	0.76
Main	7920	StreamStats 2-yr	PR	166.00	238.30	240.35		240.62	0.008057	4.19	39.60	42.27	0.76
Main	7820	FEMA 100-yr	EX	4641.00	238.10	245.22		246.19	0.003899	10.93	1310.25	357.19	0.74
Main	7820	FEMA 100-yr	PR	4641.00	238.10	245.22		246.19	0.003899	10.93	1310.27	357.19	0.74
Main	7820	StreamStats 100-	EX	2670.00	238.10	243.59		244.49	0.004511	9.79	772.89	295.79	0.76
Main	7820	StreamStats 100-	PR	2670.00	238.10	243.59		244.49	0.004511	9.79	772.89	295.79	0.76
Main	7820	StreamStats 50-y	EX	1840.00	238.10	242.81		243.57	0.004394	8.66	557.72	253.85	0.73
Main	7820	StreamStats 50-y	PR	1840.00	238.10	242.81		243.57	0.004394	8.66	557.72	253.85	0.73
Main	7820	StreamStats 25-y	EX	1260.00	238.10	242.16		242.78	0.004111	7.52	404.01	219.03	0.69

HEC-RAS River: Piney Branch Reach: Main (Continued)

Reach	River Sta	Profile	Plan	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl
				(cfs)	(ft)	(ft)	(ft)	(ft)	(ft/ft)	(ft/s)	(sq ft)	(ft)	
Main	7820	StreamStats 25-y	PR	1260.00	238.10	242.16		242.78	0.004111	7.52	404.01	219.03	0.69
Main	7820	StreamStats 10-y	EX	698.00	238.10	241.36		241.78	0.003512	5.91	253.52	171.47	0.61
Main	7820	StreamStats 10-y	PR	698.00	238.10	241.36		241.78	0.003512	5.91	253.52	171.47	0.61
Main	7820	StreamStats 5-yr	EX	412.00	238.10	240.75		241.08	0.003344	4.94	155.03	152.86	0.57
Main	7820	StreamStats 5-yr	PR	412.00	238.10	240.75		241.08	0.003344	4.94	155.03	152.86	0.57
Main	7820	StreamStats 2-yr	EX	166.00	238.10	239.82		240.05	0.003874	3.86	43.01	30.14	0.57
Main	7820	StreamStats 2-yr	PR	166.00	238.10	239.82		240.05	0.003874	3.86	43.01	30.14	0.57
Main	7720	FEMA 100-yr	EX	4641.00	237.00	245.11		245.81	0.002334	8.40	1393.63	363.54	0.57
Main	7720	FEMA 100-yr	PR	4641.00	237.00	245.11		245.81	0.002334	8.40	1393.64	363.54	0.57
Main	7720	StreamStats 100-	EX	2670.00	237.00	243.49		244.07	0.002482	7.20	847.27	305.18	0.56
Main	7720	StreamStats 100-	PR	2670.00	237.00	243.49		244.07	0.002482	7.20	847.27	305.18	0.56
Main	7720	StreamStats 50-y	EX	1840.00	237.00	242.70		243.17	0.002367	6.28	621.45	266.98	0.54
Main	7720	StreamStats 50-y	PR	1840.00	237.00	242.70		243.17	0.002367	6.28	621.45	266.98	0.54
Main	7720	StreamStats 25-y	EX	1260.00	237.00	242.04		242.41	0.002205	5.41	455.69	235.02	0.50
Main	7720	StreamStats 25-y	PR	1260.00	237.00	242.04		242.41	0.002205	5.41	455.69	235.02	0.50
Main	7720	StreamStats 10-y	EX	698.00	237.00	241.24		241.48	0.001840	4.18	283.93	194.66	0.44
Main	7720	StreamStats 10-y	PR	698.00	237.00	241.24		241.48	0.001840	4.18	283.93	194.66	0.44
Main	7720	StreamStats 5-yr	EX	412.00	237.00	240.64		240.80	0.001654	3.38	175.82	164.17	0.40
Main	7720	StreamStats 5-yr	PR	412.00	237.00	240.64		240.80	0.001654	3.38	175.82	164.17	0.40
Main	7720	StreamStats 2-yr	EX	166.00	237.00	239.66		239.76	0.001733	2.57	64.65	45.82	0.38
Main	7720	StreamStats 2-yr	PR	166.00	237.00	239.66		239.76	0.001733	2.57	64.65	45.82	0.38
Main	7620	FEMA 100-yr	EX	4641.00	236.20	244.85		245.47	0.002313	8.00	1456.92	382.69	0.56
Main	7620	FEMA 100-yr	PR	4641.00	236.20	244.85		245.47	0.002312	8.00	1456.94	382.70	0.56
Main	7620	StreamStats 100-	EX	2670.00	236.20	243.14		243.70	0.002813	7.15	854.19	321.79	0.59
Main	7620	StreamStats 100-	PR	2670.00	236.20	243.14		243.70	0.002813	7.15	854.20	321.79	0.59
Main	7620	StreamStats 50-y	EX	1840.00	236.20	242.26		242.78	0.003241	6.66	584.93	287.92	0.61
Main	7620	StreamStats 50-y	PR	1840.00	236.20	242.26		242.78	0.003241	6.66	584.93	287.92	0.61
Main	7620	StreamStats 25-y	EX	1260.00	236.20	241.49		242.00	0.003901	6.27	379.50	246.13	0.64
Main	7620	StreamStats 25-y	PR	1260.00	236.20	241.49		242.00	0.003901	6.27	379.50	246.13	0.64
Main	7620	StreamStats 10-y	EX	698.00	236.20	240.48	240.34	241.02	0.006362	6.05	162.77	182.36	0.77
Main	7620	StreamStats 10-y	PR	698.00	236.20	240.48	240.34	241.02	0.006362	6.05	162.77	182.36	0.77
Main	7620	StreamStats 5-yr	EX	412.00	236.20	239.76	239.62	240.31	0.009766	5.92	69.59	50.93	0.89
Main	7620	StreamStats 5-yr	PR	412.00	236.20	239.76	239.62	240.31	0.009766	5.92	69.59	50.93	0.89
Main	7620	StreamStats 2-yr	EX	166.00	236.20	238.87		239.26	0.009724	5.01	33.13	30.58	0.85
Main	7620	StreamStats 2-yr	PR	166.00	236.20	238.87		239.26	0.009724	5.01	33.13	30.58	0.85
Main	7520	FEMA 100-yr	EX	4641.00	235.80	244.59		245.17	0.002960	10.52	1658.44	391.00	0.65
Main	7520	FEMA 100-yr	PR	4641.00	235.80	244.59		245.17	0.002960	10.52	1658.46	391.00	0.65
Main	7520	StreamStats 100-	EX	2670.00	235.80	242.89		243.36	0.002892	8.91	1056.16	314.62	0.61
Main	7520	StreamStats 100-	PR	2670.00	235.80	242.89		243.36	0.002892	8.91	1056.16	314.62	0.61
Main	7520	StreamStats 50-y	EX	1840.00	235.80	242.03		242.42	0.002656	7.77	802.66	276.34	0.58

HEC-RAS River: Piney Branch Reach: Main (Continued)

Reach	River Sta	Profile	Plan	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl
				(cfs)	(ft)	(ft)	(ft)	(ft)	(ft/ft)	(ft/s)	(sq ft)	(ft)	
Main	7520	StreamStats 50-y	PR	1840.00	235.80	242.03		242.42	0.002656	7.77	802.66	276.34	0.58
Main	7520	StreamStats 25-y	EX	1260.00	235.80	241.29		241.61	0.002407	6.74	611.08	242.80	0.54
Main	7520	StreamStats 25-y	PR	1260.00	235.80	241.29		241.61	0.002407	6.74	611.08	242.80	0.54
Main	7520	StreamStats 10-y	EX	698.00	235.80	240.31		240.55	0.002100	5.44	396.11	198.49	0.48
Main	7520	StreamStats 10-y	PR	698.00	235.80	240.31		240.55	0.002100	5.44	396.11	198.49	0.48
Main	7520	StreamStats 5-yr	EX	412.00	235.80	239.60		239.79	0.001919	4.55	264.56	172.34	0.45
Main	7520	StreamStats 5-yr	PR	412.00	235.80	239.60		239.79	0.001919	4.55	264.56	172.34	0.45
Main	7520	StreamStats 2-yr	EX	166.00	235.80	238.58	237.80	238.75	0.002150	3.74	103.73	142.07	0.44
Main	7520	StreamStats 2-yr	PR	166.00	235.80	238.58	237.80	238.75	0.002150	3.74	103.73	142.07	0.44
Main	7420	FEMA 100-yr	EX	4641.00	235.60	244.07		244.83	0.003010	9.98	1422.99	344.75	0.65
Main	7420	FEMA 100-yr	PR	4641.00	235.60	244.07		244.83	0.003010	9.98	1423.01	344.75	0.65
Main	7420	StreamStats 100-	EX	2670.00	235.60	242.51		243.05	0.002721	8.07	938.25	276.49	0.60
Main	7420	StreamStats 100-	PR	2670.00	235.60	242.51		243.05	0.002721	8.07	938.25	276.49	0.60
Main	7420	StreamStats 50-y	EX	1840.00	235.60	241.75		242.15	0.002319	6.77	740.81	247.40	0.54
Main	7420	StreamStats 50-y	PR	1840.00	235.60	241.75		242.15	0.002319	6.77	740.81	247.40	0.54
Main	7420	StreamStats 25-y	EX	1260.00	235.60	241.07		241.37	0.002044	5.75	576.94	228.17	0.49
Main	7420	StreamStats 25-y	PR	1260.00	235.60	241.07		241.37	0.002044	5.75	576.94	228.17	0.49
Main	7420	StreamStats 10-y	EX	698.00	235.60	240.12		240.34	0.001830	4.60	374.24	201.86	0.45
Main	7420	StreamStats 10-y	PR	698.00	235.60	240.12		240.34	0.001830	4.60	374.24	201.86	0.45
Main	7420	StreamStats 5-yr	EX	412.00	235.60	239.42		239.59	0.001774	3.85	241.53	174.74	0.42
Main	7420	StreamStats 5-yr	PR	412.00	235.60	239.42		239.59	0.001774	3.85	241.53	174.74	0.42
Main	7420	StreamStats 2-yr	EX	166.00	235.60	238.19	237.78	238.43	0.004470	3.98	57.82	124.55	0.60
Main	7420	StreamStats 2-yr	PR	166.00	235.60	238.19	237.78	238.43	0.004470	3.98	57.82	124.55	0.60
Main	7320	FEMA 100-yr	EX	4641.00	235.20	243.16		244.38	0.003715	10.90	1144.67	335.38	0.72
Main	7320	FEMA 100-yr	PR	4641.00	235.20	243.16		244.38	0.003715	10.90	1144.72	335.39	0.72
Main	7320	StreamStats 100-	EX	2670.00	235.20	241.88		242.69	0.002908	8.44	759.88	268.71	0.62
Main	7320	StreamStats 100-	PR	2670.00	235.20	241.88		242.69	0.002908	8.44	759.88	268.71	0.62
Main	7320	StreamStats 50-y	EX	1840.00	235.20	241.32		241.87	0.002167	6.81	613.89	248.77	0.52
Main	7320	StreamStats 50-y	PR	1840.00	235.20	241.32		241.87	0.002167	6.81	613.89	248.77	0.52
Main	7320	StreamStats 25-y	EX	1260.00	235.20	240.75		241.14	0.001685	5.56	478.12	228.67	0.45
Main	7320	StreamStats 25-y	PR	1260.00	235.20	240.75		241.14	0.001685	5.56	478.12	228.67	0.45
Main	7320	StreamStats 10-y	EX	698.00	235.20	239.92		240.16	0.001205	4.13	301.49	195.97	0.37
Main	7320	StreamStats 10-y	PR	698.00	235.20	239.92		240.16	0.001205	4.13	301.49	195.97	0.37
Main	7320	StreamStats 5-yr	EX	412.00	235.20	239.30		239.44	0.000857	3.09	194.61	144.91	0.30
Main	7320	StreamStats 5-yr	PR	412.00	235.20	239.30		239.44	0.000857	3.09	194.61	144.91	0.30
Main	7320	StreamStats 2-yr	EX	166.00	235.20	238.14		238.21	0.000686	2.05	81.59	50.91	0.25
Main	7320	StreamStats 2-yr	PR	166.00	235.20	238.14		238.21	0.000686	2.05	81.59	50.91	0.25
Main	7220	FEMA 100-yr	EX	4641.00	234.80	242.99		243.85	0.004604	11.53	1391.01	409.36	0.79
Main	7220	FEMA 100-yr	PR	4641.00	234.80	242.99		243.85	0.004604	11.53	1391.09	409.37	0.79
Main	7220	StreamStats 100-	EX	2670.00	234.80	241.35		242.27	0.005911	10.84	798.48	309.97	0.85

HEC-RAS River: Piney Branch Reach: Main (Continued)

Reach	River Sta	Profile	Plan	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl
				(cfs)	(ft)	(ft)	(ft)	(ft)	(ft/ft)	(ft/s)	(sq ft)	(ft)	
Main	7220	StreamStats 100-	PR	2670.00	234.80	241.35		242.27	0.005910	10.84	798.53	309.97	0.85
Main	7220	StreamStats 50-y	EX	1840.00	234.80	240.46	240.46	241.46	0.007253	10.55	537.53	275.42	0.91
Main	7220	StreamStats 50-y	PR	1840.00	234.80	240.46	240.46	241.46	0.007253	10.55	537.53	275.42	0.91
Main	7220	StreamStats 25-y	EX	1260.00	234.80	239.94	239.94	240.79	0.006652	9.24	399.34	253.39	0.85
Main	7220	StreamStats 25-y	PR	1260.00	234.80	239.94	239.94	240.79	0.006652	9.24	399.34	253.39	0.85
Main	7220	StreamStats 10-y	EX	698.00	234.80	239.18	239.18	239.88	0.006343	7.72	226.37	199.62	0.80
Main	7220	StreamStats 10-y	PR	698.00	234.80	239.18	239.18	239.88	0.006343	7.72	226.37	199.62	0.80
Main	7220	StreamStats 5-yr	EX	412.00	234.80	238.59	238.59	239.20	0.006428	6.68	121.83	158.52	0.78
Main	7220	StreamStats 5-yr	PR	412.00	234.80	238.59	238.59	239.20	0.006428	6.68	121.83	158.52	0.78
Main	7220	StreamStats 2-yr	EX	166.00	234.80	237.26	237.26	237.96	0.012928	6.71	24.73	17.94	1.01
Main	7220	StreamStats 2-yr	PR	166.00	234.80	237.26	237.26	237.96	0.012928	6.71	24.73	17.94	1.01
Main	7120	FEMA 100-yr	EX	4641.00	234.40	242.70		243.28	0.004458	12.38	1555.45	383.84	0.78
Main	7120	FEMA 100-yr	PR	4641.00	234.40	242.70		243.28	0.004458	12.38	1555.53	383.86	0.78
Main	7120	StreamStats 100-	EX	2670.00	234.40	241.23		241.62	0.003600	9.68	1063.15	300.81	0.68
Main	7120	StreamStats 100-	PR	2670.00	234.40	241.23		241.62	0.003599	9.68	1063.20	300.81	0.68
Main	7120	StreamStats 50-y	EX	1840.00	234.40	240.42		240.73	0.003173	8.30	832.68	270.80	0.62
Main	7120	StreamStats 50-y	PR	1840.00	234.40	240.42		240.73	0.003173	8.30	832.68	270.80	0.62
Main	7120	StreamStats 25-y	EX	1260.00	234.40	239.69		239.94	0.002843	7.15	644.41	243.25	0.58
Main	7120	StreamStats 25-y	PR	1260.00	234.40	239.69		239.94	0.002843	7.15	644.41	243.25	0.58
Main	7120	StreamStats 10-y	EX	698.00	234.40	238.73		238.91	0.002472	5.75	429.07	206.66	0.52
Main	7120	StreamStats 10-y	PR	698.00	234.40	238.73		238.91	0.002472	5.75	429.07	206.66	0.52
Main	7120	StreamStats 5-yr	EX	412.00	234.40	238.01		238.16	0.002313	4.84	290.54	179.22	0.48
Main	7120	StreamStats 5-yr	PR	412.00	234.40	238.01		238.16	0.002313	4.84	290.54	179.22	0.48
Main	7120	StreamStats 2-yr	EX	166.00	234.40	236.98		237.13	0.002903	4.15	126.90	137.56	0.51
Main	7120	StreamStats 2-yr	PR	166.00	234.40	236.98		237.13	0.002903	4.15	126.90	137.56	0.51
Main	7020	FEMA 100-yr	EX	4641.00	234.00	241.23	240.95	242.56	0.007631	14.91	1147.17	332.86	1.01
Main	7020	FEMA 100-yr	PR	4641.00	234.00	241.23	240.95	242.56	0.007641	14.92	1146.56	332.78	1.01
Main	7020	StreamStats 100-	EX	2670.00	234.00	239.90	239.73	241.00	0.007251	12.58	742.16	274.38	0.94
Main	7020	StreamStats 100-	PR	2670.00	234.00	239.90	239.73	241.00	0.007257	12.58	741.88	274.34	0.95
Main	7020	StreamStats 50-y	EX	1840.00	234.00	239.09	239.08	240.14	0.007616	11.59	532.06	242.43	0.94
Main	7020	StreamStats 50-y	PR	1840.00	234.00	239.09	239.08	240.14	0.007616	11.59	532.06	242.43	0.94
Main	7020	StreamStats 25-y	EX	1260.00	234.00	238.49	238.49	239.40	0.007086	10.21	394.56	219.01	0.89
Main	7020	StreamStats 25-y	PR	1260.00	234.00	238.49	238.49	239.40	0.007086	10.21	394.56	219.01	0.89
Main	7020	StreamStats 10-y	EX	698.00	234.00	237.68	237.68	238.43	0.006576	8.50	232.26	178.60	0.83
Main	7020	StreamStats 10-y	PR	698.00	234.00	237.68	237.68	238.43	0.006576	8.50	232.26	178.60	0.83
Main	7020	StreamStats 5-yr	EX	412.00	234.00	237.05	237.05	237.71	0.006539	7.35	132.26	136.03	0.79
Main	7020	StreamStats 5-yr	PR	412.00	234.00	237.05	237.05	237.71	0.006539	7.35	132.26	136.03	0.79
Main	7020	StreamStats 2-yr	EX	166.00	234.00	236.20	235.83	236.65	0.006018	5.45	40.79	79.09	0.71
Main	7020	StreamStats 2-yr	PR	166.00	234.00	236.20	235.83	236.65	0.006018	5.45	40.79	79.09	0.71
Main	6920	FEMA 100-yr	EX	4641.00	233.00	241.08		241.85	0.002642	8.50	1338.57	410.40	0.60

HEC-RAS River: Piney Branch Reach: Main (Continued)

Reach	River Sta	Profile	Plan	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl
				(cfs)	(ft)	(ft)	(ft)	(ft)	(ft/ft)	(ft/s)	(sq ft)	(ft)	
Main	6920	FEMA 100-yr	PR	4641.00	233.00	241.08		241.84	0.002645	8.51	1337.72	410.21	0.60
Main	6920	StreamStats 100-	EX	2670.00	233.00	239.89		240.35	0.001997	6.41	915.17	307.61	0.51
Main	6920	StreamStats 100-	PR	2670.00	233.00	239.89		240.35	0.001998	6.41	914.86	307.57	0.51
Main	6920	StreamStats 50-y	EX	1840.00	233.00	239.14		239.49	0.001804	5.47	696.36	275.66	0.47
Main	6920	StreamStats 50-y	PR	1840.00	233.00	239.14		239.49	0.001804	5.47	696.36	275.66	0.47
Main	6920	StreamStats 25-y	EX	1260.00	233.00	238.44		238.71	0.001729	4.75	512.54	245.63	0.44
Main	6920	StreamStats 25-y	PR	1260.00	233.00	238.44		238.71	0.001729	4.75	512.54	245.63	0.44
Main	6920	StreamStats 10-y	EX	698.00	233.00	237.48		237.68	0.001799	3.93	298.48	198.25	0.43
Main	6920	StreamStats 10-y	PR	698.00	233.00	237.48		237.68	0.001799	3.93	298.48	198.25	0.43
Main	6920	StreamStats 5-yr	EX	412.00	233.00	236.75	236.06	236.92	0.002179	3.47	169.04	158.16	0.45
Main	6920	StreamStats 5-yr	PR	412.00	233.00	236.75	236.06	236.92	0.002179	3.47	169.04	158.16	0.45
Main	6920	StreamStats 2-yr	EX	166.00	233.00	235.82	235.33	235.96	0.003554	2.98	55.75	54.21	0.52
Main	6920	StreamStats 2-yr	PR	166.00	233.00	235.82	235.33	235.96	0.003554	2.98	55.75	54.21	0.52
Main	6820	FEMA 100-yr	EX	4641.00	232.50	240.60		241.36	0.004252	12.19	1617.97	498.35	0.77
Main	6820	FEMA 100-yr	PR	4641.00	232.50	240.59		241.36	0.004264	12.21	1615.97	498.08	0.77
Main	6820	StreamStats 100-	EX	2670.00	232.50	238.66	238.60	239.79	0.006911	12.87	797.34	339.44	0.93
Main	6820	StreamStats 100-	PR	2670.00	232.50	238.66	238.60	239.79	0.006884	12.85	798.78	339.81	0.93
Main	6820	StreamStats 50-y	EX	1840.00	232.50	237.90	237.90	238.96	0.006847	11.69	564.92	274.24	0.91
Main	6820	StreamStats 50-y	PR	1840.00	232.50	237.90	237.90	238.96	0.006847	11.69	564.92	274.24	0.91
Main	6820	StreamStats 25-y	EX	1260.00	232.50	237.26	237.26	238.21	0.006461	10.39	404.33	228.79	0.86
Main	6820	StreamStats 25-y	PR	1260.00	232.50	237.26	237.26	238.21	0.006461	10.39	404.33	228.79	0.86
Main	6820	StreamStats 10-y	EX	698.00	232.50	236.37	236.37	237.18	0.006173	8.77	227.98	165.04	0.81
Main	6820	StreamStats 10-y	PR	698.00	232.50	236.37	236.37	237.18	0.006173	8.77	227.98	165.04	0.81
Main	6820	StreamStats 5-yr	EX	412.00	232.50	235.61	235.61	236.35	0.006550	7.73	123.06	114.87	0.80
Main	6820	StreamStats 5-yr	PR	412.00	232.50	235.61	235.61	236.35	0.006550	7.73	123.06	114.87	0.80
Main	6820	StreamStats 2-yr	EX	166.00	232.50	234.40	234.40	235.08	0.010221	6.69	29.32	39.38	0.92
Main	6820	StreamStats 2-yr	PR	166.00	232.50	234.40	234.40	235.08	0.010221	6.69	29.32	39.38	0.92
Main	6720	FEMA 100-yr	EX	4641.00	231.60	240.58		241.07	0.001174	6.65	1752.76	477.15	0.42
Main	6720	FEMA 100-yr	PR	4641.00	231.60	240.58		241.07	0.001177	6.66	1751.08	476.90	0.42
Main	6720	StreamStats 100-	EX	2670.00	231.60	238.99		239.34	0.001011	5.30	1090.07	359.58	0.38
Main	6720	StreamStats 100-	PR	2670.00	231.60	239.00		239.34	0.001010	5.30	1090.84	359.73	0.38
Main	6720	StreamStats 50-y	EX	1840.00	231.60	238.13		238.38	0.000875	4.46	804.74	298.45	0.34
Main	6720	StreamStats 50-y	PR	1840.00	231.60	238.13		238.38	0.000874	4.46	805.01	298.52	0.34
Main	6720	StreamStats 25-y	EX	1260.00	231.60	237.35		237.54	0.000755	3.73	593.54	245.23	0.31
Main	6720	StreamStats 25-y	PR	1260.00	231.60	237.35		237.54	0.000755	3.73	593.55	245.23	0.31
Main	6720	StreamStats 10-y	EX	698.00	231.60	236.34		236.45	0.000589	2.79	380.32	176.38	0.26
Main	6720	StreamStats 10-y	PR	698.00	231.60	236.34		236.45	0.000589	2.79	380.32	176.38	0.26
Main	6720	StreamStats 5-yr	EX	412.00	231.60	235.62		235.69	0.000459	2.12	268.96	142.28	0.22
Main	6720	StreamStats 5-yr	PR	412.00	231.60	235.62		235.69	0.000459	2.12	268.98	142.29	0.22
Main	6720	StreamStats 2-yr	EX	166.00	231.60	234.48		234.52	0.000468	1.52	125.73	108.70	0.21
Main	6720	StreamStats 2-yr	PR	166.00	231.60	234.48		234.52	0.000470	1.52	125.45	108.62	0.21

HEC-RAS River: Piney Branch Reach: Main (Continued)

Reach	River Sta	Profile	Plan	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl
				(cfs)	(ft)	(ft)	(ft)	(ft)	(ft/ft)	(ft/s)	(sq ft)	(ft)	
Main	6620	FEMA 100-yr	EX	4641.00	231.20	239.98		240.85	0.003074	10.39	1459.14	395.62	0.67
Main	6620	FEMA 100-yr	PR	4641.00	231.20	239.98		240.85	0.003087	10.40	1456.47	395.33	0.67
Main	6620	StreamStats 100-	EX	2670.00	231.20	238.22		239.11	0.003731	9.57	826.17	320.68	0.70
Main	6620	StreamStats 100-	PR	2670.00	231.20	238.22		239.11	0.003703	9.54	828.95	321.05	0.70
Main	6620	StreamStats 50-y	EX	1840.00	231.20	237.39		238.17	0.003666	8.54	580.33	267.17	0.68
Main	6620	StreamStats 50-y	PR	1840.00	231.20	237.39		238.17	0.003656	8.54	581.08	267.37	0.68
Main	6620	StreamStats 25-y	EX	1260.00	231.20	236.75		237.36	0.003177	7.25	424.83	221.13	0.62
Main	6620	StreamStats 25-y	PR	1260.00	231.20	236.75		237.36	0.003177	7.25	424.84	221.14	0.62
Main	6620	StreamStats 10-y	EX	698.00	231.20	235.96		236.32	0.002283	5.36	272.36	164.84	0.51
Main	6620	StreamStats 10-y	PR	698.00	231.20	235.96		236.32	0.002282	5.36	272.37	164.84	0.51
Main	6620	StreamStats 5-yr	EX	412.00	231.20	235.37		235.59	0.001718	4.11	183.46	135.20	0.43
Main	6620	StreamStats 5-yr	PR	412.00	231.20	235.37		235.59	0.001718	4.11	183.48	135.21	0.43
Main	6620	StreamStats 2-yr	EX	166.00	231.20	234.29		234.42	0.001726	3.01	66.73	81.26	0.40
Main	6620	StreamStats 2-yr	PR	166.00	231.20	234.28		234.42	0.001740	3.02	66.41	81.06	0.40
Main	6520	FEMA 100-yr	EX	4641.00	230.80	239.32		240.39	0.005562	13.14	1203.85	324.58	0.85
Main	6520	FEMA 100-yr	PR	4641.00	230.80	239.30		240.39	0.005619	13.18	1198.64	323.70	0.85
Main	6520	StreamStats 100-	EX	2670.00	230.80	237.73		238.62	0.005552	11.18	756.84	244.34	0.82
Main	6520	StreamStats 100-	PR	2670.00	230.80	237.75	237.20	238.63	0.005468	11.11	761.47	244.87	0.81
Main	6520	StreamStats 50-y	EX	1840.00	230.80	236.86	236.50	237.68	0.005689	10.16	556.01	220.04	0.80
Main	6520	StreamStats 50-y	PR	1840.00	230.80	236.89	236.50	237.69	0.005548	10.07	561.69	220.76	0.79
Main	6520	StreamStats 25-y	EX	1260.00	230.80	236.23	235.95	236.91	0.005228	8.89	421.76	202.17	0.75
Main	6520	StreamStats 25-y	PR	1260.00	230.80	236.23	235.95	236.91	0.005221	8.89	421.99	202.20	0.75
Main	6520	StreamStats 10-y	EX	698.00	230.80	235.37	235.23	235.95	0.004911	7.44	258.96	179.42	0.70
Main	6520	StreamStats 10-y	PR	698.00	230.80	235.37	235.23	235.95	0.004915	7.44	258.88	179.40	0.70
Main	6520	StreamStats 5-yr	EX	412.00	230.80	234.76	234.67	235.27	0.004754	6.43	154.05	163.43	0.67
Main	6520	StreamStats 5-yr	PR	412.00	230.80	234.76	234.67	235.27	0.004763	6.44	153.89	163.41	0.67
Main	6520	StreamStats 2-yr	EX	166.00	230.80	233.65		234.09	0.005495	5.29	31.37	16.47	0.68
Main	6520	StreamStats 2-yr	PR	166.00	230.80	233.64		234.08	0.005604	5.33	31.14	16.42	0.68
Main	6420	FEMA 100-yr	EX	4641.00	230.40	238.64	237.94	239.88	0.004271	10.36	974.99	291.07	0.76
Main	6420	FEMA 100-yr	PR	4641.00	230.40	238.52	237.94	239.84	0.004657	10.66	938.92	286.44	0.79
Main	6420	StreamStats 100-	EX	2670.00	230.40	236.93	236.53	238.03	0.005465	9.31	535.83	219.57	0.81
Main	6420	StreamStats 100-	PR	2670.00	230.40	236.82	236.53	238.00	0.006066	9.63	511.63	214.58	0.85
Main	6420	StreamStats 50-y	EX	1840.00	230.40	236.03	235.84	237.03	0.006565	8.66	356.04	179.25	0.85
Main	6420	StreamStats 50-y	PR	1840.00	230.40	235.97	235.84	237.02	0.007056	8.86	345.06	176.75	0.88
Main	6420	StreamStats 25-y	EX	1260.00	230.40	235.27	235.25	236.21	0.008394	8.19	230.53	151.41	0.92
Main	6420	StreamStats 25-y	PR	1260.00	230.40	235.27	235.25	236.21	0.008415	8.19	230.29	151.35	0.92
Main	6420	StreamStats 10-y	EX	698.00	230.40	234.53	234.53	235.24	0.009672	6.92	127.86	124.37	0.93
Main	6420	StreamStats 10-y	PR	698.00	230.40	234.53	234.53	235.24	0.009663	6.92	127.92	124.39	0.93
Main	6420	StreamStats 5-yr	EX	412.00	230.40	233.83	233.77	234.55	0.010707	6.79	60.69	38.70	0.96
Main	6420	StreamStats 5-yr	PR	412.00	230.40	233.83	233.74	234.55	0.010676	6.78	60.75	38.73	0.95

HEC-RAS River: Piney Branch Reach: Main (Continued)

Reach	River Sta	Profile	Plan	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl
				(cfs)	(ft)	(ft)	(ft)	(ft)	(ft/ft)	(ft/s)	(sq ft)	(ft)	
Main	6420	StreamStats 2-yr	EX	166.00	230.40	232.88	232.73	233.34	0.009864	5.47	30.35	25.02	0.88
Main	6420	StreamStats 2-yr	PR	166.00	230.40	232.92		233.35	0.009190	5.31	31.25	25.53	0.85
Main	6320	FEMA 100-yr	EX	4641.00	229.80	238.71		239.46	0.001922	7.36	1022.73	296.45	0.52
Main	6320	FEMA 100-yr	PR	4641.00	229.80	238.59		239.38	0.002062	7.53	988.61	290.41	0.53
Main	6320	StreamStats 100-	EX	2670.00	229.80	236.99		237.55	0.002055	6.17	587.93	213.38	0.51
Main	6320	StreamStats 100-	PR	2670.00	229.80	236.89		237.48	0.002237	6.33	565.52	208.48	0.53
Main	6320	StreamStats 50-y	EX	1840.00	229.80	236.06		236.51	0.002197	5.48	408.77	170.36	0.50
Main	6320	StreamStats 50-y	PR	1840.00	229.80	236.00		236.47	0.002333	5.58	398.23	167.51	0.52
Main	6320	StreamStats 25-y	EX	1260.00	229.80	235.26		235.63	0.002430	4.89	285.45	138.34	0.51
Main	6320	StreamStats 25-y	PR	1260.00	229.80	235.26		235.62	0.002435	4.90	285.20	138.26	0.51
Main	6320	StreamStats 10-y	EX	698.00	229.80	234.27		234.54	0.003116	4.18	168.22	99.31	0.54
Main	6320	StreamStats 10-y	PR	698.00	229.80	234.31		234.57	0.002901	4.09	172.28	100.91	0.52
Main	6320	StreamStats 5-yr	EX	412.00	229.80	233.65		233.85	0.003223	3.62	113.71	76.74	0.52
Main	6320	StreamStats 5-yr	PR	412.00	229.80	233.65		233.86	0.003195	3.61	114.11	76.91	0.52
Main	6320	StreamStats 2-yr	EX	166.00	229.80	232.49		232.68	0.003798	3.50	47.39	37.68	0.55
Main	6320	StreamStats 2-yr	PR	166.00	229.80	232.60		232.76	0.003201	3.21	51.76	41.41	0.51
Main	6220	FEMA 100-yr	EX	4641.00	229.60	238.18		239.19	0.002741	8.90	1007.20	293.52	0.62
Main	6220	FEMA 100-yr	PR	4641.00	229.60	237.96		239.08	0.003157	9.33	942.53	285.84	0.66
Main	6220	StreamStats 100-	EX	2670.00	229.60	236.50		237.28	0.002902	7.50	577.03	215.87	0.60
Main	6220	StreamStats 100-	PR	2670.00	229.60	236.29		237.16	0.003438	7.92	532.46	205.71	0.65
Main	6220	StreamStats 50-y	EX	1840.00	229.60	235.60		236.23	0.002987	6.62	401.71	175.56	0.59
Main	6220	StreamStats 50-y	PR	1840.00	229.60	235.47		236.16	0.003380	6.88	379.49	170.32	0.63
Main	6220	StreamStats 25-y	EX	1260.00	229.60	234.81		235.32	0.003205	5.89	275.56	143.27	0.59
Main	6220	StreamStats 25-y	PR	1260.00	229.60	234.80		235.32	0.003219	5.90	274.99	143.11	0.59
Main	6220	StreamStats 10-y	EX	698.00	229.60	233.74		234.15	0.004326	5.16	146.16	98.88	0.64
Main	6220	StreamStats 10-y	PR	698.00	229.60	233.88		234.24	0.003446	4.82	160.28	105.02	0.58
Main	6220	StreamStats 5-yr	EX	412.00	229.60	232.99		233.36	0.007098	4.88	84.42	65.65	0.76
Main	6220	StreamStats 5-yr	PR	412.00	229.60	233.17		233.46	0.004620	4.28	96.86	73.56	0.63
Main	6220	StreamStats 2-yr	EX	166.00	229.60	232.08		232.31	0.003256	3.88	42.81	25.62	0.53
Main	6220	StreamStats 2-yr	PR	166.00	229.60	232.24		232.43	0.003156	3.50	47.43	32.58	0.51
Main	6120	FEMA 100-yr	EX	4641.00	229.20	238.32		238.86	0.001185	6.56	1350.09	284.37	0.42
Main	6120	FEMA 100-yr	PR	4641.00	229.20	238.18	235.40	238.69	0.001199	6.51	1309.67	279.97	0.42
Main	6120	StreamStats 100-	EX	2670.00	229.20	236.62		236.96	0.001016	5.13	905.31	239.84	0.37
Main	6120	StreamStats 100-	PR	2670.00	229.20	236.46	234.11	236.80	0.001084	5.20	866.22	235.72	0.38
Main	6120	StreamStats 50-y	EX	1840.00	229.20	235.69		235.94	0.000912	4.33	693.36	216.40	0.34
Main	6120	StreamStats 50-y	PR	1840.00	229.20	235.59	233.40	235.84	0.000958	4.38	671.14	213.76	0.35
Main	6120	StreamStats 25-y	EX	1260.00	229.20	234.87		235.06	0.000833	3.67	524.65	195.47	0.32
Main	6120	StreamStats 25-y	PR	1260.00	229.20	234.88	232.84	235.06	0.000813	3.63	525.32	195.56	0.31
Main	6120	StreamStats 10-y	EX	698.00	229.20	233.77		233.89	0.000794	2.91	324.51	164.31	0.29
Main	6120	StreamStats 10-y	PR	698.00	229.20	233.91	232.15	234.02	0.000670	2.76	347.95	169.66	0.27

HEC-RAS River: Piney Branch Reach: Main (Continued)

Reach	River Sta	Profile	Plan	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl
				(cfs)	(ft)	(ft)	(ft)	(ft)	(ft/ft)	(ft/s)	(sq ft)	(ft)	
Main	6120	StreamStats 5-yr	EX	412.00	229.20	232.99		233.08	0.000791	2.39	208.47	134.76	0.28
Main	6120	StreamStats 5-yr	PR	412.00	229.20	233.17	231.63	233.24	0.000599	2.19	233.63	141.69	0.25
Main	6120	StreamStats 2-yr	EX	166.00	229.20	232.05		232.09	0.000835	1.71	98.03	98.73	0.26
Main	6120	StreamStats 2-yr	PR	166.00	229.20	232.23	230.93	232.26	0.000540	1.50	116.45	105.59	0.22
Main	6020	FEMA 100-yr	EX	4641.00	228.80	237.93		238.67	0.002368	8.94	1411.66	337.89	0.58
Main	6020	FEMA 100-yr	PR	4641.00	228.80	238.32	235.64	238.53	0.000849	5.54	1947.84	378.32	0.35
Main	6020	StreamStats 100-	EX	2670.00	228.80	236.20		236.79	0.002431	7.56	878.91	277.97	0.56
Main	6020	StreamStats 100-	PR	2670.00	228.80	236.47	234.85	236.66	0.001002	5.01	1258.78	367.42	0.37
Main	6020	StreamStats 50-y	EX	1840.00	228.80	235.30		235.78	0.002349	6.61	646.14	240.17	0.54
Main	6020	StreamStats 50-y	PR	1840.00	228.80	235.53	233.63	235.72	0.001142	4.76	916.07	361.87	0.38
Main	6020	StreamStats 25-y	EX	1260.00	228.80	234.53		234.91	0.002246	5.73	474.00	205.93	0.51
Main	6020	StreamStats 25-y	PR	1260.00	228.80	234.74	233.39	234.95	0.001367	4.63	631.79	357.21	0.40
Main	6020	StreamStats 10-y	EX	698.00	228.80	233.44		233.74	0.002520	4.87	272.55	168.32	0.51
Main	6020	StreamStats 10-y	PR	698.00	228.80	233.73	232.75	233.90	0.001423	3.91	322.50	176.35	0.39
Main	6020	StreamStats 5-yr	EX	412.00	228.80	232.59		232.90	0.003763	4.68	138.55	147.07	0.59
Main	6020	StreamStats 5-yr	PR	412.00	228.80	232.97	232.27	233.13	0.001624	3.47	196.94	157.14	0.40
Main	6020	StreamStats 2-yr	EX	166.00	228.80	231.68		231.90	0.004614	3.79	43.84	35.88	0.60
Main	6020	StreamStats 2-yr	PR	166.00	228.80	231.97	231.22	232.11	0.002596	3.04	54.67	40.54	0.46
Main	5881	FEMA 100-yr	EX	4641.00	228.19	237.50		238.25	0.002065	8.69	1392.83	321.92	0.55
Main	5881	FEMA 100-yr	PR	4641.00	228.19	237.75	235.89	238.24	0.001452	7.44	1747.27	374.08	0.47
Main	5881	StreamStats 100-	EX	2670.00	228.19	235.66		236.33	0.002304	7.65	828.16	286.59	0.56
Main	5881	StreamStats 100-	PR	2670.00	228.19	235.82	234.84	236.31	0.001792	6.87	1035.74	362.85	0.49
Main	5881	StreamStats 50-y	EX	1840.00	228.19	234.68		235.30	0.002487	7.03	557.47	261.63	0.56
Main	5881	StreamStats 50-y	PR	1840.00	228.19	234.71	233.65	235.30	0.002353	6.87	638.83	356.43	0.55
Main	5881	StreamStats 25-y	EX	1260.00	228.19	233.84	232.73	234.42	0.002678	6.44	348.14	232.87	0.57
Main	5881	StreamStats 25-y	PR	1260.00	228.19	233.84	232.84	234.42	0.002678	6.44	348.12	232.87	0.57
Main	5881	StreamStats 10-y	EX	698.00	228.19	232.87		233.26	0.002415	5.08	174.43	119.38	0.51
Main	5881	StreamStats 10-y	PR	698.00	228.19	233.02	231.83	233.24	0.002027	4.81	194.62	140.30	0.47
Main	5881	StreamStats 5-yr	EX	412.00	228.19	232.01		232.29	0.002702	4.31	100.54	67.16	0.51
Main	5881	StreamStats 5-yr	PR	412.00	228.19	232.06	231.21	232.33	0.002502	4.21	103.97	70.24	0.50
Main	5881	StreamStats 2-yr	EX	166.00	228.19	230.83		231.04	0.004433	3.67	45.19	37.95	0.59
Main	5881	StreamStats 2-yr	PR	166.00	228.19	230.79	230.39	231.06	0.004812	3.79	43.79	37.31	0.62
Main	5820	FEMA 100-yr	EX	4641.00	228.20	237.18		238.04	0.002571	9.50	1358.74	339.04	0.61
Main	5820	FEMA 100-yr	PR	4641.00	228.20	237.18	235.81	238.04	0.002571	9.50	1358.74	339.04	0.61
Main	5820	StreamStats 100-	EX	2670.00	228.20	235.32		236.10	0.002920	8.41	788.11	274.83	0.62
Main	5820	StreamStats 100-	PR	2670.00	228.20	235.32	234.49	236.10	0.002921	8.41	788.11	274.82	0.62
Main	5820	StreamStats 50-y	EX	1840.00	228.20	234.32		235.05	0.003238	7.79	529.50	240.12	0.63
Main	5820	StreamStats 50-y	PR	1840.00	228.20	234.32	233.70	235.05	0.003238	7.79	529.50	240.12	0.63
Main	5820	StreamStats 25-y	EX	1260.00	228.20	233.44	232.98	234.15	0.003690	7.26	334.17	202.00	0.65
Main	5820	StreamStats 25-y	PR	1260.00	228.20	233.44	233.00	234.15	0.003690	7.26	334.17	202.00	0.65

HEC-RAS River: Piney Branch Reach: Main (Continued)

Reach	River Sta	Profile	Plan	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl
				(cfs)	(ft)	(ft)	(ft)	(ft)	(ft/ft)	(ft/s)	(sq ft)	(ft)	
Main	5820	StreamStats 10-y	EX	698.00	228.20	232.33	231.67	232.96	0.004558	6.45	139.54	148.05	0.68
Main	5820	StreamStats 10-y	PR	698.00	228.20	232.33	231.68	232.96	0.004558	6.45	139.54	148.05	0.68
Main	5820	StreamStats 5-yr	EX	412.00	228.20	231.55		231.99	0.004226	5.36	76.86	34.52	0.63
Main	5820	StreamStats 5-yr	PR	412.00	228.20	231.55	230.79	231.99	0.004226	5.36	76.86	34.52	0.63
Main	5820	StreamStats 2-yr	EX	166.00	228.20	230.56		230.76	0.002527	3.55	46.78	26.47	0.47
Main	5820	StreamStats 2-yr	PR	166.00	228.20	230.56	229.66	230.76	0.002527	3.55	46.78	26.47	0.47
Main	5720	FEMA 100-yr	EX	4641.00	228.00	237.14		237.73	0.001612	8.12	1644.94	359.53	0.49
Main	5720	FEMA 100-yr	PR	4641.00	228.00	237.14		237.73	0.001612	8.12	1644.94	359.53	0.49
Main	5720	StreamStats 100-	EX	2670.00	228.00	235.31		235.76	0.001558	6.76	1038.95	300.44	0.47
Main	5720	StreamStats 100-	PR	2670.00	228.00	235.31		235.76	0.001558	6.76	1038.94	300.44	0.47
Main	5720	StreamStats 50-y	EX	1840.00	228.00	234.32		234.70	0.001512	5.97	757.86	268.41	0.45
Main	5720	StreamStats 50-y	PR	1840.00	228.00	234.32		234.70	0.001512	5.97	757.86	268.41	0.45
Main	5720	StreamStats 25-y	EX	1260.00	228.00	233.45		233.78	0.001472	5.26	540.01	232.80	0.43
Main	5720	StreamStats 25-y	PR	1260.00	228.00	233.45		233.78	0.001472	5.26	540.01	232.80	0.43
Main	5720	StreamStats 10-y	EX	698.00	228.00	232.33		232.58	0.001434	4.33	307.75	180.82	0.40
Main	5720	StreamStats 10-y	PR	698.00	228.00	232.33		232.58	0.001434	4.33	307.75	180.82	0.40
Main	5720	StreamStats 5-yr	EX	412.00	228.00	231.44		231.64	0.001561	3.73	168.46	130.16	0.40
Main	5720	StreamStats 5-yr	PR	412.00	228.00	231.44		231.64	0.001561	3.73	168.46	130.16	0.40
Main	5720	StreamStats 2-yr	EX	166.00	228.00	230.40		230.51	0.001526	2.65	67.35	63.77	0.37
Main	5720	StreamStats 2-yr	PR	166.00	228.00	230.40		230.51	0.001526	2.65	67.35	63.77	0.37
Main	5620	FEMA 100-yr	EX	4641.00	228.00	236.99		237.56	0.001605	7.95	1823.97	495.91	0.49
Main	5620	FEMA 100-yr	PR	4641.00	228.00	236.99		237.56	0.001605	7.95	1823.97	495.91	0.49
Main	5620	StreamStats 100-	EX	2670.00	228.00	235.12		235.59	0.001677	6.82	1041.51	326.40	0.48
Main	5620	StreamStats 100-	PR	2670.00	228.00	235.12		235.59	0.001677	6.82	1041.50	326.40	0.48
Main	5620	StreamStats 50-y	EX	1840.00	228.00	234.11		234.53	0.001732	6.15	732.75	285.25	0.48
Main	5620	StreamStats 50-y	PR	1840.00	228.00	234.11		234.53	0.001732	6.15	732.75	285.25	0.48
Main	5620	StreamStats 25-y	EX	1260.00	228.00	233.24		233.60	0.001788	5.52	503.15	237.76	0.47
Main	5620	StreamStats 25-y	PR	1260.00	228.00	233.24		233.60	0.001788	5.52	503.15	237.76	0.47
Main	5620	StreamStats 10-y	EX	698.00	228.00	232.10		232.40	0.001945	4.70	268.96	173.73	0.47
Main	5620	StreamStats 10-y	PR	698.00	228.00	232.10		232.40	0.001945	4.70	268.96	173.73	0.47
Main	5620	StreamStats 5-yr	EX	412.00	228.00	231.15		231.43	0.002674	4.34	131.95	113.84	0.51
Main	5620	StreamStats 5-yr	PR	412.00	228.00	231.15		231.43	0.002674	4.34	131.95	113.84	0.51
Main	5620	StreamStats 2-yr	EX	166.00	228.00	229.98		230.22	0.005853	3.92	42.37	40.09	0.67
Main	5620	StreamStats 2-yr	PR	166.00	228.00	229.98		230.22	0.005853	3.92	42.37	40.09	0.67
Main	5520	FEMA 100-yr	EX	4641.00	227.80	237.00	234.24	237.36	0.001002	6.64	2131.72	436.04	0.39
Main	5520	FEMA 100-yr	PR	4641.00	227.80	237.00	234.24	237.36	0.001002	6.64	2131.72	436.04	0.39
Main	5520	StreamStats 100-	EX	2670.00	227.80	235.10	233.02	235.41	0.001000	5.66	1351.84	384.04	0.38
Main	5520	StreamStats 100-	PR	2670.00	227.80	235.10	233.02	235.41	0.001000	5.66	1351.84	384.04	0.38
Main	5520	StreamStats 50-y	EX	1840.00	227.80	234.08	231.89	234.35	0.001001	5.10	974.00	352.09	0.37
Main	5520	StreamStats 50-y	PR	1840.00	227.80	234.08	231.89	234.35	0.001001	5.10	974.00	352.09	0.37

HEC-RAS River: Piney Branch Reach: Main (Continued)

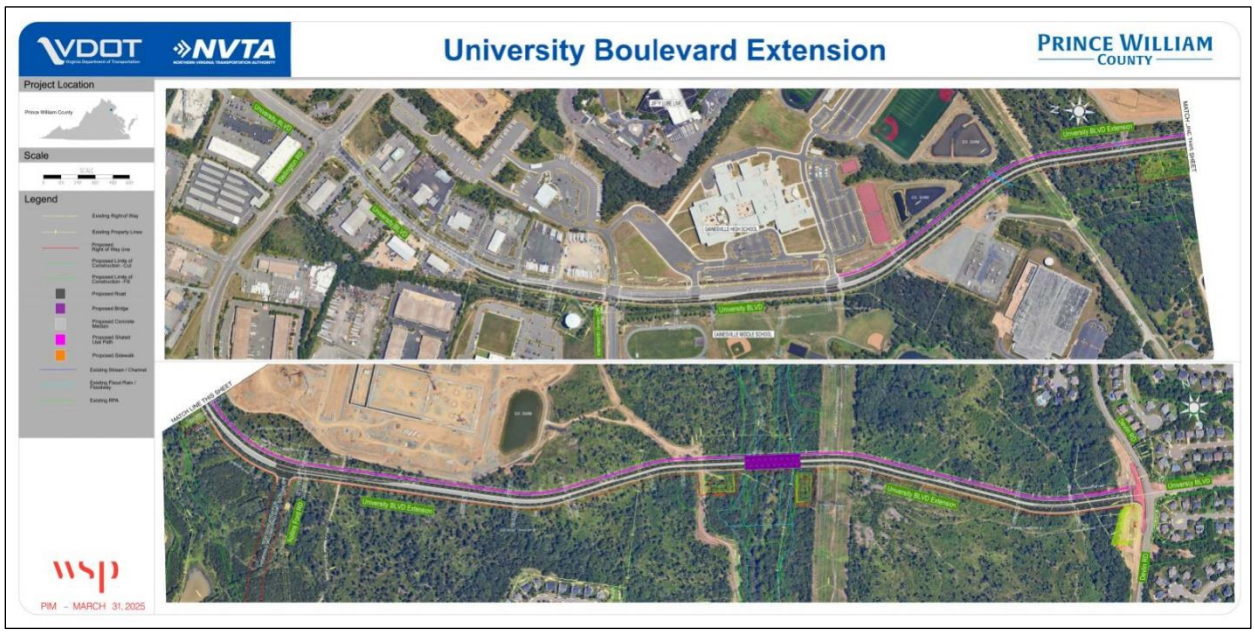
Reach	River Sta	Profile	Plan	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl
				(cfs)	(ft)	(ft)	(ft)	(ft)	(ft/ft)	(ft/s)	(sq ft)	(ft)	
Main	5520	StreamStats 25-y	EX	1260.00	227.80	233.18	231.28	233.43	0.001001	4.58	674.50	317.45	0.36
Main	5520	StreamStats 25-y	PR	1260.00	227.80	233.18	231.28	233.43	0.001001	4.58	674.50	317.45	0.36
Main	5520	StreamStats 10-y	EX	698.00	227.80	232.02	230.28	232.22	0.001000	3.85	332.25	271.58	0.34
Main	5520	StreamStats 10-y	PR	698.00	227.80	232.02	230.28	232.22	0.001000	3.85	332.25	271.58	0.34
Main	5520	StreamStats 5-yr	EX	412.00	227.80	231.07	229.52	231.22	0.001000	3.21	187.83	128.07	0.33
Main	5520	StreamStats 5-yr	PR	412.00	227.80	231.07	229.52	231.22	0.001000	3.21	187.83	128.07	0.33
Main	5520	StreamStats 2-yr	EX	166.00	227.80	229.87	228.76	229.96	0.001000	2.31	71.99	39.43	0.30
Main	5520	StreamStats 2-yr	PR	166.00	227.80	229.87	228.76	229.96	0.001000	2.31	71.99	39.43	0.30

PRINCE WILLIAM COUNTY

UNIVERSITY BOULEVARD BRIDGE OVER PINEY BRANCH

PRELIMINARY SCOUR REPORT

Original Report: January 21, 2026



UNIVERSITY BOULEVARD BRIDGE OVER PINEY BRANCH
PRELIMINARY SCOUR REPORT

PRINCE WILLIAM COUNTY

Original Report: January 21, 2026

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QUALITY MANAGEMENT

ISSUE/REVISION	FIRST ISSUE	REVISION 1	REVISION 2	REVISION 3	REVISION 4
Remarks	Rev 0				
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Checked by	Mike Coco				
Signature					
Authorized by	Brian Tetrick				
Signature					
Project number					
Report number					
File reference					

TABLES

FIGURES

APPENDICES

1 EXECUTIVE SUMMARY

A hydrologic and hydraulic study was conducted for the University Boulevard Extension Bridge over Piney Branch in Prince William County, Virginia, to support bridge design and scour evaluation in accordance with VDOT and FHWA guidance. The proposed project consists of a new 2.5-mile roadway segment extending from Devlin Road to Wellington Road, including construction of a new bridge crossing.

Hydrologic analyses were based on the effective FEMA hydrology associated with Letter of Map Revision (LOMR) No. 20-03-0070P, supplemented with additional analyses to develop 200- and 500-year peak discharges using WinTR-55 and NOAA Atlas 14 rainfall data. Hydraulic conditions were evaluated using a one-dimensional HEC-RAS model comparing existing and proposed bridge conditions.

Scour analyses were performed in accordance with HEC-18 and the VDOT Bridge Manual, including evaluation of contraction scour, pier scour, and abutment scour for the 100-, 200-, and 500-year events.

The 500-year event produced the maximum computed scour depths at the site. Governing abutment scour resulted in a final scour elevation of El. 221.4 ft at Abutment B (east abutment). Maximum pier scour was also associated with the 500-year event, with a computed scour depth of approximately 15.7 ft (Elevation 213.1 ft). In accordance with VDOT policy for new bridges, no scour countermeasures are recommended at the bridge pier, and pier foundations are designed to be scour-stable.

Based on the abutment scour results, riprap revetment is recommended at the channel banks adjacent to both abutments in accordance with HEC-23. At a minimum, the revetment should consist of 12-inch D_{50} riprap, placed at a maximum slope of 3H:1V, with a minimum thickness of 12 inches, extending approximately one bridge width upstream and downstream of the proposed crossing. These measures are intended to provide long-term erosion protection and slope stability during design and check flood events.

2 PROJECT DESCRIPTION

2.1 EXISTING STRUCTURE

There is no existing bridge or roadway crossing at the project location. The project involves the construction of a new 2.5-mile roadway segment extending from Devlin Road to Wellington Road along a new alignment that crosses Piney Branch (tributary to Rocky Branch) in Prince William County, Virginia. The proposed bridge will be owned and maintained by the Virginia Department of Transportation (VDOT). The project site is located at approximately latitude 38°46′15.68″ N and longitude 77°34′42.41″ W. A location map showing the project site is included in Figure 2-1 below:

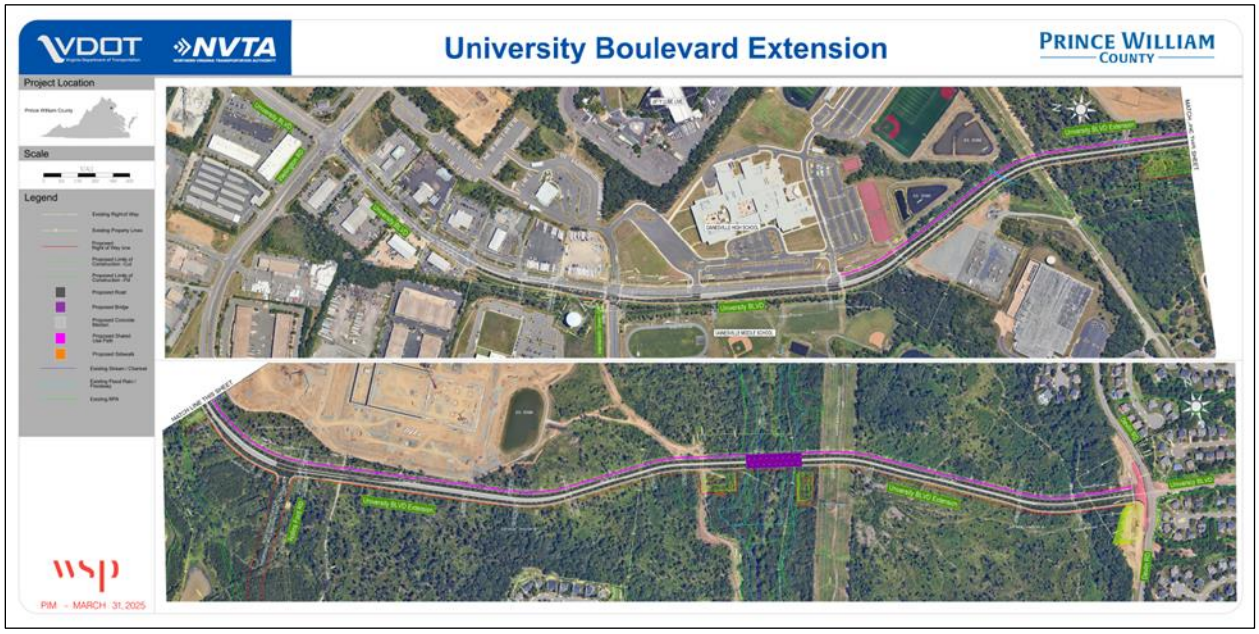


Figure 2-1: Project Site Location

2.1.1 CROSSED WATERWAY AT BRIDGE LOCATION

Piney Branch originates on the south side of Interstate 66, approximately 2.5 miles upstream of the project site. From its headwaters, Piney Branch flows generally southerly, then southeasterly, traversing a predominantly undeveloped watershed. Approximately 5,250 feet downstream of the project site, Piney Branch confluences with Rocky Branch.

2.1.2 HIGHWAY CONVEYED

At the proposed crossing, University Boulevard will be approximately 93 feet wide and will carry two travel lanes in each direction. Based on the VDOT Functional Classification, University Boulevard is classified as a Major Collector.

Accordingly, scour was evaluated for the 100-, 200-, and 500-year flood events, and the governing scour depth was identified as the maximum computed scour resulting from events up to the 500-year return period.

2.1.3 FEMA EFFECTIVE STUDIES

The current effective Flood Insurance Study (FIS) for Prince William County, Virginia and Incorporated Areas is dated August 3, 2015 (Community No. 510119). According to this study, no detailed hydrologic or hydraulic analysis was originally provided for the Piney Branch. However, a subsequent Letter of Map Revision (LOMR Case No. 20-03-0070P), effective December 3, 2020, provided updated hydrologic and hydraulic analyses for Piney Branch to Rocky Branch, identified in the LOMR as Piney Branch. The revised FEMA study reach extends to a location approximately 400 feet downstream of the proposed University Boulevard Extension bridge crossing, placing the project site immediately upstream of the downstream limit of the effective study reach. Given the close proximity of the project crossing to the effective study reach, the hydrologic and hydraulic conditions evaluated in the FEMA study are considered sufficient and applicable for use in the bridge hydrologic and hydraulic analysis. In the FIS, the study location is at a location approximately 0.57 miles upstream of Linton Hall Road, the drainage area contributing to the Piney Branch is 1.89 square miles, with a 100-year peak discharge of 4,641 cubic feet per second (cfs). The LOMR includes Base Flood Elevations (BFEs) both with and without consideration of the regulatory floodway.

The most recent effective hydraulic model for the Piney Branch is associated with LOMR 20-03-0070P (effective date December 3, 2020).
Figure 2-2 below shows FEMA Map No 5101190089D in the vicinity of the Bridge.

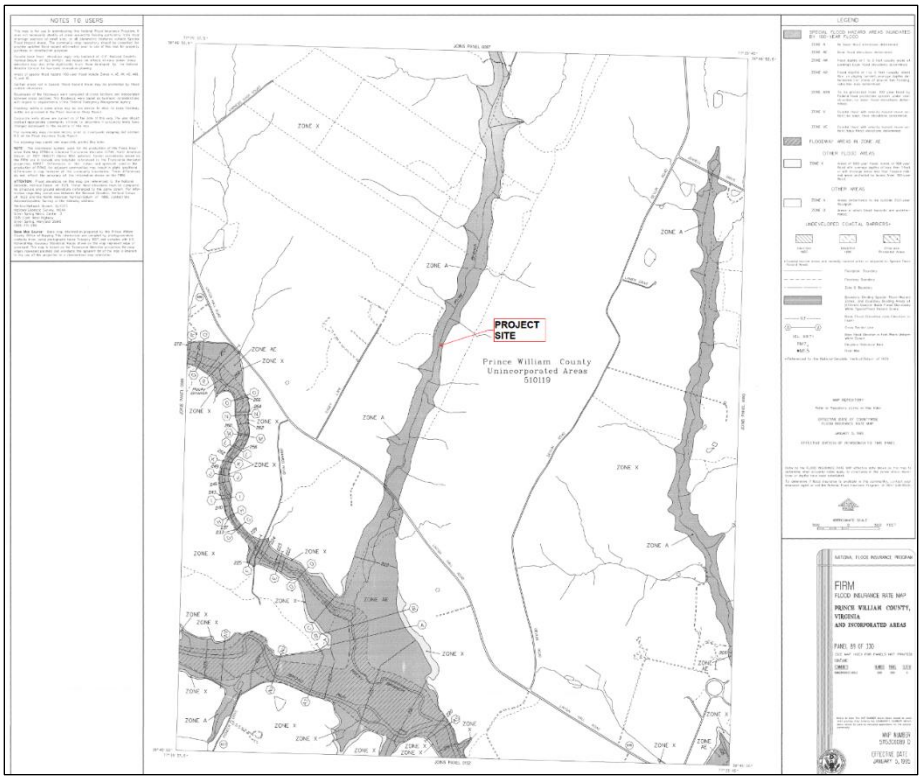


Figure 2-2: Prince William County Flood Insurance Rate Map 5101190089D Showing Project Site

2.2 PROPOSED ACTION

The proposed action consists of the construction of a new 2.5-mile roadway segment, University Boulevard Extension, extending from Devlin Road to Wellington Road along a new alignment. The project includes a new bridge crossing of Piney Branch to Rocky Branch in Prince William County, Virginia. Proposed Bridge construction plans can be found in Appendix A.

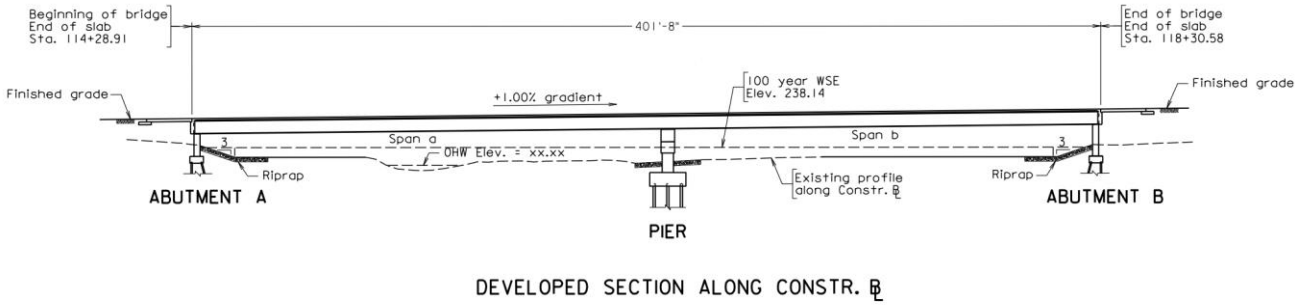


Figure 2-3: Proposed Bridge Section View

3 DATA COLLECTION

Major project data sources are summarized in Table 3-1 below.

Table 3-1: Data Sources

DATA	SOURCE	YEAR
Topography	Virginia 2.5-ft LiDAR	2024
Streams	Prince William County Database OpenData Stream.shp	
Rainfall Depth Data	https://hdsc.nws.noaa.gov/pfds/pfds_map_cont.html?bkmrk=va	2026
LOMR	FEMA (WSP provided)	2025

3.1 PREVIOUS STUDIES

The most recent effective hydraulic model and hydrology study for Piney Branch is associated with LOMR 20-03-0070P, with an effective date of December 3, 2020.

The hydrologic analysis for the Piney Branch LOMR was developed using the TR-55 methodology. The resulting 100-year peak discharge of 4,641 cubic feet per second (cfs) was applied in the HEC-RAS hydraulic model for this analysis.

3.2 SUBSURFACE AND GEOLOGIC INVESTIGATION

A geotechnical investigation was completed by Terracon on December 29, 2025. The investigation included six (6) subsurface borings located at the proposed abutment locations and immediately adjacent to the channel alignment. Two borings were advanced near the west abutment (Abutment A), two borings were advanced near the east abutment (Abutment B), and two borings were advanced in close proximity to the channel centerline.

The median bed material sizes (D_{50}) used for scour evaluation were interpreted from the geotechnical laboratory testing and are summarized below:

Table 3-2: Median Grain Size (D_{50}) Summary (Inferred Bed and Near-Bed Material)

Location	Boring ID	Depth (ft)	D_{50} (mm)	Notes
West Abutment (Abutment A)	B-151	6	0.28	Used for abutment scour evaluation
	B-152	4	0.6	Used for abutment scour evaluation
Channel	B-153	4	10.3	Gravel-sized bed material
	B-154	4	10.2	Gravel-sized bed material
East Abutment (Abutment B)	B-155	0	N/A	N/A
	B-156	4	0.29	Used for abutment scour evaluation

(Note: D_{50} values are based on subsurface samples from geotechnical borings and are assumed representative of bed and near-bed material exposed under anticipated scour depths.)

Terracon also provided coring logs including Rock Quality designation (RQD) for the samples, table below shows RQD summarized for samples been applied for scour analysis. See Appendix G for the coring results and photos

Table 3-3: Rock Quality Designation Summary

Location	Boring ID	Depth (ft)	RQD (%)
West Abutment (Abutment A)	B-151	12	37
		17.5	8
	B-152	13.5	12
		18.5	23
Channel	B-153	13.5	23
		18.5	44
	B-154	9.5	18
		14.5	18
East Abutment (Abutment B)	B-155	9.5	6
		14.5	0
	B-156	9.5	12
		14.5	17

RQD results indicate that the encountered rock is of poor quality. Although some RQD results would be sufficient for resisting scour, the results are inconsistent and samples highly fractured and is not suitable for direct scour resistance assessment as intact bedrock. While the rock mass would likely provide greater resistance to scour than overlying soils, its highly fractured nature suggests that it remains susceptible to scour and erosion under design flow conditions.

Median grain size (D_{50}) values summarized in Table 3-2 from available soil borings were derived from laboratory testing and were used to support contraction, pier, and abutment scour analyses. A more detailed analysis of the bedrock during the final bridge design may permit the assumption of higher resistance.

The full geotechnical investigation report, including boring logs and laboratory test results, is provided in Appendix G.

4 ENGINEERING METHODS

4.1 HYDROLOGIC ANALYSES

The hydrologic analysis for Piney Branch is based on the effective hydrology study associated with LOMR No. 20-03-0070P. The effective study includes the drainage area delineation, hydraulic roughness (friction) coefficient calculations, and a TR-55 hydrologic model.

The contributing drainage area at the bridge crossing is 1,208.8 acres (1.89 square miles), with a weighted Curve Number (CN) of 91 and a time of concentration (Tc) of 0.977 hours. The effective TR-55 model includes storm events with return periods of 1-, 2-, 5-, 10-, 25-, 50-, and 100-year.

To satisfy VDOT scour design requirements for the 200- and 500-year events, additional hydrologic calculations were performed. Rainfall depth data for the full range of return periods were obtained from NOAA Atlas 14. The original TR-55 hydrologic model includes storm events up to the 100-year return period and does not provide peak discharges for the 200- or 500-year events. To extend the analysis, rainfall depths for the 200- and 500-year events were required for input to TR-55.

To calculate the 200- and 500-year storm discharges, WSP added rainfall depths for the 200- and 500-year storm to the LOMR TR-55 model. NOAA Atlas 14 depths are available for this area. But because the LOMR rainfall depths in the TR-55 model are larger than Atlas 14 "average" depths for all storms (1-year through 100-year) WSP scaled the Atlas 14 200- and 500-year depths. The depths are displayed in Table 4-1. The "ratio" displays the TR-55 divided by NOAA "average" rainfall depths. All depths used fall within the 90% confidence interval for the Atlas 14 rainfall depths at this location.

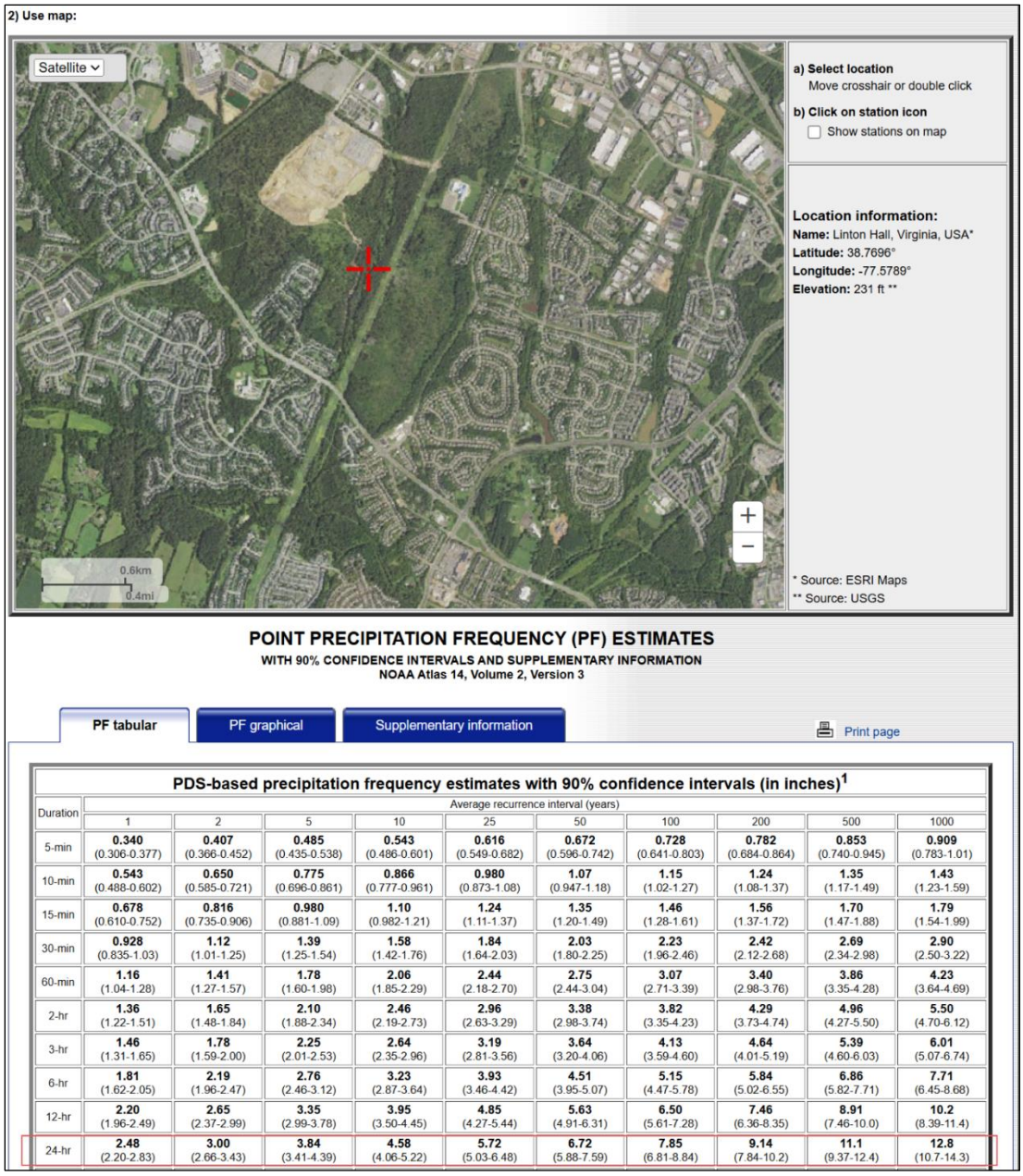


Figure 4-1: NOAA Precipitation Depths Used for Hydrologic Analysis

Table 4-1: 24-Hour Rainfall Depth Comparison and Calibration Factors

	Average recurrence interval (years)								
Source	1	2	5	10	25	50	100	200	500
NOAA Atlas 14 (24-hr), in	2.48	3	3.84	4.58	5.72	6.72	7.85	9.14	11.1
Effective TR-55 (24-hr), in	2.6	3.1	4	4.8	6.0	7.0	8.2	9.54*	11.59*
TR-55 / NOAA Ratio	1.05	1.03	1.04	1.05	1.05	1.04	1.05	1.04	1.04

(Note: 200- and 500-year rainfall depths were added to the LOMR TR-55 model to compute peak discharges.)

Based on the criteria in Section 12.2.3.2.2 (Scour) of the VDOT Bridge Manual, scour evaluations are required to consider the flood event that produces the maximum scour depth for events up to the 500-year return period. Accordingly, scour depths were computed for the 100-, 200-, and 500-year events, and the governing design and check scoured-bed elevations were taken as the maximum scour condition within this range.

The 200- and 500-year rainfall depths were added to the effective WinTR-55 (a 32-bit Windows-based application, Version 1.00.10, compiled April 1, 2011) hydrologic model to compute the corresponding peak discharges. The resulting 200- and 500-year peak flow estimates used for this scour evaluation are summarized in Table 4-2 below.

Table 4-2: Peak Discharges Used for Design

Return Period (year)	Annual Exceedance Probability (%)	Peak Discharge (ft3/sec)
100	1%	4,641
200	0.5%	5,478
500	0.2%	6,733

4.2 1D HYDRAULIC ANALYSES

4.2.1 HYDRAULIC ANALYSIS

A hydraulic analysis was conducted using the U.S. Army Corps of Engineers' Hydrologic Engineering Center's River Analysis System (HEC-RAS), Version 6.6, for Piney Branch. The HEC-RAS model was used not only to evaluate floodplain impacts associated with the proposed University Boulevard Extension, but also to develop the hydraulic parameters required for the bridge scour analysis. Model outputs including water surface elevations, flow depths, velocities, flow distributions between the main channel and overbanks, and contracted opening hydraulics were extracted and used to evaluate contraction scour, pier scour, and abutment scour under the 100-, 200-, and 500-year flow conditions.

Based on the FEMA Effective HEC-RAS Model Files (LOMR 20-03-0070P), the stream centerline was updated based on high-resolution imagery and topographic contours. Cross section 5920 was removed due to overlap with the proposed bridge structure, and cross section 5881 was added to reflect the proposed geometry for accurate comparison. Although the area of revision related to bridge construction is limited to cross sections 6020 and 5881, the full extent of the hydraulic model was retained without truncation for consistency with the effective model. See figure below for HEC-RAS geometry.

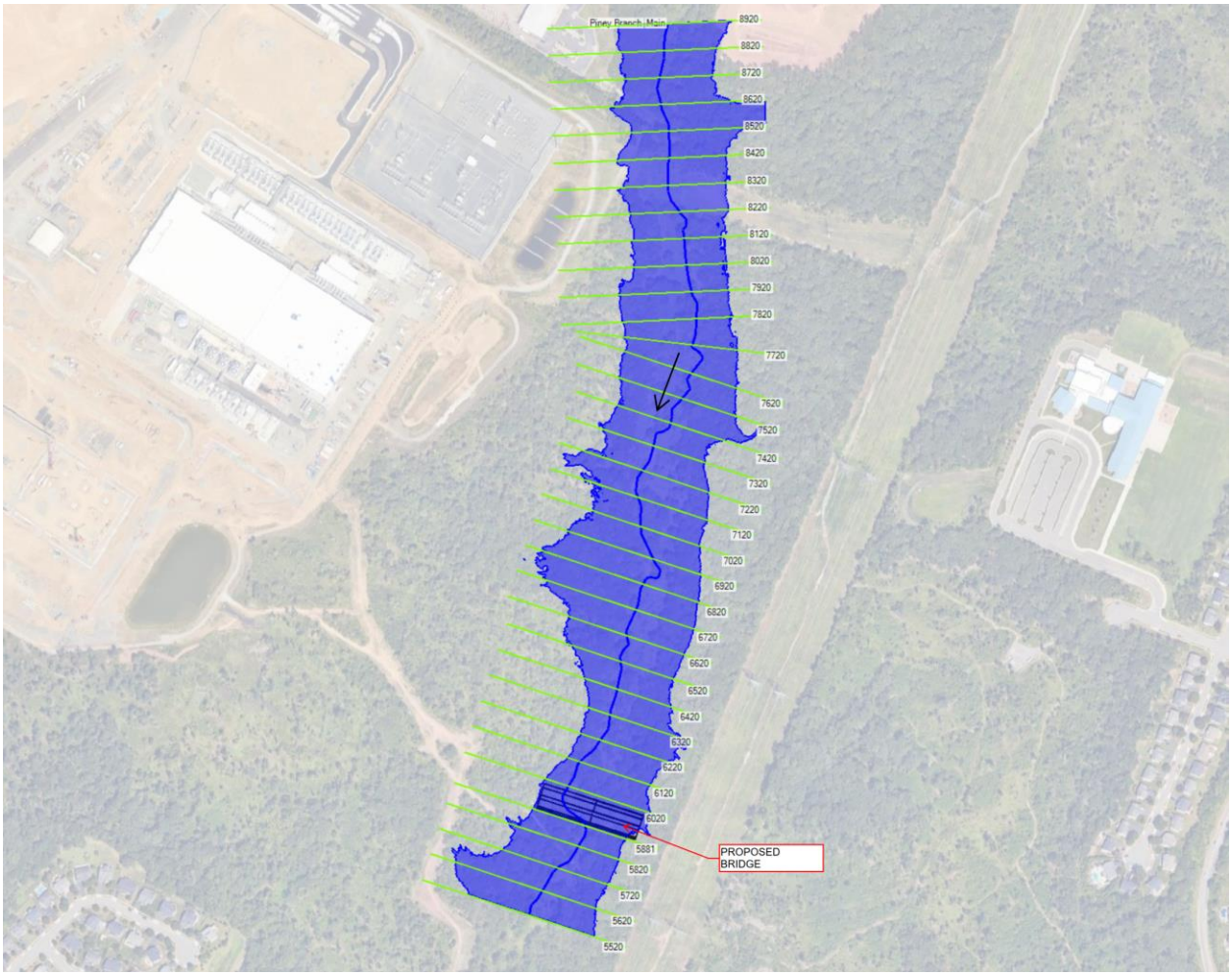


Figure 4-2: HEC-RAS Geometry

4.2.2 DATUM

The Existing Conditions model from the Letter of Map Revision (LOMR Case No. 20-03-0070P, 2020) was developed in the North American Vertical Datum of 1988 (NAVD88). The current project model was developed directly from this LOMR model and is therefore also referenced to NAVD88.

Two primary datasets were used to develop the project surface:

- LiDAR Surface: State of Virginia, 2024 (https://vgin.vdem.virginia.gov/apps/VGIN::virginia-lidar-download-application/explore?path=)
- Effective Model Surface: FEMA Study Reference 20-03-0070P_Hydraulics, 2020

The effective model channel elevations were retained where appropriate, while overbank elevations were supplemented with LiDAR data to ensure consistency across the NAVD88 datum.

The effective FEMA Flood Insurance Study (FIS) materials, including FIRMs and LOMAs, were originally developed in NGVD29. The effective model elevations were successfully converted to NAVD88 using the National Geodetic Survey (NGS) conversion tool (NGVD29 minus 0.78 ft = NAVD88).

Key consistency checks were performed:

- The downstream boundary condition in the current model matches the converted LOMA Map BFE elevation.
- The LiDAR ground surface is consistent with the effective model surface.

Based on these checks, the current hydraulic model accurately reflects the correct vertical datum and ground surface conditions in NAVD88. All floodplain elevation data presented in this report are reported in NAVD 88.

4.2.3 EXISTING CONDITIONS MODEL

The effective conditions model was upgraded to HEC-RAS 6.6 and used to develop the existing conditions model. The model ran successfully without requiring changes to input parameters.

The stream centerline was updated using high-resolution 2024 State LiDAR data accessed from the Virginia FEMA DEM Viewer. The LiDAR dataset, dated September 2024, has a cell resolution of 2.5 ft by 2.5 ft and was verified in ArcMap for accuracy. Reach lengths were adjusted accordingly to match the updated stream centerline, while cross section stationing and elevation data were retained from the FEMA effective model. Comparison with the LiDAR surface confirmed that the original cross section elevations provide a reasonable approximation for use in the Existing model.

A normal depth slope of S = 0.001 was applied as the downstream boundary condition, consistent with the FEMA effective model. Manning's n values of 0.1 for the overbanks and 0.03 for the main channel were used throughout the model to represent flow resistance, matching the parameters used in the FEMA effective model.

Cross section 5920 from the FEMA effective model was removed due to its overlap with the proposed bridge footprint. A new cross section, 5881, was added just downstream of the proposed bridge to facilitate comparison between existing and proposed conditions. The station-elevation data for 5881 were extracted from the 2024 State LiDAR, and no changes were made to other model parameters.

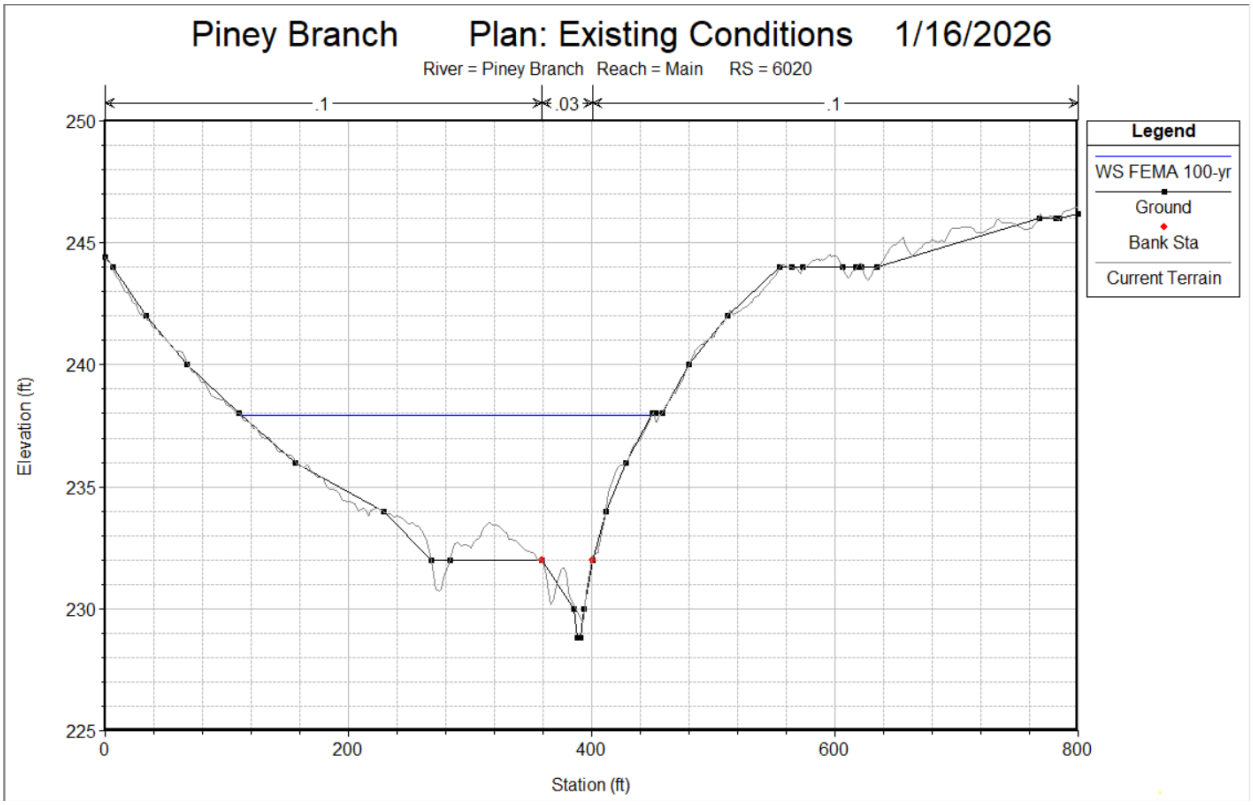


Figure 4-3: River Station 6020 FEMA Section (Black) vs 2024 State LiDAR Terrain (Grey)

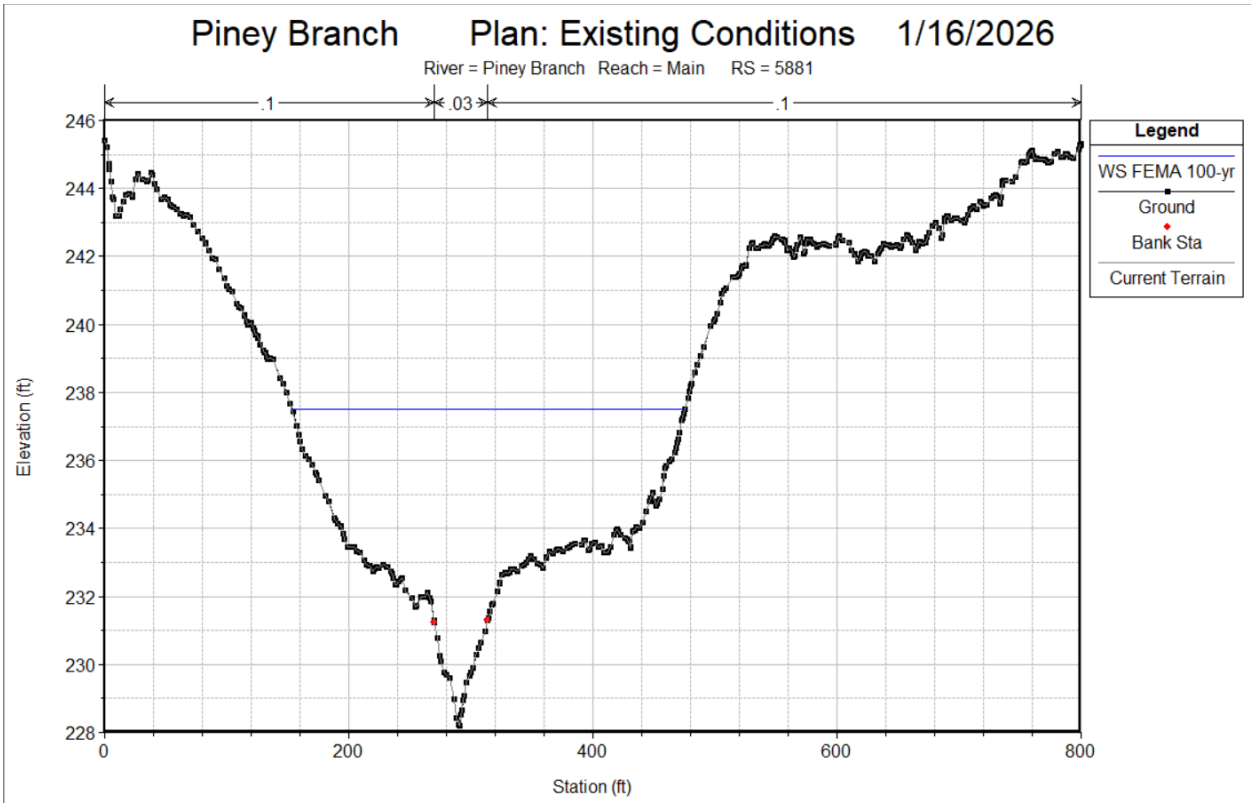


Figure 4-4: River Station 5881 Geometry from State LiDAR

4.2.4 PROPOSED CONDITIONS MODEL

In the proposed conditions HEC-RAS model, the proposed bridge was added between cross sections 6020 and 5881. The internal bridge cross sections were assigned a Manning's n value of 0.07 to reflect the expected maintenance conditions. Areas around the bridge abutments are expected to be cleared of woody vegetation, and shading from the bridge superstructure will limit vegetative regrowth. In addition, the ground surface within the bridge opening will be stabilized with stone riprap or similar scour protection measures, resulting in a relatively uniform and maintained surface. The selected Manning's n value of 0.07 is consistent with VDOT-recommended roughness values for riprap-lined channels is lower than the Manning's n value of 0.10 assigned to the surrounding wooded floodplain, making it reasonable and appropriate for representing hydraulic conditions within the bridge opening.

Grading was applied within the bridge opening and extended to the adjacent upstream and downstream cross sections to maintain floodplain continuity and enhance conveyance. The internal bridge geometry was developed by interpolating from Cross Sections 6020 and 5881, which are immediately adjacent to the bridge location. Ground elevations within the bridge opening were graded to Elevation 234.0 ft, representing the proposed excavation necessary to open the floodplain and allow unobstructed flow through the bridge. Internal cross section

bottom elevations were aligned with existing ground to maintain consistent longitudinal slope through the bridge.

Ineffective flow areas were defined at the bridge cross sections using a 1:1 contraction ratio and a 2:1 expansion ratio, consistent with HEC-RAS guidance. Due to the wide bridge span and elevated deck, the structure does not restrict flow or induce hydraulic contraction through the bridge opening. Accordingly, contraction and expansion coefficients of 0.10 and 0.30, respectively, were applied at the cross sections immediately upstream and downstream of the bridge. Modeled water surface elevations remain below the bridge deck under all analyzed flow conditions. The bridge pier is the only structural feature causing energy losses; flow beneath the superstructure does not contract around the abutments.

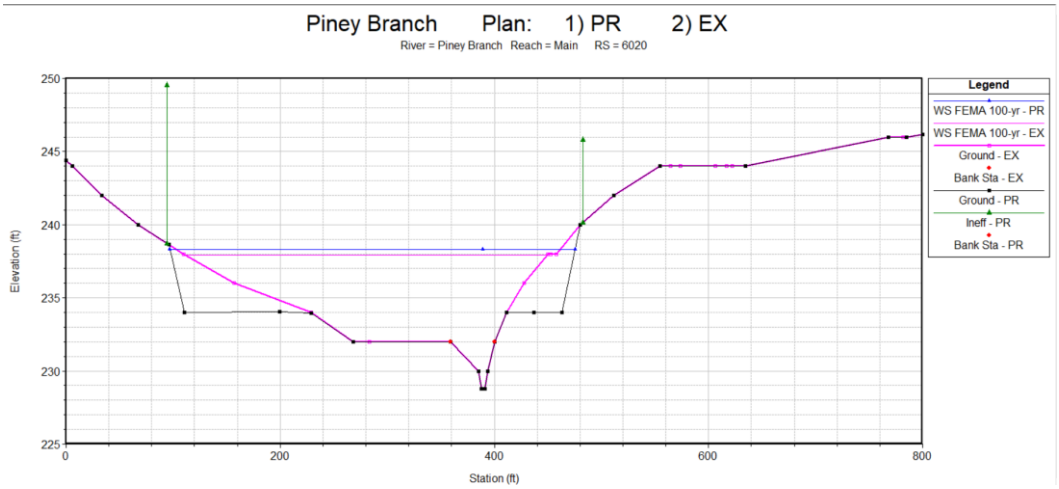


Figure 4-5: River Station 6020 Proposed Geometry (Black) vs Existing Geometry (Magenta)

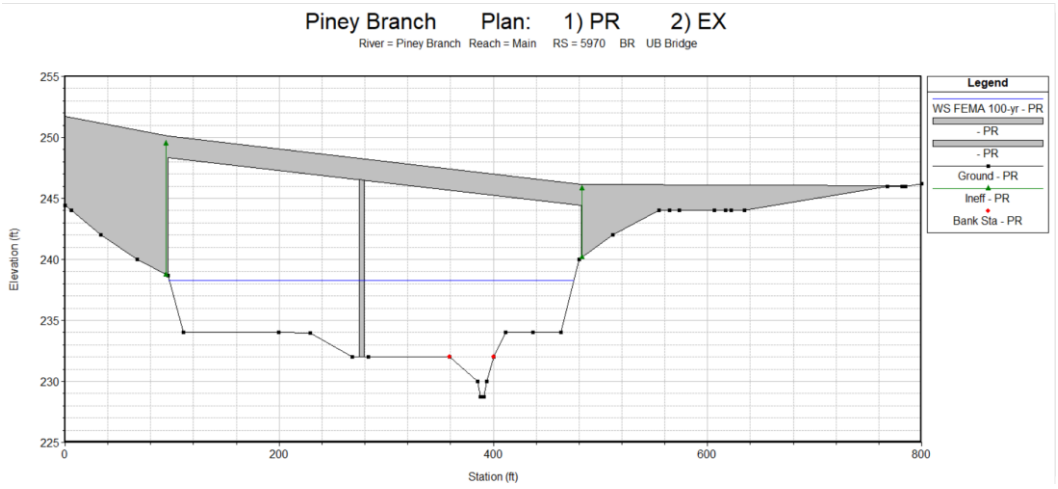


Figure 4-6: Bridge Upstream Internal Cross Section Proposed Geometry

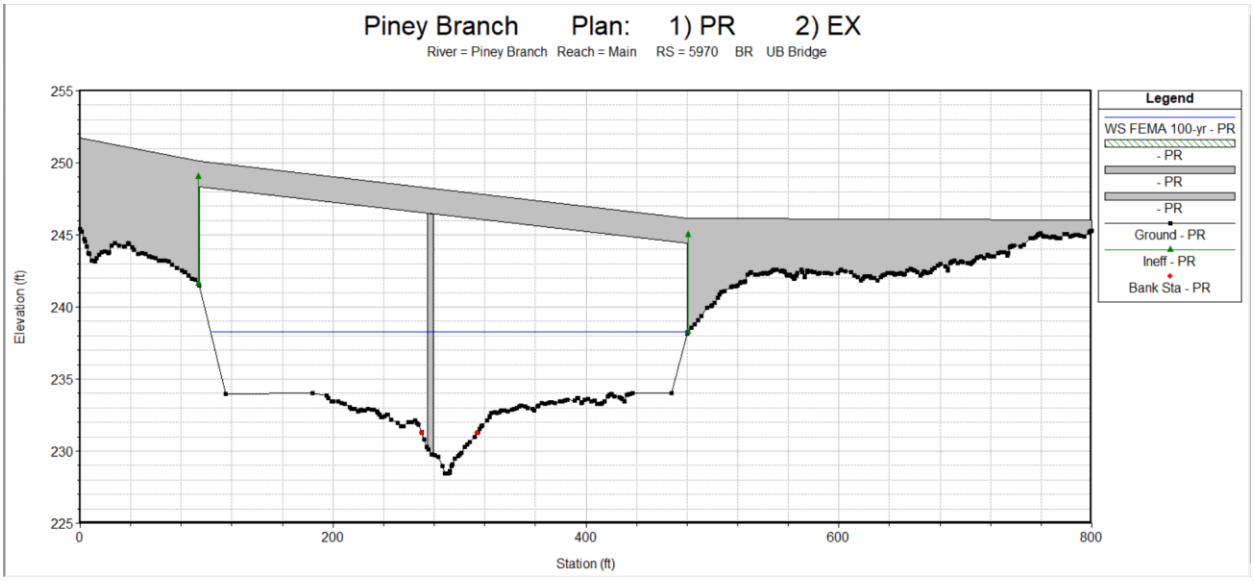


Figure 4-7: Bridge Downstream Internal Cross Section Proposed Geometry

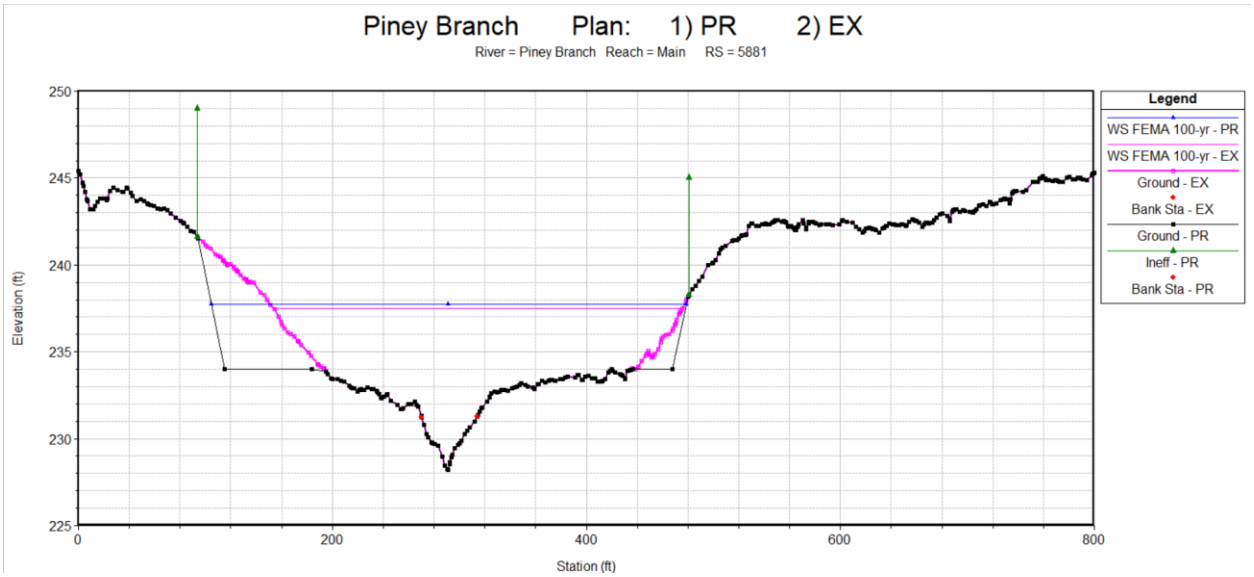


Figure 4-8: River Station 5881 Proposed Geometry (Black) vs Existing Geometry (Magenta)

4.3 SCOUR SAFETY ANALYSES

The scour analysis for this site was performed in accordance with the VDOT Drainage Design Manual, Section 12.3.2, using the procedures and empirical equations outlined in the Federal Highway Administration's Hydraulic Engineering Circular No. 18, Evaluating Scour at Bridges (HEC-18, FHWA 2012). The analysis evaluates contraction, pier, and abutment scour mechanisms to assess the potential impacts of scour on the proposed bridge structure.

While the empirical equations from HEC-18 are considered the best available quantitative methods for the design and analysis of scour at bridges and culverts, scour estimates should be weighed against historical observations of actual scour in the field and professional judgment of scour potential given the material makeup and conditions of the specific channel. For this analysis, the equations used to produce the scour results are considered conservative.

Four scour processes are considered as part of this analysis:

- General Scour
- Contraction Scour
- Pier Scour
- Abutment Scour

Scour computations are presented in Appendix G and are summarized below.

4.3.1 GENERAL SCOUR (LONG-TERM DEGRADATION)

Over time, changes to the channel bed elevations can occur as a result of the natural trend of the stream or changes within the stream or contributing watershed. Long-term degradation does not include the cutting of the streambed at the roadway crossing due to a significant storm event, that is accounted for following the contraction and local scour analysis outlined above.

Long-term channel degradation was not assessed as part of this study. However, no evidence of active or recent vertical incision was observed. A geomorphic assessment is recommended to evaluate the potential for long-term channel degradation and associated scour risk.

4.3.2 CONTRACTION SCOUR

LIVE BED DETERMINATION (FHWA 2012)

One of the first steps in a scour analysis is a determination of whether live-bed or clear-water contraction scour conditions prevail at the project location. Generally, live-bed contraction scour occurs when bed sediment transport is actively occurring. Clear-water contraction scour occurs when there is no such bed sediment transport. These conditions are determined through comparing the average velocity of the flow in the main channel upstream of the bridge opening against the critical velocity for initiating motion of the D50 size of the channel bed material. D50 of 10.2 mm reflecting gravel in the channel was utilized.

The equation for critical velocity is shown below.

$$V_c = K_u y^{\frac{1}{6}} D^{\frac{1}{3}}$$

Figure 4-9: Critical Velocity Equation (HEC-18 Eqn. 6.1)

Where:

- V_c = Critical velocity above which bed material of size D and smaller will be transported, ft/s
- y = Average depth of flow upstream of the bridge, ft
- D = Particle size for Vc, ft
- D_{50} = Particle size in a mixture of which 50 percent are smaller, ft
- K_u = 11.17 English units

The upstream approach cross section was defined using Cross Section 6120; the corresponding cross-section view is provided in Appendix D. A summary of model outputs and computations are presented below. The detailed calculation is provided in Appendix E.

Table 4-3: Upstream Velocity Comparison

Model Scenario		*Critical Velocity (ft/s)*	*Average Velocity Upstream (ft/s)*
Proposed Conditions	*100-YR*	5.0	6.5
	200-YR	5.1	6.9
	500-YR	5.2	7.5

(Note: Average Velocity Upstream is HEC-RAS XS 6120 Channel Velocity)

These calculations indicate that the critical velocity is less than the average approach flow velocity in the main channel upstream of the bridge opening. Therefore, live-bed scour conditions are expected along the stream bed and floodplain valley.

For completeness, both live-bed and clear-water contraction scour conditions were evaluated as part of this analysis. In accordance with HEC-18 Section 6.2, live-bed contraction scour may be limited by bed armoring or by sediment transport into the contracted section. Under these conditions, contraction scour is determined by computing scour depths using both the live-bed and clear-water contraction scour equations and adopting the smaller of the two depths as the governing contraction scour.

Accordingly, for this crossing, both clear-water and live-bed contraction scour depths were calculated, and the smaller resulting depth was selected as the governing contraction scour depth. Based on the results, both the clear-water and live-bed contraction scour equations yielded negative values, indicating that no contraction scour is predicted at the site. Accordingly, the contraction scour depth was taken as zero.

Table 4-4: Clear-Water and Live-Bed Contraction Scour Depths

Model Scenario		*Clear-Water Contraction Scour (ft)*	*Live-Bed Contraction Scour (ft)*
Proposed Conditions	*100-YR*	0	0
	200-YR	0	0
	500-YR	0	0

4.3.3 LOCAL SCOUR AT PIER

HEC-18 GENERAL PIER EQUATION (FHWA 2012)

The primary pier scour equation in HEC-18 is applicable for both live-bed and clearwater conditions. This equation represents piers using a representative width and is often referred to as the "simple" pier scour method. This equation predicts maximum pier scour depths and is shown in Figure 4-10.

$$\frac{y_s}{y_1} = 2.0 K_1 K_2 K_3 \left(\frac{a}{y_1}\right)^{0.65} Fr_1{}^{0.43}$$

Figure 4-10: General Pier Scour Equation (HEC-18 Eqn. 7.3)

The variables used in these computations are as follows:

- ys = Scour depth, ft
- y1 = Flow depth directly upstream of the pier, ft
- K1 = Correction factor for pier nose shape from HEC-18 Figure 7.3 and HEC-18 Table 7.1
- K2 = Correction factor for angle of attack of flow from HEC-18 Table 7.2 or HEC-18 Equation 7.4
- K3 = Correction factor for bed condition from HEC-18 Table 7.3
- a = Pier width, ft (m)
- L = Length of pier, ft (m)
- Fr1 = Froude Number directly upstream of the pier = V1/(gy1)1/2
- V1 = Mean velocity of flow directly upstream of the pier, ft/s
- g = Acceleration of gravity (32.2 ft/s2)

The HEC-18 general pier scour equations were carried out in accordance with HEC-18 Section 7. The results of the analysis are presented below with spreadsheet-based calculations included in Appendix E. The streambed thalweg elevation (El. 228.8 ft) is provided to document the reference elevation used to compute the scoured bed elevation at the pier, which was calculated by subtracting the computed pier scour depth from the existing thalweg elevation.

Table 4-5: General Pier Scour Results (Scour Depth)

MODEL SCENARIO	RETURN FREQUENCY (YR)	TOTAL SCOUR DEPTH (FT)
Proposed Condition	100 yr	8.3
	200 yr	8.5
	500 yr	8.9

Table 4-6: General Pier Scour Results (Scour Elevation)

Model Scenario	Return Frequency (yr)	Total Scour Elevation (ft)
Proposed Condition	100 yr	220.4
	200 yr	220.2
	500 yr	219.9

(Note: Streambed Thalweg Elevation (ft): 228.8)

4.3.4 LOCAL SCOUR AT ABUTMENTS

HEC-18 NCHRP 24-20 ABUTMENT SCOUR APPROACH (FHWA 2012)

NCHRP 24-20 methods provide a single combined local and contraction scour depth value based on velocity, depth, and area for the flow obstructed by the abutments. Main channel and overbank hydraulic parameters were extracted from the HEC-RAS simulations and used to compute abutment scour using in accordance with HEC-18 Section 8. Considering the proximity of each abutment to the main channel, scour condition location type a (main channel) and type b (overbanks) were evaluated. Scour depths were computed under both live-bed and clear-water conditions, and the more conservative scour depth was selected for design considerations. Local Abutment Scour Condition B Clear-Water governs the design. This condition is appropriate because the abutments are located within the overbank areas and are primarily influenced by overbank flow rather than main-channel hydraulics. For purposes of this analysis, left and right abutments are defined based on the HEC-RAS convention of looking downstream. Accordingly, the left abutment corresponds to Abutment B, and the right abutment corresponds to Abutment A.

For purposes of reporting abutment scour elevations, a reference elevation of 234.01 ft was used, corresponding to the proposed graded bench elevation at Cross Section 5970 beneath the bridge opening. This elevation is lower than the existing ground at the face of the proposed abutment and reflects the planned excavation to open the floodplain and improve conveyance through the bridge. Using this lower reference elevation to compute total abutment scour elevations is therefore conservative, as it results in a deeper calculated scour elevation than would be obtained using the existing abutment toe elevation. This approach ensures that the reported abutment scour elevations represent a worst-case condition consistent with the proposed grading and design intent. For design purposes, the lower of the computed left and right abutment scour elevations was adopted as the governing value, providing a conservative basis for design.

Table 4-7: Local Abutment Scour Condition A Live-Bed

Model Scenario	Return Frequency (yr)	Abutment	Reference Location Elevation (ft)	Abutment Scour Depth (ft)	Total Scour Elevation at Abutment (ft)
Proposed Condition	100 yr	Left	234.01	3.9	230.1
		Right	234.01	3.9	230.1
	200 yr	Left	234.01	3.8	230.2
		Right	234.01	3.8	230.2
	500 yr	Left	234.01	3.6	230.4
		Right	234.01	3.6	230.4

Table 4-8: Local Abutment Scour Condition A Clear-Water

Model Scenario	Return Frequency (yr)	Abutment	Reference Location Elevation (ft)	Abutment Scour Depth (ft)	Total Scour Elevation at Abutment (ft)
Proposed Condition	100 yr	Left	234.01	5.9	228.1
		Right	234.01	5.9	228.1
	200 yr	Left	234.01	6.4	227.6
		Right	234.01	6.4	227.6
	500 yr	Left	234.01	7.1	226.9
		Right	234.01	7.1	226.9

Table 4-9: Local Abutment Scour Condition B Live-Bed

Model Scenario	Return Frequency (yr)	Abutment	Reference Location Elevation (ft)	Abutment Scour Depth (ft)	Total Scour Elevation at Abutment (ft)
Proposed Condition	100 yr	Left	234.01	8.8	225.2
		Right	234.01	7.0	227.0
	200 yr	Left	234.01	9.4	224.6
		Right	234.01	6.5	227.5
	500 yr	Left	234.01	10.3	223.7
		Right	234.01	6.6	227.4

Table 4-10: Local Abutment Scour Condition B Clear-Water

Model Scenario	Return Frequency (yr)	Abutment	Reference Location Elevation (ft)	Abutment Scour Depth (ft)	Total Scour Elevation at Abutment (ft)
Proposed Condition	100 yr	Left	234.01	9.1	224.9
		Right	234.01	7.1	226.9
	200 yr	Left	234.01	10.5	223.5
		Right	234.01	7.8	226.3
	500 yr	Left	234.01	12.6	221.4
		Right	234.01	8.4	225.6

4.3.5 SCOUR SUMMARY

This section summarizes the contraction, pier, and abutment scour results for the 100-, 200-, and 500-year events. Contraction scour was calculated as zero for all cases. Abutment scour was governed by the deeper scour depth and lower scour elevation from the left and right abutment results to provide a conservative design basis.

Table 4-11: Summary of Calculated Scour

Model Scenario	Return Frequency (yr)	[1] Contraction Scour (ft)	[2] Max Local Pier Scour (ft)	[3] Long Term Degradation (ft)	[4] Abutment Scour (ft)	[3] + [4] Design Total Abutment Scour (ft)	Design Total Abutment Scour Elevation (ft)*	[1] + [2] + [3] Design Total Pier Scour (ft)	Design Total Pier Scour Elevation (ft)
Proposed Condition	100 yr	0.0	8.3	0.0	9.1	9.1	224.9	8.3	220.4
	200 yr	0.0	8.5	0.0	10.5	10.5	223.5	8.5	220.2
	500 yr	0.0	8.9	0.0	12.6	12.6	221.4	8.9	219.9

4.4 RIPRAP REVETMENT DESIGN

In accordance with VDOT Bridge Manual Section 12.6 and the AASHTO LRFD Bridge Design philosophy, the proposed bridge is designed to be scour-stable without reliance on scour countermeasures. The bridge foundations are designed to accommodate the computed design scour depths.

No riprap or other scour countermeasures are proposed at the bridge pier. In accordance with VDOT guidance, riprap is not considered an acceptable permanent scour countermeasure at bridge piers for new construction.

Riprap revetment is proposed at the abutments to provide protection of the embankment slopes against surface runoff and localized flow impingement during flood events. The abutment revetment is intended as slope protection and erosion control, not as a substitute for scour-stable foundation design.

All abutment revetment, including stone sizing, thickness, bedding, and extent, will be designed in accordance with FHWA Hydraulic Engineering Circular No. 23 (HEC-23) and VDOT Bridge Manual Section 12.6.

As the distance from the near edge of the main channel to the left and right abutment toes are minimal, riprap revetments were sized to protect the left and right channel banks through the proposed bridge crossing. Rock riprap revetment countermeasures were sized following HEC-23 Volume 2 Design Guideline 4. For these computations, check flood outputs from Section 4.3.5

were input to scour calculations for the left and right banks (abutments). Hydraulics Toolbox-based calculations are included in Appendix F.

Table 4-12: Summary of Computed Scour Countermeasure Design at Channel Banks

Model Scenario	Return Frequency (yr)	Riprap Size D_{50} (inches)	Riprap Size D_{100} (inches)	Riprap Thickness (feet)
Proposed Conditions	500 yr	6	12	1

At a minimum the riprap revetments should be constructed of 6-inch D_{50} riprap at a recommended maximum slope of 3H:1V. Minimum riprap thickness of 12-inches should be utilized in construction. The recommended length of protection is recommended as equivalent to the bridge width up and downstream of the proposed bridge.

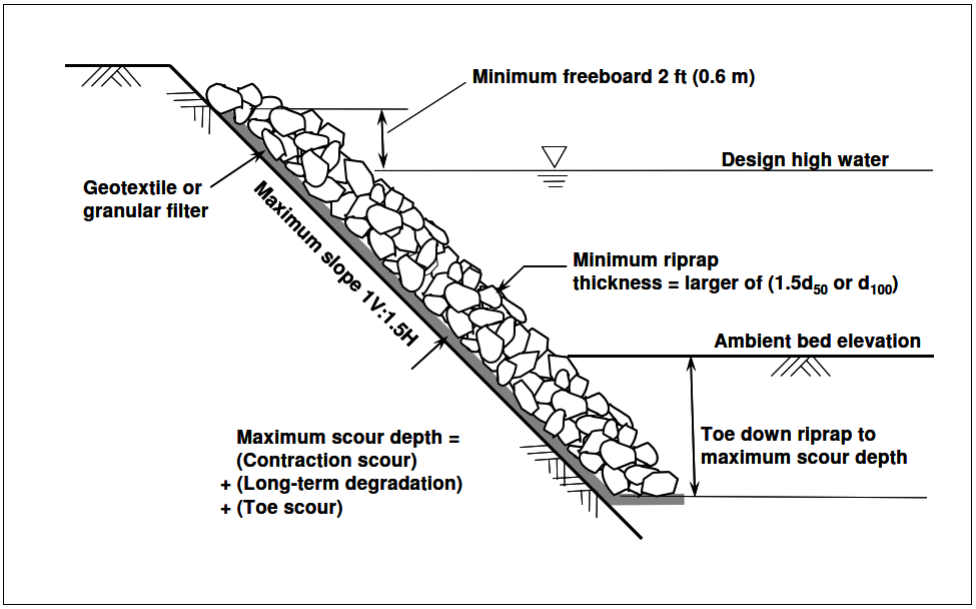


Figure 4-11: Riprap Revetment with Buried Toe (HEC-23 Figure 4.3)

5 CONCLUSIONS AND RECOMMENDATIONS

5.1 CONCLUSIONS

As part of the University Boulevard Extension Project, a scour study was performed to support the bridge design. A flood-frequency analysis was developed based on the effective FEMA hydrologic study, and the resulting peak discharges were applied in the hydraulic analyses.

A one-dimensional HEC-RAS model was used to evaluate hydraulic conditions under both existing and proposed bridge scenarios. The analysis included evaluation of contraction scour, pier scour, and abutment scour in accordance with applicable VDOT and FHWA guidance.

Scour countermeasures were evaluated based on the check flood results and the computed abutment scour depths. Where appropriate, riprap revetment countermeasures were identified for abutment slope protection and erosion control. The proposed countermeasures are discussed in Section 4.4.

5.2 RECOMMENDATIONS

The governing scour condition for the proposed bridge corresponds to the 500-year flood event.

- Pier design: Assume a design scour elevation of El. 219.9 ft. Pier foundations shall be designed to be scour-stable without the use of scour countermeasures, consistent with the VDOT Bridge Manual for new construction.
- Abutment design: Assume a design scour elevation of El. 221.4 ft (Abutment B). Abutment foundations shall be designed to be scour-stable.
- Scour protection: Provide riprap revetment at both abutments above Elevation 221.4 ft for bank and slope protection. At a minimum, provide 6-inch D_{50} riprap with a minimum thickness of 12 inches, placed on a maximum slope of 3H:1V, and extending approximately one bridge width upstream and downstream of the crossing.

Table 5-1: Summary of Calculated Scour

Model Scenario	Design Total Abutment Scour (ft)	Design Total Abutment Scour Elevation (ft)	Design Total Pier Scour (ft)	Design Total Pier Scour Elevation (ft)
Proposed Conditions	12.6	221.4	15.7	219.9

(Note: Total pier scour includes contraction and pier scour. Abutment results represent the left abutment (Abutment B).)

6 REFERENCES

6.1 DATA SOURCES

6.2 DATA APPLICATION

1 US Department of Agriculture, Natural Resources Conservation Service, Urban Hydrology for Small Watersheds TR-55, June 1986.

2 US Department of Commerce, National Oceanic and Atmospheric Administration, Rainfall Atlas 14, Volume 10, Version 3,

3 US Department of Transportation, Federal Highway Administration, Highways in the River Environment – Floodplains, Extreme Events, Risk, and Resilience Hydraulic Engineering Circular No 17, 2nd Edition, Publication No FHWA-HIF-16-018 June 2016.

4 Federal Emergency Management Agency (FEMA). Flood Insurance Study, Prince William County, Virginia and Incorporated Areas, Revised August 3, 2015.

5 Federal Emergency Management Agency (FEMA). Letter of Map Revision (LOMR) Case No. 20-03-0070P-510119, Effective December 3, 2020.

6 U.S. Army Corps of Engineers, Hydrologic Engineering Center (HEC). HEC-RAS Hydraulic Reference Manual. Retrieved from https://www.hec.usace.army.mil/confluence/rasdocs/ras1dtechref/latest

7 FHWA, 2012. Evaluating Scour at Bridges (HEC-18). Hydraulic Engineering Circular No. 18. Federal Highway Administration, U.S. Department of Transportation.

8 FHWA, 2009. Bridge Scour and Stream Instability Countermeasures: Experience, Selection, and Design Guidance-Third Edition, U.S. Department of Transportation.

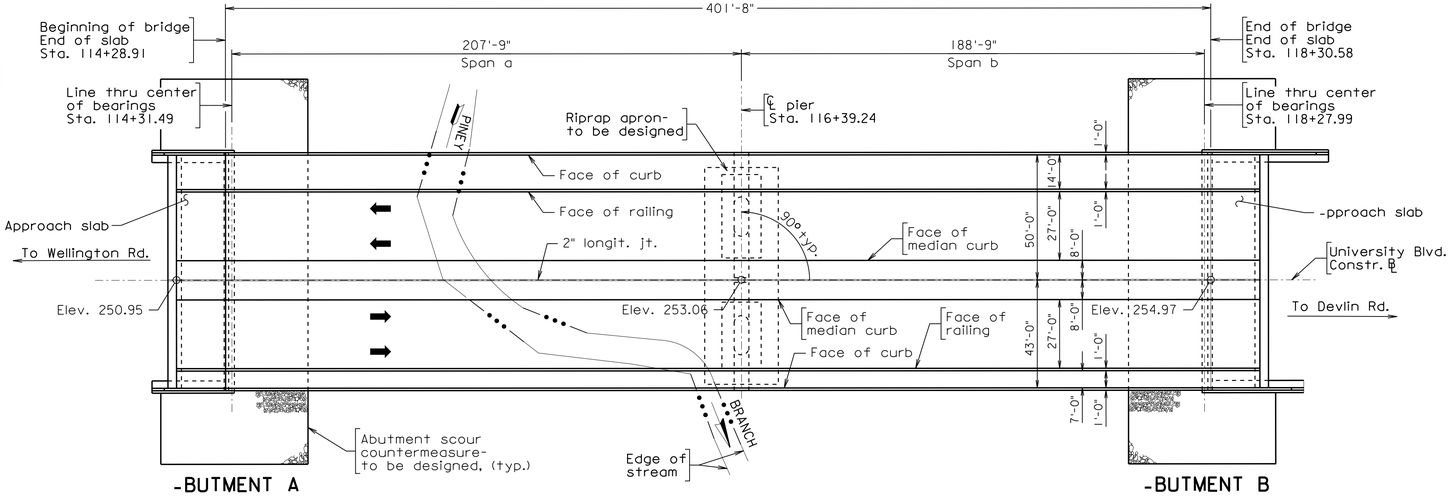
9 United States Army Corps of Engineers, Hydrologic Engineering Center. HEC-RAS River Analysis System User's Manual, Version 6.6. September 2024.

10 FHWA, 2020. Hydraulic Toolbox, Version 6.0. Federal Highway Administration, U.S. Department of Transportation. Available at: https://www.fhwa.dot.gov/engineering/hydraulics/software/toolbox/

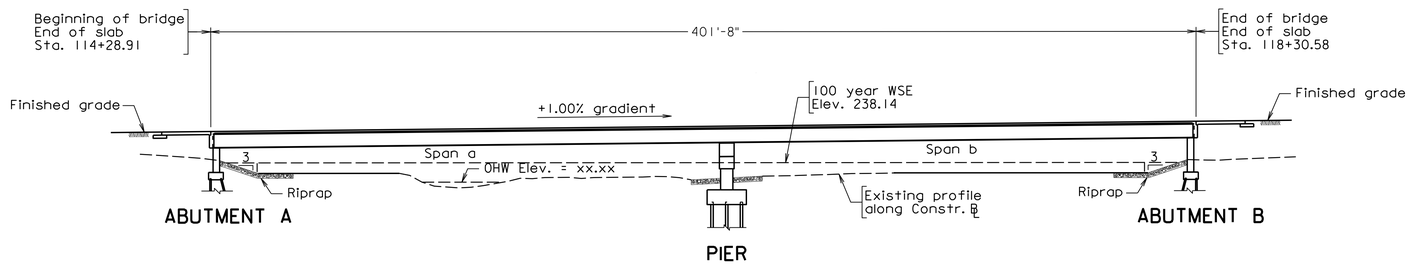
APPENDICES

APPENDIX A
CONSTRUCTION DRAWINGS

STATE	FEDERAL AID		STATE		SHEET NO.
	ROUTE	PROJECT	ROUTE	PROJECT	
V-.	840	RSTP-5B01 (576)	840	0840-076-R21	14(1)
Federal Structure No. 0000000000XXXXX			FHW- Construction and Scour Code:		
Federal Stewardship and Oversight Code:		NFO		UPC No. 118313	



PLAN



DEVELOPED SECTION ALONG CONSTR. ℄

DESIGN EXCEPTION(S):

None

GENERAL NOTES:

Width: 14'-0" shared use path, 12" barrier. 27'-0" roadway, 16'-0" median, 27'-0" roadway, 12" barrier, 7'-0" sidewalk. Overall width: 93'-0" face to face of curbs.

Span layout: 207'-9" - 188'-9"

Capacity: HL-93 loading.

Specifications:

Construction: Virginia Department of Transportation Road and Bridge Specifications, 2020.

Design: A-SHTO LRFD Bridge Design Specifications, 9th Edition, 2020; and VDOT Modifications.

Standards: Virginia Department of Transportation Road and Bridge Standards, 2016; including all current revisions.

These plans are incomplete unless accompanied by the Supplemental Specifications and Special Provisions included in the contract documents.

GP&E.dgn

WSP USA
HERNDON, VA
STRUCTURAL ENGINEER

PL-NS BY:	WSP US-, INC.
COORDINATED:	
SUPERVISED:	MICH-EL MAGYARICS, P.E.
DESIGNED:	MEGAN ZELLNER
DRAWN:	CL-RIS- V. MAYHAY
CHECKED:	MICH-EL MAGYARICS, P.E.

Scale: 1" = 30'

No.	Description	Date
	REVISIONS	
	For Table of Revisions, see Sheet 2.	

VDOT

COMMONWEALTH OF VIRGINIA

DEPARTMENT OF TRANSPORTATION

PROPOSED BRIDGE ON

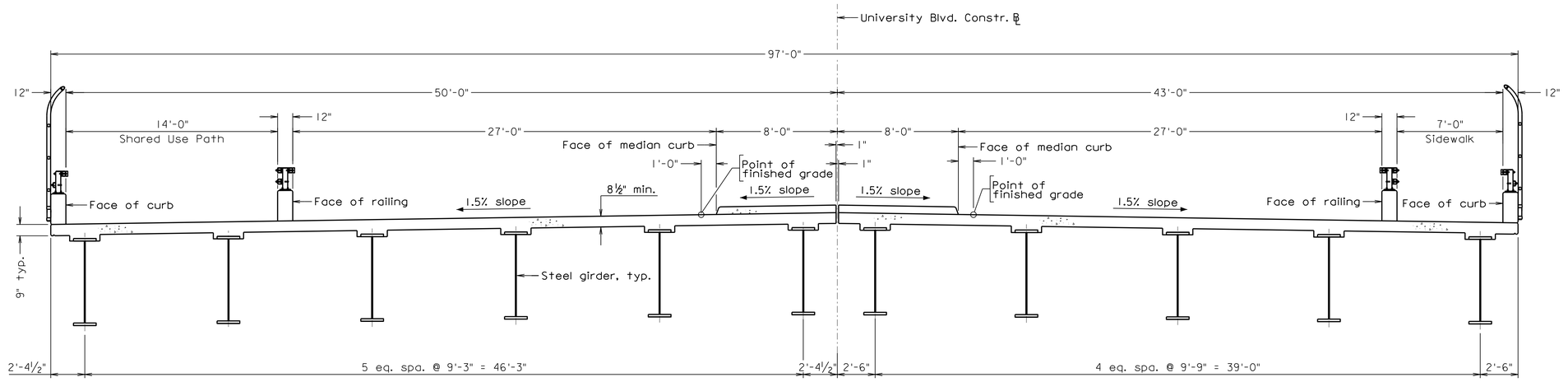
UNIVERSITY BOULEVARD OVER PINEY BRANCH
PRINCE WILLIAM COUNTY - 0.5 MI. RTE. 840
PROJ. 0840-076-R21

Recommended for Approval: _____ _____
District Project Development Engineer Date

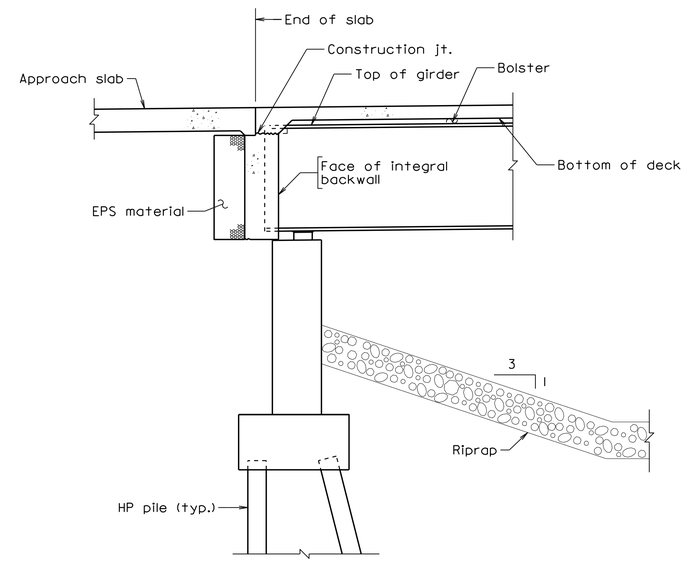
Approved: _____ _____
District Administrator Date

Date: _____

STATE	FEDERAL AID		STATE		SHEET NO.
	ROUTE	PROJECT	ROUTE	PROJECT	
V-.	840	RSTP-5B01 (576)	840	0840-076-R21	14(2)



TRANSVERSE SECTION



SEMI-INTEGRAL ABUTMENT DETAIL

TRANSVERSE SECTION.dgn

WSP USA
HERNDON, VA
STRUCTURAL ENGINEER

Scale: ¼" = 1'-0"

No.	Description	Date
	Revisions	

COMMONWE-LTH OF VIRGINIA
DEP-RTMENT OF TR-NSPORT-TION

STRUCTURE -ND BRIDGE DIVISION

TRANSVERSE SECTION AND ABUTMENT DETAIL

Designed: MZ	Date	Plan No.	Sheet No.
Drawn: CYM	July 2025	XXX-XX	2 of 2
Checked: MM			

APPENDIX B
FEMA FIRMs FOR PROJECT SITE

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, or all planimetric features outside Special Flood Hazard Areas. The community map repository should be consulted for possible updated flood hazard information prior to use of this map for property purchase or construction purposes.

Coastal base flood elevations apply only landward of 0.0' National Geodetic Vertical Datum of 1929 (NVGD), and include the effects of wave action; these elevations may also differ significantly from those developed by the National Weather Service for hurricane evacuation planning.

Areas of special flood hazard (100-year flood) include Zones A, AE, AH, AO, A99, V, and VE.

Certain areas not in Special Flood Hazard Areas may be protected by flood control structures.

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 Federal Emergency Management Agency.

Floodway widths in some areas may be too narrow to show to scale. Floodway widths are provided in the Flood Insurance Study Report.

Corporate limits shown are current as of the date of this map. The user should contact appropriate community officials to determine if corporate limits have changed subsequent to the issuance of this map.

For community map revision history prior to countywide mapping, see section 6.0 of the Flood Insurance Study Report.

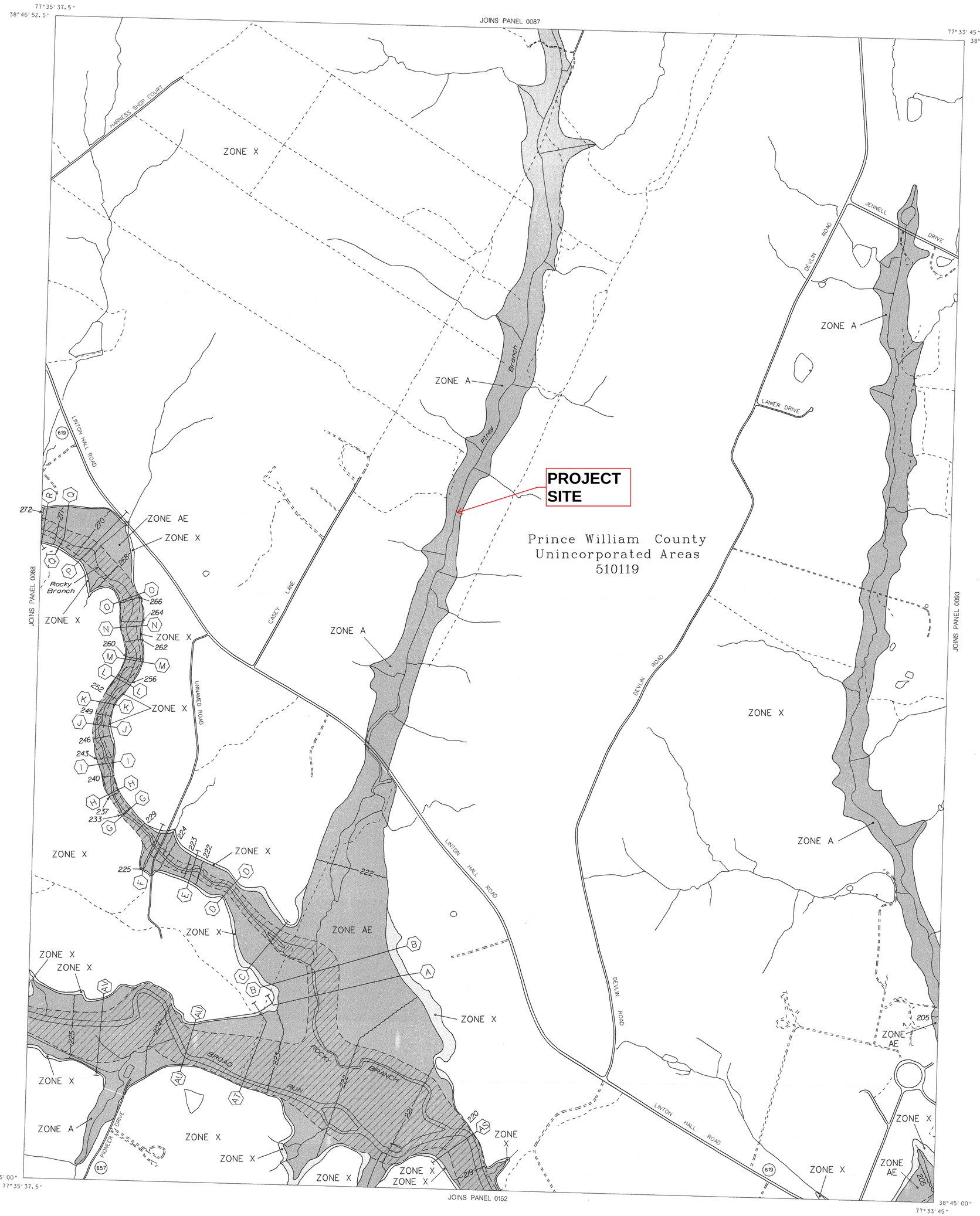
For adjoining map panels see separately printed Map Index.

NOTE: The coordinate system used for the production of this Flood Insurance Rate Map (FIRM) is Universal Transverse Mercator (UTM), North American Datum of 1927 (NAD27), Clarke 1866 spheroid. Corner coordinates shown on the FIRM are in latitude and longitude referenced to the Transverse Mercator projection, NAD27. Differences in the datum and spheroid used in the production of FIRMS for adjacent communities may result in slight positional differences in map features at the community boundaries. These differences do not affect the accuracy of the information shown on the FIRM.

ATTENTION: Flood elevations on this map are referenced to the National Geodetic Vertical Datum of 1929. These flood elevations must be compared to structure and ground elevations referenced to the same datum. For information regarding conversion between the National Geodetic Vertical Datum of 1929 and the North American Vertical Datum of 1988, contact the National Geodetic Survey at the following address:

Vertical Network Branch, N/CG13
National Geodetic Survey, NOAA
Silver Spring Metro Center 3
1315 East- West Highway
Silver Spring, Maryland 20910
(301) 713-3191

Base Map Source: Base map information prepared by the Prince William County Office of Mapping. This information was compiled by photogrammetric methods from aerial photographs taken February 1987, and complies with U.S. National Map Accuracy Standards. Roads shown on this map represent edge of pavement. This map is based on the Transverse Mercator projection: the map edges represent parallels and meridians. the apparent tilt of the map is inherent in the use of this projection in a standardized map orientation.



LEGEND

SPECIAL FLOOD HAZARD AREAS INUNDATED BY 100-YEAR 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 A99	To be protected from 100-year flood by Federal flood protection system under construction; no base flood elevations determined.
ZONE V	Coastal flood with velocity hazard (wave action); no base flood elevations determined.
ZONE VE	Coastal flood with velocity hazard (wave action); base flood elevations determined.

FLOODWAY AREAS IN ZONE AE

OTHER FLOOD AREAS

ZONE X	Areas of 500-year flood; areas of 100-year flood with average depths of less than 1 foot or with drainage areas less than 1 square mile, and areas protected by levees from 100-year flood.

OTHER AREAS

ZONE X	Areas determined to be outside 500-year floodplain.
ZONE D	Areas in which flood hazards are undetermined.

UNDEVELOPED COASTAL BARRIERS*

Identified 1983 | Identified 1990 | Otherwise Protected Areas

*Coastal barrier areas are normally located within or adjacent to Special Flood Hazard Areas.

- Floodplain Boundary
- Floodway Boundary
- Zone D Boundary
- Boundary Dividing Special Flood Hazard Zones, and Boundary Dividing Areas of Different Coastal Base Flood Elevations Within Special Flood Hazard Zones.
- 513 — Base Flood Elevation Line; Elevation in Feet**
- A — A — Cross Section Line
- (EL 987) — Base Flood Elevation in Feet Where Uniform Within Zone**
- RM7x — Elevation Reference Mark
- M1.5 — River Mile

**Referenced to the National Geodetic Vertical Datum of 1929

MAP REPOSITORY

Refer to Repository Listing on Map Index

EFFECTIVE DATE OF COUNTYWIDE FLOOD INSURANCE RATE MAP

JANUARY 5, 1995

EFFECTIVE DATE(S) OF REVISION(S) TO THIS PANEL

Refer to the FLOOD INSURANCE RATE MAP effective date shown on this map to determine when actuarial rates apply to structures in the zones where elevations or depths have been established.

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

APPROXIMATE SCALE
500 0 500 FEET

NATIONAL FLOOD INSURANCE PROGRAM

FIRM
FLOOD INSURANCE RATE MAP

PRINCE WILLIAM COUNTY, VIRGINIA AND INCORPORATED AREAS

PANEL 89 OF 330

(SEE MAP INDEX FOR PANELS NOT PRINTED)

CONTAINS:

COMMUNITY	NUMBER	PANEL	SUFFIX
UNINCORPORATED AREAS	5101 9	0089	D

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
51153C0089 D

EFFECTIVE DATE :
JANUARY 5, 1995

Federal Emergency Management Agency

APPENDIX C
HYDROLOGIC ANALYSES

NOAA Atlas 14, Volume 2, Version 3
Location name: Linton Hall, Virginia, USA*
Latitude: 38.7696°, Longitude: -77.5789°
Elevation: 231 ft**
* source: ESRI Maps
** source: USGS

POINT PRECIPITATION FREQUENCY ESTIMATES

G.M. Bonnin, D. Martin, B. Lin, T. Parzybok, M.Yekta, and D. Riley

NOAA, National Weather Service, Silver Spring, Maryland

PF_tabular | PF_graphical | Maps_&_aerials

PF tabular

PDS-based point precipitation frequency estimates with 90% confidence intervals (in inches)[1]

Duration	Average recurrence interval (years)									
	1	2	5	10	25	50	100	200	500	1000
5-min	**0.340** (0.306-0.377)	**0.407** (0.366-0.452)	**0.485** (0.435-0.538)	**0.543** (0.486-0.601)	**0.616** (0.549-0.682)	**0.672** (0.596-0.742)	**0.728** (0.641-0.803)	**0.782** (0.684-0.864)	**0.853** (0.740-0.945)	**0.909** (0.783-1.01)
10-min	**0.543** (0.488-0.602)	**0.650** (0.585-0.721)	**0.775** (0.696-0.861)	**0.866** (0.777-0.961)	**0.980** (0.873-1.08)	**1.07** (0.947-1.18)	**1.15** (1.02-1.27)	**1.24** (1.08-1.37)	**1.35** (1.17-1.49)	**1.43** (1.23-1.59)
15-min	**0.678** (0.610-0.752)	**0.816** (0.735-0.906)	**0.980** (0.881-1.09)	**1.10** (0.982-1.21)	**1.24** (1.11-1.37)	**1.35** (1.20-1.49)	**1.46** (1.28-1.61)	**1.56** (1.37-1.72)	**1.70** (1.47-1.88)	**1.79** (1.54-1.99)
30-min	**0.928** (0.835-1.03)	**1.12** (1.01-1.25)	**1.39** (1.25-1.54)	**1.58** (1.42-1.76)	**1.84** (1.64-2.03)	**2.03** (1.80-2.25)	**2.23** (1.96-2.46)	**2.42** (2.12-2.68)	**2.69** (2.34-2.98)	**2.90** (2.50-3.22)
60-min	**1.16** (1.04-1.28)	**1.41** (1.27-1.57)	**1.78** (1.60-1.98)	**2.06** (1.85-2.29)	**2.44** (2.18-2.70)	**2.75** (2.44-3.04)	**3.07** (2.71-3.39)	**3.40** (2.98-3.76)	**3.86** (3.35-4.28)	**4.23** (3.64-4.69)
2-hr	**1.36** (1.22-1.51)	**1.65** (1.48-1.84)	**2.10** (1.88-2.34)	**2.46** (2.19-2.73)	**2.96** (2.63-3.29)	**3.38** (2.98-3.74)	**3.82** (3.35-4.23)	**4.29** (3.73-4.74)	**4.96** (4.27-5.50)	**5.50** (4.70-6.12)
3-hr	**1.46** (1.31-1.65)	**1.78** (1.59-2.00)	**2.25** (2.01-2.53)	**2.64** (2.35-2.96)	**3.19** (2.81-3.56)	**3.64** (3.20-4.06)	**4.13** (3.59-4.60)	**4.64** (4.01-5.19)	**5.39** (4.60-6.03)	**6.01** (5.07-6.74)
6-hr	**1.81** (1.62-2.05)	**2.19** (1.96-2.47)	**2.76** (2.46-3.12)	**3.23** (2.87-3.64)	**3.93** (3.46-4.42)	**4.51** (3.95-5.07)	**5.15** (4.47-5.78)	**5.84** (5.02-6.55)	**6.86** (5.82-7.71)	**7.71** (6.45-8.68)
12-hr	**2.20** (1.96-2.49)	**2.65** (2.37-2.99)	**3.35** (2.99-3.78)	**3.95** (3.50-4.45)	**4.85** (4.27-5.44)	**5.63** (4.91-6.31)	**6.50** (5.61-7.28)	**7.46** (6.36-8.35)	**8.91** (7.46-10.0)	**10.2** (8.39-11.4)
24-hr	**2.48** (2.20-2.83)	**3.00** (2.66-3.43)	**3.84** (3.41-4.39)	**4.58** (4.06-5.22)	**5.72** (5.03-6.48)	**6.72** (5.88-7.59)	**7.85** (6.81-8.84)	**9.14** (7.84-10.2)	**11.1** (9.37-12.4)	**12.8** (10.7-14.3)
2-day	**2.88** (2.58-3.25)	**3.48** (3.12-3.93)	**4.45** (3.99-5.02)	**5.29** (4.72-5.95)	**6.54** (5.80-7.34)	**7.63** (6.72-8.54)	**8.84** (7.72-9.88)	**10.2** (8.82-11.4)	**12.2** (10.4-13.6)	**14.0** (11.8-15.6)
3-day	**3.05** (2.74-3.42)	**3.69** (3.31-4.14)	**4.71** (4.23-5.28)	**5.59** (5.00-6.25)	**6.91** (6.15-7.70)	**8.06** (7.12-8.96)	**9.33** (8.18-10.3)	**10.7** (9.34-11.9)	**12.9** (11.0-14.2)	**14.7** (12.4-16.2)
4-day	**3.22** (2.90-3.59)	**3.89** (3.51-4.34)	**4.97** (4.47-5.53)	**5.90** (5.29-6.55)	**7.28** (6.49-8.06)	**8.48** (7.52-9.36)	**9.82** (8.63-10.8)	**11.3** (9.85-12.4)	**13.5** (11.6-14.8)	**15.4** (13.1-16.9)
7-day	**3.73** (3.36-4.15)	**4.49** (4.05-4.99)	**5.66** (5.11-6.29)	**6.67** (6.00-7.40)	**8.17** (7.31-9.03)	**9.46** (8.42-10.4)	**10.9** (9.61-12.0)	**12.4** (10.9-13.7)	**14.7** (12.8-16.2)	**16.7** (14.3-18.4)
10-day	**4.26** (3.87-4.70)	**5.11** (4.64-5.64)	**6.38** (5.80-7.03)	**7.44** (6.73-8.18)	**8.97** (8.09-9.84)	**10.2** (9.20-11.2)	**11.6** (10.4-12.7)	**13.1** (11.6-14.3)	**15.2** (13.4-16.7)	**17.0** (14.8-18.6)
20-day	**5.77** (5.30-6.30)	**6.86** (6.30-7.49)	**8.28** (7.61-9.04)	**9.44** (8.66-10.3)	**11.1** (10.1-12.0)	**12.4** (11.3-13.5)	**13.7** (12.4-14.9)	**15.1** (13.6-16.5)	**17.0** (15.2-18.6)	**18.5** (16.5-20.3)
30-day	**7.08** (6.58-7.64)	**8.37** (7.78-9.04)	**9.95** (9.24-10.7)	**11.2** (10.4-12.1)	**13.0** (12.0-14.0)	**14.3** (13.2-15.5)	**15.8** (14.5-17.0)	**17.2** (15.7-18.6)	**19.2** (17.4-20.7)	**20.7** (18.7-22.4)
45-day	**8.90** (8.33-9.49)	**10.5** (9.82-11.2)	**12.2** (11.5-13.1)	**13.6** (12.7-14.5)	**15.4** (14.4-16.4)	**16.7** (15.6-17.8)	**18.1** (16.8-19.3)	**19.4** (18.0-20.6)	**21.0** (19.5-22.5)	**22.3** (20.5-23.8)
60-day	**10.6** (9.93-11.3)	**12.4** (11.7-13.2)	**14.4** (13.5-15.3)	**15.8** (14.8-16.8)	**17.7** (16.6-18.8)	**19.1** (17.8-20.3)	**20.4** (19.0-21.7)	**21.7** (20.1-23.1)	**23.3** (21.5-24.8)	**24.4** (22.5-26.1)

[1] Precipitation frequency (PF) estimates in this table are based on frequency analysis of partial duration series (PDS).

Numbers in parenthesis are PF estimates at lower and upper bounds of the 90% confidence interval. The probability that precipitation frequency estimates (for a given duration and average recurrence interval) will be greater than the upper bound (or less than the lower bound) is 5%. Estimates at upper bounds are not checked against probable maximum precipitation (PMP) estimates and may be higher than currently valid PMP values.

Please refer to NOAA Atlas 14 document for more information.

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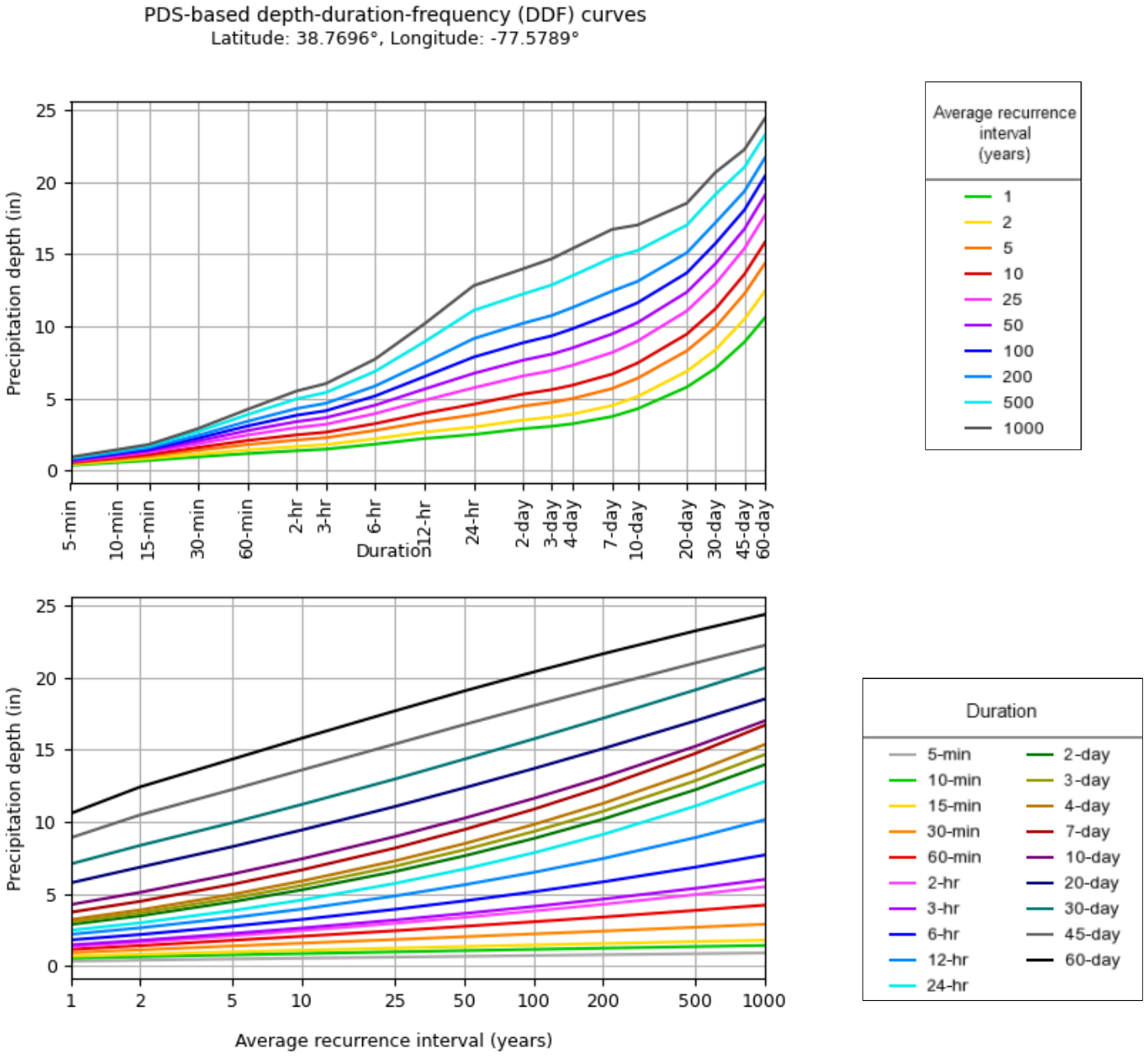
PF graphical



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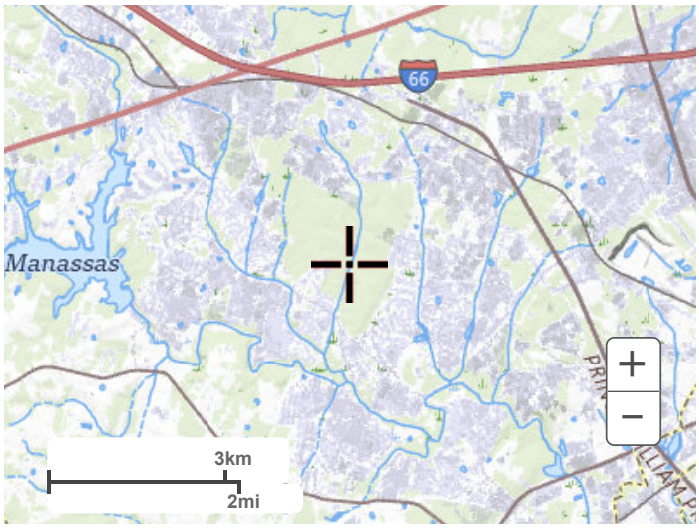
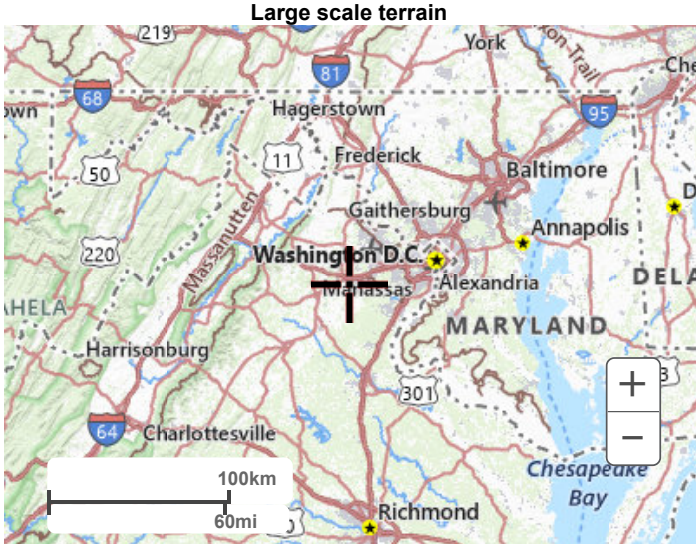
Maps & aerials

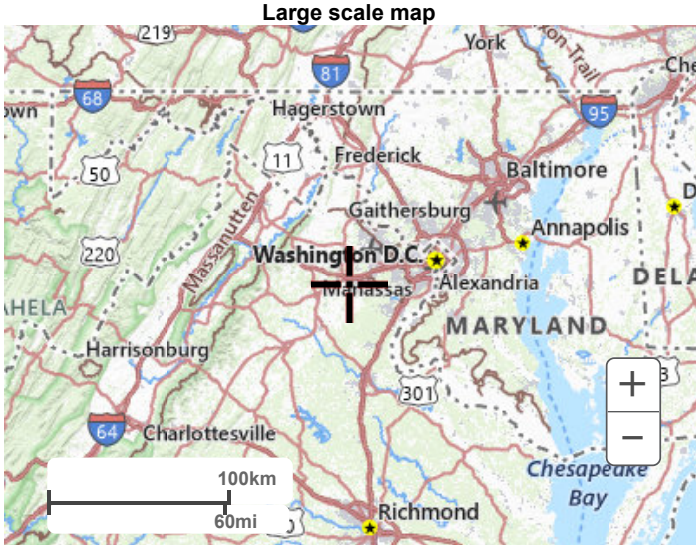
Small scale terrain



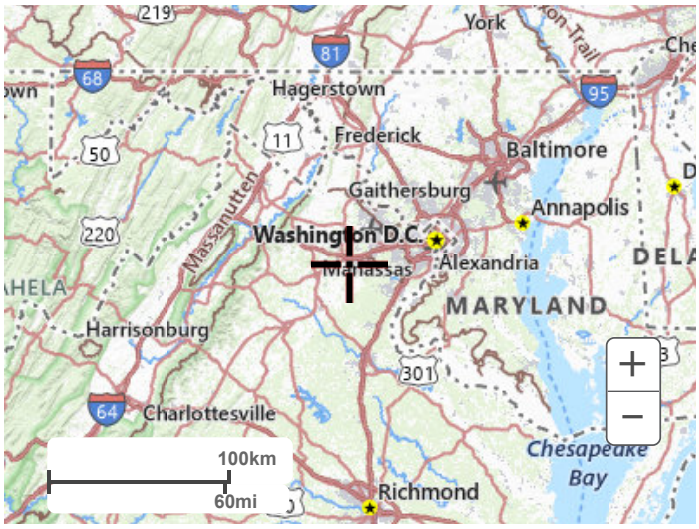
Large scale terrain



Large scale map



Large scale aerial



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National Oceanic and Atmospheric Administration
National Weather Service
National Water Center
1325 East West Highway
Silver Spring, MD 20910
Questions?: HDSC.Questions@noaa.gov

Disclaimer

LOMR TR-55 DATA - MODIFIED TO ADD 200- AND 500-YR ANALYSIS

WinTR-55 Current Data Description

--- Identification Data ---

User: CVF
Project:
SubTitle:
State: Virginia
County: Prince William NOAA_C
Filename: C:\Users\USLL709941\OneDrive - WSP O365\Desktop\University Blvd VA\hydrology\Flow Calcs.w55

Date: 1/16/2026
Units: English
Areal Units: Acres

--- Sub-Area Data ---

Name	Description	Reach	Area(ac)	RCN	Tc
DA		Outlet	1208.8	91	.977

Total area: 1208.80 (ac)

--- Storm Data --

Rainfall Depth by Rainfall Return Period

2-Yr (in)	5-Yr (in)	10-Yr (in)	25-Yr (in)	100-Yr (in)	200-Yr (in)	500-Yr (in)
3.1	4.0	4.8	6.0	8.2	9.54	11.59

Storm Data Source: User-provided custom storm data
Rainfall Distribution Type: Type II
Dimensionless Unit Hydrograph: <standard>

CVF

Prince William NOAA_C County, Virginia

Storm Data

Rainfall Depth by Rainfall Return Period

2-Yr (in)	5-Yr (in)	10-Yr (in)	25-Yr (in)	100-Yr (in)	200-Yr (in)	500-Yr (in)
3.1	4.0	4.8	6.0	8.2	9.54	11.59

Storm Data Source: User-provided custom storm data
Rainfall Distribution Type: Type II
Dimensionless Unit Hydrograph: <standard>

CVF

Prince William NOAA_C County, Virginia

Watershed Peak Table

Sub-Area or Reach Identifier	Peak Flow by Rainfall Return Period 2-Yr (cfs)	5-Yr (cfs)	10-Yr (cfs)	25-Yr (cfs)	100-Yr (cfs)	200-Yr (cfs)	500-Yr (cfs)
SUBAREAS							
DA	1475.58	2039.49	2542.46	3292.33	4640.62	5478.10	6732.77
REACHES							
OUTLET	1475.58	2039.49	2542.46	3292.33	4640.62	5478.10	6732.77

CVF

Prince William NOAA_C County, Virginia

Hydrograph Peak/Peak Time Table

Sub-Area or Reach Identifier	Peak Flow and Peak Time (hr) by Rainfall Return Period						
	2-Yr	5-Yr	10-Yr	25-Yr	100-Yr	200-Yr	500-Yr
	(cfs) (hr)	(cfs) (hr)	(cfs) (hr)	(cfs) (hr)	(cfs) (hr)	(cfs) (hr)	(cfs) (hr)
SUBAREAS							
DA	1475.58 12.45	2039.49 12.43	2542.46 12.45	3292.33 12.45	4640.62 12.42	5478.10 12.45	6732.77 12.44
REACHES							
OUTLET	1475.58	2039.49	2542.46	3292.33	4640.62	5478.10	6732.77

CVF

Prince William NOAA_C County, Virginia

Sub-Area Summary Table

Sub-Area Identifier	Drainage Area (ac)	Time of Concentration (hr)	Curve Number	Receiving Reach	Sub-Area Description
DA	1208.80	0.977	91	Outlet	

Total Area: 1208.80 (ac)

CVF

Prince William NOAA_C County, Virginia

Sub-Area Time of Concentration Details

Sub-Area Identifier/	Flow Length (ft)	Slope (ft/ft)	Mannings's n	End Area (sq ft)	Wetted Perimeter (ft)	Velocity (ft/sec)	Travel Time (hr)
DA							
SHEET	100	0.0100	0.400				0.480
SHALLOW	1060	0.0226	0.050				0.121
CHANNEL	12185	0.0097	0.030	50.00	20.00	9.002	0.376
					Time of Concentration		.977

CVF

Prince William NOAA_C County, Virginia

Sub-Area Land Use and Curve Number Details

Sub-Area Identifier	Land Use		Hydrologic Soil Group	Sub-Area Area (ac)	Curve Number
DA	Open space; grass cover > 75%	(good)	A	4.5	39
	Open space; grass cover > 75%	(good)	B	2.2	61
	Open space; grass cover > 75%	(good)	C	14	74
	Open space; grass cover > 75%	(good)	D	50.4	80
	Industrial		A	5.4	81
	Industrial		B	14.3	88
	Industrial		C	108	91
	Industrial		D	915.8	93
	Residential districts (1 acre)		C	15	79
	Residential districts (1 acre)		D	79.2	84
	Total Area / Weighted Curve Number			1208.8	91

APPENDIX D
HYDRAULIC ANALYSES

HEC-RAS Plan: PR River: Piney Branch Reach: Main

Reach	River Sta	Profile	Top W Right	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl	Q Channel	Q Left	Q Right	Top W Left	Top W Chnl
			(ft)	(ft)	(ft)	(ft)	(ft)	(ft/ft)	(ft/s)	(sq ft)	(ft)		(cfs)	(cfs)	(cfs)	(ft)	(ft)
Main	8920	FEMA 100-yr	133.31	243.50	251.27		251.91	0.001654	7.37	1380.21	370.61	0.49	3508.64	650.50	481.86	169.30	68.00
Main	8920	FEMA 200-yr	147.31	243.50	251.82		252.53	0.001699	7.85	1592.53	401.43	0.50	4033.39	827.39	617.32	186.11	68.00
Main	8920	FEMA 500-yr	160.30	243.50	252.58		253.36	0.001710	8.40	1910.21	429.21	0.51	4749.10	1132.35	851.32	200.91	68.00
Main	8820	FEMA 100-yr	115.17	243.00	249.92	249.65	251.54	0.005064	11.42	853.88	293.63	0.83	3682.50	464.41	494.09	123.47	55.00
Main	8820	FEMA 200-yr	125.61	243.00	250.46	250.24	252.16	0.004895	11.90	1018.57	318.27	0.83	4190.44	629.14	658.51	137.65	55.00
Main	8820	FEMA 500-yr	141.23	243.00	251.29	250.86	253.01	0.004419	12.27	1298.40	354.75	0.80	4879.98	916.96	935.84	158.52	55.00
Main	8720	FEMA 100-yr	94.38	242.50	249.45	249.09	251.01	0.004999	11.36	875.38	286.27	0.83	3568.32	764.69	307.99	138.39	53.50
Main	8720	FEMA 200-yr	103.78	242.50	249.77	249.63	251.62	0.005613	12.47	970.35	303.62	0.88	4133.19	946.25	398.66	146.34	53.50
Main	8720	FEMA 500-yr	115.84	242.50	250.34	250.33	252.45	0.005902	13.56	1150.73	329.89	0.92	4905.24	1248.30	579.23	160.55	53.50
Main	8620	FEMA 100-yr	119.54	240.50	248.73	248.73	250.47	0.005027	12.55	996.80	354.05	0.84	3282.33	862.22	496.45	196.81	37.70
Main	8620	FEMA 200-yr	136.21	240.50	249.26	249.26	251.06	0.004932	13.06	1196.15	391.12	0.84	3679.72	1143.43	654.95	217.21	37.70
Main	8620	FEMA 500-yr	157.11	240.50	249.93	249.70	251.83	0.004930	13.83	1474.17	437.61	0.85	4245.40	1578.71	908.66	242.80	37.70
Main	8520	FEMA 100-yr	114.30	239.50	248.92		249.72	0.002499	10.23	1601.81	411.78	0.61	2218.04	1490.98	931.98	272.46	25.01
Main	8520	FEMA 200-yr	118.05	239.50	249.54		250.33	0.002391	10.48	1859.49	421.03	0.61	2433.98	1919.25	1124.88	277.97	25.01
Main	8520	FEMA 500-yr	123.49	239.50	250.35		251.15	0.002331	10.94	2205.58	435.35	0.61	2762.07	2558.31	1412.40	286.85	25.01
Main	8420	FEMA 100-yr	190.56	239.30	249.07		249.47	0.000808	6.00	1831.62	372.91	0.36	3224.81	444.60	971.59	121.74	60.60
Main	8420	FEMA 200-yr	199.21	239.30	249.64		250.09	0.000869	6.48	2047.42	387.30	0.37	3707.32	571.62	1199.16	127.49	60.60
Main	8420	FEMA 500-yr	208.86	239.30	250.40		250.93	0.000947	7.13	2348.09	404.22	0.39	4403.60	771.97	1557.19	134.76	60.60
Main	8320	FEMA 100-yr	147.04	239.10	248.69		249.32	0.002222	9.59	1652.29	354.89	0.57	1924.44	1460.33	1256.23	184.98	22.87
Main	8320	FEMA 200-yr	152.35	239.10	249.27		249.93	0.002279	10.13	1858.80	366.27	0.58	2165.33	1790.05	1522.72	191.05	22.87
Main	8320	FEMA 500-yr	159.90	239.10	250.02		250.76	0.002376	10.89	2142.14	381.89	0.60	2517.81	2291.47	1923.49	199.12	22.87
Main	8220	FEMA 100-yr	164.87	238.90	248.36		249.04	0.002846	11.39	1597.52	339.39	0.66	1446.04	1312.52	1882.44	160.82	13.70
Main	8220	FEMA 200-yr	170.08	238.90	248.92		249.64	0.002928	12.02	1792.89	351.64	0.68	1618.67	1615.19	2244.24	167.86	13.70
Main	8220	FEMA 500-yr	176.97	238.90	249.67		250.46	0.003056	12.89	2061.91	367.83	0.70	1868.76	2077.35	2786.66	177.16	13.70
Main	8120	FEMA 100-yr	171.47	238.70	246.72	246.72	248.45	0.006796	15.69	1073.91	294.97	0.99	2006.14	760.11	1874.76	107.13	16.37
Main	8120	FEMA 200-yr	177.90	238.70	247.18	247.18	249.03	0.007062	16.62	1213.62	309.79	1.02	2250.61	953.47	2274.02	115.52	16.37
Main	8120	FEMA 500-yr	186.84	238.70	247.83	247.83	249.82	0.007304	17.77	1419.18	330.39	1.05	2592.67	1261.77	2878.33	127.18	16.37
Main	8020	FEMA 100-yr	178.99	238.50	245.82	245.82	247.42	0.007557	15.42	1059.10	303.16	1.03	1910.67	579.33	2151.00	106.56	17.61
Main	8020	FEMA 200-yr	183.58	238.50	246.29	246.22	247.97	0.007602	16.16	1206.22	316.48	1.04	2136.67	756.45	2584.98	115.30	17.61
Main	8020	FEMA 500-yr	191.32	238.50	247.05	246.81	248.73	0.007160	16.72	1453.24	336.54	1.03	2433.27	1063.58	3235.93	127.61	17.61
Main	7920	FEMA 100-yr	192.33	238.30	245.48	244.90	246.68	0.004333	10.49	1068.93	339.06	0.76	3209.65	462.84	968.51	94.73	52.00
Main	7920	FEMA 200-yr	211.22	238.30	246.03	245.34	247.28	0.004161	10.91	1261.85	365.77	0.76	3648.05	596.63	1233.42	102.55	52.00
Main	7920	FEMA 500-yr	230.19	238.30	246.79		248.09	0.003905	11.39	1551.86	397.74	0.75	4257.04	798.79	1676.94	115.55	52.00
Main	7820	FEMA 100-yr	232.74	238.10	245.22		246.19	0.003899	10.93	1310.27	357.19	0.74	2315.51	393.80	1931.70	93.22	31.23
Main	7820	FEMA 200-yr	243.09	238.10	245.81		246.79	0.003727	11.30	1525.67	376.22	0.73	2600.06	524.43	2353.61	101.90	31.23
Main	7820	FEMA 500-yr	255.11	238.10	246.61		247.62	0.003538	11.79	1834.31	400.00	0.73	3004.76	732.27	2995.75	113.66	31.23
Main	7720	FEMA 100-yr	212.50	237.00	245.11		245.81	0.002334	8.40	1393.64	363.54	0.57	2919.20	299.41	1422.39	98.95	52.09
Main	7720	FEMA 200-yr	220.41	237.00	245.68		246.43	0.002294	8.80	1608.50	381.06	0.58	3323.39	407.53	1747.19	108.56	52.09
Main	7720	FEMA 500-yr	233.35	237.00	246.45		247.28	0.002305	9.43	1916.42	421.68	0.59	3936.68	559.86	2236.23	136.24	52.09
Main	7620	FEMA 100-yr	203.11	236.20	244.85		245.47	0.002312	8.00	1456.94	382.70	0.56	2839.70	438.58	1362.73	123.29	56.30
Main	7620	FEMA 200-yr	211.01	236.20	245.44		246.10	0.002223	8.33	1690.69	402.36	0.56	3236.29	577.70	1664.11	135.05	56.30
Main	7620	FEMA 500-yr	222.18	236.20	246.23		246.94	0.002154	8.81	2018.94	428.29	0.56	3816.51	802.77	2113.50	149.82	56.30

HEC-RAS Plan: PR River: Piney Branch Reach: Main (Continued)

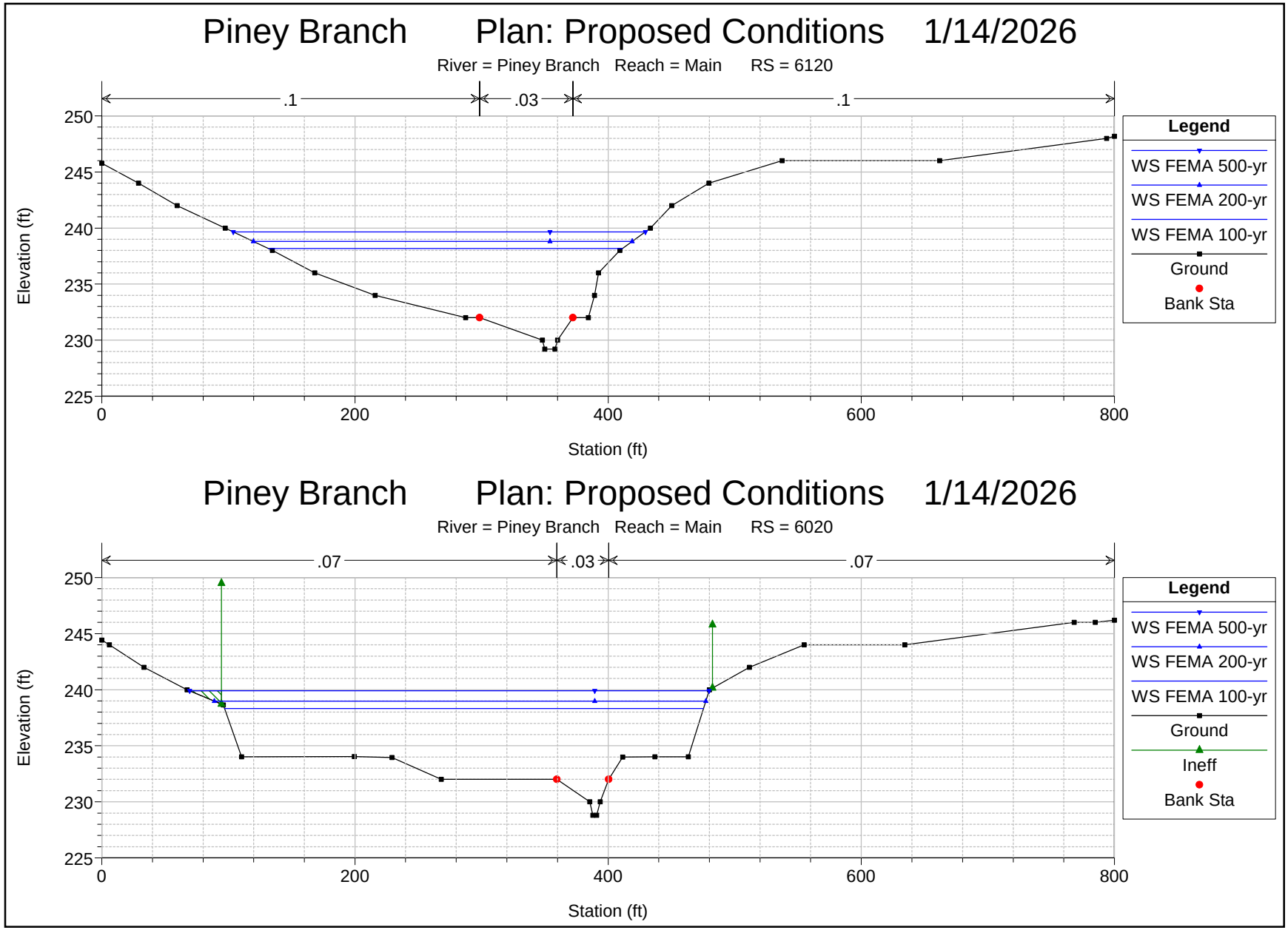
Reach	River Sta	Profile	Top W Right	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl	Q Channel	Q Left	Q Right	Top W Left	Top W Chnl
			(ft)	(ft)	(ft)	(ft)	(ft)	(ft/ft)	(ft/s)	(sq ft)	(ft)		(cfs)	(cfs)	(cfs)	(ft)	(ft)
Main	7520	FEMA 100-yr	201.43	235.80	244.59		245.17	0.002960	10.52	1658.46	391.00	0.65	1408.35	900.24	2332.41	173.31	16.26
Main	7520	FEMA 200-yr	217.07	235.80	245.19		245.80	0.002979	11.06	1900.65	417.92	0.66	1588.20	1177.39	2712.51	184.59	16.26
Main	7520	FEMA 500-yr	238.00	235.80	245.99		246.64	0.002992	11.74	2249.96	453.94	0.67	1839.45	1606.55	3286.78	199.68	16.26
Main	7420	FEMA 100-yr	159.27	235.60	244.07		244.83	0.003010	9.98	1423.01	344.75	0.65	2155.80	749.28	1735.92	155.62	29.86
Main	7420	FEMA 200-yr	172.51	235.60	244.59		245.45	0.003169	10.73	1609.34	370.45	0.68	2483.76	971.28	2023.05	168.09	29.86
Main	7420	FEMA 500-yr	190.34	235.60	245.30		246.27	0.003343	11.68	1881.44	405.07	0.71	2947.65	1323.87	2461.25	184.87	29.86
Main	7320	FEMA 100-yr	129.42	235.20	243.16		244.38	0.003715	10.90	1144.72	335.39	0.72	3028.91	1020.95	591.14	166.67	39.30
Main	7320	FEMA 200-yr	146.46	235.20	243.61	242.89	244.97	0.003930	11.68	1302.22	359.80	0.75	3455.02	1282.35	740.74	174.04	39.30
Main	7320	FEMA 500-yr	168.10	235.20	244.34		245.79	0.003900	12.38	1578.08	394.23	0.76	4015.40	1693.10	1024.28	186.83	39.30
Main	7220	FEMA 100-yr	157.20	234.80	242.99		243.85	0.004604	11.53	1391.09	409.37	0.79	1815.02	1904.46	921.52	228.68	23.49
Main	7220	FEMA 200-yr	175.73	234.80	243.53		244.40	0.004416	11.89	1617.97	434.17	0.78	2021.82	2324.35	1131.93	234.95	23.49
Main	7220	FEMA 500-yr	213.04	234.80	244.29		245.21	0.004335	12.59	1962.63	481.11	0.78	2362.81	3007.63	1362.33	244.58	23.49
Main	7120	FEMA 100-yr	201.63	234.40	242.70		243.28	0.004458	12.38	1555.53	383.86	0.78	985.54	1729.18	1926.28	172.04	10.19
Main	7120	FEMA 200-yr	233.62	234.40	243.19		243.84	0.004757	13.32	1752.92	421.98	0.81	1126.65	2121.05	2230.41	178.16	10.19
Main	7120	FEMA 500-yr	284.38	234.40	243.97		244.65	0.004712	14.07	2104.39	482.44	0.82	1301.72	2697.08	2733.97	187.87	10.19
Main	7020	FEMA 100-yr	152.86	234.00	241.23	240.95	242.56	0.007641	14.92	1146.56	332.78	1.01	1678.54	1678.76	1283.70	163.47	16.45
Main	7020	FEMA 200-yr	171.22	234.00	241.78	241.44	243.12	0.007296	15.35	1336.41	357.09	1.00	1866.07	2057.05	1554.98	169.43	16.45
Main	7020	FEMA 500-yr	220.24	234.00	242.45	241.91	243.92	0.007460	16.45	1596.00	413.18	1.02	2181.72	2655.98	1895.07	176.49	16.45
Main	6920	FEMA 100-yr	206.06	233.00	241.08		241.84	0.002645	8.51	1337.72	410.21	0.60	3112.96	981.82	546.22	145.03	59.13
Main	6920	FEMA 200-yr	244.60	233.00	241.59		242.43	0.002662	9.00	1560.95	457.08	0.61	3567.47	1185.66	724.97	153.35	59.13
Main	6920	FEMA 500-yr	287.91	233.00	242.33		243.21	0.002569	9.48	1920.39	510.26	0.61	4170.35	1494.68	1067.74	163.22	59.13
Main	6820	FEMA 100-yr	291.05	232.50	240.59		241.36	0.004264	12.21	1615.97	498.08	0.77	1418.41	1997.10	1225.50	192.23	14.80
Main	6820	FEMA 200-yr	327.05	232.50	241.23		241.92	0.003803	12.14	1944.67	541.13	0.73	1524.09	2341.69	1612.32	199.28	14.80
Main	6820	FEMA 500-yr	373.72	232.50	242.08		242.71	0.003316	12.08	2433.00	597.18	0.70	1670.57	2832.19	2230.01	208.66	14.80
Main	6720	FEMA 100-yr	275.71	231.60	240.58		241.07	0.001177	6.66	1751.08	476.90	0.42	3290.54	553.97	796.49	137.71	63.48
Main	6720	FEMA 200-yr	310.45	231.60	241.14		241.67	0.001209	7.07	2029.13	515.98	0.43	3744.20	708.85	1025.06	142.05	63.48
Main	6720	FEMA 500-yr	358.94	231.60	241.92		242.51	0.001226	7.56	2453.84	570.52	0.44	4377.68	946.68	1408.41	148.10	63.48
Main	6620	FEMA 100-yr	209.93	231.20	239.98		240.85	0.003087	10.40	1456.47	395.33	0.67	2332.26	1234.84	1073.91	155.50	29.90
Main	6620	FEMA 200-yr	222.71	231.20	240.57		241.46	0.002968	10.73	1699.04	415.75	0.67	2598.44	1495.98	1383.68	163.14	29.90
Main	6620	FEMA 500-yr	239.92	231.20	241.40		242.29	0.002823	11.17	2052.14	443.54	0.66	2977.33	1889.77	1865.67	173.72	29.90
Main	6520	FEMA 100-yr	129.75	230.80	239.30		240.39	0.005619	13.18	1198.64	323.70	0.85	1732.44	2406.93	501.63	176.19	17.76
Main	6520	FEMA 200-yr	155.22	230.80	239.88		241.01	0.005483	13.70	1396.95	355.89	0.85	1942.28	2851.67	684.15	182.91	17.76
Main	6520	FEMA 500-yr	192.25	230.80	240.72		241.86	0.005209	14.27	1713.53	405.42	0.85	2233.44	3480.32	1019.01	195.41	17.76
Main	6420	FEMA 100-yr	81.42	230.40	238.52	237.94	239.84	0.004657	10.66	938.92	286.44	0.79	3421.38	903.46	316.17	148.92	56.10
Main	6420	FEMA 200-yr	90.83	230.40	239.12	238.44	240.48	0.004338	11.01	1118.92	308.83	0.77	3904.71	1142.14	431.24	161.89	56.10
Main	6420	FEMA 500-yr	103.84	230.40	239.96		241.37	0.003974	11.44	1389.78	339.74	0.75	4595.79	1516.89	620.08	179.80	56.10
Main	6320	FEMA 100-yr	57.03	229.80	238.59		239.38	0.002062	7.53	988.61	290.41	0.53	4135.47	295.70	209.83	144.85	88.54
Main	6320	FEMA 200-yr	61.89	229.80	239.19		240.04	0.002024	7.94	1171.51	321.45	0.54	4777.27	424.78	276.05	171.02	88.54
Main	6320	FEMA 500-yr	68.66	229.80	240.02		240.96	0.001958	8.43	1456.26	364.18	0.54	5692.50	658.16	382.12	206.98	88.54
Main	6220	FEMA 100-yr	44.24	229.60	237.96		239.08	0.003157	9.33	942.53	285.84	0.66	3845.08	631.05	164.87	175.60	66.00
Main	6220	FEMA 200-yr	48.78	229.60	238.59		239.76	0.002979	9.67	1129.74	306.22	0.65	4386.48	868.09	223.54	191.45	66.00
Main	6220	FEMA 500-yr	54.94	229.60	239.46		240.69	0.002768	10.09	1409.25	333.39	0.64	5160.92	1252.67	319.18	212.45	66.00

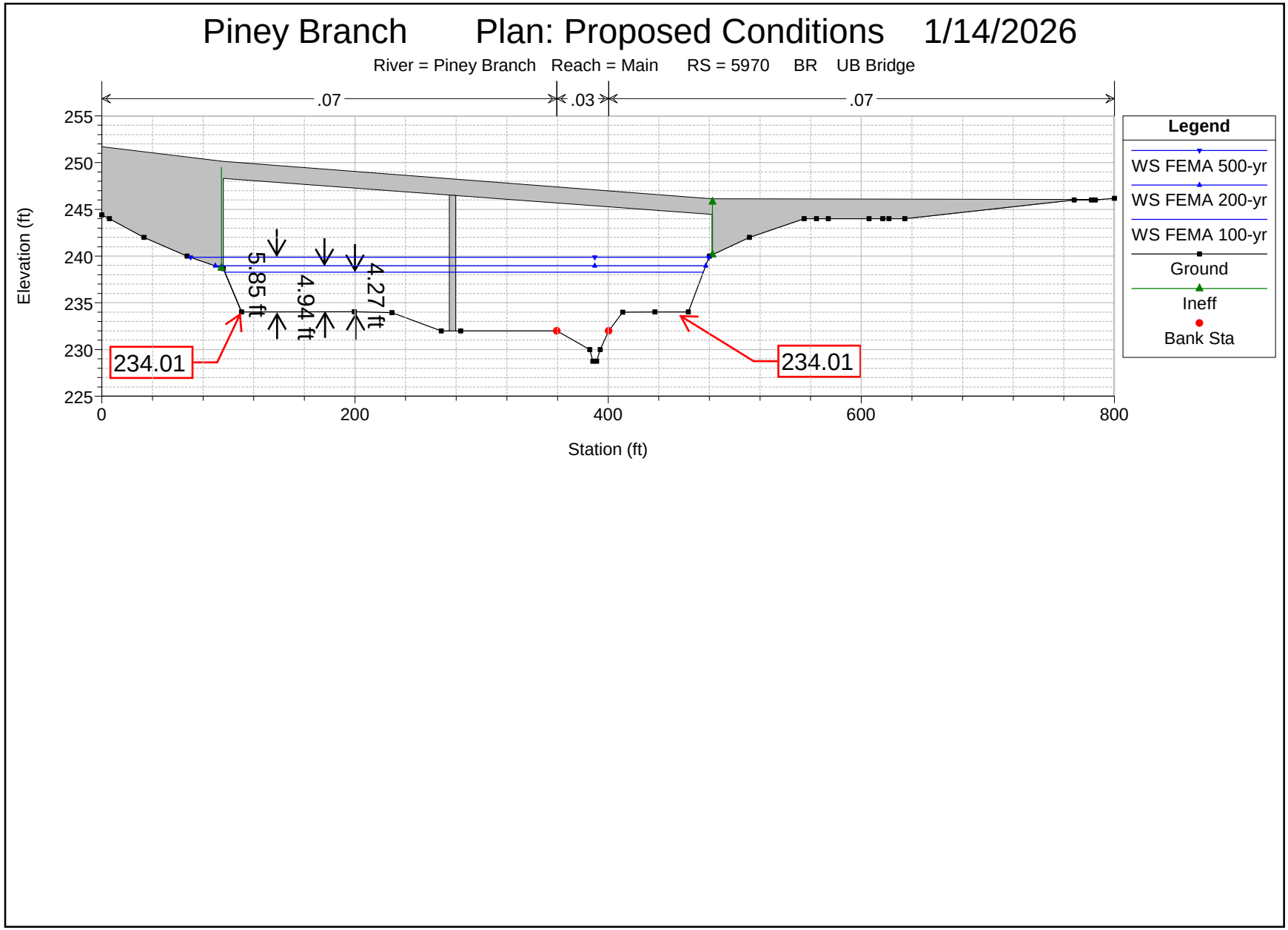
HEC-RAS Plan: PR River: Piney Branch Reach: Main (Continued)

Reach	River Sta	Profile	Top W Right	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl	Q Channel	Q Left	Q Right	Top W Left	Top W Chnl
			(ft)	(ft)	(ft)	(ft)	(ft)	(ft/ft)	(ft/s)	(sq ft)	(ft)		(cfs)	(cfs)	(cfs)	(ft)	(ft)
Main	6120	FEMA 100-yr	39.30	229.20	238.18	235.40	238.69	0.001199	6.51	1309.67	279.97	0.42	3571.85	879.70	189.45	167.05	73.62
Main	6120	FEMA 200-yr	46.85	229.20	238.80	235.88	239.38	0.001223	6.94	1490.24	299.15	0.43	4125.48	1114.02	238.60	178.68	73.62
Main	6120	FEMA 500-yr	57.28	229.20	239.66	236.54	240.31	0.001245	7.49	1759.23	325.65	0.44	4927.88	1484.13	320.75	194.75	73.62
Main	6020	FEMA 100-yr	74.79	228.80	238.32	235.64	238.53	0.000849	5.54	1947.84	378.32	0.35	1749.94	2406.71	484.35	262.41	41.11
Main	6020	FEMA 200-yr	76.66	228.80	238.98	235.92	239.21	0.000823	5.76	2201.33	388.31	0.35	1978.25	2896.34	603.51	270.54	41.11
Main	6020	FEMA 500-yr	79.22	228.80	239.90	236.31	240.14	0.000790	6.05	2553.41	410.36	0.35	2305.86	3644.24	782.67	290.03	41.11
Main	5970		Bridge														
Main	5881	FEMA 100-yr	164.88	228.19	237.75	235.89	238.24	0.001452	7.44	1747.27	374.08	0.47	2567.98	1047.64	1025.38	165.71	43.50
Main	5881	FEMA 200-yr	167.87	228.19	238.42	236.26	238.92	0.001406	7.73	1998.54	378.98	0.46	2891.43	1305.21	1281.47	167.61	43.50
Main	5881	FEMA 500-yr	177.07	228.19	239.33	236.75	239.86	0.001358	8.12	2344.29	390.78	0.46	3361.58	1692.05	1679.15	170.21	43.50
Main	5820	FEMA 100-yr	179.08	228.20	237.18	235.81	238.04	0.002571	9.50	1358.74	339.04	0.61	2769.27	826.94	1044.79	121.75	38.21
Main	5820	FEMA 200-yr	193.67	228.20	237.84	236.28	238.73	0.002487	9.88	1589.35	361.78	0.61	3126.66	1028.83	1322.61	129.89	38.21
Main	5820	FEMA 500-yr	236.97	228.20	238.79	236.91	239.68	0.002286	10.18	1946.01	418.44	0.59	3592.82	1324.18	1815.78	143.26	38.21
Main	5720	FEMA 100-yr	157.33	228.00	237.14		237.73	0.001612	8.12	1644.94	359.53	0.49	2594.51	1236.78	809.71	164.01	38.20
Main	5720	FEMA 200-yr	166.70	228.00	237.79		238.43	0.001624	8.56	1885.97	380.42	0.50	2950.57	1491.35	1036.18	175.51	38.20
Main	5720	FEMA 500-yr	186.82	228.00	238.71		239.40	0.001627	9.14	2251.40	417.63	0.51	3470.85	1890.06	1371.86	192.61	38.20
Main	5620	FEMA 100-yr	298.10	228.00	236.99		237.56	0.001605	7.95	1823.97	495.91	0.49	2593.97	1147.16	899.87	157.32	40.49
Main	5620	FEMA 200-yr	307.21	228.00	237.69		238.24	0.001473	8.05	2177.79	512.17	0.48	2856.06	1365.36	1256.69	164.46	40.49
Main	5620	FEMA 500-yr	327.34	228.00	238.67		239.20	0.001353	8.28	2691.63	549.70	0.47	3262.55	1667.03	1803.19	181.87	40.49
Main	5520	FEMA 100-yr	200.32	227.80	237.00	234.24	237.36	0.001002	6.64	2131.72	436.04	0.39	2370.78	1214.72	1055.50	195.72	40.00
Main	5520	FEMA 200-yr	205.99	227.80	237.68	234.64	238.06	0.001000	6.97	2432.74	452.41	0.40	2676.05	1474.30	1327.75	206.42	40.00
Main	5520	FEMA 500-yr	215.61	227.80	238.63	235.19	239.04	0.001000	7.42	2877.39	484.88	0.40	3131.99	1851.65	1749.13	229.27	40.00

HEC-RAS Plan: PR River: Piney Branch Reach: Main

Reach	River Sta	Profile	E.G. Elev	W.S. Elev	Crit W.S.	Frctn Loss	C & E Loss	Top Width	Q Left	Q Channel	Q Right	Vel Chnl	Top W Chnl	Top W Left	Top W Right	Hydr Depth L	Hydr Depth R
			(ft)	(ft)	(ft)	(ft)	(ft)	(ft)	(cfs)	(cfs)	(cfs)	(ft/s)	(ft)	(ft)	(ft)	(ft)	(ft)
Main	6120	FEMA 100-yr	238.69	238.18	235.40	0.11	0.10	279.97	879.70	3571.85	189.45	6.51	73.62	167.05	39.30	3.77	3.34
Main	6120	FEMA 200-yr	239.38	238.80	235.88	0.10	0.12	299.15	1114.02	4125.48	238.60	6.94	73.62	178.68	46.85	4.13	3.37
Main	6120	FEMA 500-yr	240.31	239.66	236.54	0.10	0.15	325.65	1484.13	4927.88	320.75	7.49	73.62	194.75	57.28	4.61	3.54
Main	6020	FEMA 100-yr	238.53	238.32	235.64	0.01	0.00	378.32	2406.71	1749.94	484.35	5.54	41.11	262.41	74.79	5.05	4.11
Main	6020	FEMA 200-yr	239.21	238.98	235.92	0.01	0.00	388.31	2896.34	1978.25	603.51	5.76	41.11	270.54	76.66	5.66	4.67
Main	6020	FEMA 500-yr	240.14	239.90	236.31	0.01	0.00	410.36	3644.24	2305.86	782.67	6.05	41.11	290.03	79.22	6.58	5.42
Main	5970 BR U	FEMA 100-yr	238.51	238.28	235.60	0.10	0.04	373.12	2350.05	1796.77	494.18	5.71	41.11	257.31	74.70	4.99	4.08
Main	5970 BR U	FEMA 200-yr	239.19	238.95	235.89	0.09	0.04	376.11	2827.26	2033.70	617.15	5.94	41.11	258.44	76.56	5.63	4.64
Main	5970 BR U	FEMA 500-yr	240.12	239.86	236.30	0.09	0.04	378.67	3547.11	2381.07	804.59	6.27	41.11	258.44	79.12	6.55	5.39
Main	5970 BR D	FEMA 100-yr	238.38	238.28	234.91	0.10	0.04	371.81	1594.51	755.09	2291.39	2.32	38.50	167.21	166.10	4.75	4.72
Main	5970 BR D	FEMA 200-yr	239.06	238.95	235.11	0.09	0.04	373.73	1909.78	816.54	2751.78	2.32	38.50	169.13	166.10	5.36	5.39
Main	5970 BR D	FEMA 500-yr	239.99	239.87	235.38	0.09	0.04	376.35	2384.18	907.45	3441.15	2.34	38.50	171.75	166.10	6.20	6.31
Main	5881	FEMA 100-yr	238.24	237.75	235.89	0.16	0.04	374.08	1047.64	2567.98	1025.38	7.44	43.50	165.71	164.88	4.26	4.22
Main	5881	FEMA 200-yr	238.92	238.42	236.26	0.15	0.04	378.98	1305.21	2891.43	1281.47	7.73	43.50	167.61	167.87	4.88	4.84
Main	5881	FEMA 500-yr	239.86	239.33	236.75	0.15	0.04	390.78	1692.05	3361.58	1679.15	8.12	43.50	170.21	177.07	5.71	5.75
Main	5820	FEMA 100-yr	238.04	237.18	235.81	0.23	0.08	339.04	826.94	2769.27	1044.79	9.50	38.21	121.75	179.08	3.74	3.42
Main	5820	FEMA 200-yr	238.73	237.84	236.28	0.23	0.08	361.78	1028.83	3126.66	1322.61	9.88	38.21	129.89	193.67	4.15	3.79
Main	5820	FEMA 500-yr	239.68	238.79	236.91	0.22	0.06	418.44	1324.18	3592.82	1815.78	10.18	38.21	143.26	236.97	4.67	4.60

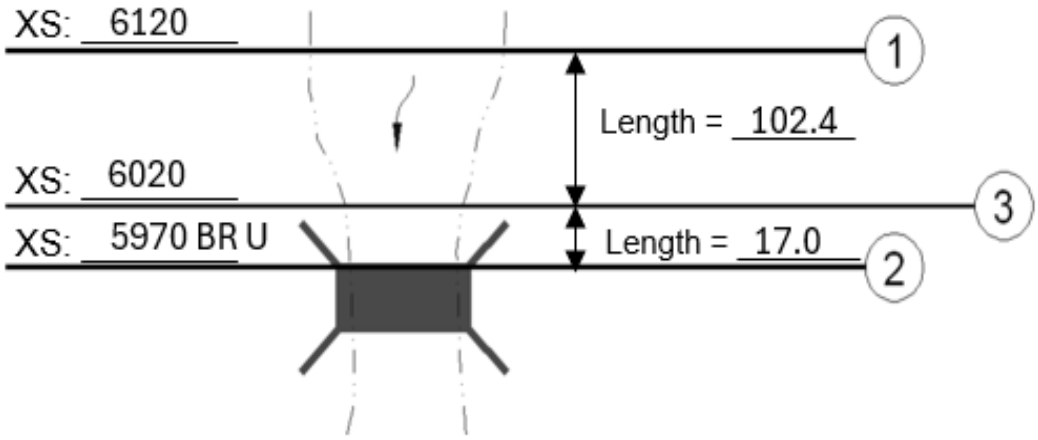

Piney Branch Plan: Proposed Conditions 1/14/2026
River = Piney Branch Reach = Main RS = 6120
.1
.03
.1
Elevation (ft)
250
245
240
235
230
225
0
200
400
600
800
Station (ft)
Legend
WS FEMA 500-yr
WS FEMA 200-yr
WS FEMA 100-yr
Ground
Bank Sta
Piney Branch Plan: Proposed Conditions 1/14/2026
River = Piney Branch Reach = Main RS = 6020
.07
.03
.07
Elevation (ft)
250
245
240
235
230
225
0
200
400
600
800
Station (ft)
Legend
WS FEMA 500-yr
WS FEMA 200-yr
WS FEMA 100-yr
Ground
Ineff
Bank Sta


Piney Branch Plan: Proposed Conditions 1/14/2026
River = Piney Branch Reach = Main RS = 5970 BR UB Bridge
.07
.03
.07
Elevation (ft)
255
250
245
240
235
230
225
0
200
400
600
800
Station (ft)
5.85 ft
4.94 ft
4.27 ft
234.01
234.01
Legend
WS FEMA 500-yr
WS FEMA 200-yr
WS FEMA 100-yr
Ground
Ineff
Bank Sta

APPENDIX E
SCOUR ESTIMATE CALCULATIONS

2. Contraction Scour

HEC-RAS Sections - fill in the appropriate information from the proposed HEC-RAS model



Key
1. Upstream uncontracted cross section (XS output)
2. Internal bridge cross section (BR U or BR D in HEC-RAS output)
3. Upstream bounding cross section (XS output)

Comments: _____

_____

_____

Compute Contraction Scour
(Check for live-bed or clear-water)
Critical Velocity Determination

Design By: MC, LL

$V_c = K_u y^{1/6} D^{1/3}$ [HEC-18 p. 6.2, Eqn. 6.1]

where:

V_c	=	Critical velocity above which bed material of size D and smaller will be transported, ft/s (m/s)	
y	=	Average depth of flow upstream of the bridge, ft (m)	
D	=	Particle size for V_c, ft (m)	
D_{50}	=	Particle size in a mixture of which 50 percent are smaller, ft (m)	
K_u	=	6.19	SI units
K_u	=	11.17	English units

Approach Section *XS 6120*
y *Hydraulic depth in Channel (Hydr Depth C)*
V *Average velocity of flow in main channel (Vel Chnl)*

Clear-Water: Approach Section Velocity < V_c

Live-Bed: Approach Section Velocity > V_c

Summary of Results

Modeled Scenario	K_u	HEC RAS XS6120 Hydr Depth C y (ft)	Boring Sample B 154 at depth of 4 ft D_{50} (mm)	D_{50} (ft)	V_c (ft/s)	HEC RAS XS6120 Vel Chnl Approach section main channel average velocity V (ft/s)	V/Vc < 1?	Contraction Scour Method
Q100	11.17	7.45	10.20	0.033	5.0	6.5	No	Live-Bed
Q200	11.17	8.07	10.20	0.033	5.1	6.9	No	Live-Bed
Q500	11.17	8.94	10.20	0.033	5.2	7.5	No	Live-Bed

Compute Contraction Scour
Clear-Water Contraction Scour Calculations

Design By: MC, LL

6.4 CLEAR-WATER CONTRACTION SCOUR

The recommended clear-water contraction scour equation is based on a development suggested by Laursen (1963) (presented in the Appendix C). The equation is:

$$y_2 = \left[\frac{K_u Q^2}{D_m^{2/3} W^2}\right]^{3/7} \quad (6.4)$$

$y_s = y_2 - y_o$ = (average contraction scour depth) (6.5)

where:

- y_2 = Average equilibrium depth in the contracted section after contraction scour, ft (m)
- Q = Discharge through the bridge or on the set-back overbank area at the bridge associated with the width W, ft^3/s (m^3/s)
- D_m = Diameter of the smallest nontransportable particle in the bed material (1.25 D_{50}) in the contracted section, ft (m)
- D_{50} = Median diameter of bed material, ft (m)
- W = Bottom width of the contracted section less pier widths, ft (m)
- y_o = Average existing depth in the contracted section, ft (m)
- K_u = 0.0077 English units
- K_u = 0.025 SI units

Contracted Sectio *XS 5970 BR U*

y0	*Hydraulic depth in Channel (Hydr Depth C)*
Q	*Total Peak Discharge*
W	Bridge Opening Width - Pier Width

Clear Water Contraction Scour - Summary of Results

Simulation	Bridge Opening Width - Pier Width W (ft)	XS 5970 BR U Q Total Q (cfs)	D_{50} (ft)	D_m (ft)	K_u	y_2 (ft)	XS 5970 BR U Hydr Depth C y_o (ft)	y_s (ft) *
Q100	383.00	4641.0	0.0335	0.0418	0.0077	2.61	7.66	-5.0
Q200	383.00	5478.1	0.0335	0.0418	0.0077	3.01	8.32	-5.3
Q500	383.00	6732.8	0.0335	0.0418	0.0077	3.59	9.24	-5.6

*Note: If calculated y_s returns a negative answer, the contraction scour depth equals zero.

Compute Contraction Scour
Live-Bed Contraction Scour Calculations

Design By: MC, LL

where:

y_1 = Average depth in the upstream main channel, ft (m)
y_2 = Average depth in the contracted section, ft (m)
y_o = Existing depth in the contracted section before scour, ft (m) (see Note 7)
Q_1 = Flow in the upstream channel transporting sediment, ft^3/s (m^3/s)
Q_2 = Flow in the contracted channel, ft^3/s (m^3/s)
W_1 = Bottom width of the upstream main channel that is transporting bed material, ft (m)
W_2 = Bottom width of main channel in contracted section less pier width(s), ft (m)
k_1 = Exponent determined below

V_*/T	k_1	Mode of Bed Material Transport
<0.50	0.59	Mostly contact bed material discharge
0.50 to 2.0	0.64	Some suspended bed material discharge
>2.0	0.69	Mostly suspended bed material discharge

V_* = $(\vartheta_o/\Delta)^{1/2} = (gy_1 S_1)^{1/2}$, shear velocity in the upstream section, ft/s (m/s)
T = Fall velocity of bed material based on the D_{50}, m/s (Figure 6.8)
For fall velocity in English units (ft/s) multiply T in m/s by 3.28
g = Acceleration of gravity (32.2 ft/s^2) (9.81 m/s^2)
S_1 = Slope of energy grade line of main channel, ft/ft (m/m)
ϑ_o = Shear stress on the bed, (lb/ft^2) (Pa (N/m^2))
Δ = Density of water (1.94 $slugs/ft^3$) (1000 kg/m^3)

S1 Energy gradient slope from XS6120 to XS5970
T using Figure 6.8, assume temperature at 20, check in Hydraulics Tool
y0 Hydraulics Depth Channel 5970 BR U
Q1 Q Channel @ XS6120
Q2 Q Channel @ XS5970 BR U
W Top Channel Width

$$\frac{y_2}{y_1} = \left(\frac{Q_2}{Q_1}\right)^{6/7} \left(\frac{W_1}{W_2}\right)^{k_1}$$

[HEC-18 p. 6.10, Eqn. 6.2]

$y_s = y_2 - y_o$ = (average contraction scour depth)

[HEC-18 p. 6.10, Eqn. 6.3]

Inputs

Modeled Scenario	Energy gradient slope between XS6120 and XS5970 BR D S_1	Approach section main channel average depth y_1 (ft)	V* (ft/s)	T (ft/s)	V*/T	k_1
Q100	0.001442	7.45	0.59	1.45	0.41	0.59
Q200	0.001488	8.07	0.62	1.45	0.43	0.59
Q500	0.001488	8.94	0.65	1.45	0.45	0.59

Live-Bed Contraction Scour - Summary of Results

Modeled Scenario	XS 5970 BR U Hydr Depth C Contracted section main channel average depth y_o (ft)	XS 6120 Q Channel Approach Section Main Channel Flow Q_1 (cfs)	XS 5970 BR U Q Channel Contracted section main channel flow Q_2 (cfs)	XS 6120 Top W Chnl Approach section main channel width W_1 (ft)	XS 5970 BR U Top W Chnl Contracted section main channel adjusted width W_2 (ft)	y_2 (ft)	y_s (ft) *
Q100	7.66	3571.9	1796.8	73.62	41.11	5.83	-1.83
Q200	8.32	4125.5	2033.7	73.62	41.11	6.21	-2.11
Q500	9.24	4927.9	2381.1	73.62	41.11	6.76	-2.48

*Note: If calculated y_s returns a negative answer, the contraction scour depth equals zero.

Compute Magnitude of Local Scour At Piers
Hec-18 General Pier Scour Equation

Design By: MC, LL

y1 Hydraulics Depth Channel @ XS 6020
V1 Velocity Channel @XS 6020
Angle of Attack Meausre pier to the floodplain

Table 7.1 (HEC-18) Correction Factor, K_1	
Shape of Pier Nose	K_1
Square nose	1.10
Round nose	1.00
Circular cylinder	1.00
Group of cylinders	1.00
Sharp nose	0.90

$$K_2 = (\text{Cos}\ \theta + \frac{L}{a}\ \text{Sin}\ \theta)^{0.65}$$

Ref. HEC-18 Page 7.4, Eqn. 7.4

Table 7.3 (HEC-18) Increase in Equilibrium Pier Scour Depths, K3, for Bed Condition.		
Bed Condition	Dune Height ft	K3
Clear-Water Scour	N/A	1.1
Plane Bed and Antidune Flow	N.A	1.1
Small Dunes	10 > H >= 2	1.1
Medium Dunes	30 > H >= 10	1.2 to 1.1
Large Dunes	H >= 30	1.3

$$\frac{y_s}{y_1} = 2.0\ K_1\ K_2\ K_3 \left(\frac{a}{y_1}\right)^{0.65} Fr_1^{0.43} \quad (7.1)$$

As a Rule of Thumb, the maximum scour depth for round nose piers aligned with the flow is:

$y_s \le 2.4$ times the pier width (a) for $Fr \le 0.8$ (7.2)
$y_s \le 3.0$ times the pier width (a) for $Fr > 0.8$

In terms of y_s/a, Equation 7.1 is:

$$\frac{y_s}{a} = 2.0\ K_1\ K_2\ K_3 \left(\frac{y_1}{a}\right)^{0.35} Fr_1^{0.43} \quad (7.3)$$

where:

y_s = Scour depth, ft (m)
y_1 = Flow depth directly upstream of the pier, ft (m)
K_1 = Correction factor for pier nose shape from Figure 7.3 and Table 7.1
K_2 = Correction factor for angle of attack of flow from Table 7.2 or Equation 7.4
K_3 = Correction factor for bed condition from Table 7.3
a = Pier width, ft (m)
L = Length of pier, ft (m)
Fr_1 = Froude Number directly upstream of the pier = $V_1/(gy_1)^{1/2}$
V_1 = Mean velocity of flow directly upstream of the pier, ft/s (m/s)
g = Acceleration of gravity (32.2 ft/s^2) (9.81 m/s^2)

HEC-18 General Pier Scour - Summary of Computations

PIER	Simulation	Shape	XS 6020 Hydr Depth C y_1	XS 6020 Vel Chnl V_1	Pier Width a	Pier Length L	L/a	Angle of Attack of Flow (Degrees)	Angle of Attack of Flow (Radians)	Fr_1	K1	K2	K3	y_s, ft
1	Q100	Square nose	7.68	5.54	5	93	12.00	1.00	0.02	0.35	0.90	1.13	1.10	8.3
	Q200	Square nose	8.35	5.76	5	93	12.00	1.00	0.02	0.35	0.90	1.13	1.10	8.5
	Q500	Square nose	9.27	6.05	5	93	12.00	1.00	0.02	0.35	0.90	1.13	1.10	8.9
Note: In all instances the depth and velocity at the max unit discharge is used.														

Streambed Thalweg Elevation (ft): 228.8 XS 5970 BR U Channel Bottom Elevation

PIER	Simulation	Total Scour Elevation
1	Q100	220.4
	Q200	220.2
	Q500	219.9

Notes (From HEC-18 Page 7.5):

1. The correction factor K1 for pier nose shape should be determined using Table 7.1 for angles of attack up to 5 degrees. For greater angles, K2 dominates and K1 should be considered as 1.0. If L/a is larger than 12, use the values for L/a = 12 as a maximum in Table 7.2 and Equation 7.4.

2. The values of the correction factor K2 should be applied only when the field conditions are such that the entire length of the pier is subjected to the angle of attack of the flow. Use of this factor will result in a significant over-prediction of scour if (1) a portion of the pier is shielded from the direct impingement of the flow by an abutment or another pier; or (2) an abutment or another pier redirects the flow in a direction parallel to the pier. For such cases, judgment must be exercised to reduce the value of the K2 factor by selecting the effective length of the pier actually subjected to the angle of attack of the flow. Equation 7.4 should be used for evaluation and design. Table 7.2 is intended to illustrate the importance of angle of attack in pier scour computations and to establish a cutoff point for K2 (i.e., a maximum value of 5.0).

3. The correction factor K3 results from the fact that for plane-bed conditions, which is typical of most bridge sites for the flood frequencies employed in scour design, the maximum scour may be 10 percent greater than computed with Equation 7.1. In the unusual situation where a dune bed configuration with large dunes exists at a site during flood flow, the maximum pier scour may be 30 percent greater than the predicted equation value. This may occur on very large rivers, such as the Mississippi. For smaller streams that have a dune bed configuration at flood flow, the dunes will be smaller and the maximum scour may be only 10 to 20 percent larger than equilibrium scour. For antidune bed configuration the maximum scour depth may be 10 percent greater than the computed equilibrium pier scour depth.

4. Piers set close to abutments (for example at the toe of a spill through abutment) must be carefully evaluated for the angle of attack and velocity of the flow coming around the abutment.

Compute Abutment Scour
Scour Condition A - Live Bed

Main Channel

Design By: MC, LL

$$y_c = y_1\left(\frac{q_{2c}}{q_1}\right)^{6/7} \quad (8.5)$$

where:

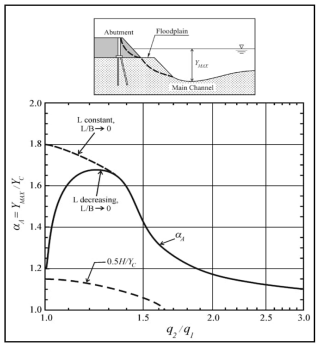
y_c	=	Flow depth including live-bed contraction scour, ft (m)
y_1	=	Upstream flow depth, ft (m)
q_1	=	Upstream unit discharge, ft^2/s (m^2/s)
q_{2c}	=	Unit discharge in the constricted opening accounting for non-uniform flow distribution, ft^2/s (m^2/s)

$$y_{max} = \alpha_A\, y_c \text{ or } y_{max} = \alpha_B\, y_c \quad (8.3)$$

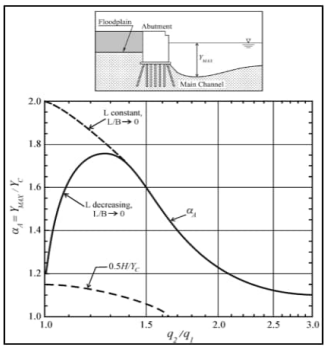
$$y_s = y_{max} - y_0 \quad (8.4)$$

where:

y_{max}	=	Maximum flow depth resulting from abutment scour, ft (m)
y_c	=	Flow depth including live-bed or clear-water contraction scour, ft (m)
α_A	=	Amplification factor for live-bed conditions
α_B	=	Amplification factor for clear-water conditions
y_s	=	Abutment scour depth, ft (m)
y_0	=	Flow depth prior to scour, ft (m)



HEC-18 Fig 8.9



HEC-18 Fig 8.10

q1 Approach XS Q1/W1
q2 Contracted XS Q2/W2

y1 q1 q2 calculated from Live-Bed Contraction Scour Tab
y0 WSEL at XS 5970 - grading elevation 234.01

Inputs

Simulation	Abutment	Scour Condition	Abutment Type	XS 6120 Q1/W1 Unit Discharge, Upstream in Main Channel, cfs/ft q_1	XS 5970 BR U Q2/W2 Unit Discharge in Constricted Area, cfs/ft q_2	q_2 / q_1	XS 6120 Hydr Depth C Upstream Flow Depth (y_1)	Amplification Factor
Q100	Left Abutment	A	Vertical-wall	48.52	43.71	0.90	7.45	1.20
	Right Abutment	A	Vertical-wall	48.52	43.71	0.90	7.45	1.20
Q200	Left Abutment	A	Vertical-wall	56.04	49.47	0.88	8.07	1.20
	Right Abutment	A	Vertical-wall	56.04	49.47	0.88	8.07	1.20
Q500	Left Abutment	A	Vertical-wall	66.94	57.92	0.87	8.94	1.20
	Right Abutment	A	Vertical-wall	66.94	57.92	0.87	8.94	1.20

Summary of Results

Simulation	Abutment	Flow depth including contraction scour, ft y_c	Scour Depth from Long Term Degradation (ft)	Maximum Flow Depth including Abutment Scour, ft y_{max}	XS 5970 BR W.S. Elev - bench elevation 234.01 Depth at Abutment Toe Prior to Scour, ft y_o	Abutment Scour Hole Depth y_s (ft)
Q100	Left Abutment	6.81	0.0	8.17	4.27	3.9
	Right Abutment	6.81	0.0	8.17	4.27	3.9
Q200	Left Abutment	7.25	0.0	8.70	4.94	3.8
	Right Abutment	7.25	0.0	8.70	4.94	3.8
Q500	Left Abutment	7.90	0.0	9.48	5.85	3.6
	Right Abutment	7.90	0.0	9.48	5.85	3.6

*Note: If calculated y_s returns a negative answer, the contraction scour depth equals zero.

Simulation	Abutment	XS 5970 BR Bench Elevation 234.01 Reference Location Elevation (ft)	Total Scour Elevation at Abutment (ft)
Q100	Left Abutment	234.01	230.1
	Right Abutment	234.01	230.1
Q200	Left Abutment	234.01	230.2
	Right Abutment	234.01	230.2
Q500	Left Abutment	234.01	230.4
	Right Abutment	234.01	230.4

Compute Abutment Scour

Scour Condition A - Clear Water

Main Channel

Design By: _____

$$y_c = \left(\frac{q_{2f}}{K_u D_{50}^{1/3}} \right)^{6/7} \quad (8.6)$$

where:

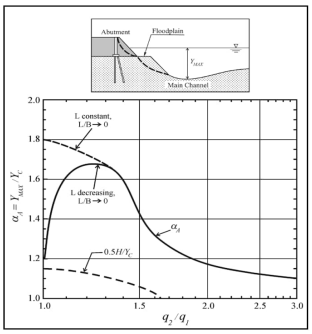
y_c	=	Flow depth including clear-water contraction scour, ft (m)
q_{2f}	=	Unit discharge in the constricted opening accounting for non-uniform flow distribution, ft^2/s (m^2/s)
K_u	=	11.17 English units
K_u	=	6.19 SI
D_{50}	=	Particle size with 50 percent finer, ft (m)

$$y_{max} = \alpha_A \, y_c \text{ or } y_{max} = \alpha_B \, y_c \quad (8.3)$$

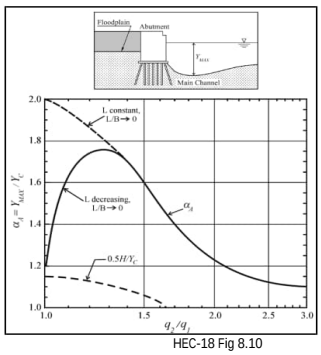
$$y_s = y_{max} - y_0 \quad (8.4)$$

where:

y_{max}	=	Maximum flow depth resulting from abutment scour, ft (m)
y_c	=	Flow depth including live-bed or clear-water contraction scour, ft (m)
α_A	=	Amplification factor for live-bed conditions
α_B	=	Amplification factor for clear-water conditions
y_s	=	Abutment scour depth, ft (m)
y_0	=	Flow depth prior to scour, ft (m)



HEC-18 Fig 8.9



HEC-18 Fig 8.10

q1 approach section

q2

Inputs

Simulation	Abutment	Scour Condition	Abutment Type	K_u	XS 6120 Q1/W1 Unit Discharge, Upstream in Main Channel, cfs/ft q_1	XS 5970 BR U Q2/W2 Unit Discharge in Constricted Area, cfs/ft q_2	q_{2f} / q_1
Q100	Left Abutment	A	Vertical-wall	11.17	48.52	43.71	0.90
	Right Abutment	A	Vertical-wall	11.17	48.52	43.71	0.90
Q200	Left Abutment	A	Vertical-wall	11.17	56.04	49.47	0.88
	Right Abutment	A	Vertical-wall	11.17	56.04	49.47	0.88
Q500	Left Abutment	A	Vertical-wall	11.17	66.94	57.92	0.87
	Right Abutment	A	Vertical-wall	11.17	66.94	57.92	0.87

Summary of Results

Simulation	Abutment	D_{50} (ft)	Flow depth including contraction scour, ft y_c	Amplification Factor	Scour Depth from Long Term Degradation (ft)	Maximum Flow Depth including Abutment Scour, ft y_{max}	XS 5970 BR W.S. Elev - bench elevation 234.01 Depth at Abutment Toe Prior to Scour, ft y_0	Abutment Scour Hole Depth y_s (ft)
Q100	Left Abutment	0.0335	8.50	1.20	0.00	10.20	4.27	5.9
	Right Abutment	0.0335	8.50	1.20	0.00	10.20	4.27	5.9
Q200	Left Abutment	0.0335	9.45	1.20	0.00	11.34	4.94	6.4
	Right Abutment	0.0335	9.45	1.20	0.00	11.34	4.94	6.4
Q500	Left Abutment	0.0335	10.82	1.20	0.00	12.98	5.85	7.1
	Right Abutment	0.0335	10.82	1.20	0.00	12.98	5.85	7.1

*Note: If calculated y_s returns a negative answer, the contraction scour depth equals zero.

Simulation	Abutment	XS 5970 BR Bench Elevation 234.01 Reference Location Elevation (ft)	Total Scour Elevation at Abutment (ft)
Q100	Left Abutment	234.01	228.1
	Right Abutment	234.01	228.1
Q200	Left Abutment	234.01	227.6
	Right Abutment	234.01	227.6
Q500	Left Abutment	234.01	226.9
	Right Abutment	234.01	226.9

Compute Abutment Scour

Scour Condition B - Live Bed Overbanks Design By: MC, LL

$$y_c = y_1\left(\frac{q_{2c}}{q_1}\right)^{6/7} \quad (8.5)$$

where:

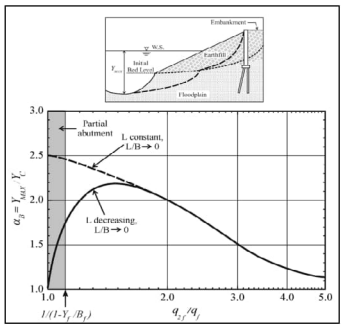
- y_c = Flow depth including live-bed contraction scour, ft (m)
- y_1 = Upstream flow depth, ft (m)
- q_1 = Upstream unit discharge, ft^2/s (m^2/s)
- q_{2c} = Unit discharge in the constricted opening accounting for non-uniform flow distribution, ft^2/s (m^2/s)

$$y_{max} = \alpha_A\, y_c \text{ or } y_{max} = \alpha_B\, y_c \quad (8.3)$$

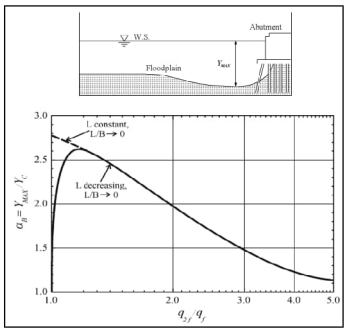
$$y_s = y_{max} - y_0 \quad (8.4)$$

where:

- y_{max} = Maximum flow depth resulting from abutment scour, ft (m)
- y_c = Flow depth including live-bed or clear-water contraction scour, ft (m)
- α_A = Amplification factor for live-bed conditions
- α_B = Amplification factor for clear-water conditions
- y_s = Abutment scour depth, ft (m)
- y_0 = Flow depth prior to scour, ft (m)



HEC-18 Fig 8.11



HEC-18 Fig 8.12

Inputs

Simulation	Abutment	Scour Condition	Abutment Type	XS 6120 Q Left, Q Right Peak Discharge, Upstream at Overbanks, cfs Q1	XS 6120 Top W Left, Right Upstream at Overbanks, ft W1	Q1/W1 Unit Discharge, Upstream in Main Channel, cfs/ft q_1	XS 5970 BR U Q Left, Q Right Peak Discharge, Constricted Area at Overbanks, cfs Q2	XS 5970 BR U Top W Left, Right Constricted Area at Overbanks, ft W2	Q2/W2 Unit Discharge in Constricted Area, cfs/ft q_2	q_2 / q_1	XS 6120 Hydr Depth L, R Upstream Flow Depth (y_1)	Amplification Factor
Q100	Left Abutment	B	Vertical-wall	879.70	167.05	5.27	2350.05	257.31	9.13	1.73	3.77	2.17
	Right Abutment	B	Vertical-wall	189.45	39.30	4.69	494.18	74.70	6.62	1.41	3.44	2.45
Q200	Left Abutment	B	Vertical-wall	1114.02	178.68	6.23	2827.26	258.44	10.94	1.75	4.13	2.15
	Right Abutment	B	Vertical-wall	238.60	46.85	5.09	617.15	76.56	8.06	1.58	3.37	2.30
Q500	Left Abutment	B	Vertical-wall	1484.13	194.75	7.62	3547.11	258.44	13.72	1.80	4.61	2.12
	Right Abutment	B	Vertical-wall	320.75	57.28	5.60	804.59	79.12	10.17	1.82	3.54	2.11

Summary of Results

Simulation	Abutment	Flow depth including contraction scour, ft y_c	Scour Depth from Long Term Degradation (ft)	Maximum Flow Depth including Abutment Scour, ft y_{max}	XS 5970 BR W.S. Elev - bench elevation 234.01 Depth at Abutment Toe Prior to Scour, ft y_o	Abutment Scour Hole Depth y_s (ft)
Q100	Left Abutment	6.04	0.0	13.12	4.27	8.8
	Right Abutment	4.62	0.0	11.31	4.27	7.0
Q200	Left Abutment	6.69	0.0	14.38	4.94	9.4
	Right Abutment	5.00	0.0	11.49	4.94	6.5
Q500	Left Abutment	7.63	0.0	16.18	5.85	10.3
	Right Abutment	5.90	0.0	12.46	5.85	6.6

*Note: If calculated y_s returns a negative answer, the contraction scour depth equals zero.

Simulation	Abutment	XS 5970 BR Bench Elevation 234.01 Reference Location Elevation (ft)	Total Scour Elevation at Abutment (ft)
Q100	Left Abutment	234.01	225.2
	Right Abutment	234.01	227.0
Q200	Left Abutment	234.01	224.6
	Right Abutment	234.01	227.5
Q500	Left Abutment	234.01	223.7
	Right Abutment	234.01	227.4

Compute Abutment Scour
Scour Condition B - Clear Water Overbanks Design By: _____

$$y_c = \left(\frac{q_{2f}}{K_u D_{50}^{1/3}} \right)^{6/7} \quad (8.6)$$

where:

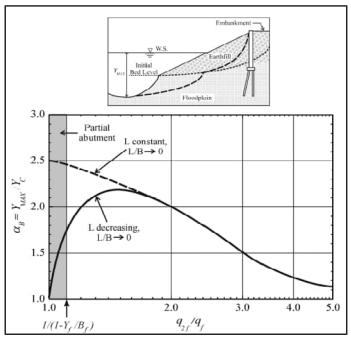
y_c	=	Flow depth including clear-water contraction scour, ft (m)
q_{2f}	=	Unit discharge in the constricted opening accounting for non-uniform flow distribution, ft^2/s (m^2/s)
K_u	=	11.17 English units
K_u	=	6.19 SI
D_{50}	=	Particle size with 50 percent finer, ft (m)

$$y_{max} = \alpha_A y_c \text{ or } y_{max} = \alpha_B y_c \quad (8.3)$$

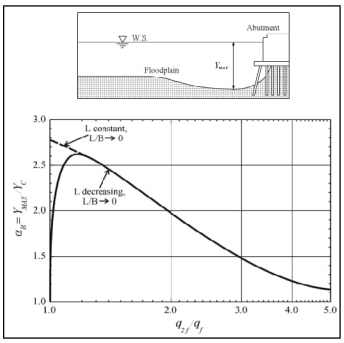
$$y_s = y_{max} - y_0 \quad (8.4)$$

where:

y_{max}	=	Maximum flow depth resulting from abutment scour, ft (m)
y_c	=	Flow depth including live-bed or clear-water contraction scour, ft (m)
α_A	=	Amplification factor for live-bed conditions
α_B	=	Amplification factor for clear-water conditions
y_s	=	Abutment scour depth, ft (m)
y_0	=	Flow depth prior to scour, ft (m)



HEC-18 Fig 8.11



HEC-18 Fig 8.12

Inputs

Simulation	Abutment	Scour Condition	Abutment Type	K_u	Q1/W1 Unit Discharge, Upstream in Main Channel, cfs/ft q_1	Q2/W2 Unit Discharge in Constricted Area, cfs/ft q_{2f}	q_{2f} / q_1
Q100	Left Abutment	B	Vertical-wall	11.17	5.27	9.13	1.73
	Right Abutment	B	Vertical-wall	11.17	4.69	6.62	1.41
Q200	Left Abutment	B	Vertical-wall	11.17	6.23	10.94	1.75
	Right Abutment	B	Vertical-wall	11.17	5.09	8.06	1.58
Q500	Left Abutment	B	Vertical-wall	11.17	7.62	13.72	1.80
	Right Abutment	B	Vertical-wall	11.17	5.60	10.17	1.82

Summary of Results

Simulation	Abutment	D_{50} (ft)	Flow depth including contraction scour, ft y_c	Amplification Factor	Scour Depth from Long Term Degradation (ft)	Maximum Flow Depth including Abutment Scour, ft y_{max}	XS 5970 BR W.S. Elev bench elevation 234.01 Depth at Abutment Toe Prior to Scour, ft y_0	Abutment Scour Hole Depth y_s (ft)
Q100	Left Abutment	0.00095	6.14	2.17	0.00	13.33	4.27	9.1
	Right Abutment	0.00095	4.66	2.45	0.00	11.42	4.27	7.1
Q200	Left Abutment	0.00095	7.17	2.15	0.00	15.42	4.94	10.5
	Right Abutment	0.00095	5.52	2.30	0.00	12.69	4.94	7.8
Q500	Left Abutment	0.00095	8.71	2.12	0.00	18.46	5.85	12.6
	Right Abutment	0.00095	6.74	2.11	0.00	14.21	5.85	8.4

*Note: If calculated y_s returns a negative answer, the contraction scour depth equals zero.

Simulation	Abutment	XS 5970 BR Bench Elevation 234.01 Reference Location Elevation (ft)	Total Scour Elevation at Abutment (ft)
Q100	Left Abutment	234.01	224.9
	Right Abutment	234.01	226.9
Q200	Left Abutment	234.01	223.5
	Right Abutment	234.01	226.3
Q500	Left Abutment	234.01	221.4
	Right Abutment	234.01	225.6

APPENDIX F

RIPRAP REVETMENT DESIGN CALCULATIONS

Hydraulic Analysis Report

Project Data

Project Title: Project - University Blvd Extension

Designer:

Project Date: Wednesday, January 14, 2026

Project Units: U.S. Customary Units

Notes:

Riprap Analysis: Riprap Analysis for Abutments

Notes:

Input Parameters

Riprap Type: Revetment

The channel is a natural channel

Local Depth of Flow: 6 ft

Riprap Shape is Angular

Stability Coefficient: 0.3

This value is updated by the selected Riprap Shape

Blanket Thickness Coefficient: 1

Channel Cross-sectional Average Velocity: 6.27 ft/s

Which is the Average Velocity with Spurs

Centerline Radius of Curvature of Channel Bend: 1e+09 ft

Width of Water Surface at Upstream End of Channel Bend: 300 ft

Bank Angle: 3 :1 H:V

.966 < Bank Angle < 4.011

The location of the revetment protection is on a straight channel

Specific Gravity of Riprap: 2.65

Safety Factor: 1.1

Result Parameters

Side slope Correction Factor: 0.976738

Velocity Distribution Coefficient: 1

Design Velocity: 6.27 ft/s

Design velocity never less than average channel velocity

Computed D30: 45.4675 mm

Computed D50: 54.561 mm

Riprap Class

Riprap Class Name:CLASS I

Riprap Class Order:1

The following values are an 'average' of the size fraction range for the selected riprap class.

D100: 304.80 mm

D85: 228.60 mm

D50: 165.10 mm

D15: 114.30 mm

Layout Recommendations

Minimum Riprap Thickness: 12.00 in

No channel used in calculations

Selected Profile: FHWA Profile (read-only)

Culvert Assessment Profiles

Culvert Assessment Profile Name: Standard (read-only)

Maximum Excavation Depth: 20.00 ft

Maximum Shallow Cover: 4.00 ft

Maximum Small Pipe Size: 36.00 ft

Minimum Manned Entry Size: 48.00 in

Riprap Classes

Riprap Class Name:CLASS I

Riprap Class Order:1

The following values are an 'average' of the size fraction range for the selected riprap class.

D100: 304.80 mm

D85: 228.60 mm

D50: 165.10 mm

D15: 114.30 mm

Riprap Class Name:CLASS II

Riprap Class Order:2
The following values are an 'average' of the size fraction range for the selected riprap class.

D100: 457.20 mm

D85: 330.20 mm

D50: 241.30 mm

D15: 177.80 mm

Riprap Class Name:CLASS III

Riprap Class Order:3
The following values are an 'average' of the size fraction range for the selected riprap class.

D100: 609.60 mm

D85: 431.80 mm

D50: 317.50 mm

D15: 228.60 mm

Riprap Class Name:CLASS IV

Riprap Class Order:4
The following values are an 'average' of the size fraction range for the selected riprap class.

D100: 762.00 mm

D85: 533.40 mm

D50: 393.70 mm

D15: 266.70 mm

Riprap Class Name:CLASS V

Riprap Class Order:5
The following values are an 'average' of the size fraction range for the selected riprap class.

D100: 914.40 mm

D85: 647.70 mm

D50: 469.90 mm

D15: 330.20 mm

Riprap Class Name:CLASS VI

Riprap Class Order:6
The following values are an 'average' of the size fraction range for the selected riprap class.

D100: 1066.80 mm

D85: 762.00 mm

D50: 546.10 mm

D15: 381.00 mm

Riprap Class Name:CLASS VII

Riprap Class Order:7
The following values are an 'average' of the size fraction range for the selected riprap class.

D100: 1257.30 mm

D85: 889.00 mm

D50: 647.70 mm

D15: 444.50 mm

Riprap Class Name:CLASS VIII

Riprap Class Order:8
The following values are an 'average' of the size fraction range for the selected riprap class.

D100: 1524.00 mm

D85: 1079.50 mm

D50: 800.10 mm

D15: 558.80 mm

Riprap Class Name:CLASS IX

Riprap Class Order:9
The following values are an 'average' of the size fraction range for the selected riprap class.

D100: 1828.80 mm

D85: 1295.40 mm

D50: 965.20 mm

D15: 660.40 mm

Riprap Class Name:CLASS X

Riprap Class Order:10
The following values are an 'average' of the size fraction range for the selected riprap class.

D100: 2133.60 mm

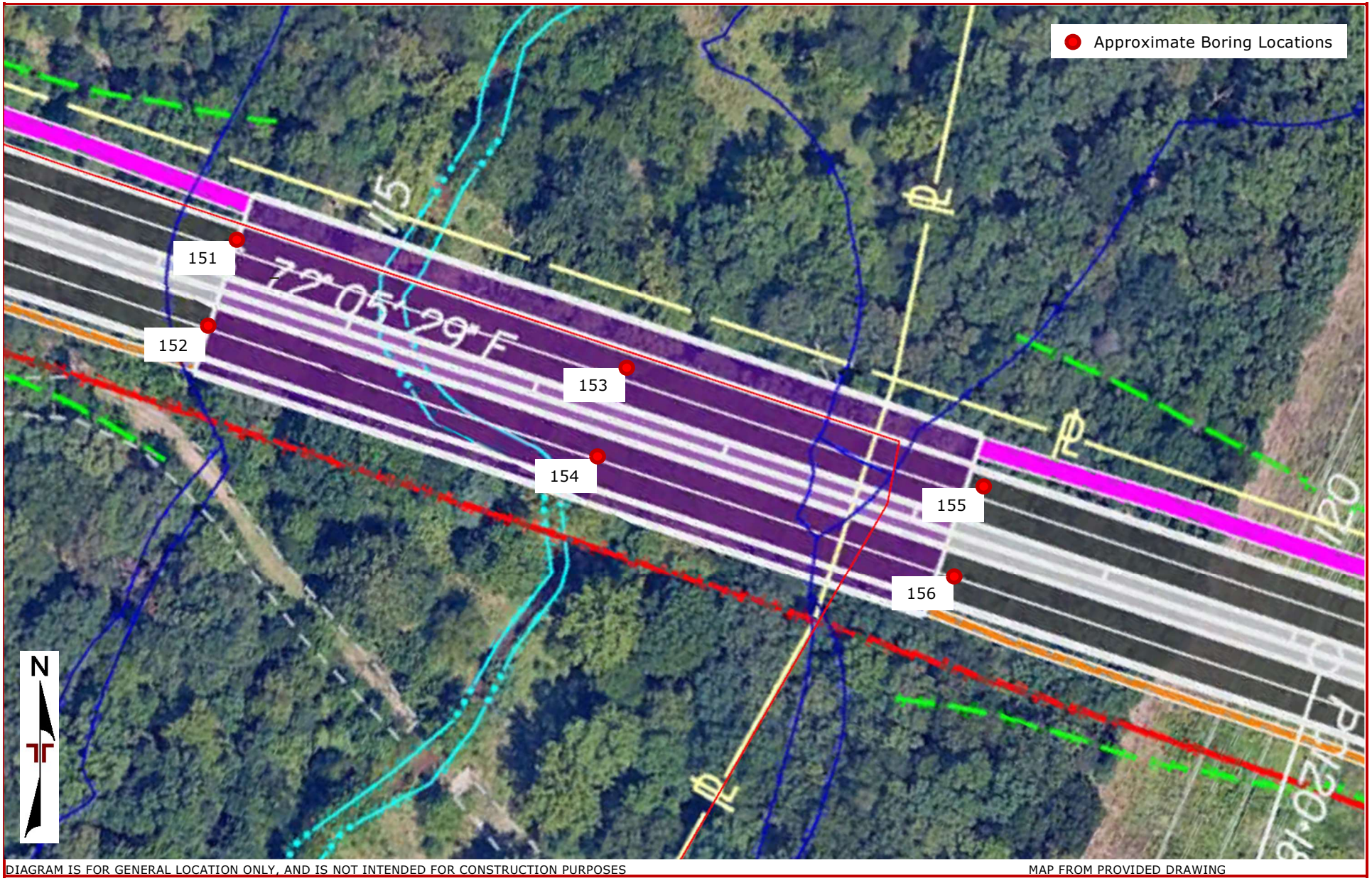
D85: 1511.30 mm

D50: 1130.30 mm

D15: 787.40 mm

APPENDIX G
GEOTECHNICAL RESULTS

Exploration Plan



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University Boulevard | Bristow, VA
Terracon Project No. EV245036

Terracon
14001 Crown Ct, Ste 109
Woodbridge, VA

Summary of Laboratory Results

Boring ID	Depth (Ft.)	Description	PL	LL	PI	% Gravel	% Sand	Fines	WC
B-119	2	SILTY SAND(SM) / A-2-6 (1)	26	40	14	0.0	66.6	33.4	18.8
B-120	6	SILTY SAND(SM) / A-1-B (0)	24	29	5	0.0	77.8	22.2	14.0
B-123	0	LEAN CLAY WITH SAND(CL) / A-6 (7)	20	31	11	0.0	21.4	78.6	9.6
B-151	6	CLAYEY SAND(SC) / A-6 (2)	19	34	15	6.3	54.9	38.8	16.0
B-152	4	CLAYEY SAND(SC) / A-2-4 (0)	16	26	10	7.4	66.9	25.6	7.1
B-153	4	SILTY GRAVEL WITH SAND(GM) / A-2-4 (0)	25	35	10	67.1	16.3	16.5	17.8
B-154	4	POORLY GRADED GRAVEL WITH CLAY(GP-GC) / A-2-6 (0)	23	35	12	81.6	11.6	6.8	18.9
B-155	0	SANDY LEAN CLAY(CL) / A-6 (5)	21	33	12	14.0	24.5	61.6	9.5
B-156	4	CLAYEY SAND(SC) / A-7-6 (39)	23	135	112	8.3	45.2	46.4	9.5

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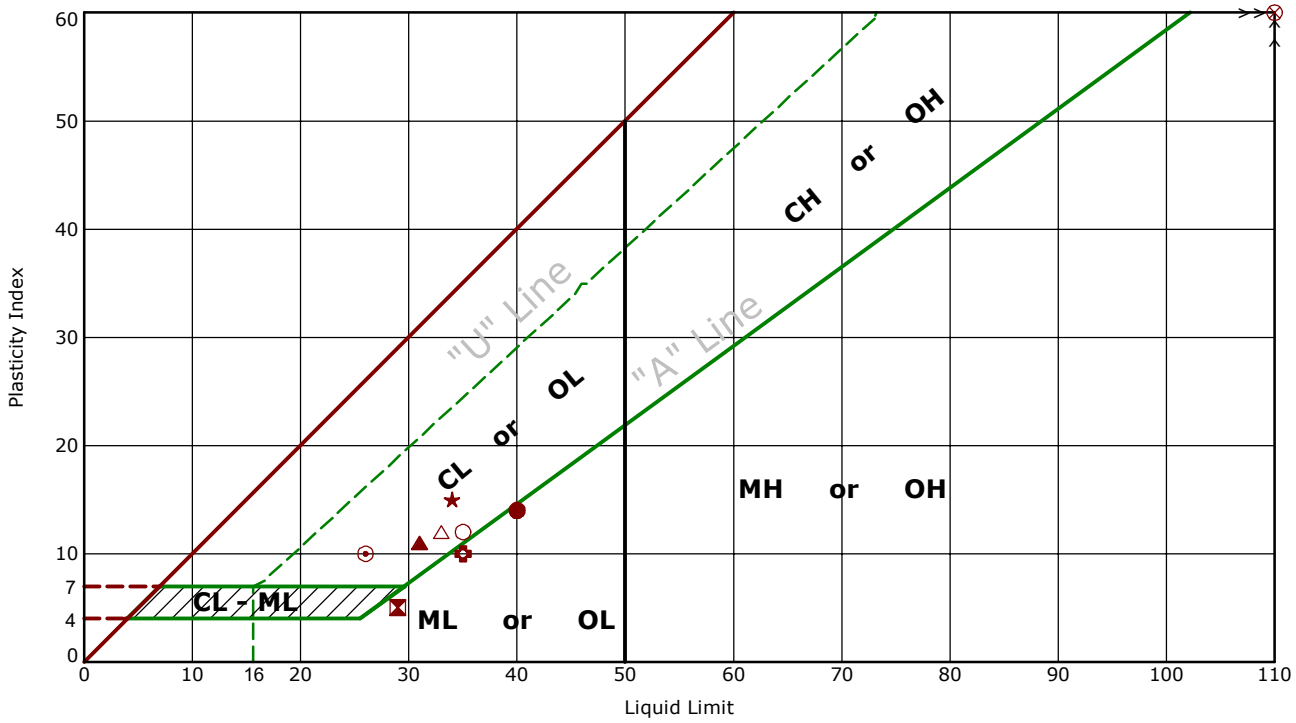
Atterberg Limit Results

ASTM D4318



	Boring ID	Depth (Ft)	LL	PL	PI	Fines	USCS	Description
●	B-119	2	40	26	14	33.4	SM	SILTY SAND
▲	B-123	0	31	20	11	78.6	CL	LEAN CLAY with SAND
★	B-151	6	34	19	15	38.8	SC	CLAYEY SAND
⊙	B-152	4	26	16	10	25.6	SC	CLAYEY SAND
○	B-154	4	35	23	12	6.8	GP-GC	POORLY GRADED GRAVEL with CLAY
⊗	B-156	4	135	23	112	46.4	SC	CLAYEY SAND

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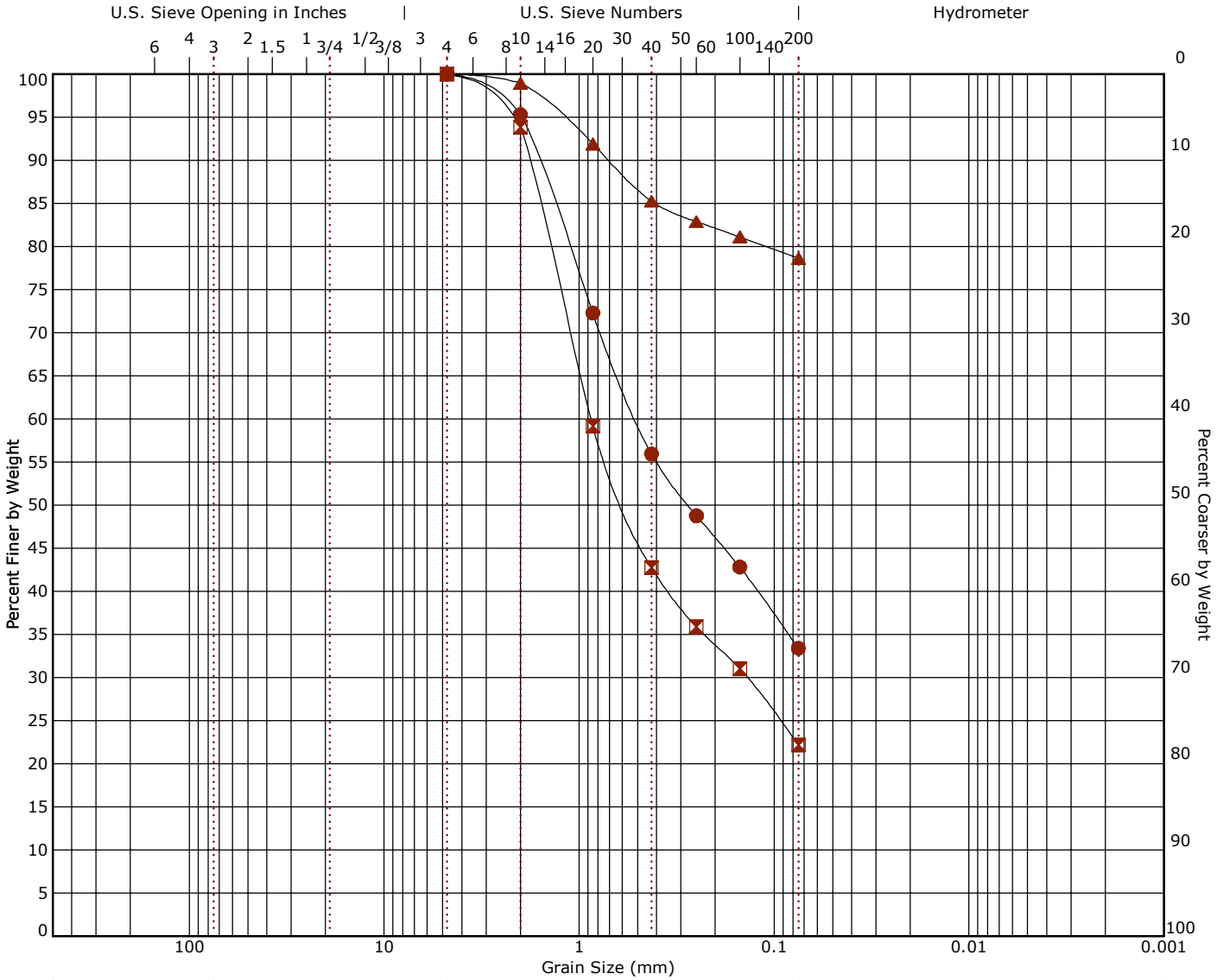
Grain Size Distribution

ASTM D422 / ASTM C136 / AASHTO T27



Cobbles	Gravel		Sand			Silt or Clay
	coarse	fine	coarse	medium	fine	

	Boring ID	Depth	% Cobbles	% Gravel	% Sand	% Fines	% Silt	% Clay	USCS
●	B-119	2	0.0	0.0	66.6	33.4			SM
⊠	B-120	6	0.0	0.0	77.8	22.2			SM
▲	B-123	0	0.0	0.0	21.4	78.6			CL

	Description
●	SILTY SAND
⊠	SILTY SAND
▲	LEAN CLAY with SAND

Remarks
●
⊠
▲

●		⊠		▲	
Sieve	% Finer	Sieve	% Finer	Sieve	% Finer
#4	100.0	#4	100.0	#4	100.0
#10	95.3	#10	93.84	#10	98.94
#20	72.28	#20	59.17	#20	91.92
#40	55.94	#40	42.74	#40	85.26
#60	48.76	#60	35.87	#60	82.88
#100	42.82	#100	31.04	#100	81.12
#200	33.4	#200	22.16	#200	78.63

Grain Size	●	⊠	▲
D_{60}	0.505	0.868	
D_{10}			

Coefficients	●	⊠	▲
C_c			
C_u			

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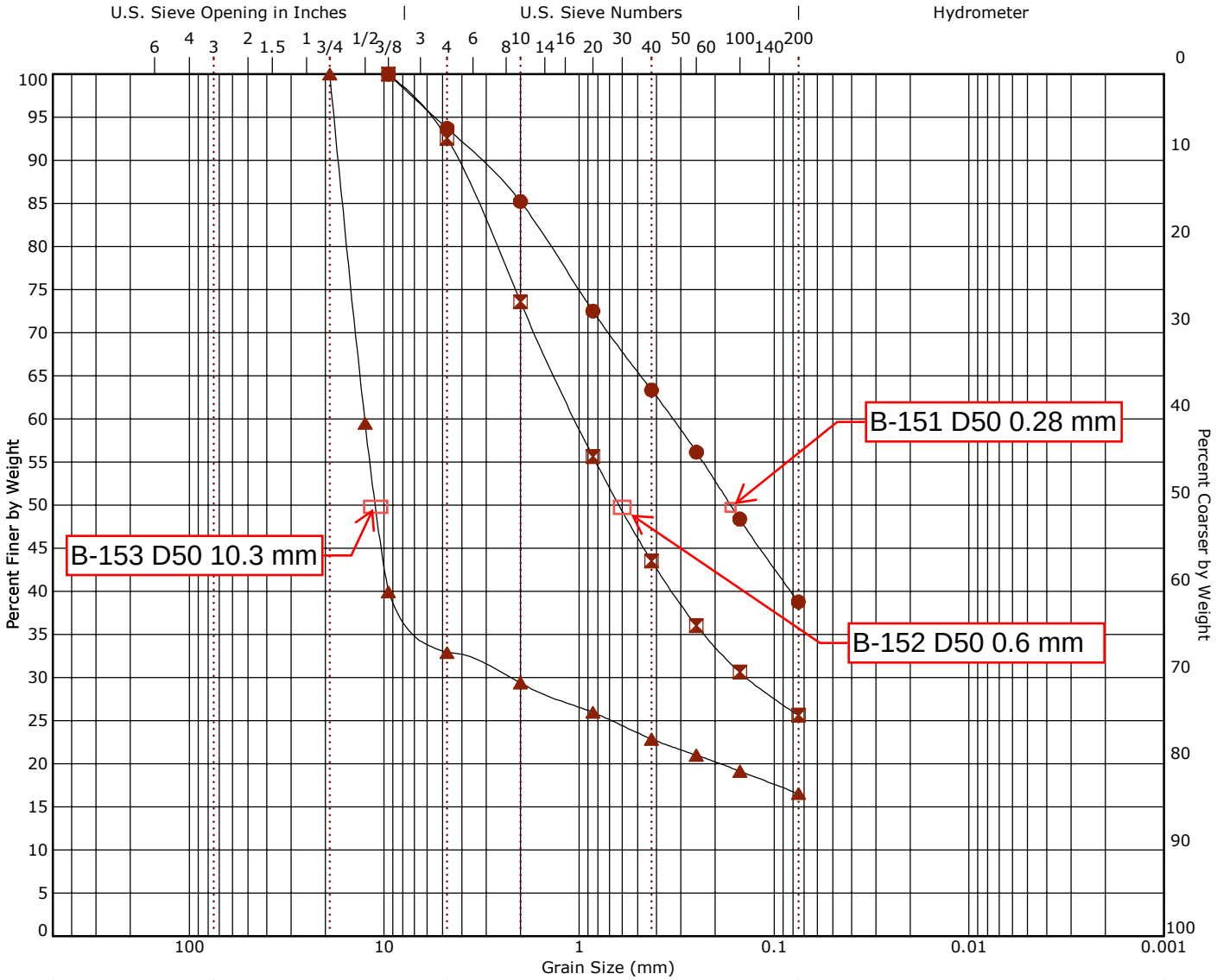
Grain Size Distribution

ASTM D422 / ASTM C136 / AASHTO T27



Cobbles	Gravel		Sand			Silt or Clay
	coarse	fine	coarse	medium	fine	

	Boring ID	Depth	% Cobbles	% Gravel	% Sand	% Fines	% Silt	% Clay	USCS
●	B-151	6	0.0	6.3	54.9	38.8			SC
⊠	B-152	4	0.0	7.4	66.9	25.6			SC
▲	B-153	4	0.0	67.1	16.3	16.5			GM

	Description
●	CLAYEY SAND
⊠	CLAYEY SAND
▲	SILTY GRAVEL with SAND

Remarks
●
⊠
▲

●		⊠		▲	
Sieve	% Finer	Sieve	% Finer	Sieve	% Finer
3/8"	100.0	3/8"	100.0	3/4"	100.0
#4	93.71	#4	92.57	1/2"	59.48
#10	85.22	#10	73.61	3/8"	39.93
#20	72.51	#20	55.65	#4	32.88
#40	63.36	#40	43.53	#10	29.41
#60	56.14	#60	36.02	#20	25.96
#100	48.38	#100	30.63	#40	22.86
#200	38.78	#200	25.62	#60	20.99
				#100	19.15
				#200	16.53

Grain Size	●	⊠	▲
D_{60}	0.332	1.046	12.567
D_{10}			

Coefficients	●	⊠	▲
C_c			
C_u			

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Terracon Project No. EV245036

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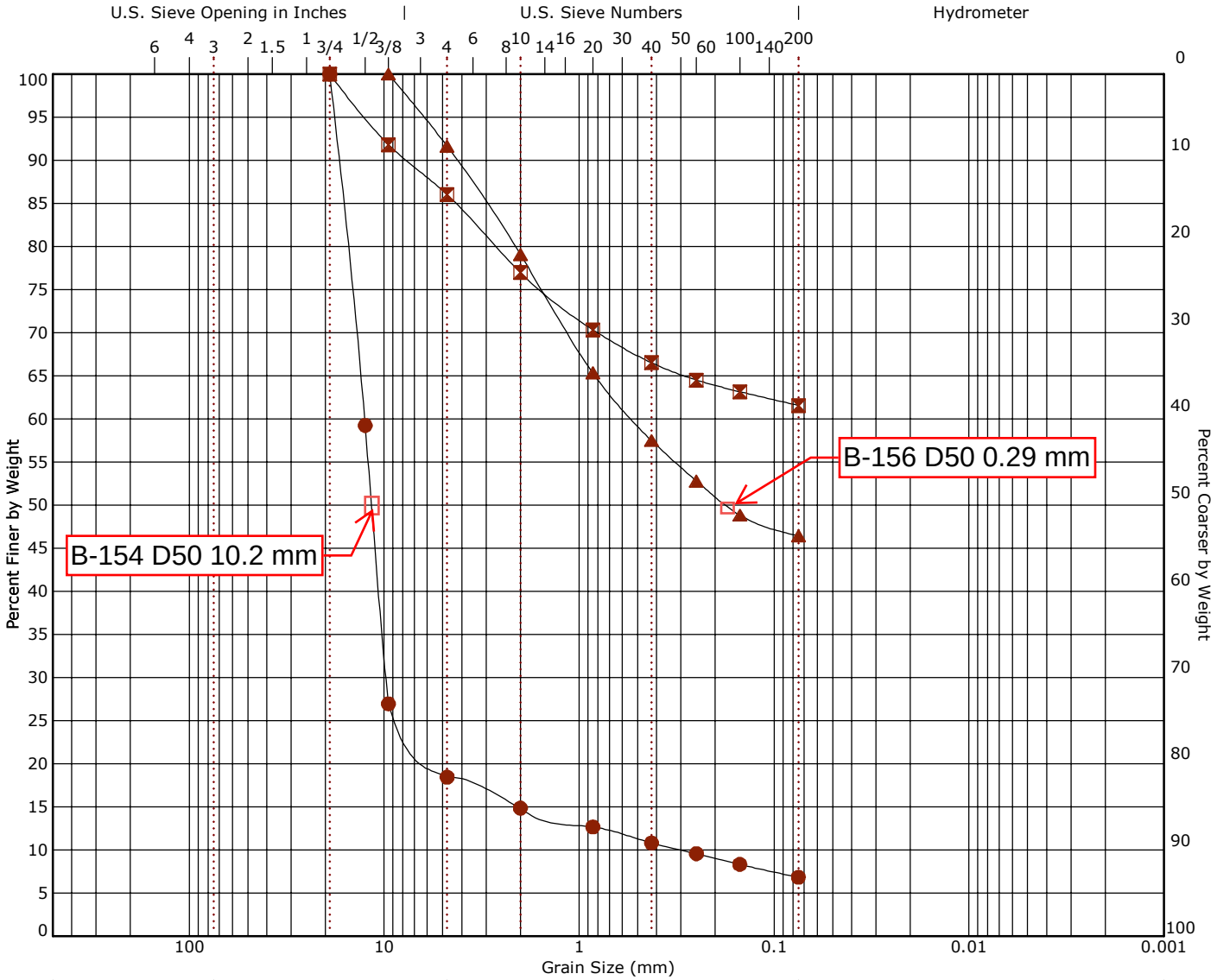
Grain Size Distribution

ASTM D422 / ASTM C136 / AASHTO T27



Cobbles	Gravel		Sand			Silt or Clay
	coarse	fine	coarse	medium	fine	

	Boring ID	Depth	% Cobbles	% Gravel	% Sand	% Fines	% Silt	% Clay	USCS
●	B-154	4	0.0	81.6	11.6	6.8			GP-GC
⊠	B-155	0	0.0	14.0	24.5	61.6			CL
▲	B-156	4	0.0	8.3	45.2	46.4			SC

	Description
●	POORLY GRADED GRAVEL with CLAY
⊠	SANDY LEAN CLAY
▲	CLAYEY SAND

Remarks
●
⊠
▲

●		⊠		▲	
Sieve	% Finer	Sieve	% Finer	Sieve	% Finer
3/4"	100.0	3/4"	100.0	3/8"	100.0
1/2"	59.25	3/8"	91.82	#4	91.65
3/8"	26.95	#4	86.03	#10	79.08
#4	18.44	#10	76.96	#20	65.33
#10	14.86	#20	70.35	#40	57.5
#20	12.66	#40	66.51	#60	52.79
#40	10.81	#60	64.51	#100	48.84
#60	9.57	#100	63.16	#200	46.45
#100	8.33	#200	61.57		
#200	6.84				

Grain Size	●	⊠	▲
D_{60}	12.597		0.53
D_{10}	0.301		

Coefficients	●	⊠	▲
C_C	25.09		
C_U	41.89		

Virginia Department of Transportation

PROJECT #: EV245036
LOCATION: Prince William County Virginia
STRUCTURE: UNIVERSITY BLVD ROADWAY

B-151

STATION: OFFSET:
LATITUDE: 38.771021° N LONGITUDE: 77.578718° W
SURFACE ELEVATION: 237.0 ft COORD. DATUM: NAD 83

Date(s) Drilled: 9/24/2025 - 9/24/2025
Drilling Method(s): 3.25" ID HSA
SPT Method: Automatic Hammer
Other Test(s): Not Applicable
Driller: Terracon (M. Moeller)
Logger: Terracon (J. Tomechko)

GROUND WATER
NOT ENCOUNTERED DURING DRILLING
NO LONG TERM MEASUREMENTS TAKEN

FIELD DATA | **LAB DATA**

PKT. PENETROMETER (tsf)	DEPTH (ft)	ELEVATION (ft)	SOIL: STANDARD PENETRATION TEST HAMMER BLOWS	SOIL: SOIL RECOVERY (%)	SAMPLE LEGEND	SAMPLE INTERVAL	ROCK: CORE RECOVERY (%)	ROCK: ROCK QUALITY DESIGNATION	ROCK: DIP ° STRATA	ROCK: DIP ° JOINTS	STRATA LEGEND	FIELD DESCRIPTION OF STRATA	LAB: LIQUID LIMIT (LL)	LAB: PLASTICITY INDEX (PI)	LAB: MOISTURE CONTENT (%)
			4 5 15 11	85		2						0.0 / 237.0 TOPSOIL = 4 INCHES **TOPS**			9.4
5		235	8 13 16 20	65		4						0.3 / 236.7 *Alluvium*, gray-brown, SILT, very stiff, moist **ML**			13.9
	5		5 9 15 11	75		6						2.0 / 235.0 *Alluvium*, dark brown, fine, SANDY LEAN CLAY, hard, moist **CL**			10.1
		230	15 21 25 50/4"	100		7.8						4.0 / 233.0 *Alluvium*, dark brown, fine to medium, CLAYEY SAND, dense, moist **SC** SAME: below 6 ft. dark red, very dense *IGM*, SAME: below 7 ft			16.0
			32 50/4"	100		8 8.8						8.0 / 229.0 *IGM*, dark red, fine to coarse, SILTY SAND WITH ROCK FRAGMENTS, very dense, moist **SM**			4.0
	10					10						Auger refusal at 10 ft.			
		225					100	37				10.0 / 227.0 Moderately weathered, moderately hard, gray, HORNFELS, highly fractured **HRNF**			
	15					15						SAME: below 13.3 ft. decomposed, very soft, red-brown SAME: below 15 ft. highly weathered, very soft to soft, intensely fractured			
		220					82	8							
	20					20						Bottom of coring at 20 ft.			

REMARKS: Rig Type: CME 55.
Groundwater levels may be affected by water introduced during rock coring.

VDOT Virginia Department of Transportation

PROJECT #: EV245036
LOCATION: Prince William County Virginia
STRUCTURE: UNIVERSITY BLVD ROADWAY

B-152

STATION: OFFSET:
LATITUDE: 38.770899° N LONGITUDE: 77.578767° W
SURFACE ELEVATION: 236.0 ft COORD. DATUM: NAD 83

FIELD DATA

Date(s) Drilled: 9/25/2025 - 9/25/2025
Drilling Method(s): 3.25" ID HSA
SPT Method: Automatic Hammer
Other Test(s): Not Applicable
Driller: Terracon (M. Moeller)
Logger: Terracon (J. Tomechko)

GROUND WATER
NOT ENCOUNTERED DURING DRILLING
NO LONG TERM MEASUREMENTS TAKEN

LAB DATA

PKT. PENETROMETER (tsf)	DEPTH (ft)	ELEVATION (ft)	SOIL: STANDARD PENETRATION TEST HAMMER BLOWS	SOIL: SOIL RECOVERY (%)	SAMPLE LEGEND	SAMPLE INTERVAL	ROCK: CORE RECOVERY (%)	ROCK: ROCK QUALITY DESIGNATION	ROCK: DIP ° STRATA	ROCK: DIP ° JOINTS	STRATA LEGEND	FIELD DESCRIPTION OF STRATA	LAB: LIQUID LIMIT (LL)	LAB: PLASTICITY INDEX (PI)	LAB: MOISTURE CONTENT (%)
0.5		235	4 6 10 10	50		2						0.0 / 236.0 *Alluvium*, gray-brown, SILT, very stiff, moist **ML**			8.5
5			8 12 18 30	85		4						2.0 / 234.0 *Alluvium*, dark red, fine to coarse, SANDY LEAN CLAY WITH ROCK FRAGMENTS, hard, moist **CL**			9.8
	5		9 6 15 21	15		6						4.0 / 232.0 *Alluvium*, dark red, fine to medium, SILTY SAND, medium dense, moist **SM**			7.1
		230	50/5"	100		6.4						*IGM*, SAME: below 6 ft. very dense			6.2
			50/0"	100		8 8.04						8.0 / 228.0 *IGM*, dark red, coarse, POORLY GRADED ROCK FRAGMENTS, very dense **GP**			2.5
	10	225				11						Auger refusal at 11 ft.			
							52	12				11.0 / 225.0 Highly weathered, soft, dark red, HORNFELS, highly fractured **HRNF**			
	15	220				16									
							66	23							
	20	215				21						Bottom of coring at 21 ft.			

REMARKS: Rig Type: CME 55.
Groundwater levels may be affected by water introduced during rock coring.

Virginia Department of Transportation

PROJECT #: EV245036
LOCATION: Prince William County Virginia
STRUCTURE: UNIVERSITY BLVD ROADWAY

B-153
PAGE 1 OF 1

STATION: OFFSET:
LATITUDE: 38.770845° N LONGITUDE: 77.578036° W
SURFACE ELEVATION: 233.0 ft COORD. DATUM: NAD 83

Date(s) Drilled: 9/23/2025 - 9/23/2025
Drilling Method(s): 3.25" ID HSA
SPT Method: Automatic Hammer
Other Test(s): Not Applicable
Driller: Terracon (M. Moeller)
Logger: Terracon (J. Tomechko)

GROUND WATER
NOT ENCOUNTERED DURING DRILLING
NO LONG TERM MEASUREMENTS TAKEN

FIELD DATA | **LAB DATA**

PKT. PENETROMETER (tsf)	DEPTH (ft)	ELEVATION (ft)	SOIL: STANDARD PENETRATION TEST HAMMER BLOWS	SOIL: SOIL RECOVERY (%)	SAMPLE LEGEND	SAMPLE INTERVAL	ROCK: CORE RECOVERY (%)	ROCK: ROCK QUALITY DESIGNATION	ROCK: DIP ° STRATA	ROCK: DIP ° JOINTS	STRATA LEGEND	FIELD DESCRIPTION OF STRATA	LAB: LIQUID LIMIT (LL)	LAB: PLASTICITY INDEX (PI)	LAB: MOISTURE CONTENT (%)
			5 5 3 3	70		2						0.0 / 233.0 *Alluvium*, brown, fine to medium, SANDY SILT, stiff, moist **ML**			11.3
2		230	4 4 5 6	75		4						2.0 / 231.0 *Alluvium*, dark brown, fine, LEAN CLAY WITH SAND, stiff, moist **CL**			27.5
1.75	5		2 3 6 6	40		6									17.8
0.5			12 14 15 36	20								SAME: BELOW 6 FT, hard, with Quartz			39.5
		225	50/5"	100		8 8.4						*IGM*, SAME: BELOW 8 FT, very hard			9.8
	10					11						Auger refusal at 11 ft.			
		220					94	23				11.0 / 222.0 Highly weathered, soft, red-brown and gray, HORNFELS, highly fractured **HRNF**			
	15					16									
		215					100	44							
	20					21						Bottom of coring at 21 ft.			

REMARKS: Rig Type: CME 55.
Groundwater levels may be affected by water introduced during rock coring.

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SPT_LOGA:EV245036 - UNIVERSITY BOULEVARD VDOT FORMATTED GINT.GPJ:SPT7.GDT: Lib version 20200505 : gINT version 10.03.00.10 : 11/12/25 : Terracon Consultants

PROJECT #: EV245036
LOCATION: Prince William County Virginia
STRUCTURE: UNIVERSITY BLVD ROADWAY

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STATION: OFFSET:
LATITUDE: 38.770726° N LONGITUDE: 77.578087° W
SURFACE ELEVATION: 233.0 ft COORD. DATUM: NAD 83

Date(s) Drilled: 9/23/2025 - 9/23/2025
Drilling Method(s): 3.25" ID HSA
SPT Method: Automatic Hammer
Other Test(s): Not Applicable
Driller: Terracon (M. Moeller)
Logger: Terracon (J. Tomechko)

GROUND WATER
NOT ENCOUNTERED DURING DRILLING
NO LONG TERM MEASUREMENTS TAKEN

FIELD DATA													LAB DATA		
PKT. PENETROMETER (tsf)	DEPTH (ft)	ELEVATION (ft)	SOIL: STANDARD PENETRATION TEST HAMMER BLOWS	SOIL: SOIL RECOVERY (%)	SAMPLE LEGEND	SAMPLE INTERVAL	ROCK: CORE RECOVERY (%)	ROCK: ROCK QUALITY DESIGNATION	ROCK: DIP ° STRATA	ROCK: DIP ° JOINTS	STRATA LEGEND	FIELD DESCRIPTION OF STRATA	LIQUID LIMIT (LL)	PLASTICITY INDEX (PI)	MOISTURE CONTENT (%)
			5 7 4 4	40		2						0.0 / 233.0 *Alluvium*, brown, fine to medium, SANDY SILT WITH GRAVEL, stiff, moist **ML**			12.7
1		230	4 4 4 6	45		4						2.0 / 231.0 *Alluvium*, Dark brown, fine to medium, LEAN CLAY WITH SAND, stiff, moist **CL**			33.7
	5		4 5 11 12	75		6						4.0 / 229.0 *Alluvium*, Dark red, fine to coarse, SILTY SAND WITH ROCK FRAGMENTS, medium dense, moist **SM**			18.9
			12 50/5"	100		6.9 7						6.0 / 227.0 *IGM*, dark red, ROCK FRAGMENTS AND SILT, very hard, moist **ML** Auger refusal at 7 ft			29.1
		225										7.0 / 226.0 Highly weathered, soft, red-brown, HORNFELS, highly fractured **HRNF**			
	10						98	18							
						12						moderately hard			
		220													
	15						100	18							
						17						Bottom of coring at 17 ft.			

REMARKS: Rig Type: CME 55.
Groundwater levels may be affected by water introduced during rock coring.

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PROJECT #: EV245036
LOCATION: Prince William County Virginia
STRUCTURE: UNIVERSITY BLVD ROADWAY

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PAGE 1 OF 1

STATION: OFFSET:
LATITUDE: 38.770682° N LONGITUDE: 77.577411° W
SURFACE ELEVATION: 241.0 ft COORD. DATUM: NAD 83

Date(s) Drilled: 9/22/2025 - 9/22/2025
Drilling Method(s): 3.25" ID HSA
SPT Method: Automatic Hammer
Other Test(s): Not Applicable
Driller: Terracon (M. Moeller)
Logger: Terracon (J. Tomechko)

GROUND WATER
NOT ENCOUNTERED DURING DRILLING
NO LONG TERM MEASUREMENTS TAKEN

DEPTH (ft)	ELEVATION (ft)	SOIL: STANDARD PENETRATION TEST HAMMER BLOWS	SOIL: SOIL RECOVERY (%)	SOIL: SAMPLE LEGEND	SOIL: SAMPLE INTERVAL	ROCK: CORE RECOVERY (%)	ROCK: ROCK QUALITY DESIGNATION	ROCK: DIP ° STRATA	ROCK: DIP ° JOINTS	STRATA LEGEND	FIELD DESCRIPTION OF STRATA	LAB: LIQUID LIMIT (LL)	LAB: PLASTICITY INDEX (PI)	LAB: MOISTURE CONTENT (%)
		3 5 8 12									0.0 / 241.0			
	240	50/5"	55		2						*Alluvium*, brown, SILT WITH SAND, stiff, moist **ML**			9.5
			100		2.4						SAME: below 2 ft. *IGM*, hard			10.0
		31 29 50/5"			4						4.0 / 237.0			
5			100		5.4						*IGM*, gray-brown, SANDY SILT, hard, moist **ML**			5.8
	235	50/2"	0		6									5.0
					6.2						Auger refusal at 7 ft.			
					7						7.0 / 234.0			
						65	6				Highly weathered, soft, gray, HORNFELS, highly fractured **HRNF**			
10	230				12									
						62	0							
15	225				17						Bottom of coring at 17 ft.			

REMARKS: Rig Type: CME 55.
Groundwater levels may be affected by water introduced during rock coring.

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Virginia Department of Transportation

PROJECT #: EV245036
LOCATION: Prince William County Virginia
STRUCTURE: UNIVERSITY BLVD ROADWAY

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STATION: OFFSET:
LATITUDE: 38.770561° N LONGITUDE: 77.577465° W
SURFACE ELEVATION: 241.0 ft COORD. DATUM: NAD 83

Date(s) Drilled: 9/22/2025 - 9/22/2025
Drilling Method(s): 3.25" ID HSA
SPT Method: Automatic Hammer
Other Test(s): Not Applicable
Driller: Terracon (M. Moeller)
Logger: Terracon (J. Tomechko)

GROUND WATER
NOT ENCOUNTERED DURING DRILLING
NO LONG TERM MEASUREMENTS TAKEN

FIELD DATA | **LAB DATA**

PKT. PENETROMETER (tsf)	DEPTH (ft)	ELEVATION (ft)	SOIL: STANDARD PENETRATION TEST HAMMER BLOWS	SOIL: SOIL RECOVERY (%)	SAMPLE LEGEND	SAMPLE INTERVAL	ROCK: CORE RECOVERY (%)	ROCK: ROCK QUALITY DESIGNATION	ROCK: DIP ° STRATA	ROCK: DIP ° JOINTS	STRATA LEGEND	FIELD DESCRIPTION OF STRATA	LAB: LIQUID LIMIT (LL)	LAB: PLASTICITY INDEX (PI)	LAB: MOISTURE CONTENT (%)
		240	3 5 8 12	55								0.0 / 241.0 *Alluvium*, brown, SILT WITH SAND, very stiff, moist **ML**			14.2
5			50/5"	100		2 2.4						*IGM*, SAME: below 2 ft. very hard			11.4
			31 29 50/5"	100		4 5.4						4.0 / 237.0 *IGM*, gray-brown, fine to medium, SANDY SILT, very hard, moist **ML**			9.5
5	5	235	50/2"	100		6 6.2						SAME: below 6 ft. very hard			8.4
						7						Auger refusal at 7 ft.			
												7.0 / 234.0 Highly weathered, moderately hard, dark gray, HORNFELS, intensely fractured **HRNF**			
	10	230					100	12							
						12						SAME: below 12 ft. moderately weathered, highly fractured			
	15	225					95	17							
						17						Bottom of coring at 17 ft.			

REMARKS: Rig Type: CME 55.
Groundwater levels may be affected by water introduced during rock coring.

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ROCK CORE PHOTO LOG

University Boulevard Extension
Terracon Project No. EV245036

Boring No.	Row No. [1]	Run No.	Start Depth (ft)	End Depth (ft)	Length (in)	Recovery (in)	Recovery (%)	RQD (in)	RQD (%)
B-123	1	5	23	28	60	60	100	60	100
B-123	2	6	28	33	60	37.5	62	31	52
B-153	3	1	11	16	60	56	93	13.5	23
B-153	4	2	16	21	60	60	100	26.5	44

1. Row starts from top left

ROCK CORE PHOTO LOG

University Boulevard Extension
Terracon Project No. EV245036

Boring No.	Row No. [1]	Run No.	Start Depth (ft)	End Depth (ft)	Length (in)	Recovery (in)	Recovery (%)	RQD (in)	RQD (%)
B-154	1	1	7	12	60	59	98	10.5	18
B-154	2	2	12	17	60	60	100	11	18
B-151	3	1	10	15	60	60	100	22	37
B-151	4	2	15	20	60	49	82	5	8

1. Row starts from top left

ROCK CORE PHOTO LOG

University Boulevard Extension
Terracon Project No. EV245036

Boring No.	Row No. [1]	Run No.	Start Depth (ft)	End Depth (ft)	Length (in)	Recovery (in)	Recovery (%)	RQD (in)	RQD (%)
B-152	1	1	11	16	60	31	52	7	12
B-152	2	2	16	21	60	40	66	14	23

1. Row starts from top left

ROCK CORE PHOTO LOG

University Boulevard Extension
Terracon Project No. EV245036

Boring No.	Row No. [1]	Run No.	Start Depth (ft)	End Depth (ft)	Length (in)	Recovery (in)	Recovery (%)	RQD (in)	RQD (%)
B-155	1	1	4	9	60	39	65	4	6
B-155	2	2	9	14	60	37	62	0	0

1. Row starts from top left