Location Hydraulic Report

Florida Department of Transportation

ETDM Number: 14193
Financial Management No.: 436292-1-22-01
Federal Aid Project Number: NA

Prepared for:
FDOT District 5
719 South Woodland Boulevard,
DeLand, Florida 32720

October 2020

Leave Blank

Location Hydraulic Report
Florida Department of Transportation

I hereby certify that I am a registered professional engineer in the State of Florida practicing engineering with STANTEC CONSULTING SERVICES INC and that I have supervised the preparation of and approve the analysis, findings, opinions, conclusions and technical advice hereby reported for:

PROJECT: Pioneer Trail (CR 4118) Interchange PD&E Study from Williamson Boulevard to Turnbull Bay Road in Volusia County, Florida
ETDM Number: 14193
Financial Management No.: 436292-1-22-01
Federal Aid Project Number: NA

The engineering work represented by this document was performed through the following duly authorized engineering business:

STANTEC CONSULTING SERVICES INC
777 S Harbour Island Boulevard Suite 600
Tampa, Florida 33602-5729
Telephone: 813-221-1981

This report provides the results of a summary of data collection efforts, and limited calculation for the existing and the proposed cross drain and floodplain evaluations prepared for the conceptual analyses for the Location Hydraulic Report for the Project Development and Environmental Study for Pioneer Trail from Williamson Boulevard to Turnbull Bay Road. I acknowledge that the procedures and references used to develop the results contained in this report are standard to the professional practice of hydrologic analysis and hydraulic engineering as applied through the professional judgment and experience. This document is for planning purposes only and is not to replace any effort required for final design.

Any engineering analysis, documents, conclusions ore recommendations relied upon from other professional sources or provided with responsibility by the client are referenced accordingly in the following report.

The environmental review, consultation, and other actions required by applicable federal environmental laws for this project are being, or have been, carried out by FDOT pursuant

to 23 U.S.C § 327 and a Memorandum of Understanding dated December 14, 2016 and executed by FHWA and FDOT.

FLORIDA REGISTERED ENGINEER:
Dominique H. Rudajev, Professional Engineer, License No. 61829

Dominique Rudajev

Digitally signed by Dominique Rudajev
Date: 2020.10.20 17:32:41 -04'00'

Table of Contents

LIST OF TABLES

LIST OF APPENDICES

1.0 INTRODUCTION

The Project Development and Environment (PD&E) drainage design services for Florida Department of Transportation (FDOT) District 5 for the new interchange on Interstate 95 (I-95) at Pioneer Trail (CR 4118) near Milepost (MP) 19.032 located in Volusia County, Florida. The proposed interchange is located between two existing interchanges on I-95 with SR 421 at MP 23.300 to the north and with SR 44 at MP 16.287 to the south. There are three potential interchange alternatives currently being analyzed. The study area is within Volusia County. The FDOT is proposing to add capacity to Pioneer Trail by widening the current roadway from a two-lane undivided to a four-lane divided urban arterial by adding one new lane in each direction. The proposed roadway along this segment of Pioneer Trail will consist of two 12-ft travel lanes, 5-ft bike lanes and an 8-ft sidewalk in each direction. A 22-ft median separates the eastbound and the westbound travel lanes. A six-lane section is also provided for deceleration and acceleration lanes to and from the ramps as needed. The project horizontal datum is Florida State Plane East Zone (NAD 1983), and the vertical datum is NAVD'88, which is 1.14 ft below NGVD'29 (0.00 ft NGVD'29 = -1.14 ft NAVD'88). The project is located within Spruce Creek in the St. Johns River Water Management District (SJRWMD). See **Figure A-1** in **Appendix A** for the Project Location Map.

Volusia County Federal Emergency Management Agency (FEMA) Flood Insurance Rate Map (FIRM) Panel Number 12127C0517J dated February 19, 2014 was used to identify the floodplain and floodway limits associated with this project. FEMA Flood Zone A intermittently encroaches throughout the project area. Special Flood Hazard Zone A is defined as "No base flood elevation determined". Zone A are areas that have a 1% probability of occurring (also known as the "100-year floodplain"), and where predicted flood water elevations have not been established. Properties in Zone A are considered to be at high risk of flooding under the National Flood Insurance Program (NFIP). The FEMA floodplain Map is included in **Appendix A**, **Figure A-2**.

The project area is within the Spruce Creek Hydrologic basin within the jurisdiction of SJRWMD. The existing basins conditions, onsite runoff is conveyed by means of grassed roadside swales and cross drains. The existing roadway median along I-95 is comprised of low-quality wetlands. Since the cross drains either discharge to or collect water from the wetlands located in the medians, this area provides some treatment for the runoff. There are no stormwater ponds in the existing condition except for a Wet Detention Pond near Williamson Boulevard. The existing basins are open basins, which discharge to interconnected wetlands and will drain to the Spruce Creek, an impaired water body for nutrients and an Outstanding Florida Water (OFW).

Contributing areas were delineated using surveyed information and reviewing existing permits and plans. Relevant permit information is contained within **Appendix B**. A field survey to verify pipe sizes and review cross drain locations was conducted on March 23, 2020. Proposed pipe locations were determined from field review, LiDAR, and available information including FEMA floodplains, USGS topographic information (**Figure A-3,**

Appendix A), NRCS Mapped Soils (**Figure A-4, Appendix A**) and permits for upstream or downstream culverts. Generally, proposed pipes were located where there are existing open channels or depressional areas and at the proposed stormwater ponds.

The existing peak flows through the cross drains were calculated using FDOT Velocity Method or permit information from upstream and downstream culvert. **Section 3.0 Cross Drain Analysis Methodology** of the report details the methods used for the input parameters.

2.0 PURPOSE

The purpose of this Location Hydraulics Report is to assess locations of off-site runoff towards the I-95 at Pioneer Trail Interchange alternatives analyzed within the PD&E Study. The intent of the I-95 at Pioneer Trail Interchange PD&E Study is to develop a proposed improvement strategy that is technically sound, environmentally sensitive, and publicly acceptable. The need for the project is to meet social demands. Analysis within this report is to provide estimated quantity and capacity to accommodate off-site runoff needs.

3.0 CROSS DRAIN ANALYSIS METHODOLOGY

The proposed cross drains along the new interchange will be designed to allow the offsite flow to follow the pre-development conditions. The existing basins are open basins, which discharge to interconnected wetlands that flow from west to east and ultimately outfalls to Spruce Creek. Refer to **Figures 5** and **6** in **Appendix A** for existing and proposed cross drains.

The Velocity Method was employed to calculate discharge rates for the design, base, and greatest flood years which used permitted discharge rates within the Williamson Boulevard Extension Permit, SJRWMD ERP No. 134174-1 and I-95 from SR 44 to South I-4 Permit, SJRWMD ERP No. 118421-2. The intensity for each storm event were attained directly from the IDF curve for Zone 7. Time of concentration was calculated for the basins. Discharge rates using the rational method (drainage areas less than 600 acres, Q=ciA and per existing permit 118421-2) for the 25-year, 50-year, 100-year and 500-year were calculated. Calculated discharge rates were entered in the HY-8 v 7.30 software program.

Table 1 provides the required storm events to be analyzed for each cross drain, per the FDOT Drainage Manual and Culvert Handbook requirements.

TABLE 1: STORM FREQUENCY CRITERIAS

Storm Event	Reason
10-year	General Roadside Ditch Culverts Pedestrian and Trail Bridge
25-year	Design Flood Event (20-year projection of AADT<1,500)
50-year	High Use or Essential (20-year projection of AADT>1,500) Mainline Interstate and Limited Access Facilities
100-year	Base Flood Event
500-year	Greatest Flood Event

3.1 CULVERT DESIGN

All cross drains were designed to have sufficient hydraulic capacity to convey the 50-year design frequency storm event and analyzed for the base flood (100-year) and greatest flood event (500-year). In the event of overtopping the pipes were adjusted in the post conditions to meet the 50-year design frequency.

The tailwater was assumed to be constant and utilized the more reasonable value from the crown of pipe, previously identified tailwater elevation, or Seasonal Highwater Table (SHWT) information obtained from field survey. The location, pipe length, and pipe inverts for each existing cross drain were found from field survey or using LiDAR to approximate the existing ground elevation at proposed right of way edge for each alternative.

4.0 EXISTING CONDITIONS

4.1 PREVIOUSLY PERMITTED INFORMATION

Existing drainage basin locations and previously permitted cross drains located upstream and downstream of the project were used to determine the sizing and flow for the proposed cross drains. GPI conducted an initial survey on March 23rd of 2020 along the study area; verified the location and sizing of previously permitted cross drains. The pertinent cross drains found within the project boundaries were verified. There is no history of flooding within the project limits.

Table 2 provides a list of SJRWMD ERPS as well as FDOT Record Drawings reviewed for cross drain information and locations along Pioneer Trail (CR 4118) Interchange from Williamson Boulevard to Turnbull Bay.

TABLE 1: EXISTING PLANS WITHIN PIONEER TRAIL INTERCHANGE FROM WILLIAMSON BOULEVARD TO TURNBULL BAY

Permit Number	FPID Number	Project Name	Plans show pertinent Cross Drain?
118421-2	406869-6	I-95 (SR 44 to I-4)	Yes
103479-1	Unknown	Pioneer Trail Curve Realignment	No
156663-1	Unknown	Shell Pointe Colony	No
134174-1	Unknown	Williamson Boulevard South Ext. (Airport Blvd. to Pioneer Trail)	Yes

Plans showing pertinent cross drains within the project vicinity are included in **Appendix B**.

4.2 CROSS DRAINS

In developing the direction of flow for the existing conditions, we relied on the LiDAR data, previously permitted data for the site, as-built data and survey. See **Figure 5** in **Appendix A** for existing cross drains.

Table 3 provides a list of the existing cross drains. The South-Offsite existing cross drain will be abandoned in the proposed conditions.

TABLE 2: EXISTING CROSS DRAINS

Existing Cross Drain ID	SIZE	Flow Direction	US Invert (NAVD 88)	DS Invert (NAVD 88)	Pipe Length
P01A-South	2.25'x8.75'	North	23.05'	22.77'	67'
P01A-01B	(5) 19"x30"	East	24.37'	24.15'	129'
P01B-Offsite	36" RCP	East	22.09'	21.94'	278'
South-Spruce Creek	(2) 7'x5'	Northeast	20.93'	20.88'	93'
South-Offsite	30" RCP	East	23.38'	22.85'	280'
South01-I-95	7'x6'	Southwest	21.15'	20.76'	185'
South02-I-95	7'x6'	Northeast	20.63'	20.13'	185'
South 03-I-95	(2) 36" RCP	Southwest	23.35'	22.35'	121'
South-04-I-95	(2) 36"	Southwest	22.98'	22.72'	120'
North01-I-95	5'x7'	West	22.84'	21.46'	123'
North02-I-95	5'x7'	West	23.93'	23.10'	123'

5.0 PROPOSED CONDITIONS

5.1 ROADWAY IMPACTS

Potential floodplain impacts as a result of the construction of the I-95 at Pioneer Trail Interchange from Williamson Boulevard to Turnbull Bay Road in Volusia County were reviewed along the contributing basins. Any floodplain impacts associated with the proposed interchange will be handled during the design phase.

Encroachment of the proposed roadway on the existing 100-year floodplain at cross drain locations and along the corridor will be mitigated by routing this volume to the project's proposed stormwater management facilities.

5.1.1 Longitudinal or Transverse Encroachments

Most of the encroachments will be longitudinal. However, locations near the east side of the project is where transverse encroachments may occur. There are two FPC sites proposed that will provide volume compensation (cup for cup) for all floodplain impacts resulting from floodplain encroachments.

5.2 PROPOSED CROSS DRAINS

The proposed cross drains are estimated to allow the offsite flow to mimic the existing conditions. Evaluation of the upstream and downstream condition was performed to determine existing cross drains, flows, and patterns in order to determine the best available information to estimate a size for the proposed cross drains. Each proposed

cross drain will be analyzed during the design phase for their respective hydraulic adequacy. There are 4 proposed cross drains with Recommended Alternative 3.

The proposed conditions is an update to the existing conditions using preliminary calculations and site plans from the roadway and stormwater pond design. The revisions were limited to only those areas impacted by the proposed roadway. See **Figure 6** in **Appendix A** for proposed cross drains for the Recommended Alternative.

As shown in **Table 4** there are 3 proposed cross drains which will be sized and anlyzed during the design phase.

TABLE 1: PROPOSED CROSS DRAINS AND/OR MODIFIED CROSS DRAINS

Existing Cross Drain ID	SIZE	Flow Direction	Pipe Length
P01A-South	2.25'x8.75'	North	110'
P01A-01B	(6) 19"x30"	East	129'
P01B-Offsite	48" RCP	East	278'
South-Spruce Creek	(2) 7'x5'	Northeast	164'
South03-I-95	(2) 36" RCP	Southwest	140'
P01B-Ramp (NEW)[1]	To be determined	East	80'
Offsite-Spruce Creek (NEW)[1]	To be determined	East	170'
South01-Ramp (NEW)[1]	To be determined	Southwest	80'

6.0 CONCLUSION

In summary, the existing cross drains have been evaluated for headwater impacts to see if replacement is necessary. The drainage features will be designed in accordance with the FDOT Drainage Manual and to better align with Section 13.2.2.1 and Figure 13-1 of the FDOT PD&E Manual.

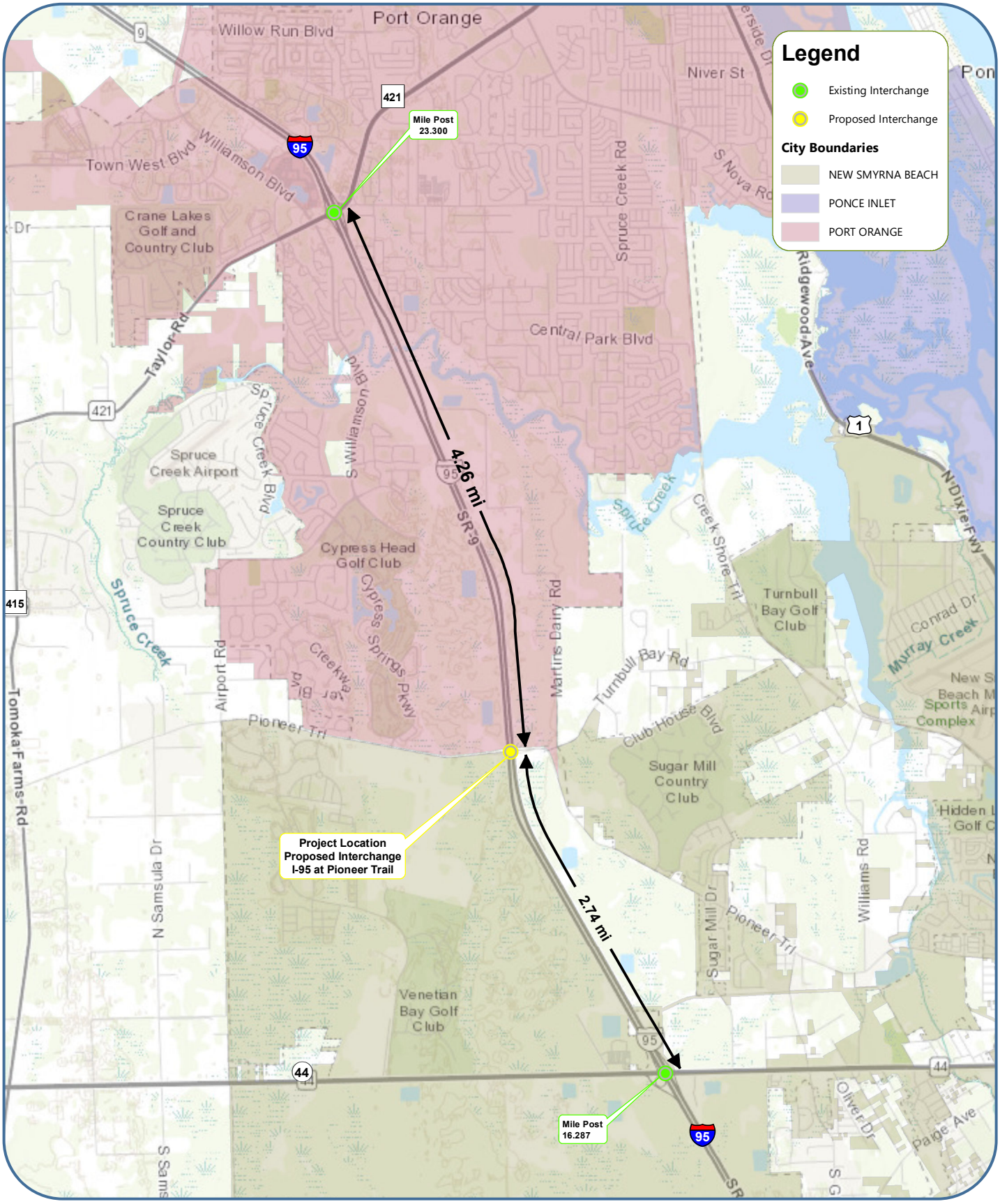
Additional right-of-way is anticipated for offsite floodplain compensation sites to mitigate for impacts to the floodplain on a cup-for-cup basis and a determination to the best location for compensation should be performed during the design phase. Refer to the Pond Siting Report for additional information.

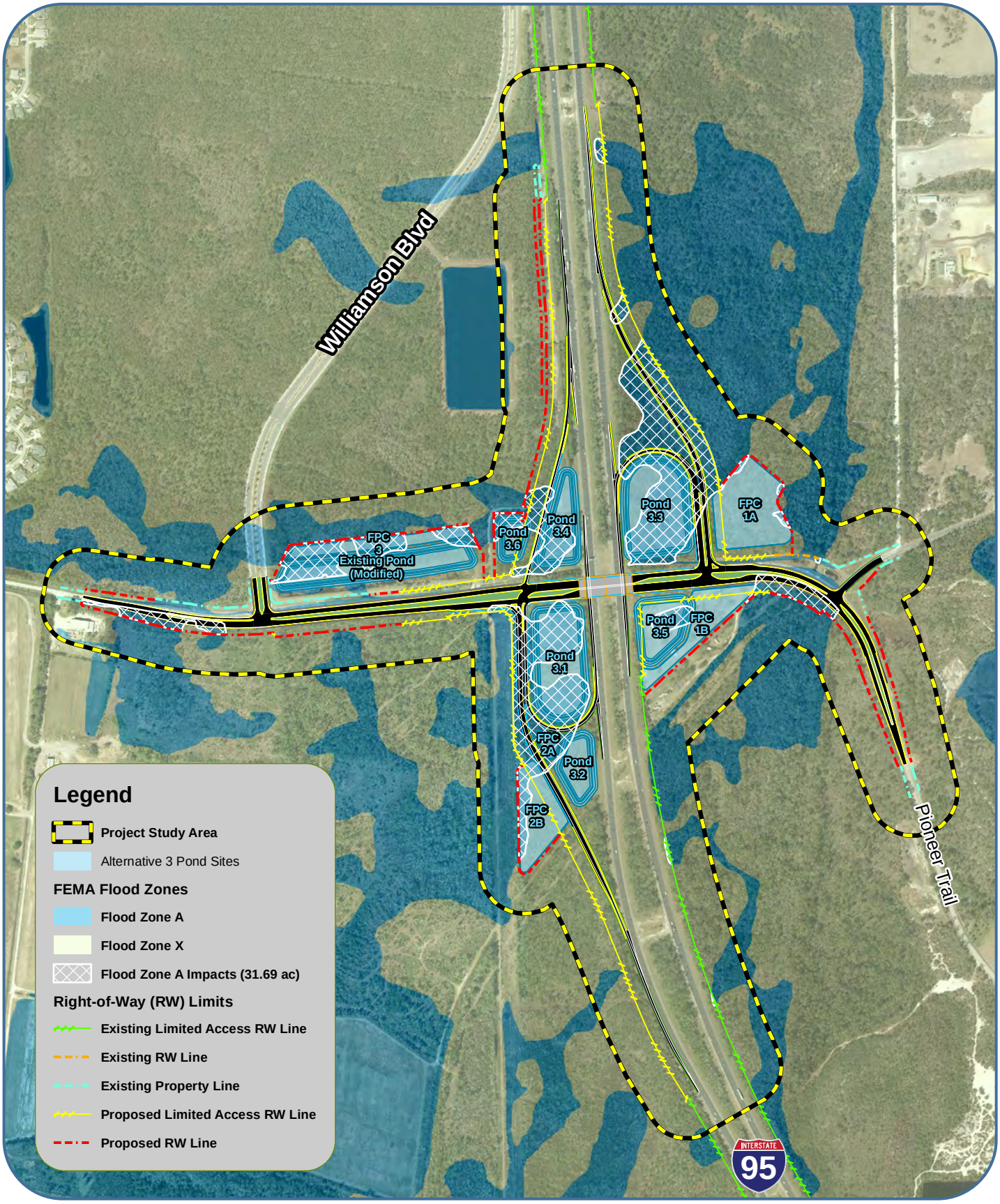
Therefore, it has been determined that the encroachment type for this study is classified as "minimal".

During the design phase, the cross-drain calculations from this Location Hydraulics Analysis should be updated to show the hydraulic improvement and prove there will be no adverse impacts; drainage features will be designed in accordance with the FDOT Drainage Manual and to better align with Section 13.2.2.1 and Figure 13-1 of the FDOT PD&E Manual. Additional modeling may be required to account for upstream basin storage. It is expected that cross drain flows will decrease because on-site runoff will no

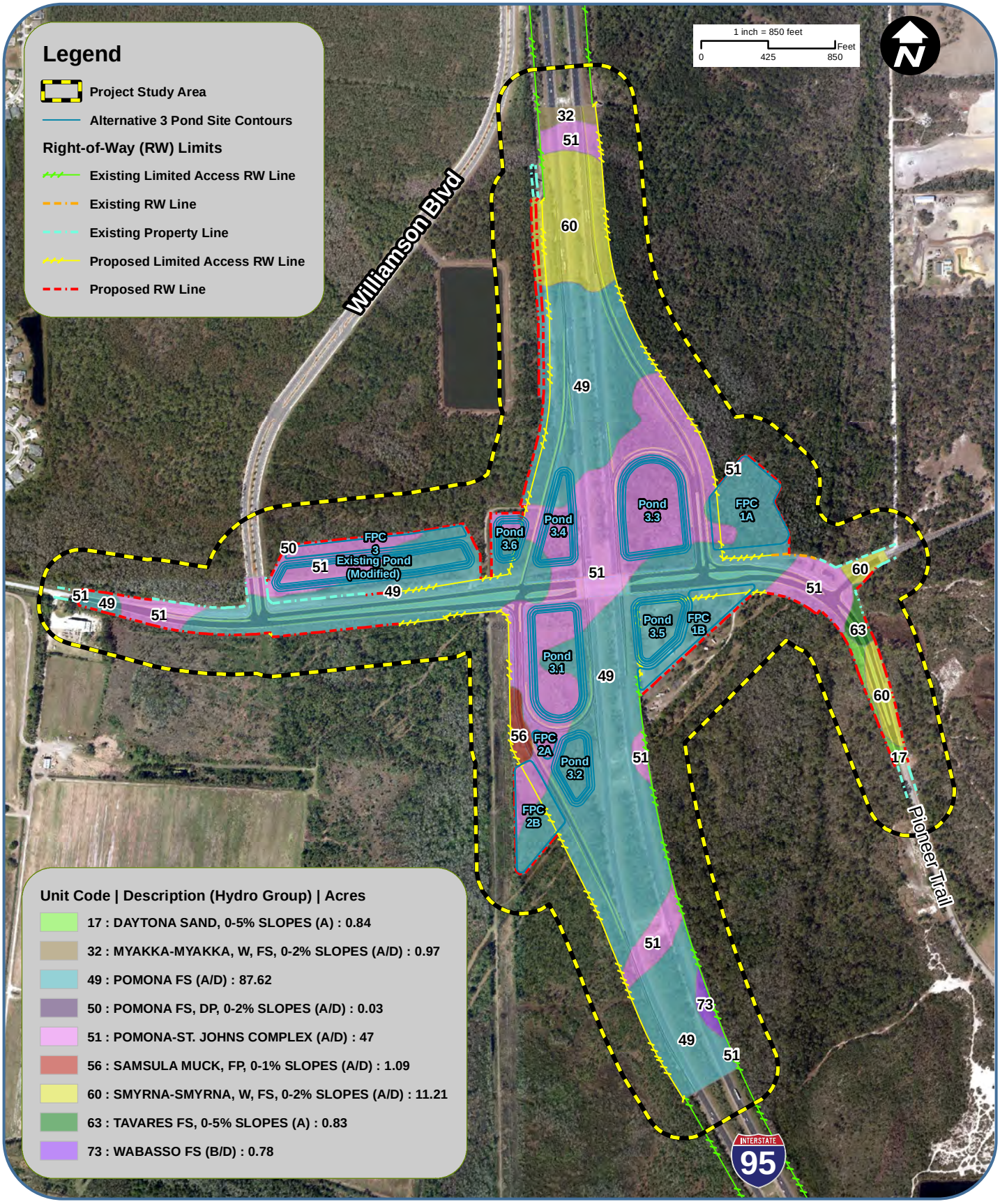
longer contribute to the volume through the cross drains. Tailwater assumptions will also be confirmed during design with seasonal high-water table input from geotechnical investigation and normal water levels within adjacent wetlands. The proposed cross drains along the I-95 at Pioneer Trail Interchange will be finalized during the design phase. There shall be no adverse impacts due to the extension or incorporation of cross drains along the I-95 at Pioneer Trail Interchange.

APPENDIX A - FIGURES


Legend
Existing Interchange
Proposed Interchange
City Boundaries
NEW SMYRNA BEACH
PONCE INLET
PORT ORANGE
Port Orange
Willow Run Blvd
Niver St
Mile Post 23.300
Town West Blvd
Williamson Blvd
Crane Lakes Golf and Country Club
Spruce Creek Rd
S Nova Rd
Ridgewood Ave
Central Park Blvd
Taylor Rd
Spruce Creek Airport
Spruce Creek Country Club
Spruce Creek Blvd
S Williamson Blvd
4.26 mi
SR 9
Cypress Head Golf Club
Cypress Springs Pkwy
Martins Dairy Rd
Spruce Creek
Creek Shore Trl
Turnbull Bay Golf Club
N Dixie Fwy
Conrad Dr
Murray Creek
Turnbull Bay Rd
Club House Blvd
Sugar Mill Country Club
Airport Rd
Pioneer Trl
Tomoka Farms Rd
N Samsula Dr
Project Location
Proposed Interchange
I-95 at Pioneer Trail
2.74 mi
Sugar Mill Dr
Williams Rd
Venetian Bay Golf Club
Mile Post 16.287
Oliver Dr
Paige Ave
421
95
44
415
1
9


Williamson Blvd
Pioneer Trail
FPC 3 Existing Pond (Modified)
Pond 3.6
Pond 3.4
Pond 3.3
FPC 1A
Pond 3.5
FPC 1B
Pond 3.1
FPC 2A
Pond 3.2
FPC 2B
INTERSTATE 95
Legend
Project Study Area
Alternative 3 Pond Sites
FEMA Flood Zones
Flood Zone A
Flood Zone X
Flood Zone A Impacts (31.69 ac)
Right-of-Way (RW) Limits
Existing Limited Access RW Line
Existing RW Line
Existing Property Line
Proposed Limited Access RW Line
Proposed RW Line


1 inch = 850 feet
Feet
0
425
850
N
Williamson Blvd
Pioneer Trail
Pond 3.4
Pond 3.3
FPC 1A
Pond 3.6
FPC 3
Existing Pond (Modified)
FPC 1B
Pond 3.5
Pond 3.1
FPC 2A
Pond 3.2
FPC 2B
INTERSTATE 95
Legend
Project Study Area
Alternative 3 Pond Sites
Right-of-Way (RW) Limits
Existing Limited Access RW Line
Existing RW Line
Existing Property Line
Proposed Limited Access RW Line
Proposed RW Line


Legend
Project Study Area
Alternative 3 Pond Site Contours
Right-of-Way (RW) Limits
Existing Limited Access RW Line
Existing RW Line
Existing Property Line
Proposed Limited Access RW Line
Proposed RW Line
1 inch = 850 feet
0
425
850
Feet
N
Williamson Blvd
Pioneer Trail
Pond 3.3
Pond 3.4
Pond 3.6
Pond 3.5
Pond 3.1
Pond 3.2
FPC 1A
FPC 1B
FPC 2A
FPC 2B
FPC 3
Existing Pond (Modified)
Unit Code | Description (Hydro Group) | Acres
17 : DAYTONA SAND, 0-5% SLOPES (A) : 0.84
32 : MYAKKA-MYAKKA, W, FS, 0-2% SLOPES (A/D) : 0.97
49 : POMONA FS (A/D) : 87.62
50 : POMONA FS, DP, 0-2% SLOPES (A/D) : 0.03
51 : POMONA-ST. JOHNS COMPLEX (A/D) : 47
56 : SAMSULA MUCK, FP, 0-1% SLOPES (A/D) : 1.09
60 : SMYRNA-SMYRNA, W, FS, 0-2% SLOPES (A/D) : 11.21
63 : TAVARES FS, 0-5% SLOPES (A) : 0.83
73 : WABASSO FS (B/D) : 0.78
INTERSTATE 95

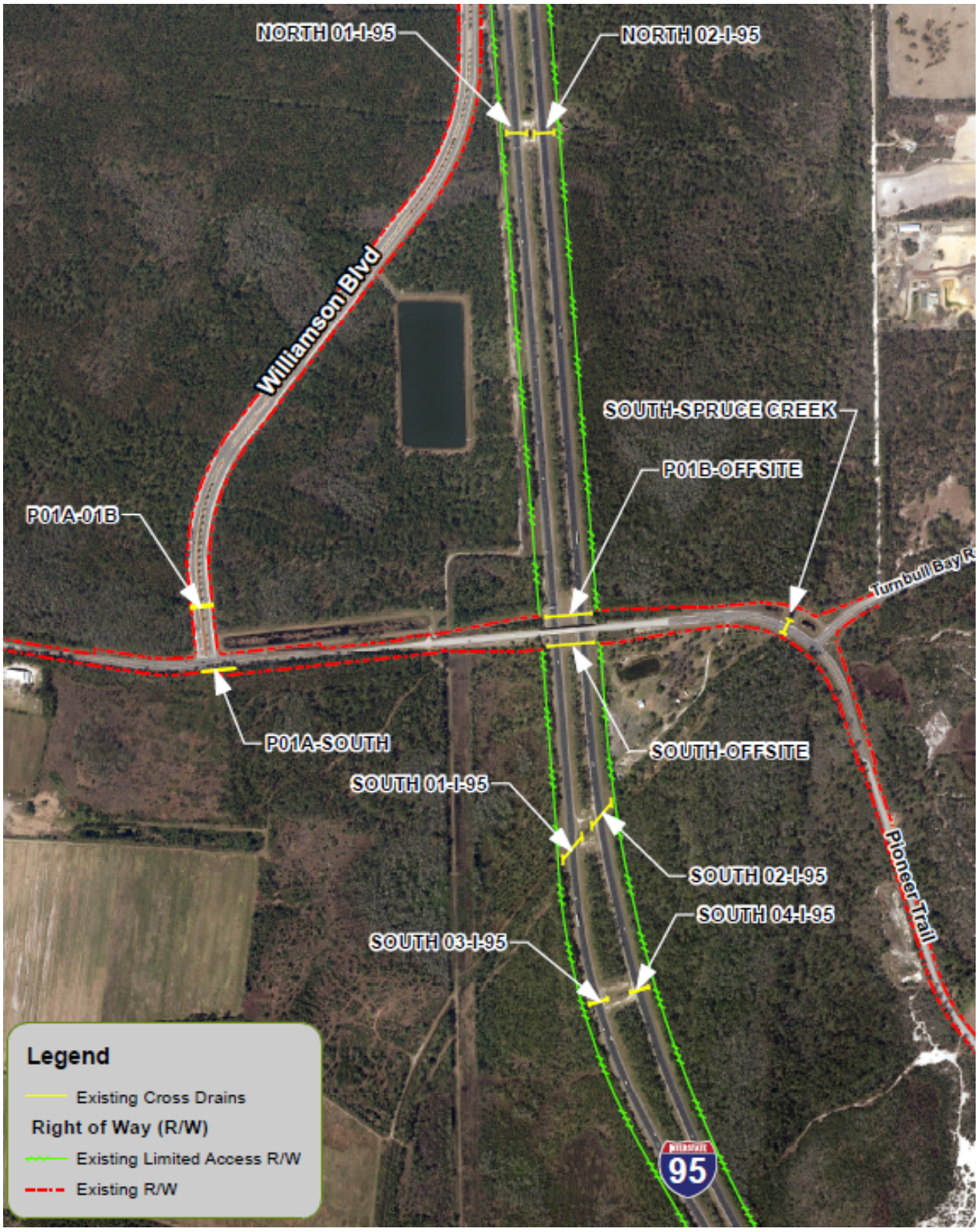
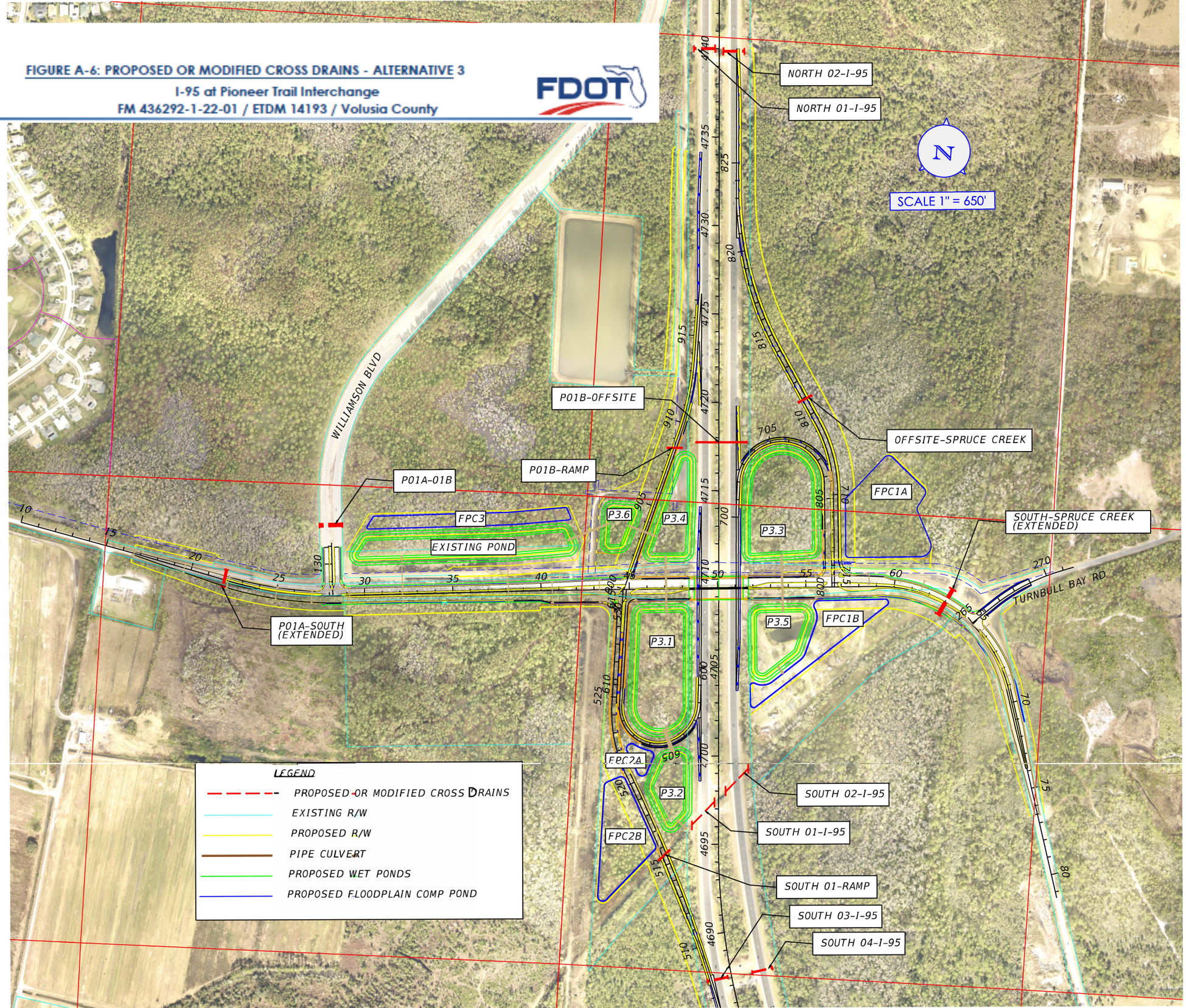

NORTH 01-I-95
NORTH 02-I-95
Williamson Blvd
SOUTH-SPRUCE CREEK
P01B-OFFSITE
P01A-01B
Turnbull Bay R
P01A-SOUTH
SOUTH-OFFSITE
SOUTH 01-I-95
SOUTH 02-I-95
SOUTH 04-I-95
SOUTH 03-I-95
Pioneer Trail
95
Legend
Existing Cross Drains
Right of Way (R/W)
Existing Limited Access R/W
Existing R/W

FIGURE A-6: PROPOSED OR MODIFIED CROSS DRAINS - ALTERNATIVE 3

I-95 at Pioneer Trail Interchange

FM 436292-1-22-01 / ETDM 14193 / Volusia County



APPENDIX B – EXISTING DOCUMENTS

PERMIT SUBMITTAL
DRAINAGE REPORT
VOLUME I

SR 9/I-95 Segment 4
From North of SR 44 to South of SR 400/I-4
Volusia County
Financial Project ID: 406869-6-52-01

Prepared For:

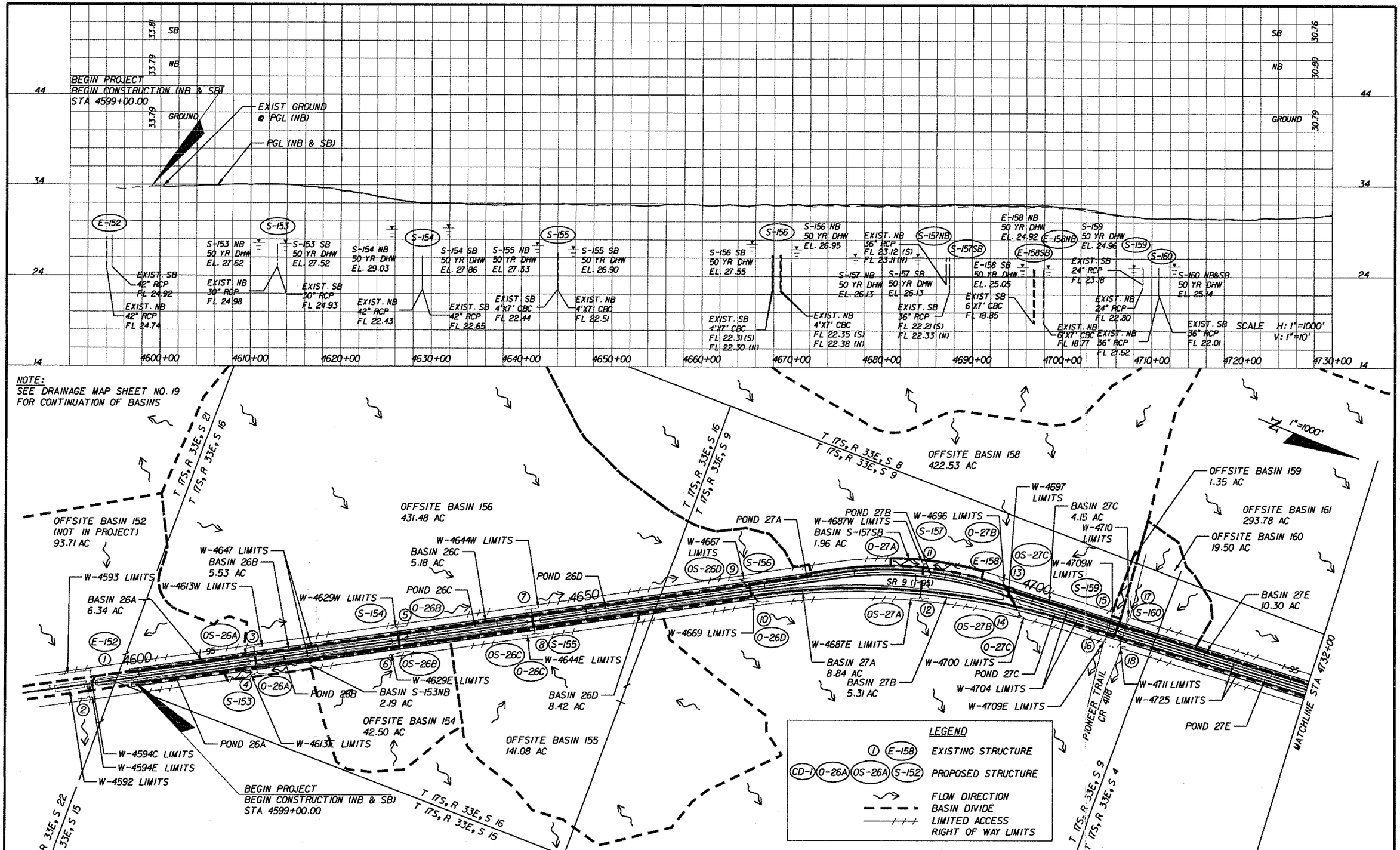
FLORIDA DEPARTMENT OF TRANSPORTATION
DISTRICT FIVE
719 South Woodland Boulevard
DeLand, FL 32720
(386) 943-5000

Prepared By:

REYNOLDS, SMITH AND HILLS, INC.
The Gateway Center
1000 Legion Place, Suite 800
Orlando, FL 32801
(407) 893-5800

September 26, 2008

RS&H Project Number: 107-7108-000



DO NOT USE INFORMATION ON THIS SHEET FOR CONSTRUCTION PURPOSES. THIS SHEET IS IN THE PLANS FOR DOCUMENTATION AND TO ASSIST CONSTRUCTION PERSONNEL WITH DRAINAGE CONCERNS.

REVISIONS					
DATE	BY	DESCRIPTION	DATE	BY	DESCRIPTION

RS&H
Reynolds, Smith and Hills, Inc.
1000 Legion Place, Suite 800
Orlando, Florida 32801
407-893-5800
FL Cert. No. EB0005620
Engineer of Record: Jeffrey S. Glenn PE No. 47210

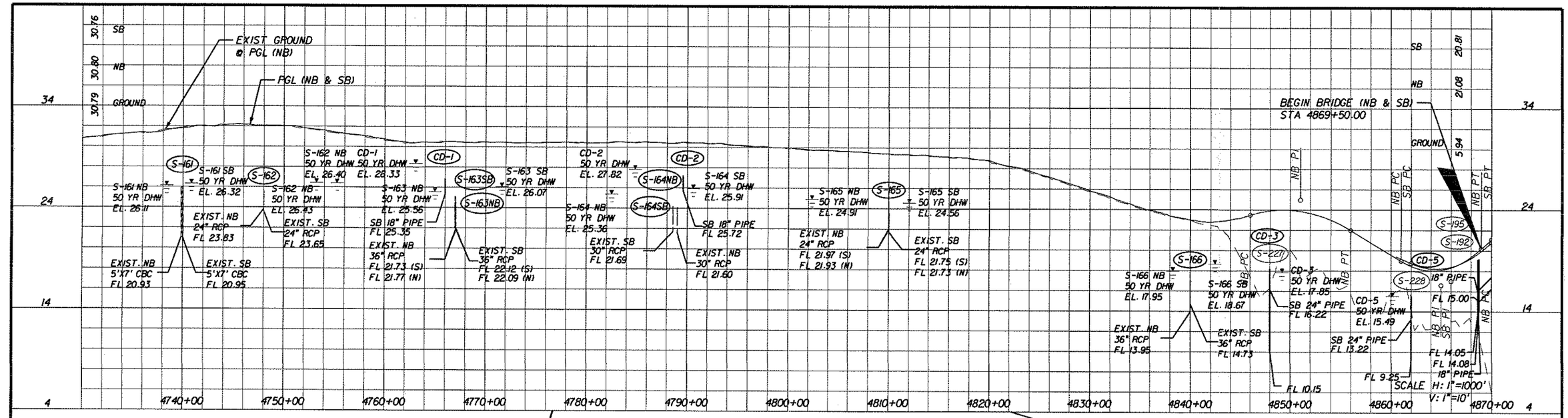
STATE OF FLORIDA
DEPARTMENT OF TRANSPORTATION

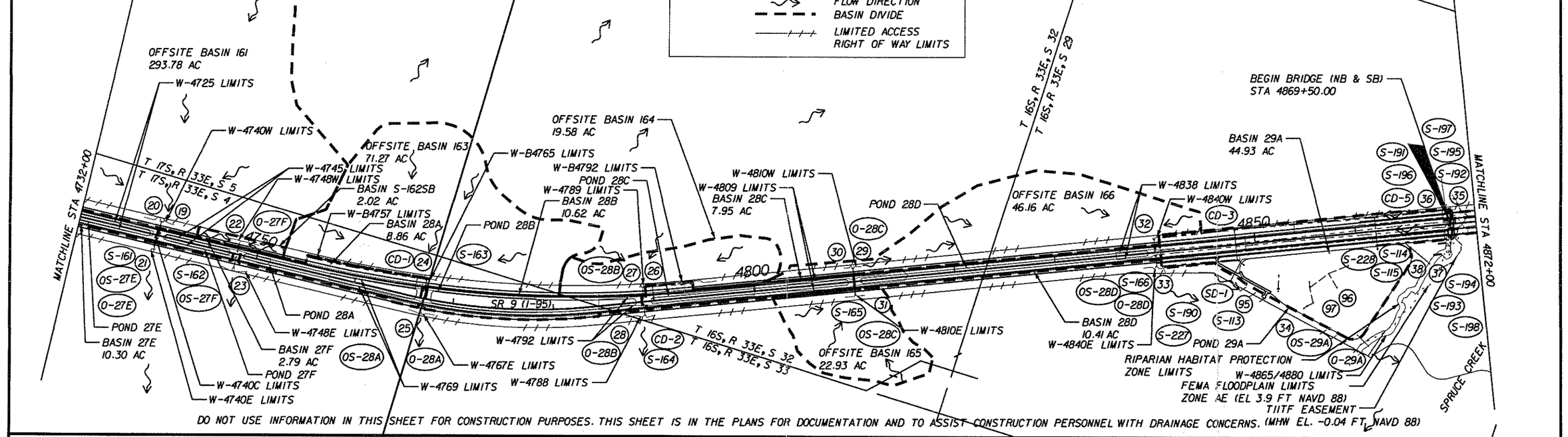
ROAD NO.	COUNTY	FINANCIAL PROJECT ID
9	VOLUSIA	406869-6-52-01

DRAINAGE MAP

SHEET NO. III-1

ShirleyE 9/23/2008 10:39:08 AM \\ORLFILE01\Transportation\P\4068696320\drainage\DRMPRD02.dgn





DO NOT USE INFORMATION IN THIS SHEET FOR CONSTRUCTION PURPOSES. THIS SHEET IS IN THE PLANS FOR DOCUMENTATION AND TO ASSIST CONSTRUCTION PERSONNEL WITH DRAINAGE CONCERNS. (MHW EL. -0.04 FT NAVD 88)

REVISIONS					
DATE	BY	DESCRIPTION	DATE	BY	DESCRIPTION

RS&H
Reynolds, Smith and Hills, Inc.
1000 Legion Place, Suite 800
Orlando, Florida 32801
407-893-5800
FL Cert. No. EB0005620
Engineer of Record: Jeffrey S. Glenn PE No. 47210

STATE OF FLORIDA
DEPARTMENT OF TRANSPORTATION

ROAD NO.	COUNTY	FINANCIAL PROJECT ID
9	VOLUSIA	406869-6-52-01

DRAINAGE MAP

SHEET NO. III-2

ShirleyE 9/23/2008 10:29:48 AM \\ORLFILE01\Transportation\P\406869620I\drainage\DRMPRD03.dgn

Project: I-95 from SR 44 to I-4 **Project No.:** 406869-6-52-01
Designed by: ARK **Checked by:** JSG
Date: 7/18/2008 **Date:** 7/22/2008

EXISTING CONDITION
CROSS DRAIN ANALYSIS
Cross Drain S-157 NB

Estimate Runoff Volume

Rational Method (Drainage Area < 600 acres)

Q = C i A where Q = Flow (cfs)
C = Rational Coefficient (unitless)
i = Rainfall intensity (in/hr)
A = Drainage Area (acres)

Q_{50} =	$C_{50}\ i_{50}\ A$ =	(0.30) * (2.80) * (11.60) =	9.73 cfs	(see calculations below)
Q_{100} =	$C_{100}\ i_{100}\ A$ =	(0.31) * (3.10) * (11.60) =	11.22 cfs	(see calculations below)
Q_{500} =	15.62 cfs =		15.62 cfs	(extrapolated from 50 and 100 year flows, see calculations below)

Find weighted Rational Coefficient, C

Initial Input: Total Area, Design Frequencies to be analyzed

Total Area = 505463 sf
Total Area = 11.60 acres
Design Frequencies = 50 year
100 year

	Area	Slope	Slope	Land Use	Sand or Clay	Rational Coefficient Range[1]	Rational Coefficient Selected
Sub Area 1	10.16 acres	0.005 ft/ft	Flat	Grass	Sand	10 to 15	0.15
Sub Area 2	1.44 acres	0.042 ft/ft	Rolling	Pavement	Sand	0.95	0.95
Sub Area 3							
Sub Area 4							
Sub Area 5							
Total Area = 11.60 acres					Weighted Average Rational Coefficient =		0.25

[1] The rational coefficient range is collected from Table T-4 of the 2004 FDOT Hydrology Handbook.

Apply Design Frequecy Factors to the Weighted Average Rational Coefficient

Storm Frequency	Design Storm Frequency Factor, X_T[2]	Weighted Average Rational Coefficient	Adjusted Weighted Average Rational Coefficient
50 year	1.20	0.25	0.30
100 year	1.25	0.25	0.31

[2] The Design Storm Frequency Factor is collected from Table T-5 of the 2004 FDOT Hydrology Handbook.

Find Rainfall Intensity, i

For Basin S-157 NB 103.00 min = T_c (Please check basin tc calcs)

Use the time of concentration with the FDOT IDF Curves to obtain the Rainfall Intensity, i.

FDOT IDF Zone = 7
Time of Concentration, T_c = 103.0 min = 1.717 hrs
Design Frequencies = 50 year
100 year

Rainfall Intensity, i = 2.80 in/hr (50 year)
Rainfall Intensity, i = 3.10 in/hr (100 year)

V-50

Calculate the flow, Q

The flow, Q, can now be calculated based on the rational coefficients, intensities, and areas.

Q_{50} =	$C_{50}\ i_{50}\ A$ =	(0.30) * (2.80) * (11.60) =	9.73 cfs
Q_{100} =	$C_{100}\ i_{100}\ A$ =	(0.31) * (3.10) * (11.60) =	11.22 cfs

Crossdrain dimensions:

Circular Pipe

No. of Barrels = 2
Pipe size = 36 in
Provided Area = 14.14 sf

The analysis of the cross drain can now proceed using the FHWA HY8 software

Design Criteria

1. No overtopping or encroachment onto the roadway shoulder in the design storm (50-year).
2. Water velocity not greater than 4 ft/s in the design storm (50-year).
3. Perform SCS analysis to verify no adverse impacts at property line for 25-year, 24-hour storm event for SJRWMD.

See HY8 Output for final design parameters

Calculate the Overtopping flood frequency from extrapolation, using the HY8 output for Overtopping flow:

Initial Input: Flows and stages for the 50-year, 100-year, and overtopping storms

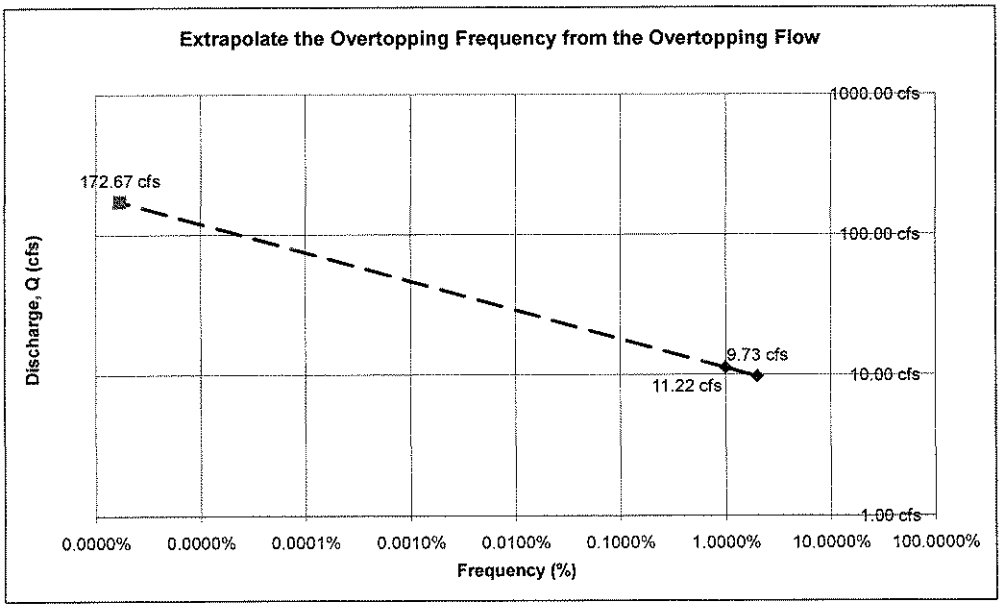
Design Frequencies = 50 year = 2.0%
100 year = 1.0%

Q_{50} = 9.73 cfs
Q_{100} = 11.22 cfs
$Q_{Overtopping}$ = 172.67 cfs

$Stage_{50}$ = 26.12 ft
$Stage_{100}$ = 26.13 ft
$Stage_{Overtopping}$ = 30.31 ft

The frequency of the overtopping storm that occurs the overtopping flow is calculated by extrapolation:

$Frequency_{Overtopping}$ = 0.00000002
$Frequency_{Overtopping}$ = 0.000002%
$Frequency_{Overtopping}$ = 59022015 year (see graph below)



Since the overtopping flood is greater than the greatest flood (500-year flood), only the the 50-year, 100-year, and 500-year floods will be analyzed.

V-51

Calculate the 500-year flow and 500-year stage from extrapolation

Initial Input: Flows and stages for the 50-year and 100-year storms

Design Frequencies = 50 year = 2.0%
100 year = 1.0%

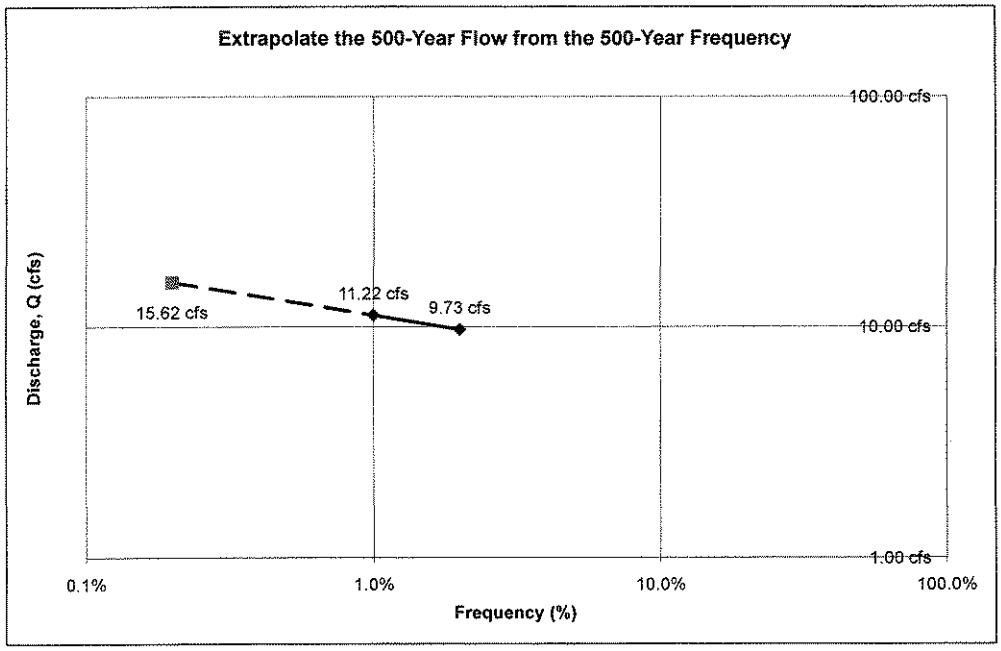
Q_{50} = 9.73 cfs
Q_{100} = 11.22 cfs

$Stage_{50}$ = 26.12 ft
$Stage_{100}$ = 26.13 ft

Plotting the 50-year and 100-year stages vs. discharge allows us to extrapolate the 500-year flow:

$Frequency_{500}$ = 0.0020
$Frequency_{500}$ = 0.20%
$Frequency_{500}$ = 500 year

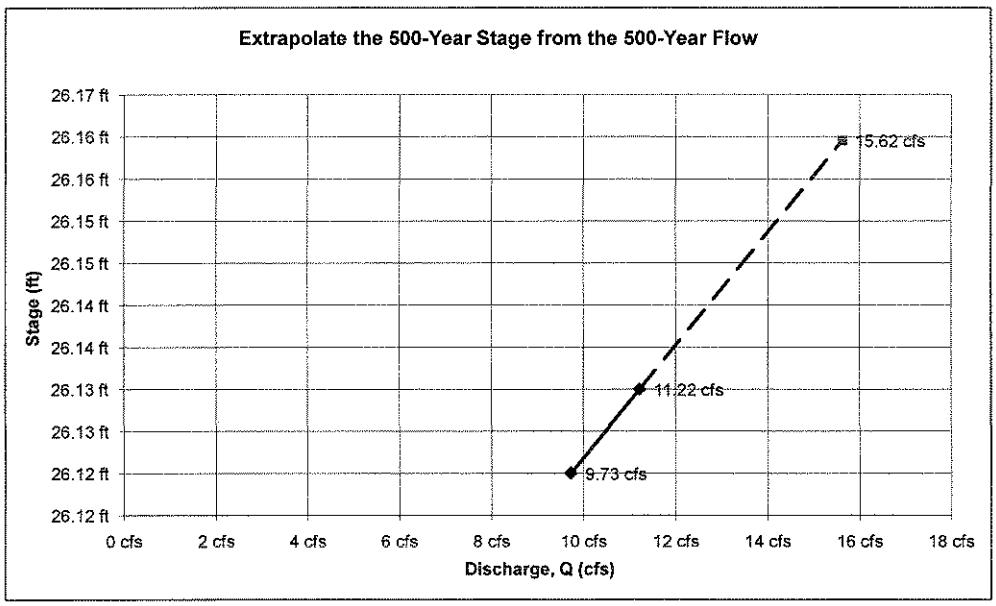
Q_{500} = 15.62 cfs (see graph below)



Plotting the 50-year and 100-year stages vs. discharge allows us to extrapolate the overtopping flow:

Q_{500} = 15.62 cfs

$Stage_{500}$ = 26.16 ft (see graph below)



Project: I-95 from SR 44 to I-4 **Project No.:** 406869-6-52-01
Designed by: ARK **Checked by:** JSG
Date: 7/18/2008 **Date:** 7/22/2008

EXISTING CONDITION
CROSS DRAIN ANALYSIS
Cross Drain S-157 SB

Estimate Runoff Volume

Rational Method (Drainage Area < 600 acres)

$Q = C\ i\ A$ where Q = Flow (cfs)
C = Rational Coefficient (unitless)
i = Rainfall intensity (in/hr)
A = Drainage Area (acres)

Q_{50} =	$C_{50}\ i_{50}\ A$ =	(0.23) * (7.90) * (1.96) =	3.58 cfs	(see calculations below)
Q_{100} =	$C_{100}\ i_{100}\ A$ =	(0.24) * (8.50) * (1.96) =	4.01 cfs	(see calculations below)
Q_{500} =	5.22 cfs =		5.22 cfs	(extrapolated from 50 and 100 year flows, see calculations below)

Find weighted Rational Coefficient, C

Initial Input: Total Area, Design Frequencies to be analyzed

Total Area = 85373 sf
Total Area = 1.96 acres
Design Frequencies = 50 year
100 year

	Area	Slope	Slope	Land Use	Sand or Clay	Rational Coefficient Range[1]	Rational Coefficient Selected
Sub Area 1	1.86 acres	0.005 ft/ft	Flat	Grass	Sand	10 to 15	0.15
Sub Area 2	0.10 acres	0.042 ft/ft	Rolling	Pavement	Sand	0.95	0.95
Sub Area 3							
Sub Area 4							
Sub Area 5							
Total Area = 1.96 acres					Weighted Average Rational Coefficient =		0.19

[1] The rational coefficient range is collected from Table T-4 of the 2004 FDOT Hydrology Handbook.

Apply Design Frequecy Factors to the Weighted Average Rational Coefficient

Storm Frequency	Design Storm Frequency Factor, X_T[2]	Weighted Average Rational Coefficient	Adjusted Weighted Average Rational Coefficient
50 year	1.20	0.19	0.23
100 year	1.25	0.19	0.24

[2] The Design Storm Frequency Factor is collected from Table T-5 of the 2004 FDOT Hydrology Handbook.

Find Rainfall Intensity, i

For Basin S-157 SB 15.00 min = T_c (Please check basin tc calcs)

Use the time of concentration with the FDOT IDF Curves to obtain the Rainfall Intensity, i.

FDOT IDF Zone = 7
Time of Concentration, T_c = 15.0 min 0.250 hrs
Design Frequencies = 50 year
100 year

Rainfall Intensity, i = 7.90 in/hr (50 year)
Rainfall Intensity, i = 8.50 in/hr (100 year)

V-54

Calculate the flow, Q

The flow, Q, can now be calculated based on the rational coefficients, intensities, and areas.

Q_{50} =	$C_{50}\ i_{50}\ A$ = (0.23) * (7.90) * (1.96) =	3.58 cfs
Q_{100} =	$C_{100}\ i_{100}\ A$ = (0.24) * (8.50) * (1.96) =	4.01 cfs

Crossdrain dimensions:

Circular Pipe

No. of Barrels = 2
Pipe size = 36 in
Provided Area = 14.14 sf

The analysis of the cross drain can now proceed using the FHWA HY8 software

Design Criteria

1. No overtopping or encroachment onto the roadway shoulder in the design storm (50-year).
2. Water velocity not greater than 4 ft/s in the design storm (50-year).
3. Perform SCS analysis to verify no adverse impacts at property line for 25-year, 24-hour storm event for SJRWMD.

See HY8 Output for final design parameters

Calculate the Overtopping flood frequency from extrapolation, using the HY8 output for Overtopping flow:

Initial Input: Flows and stages for the 50-year, 100-year, and overtopping storms

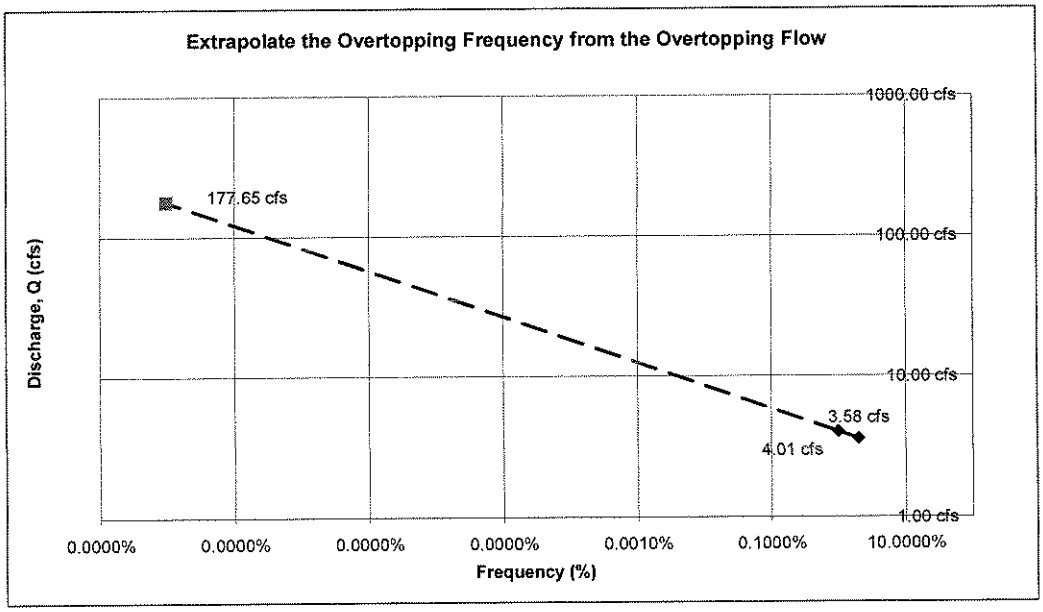
Design Frequencies = 50 year = 2.0%
100 year = 1.0%

Q_{50} = 3.58 cfs
Q_{100} = 4.01 cfs
$Q_{Overtopping}$ = 177.65 cfs

$Stage_{50}$ = 26.12 ft
$Stage_{100}$ = 26.12 ft
$Stage_{Overtopping}$ = 30.43 ft

The frequency of the overtopping storm that occurs the overtopping flow is calculated by extrapolation:

$Frequency_{Overtopping}$ = 0.000000000001
$Frequency_{Overtopping}$ = 0.0000000001%
$Frequency_{Overtopping}$ = ################ (see graph below)



Since the overtopping flood is greater than the greatest flood (500-year flood), only the the 50-year, 100-year, and 500-year floods will be analyzed.

Calculate the 500-year flow and 500-year stage from extrapolation

Initial Input: Flows and stages for the 50-year and 100-year storms

Design Frequencies = 50 year = 2.0%
100 year = 1.0%

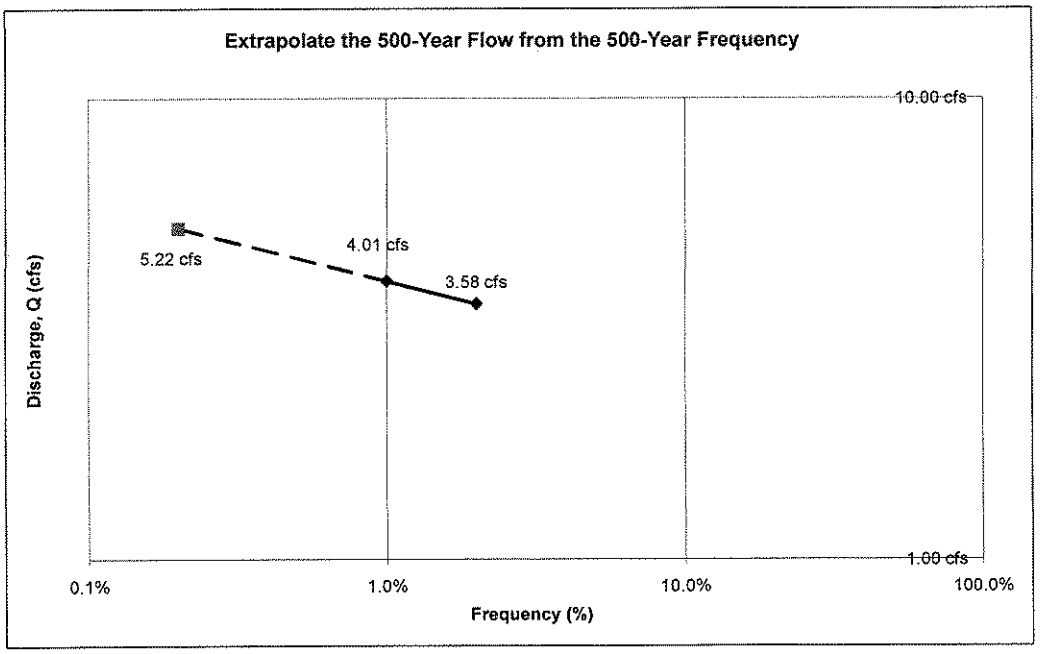
Q_{50} = 3.58 cfs
Q_{100} = 4.01 cfs

$Stage_{50}$ = 26.12 ft
$Stage_{100}$ = 26.12 ft

Plotting the 50-year and 100-year stages vs. discharge allows us to extrapolate the 500-year flow:

$Frequency_{500}$ = 0.0020
$Frequency_{500}$ = 0.20%
$Frequency_{500}$ = 500 year

Q_{500} = 5.22 cfs (see graph below)

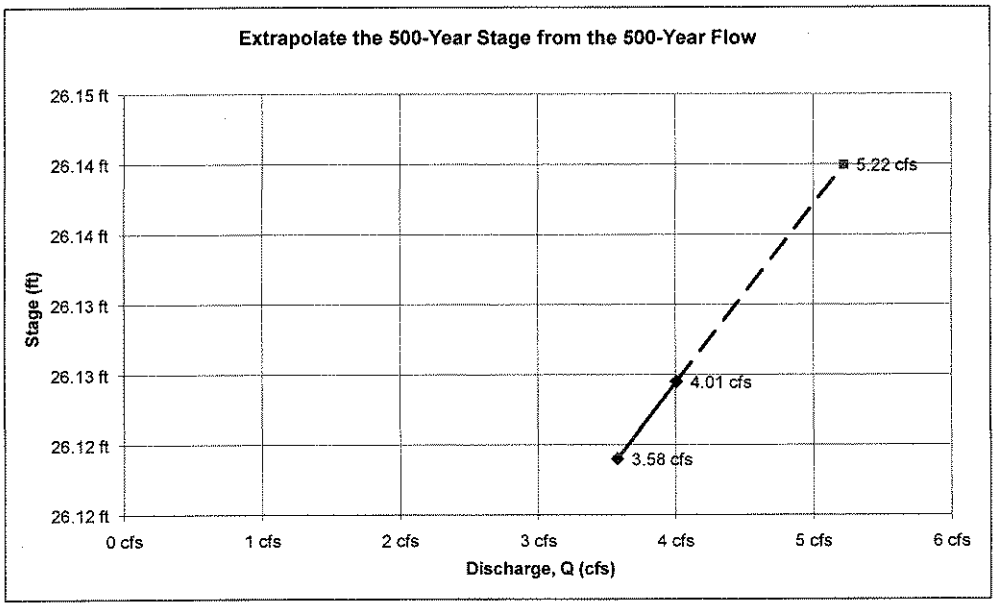


V-56

Plotting the 50-year and 100-year stages vs. discharge allows us to extrapolate the overtopping flow:

Q_{500} = 5.22 cfs

$Stage_{500}$ = 26.14 ft (see graph below)



Project: I-95 from SR 44 to I-4 **Project No.:** 406869-6-52-01
Designed by: ARK **Checked by:** JSG
Date: 7/18/2008 **Date:** 7/22/2008

EXISTING CONDITION
CROSS DRAIN ANALYSIS
Cross Drain E-158 NB

Estimate Runoff Volume

Rational Method (Drainage Area < 600 acres)

$Q = C\ i\ A$ where Q = Flow (cfs)
C = Rational Coefficient (unitless)
i = Rainfall intensity (in/hr)
A = Drainage Area (acres)

Q_{50} =	$C_{50}\ i_{50}\ A$ =	(0.19) * (1.08) * (428.24) =	88.49 cfs	(see calculations below)
Q_{100} =	$C_{100}\ i_{100}\ A$ =	(0.20) * (1.17) * (428.24) =	99.86 cfs	(see calculations below)
Q_{500} =	132.21 cfs =		132.21 cfs	(extrapolated from 50 and 100 year flows, see calculations below)

Find weighted Rational Coefficient, C

Initial Input: Total Area, Design Frequencies to be analyzed

Total Area = 18654108 sf
Total Area = 428.24 acres
Design Frequencies = 50 year
100 year

	Area	Slope	Slope	Land Use	Sand or Clay	Rational Coefficient Range[1]	Rational Coefficient Selected
Sub Area 1	423.18 acres	0.005 ft/ft	Flat	Grass	Sand	10 to .15	0.15
Sub Area 2	5.06 acres	0.042 ft/ft	Rolling	Pavement	Sand	0.95	0.95
Sub Area 3							
Sub Area 4							
Sub Area 5							
Total Area = 428.24 acres					Weighted Average Rational Coefficient =		0.16

[1] The rational coefficient range is collected from Table T-4 of the 2004 FDOT Hydrology Handbook.

Apply Design Frequecy Factors to the Weighted Average Rational Coefficient

Storm Frequency	Design Storm Frequency Factor, X_T[2]	Weighted Average Rational Coefficient	Adjusted Weighted Average Rational Coefficient
50 year	1.20	0.16	0.19
100 year	1.25	0.16	0.20

[2] The Design Storm Frequency Factor is collected from Table T-5 of the 2004 FDOT Hydrology Handbook.

Find Rainfall Intensity, i

For Basin E-158 NB 385.00 min = T_c (Please check basin tc calcs)

Use the time of concentration with the FDOT IDF Curves to obtain the Rainfall Intensity, i.

FDOT IDF Zone = 7
Time of Concentration, T_c = 385.0 min = 6.417 hrs
Design Frequencies = 50 year
100 year

Rainfall Intensity, i = 1.08 in/hr (50 year)
Rainfall Intensity, i = 1.17 in/hr (100 year)

V-58

Calculate the flow, Q

The flow, Q, can now be calculated based on the rational coefficients, intensities, and areas.

Q_{50} =	$C_{50}\ i_{50}\ A$ = (0.19) * (1.08) * (428.24) =	88.49 cfs
Q_{100} =	$C_{100}\ i_{100}\ A$ = (0.20) * (1.17) * (428.24) =	99.86 cfs

Crossdrain dimensions:

Rectangular Box Culvert

No. of Barrels = 1
Span = 7 ft
Rise = 6 ft
Provided Area = 42.00 sf

The analysis of the cross drain can now proceed using the FHWA HY8 software

Design Criteria

1. No overtopping or encroachment onto the roadway shoulder in the design storm (50-year).
2. Water velocity not greater than 4 ft/s in the design storm (50-year).
3. Perform SCS analysis to verify no adverse impacts at property line for 25-year, 24-hour storm event for SJRWMD.

See HY8 Output for final design parameters

Calculate the Overtopping flood frequency from extrapolation, using the HY8 output for Overtopping flow:

Initial Input: Flows and stages for the 50-year, 100-year, and overtopping storms

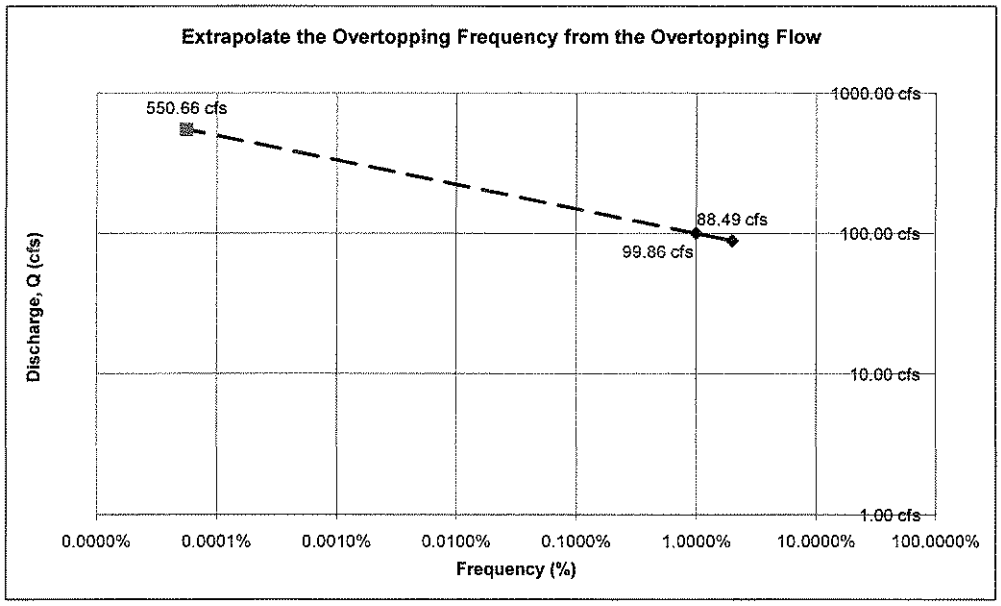
Design Frequencies = 50 year = 2.0%
100 year = 1.0%

Q_{50} = 88.49 cfs
Q_{100} = 99.86 cfs
$Q_{Overtopping}$ = 550.66 cfs

$Stage_{50}$ = 24.92 ft
$Stage_{100}$ = 24.96 ft
$Stage_{Overtopping}$ = 30.39 ft

The frequency of the overtopping storm that occurs the overtopping flow is calculated by extrapolation:

$Frequency_{Overtopping}$ = 0.000001
$Frequency_{Overtopping}$ = 0.0001%
$Frequency_{Overtopping}$ = 1788003 year (see graph below)



Since the overtopping flood is greater than the greatest flood (500-year flood), only the the 50-year, 100-year, and 500-year floods will be analyzed.

Calculate the 500-year flow and 500-year stage from extrapolation

Initial Input: Flows and stages for the 50-year and 100-year storms

Design Frequencies = 50 year = 2.0%
100 year = 1.0%

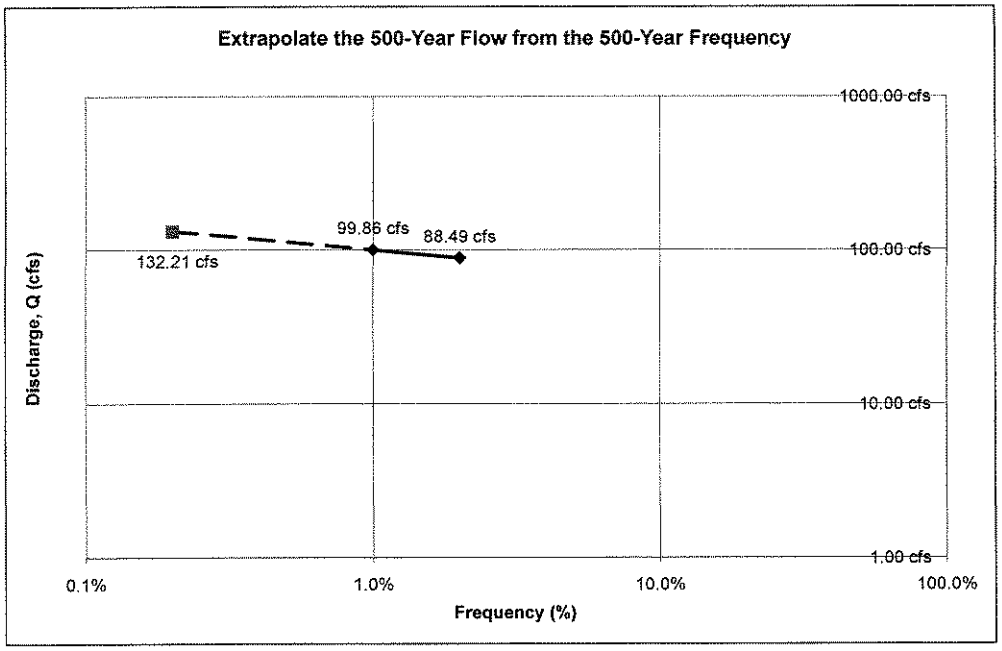
Q_{50} = 88.49 cfs
Q_{100} = 99.86 cfs

$Stage_{50}$ = 24.92 ft
$Stage_{100}$ = 24.96 ft

Plotting the 50-year and 100-year stages vs. discharge allows us to extrapolate the 500-year flow:

$Frequency_{500}$ = 0.0020
$Frequency_{500}$ = 0.20%
$Frequency_{500}$ = 500 year

Q_{500} = 132.21 cfs (see graph below)

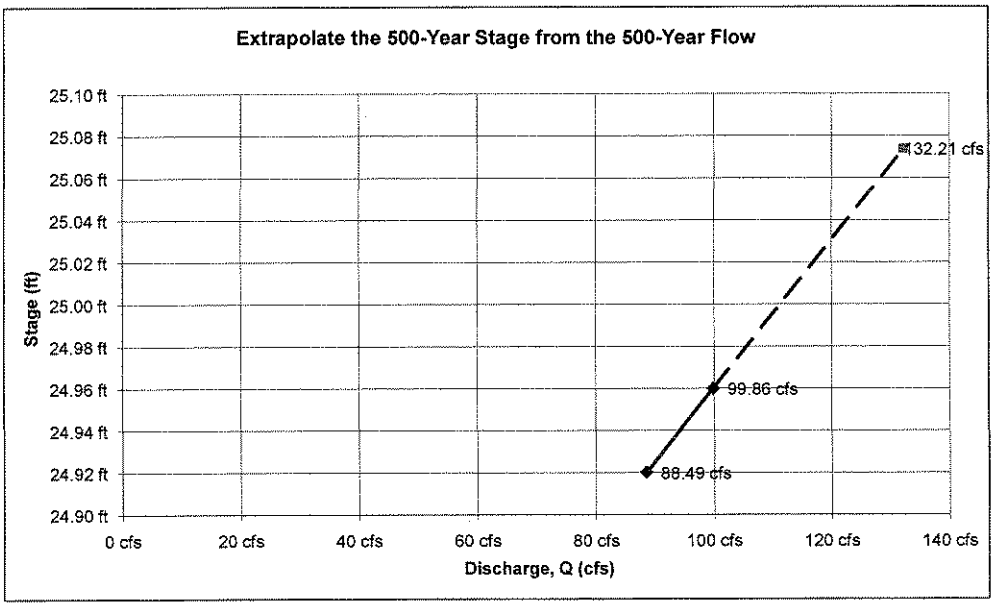


V-60

Plotting the 50-year and 100-year stages vs. discharge allows us to extrapolate the overtopping flow:

Q_{500} = 132.21 cfs

$Stage_{500}$ = 25.07 ft (see graph below)



Project: I-95 from SR 44 to I-4 **Project No.:** 406869-6-52-01
Designed by: ARK **Checked by:** JSG
Date: 7/18/2008 **Date:** 7/22/2008

EXISTING CONDITION
CROSS DRAIN ANALYSIS
Cross Drain E-158 SB

Estimate Runoff Volume

Rational Method (Drainage Area < 600 acres)

Q = C i A where Q = Flow (cfs)
C = Rational Coefficient (unitless)
i = Rainfall intensity (in/hr)
A = Drainage Area (acres)

Q_{50} =	$C_{50}\ i_{50}\ A$ =	(0.19) * (1.08) * (422.53) =	86.52 cfs	(see calculations below)
Q_{100} =	$C_{100}\ i_{100}\ A$ =	(0.20) * (1.17) * (422.53) =	97.64 cfs	(see calculations below)
Q_{500} =	129.27 cfs =		129.27 cfs	(extrapolated from 50 and 100 year flows, see calculations below)

Find weighted Rational Coefficient, C

Initial Input: Total Area, Design Frequencies to be analyzed

Total Area = 18405384 sf
Total Area = 422.53 acres
Design Frequencies = 50 year
100 year

	Area	Slope	Slope	Land Use	Sand or Clay	Rational Coefficient Range[1]	Rational Coefficient Selected
Sub Area 1	418.30 acres	0.005 ft/ft	Flat	Grass	Sand	10 to .15	0.15
Sub Area 2	4.23 acres	0.042 ft/ft	Rolling	Pavement	Sand	0.95	0.95
Sub Area 3							
Sub Area 4							
Sub Area 5							
Total Area = 422.53 acres					Weighted Average Rational Coefficient =		0.16

[1] The rational coefficient range is collected from Table T-4 of the 2004 FDOT Hydrology Handbook.

Apply Design Frequecy Factors to the Weighted Average Rational Coefficient

Storm Frequency	Design Storm Frequency Factor, X_T[2]	Weighted Average Rational Coefficient	Adjusted Weighted Average Rational Coefficient
50 year	1.20	0.16	0.19
100 year	1.25	0.16	0.20

[2] The Design Storm Frequency Factor is collected from Table T-5 of the 2004 FDOT Hydrology Handbook.

Find Rainfall Intensity, i

For Basin E-158 SB 385.00 min = T_c (Please check basin tc calcs)

Use the time of concentration with the FDOT IDF Curves to obtain the Rainfall Intensity, i.

FDOT IDF Zone = 7
Time of Concentration, T_c = 385.0 min 6.417 hrs
Design Frequencies = 50 year
100 year

Rainfall Intensity, i = 1.08 in/hr (50 year)
Rainfall Intensity, i = 1.17 in/hr (100 year)

V-62

Calculate the flow, Q

The flow, Q, can now be calculated based on the rational coefficients, intensities, and areas.

Q_{50} = $C_{50}\ i_{50}\ A$ = (0.19) * (1.08) * (422.53) = 86.52 cfs

Q_{100} = $C_{100}\ i_{100}\ A$ = (0.20) * (1.17) * (422.53) = 97.64 cfs

Crossdrain dimensions:

Rectangular Box Culvert

No. of Barrels = 1
Span = 7 ft
Rise = 6 ft
Provided Area = 42.00 sf

The analysis of the cross drain can now proceed using the FHWA HY8 software

Design Criteria

1. No overtopping or encroachment onto the roadway shoulder in the design storm (50-year).
2. Water velocity not greater than 4 ft/s in the design storm (50-year).
3. Perform SCS analysis to verify no adverse impacts at property line for 25-year, 24-hour storm event for SJRWMD.

See HY8 Output for final design parameters

Calculate the Overtopping flood frequency from extrapolation, using the HY8 output for Overtopping flow:

Initial Input: Flows and stages for the 50-year, 100-year, and overtopping storms

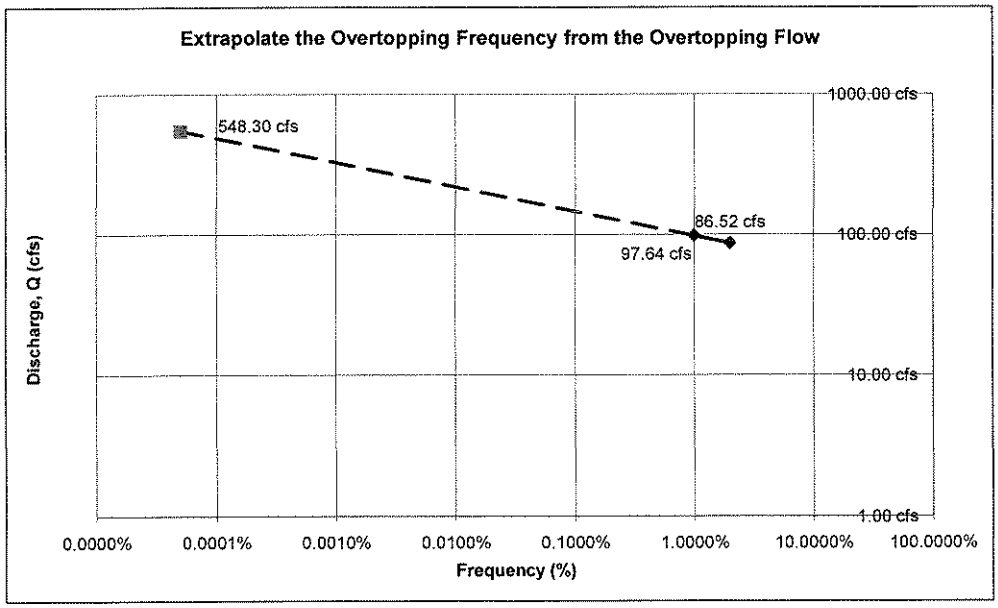
Design Frequencies = 50 year = 2.0%
100 year = 1.0%

Q_{50} = 86.52 cfs
Q_{100} = 97.64 cfs
$Q_{Overtopping}$ = 548.30 cfs

$Stage_{50}$ = 25.05 ft
$Stage_{100}$ = 25.08 ft
$Stage_{Overtopping}$ = 30.39 ft

The frequency of the overtopping storm that occurs the overtopping flow is calculated by extrapolation:

$Frequency_{Overtopping}$ = 0.000001
$Frequency_{Overtopping}$ = 0.00%
$Frequency_{Overtopping}$ = 1985102 year (see graph below)



Since the overtopping flood is greater than the greatest flood (500-year flood), only the the 50-year, 100-year, and 500-year floods will be analyzed.

V-103

Calculate the 500-year flow and 500-year stage from extrapolation

Initial Input: Flows and stages for the 50-year and 100-year storms

Design Frequencies = 50 year = 2.0%
100 year = 1.0%

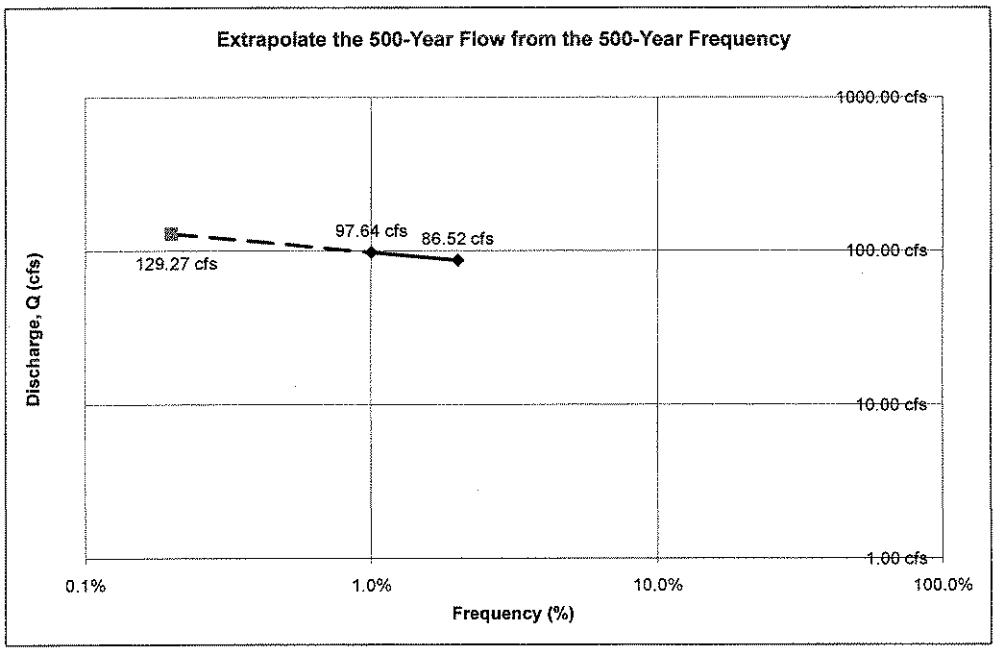
Q_{50} = 86.52 cfs
Q_{100} = 97.64 cfs

$Stage_{50}$ = 25.05 ft
$Stage_{100}$ = 25.08 ft

Plotting the 50-year and 100-year stages vs. discharge allows us to extrapolate the 500-year flow:

$Frequency_{500}$ = 0.0020
$Frequency_{500}$ = 0.20%
$Frequency_{500}$ = 500 year

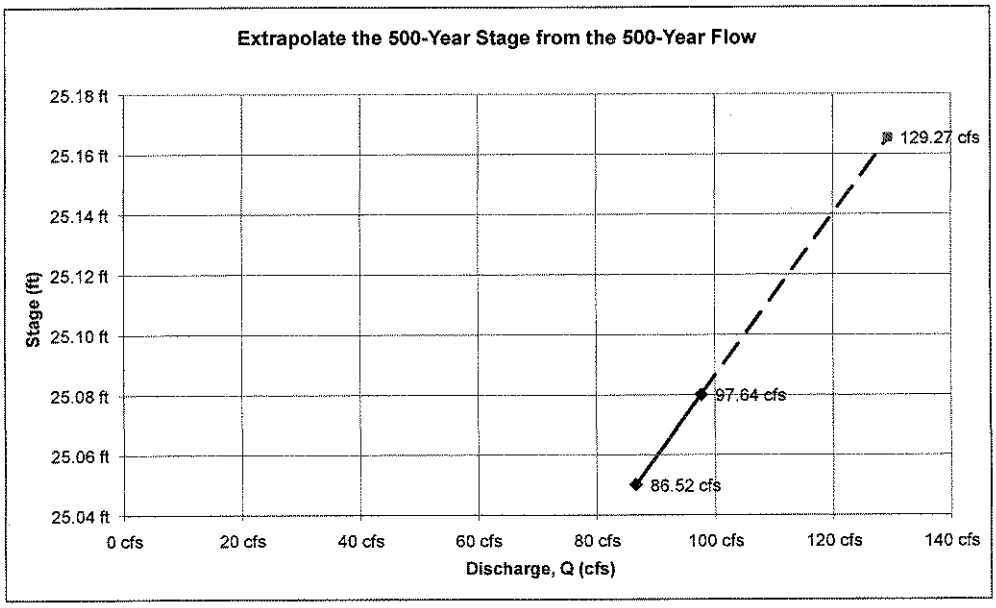
Q_{500} = 129.27 cfs (see graph below)



Plotting the 50-year and 100-year stages vs. discharge allows us to extrapolate the overtopping flow:

Q_{500} = 129.27 cfs

$Stage_{500}$ = 25.17 ft (see graph below)



Project: I-95 from SR 44 to I-4 **Project No.:** 406869-6-52-01
Designed by: ARK **Checked by:** JSG
Date: 7/18/2008 **Date:** 7/22/2008

EXISTING CONDITION
CROSS DRAIN ANALYSIS
Cross Drain S-159 NB

Estimate Runoff Volume

Rational Method (Drainage Area < 600 acres)

Q = C i A where Q = Flow (cfs)
C = Rational Coefficient (unitless)
i = Rainfall intensity (in/hr)
A = Drainage Area (acres)

Q_{50} =	$C_{50}\ i_{50}\ A$ =	(0.31) * (5.50) * (5.37) =	9.23 cfs	(see calculations below)
Q_{100} =	$C_{100}\ i_{100}\ A$ =	(0.33) * (6.00) * (5.37) =	10.49 cfs	(see calculations below)
Q_{500} =	14.11 cfs =		14.11 cfs	(extrapolated from 50 and 100 year flows, see calculations below)

Find weighted Rational Coefficient, C

Initial Input: Total Area, Design Frequencies to be analyzed

Total Area = 233702 sf
Total Area = 5.37 acres
Design Frequencies = 50 year
100 year

	Area	Slope	Slope	Land Use	Sand or Clay	Rational Coefficient Range[1]	Rational Coefficient Selected
Sub Area 1	4.62 acres	0.005 ft/ft	Flat	Grass	Sand	10 to .15	0.15
Sub Area 2	0.74 acres	0.042 ft/ft	Rolling	Pavement	Sand	0.95	0.95
Sub Area 3							
Sub Area 4							
Sub Area 5							
Total Area = 5.37 acres				Weighted Average Rational Coefficient =			0.26

[1] The rational coefficient range is collected from Table T-4 of the 2004 FDOT Hydrology Handbook.

Apply Design Frequecy Factors to the Weighted Average Rational Coefficient

Storm Frequency	Design Storm Frequency Factor, X_T[2]	Weighted Average Rational Coefficient	Adjusted Weighted Average Rational Coefficient
50 year	1.20	0.26	0.31
100 year	1.25	0.26	0.33

[2] The Design Storm Frequency Factor is collected from Table T-5 of the 2004 FDOT Hydrology Handbook.

Find Rainfall Intensity, i

For Basin S-159 NB 35.00 min = T_c (Please check basin tc calcs)

Use the time of concentration with the FDOT IDF Curves to obtain the Rainfall Intensity, i.

FDOT IDF Zone = 7
Time of Concentration, T_c = 35.0 min = 0.583 hrs
Design Frequencies = 50 year
100 year

Rainfall Intensity, i = 5.50 in/hr (50 year)
Rainfall Intensity, i = 6.00 in/hr (100 year)

V-166

Calculate the flow, Q

The flow, Q, can now be calculated based on the rational coefficients, intensities, and areas.

Q_{50} =	$C_{50}\ i_{50}\ A$ = (0.31) * (5.50) * (5.37) =	9.23 cfs
Q_{100} =	$C_{100}\ i_{100}\ A$ = (0.33) * (6.00) * (5.37) =	10.49 cfs

Crossdrain dimensions:

Circular Pipe

No. of Barrels = 1
Pipe size = 24 in
Provided Area = 3.14 sf

The analysis of the cross drain can now proceed using the FHWA HY8 software

Design Criteria

1. No overtopping or encroachment onto the roadway shoulder in the design storm (50-year).
2. Water velocity not greater than 4 ft/s in the design storm (50-year).
3. Perform SCS analysis to verify no adverse impacts at property line for 25-year, 24-hour storm event for SJRWMD.

See HY8 Output for final design parameters

Calculate the Overtopping flood frequency from extrapolation, using the HY8 output for Overtopping flow:

Initial Input: Flows and stages for the 50-year, 100-year, and overtopping storms

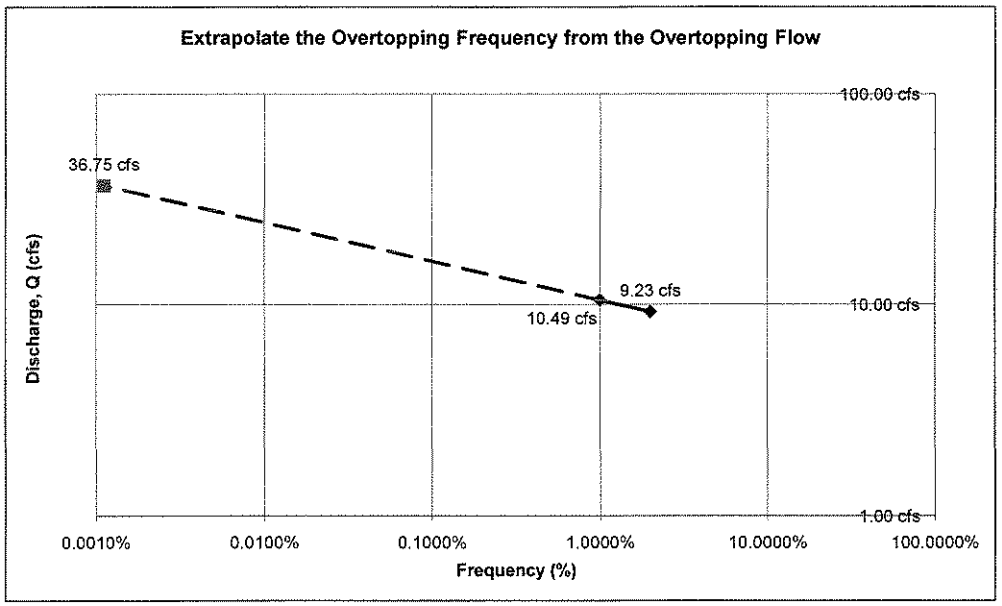
Design Frequencies = 50 year = 2.0%
100 year = 1.0%

Q_{50} = 9.23 cfs
Q_{100} = 10.49 cfs
$Q_{Overtopping}$ = 36.75 cfs

$Stage_{50}$ = 24.99 ft
$Stage_{100}$ = 25.07 ft
$Stage_{Overtopping}$ = 29.24 ft

The frequency of the overtopping storm that occurs the overtopping flow is calculated by extrapolation:

$Frequency_{Overtopping}$ = 0.000011
$Frequency_{Overtopping}$ = 0.0011%
$Frequency_{Overtopping}$ = 89710 year (see graph below)



Since the overtopping flood is greater than the greatest flood (500-year flood), only the the 50-year, 100-year, and 500-year floods will be analyzed.

V-67

Calculate the 500-year flow and 500-year stage from extrapolation

Initial Input: Flows and stages for the 50-year and 100-year storms

Design Frequencies = 50 year = 2.0%
100 year = 1.0%

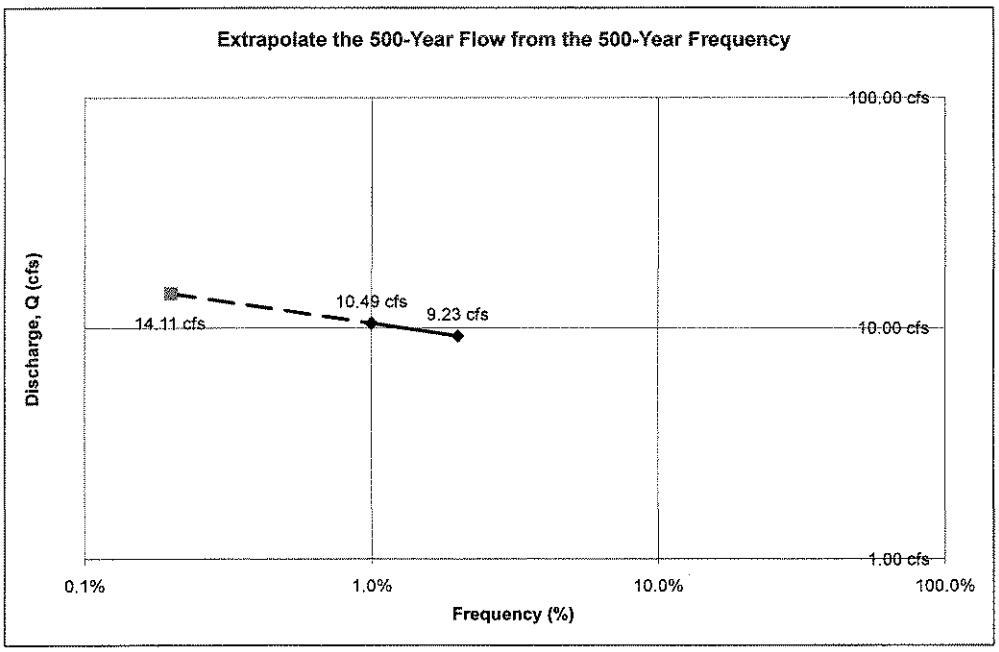
Q_{50} = 9.23 cfs
Q_{100} = 10.49 cfs

$Stage_{50}$ = 24.99 ft
$Stage_{100}$ = 25.07 ft

Plotting the 50-year and 100-year stages vs. discharge allows us to extrapolate the 500-year flow:

$Frequency_{500}$ = 0.0020
$Frequency_{500}$ = 0.20%
$Frequency_{500}$ = 500 year

Q_{500} = 14.11 cfs (see graph below)

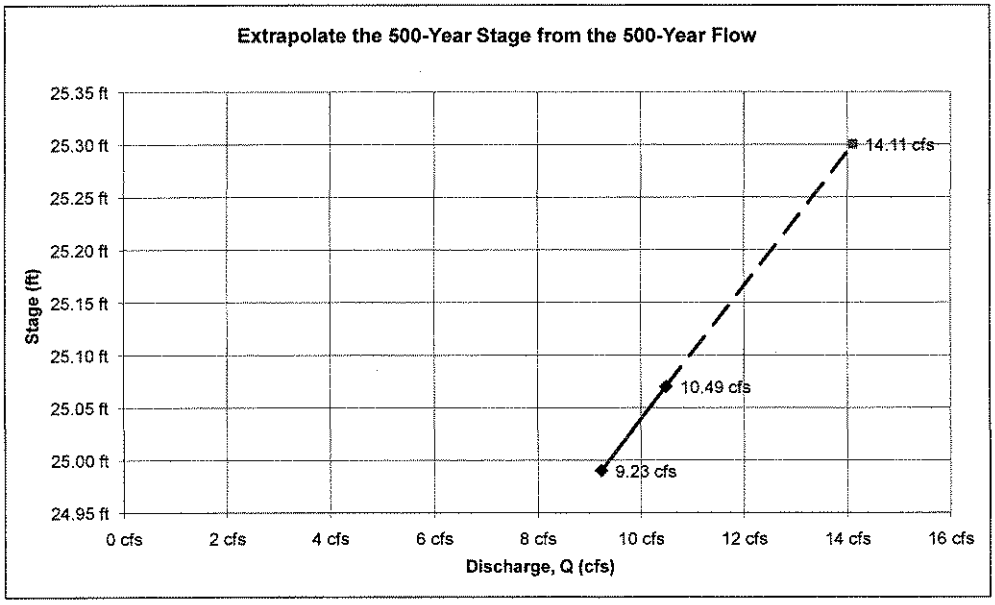


V-68

Plotting the 50-year and 100-year stages vs. discharge allows us to extrapolate the overtopping flow:

Q_{500} = 14.11 cfs

$Stage_{500}$ = 25.30 ft (see graph below)



Project: I-95 from SR 44 to I-4 **Project No.:** 406869-6-52-01
Designed by: ARK **Checked by:** JSG
Date: 7/18/2008 **Date:** 7/22/2008

EXISTING CONDITION
CROSS DRAIN ANALYSIS
Cross Drain S-159 SB

Estimate Runoff Volume

Rational Method (Drainage Area < 600 acres)

Q = C i A where Q = Flow (cfs)
C = Rational Coefficient (unitless)
i = Rainfall intensity (in/hr)
A = Drainage Area (acres)

Q_{50} =	$C_{50}\ i_{50}\ A$ =	(0.54) * (6.20) * (1.35) =	4.51 cfs	(see calculations below)
Q_{100} =	$C_{100}\ i_{100}\ A$ =	(0.56) * (6.70) * (1.35) =	5.08 cfs	(see calculations below)
Q_{500} =	6.68 cfs =		6.68 cfs	(extrapolated from 50 and 100 year flows, see calculations below)

Find weighted Rational Coefficient, C

Initial Input: Total Area, Design Frequencies to be analyzed

Total Area = 58784 sf
Total Area = 1.35 acres
Design Frequencies = 50 year
100 year

	Area	Slope	Slope	Land Use	Sand or Clay	Rational Coefficient Range[1]	Rational Coefficient Selected
Sub Area 1	0.84 acres	0.005 ft/ft	Flat	Grass	Sand	10 to 15	0.15
Sub Area 2	0.50 acres	0.042 ft/ft	Rolling	Pavement	Sand	0.95	0.95
Sub Area 3							
Sub Area 4							
Sub Area 5							
Total Area = 1.35 acres					Weighted Average Rational Coefficient =		0.45

[1] The rational coefficient range is collected from Table T-4 of the 2004 FDOT Hydrology Handbook.

Apply Design Frequecy Factors to the Weighted Average Rational Coefficient

Storm Frequency	Design Storm Frequency Factor, X_T[2]	Weighted Average Rational Coefficient	Adjusted Weighted Average Rational Coefficient
50 year	1.20	0.45	0.54
100 year	1.25	0.45	0.56

[2] The Design Storm Frequency Factor is collected from Table T-5 of the 2004 FDOT Hydrology Handbook.

Find Rainfall Intensity, i

For Basin S-159 SB 27.00 min = T_c (Please check basin tc calcs)

Use the time of concentration with the FDOT IDF Curves to obtain the Rainfall Intensity, i.

FDOT IDF Zone = 7
Time of Concentration, T_c = 27.0 min = 0.450 hrs
Design Frequencies = 50 year
100 year

Rainfall Intensity, i = 6.20 in/hr (50 year)
Rainfall Intensity, i = 6.70 in/hr (100 year)

V-70

Calculate the flow, Q

The flow, Q, can now be calculated based on the rational coefficients, intensities, and areas.

Q_{50} =	$C_{50}\ i_{50}\ A$ = (0.54) * (6.20) * (1.35) =	4.51 cfs
Q_{100} =	$C_{100}\ i_{100}\ A$ = (0.56) * (6.70) * (1.35) =	5.08 cfs

Crossdrain dimensions:

Circular Pipe

No. of Barrels = 1
Pipe size = 24 in
Provided Area = 3.14 sf

The analysis of the cross drain can now proceed using the FHWA HY8 software

Design Criteria

1. No overtopping or encroachment onto the roadway shoulder in the design storm (50-year).
2. Water velocity not greater than 4 ft/s in the design storm (50-year).
3. Perform SCS analysis to verify no adverse impacts at property line for 25-year, 24-hour storm event for SJRWMD.

See HY8 Output for final design parameters

Calculate the Overtopping flood frequency from extrapolation, using the HY8 output for Overtopping flow:

Initial Input: Flows and stages for the 50-year, 100-year, and overtopping storms

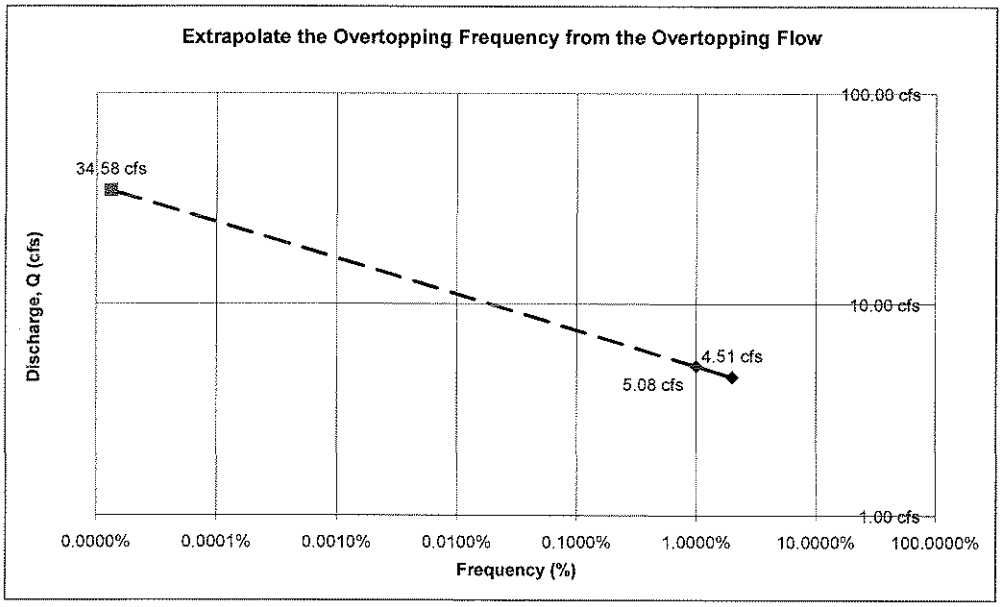
Design Frequencies = 50 year = 2.0%
100 year = 1.0%

Q_{50} = 4.51 cfs
Q_{100} = 5.08 cfs
$Q_{Overtopping}$ = 34.58 cfs

$Stage_{50}$ = 25.07 ft
$Stage_{100}$ = 25.09 ft
$Stage_{Overtopping}$ = 29.24 ft

The frequency of the overtopping storm that occurs the overtopping flow is calculated by extrapolation:

$Frequency_{Overtopping}$ = 0.0000001
$Frequency_{Overtopping}$ = 0.00001%
$Frequency_{Overtopping}$ = 7562133 year (see graph below)



Since the overtopping flood is greater than the greatest flood (500-year flood), only the the 50-year, 100-year, and 500-year floods will be analyzed.

Calculate the 500-year flow and 500-year stage from extrapolation

Initial Input: Flows and stages for the 50-year and 100-year storms

Design Frequencies = 50 year = 2.0%
100 year = 1.0%

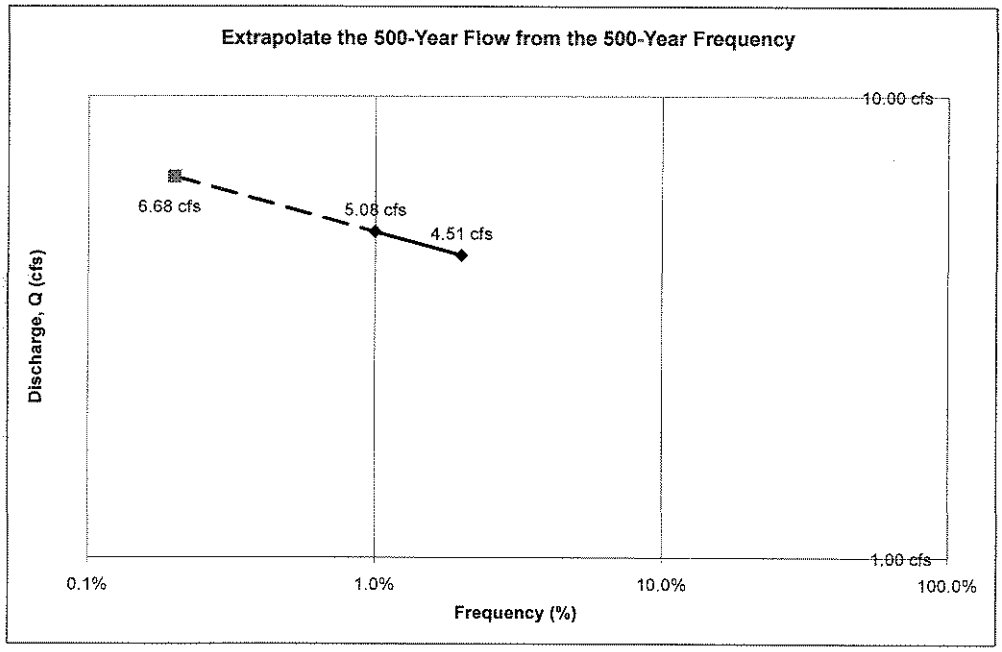
Q_{50} = 4.51 cfs
Q_{100} = 5.08 cfs

$Stage_{50}$ = 25.07 ft
$Stage_{100}$ = 25.09 ft

Plotting the 50-year and 100-year stages vs. discharge allows us to extrapolate the 500-year flow:

$Frequency_{500}$ = 0.0020
$Frequency_{500}$ = 0.20%
$Frequency_{500}$ = 500 year

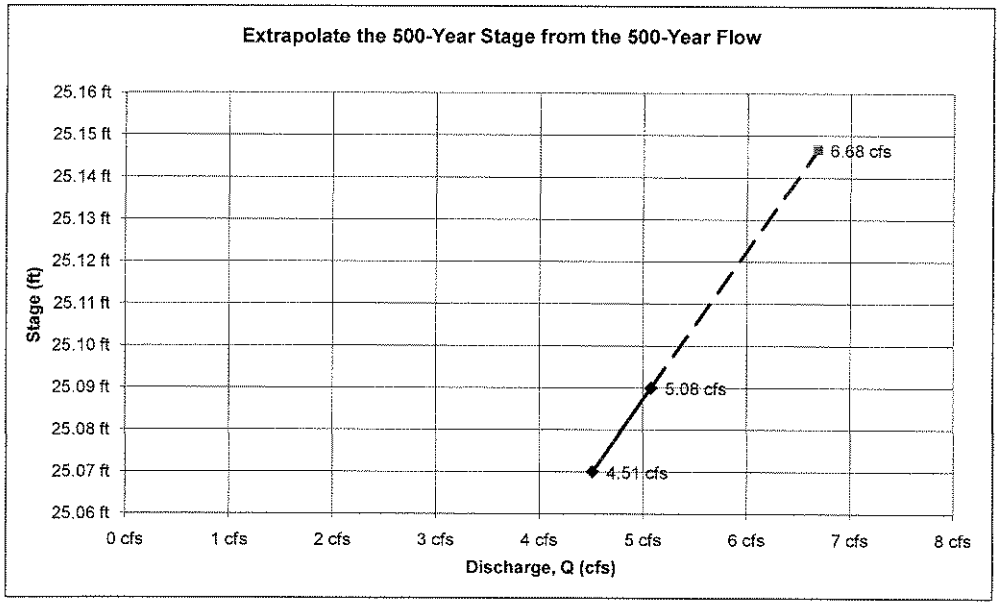
Q_{500} = 6.68 cfs (see graph below)



Plotting the 50-year and 100-year stages vs. discharge allows us to extrapolate the overtopping flow:

Q_{500} = 6.68 cfs

$Stage_{500}$ = 25.15 ft (see graph below)



Project: I-95 from SR 44 to I-4 **Project No.:** 406869-6-52-01
Designed by: ARK **Checked by:** JSG
Date: 7/18/2008 **Date:** 7/22/2008

EXISTING CONDITION
CROSS DRAIN ANALYSIS
Cross Drain S-160 NB

Estimate Runoff Volume

Rational Method (Drainage Area < 600 acres)

Q = C i A where Q = Flow (cfs)
C = Rational Coefficient (unitless)
i = Rainfall intensity (in/hr)
A = Drainage Area (acres)

Q_{50} =	$C_{50}\ i_{50}\ A$ =	(0.19) * (8.90) * (20.09) =	33.35 cfs	(see calculations below)
Q_{100} =	$C_{100}\ i_{100}\ A$ =	(0.19) * (9.70) * (20.09) =	37.87 cfs	(see calculations below)
Q_{500} =	50.84 cfs =		50.84 cfs	(extrapolated from 50 and 100 year flows, see calculations below)

Find weighted Rational Coefficient, C

Initial Input: Total Area, Design Frequencies to be analyzed

Total Area = 875309 sf
Total Area = 20.09 acres
Design Frequencies = 50 year
100 year

	Area	Slope	Slope	Land Use	Sand or Clay	Rational Coefficient Range[1]	Rational Coefficient Selected
Sub Area 1	19.96 acres	0.005 ft/ft	Flat	Grass	Sand	10 to 15	0.15
Sub Area 2	0.14 acres	0.042 ft/ft	Rolling	Pavement	Sand	0.95	0.95
Sub Area 3							
Sub Area 4							
Sub Area 5							
Total Area = 20.09 acres					Weighted Average Rational Coefficient =		0.16

[1] The rational coefficient range is collected from Table T-4 of the 2004 FDOT Hydrology Handbook.

Apply Design Frequecy Factors to the Weighted Average Rational Coefficient

Storm Frequency	Design Storm Frequency Factor, X_T[2]	Weighted Average Rational Coefficient	Adjusted Weighted Average Rational Coefficient
50 year	1.20	0.16	0.19
100 year	1.25	0.16	0.19

[2] The Design Storm Frequency Factor is collected from Table T-5 of the 2004 FDOT Hydrology Handbook.

Find Rainfall Intensity, i

For Basin S-160 NB 10.00 min = T_c (Please check basin tc calcs)

Use the time of concentration with the FDOT IDF Curves to obtain the Rainfall Intensity, i.

FDOT IDF Zone = 7
Time of Concentration, T_c = 10.0 min = 0.167 hrs
Design Frequencies = 50 year
100 year

Rainfall Intensity, i = 8.90 in/hr (50 year)
Rainfall Intensity, i = 9.70 in/hr (100 year)

Calculate the flow, Q

The flow, Q, can now be calculated based on the rational coefficients, intensities, and areas.

Q_{50} =	$C_{50}\ i_{50}\ A$ = (0.19) * (8.90) * (20.09) =	33.35 cfs
Q_{100} =	$C_{100}\ i_{100}\ A$ = (0.19) * (9.70) * (20.09) =	37.87 cfs

Crossdrain dimensions:

Circular Pipe

No. of Barrels = 1
Pipe size = 36 in
Provided Area = 7.07 sf

The analysis of the cross drain can now proceed using the FHWA HY8 software

Design Criteria

1. No overtopping or encroachment onto the roadway shoulder in the design storm (50-year).
2. Water velocity not greater than 4 ft/s in the design storm (50-year).
3. Perform SCS analysis to verify no adverse impacts at property line for 25-year, 24-hour storm event for SJRWMD.

See HY8 Output for final design parameters

Calculate the Overtopping flood frequency from extrapolation, using the HY8 output for Overtopping flow:

Initial Input: Flows and stages for the 50-year, 100-year, and overtopping storms

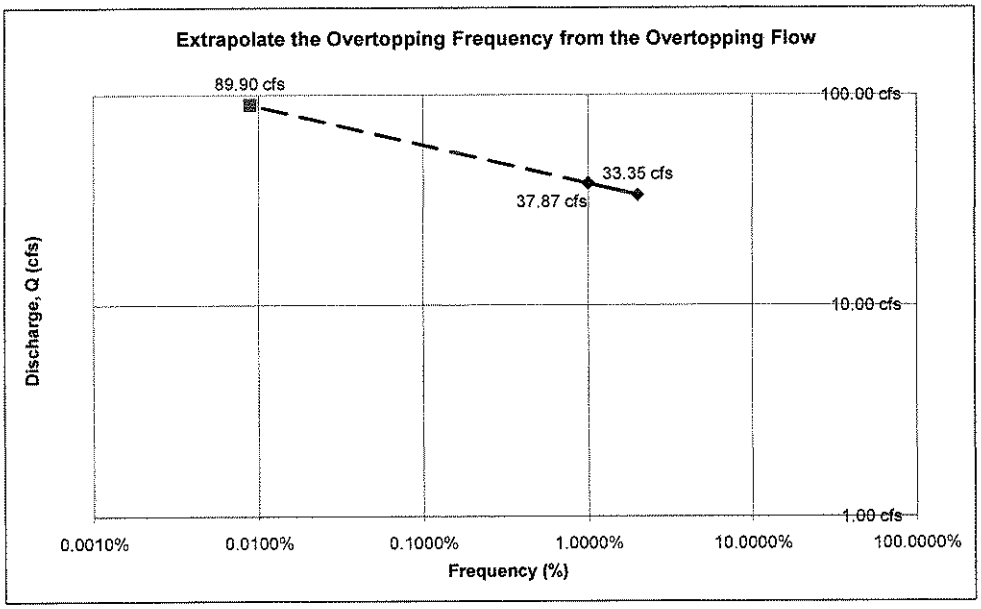
Design Frequencies = 50 year = 2.0%
100 year = 1.0%

Q_{50} = 33.35 cfs
Q_{100} = 37.87 cfs
$Q_{Overtopping}$ = 89.90 cfs

$Stage_{50}$ = 25.37 ft
$Stage_{100}$ = 25.55 ft
$Stage_{Overtopping}$ = 29.19 ft

The frequency of the overtopping storm that occurs the overtopping flow is calculated by extrapolation:

$Frequency_{Overtopping}$ = 0.000089
$Frequency_{Overtopping}$ = 0.0089%
$Frequency_{Overtopping}$ = 11250 year (see graph below)



Since the overtopping flood is greater than the greatest flood (500-year flood), only the the 50-year, 100-year, and 500-year floods will be analyzed.

Calculate the 500-year flow and 500-year stage from extrapolation

Initial Input: Flows and stages for the 50-year and 100-year storms

Design Frequencies = 50 year = 2.0%
100 year = 1.0%

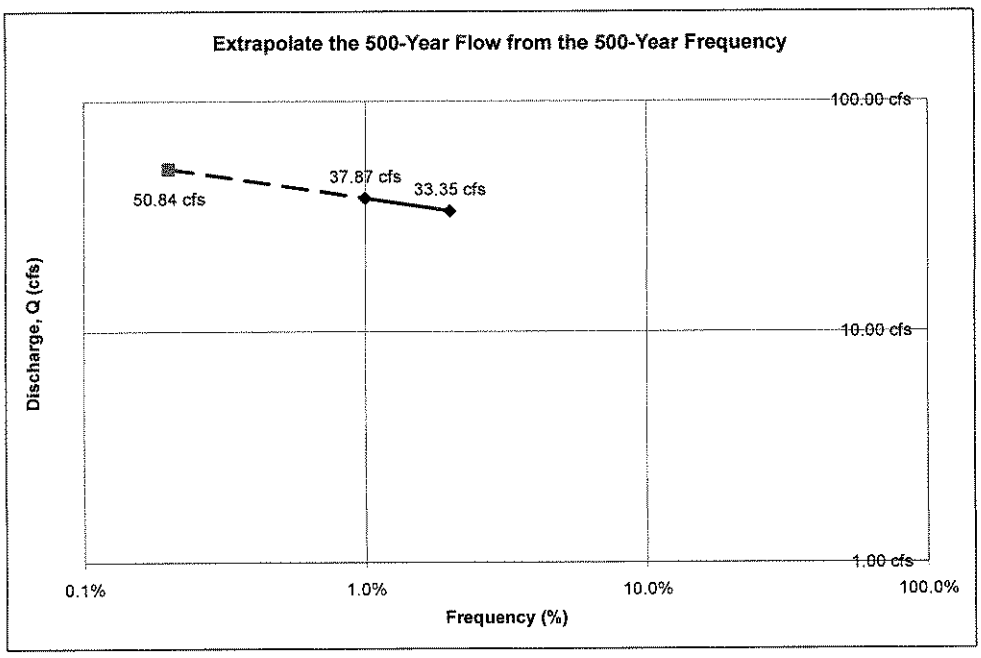
Q_{50} = 33.35 cfs
Q_{100} = 37.87 cfs

$Stage_{50}$ = 25.37 ft
$Stage_{100}$ = 25.55 ft

Plotting the 50-year and 100-year stages vs. discharge allows us to extrapolate the 500-year flow:

$Frequency_{500}$ = 0.0020
$Frequency_{500}$ = 0.20%
$Frequency_{500}$ = 500 year

Q_{500} = 50.84 cfs (see graph below)

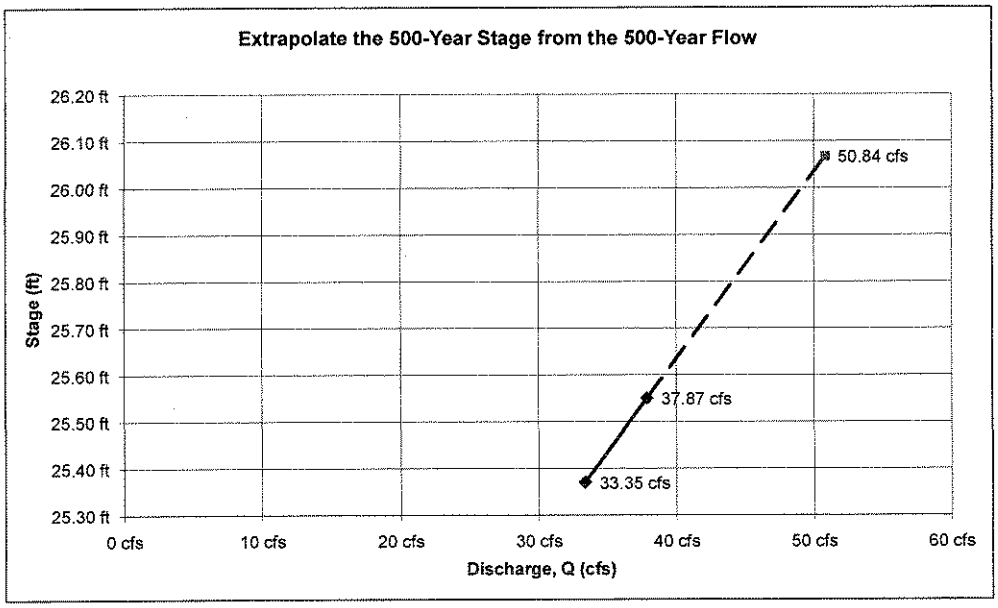


V-76

Plotting the 50-year and 100-year stages vs. discharge allows us to extrapolate the overtopping flow:

Q_{500} = 50.84 cfs

$Stage_{500}$ = 26.07 ft (see graph below)



Project: I-95 from SR 44 to I-4 **Project No.:** 406869-6-52-01
Designed by: ARK **Checked by:** JSG
Date: 7/18/2008 **Date:** 7/22/2008

EXISTING CONDITION
CROSS DRAIN ANALYSIS
Cross Drain S-160 SB

Estimate Runoff Volume

Rational Method (Drainage Area < 600 acres)

$Q = C\ i\ A$ where Q = Flow (cfs)
C = Rational Coefficient (unitless)
i = Rainfall intensity (in/hr)
A = Drainage Area (acres)

Q_{50} =	$C_{50}\ i_{50}\ A$ =	(0.21) * (5.00) * (19.50) =	20.72 cfs	(see calculations below)
Q_{100} =	$C_{100}\ i_{100}\ A$ =	(0.22) * (5.40) * (19.50) =	23.32 cfs	(see calculations below)
Q_{500} =	30.65 cfs =		30.65 cfs	(extrapolated from 50 and 100 year flows, see calculations below)

Find weighted Rational Coefficient, C

Initial Input: Total Area, Design Frequencies to be analyzed

Total Area = 849484 sf
Total Area = 19.50 acres
Design Frequencies = 50 year
100 year

	Area	Slope	Slope	Land Use	Sand or Clay	Rational Coefficient Range[1]	Rational Coefficient Selected
Sub Area 1	18.84 acres	0.005 ft/ft	Flat	Grass	Sand	10 to .15	0.15
Sub Area 2	0.66 acres	0.042 ft/ft	Rolling	Pavement	Sand	0.95	0.95
Sub Area 3							
Sub Area 4							
Sub Area 5							
Total Area = 19.50 acres					Weighted Average Rational Coefficient =		0.18

[1] The rational coefficient range is collected from Table T-4 of the 2004 FDOT Hydrology Handbook.

Apply Design Frequecy Factors to the Weighted Average Rational Coefficient

Storm Frequency	Design Storm Frequency Factor, X_T[2]	Weighted Average Rational Coefficient	Adjusted Weighted Average Rational Coefficient
50 year	1.20	0.18	0.21
100 year	1.25	0.18	0.22

[2] The Design Storm Frequency Factor is collected from Table T-5 of the 2004 FDOT Hydrology Handbook.

Find Rainfall Intensity, i

For Basin S-160 SB 43.00 min = T_c (Please check basin tc calcs)

Use the time of concentration with the FDOT IDF Curves to obtain the Rainfall Intensity, i.

FDOT IDF Zone = 7
Time of Concentration, T_c = 43.0 min = 0.717 hrs
Design Frequencies = 50 year
100 year

Rainfall Intensity, i = 5.00 in/hr (50 year)
Rainfall Intensity, i = 5.40 in/hr (100 year)

V-78

Calculate the flow, Q

The flow, Q, can now be calculated based on the rational coefficients, intensities, and areas.

Q_{50} =	$C_{50}\ i_{50}\ A$ =	(0.21) * (5.00) * (19.50) =	20.72 cfs
Q_{100} =	$C_{100}\ i_{100}\ A$ =	(0.22) * (5.40) * (19.50) =	23.32 cfs

Crossdrain dimensions:

Circular Pipe

No. of Barrels = 1
Pipe size = 36 in
Provided Area = 7.07 sf

The analysis of the cross drain can now proceed using the FHWA HY8 software

Design Criteria

1. No overtopping or encroachment onto the roadway shoulder in the design storm (50-year).
2. Water velocity not greater than 4 ft/s in the design storm (50-year).
3. Perform SCS analysis to verify no adverse impacts at property line for 25-year, 24-hour storm event for SJRWMD.

See HY8 Output for final design parameters

Calculate the Overtopping flood frequency from extrapolation, using the HY8 output for Overtopping flow:

Initial input: Flows and stages for the 50-year, 100-year, and overtopping storms

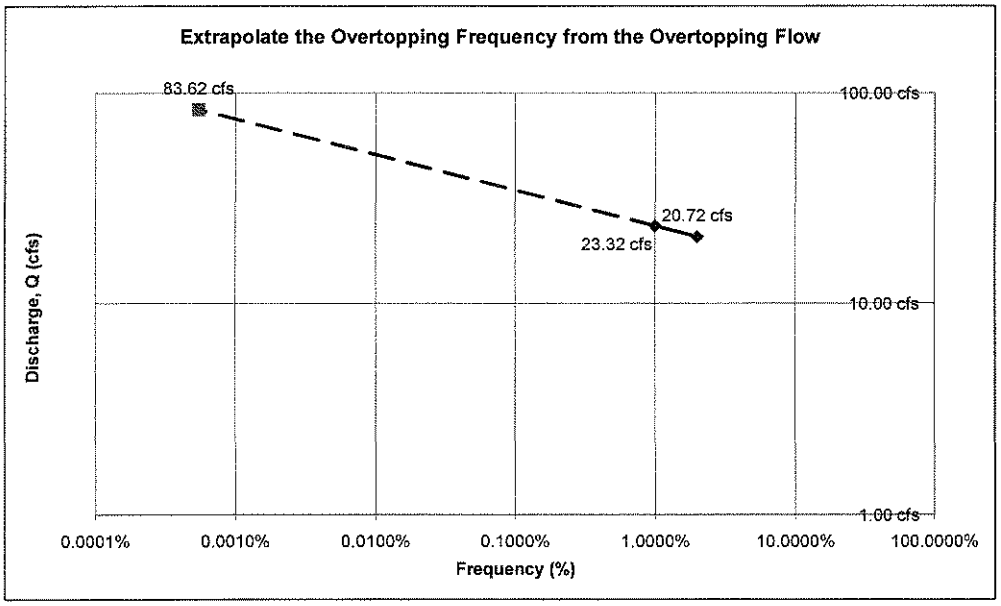
Design Frequencies = 50 year = 2.0%
100 year = 1.0%

Q_{50} = 20.72 cfs
Q_{100} = 23.32 cfs
$Q_{Overtopping}$ = 83.62 cfs

$Stage_{50}$ = 25.60 ft
$Stage_{100}$ = 25.67 ft
$Stage_{Overtopping}$ = 29.19 ft

The frequency of the overtopping storm that occurs the overtopping flow is calculated by extrapolation:

$Frequency_{Overtopping}$ = 0.000005
$Frequency_{Overtopping}$ = 0.001%
$Frequency_{Overtopping}$ = 183744 year (see graph below)



Since the overtopping flood is greater than the greatest flood (500-year flood), only the the 50-year, 100-year, and 500-year floods will be analyzed.

Calculate the 500-year flow and 500-year stage from extrapolation

Initial Input: Flows and stages for the 50-year and 100-year storms

Design Frequencies = 50 year = 2.0%
100 year = 1.0%

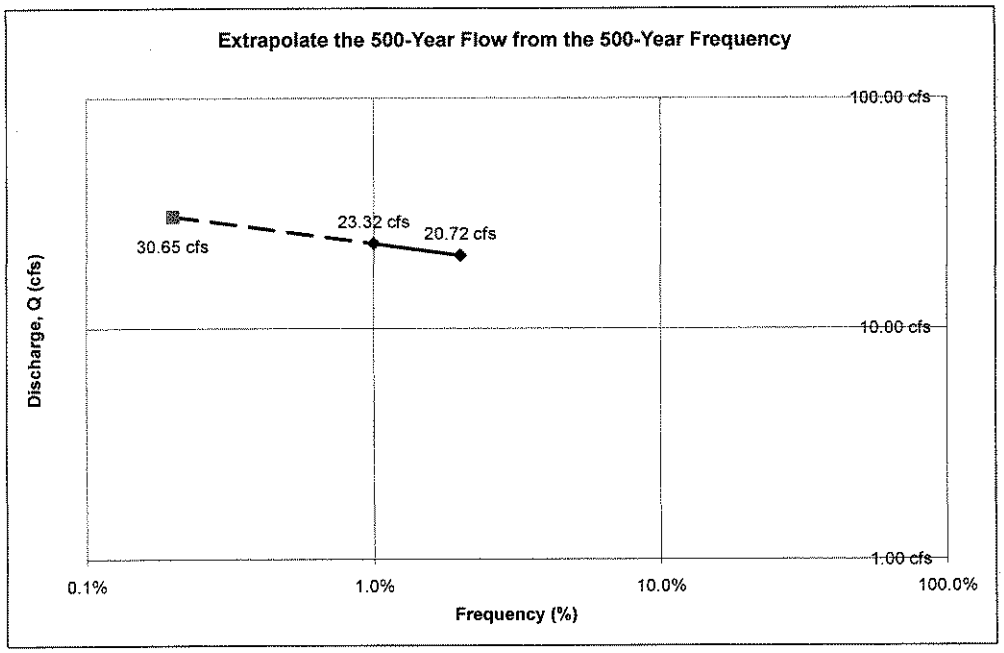
Q_{50} = 20.72 cfs
Q_{100} = 23.32 cfs

$Stage_{50}$ = 25.60 ft
$Stage_{100}$ = 25.67 ft

Plotting the 50-year and 100-year stages vs. discharge allows us to extrapolate the 500-year flow:

$Frequency_{500}$ = 0.0020
$Frequency_{500}$ = 0.20%
$Frequency_{500}$ = 500 year

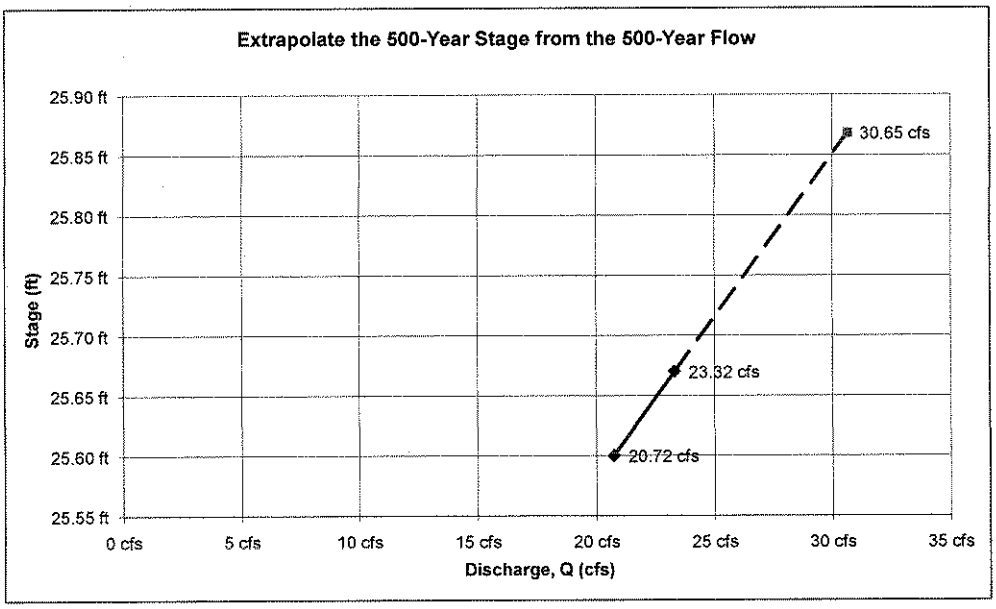
Q_{500} = 30.65 cfs (see graph below)



Plotting the 50-year and 100-year stages vs. discharge allows us to extrapolate the overtopping flow:

Q_{500} = 30.65 cfs

$Stage_{500}$ = 25.87 ft (see graph below)



Project: I-95 from SR 44 to I-4 **Project No.:** 406869-6-52-01
Designed by: ARK **Checked by:** JSG
Date: 7/18/2008 **Date:** 7/22/2008

EXISTING CONDITION
CROSS DRAIN ANALYSIS
Cross Drain S-161 NB

Estimate Runoff Volume

Rational Method (Drainage Area < 600 acres)

$Q = C\ i\ A$ where Q = Flow (cfs)
C = Rational Coefficient (unitless)
i = Rainfall intensity (in/hr)
A = Drainage Area (acres)

Q_{50} =	$C_{50}\ i_{50}\ A$ =	(0.21) * (1.55) * (304.08) =	99.63 cfs	(see calculations below)
Q_{100} =	$C_{100}\ i_{100}\ A$ =	(0.22) * (1.72) * (304.08) =	115.16 cfs	(see calculations below)
Q_{500} =	161.22 cfs =		161.22 cfs	(extrapolated from 50 and 100 year flows, see calculations below)

Find weighted Rational Coefficient, C

Initial Input: Total Area, Design Frequencies to be analyzed

Total Area = 13245513 sf
Total Area = 304.08 acres
Design Frequencies = 50 year
100 year

	Area	Slope	Slope	Land Use	Sand or Clay	Rational Coefficient Range[1]	Rational Coefficient Selected
Sub Area 1	294.13 acres	0.005 ft/ft	Flat	Grass	Sand	10 to .15	0.15
Sub Area 2	9.94 acres	0.042 ft/ft	Rolling	Pavement	Sand	0.95	0.95
Sub Area 3							
Sub Area 4							
Sub Area 5							
Total Area = 304.08 acres				Weighted Average Rational Coefficient =			0.18

[1] The rational coefficient range is collected from Table T-4 of the 2004 FDOT Hydrology Handbook.

Apply Design Frequecy Factors to the Weighted Average Rational Coefficient

Storm Frequency	Design Storm Frequency Factor, X_T[2]	Weighted Average Rational Coefficient	Adjusted Weighted Average Rational Coefficient
50 year	1.20	0.18	0.21
100 year	1.25	0.18	0.22

[2] The Design Storm Frequency Factor is collected from Table T-5 of the 2004 FDOT Hydrology Handbook.

Find Rainfall Intensity, i

For Basin S-161 NB 225.00 min = T_c (Please check basin tc calcs)

Use the time of concentration with the FDOT IDF Curves to obtain the Rainfall Intensity, i.

FDOT IDF Zone = 7
Time of Concentration, T_c = 225.0 min = 3.750 hrs
Design Frequencies = 50 year
100 year

Rainfall Intensity, i = 1.55 in/hr (50 year)
Rainfall Intensity, i = 1.72 in/hr (100 year)

Calculate the flow, Q

The flow, Q, can now be calculated based on the rational coefficients, intensities, and areas.

Q_{50} = C_{50} i_{50} A =	(0.21) * (1.55) * (304.08) =	99.63 cfs
Q_{100} = C_{100} i_{100} A =	(0.22) * (1.72) * (304.08) =	115.16 cfs

Crossdrain dimensions:

Rectangular Box Culvert

No. of Barrels = 1
Span = 7 ft
Rise = 5 ft
Provided Area = 35.00 sf

The analysis of the cross drain can now proceed using the FHWA HY8 software

Design Criteria

1. No overtopping or encroachment onto the roadway shoulder in the design storm (50-year).
2. Water velocity not greater than 4 ft/s in the design storm (50-year).
3. Perform SCS analysis to verify no adverse impacts at property line for 25-year, 24-hour storm event for SJRWMD.

See HY8 Output for final design parameters

Calculate the Overtopping flood frequency from extrapolation, using the HY8 output for Overtopping flow:

Initial Input: Flows and stages for the 50-year, 100-year, and overtopping storms

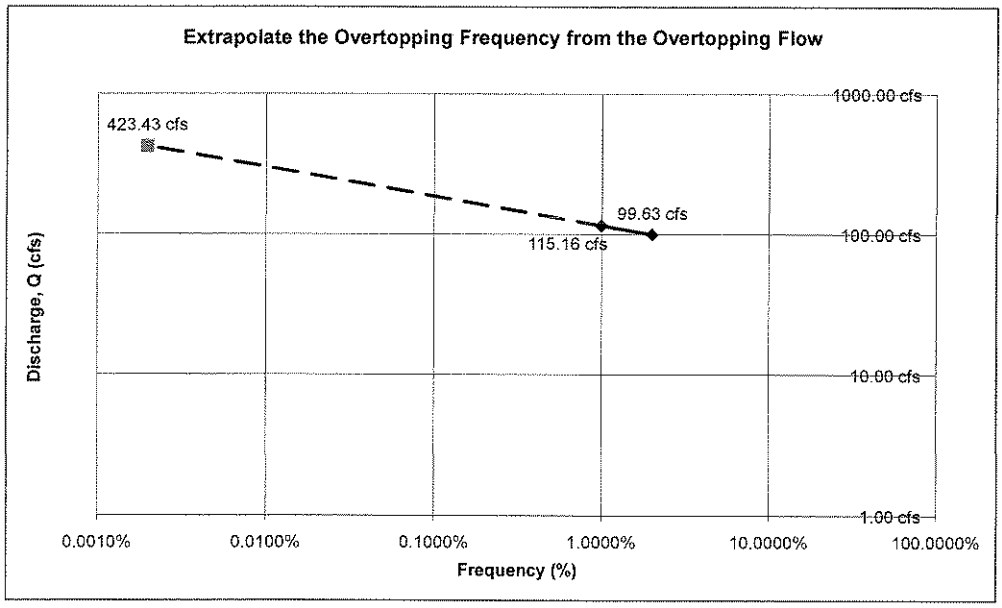
Design Frequencies = 50 year = 2.0%
100 year = 1.0%

Q_{50} = 99.63 cfs
Q_{100} = 115.16 cfs
$Q_{Overtopping}$ = 423.43 cfs

$Stage_{50}$ = 26.06 ft
$Stage_{100}$ = 26.16 ft
$Stage_{Overtopping}$ = 30.76 ft

The frequency of the overtopping storm that occurs the overtopping flow is calculated by extrapolation:

$Frequency_{Overtopping}$ = 0.000020
$Frequency_{Overtopping}$ = 0.0020%
$Frequency_{Overtopping}$ = 50715 year (see graph below)



Since the overtopping flood is greater than the greatest flood (500-year flood), only the the 50-year, 100-year, and 500-year floods will be analyzed.

Calculate the 500-year flow and 500-year stage from extrapolation

Initial Input: Flows and stages for the 50-year and 100-year storms

Design Frequencies = 50 year = 2.0%
100 year = 1.0%

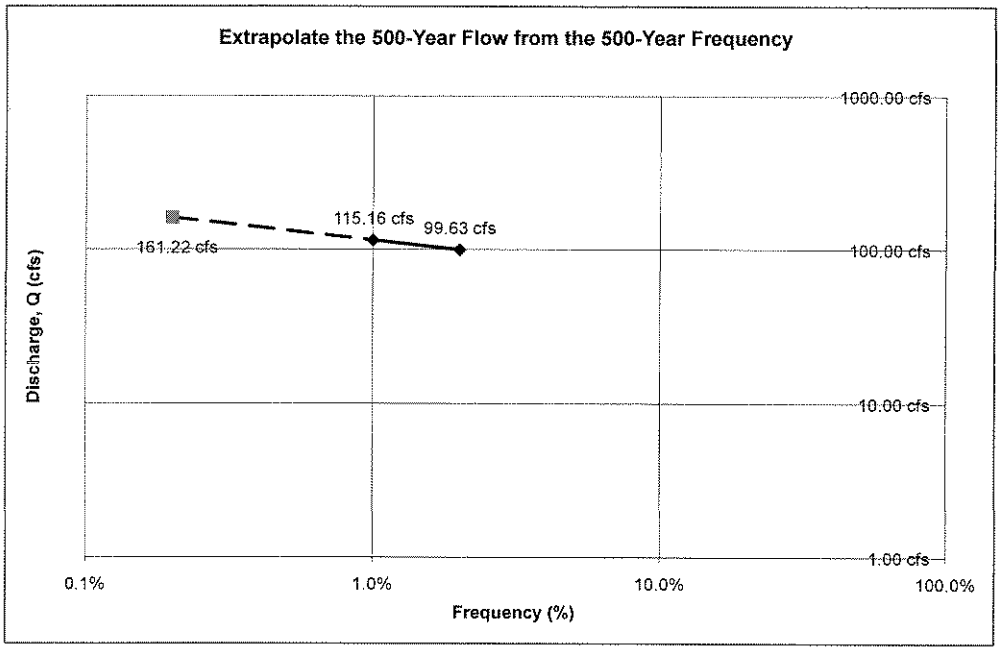
Q_{50} = 99.63 cfs
Q_{100} = 115.16 cfs

$Stage_{50}$ = 26.08 ft
$Stage_{100}$ = 26.16 ft

Plotting the 50-year and 100-year stages vs. discharge allows us to extrapolate the 500-year flow:

$Frequency_{500}$ = 0.0020
$Frequency_{500}$ = 0.20%
$Frequency_{500}$ = 500 year

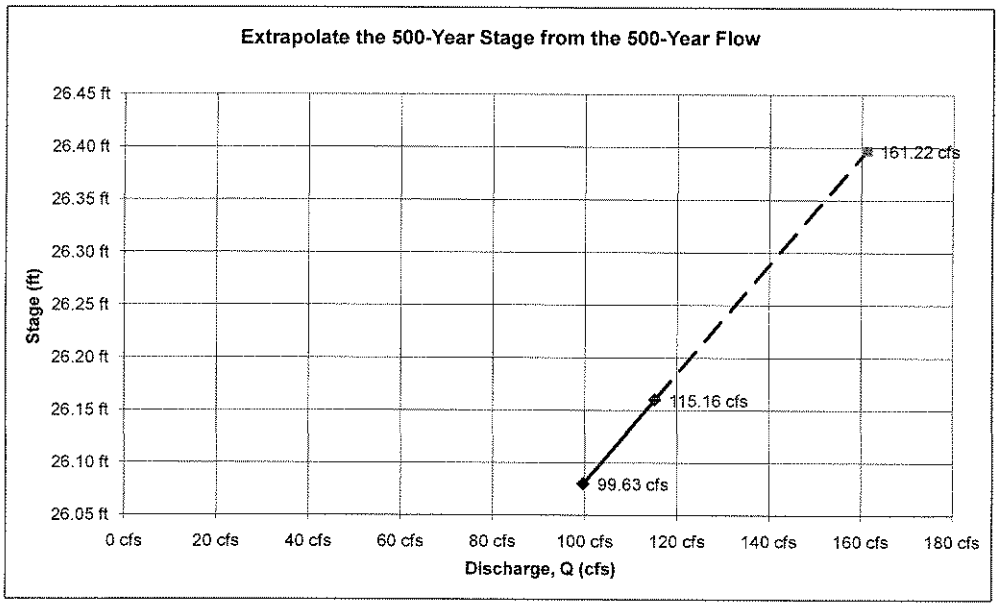
Q_{500} = 161.22 cfs (see graph below)



Plotting the 50-year and 100-year stages vs. discharge allows us to extrapolate the overtopping flow:

Q_{500} = 161.22 cfs

$Stage_{500}$ = 26.40 ft (see graph below)



Project: I-95 from SR 44 to I-4 **Project No.:** 406869-6-52-01
Designed by: ARK **Checked by:** JSG
Date: 7/18/2008 **Date:** 7/22/2008

EXISTING CONDITION
CROSS DRAIN ANALYSIS
Cross Drain S-161 SB

Estimate Runoff Volume

Rational Method (Drainage Area < 600 acres)

$Q = C\ i\ A$ where Q = Flow (cfs)
C = Rational Coefficient (unitless)
i = Rainfall intensity (in/hr)
A = Drainage Area (acres)

Q_{50} =	$C_{50}\ I_{50}\ A$ =	(0.21) * (1.55) * (293.78) =	95.91 cfs	(see calculations below)
Q_{100} =	$C_{100}\ I_{100}\ A$ =	(0.22) * (1.72) * (293.78) =	110.86 cfs	(see calculations below)
Q_{500} =	155.20 cfs =		155.20 cfs	(extrapolated from 50 and 100 year flows, see calculations below)

Find weighted Rational Coefficient, C

Initial Input: Total Area, Design Frequencies to be analyzed

Total Area = 12797218 sf
Total Area = 293.78 acres
Design Frequencies = 50 year
100 year

	Area	Slope	Slope	Land Use	Sand or Clay	Rational Coefficient Range[1]	Rational Coefficient Selected
Sub Area 1	284.41 acres	0.005 ft/ft	Flat	Grass	Sand	10 to .15	0.15
Sub Area 2	9.37 acres	0.042 ft/ft	Rolling	Pavement	Sand	0.95	0.95
Sub Area 3							
Sub Area 4							
Sub Area 5							
Total Area = 293.78 acres					Weighted Average Rational Coefficient =		0.18

[1] The rational coefficient range is collected from Table T-4 of the 2004 FDOT Hydrology Handbook.

Apply Design Frequecy Factors to the Weighted Average Rational Coefficient

Storm Frequency	Design Storm Frequency Factor, X_T[2]	Weighted Average Rational Coefficient	Adjusted Weighted Average Rational Coefficient
50 year	1.20	0.18	0.21
100 year	1.25	0.18	0.22

[2] The Design Storm Frequency Factor is collected from Table T-5 of the 2004 FDOT Hydrology Handbook.

Find Rainfall Intensity, i

For Basin S-161 SB 225.00 min = T_c (Please check basin tc calcs)

Use the time of concentration with the FDOT IDF Curves to obtain the Rainfall Intensity, i.

FDOT IDF Zone = 7
Time of Concentration, T_c = 225.0 min 3.750 hrs
Design Frequencies = 50 year
100 year

Rainfall Intensity, i = 1.55 in/hr (50 year)
Rainfall Intensity, i = 1.72 in/hr (100 year)

V-86

Calculate the flow, Q

The flow, Q, can now be calculated based on the rational coefficients, intensities, and areas.

Q_{50} =	$C_{50}\ i_{50}\ A$ = (0.21) * (1.55) * (293.78) =	95.91 cfs
Q_{100} =	$C_{100}\ i_{100}\ A$ = (0.22) * (1.72) * (293.78) =	110.86 cfs

Crossdrain dimensions:

Rectangular Box Culvert

No. of Barrels = 1
Span = 7 ft
Rise = 5 ft
Provided Area = 35.00 sf

The analysis of the cross drain can now proceed using the FHWA HY8 software

Design Criteria

1. No overtopping or encroachment onto the roadway shoulder in the design storm (50-year).
2. Water velocity not greater than 4 ft/s in the design storm (50-year).
3. Perform SCS analysis to verify no adverse impacts at property line for 25-year, 24-hour storm event for SJRWMD.

See HY8 Output for final design parameters

Calculate the Overtopping flood frequency from extrapolation, using the HY8 output for Overtopping flow:

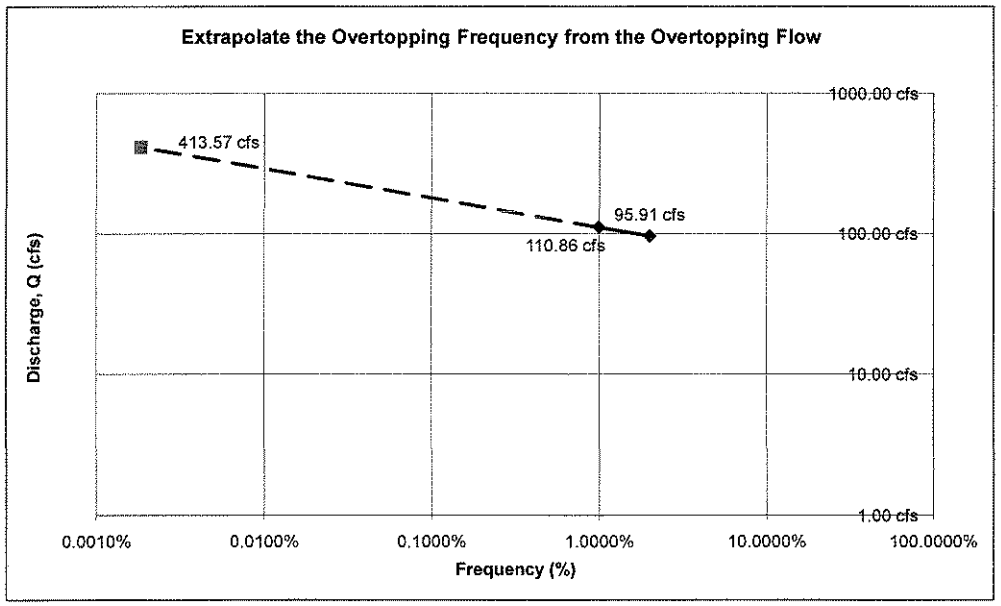
Initial Input: Flows and stages for the 50-year, 100-year, and overtopping storms

Design Frequencies = 50 year = 2.0%
100 year = 1.0%

Q_{50} = 95.91 cfs	$Stage_{50}$ = 26.29 ft
Q_{100} = 110.86 cfs	$Stage_{100}$ = 26.36 ft
$Q_{Overtopping}$ = 413.57 cfs	$Stage_{Overtopping}$ = 30.48 ft

The frequency of the overtopping storm that occurs the overtopping flow is calculated by extrapolation:

$Frequency_{Overtopping}$ = 0.000018
$Frequency_{Overtopping}$ = 0.0018%
$Frequency_{Overtopping}$ = 54354 year (see graph below)



Since the overtopping flood is greater than the greatest flood (500-year flood), only the the 50-year, 100-year, and 500-year floods will be analyzed.

V-87

Calculate the 500-year flow and 500-year stage from extrapolation

Initial Input: Flows and stages for the 50-year and 100-year storms

Design Frequencies = 50 year = 2.0%
100 year = 1.0%

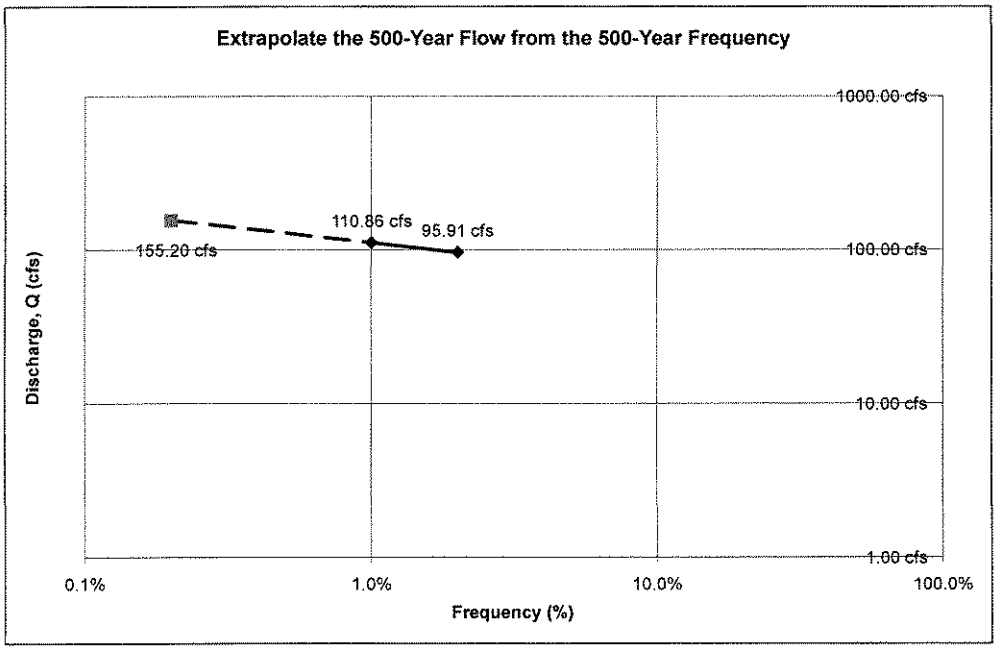
Q_{50} = 95.91 cfs
Q_{100} = 110.86 cfs

$Stage_{50}$ = 26.29 ft
$Stage_{100}$ = 26.36 ft

Plotting the 50-year and 100-year stages vs. discharge allows us to extrapolate the 500-year flow:

$Frequency_{500}$ = 0.0020
$Frequency_{500}$ = 0.20%
$Frequency_{500}$ = 500 year

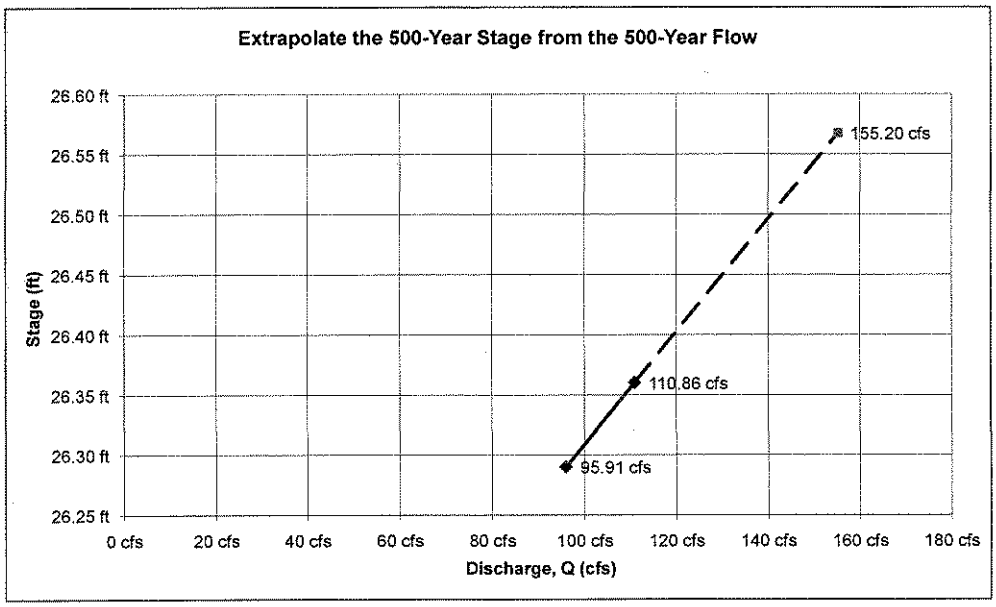
Q_{500} = 155.20 cfs (see graph below)



Plotting the 50-year and 100-year stages vs. discharge allows us to extrapolate the overtopping flow:

Q_{500} = 155.20 cfs

$Stage_{500}$ = 26.57 ft (see graph below)



APPENDIX C – CALCULATIONS

HYDROLOGIC ANALYSIS

		DATE
made by:	DHR	11-Jul-20
checked by:		
Stantec job #:		

PROJECT: I-95 Pioneer Trail Interchange

LOCATION: P01A-SOUTH

Rational Equation: $Q_T = X_T * C_T * i_{tc} * A_T$

Q_T = Peak Runoff for Return Period T (cfs).

X_T = Frequency Factor for Return Period T.

C_T = Average Runoff Coefficient for Return Period T.

i_{tc} = Average Rainfall Intensity for Return Period T (in/hr).

A_T = Total Watershed Drainage Area (ac).

$$C_T = \frac{C_1*A_1 + C_2*A_2 + C_3*A_3}{A_T}$$

A_1= 6.60 ac	C_1 = 0.95	Rooftops and Pavement and Surface Waters
A_2= 0.00 ac	C_2 = 0.20	Woodlands (Rolling with Sandy Soils)
A_3= 28.20 ac	C_3 = 0.25	Grass (Rolling with Sandy Soils)

A_T= 34.80 ac

C_T = 0.38

$X_{25\ yr}$ = 1.1	$X_{50\ yr}$ = 1.2	$X_{100\ yr}$ = 1.25
$i_{25\ yr}$ = 3.7 in/hr	$i_{50\ yr}$ = 4.1 in/hr	$i_{100\ yr}$ = 4.5 in/hr

i = based on time of concentration from Ditch Calculations -> t_c = 59.7 min

$Q_{25\ yr}$ = 54.8 cfs	**$Q_{50\ yr}$ = 65.7 cfs**	**$Q_{100\ yr}$ = 74.9 cfs**

$Q_{500\ yr}$ = 1.7 x $Q_{100\ yr}$ = **127.4 cfs**

HY-8 Culvert Analysis Report

Crossing Discharge Data

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

Minimum Flow: 65.7 cfs

Design Flow: 74.9 cfs

Maximum Flow: 127.4 cfs

Table 1 - Summary of Culvert Flows at Crossing: P01A-South (Existing)

Headwater Elevation (ft)	Total Discharge (cfs)	P01A-South (Existing) Discharge (cfs)	Roadway Discharge (cfs)	Iterations
25.62	65.70	65.70	0.00	1
25.68	71.87	71.87	0.00	1
25.71	74.90	74.90	0.00	1
25.82	84.21	84.21	0.00	1
25.90	90.38	90.38	0.00	1
25.98	96.55	96.55	0.00	1
26.07	102.72	102.72	0.00	1
26.17	108.89	108.89	0.00	1
26.27	115.06	115.06	0.00	1
26.37	121.23	121.23	0.00	1
26.49	127.40	127.40	0.00	1
28.90	198.15	198.15	0.00	Overtopping

Rating Curve Plot for Crossing: P01A-South (Existing)

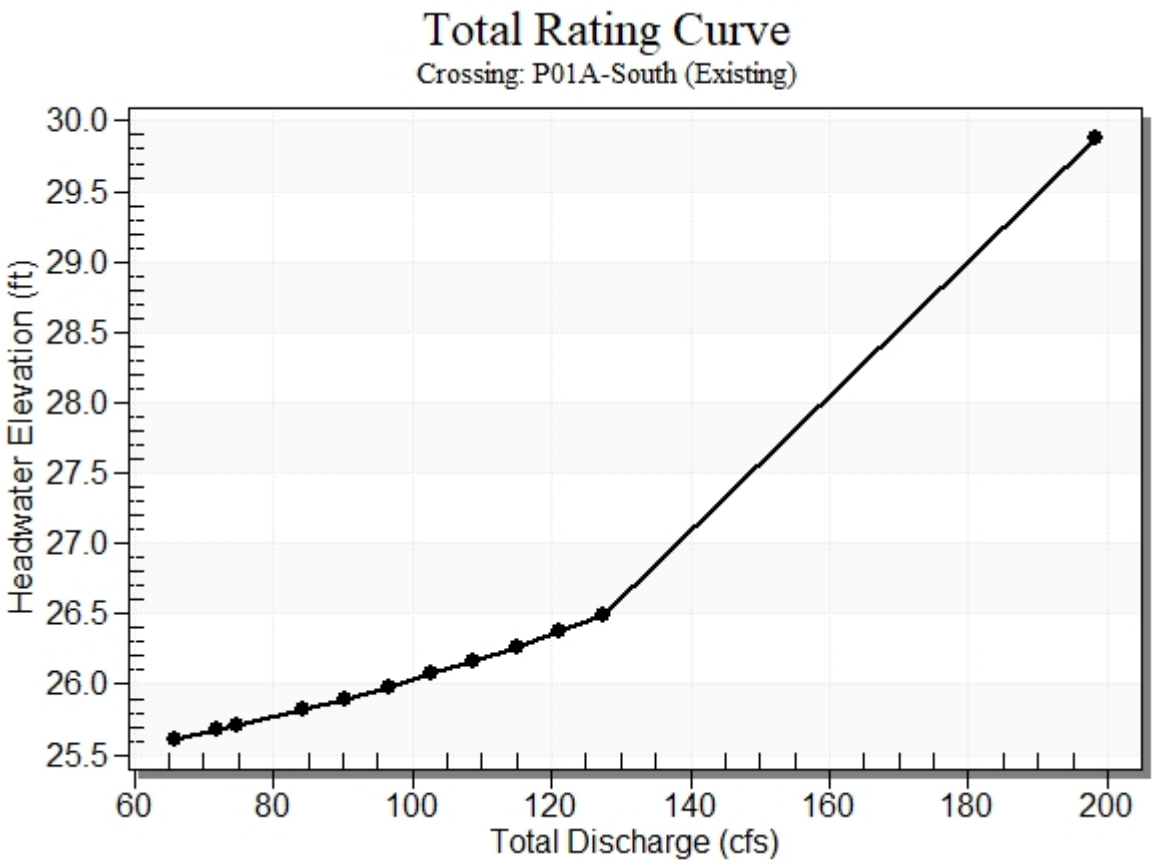


Table 2 - Culvert Summary Table: P01A-South (Existing)

Total Discharge (cfs)	Culvert Discharge (cfs)	Headwater Elevation (ft)	Inlet Control Depth (ft)	Outlet Control Depth (ft)	Flow Type	Normal Depth (ft)	Critical Depth (ft)	Outlet Depth (ft)	Tailwater Depth (ft)	Outlet Velocity (ft/s)	Tailwater Velocity (ft/s)
65.70	65.70	25.62	2.035	2.565	4-FFf	1.046	1.205	2.250	2.250	3.337	0.000
71.87	71.87	25.68	2.164	2.628	4-FFf	1.108	1.280	2.250	2.250	3.651	0.000
74.90	74.90	25.71	2.227	2.660	4-FFf	1.139	1.315	2.250	2.250	3.804	0.000
84.21	84.21	25.82	2.422	2.768	4-FFf	1.232	1.422	2.250	2.250	4.277	0.000
90.38	90.38	25.90	2.554	2.847	4-FFf	1.289	1.491	2.250	2.250	4.591	0.000
96.55	96.55	25.98	2.689	2.931	4-FFf	1.347	1.558	2.250	2.250	4.904	0.000
102.72	102.72	26.07	2.827	3.021	4-FFf	1.404	1.624	2.250	2.250	5.218	0.000
108.89	108.89	26.17	2.971	3.117	4-FFf	1.460	1.688	2.250	2.250	5.531	0.000
115.06	115.06	26.27	3.119	3.218	4-FFf	1.514	1.751	2.250	2.250	5.844	0.000
121.23	121.23	26.37	3.274	3.324	4-FFf	1.568	1.813	2.250	2.250	6.158	0.000
127.40	127.40	26.49	3.435	3.436	4-FFf	1.622	1.874	2.250	2.250	6.471	0.000

****

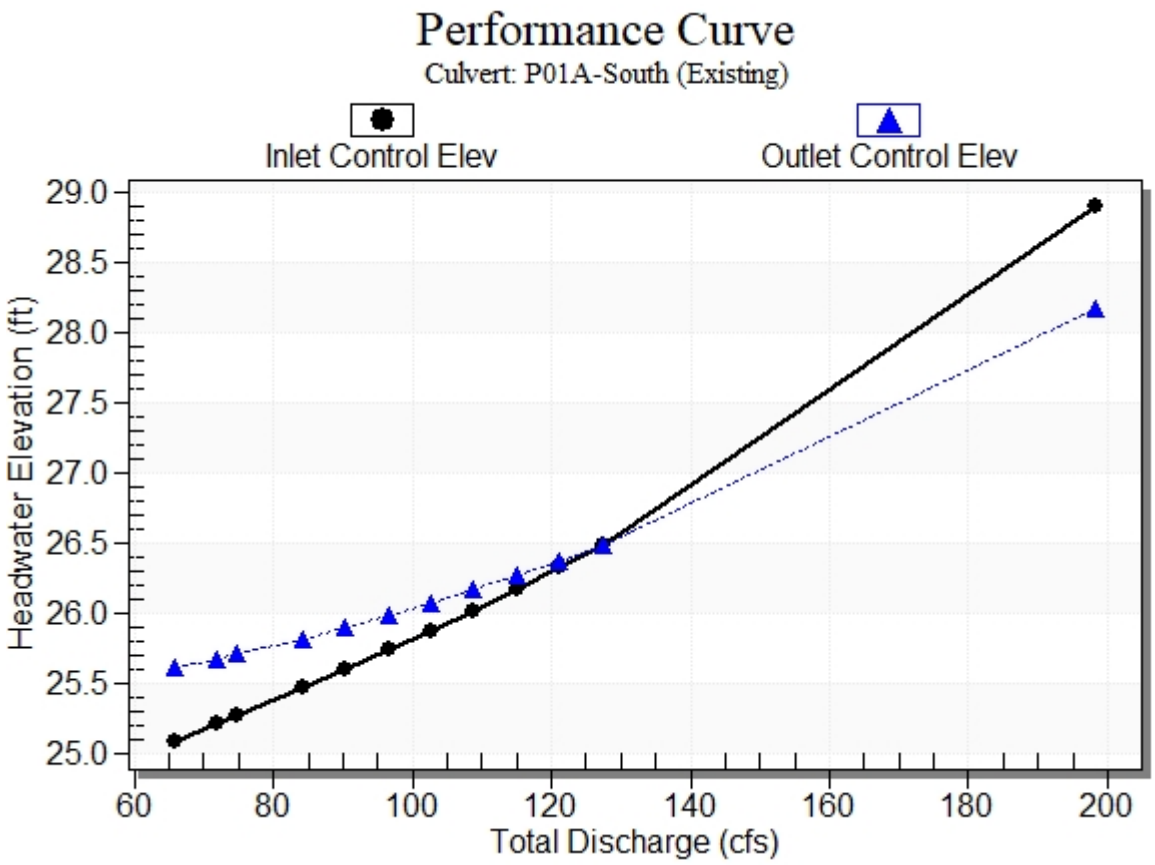
Straight Culvert

Inlet Elevation (invert): 23.05 ft, Outlet Elevation (invert): 22.77 ft

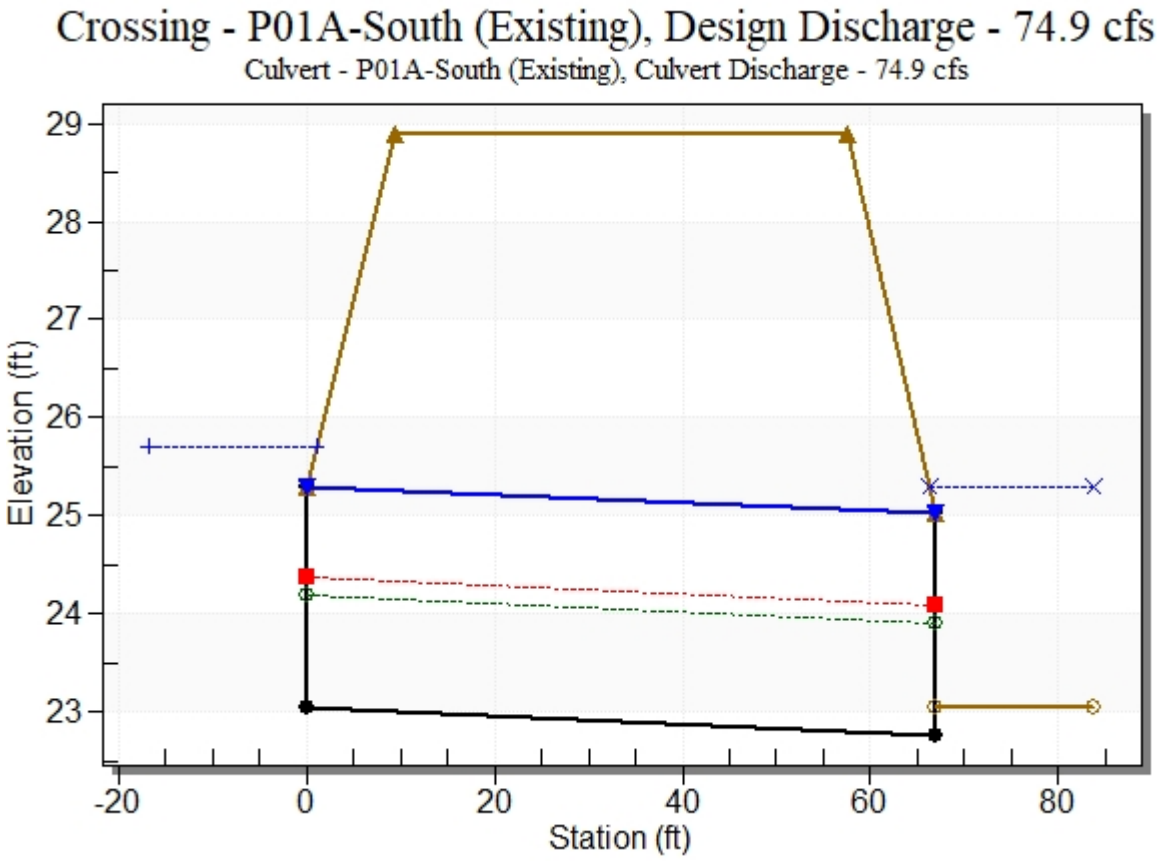
Culvert Length: 67.00 ft, Culvert Slope: 0.0042

****

Culvert Performance Curve Plot: P01A-South (Existing)



Water Surface Profile Plot for Culvert: P01A-South (Existing)



Site Data - P01A-South (Existing)

Site Data Option: Culvert Invert Data

Inlet Station: 0.00 ft

Inlet Elevation: 23.05 ft

Outlet Station: 67.00 ft

Outlet Elevation: 22.77 ft

Number of Barrels: 1

Culvert Data Summary - P01A-South (Existing)

Barrel Shape: Concrete Box

Barrel Span: 8.75 ft

Barrel Rise: 2.25 ft

Barrel Material: Concrete

Embedment: 0.00 in

Barrel Manning's n: 0.0120

Culvert Type: Straight

Inlet Configuration: Square Edge (90º) Headwall

Inlet Depression: NONE

Table 3 - Downstream Channel Rating Curve (Crossing: P01A-South (Existing))

Flow (cfs)	Water Surface Elev (ft)	Depth (ft)
65.70	25.30	2.25
71.87	25.30	2.25
74.90	25.30	2.25
84.21	25.30	2.25
90.38	25.30	2.25
96.55	25.30	2.25
102.72	25.30	2.25
108.89	25.30	2.25
115.06	25.30	2.25
121.23	25.30	2.25
127.40	25.30	2.25

Tailwater Channel Data - P01A-South (Existing)

Tailwater Channel Option: Enter Constant Tailwater Elevation

Constant Tailwater Elevation: 25.30 ft

Roadway Data for Crossing: P01A-South (Existing)

Roadway Profile Shape: Constant Roadway Elevation

Crest Length: 100.00 ft

Crest Elevation: 28.90 ft

Roadway Surface: Paved

Roadway Top Width: 48.00 ft

HY-8 Culvert Analysis Report

Crossing Discharge Data

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

Minimum Flow: 65.7 cfs

Design Flow: 74.9 cfs

Maximum Flow: 127.4 cfs

Table 1 - Summary of Culvert Flows at Crossing: P01A-South (Proposed)

Headwater Elevation (ft)	Total Discharge (cfs)	P01A-South (Proposed) Discharge (cfs)	Roadway Discharge (cfs)	Iterations
25.65	65.70	65.70	0.00	1
25.72	71.87	71.87	0.00	1
25.76	74.90	74.90	0.00	1
25.88	84.21	84.21	0.00	1
25.97	90.38	90.38	0.00	1
26.06	96.55	96.55	0.00	1
26.16	102.72	102.72	0.00	1
26.27	108.89	108.89	0.00	1
26.38	115.06	115.06	0.00	1
26.50	121.23	121.23	0.00	1
26.64	127.40	127.40	0.00	1
28.90	194.33	194.33	0.00	Overtopping

Rating Curve Plot for Crossing: P01A-South (Proposed)

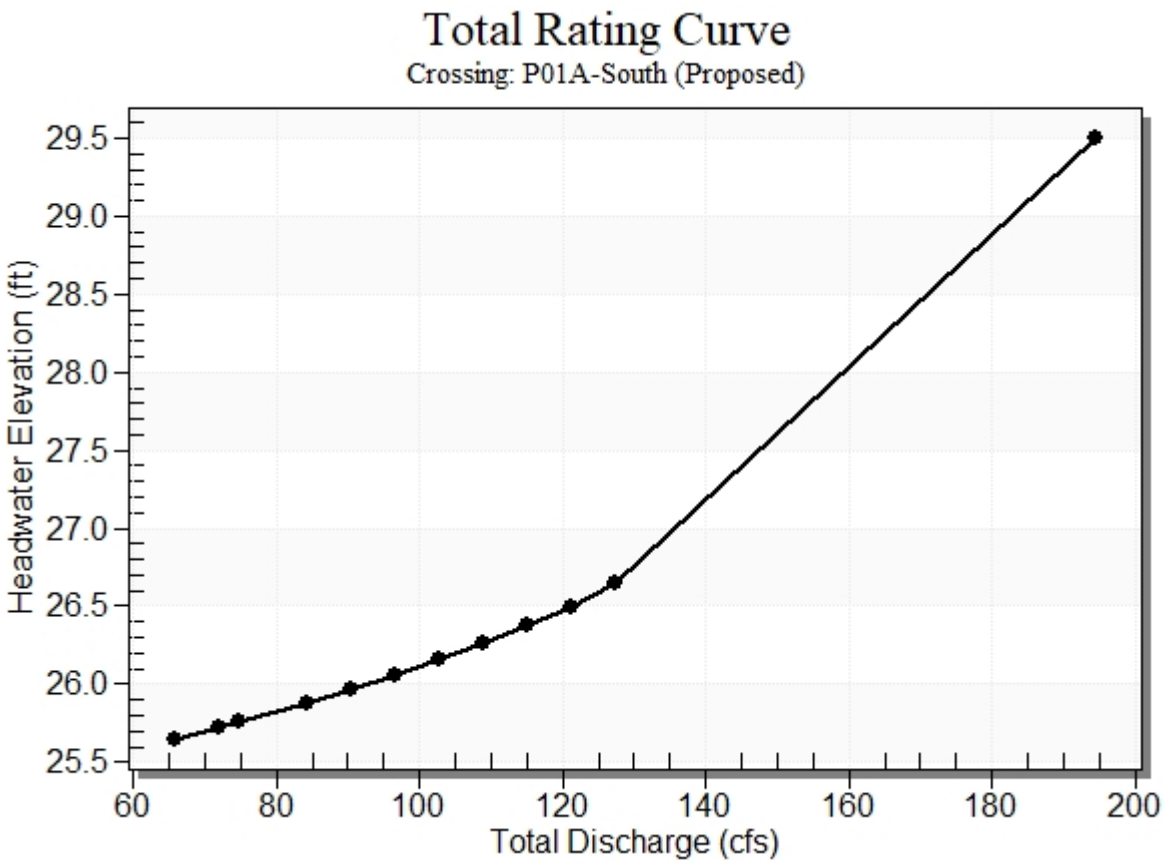


Table 2 - Culvert Summary Table: P01A-South (Proposed)

Total Discharge (cfs)	Culvert Discharge (cfs)	Headwater Elevation (ft)	Inlet Control Depth (ft)	Outlet Control Depth (ft)	Flow Type	Normal Depth (ft)	Critical Depth (ft)	Outlet Depth (ft)	Tailwater Depth (ft)	Outlet Velocity (ft/s)	Tailwater Velocity (ft/s)
65.70	65.70	25.65	2.035	2.441	1-S1f	1.061	1.205	2.250	2.250	3.337	0.000
71.87	71.87	25.72	2.164	2.511	1-S1f	1.124	1.280	2.250	2.250	3.651	0.000
74.90	74.90	25.76	2.227	2.547	1-S1f	1.155	1.315	2.250	2.250	3.804	0.000
84.21	84.21	25.88	2.422	2.668	1-S1f	1.249	1.422	2.250	2.250	4.277	0.000
90.38	90.38	25.97	2.554	2.755	4-FFf	1.308	1.491	2.250	2.250	4.591	0.000
96.55	96.55	26.06	2.689	2.849	4-FFf	1.366	1.558	2.250	2.250	4.904	0.000
102.72	102.72	26.16	2.828	2.949	4-FFf	1.425	1.624	2.250	2.250	5.218	0.000
108.89	108.89	26.27	2.971	3.056	4-FFf	1.481	1.688	2.250	2.250	5.531	0.000
115.06	115.06	26.38	3.119	3.168	4-FFf	1.536	1.751	2.250	2.250	5.844	0.000
121.23	121.23	26.50	3.274	3.287	4-FFf	1.591	1.813	2.250	2.250	6.158	0.000
127.40	127.40	26.64	3.435	3.412	4-FFf	1.646	1.874	2.250	2.250	6.471	0.000

****

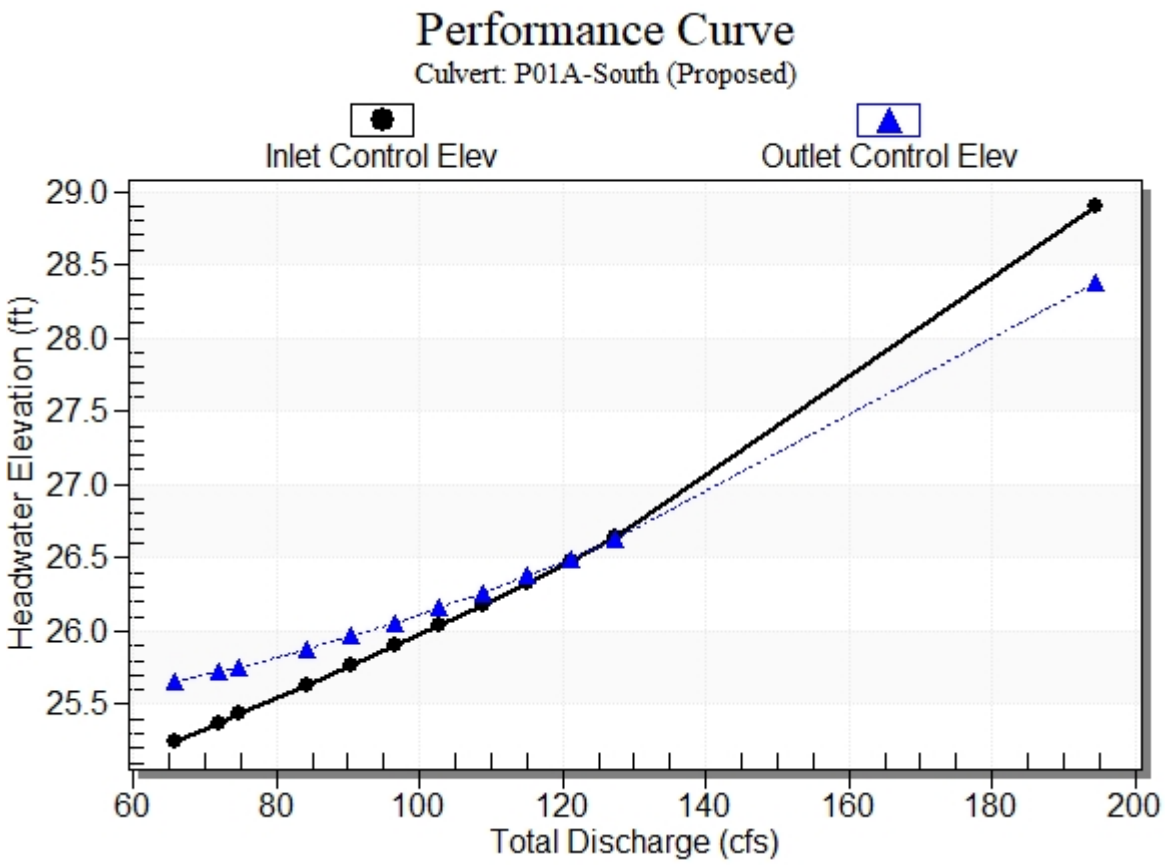
Straight Culvert

Inlet Elevation (invert): 23.21 ft, Outlet Elevation (invert): 22.77 ft

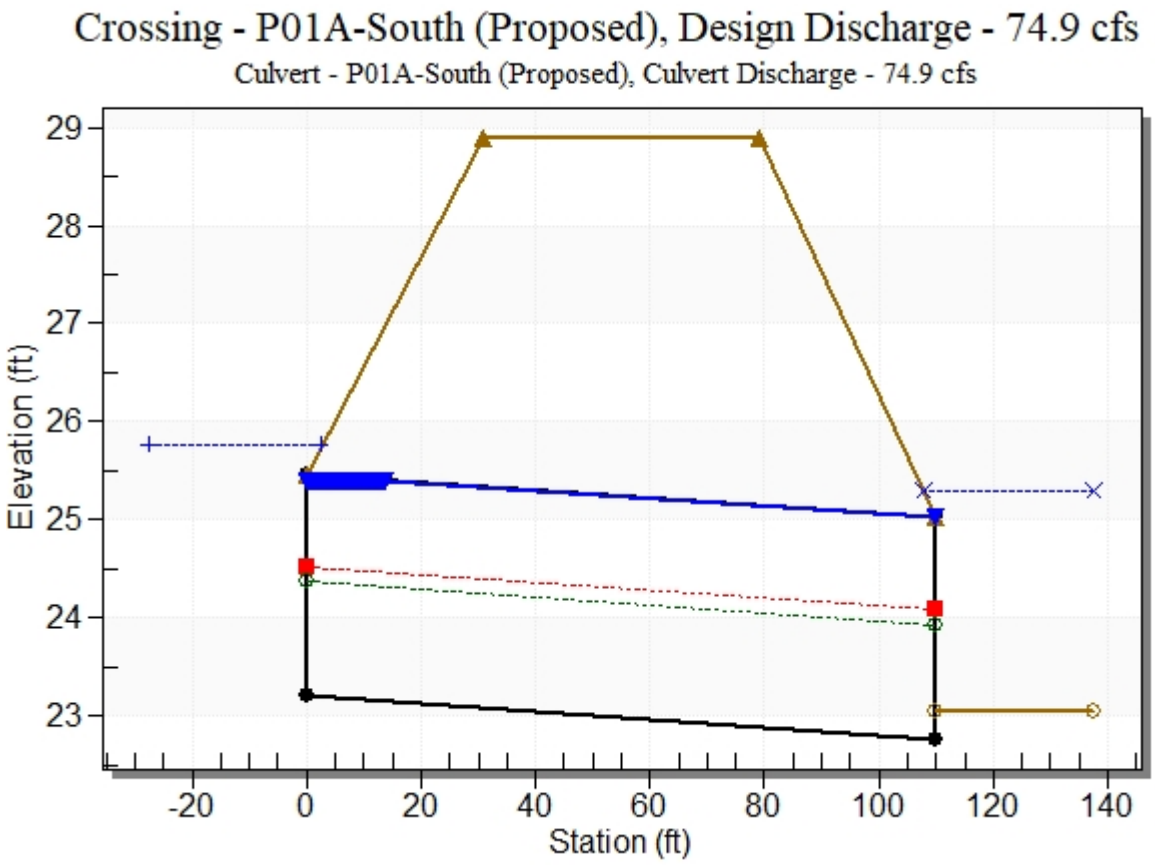
Culvert Length: 110.00 ft, Culvert Slope: 0.0040

****

Culvert Performance Curve Plot: P01A-South (Proposed)



Water Surface Profile Plot for Culvert: P01A-South (Proposed)



Site Data - P01A-South (Proposed)

Site Data Option: Culvert Invert Data

Inlet Station: 0.00 ft

Inlet Elevation: 23.21 ft

Outlet Station: 110.00 ft

Outlet Elevation: 22.77 ft

Number of Barrels: 1

Culvert Data Summary - P01A-South (Proposed)

Barrel Shape: Concrete Box

Barrel Span: 8.75 ft

Barrel Rise: 2.25 ft

Barrel Material: Concrete

Embedment: 0.00 in

Barrel Manning's n: 0.0120

Culvert Type: Straight

Inlet Configuration: Square Edge (90º) Headwall

Inlet Depression: NONE

Table 3 - Downstream Channel Rating Curve (Crossing: P01A-South (Proposed))

Flow (cfs)	Water Surface Elev (ft)	Depth (ft)
65.70	25.30	2.25
71.87	25.30	2.25
74.90	25.30	2.25
84.21	25.30	2.25
90.38	25.30	2.25
96.55	25.30	2.25
102.72	25.30	2.25
108.89	25.30	2.25
115.06	25.30	2.25
121.23	25.30	2.25
127.40	25.30	2.25

Tailwater Channel Data - P01A-South (Proposed)

Tailwater Channel Option: Enter Constant Tailwater Elevation

Constant Tailwater Elevation: 25.30 ft

Roadway Data for Crossing: P01A-South (Proposed)

Roadway Profile Shape: Constant Roadway Elevation

Crest Length: 100.00 ft

Crest Elevation: 28.90 ft

Roadway Surface: Paved

Roadway Top Width: 48.00 ft

HYDROLOGIC ANALYSIS

		DATE
made by:	DHR	11-Jul-20
checked by:		
Stantec job #:		

PROJECT: I-95 Pioneer Trail Interchange

LOCATION: P01A-01B

Rational Equation: $Q_T = X_T * C_T * i_{tc} * A_T$

Q_T = Peak Runoff for Return Period T (cfs).

X_T = Frequency Factor for Return Period T.

C_T = Average Runoff Coefficient for Return Period T.

i_{tc} = Average Rainfall Intensity for Return Period T (in/hr).

A_T = Total Watershed Drainage Area (ac).

$$C_T = \frac{C_1*A_1 + C_2*A_2 + C_3*A_3}{A_T}$$

A_1= 27.00 ac	C_1 = 0.95	Rooftops and Pavement and Surface Waters
A_2= 19.70 ac	C_2 = 0.20	Woodlands (Rolling with Sandy Soils)
A_3= 14.30 ac	C_3 = 0.25	Grass (Rolling with Sandy Soils)

A_T= 61.00 ac

C_T = 0.54

$X_{25\ yr}$ = 1.1	$X_{50\ yr}$ = 1.2	$X_{100\ yr}$ = 1.25
$i_{25\ yr}$ = 4.0 in/hr	$i_{50\ yr}$ = 4.4 in/hr	$i_{100\ yr}$ = 4.8 in/hr

i = based on time of concentration from Ditch Calculations -> t_c = 53.8 min

$Q_{25\ yr}$ = 145.2 cfs	**$Q_{50\ yr}$ = 173.9 cfs**	**$Q_{100\ yr}$ = 199.8 cfs**

$Q_{500\ yr}$ = 1.7 x $Q_{100\ yr}$ = **339.7 cfs**

HY-8 Culvert Analysis Report

Crossing Discharge Data

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

Minimum Flow: 173.9 cfs

Design Flow: 199.8 cfs

Maximum Flow: 339.7 cfs

Table 1 - Summary of Culvert Flows at Crossing: P01A-01B (Existing)

Headwater Elevation (ft)	Total Discharge (cfs)	P01A-01B (Existing) Discharge (cfs)	Roadway Discharge (cfs)	Iterations
30.95	173.90	171.84	2.04	7
31.03	190.48	173.31	16.80	7
31.07	199.80	173.92	25.51	5
31.15	223.64	175.23	48.05	5
31.19	240.22	176.01	63.78	4
31.24	256.80	176.73	79.79	4
31.28	273.38	177.40	95.81	4
31.31	289.96	178.03	111.82	4
31.35	306.54	178.62	127.49	3
31.38	323.12	179.19	143.53	3
31.42	339.70	179.75	159.63	3
30.92	171.37	171.37	0.00	Overtopping

Rating Curve Plot for Crossing: P01A-01B (Existing)

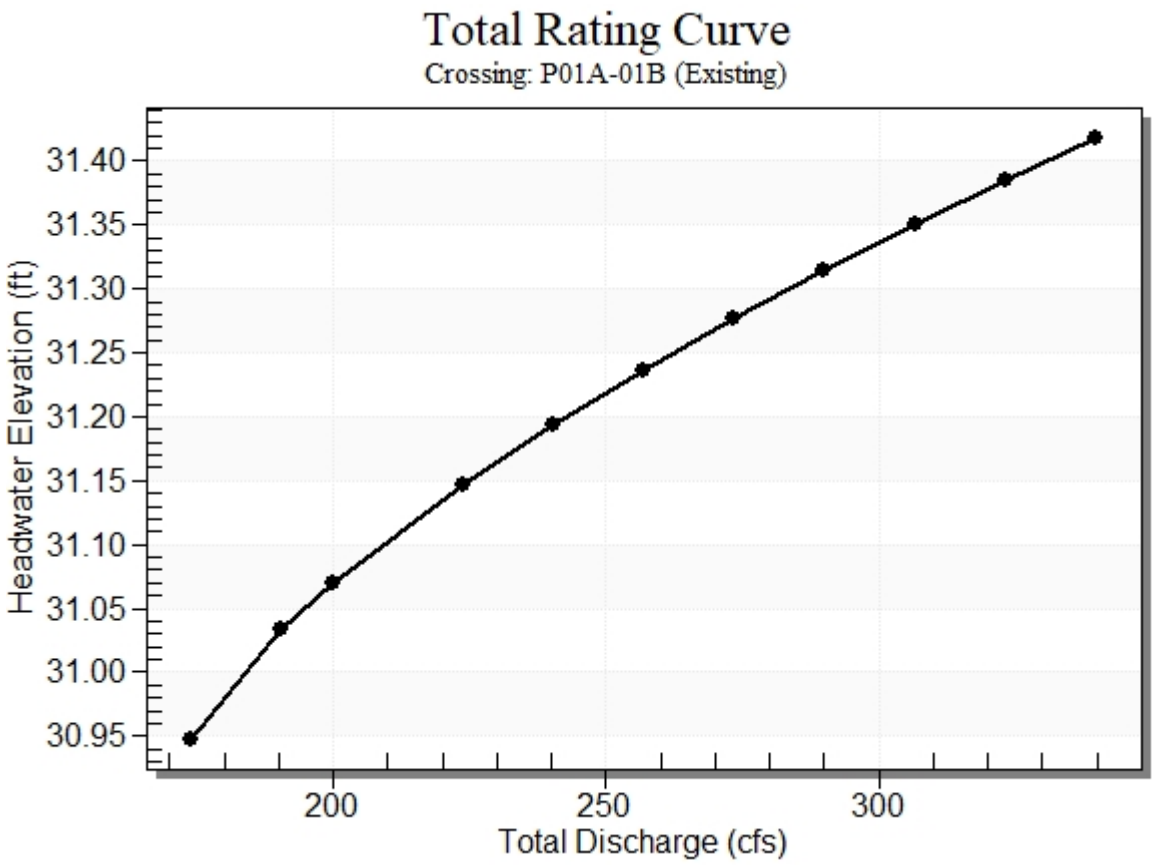


Table 2 - Culvert Summary Table: P01A-01B (Existing)

Total Discharge (cfs)	Culvert Discharge (cfs)	Headwater Elevation (ft)	Inlet Control Depth (ft)	Outlet Control Depth (ft)	Flow Type	Normal Depth (ft)	Critical Depth (ft)	Outlet Depth (ft)	Tailwater Depth (ft)	Outlet Velocity (ft/s)	Tailwater Velocity (ft/s)
173.90	171.84	30.95	5.641	6.577	4-FFf	1.583	1.542	1.583	1.580	11.251	0.000
190.48	173.31	31.03	5.724	6.663	4-FFf	1.583	1.537	1.583	1.580	11.347	0.000
199.80	173.92	31.07	5.759	6.699	4-FFf	1.583	1.535	1.583	1.580	11.387	0.000
223.64	175.23	31.15	5.834	6.776	4-FFf	1.583	1.583	1.583	1.580	11.473	0.000
240.22	176.01	31.19	5.879	6.823	4-FFf	1.583	1.583	1.583	1.580	11.524	0.000
256.80	176.73	31.24	5.921	6.866	4-FFf	1.583	1.583	1.583	1.580	11.571	0.000
273.38	177.40	31.28	5.960	6.906	4-FFf	1.583	1.583	1.583	1.580	11.615	0.000
289.96	178.03	31.31	5.996	6.944	4-FFf	1.583	1.583	1.583	1.580	11.657	0.000
306.54	178.62	31.35	6.031	6.980	4-FFf	1.583	1.583	1.583	1.580	11.695	0.000
323.12	179.19	31.38	6.065	7.014	4-FFf	1.583	1.583	1.583	1.580	11.733	0.000
339.70	179.75	31.42	6.098	7.048	4-FFf	1.583	1.583	1.583	1.580	11.769	0.000

****

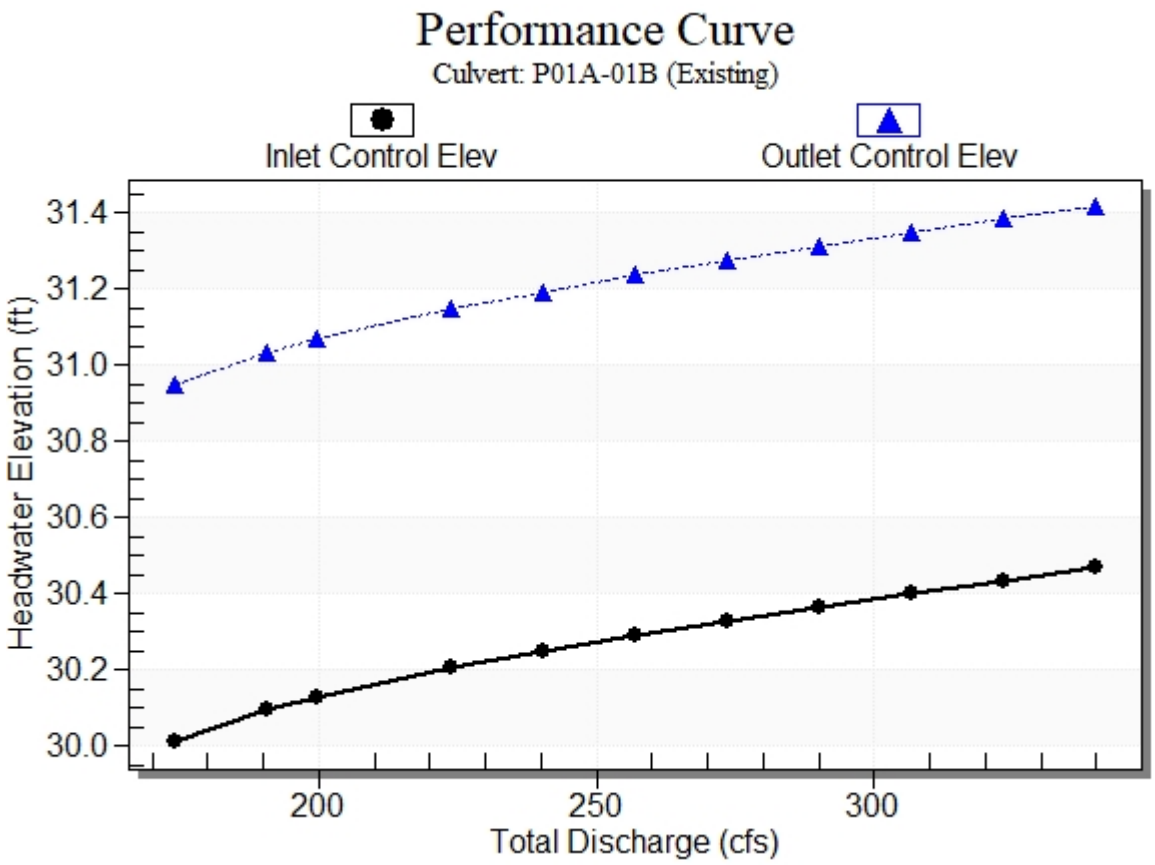
Straight Culvert

Inlet Elevation (invert): 24.37 ft, Outlet Elevation (invert): 24.15 ft

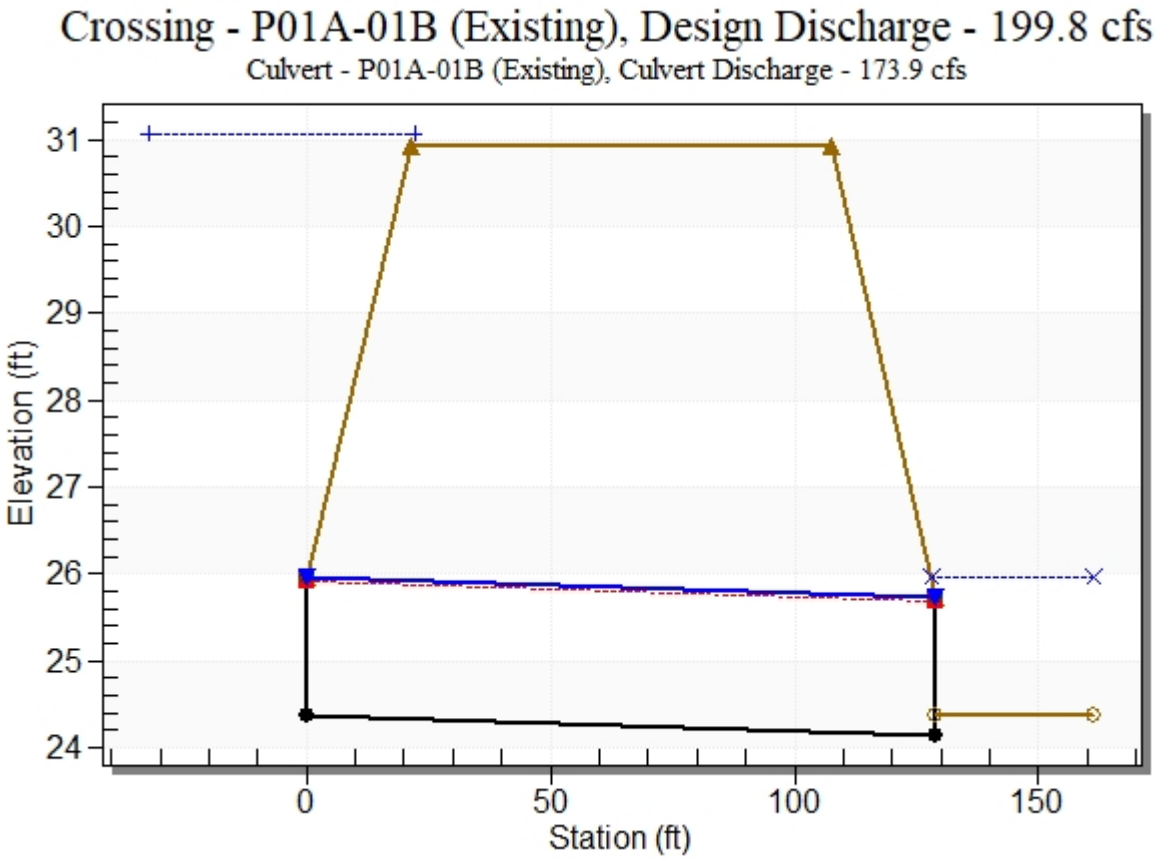
Culvert Length: 129.00 ft, Culvert Slope: 0.0017

****

Culvert Performance Curve Plot: P01A-01B (Existing)



Water Surface Profile Plot for Culvert: P01A-01B (Existing)



Site Data - P01A-01B (Existing)

Site Data Option: Culvert Invert Data

Inlet Station: 0.00 ft

Inlet Elevation: 24.37 ft

Outlet Station: 129.00 ft

Outlet Elevation: 24.15 ft

Number of Barrels: 5

Culvert Data Summary - P01A-01B (Existing)

Barrel Shape: Elliptical

Barrel Span: 30.00 in

Barrel Rise: 19.00 in

Barrel Material: Concrete

Embedment: 0.00 in

Barrel Manning's n: 0.0120

Culvert Type: Straight

Inlet Configuration: Square Edge with Headwall

Inlet Depression: NONE

Table 3 - Downstream Channel Rating Curve (Crossing: P01A-01B (Existing))

Flow (cfs)	Water Surface Elev (ft)	Depth (ft)
173.90	25.95	1.58
190.48	25.95	1.58
199.80	25.95	1.58
223.64	25.95	1.58
240.22	25.95	1.58
256.80	25.95	1.58
273.38	25.95	1.58
289.96	25.95	1.58
306.54	25.95	1.58
323.12	25.95	1.58
339.70	25.95	1.58

Tailwater Channel Data - P01A-01B (Existing)

Tailwater Channel Option: Enter Constant Tailwater Elevation

Constant Tailwater Elevation: 25.95 ft

Roadway Data for Crossing: P01A-01B (Existing)

Roadway Profile Shape: Constant Roadway Elevation

Crest Length: 150.00 ft

Crest Elevation: 30.92 ft

Roadway Surface: Paved

Roadway Top Width: 86.00 ft

HY-8 Culvert Analysis Report

Crossing Discharge Data

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

Minimum Flow: 173.9 cfs

Design Flow: 199.8 cfs

Maximum Flow: 339.7 cfs

Table 1 - Summary of Culvert Flows at Crossing: P01A-01B (Proposed)

Headwater Elevation (ft)	Total Discharge (cfs)	P01A-01B (Proposed) Discharge (cfs)	Roadway Discharge (cfs)	Iterations
29.61	173.90	173.90	0.00	1
30.35	190.48	190.48	0.00	1
30.79	199.80	199.80	0.00	1
31.04	223.64	204.97	18.36	10
31.10	240.22	206.15	33.61	5
31.15	256.80	207.18	49.39	5
31.20	273.38	208.08	64.89	4
31.24	289.96	208.93	80.77	4
31.28	306.54	209.71	96.66	4
31.32	323.12	210.45	112.56	4
31.35	339.70	211.14	128.14	3
30.92	202.54	202.54	0.00	Overtopping

Rating Curve Plot for Crossing: P01A-01B (Proposed)

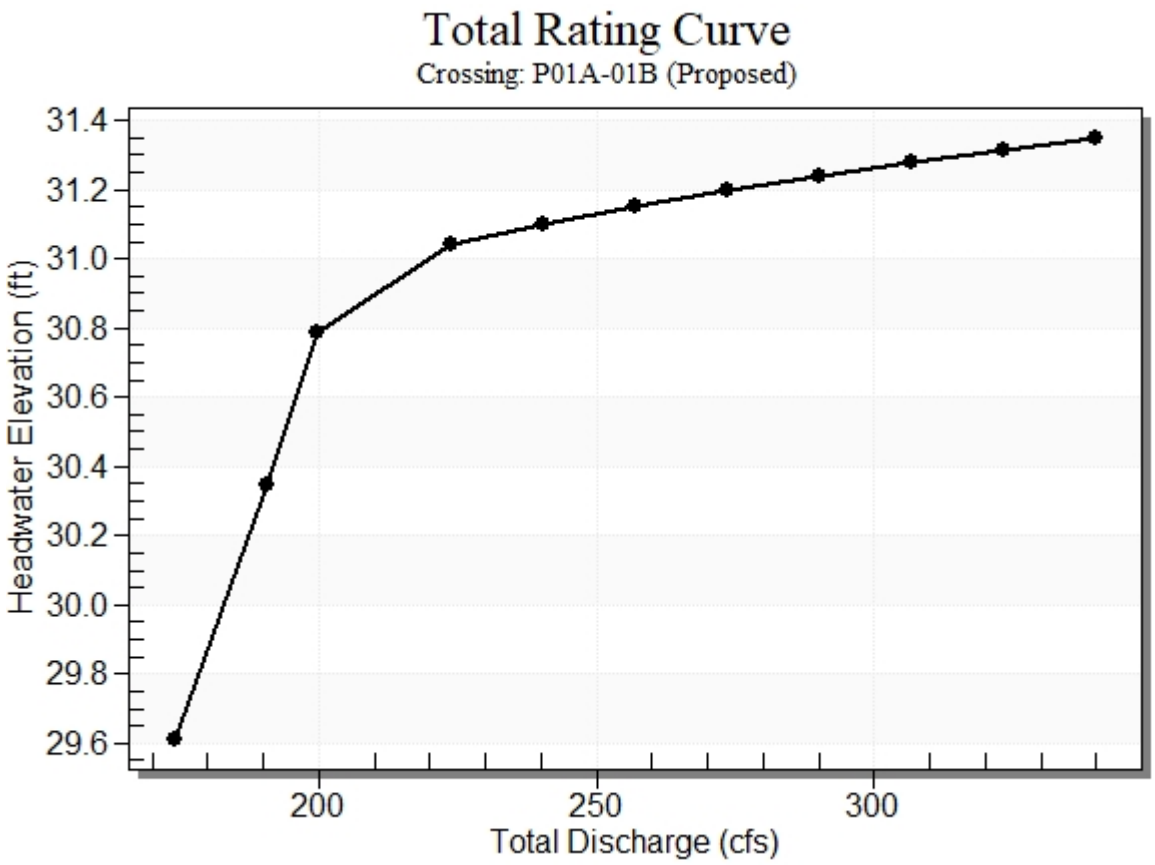


Table 2 - Culvert Summary Table: P01A-01B (Proposed)

Total Discharge (cfs)	Culvert Discharge (cfs)	Headwater Elevation (ft)	Inlet Control Depth (ft)	Outlet Control Depth (ft)	Flow Type	Normal Depth (ft)	Critical Depth (ft)	Outlet Depth (ft)	Tailwater Depth (ft)	Outlet Velocity (ft/s)	Tailwater Velocity (ft/s)
173.90	173.90	29.61	4.272	5.244	4-FFf	1.583	1.502	1.583	1.580	9.614	0.000
190.48	190.48	30.35	4.929	5.976	4-FFf	1.583	1.380	1.583	1.580	10.530	0.000
199.80	199.80	30.79	5.344	6.416	4-FFf	1.583	1.583	1.583	1.580	11.046	0.000
223.64	204.97	31.04	5.583	6.670	4-FFf	1.583	1.546	1.583	1.580	11.332	0.000
240.22	206.15	31.10	5.638	6.729	4-FFf	1.583	1.543	1.583	1.580	11.397	0.000
256.80	207.18	31.15	5.687	6.780	4-FFf	1.583	1.540	1.583	1.580	11.454	0.000
273.38	208.08	31.20	5.729	6.826	4-FFf	1.583	1.536	1.583	1.580	11.504	0.000
289.96	208.93	31.24	5.770	6.868	4-FFf	1.583	1.583	1.583	1.580	11.550	0.000
306.54	209.71	31.28	5.807	6.908	4-FFf	1.583	1.583	1.583	1.580	11.594	0.000
323.12	210.45	31.32	5.842	6.946	4-FFf	1.583	1.583	1.583	1.580	11.635	0.000
339.70	211.14	31.35	5.875	6.981	4-FFf	1.583	1.583	1.583	1.580	11.673	0.000

****

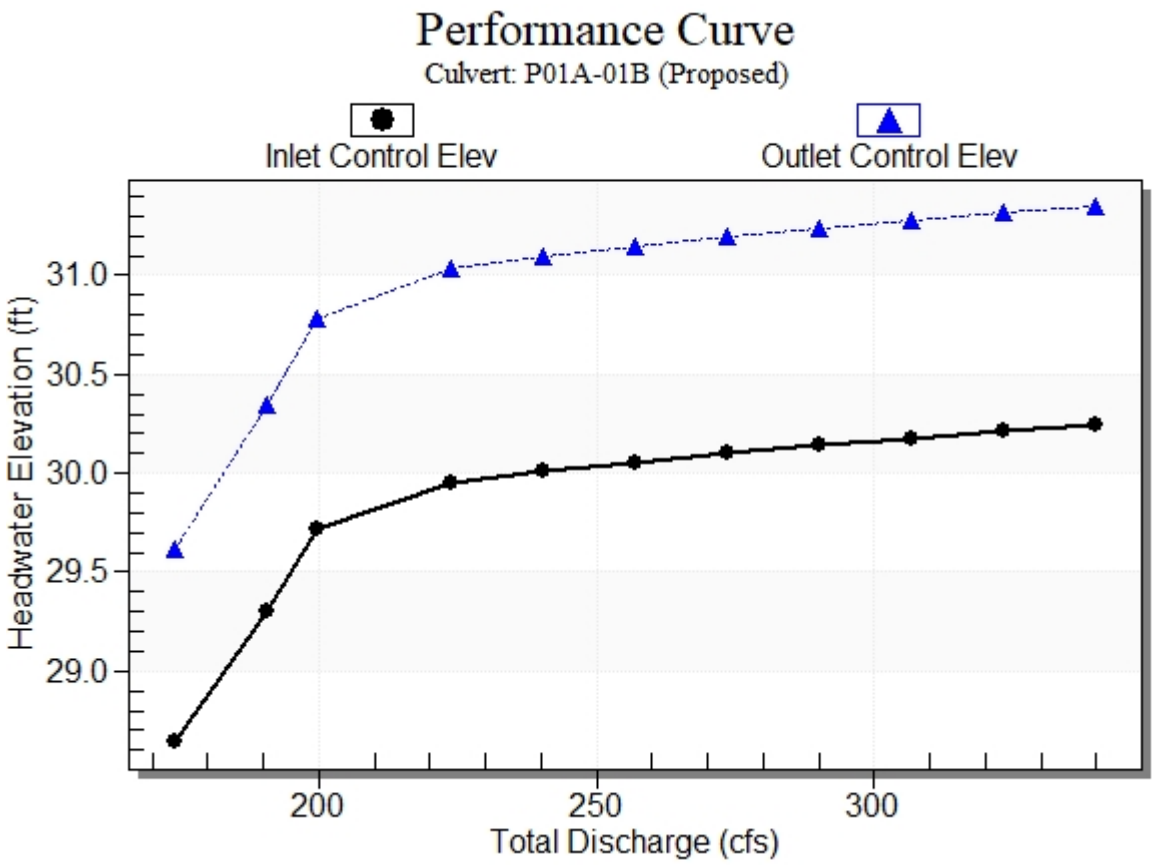
Straight Culvert

Inlet Elevation (invert): 24.37 ft, Outlet Elevation (invert): 24.15 ft

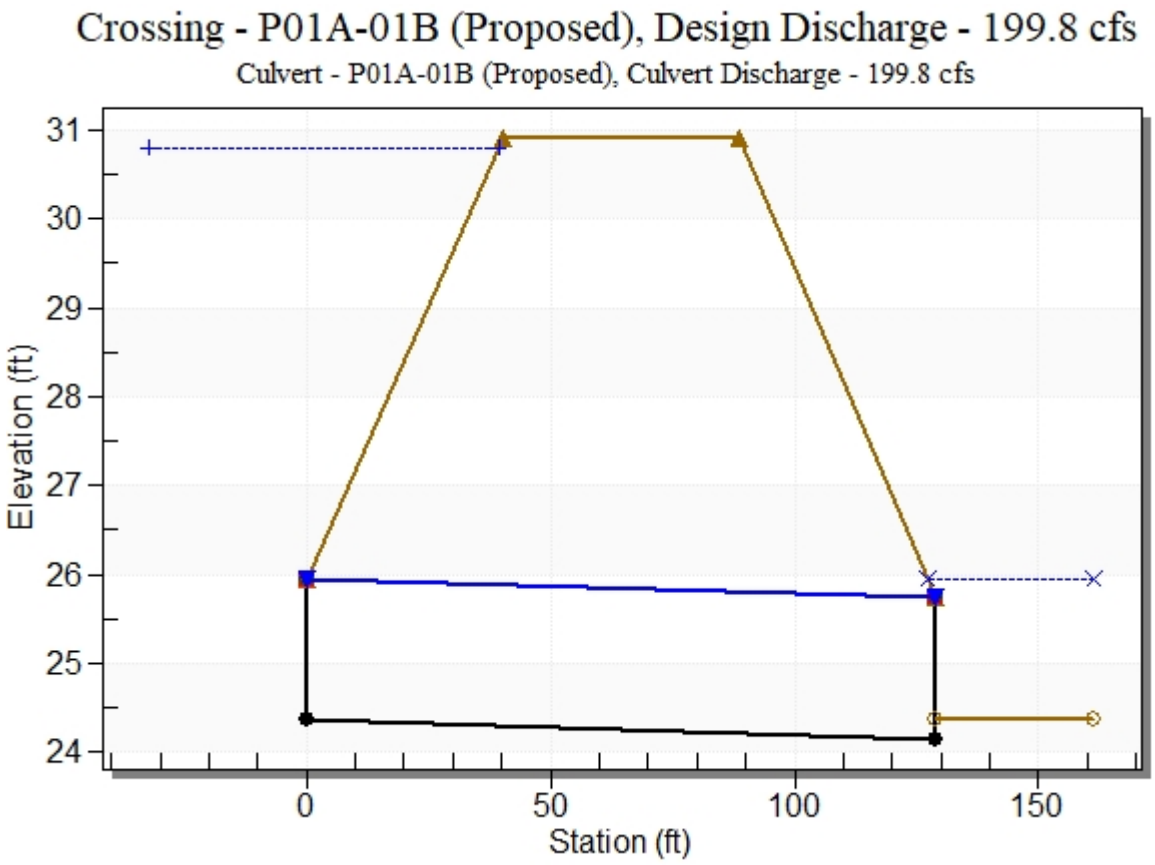
Culvert Length: 129.00 ft, Culvert Slope: 0.0017

****

Culvert Performance Curve Plot: P01A-01B (Proposed)



Water Surface Profile Plot for Culvert: P01A-01B (Proposed)



Site Data - P01A-01B (Proposed)

Site Data Option: Culvert Invert Data

Inlet Station: 0.00 ft

Inlet Elevation: 24.37 ft

Outlet Station: 129.00 ft

Outlet Elevation: 24.15 ft

Number of Barrels: 6

Culvert Data Summary - P01A-01B (Proposed)

Barrel Shape: Elliptical

Barrel Span: 30.00 in

Barrel Rise: 19.00 in

Barrel Material: Concrete

Embedment: 0.00 in

Barrel Manning's n: 0.0120

Culvert Type: Straight

Inlet Configuration: Square Edge with Headwall

Inlet Depression: NONE

Table 3 - Downstream Channel Rating Curve (Crossing: P01A-01B (Proposed))

Flow (cfs)	Water Surface Elev (ft)	Depth (ft)
173.90	25.95	1.58
190.48	25.95	1.58
199.80	25.95	1.58
223.64	25.95	1.58
240.22	25.95	1.58
256.80	25.95	1.58
273.38	25.95	1.58
289.96	25.95	1.58
306.54	25.95	1.58
323.12	25.95	1.58
339.70	25.95	1.58

Tailwater Channel Data - P01A-01B (Proposed)

Tailwater Channel Option: Enter Constant Tailwater Elevation

Constant Tailwater Elevation: 25.95 ft

Roadway Data for Crossing: P01A-01B (Proposed)

Roadway Profile Shape: Constant Roadway Elevation

Crest Length: 150.00 ft

Crest Elevation: 30.92 ft

Roadway Surface: Paved

Roadway Top Width: 48.00 ft

HYDROLOGIC ANALYSIS

		DATE
made by:	DHR	11-Jul-20
checked by:		
Stantec job #:		

PROJECT: I-95 Pioneer Trail Interchange

LOCATION: P01B-Offsite

Rational Equation: $Q_T = X_T * C_T * i_{tc} * A_T$

Q_T = Peak Runoff for Return Period T (cfs).

X_T = Frequency Factor for Return Period T.

C_T = Average Runoff Coefficient for Return Period T.

i_{tc} = Average Rainfall Intensity for Return Period T (in/hr).

A_T = Total Watershed Drainage Area (ac).

$$C_T = \frac{C_1*A_1 + C_2*A_2 + C_3*A_3}{A_T}$$

A_1= 7.46 ac	C_1 = 0.95	Rooftops and Pavement
A_2= 0.00 ac	C_2 = 0.20	Woodlands (Rolling with Sandy Soils)
A_3= 29.22 ac	C_3 = 0.25	Grass (Rolling with Sandy Soils)

A_T= 36.68 ac

C_T = 0.39

$X_{25\ yr}$ = 1.1	$X_{50\ yr}$ = 1.2	$X_{100\ yr}$ = 1.25
$i_{25\ yr}$ = 6.0 in/hr	$i_{50\ yr}$ = 6.6 in/hr	$i_{100\ yr}$ = 7.3 in/hr

i = based on time of concentration from Ditch Calculations -> t_c = 23.5 min

$Q_{25\ yr}$ = 95.5 cfs	**$Q_{50\ yr}$ = 113.6 cfs**	**$Q_{100\ yr}$ = 130.4 cfs**

$Q_{500\ yr}$ = 1.7 x $Q_{100\ yr}$ = **221.7 cfs**

HY-8 Culvert Analysis Report

Crossing Discharge Data

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

Minimum Flow: 113.6 cfs

Design Flow: 130.4 cfs

Maximum Flow: 221.7 cfs

Table 1 - Summary of Culvert Flows at Crossing: P01B-Offsite (Existing)

Headwater Elevation (ft)	Total Discharge (cfs)	P01B-Offsite (Existimg) Discharge (cfs)	Roadway Discharge (cfs)	Iterations
29.29	113.60	64.96	47.74	10
29.31	124.41	65.07	58.50	3
29.31	130.40	65.14	64.80	3
29.33	146.03	65.28	80.15	3
29.35	156.84	65.38	91.10	3
29.36	167.65	65.47	101.92	3
29.37	178.46	65.56	112.71	3
29.38	189.27	65.65	123.49	3
29.39	200.08	65.72	133.25	2
29.40	210.89	65.81	144.94	3
29.41	221.70	65.88	155.01	2
29.19	64.17	64.17	0.00	Overtopping

Rating Curve Plot for Crossing: P01B-Offsite (Existing)

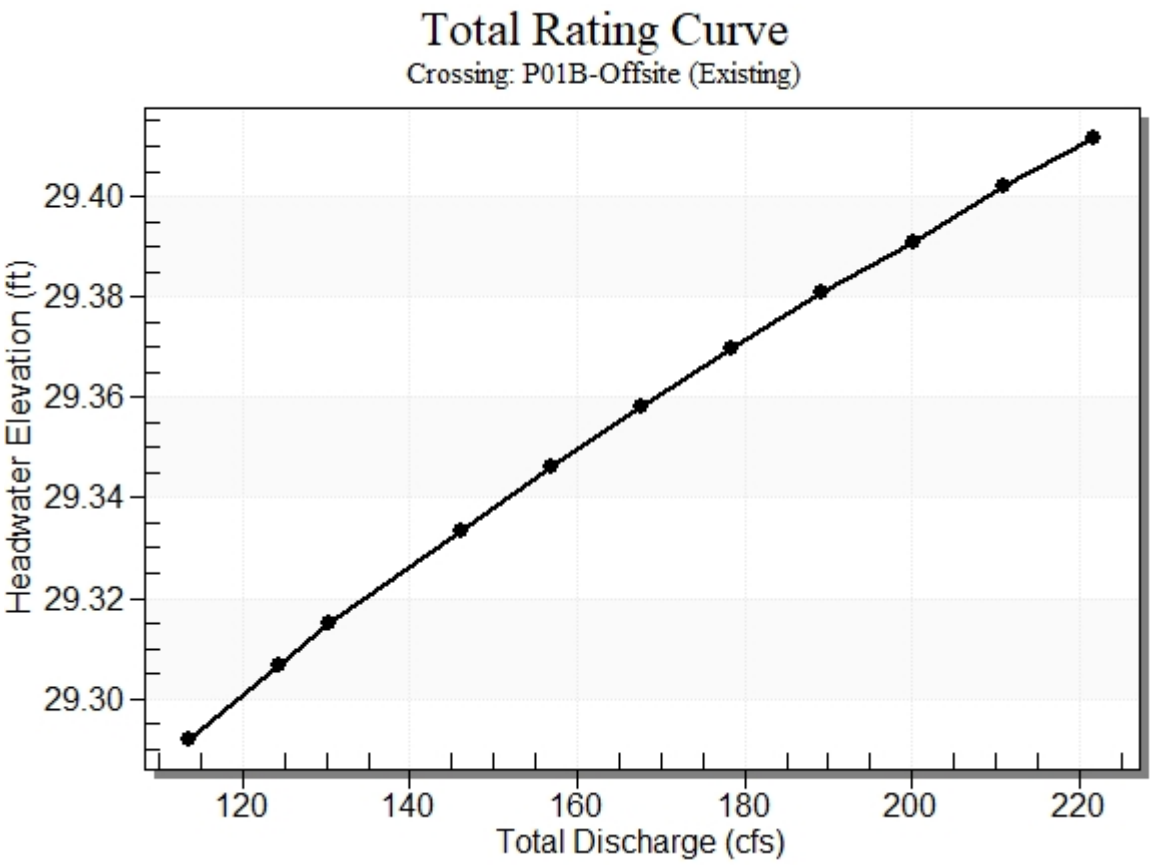


Table 2 - Culvert Summary Table: P01B-Offsite (Existimg)

Total Discharge (cfs)	Culvert Discharge (cfs)	Headwater Elevation (ft)	Inlet Control Depth (ft)	Outlet Control Depth (ft)	Flow Type	Normal Depth (ft)	Critical Depth (ft)	Outlet Depth (ft)	Tailwater Depth (ft)	Outlet Velocity (ft/s)	Tailwater Velocity (ft/s)
113.60	64.96	29.29	5.339	7.202	4-FFf	3.000	2.584	3.000	3.000	9.190	0.000
124.41	65.07	29.31	5.350	7.216	4-FFf	3.000	2.585	3.000	3.000	9.206	0.000
130.40	65.14	29.31	5.357	7.224	4-FFf	3.000	2.586	3.000	3.000	9.215	0.000
146.03	65.28	29.33	5.372	7.243	4-FFf	3.000	2.589	3.000	3.000	9.235	0.000
156.84	65.38	29.35	5.382	7.256	4-FFf	3.000	2.590	3.000	3.000	9.249	0.000
167.65	65.47	29.36	5.391	7.268	4-FFf	3.000	2.592	3.000	3.000	9.262	0.000
178.46	65.56	29.37	5.400	7.279	4-FFf	3.000	2.593	3.000	3.000	9.275	0.000
189.27	65.65	29.38	5.409	7.290	4-FFf	3.000	2.594	3.000	3.000	9.287	0.000
200.08	65.72	29.39	5.417	7.300	4-FFf	3.000	2.596	3.000	3.000	9.298	0.000
210.89	65.81	29.40	5.426	7.312	4-FFf	3.000	2.597	3.000	3.000	9.310	0.000
221.70	65.88	29.41	5.434	7.321	4-FFf	3.000	2.598	3.000	3.000	9.320	0.000

****

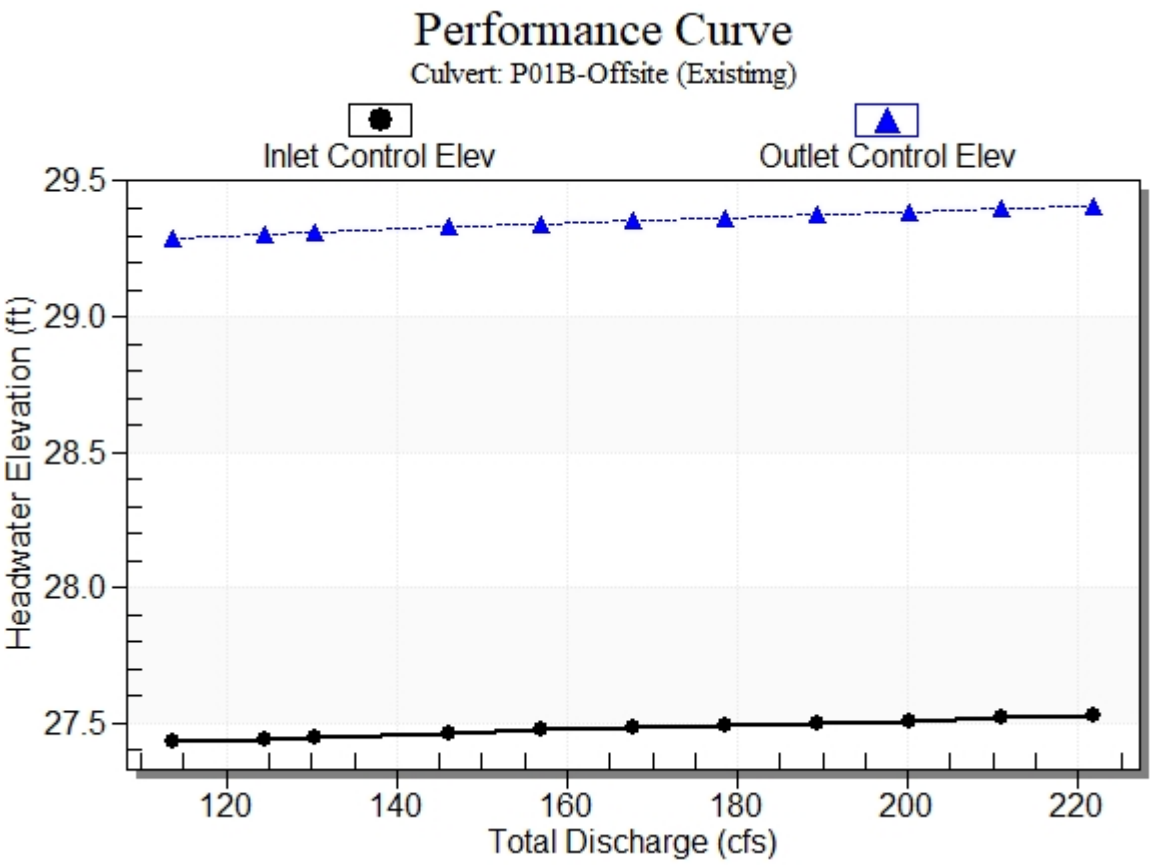
Straight Culvert

Inlet Elevation (invert): 22.09 ft, Outlet Elevation (invert): 21.94 ft

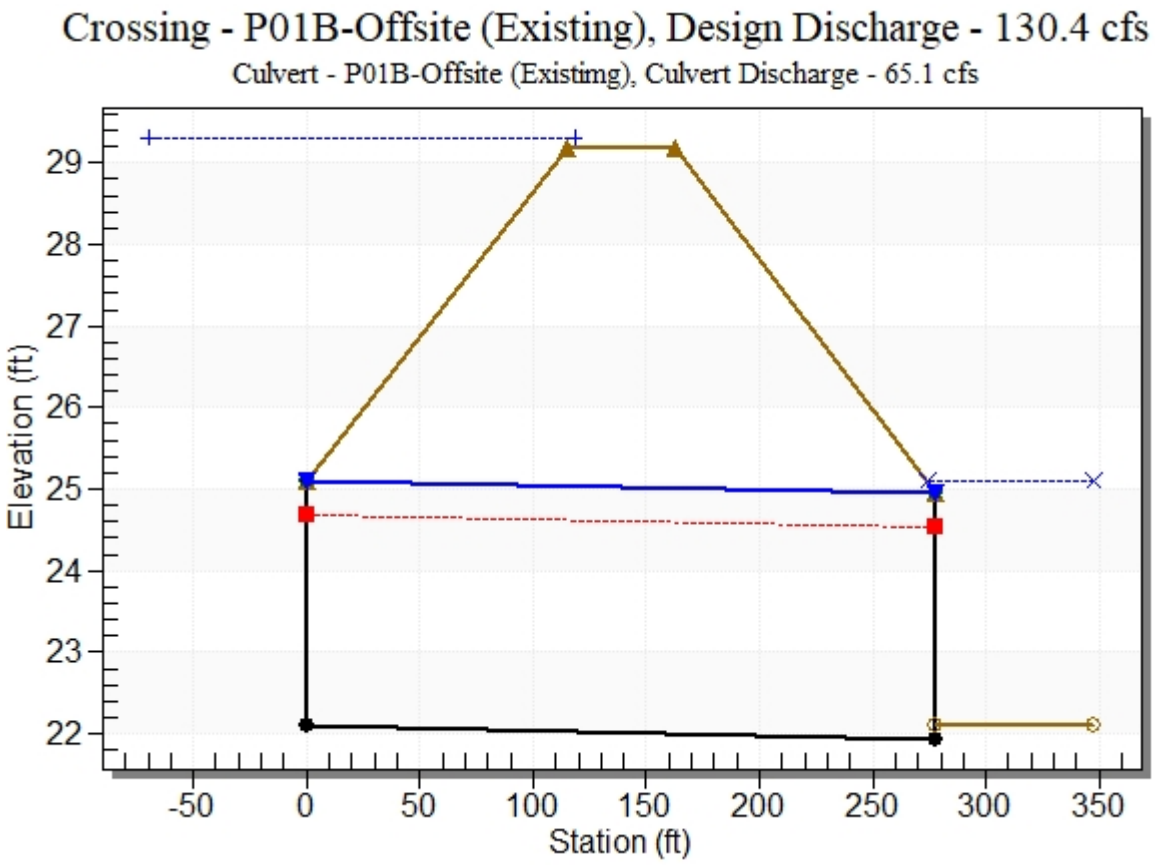
Culvert Length: 278.00 ft, Culvert Slope: 0.0005

****

Culvert Performance Curve Plot: P01B-Offsite (Existimg)



Water Surface Profile Plot for Culvert: P01B-Offsite (Existimg)



Site Data - P01B-Offsite (Existimg)

Site Data Option: Culvert Invert Data

Inlet Station: 0.00 ft

Inlet Elevation: 22.09 ft

Outlet Station: 278.00 ft

Outlet Elevation: 21.94 ft

Number of Barrels: 1

Culvert Data Summary - P01B-Offsite (Existimg)

Barrel Shape: Circular

Barrel Diameter: 3.00 ft

Barrel Material: Concrete

Embedment: 0.00 in

Barrel Manning's n: 0.0120

Culvert Type: Straight

Inlet Configuration: Square Edge with Headwall

Inlet Depression: NONE

Table 3 - Downstream Channel Rating Curve (Crossing: P01B-Offsite (Existing))

Flow (cfs)	Water Surface Elev (ft)	Depth (ft)
113.60	25.09	3.00
124.41	25.09	3.00
130.40	25.09	3.00
146.03	25.09	3.00
156.84	25.09	3.00
167.65	25.09	3.00
178.46	25.09	3.00
189.27	25.09	3.00
200.08	25.09	3.00
210.89	25.09	3.00
221.70	25.09	3.00

Tailwater Channel Data - P01B-Offsite (Existing)

Tailwater Channel Option: Enter Constant Tailwater Elevation

Constant Tailwater Elevation: 25.09 ft

Roadway Data for Crossing: P01B-Offsite (Existing)

Roadway Profile Shape: Constant Roadway Elevation

Crest Length: 500.00 ft

Crest Elevation: 29.19 ft

Roadway Surface: Paved

Roadway Top Width: 48.00 ft

HY-8 Culvert Analysis Report

Crossing Discharge Data

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

Minimum Flow: 113.6 cfs

Design Flow: 130.4 cfs

Maximum Flow: 221.7 cfs

Table 1 - Summary of Culvert Flows at Crossing: P01B-Offsite (Proposed)

Headwater Elevation (ft)	Total Discharge (cfs)	P01B-Offsite (Proposed) Discharge (cfs)	Roadway Discharge (cfs)	Iterations
28.93	113.60	113.60	0.00	1
29.22	124.41	117.75	5.91	23
29.23	130.40	117.97	11.92	5
29.26	146.03	118.36	27.27	5
29.28	156.84	118.36	38.03	4
29.29	167.65	118.56	48.14	3
29.31	178.46	118.81	58.83	3
29.32	189.27	119.04	69.61	3
29.33	200.08	119.28	80.37	3
29.35	210.89	119.48	91.08	3
29.36	221.70	119.68	101.77	3
29.19	117.38	117.38	0.00	Overtopping

Rating Curve Plot for Crossing: P01B-Offsite (Proposed)

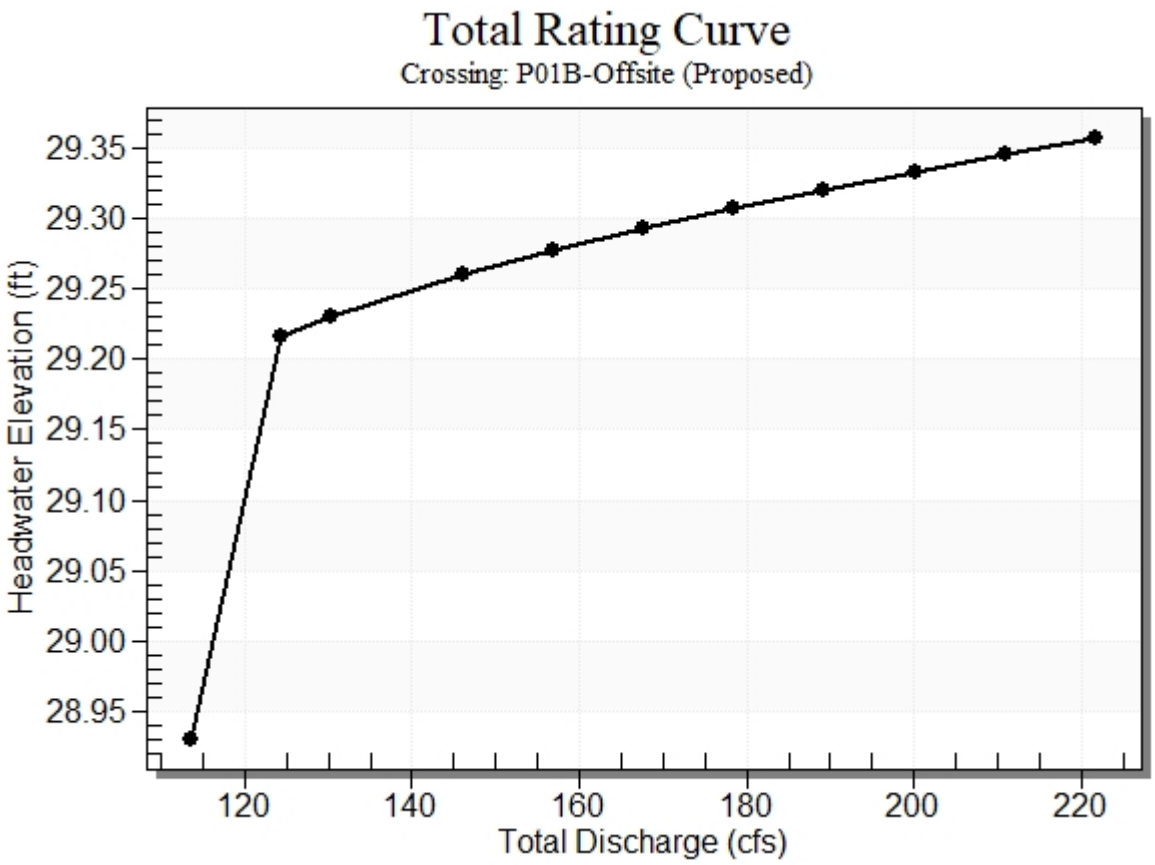


Table 2 - Culvert Summary Table: P01B-Offsite (Proposed)

Total Discharge (cfs)	Culvert Discharge (cfs)	Headwater Elevation (ft)	Inlet Control Depth (ft)	Outlet Control Depth (ft)	Flow Type	Normal Depth (ft)	Critical Depth (ft)	Outlet Depth (ft)	Tailwater Depth (ft)	Outlet Velocity (ft/s)	Tailwater Velocity (ft/s)
113.60	113.60	28.93	5.912	6.840	7-M2c	4.000	3.215	3.215	3.000	10.495	0.000
124.41	117.75	29.22	6.147	7.125	7-M2c	4.000	3.267	3.267	3.000	10.715	0.000
130.40	117.97	29.23	6.160	7.141	7-M2c	4.000	3.270	3.270	3.000	10.726	0.000
146.03	118.36	29.26	6.183	7.168	7-M2c	4.000	3.275	3.275	3.000	10.747	0.000
156.84	118.36	29.28	6.183	7.191	7-M2c	4.000	3.275	3.275	3.000	10.747	0.000
167.65	118.56	29.29	6.195	7.203	7-M2c	4.000	3.278	3.278	3.000	10.758	0.000
178.46	118.81	29.31	6.209	7.217	7-M2c	4.000	3.281	3.281	3.000	10.772	0.000
189.27	119.04	29.32	6.223	7.231	7-M2c	4.000	3.283	3.283	3.000	10.784	0.000
200.08	119.28	29.33	6.236	7.245	7-M2c	4.000	3.286	3.286	3.000	10.797	0.000
210.89	119.48	29.35	6.248	7.257	7-M2c	4.000	3.289	3.289	3.000	10.808	0.000
221.70	119.68	29.36	6.260	7.268	7-M2c	4.000	3.291	3.291	3.000	10.818	0.000

****

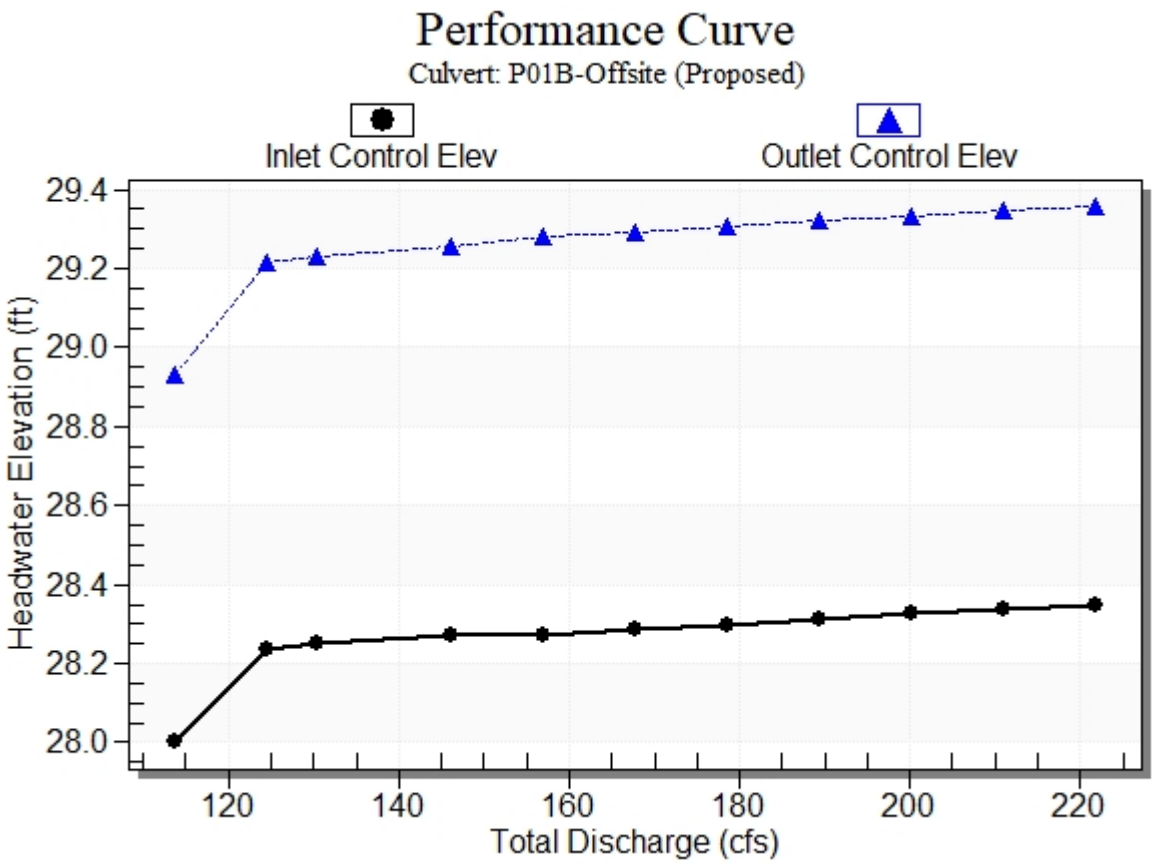
Straight Culvert

Inlet Elevation (invert): 22.09 ft, Outlet Elevation (invert): 21.94 ft

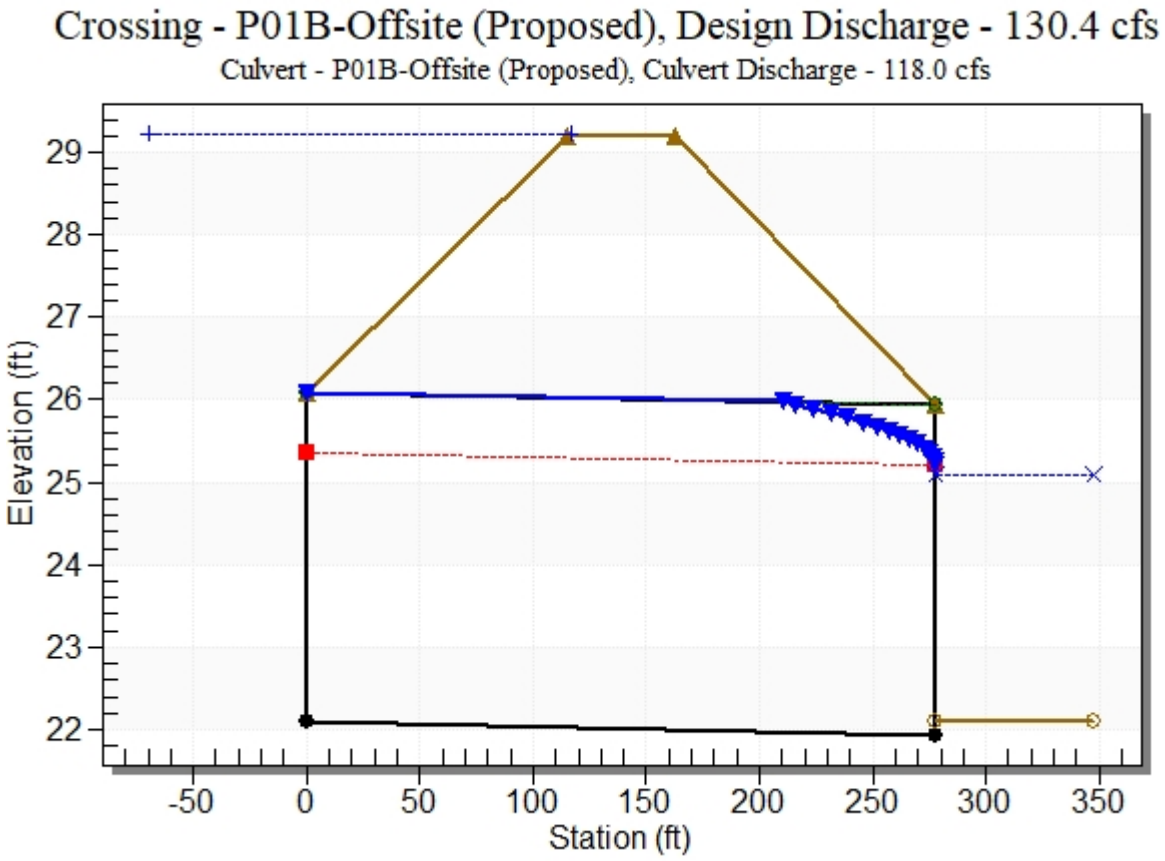
Culvert Length: 278.00 ft, Culvert Slope: 0.0005

****

Culvert Performance Curve Plot: P01B-Offsite (Proposed)



Water Surface Profile Plot for Culvert: P01B-Offsite (Proposed)



Site Data - P01B-Offsite (Proposed)

Site Data Option: Culvert Invert Data

Inlet Station: 0.00 ft

Inlet Elevation: 22.09 ft

Outlet Station: 278.00 ft

Outlet Elevation: 21.94 ft

Number of Barrels: 1

Culvert Data Summary - P01B-Offsite (Proposed)

Barrel Shape: Circular

Barrel Diameter: 4.00 ft

Barrel Material: Concrete

Embedment: 0.00 in

Barrel Manning's n: 0.0120

Culvert Type: Straight

Inlet Configuration: Square Edge with Headwall

Inlet Depression: NONE

Table 3 - Downstream Channel Rating Curve (Crossing: P01B-Offsite (Proposed))

Flow (cfs)	Water Surface Elev (ft)	Depth (ft)
113.60	25.09	3.00
124.41	25.09	3.00
130.40	25.09	3.00
146.03	25.09	3.00
156.84	25.09	3.00
167.65	25.09	3.00
178.46	25.09	3.00
189.27	25.09	3.00
200.08	25.09	3.00
210.89	25.09	3.00
221.70	25.09	3.00

Tailwater Channel Data - P01B-Offsite (Proposed)

Tailwater Channel Option: Enter Constant Tailwater Elevation

Constant Tailwater Elevation: 25.09 ft

Roadway Data for Crossing: P01B-Offsite (Proposed)

Roadway Profile Shape: Constant Roadway Elevation

Crest Length: 500.00 ft

Crest Elevation: 29.19 ft

Roadway Surface: Paved

Roadway Top Width: 48.00 ft

HYDROLOGIC ANALYSIS

		DATE
made by:	DHR	11-Jul-20
checked by:		
Stantec job #:		

PROJECT: I-95 Pioneer Trail Interchange

LOCATION: South-Spruce Creek

Rational Equation: $Q_T = X_T * C_T * i_{tc} * A_T$

Q_T = Peak Runoff for Return Period T (cfs).

X_T = Frequency Factor for Return Period T.

C_T = Average Runoff Coefficient for Return Period T.

i_{tc} = Average Rainfall Intensity for Return Period T (in/hr).

A_T = Total Watershed Drainage Area (ac).

$$C_T = \frac{C_1*A_1 + C_2*A_2 + C_3*A_3}{A_T}$$

A_1= 23.14 ac	C_1 = 0.95	Rooftops and Pavement and Surface Water
A_2= 0.00 ac	C_2 = 0.20	Woodlands (Rolling with Sandy Soils)
A_3= 114.04 ac	C_3 = 0.25	Grass (Rolling with Sandy Soils)

A_T= 137.18 ac

C_T = 0.37

$X_{25\ yr}$ = 1.1	$X_{50\ yr}$ = 1.2	$X_{100\ yr}$ = 1.25
$i_{25\ yr}$ = 6.0 in/hr	$i_{50\ yr}$ = 6.6 in/hr	$i_{100\ yr}$ = 7.2 in/hr

i = based on time of concentration from Ditch Calculations -> t_c = 23.63 min

$Q_{25\ yr}$ = 333.8 cfs	**$Q_{50\ yr}$ = 397.5 cfs**	**$Q_{100\ yr}$ = 454.4 cfs**

$Q_{500\ yr}$ = 1.7 x $Q_{100\ yr}$ = **772.5 cfs**

HY-8 Culvert Analysis Report

Crossing Discharge Data

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

Minimum Flow: 198.7 cfs

Design Flow: 227.2 cfs

Maximum Flow: 386.3 cfs

Table 1 - Summary of Culvert Flows at Crossing: South Spruce Creek (Existing)

Headwater Elevation (ft)	Total Discharge (cfs)	South Spruce Creek (Existing) Discharge (cfs)	Roadway Discharge (cfs)	Iterations
26.15	198.70	198.70	0.00	1
26.19	217.46	217.46	0.00	1
26.21	227.20	227.20	0.00	1
26.29	254.98	254.98	0.00	1
26.34	273.74	273.74	0.00	1
26.40	292.50	292.50	0.00	1
26.46	311.26	311.26	0.00	1
26.53	330.02	330.02	0.00	1
26.60	348.78	348.78	0.00	1
26.67	367.54	367.54	0.00	1
26.75	386.30	386.30	0.00	1
30.60	838.13	838.13	0.00	Overtopping

Rating Curve Plot for Crossing: South Spruce Creek (Existing)

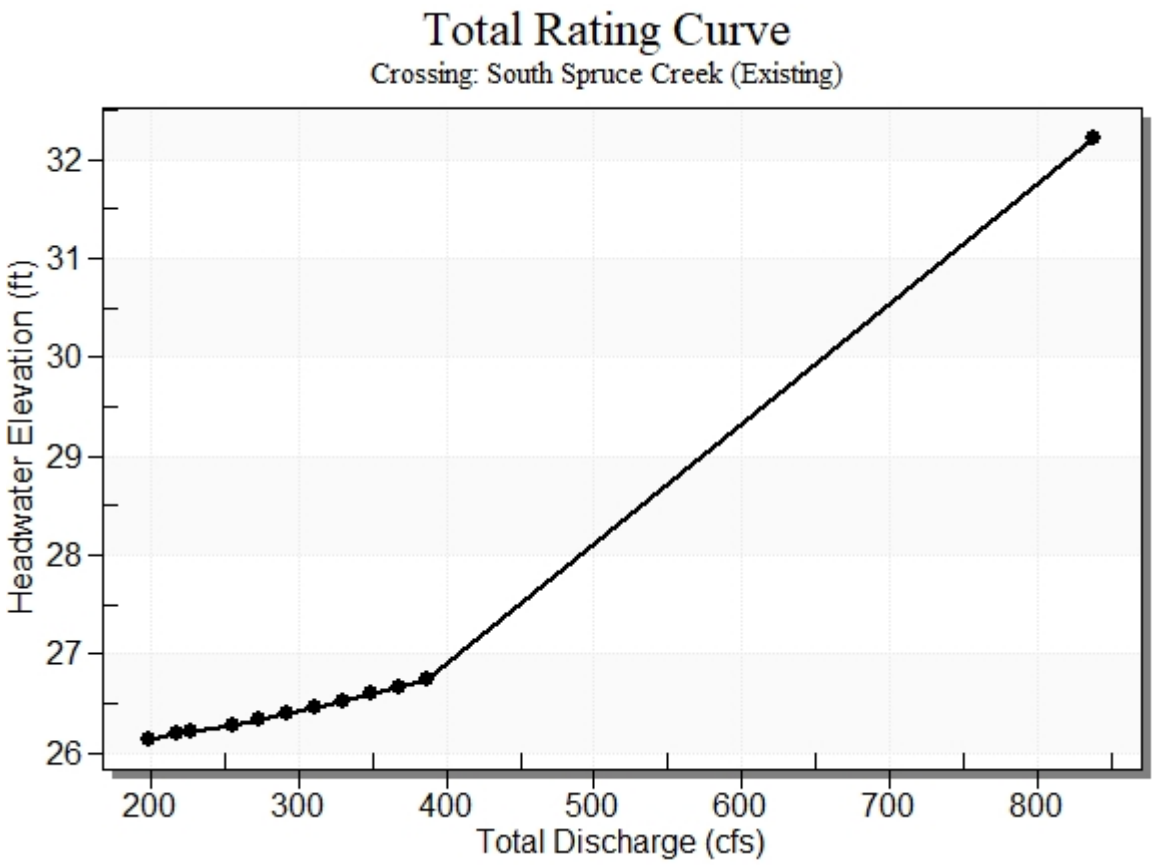


Table 2 - Culvert Summary Table: South Spruce Creek (Existing)

Total Discharge (cfs)	Culvert Discharge (cfs)	Headwater Elevation (ft)	Inlet Control Depth (ft)	Outlet Control Depth (ft)	Flow Type	Normal Depth (ft)	Critical Depth (ft)	Outlet Depth (ft)	Tailwater Depth (ft)	Outlet Velocity (ft/s)	Tailwater Velocity (ft/s)
198.70	198.70	26.15	3.138	5.216	4-FFf	3.393	1.843	5.000	5.000	2.839	0.000
217.46	217.46	26.19	3.327	5.259	4-FFf	3.633	1.957	5.000	5.000	3.107	0.000
227.20	227.20	26.21	3.422	5.283	4-FFf	3.754	2.015	5.000	5.000	3.246	0.000
254.98	254.98	26.29	3.689	5.356	4-FFf	4.099	2.176	5.000	5.000	3.643	0.000
273.74	273.74	26.34	3.863	5.411	4-FFf	4.328	2.281	5.000	5.000	3.911	0.000
292.50	292.50	26.40	4.035	5.469	4-FFf	5.000	2.384	5.000	5.000	4.179	0.000
311.26	311.26	26.46	4.204	5.531	4-FFf	5.000	2.485	5.000	5.000	4.447	0.000
330.02	330.02	26.53	4.371	5.597	4-FFf	5.000	2.584	5.000	5.000	4.715	0.000
348.78	348.78	26.60	4.536	5.667	4-FFf	5.000	2.681	5.000	5.000	4.983	0.000
367.54	367.54	26.67	4.700	5.740	4-FFf	5.000	2.777	5.000	5.000	5.251	0.000
386.30	386.30	26.75	4.864	5.818	4-FFf	5.000	2.870	5.000	5.000	5.519	0.000

****

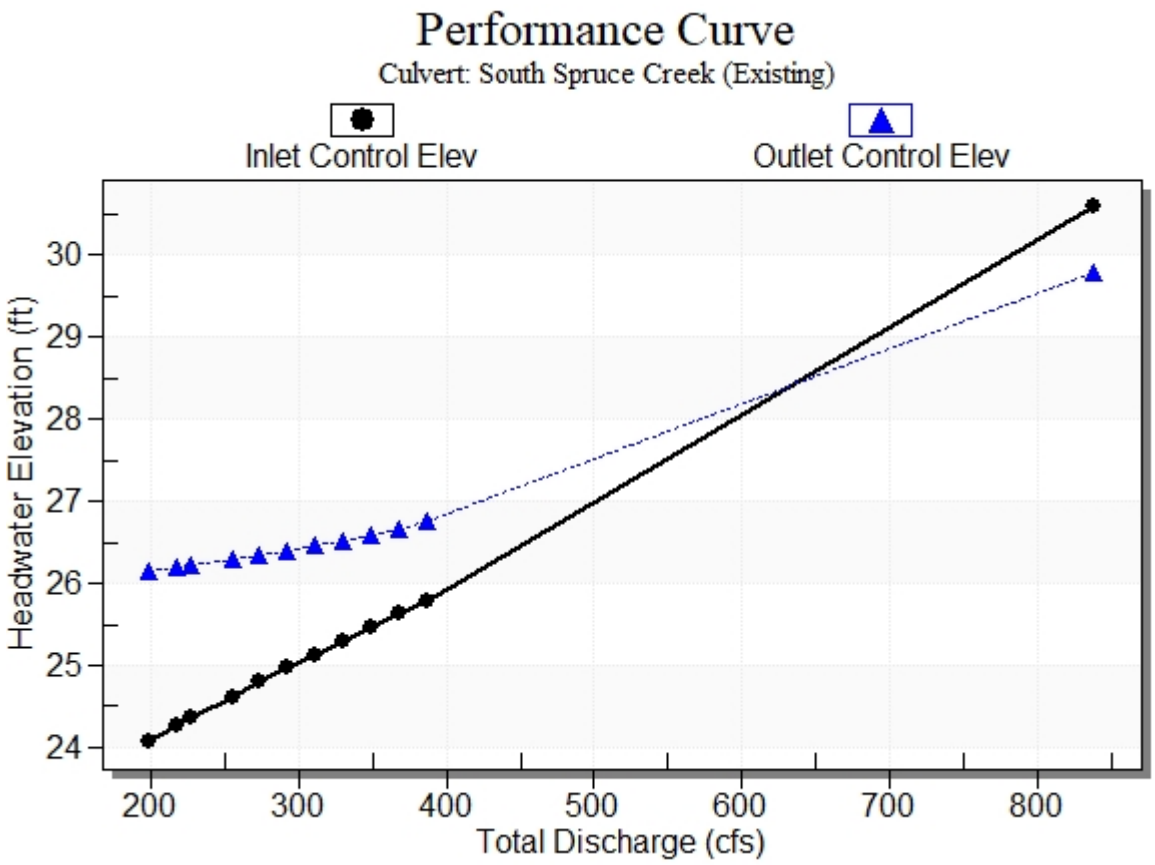
Straight Culvert

Inlet Elevation (invert): 20.93 ft, Outlet Elevation (invert): 20.88 ft

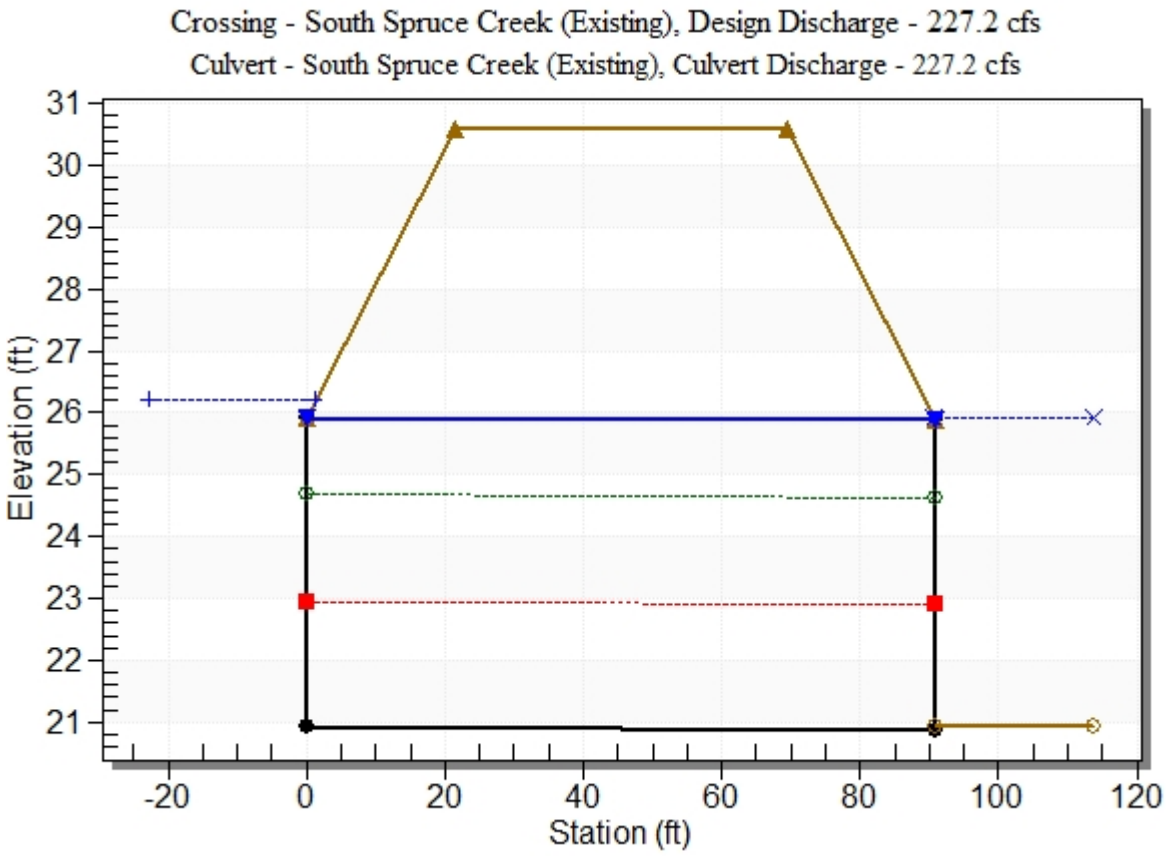
Culvert Length: 91.00 ft, Culvert Slope: 0.0005

****

Culvert Performance Curve Plot: South Spruce Creek (Existing)



Water Surface Profile Plot for Culvert: South Spruce Creek (Existing)



Site Data - South Spruce Creek (Existing)

Site Data Option: Culvert Invert Data

Inlet Station: 0.00 ft

Inlet Elevation: 20.93 ft

Outlet Station: 91.00 ft

Outlet Elevation: 20.88 ft

Number of Barrels: 2

Culvert Data Summary - South Spruce Creek (Existing)

Barrel Shape: Concrete Box

Barrel Span: 7.00 ft

Barrel Rise: 5.00 ft

Barrel Material: Concrete

Embedment: 0.00 in

Barrel Manning's n: 0.0120

Culvert Type: Straight

Inlet Configuration: Square Edge (90º) Headwall

Inlet Depression: NONE

Table 3 - Downstream Channel Rating Curve (Crossing: South Spruce Creek

Flow (cfs)	Water Surface Elev (ft)	Depth (ft)
198.70	25.93	5.00
217.46	25.93	5.00
227.20	25.93	5.00
254.98	25.93	5.00
273.74	25.93	5.00
292.50	25.93	5.00
311.26	25.93	5.00
330.02	25.93	5.00
348.78	25.93	5.00
367.54	25.93	5.00
386.30	25.93	5.00

(Existing))

Tailwater Channel Data - South Spruce Creek (Existing)

Tailwater Channel Option: Enter Constant Tailwater Elevation

Constant Tailwater Elevation: 25.93 ft

Roadway Data for Crossing: South Spruce Creek (Existing)

Roadway Profile Shape: Constant Roadway Elevation

Crest Length: 100.00 ft

Crest Elevation: 30.60 ft

Roadway Surface: Paved

Roadway Top Width: 48.00 ft

HY-8 Culvert Analysis Report

Crossing Discharge Data

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

Minimum Flow: 198.7 cfs

Design Flow: 227.2 cfs

Maximum Flow: 386.3 cfs

Table 1 - Summary of Culvert Flows at Crossing: South Spruce Creek (Proposed)

Headwater Elevation (ft)	Total Discharge (cfs)	South Spruce Creek (Proposed) Discharge (cfs)	Roadway Discharge (cfs)	Iterations
26.20	198.70	198.70	0.00	1
26.25	217.46	217.46	0.00	1
26.28	227.20	227.20	0.00	1
26.38	254.98	254.98	0.00	1
26.45	273.74	273.74	0.00	1
26.52	292.50	292.50	0.00	1
26.60	311.26	311.26	0.00	1
26.69	330.02	330.02	0.00	1
26.78	348.78	348.78	0.00	1
26.88	367.54	367.54	0.00	1
26.98	386.30	386.30	0.00	1
30.60	762.54	762.54	0.00	Overtopping

Rating Curve Plot for Crossing: South Spruce Creek (Proposed)

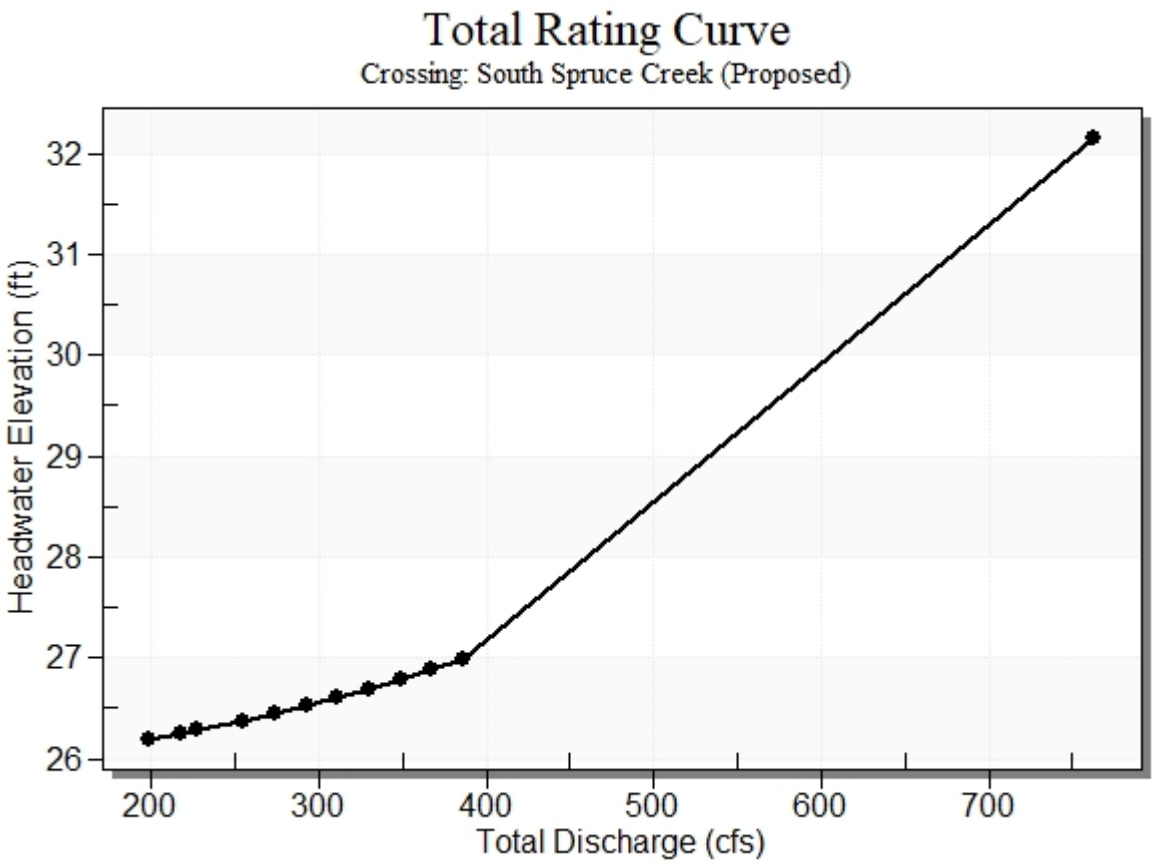


Table 2 - Culvert Summary Table: South Spruce Creek (Proposed)

Total Discharge (cfs)	Culvert Discharge (cfs)	Headwater Elevation (ft)	Inlet Control Depth (ft)	Outlet Control Depth (ft)	Flow Type	Normal Depth (ft)	Critical Depth (ft)	Outlet Depth (ft)	Tailwater Depth (ft)	Outlet Velocity (ft/s)	Tailwater Velocity (ft/s)
198.70	198.70	26.20	3.123	4.260	1-S1f	1.413	1.843	5.000	5.000	2.839	0.000
217.46	217.46	26.25	3.312	4.314	1-S1f	1.500	1.957	5.000	5.000	3.107	0.000
227.20	227.20	26.28	3.408	4.344	1-S1f	1.545	2.015	5.000	5.000	3.246	0.000
254.98	254.98	26.38	3.674	4.437	1-S1f	1.674	2.176	5.000	5.000	3.643	0.000
273.74	273.74	26.45	3.849	4.507	1-S1f	1.760	2.281	5.000	5.000	3.911	0.000
292.50	292.50	26.52	4.020	4.581	1-S1f	1.845	2.384	5.000	5.000	4.179	0.000
311.26	311.26	26.60	4.189	4.662	1-S1f	1.925	2.485	5.000	5.000	4.447	0.000
330.02	330.02	26.69	4.356	4.748	1-S1f	2.005	2.584	5.000	5.000	4.715	0.000
348.78	348.78	26.78	4.521	4.839	1-S1f	2.084	2.681	5.000	5.000	4.983	0.000
367.54	367.54	26.88	4.685	4.937	1-S1f	2.164	2.777	5.000	5.000	5.251	0.000
386.30	386.30	26.98	4.849	5.042	1-S1f	2.244	2.870	5.000	5.000	5.519	0.000

****

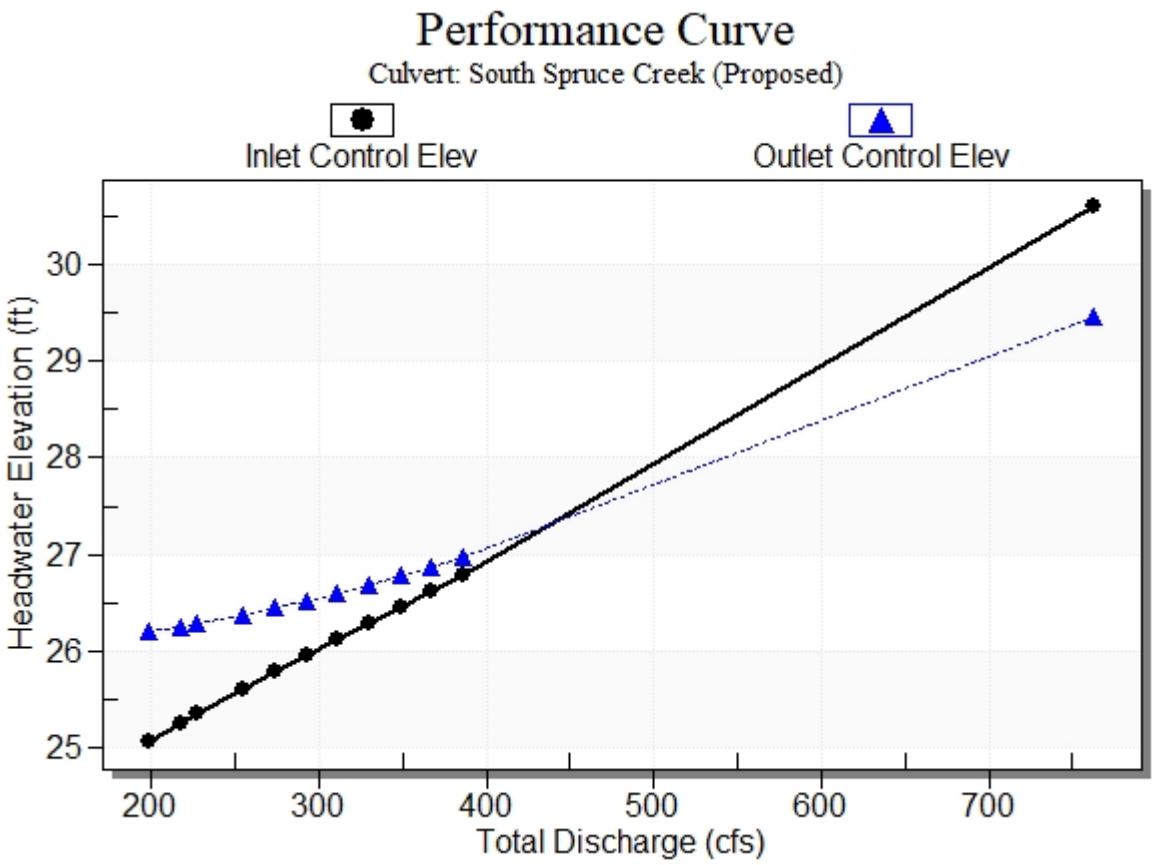
Straight Culvert

Inlet Elevation (invert): 21.94 ft, Outlet Elevation (invert): 20.88 ft

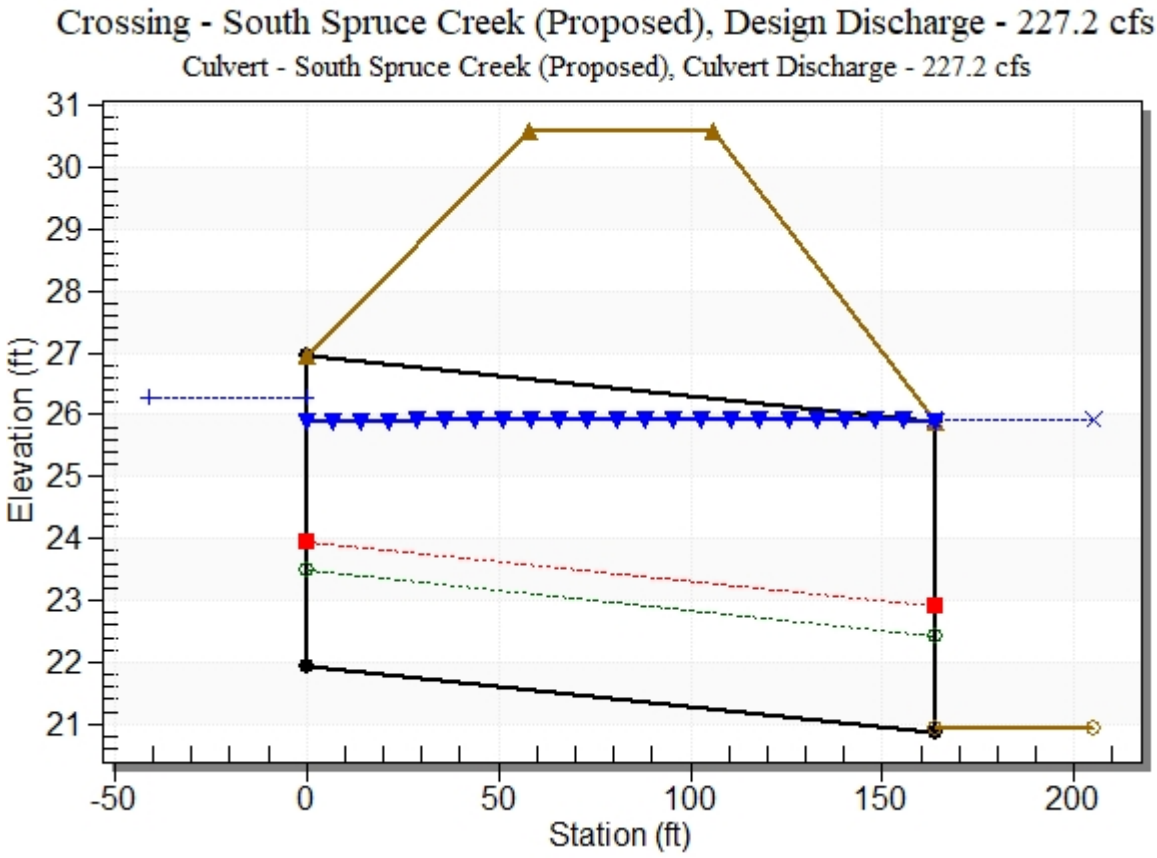
Culvert Length: 164.00 ft, Culvert Slope: 0.0065

****

Culvert Performance Curve Plot: South Spruce Creek (Proposed)



Water Surface Profile Plot for Culvert: South Spruce Creek (Proposed)



Site Data - South Spruce Creek (Proposed)

Site Data Option: Culvert Invert Data

Inlet Station: 0.00 ft

Inlet Elevation: 21.94 ft

Outlet Station: 164.00 ft

Outlet Elevation: 20.88 ft

Number of Barrels: 2

Culvert Data Summary - South Spruce Creek (Proposed)

Barrel Shape: Concrete Box

Barrel Span: 7.00 ft

Barrel Rise: 5.00 ft

Barrel Material: Concrete

Embedment: 0.00 in

Barrel Manning's n: 0.0120

Culvert Type: Straight

Inlet Configuration: Square Edge (90º) Headwall

Inlet Depression: NONE

Table 3 - Downstream Channel Rating Curve (Crossing: South Spruce Creek

Flow (cfs)	Water Surface Elev (ft)	Depth (ft)
198.70	25.93	5.00
217.46	25.93	5.00
227.20	25.93	5.00
254.98	25.93	5.00
273.74	25.93	5.00
292.50	25.93	5.00
311.26	25.93	5.00
330.02	25.93	5.00
348.78	25.93	5.00
367.54	25.93	5.00
386.30	25.93	5.00

(Proposed))

Tailwater Channel Data - South Spruce Creek (Proposed)

Tailwater Channel Option: Enter Constant Tailwater Elevation

Constant Tailwater Elevation: 25.93 ft

Roadway Data for Crossing: South Spruce Creek (Proposed)

Roadway Profile Shape: Constant Roadway Elevation

Crest Length: 100.00 ft

Crest Elevation: 30.60 ft

Roadway Surface: Paved

Roadway Top Width: 48.00 ft

HYDROLOGIC ANALYSIS

		DATE
made by:	DHR	11-Jul-20
checked by:		
Stantec job #:		

PROJECT: I-95 Pioneer Trail Interchange

LOCATION: South01-I-95

Rational Equation: $Q_T = X_T * C_T * i_{tc} * A_T$

Q_T = Peak Runoff for Return Period T (cfs).

X_T = Frequency Factor for Return Period T.

C_T = Average Runoff Coefficient for Return Period T.

i_{tc} = Average Rainfall Intensity for Return Period T (in/hr).

A_T = Total Watershed Drainage Area (ac).

$$C_T = \frac{C_1*A_1 + C_2*A_2 + C_3*A_3}{A_T}$$

A_1= 5.06 ac	C_1 = 0.95	Rooftops and Pavement
A_2= 423.18 ac	C_2 = 0.15	Woodlands (Rolling with Sandy Soils)
A_3= 0.00 ac	C_3 = 0.25	Grass (Rolling with Sandy Soils)

A_T= 428.24 ac (per previous permit, 118421-2)

C_T = 0.16

$X_{25\ yr}$ = 1.1	$X_{50\ yr}$ = 1.2	$X_{100\ yr}$ = 1.25
$i_{25\ yr}$ = 0.9 in/hr	$i_{50\ yr}$ = 1.0 in/hr	$i_{100\ yr}$ = 1.3 in/hr

i = based on time of concentration from Ditch Calculations -> t_c = 385 min (per previous permit, 118421-2)

$Q_{25\ yr}$ = 65.3 cfs	**$Q_{50\ yr}$ = 80.3 cfs**	**$Q_{100\ yr}$ = 106.7 cfs**

$Q_{500\ yr}$ = 1.7 x $Q_{100\ yr}$ = **181.4 cfs**

HY-8 Culvert Analysis Report

Crossing Discharge Data

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

Minimum Flow: 80.3 cfs

Design Flow: 106.7 cfs

Maximum Flow: 181.4 cfs

Table 1 - Summary of Culvert Flows at Crossing: South01-I-95 (Proposed)

Headwater Elevation (ft)	Total Discharge (cfs)	South01-I-95 (Proposed) Discharge (cfs)	Roadway Discharge (cfs)	Iterations
25.04	80.30	80.30	0.00	1
25.11	90.41	90.41	0.00	1
25.19	100.52	100.52	0.00	1
25.24	106.70	106.70	0.00	1
25.36	120.74	120.74	0.00	1
25.46	130.85	130.85	0.00	1
25.57	140.96	140.96	0.00	1
25.68	151.07	151.07	0.00	1
25.81	161.18	161.18	0.00	1
25.94	171.29	171.29	0.00	1
26.13	181.40	181.40	0.00	1
30.39	344.96	344.96	0.00	Overtopping

Rating Curve Plot for Crossing: South01-I-95 (Proposed)

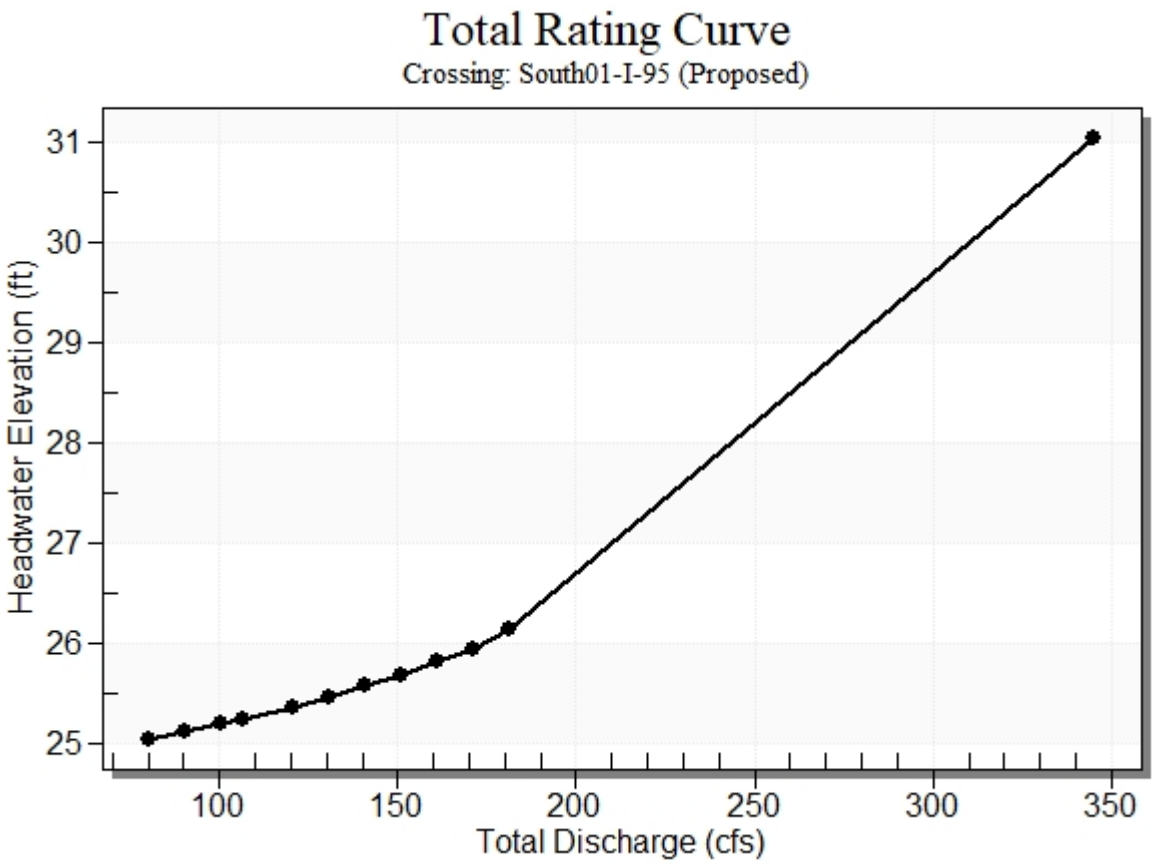


Table 2 - Culvert Summary Table: South01-I-95 (Proposed)

Total Discharge (cfs)	Culvert Discharge (cfs)	Headwater Elevation (ft)	Inlet Control Depth (ft)	Outlet Control Depth (ft)	Flow Type	Normal Depth (ft)	Critical Depth (ft)	Outlet Depth (ft)	Tailwater Depth (ft)	Outlet Velocity (ft/s)	Tailwater Velocity (ft/s)
80.30	80.30	25.04	2.713	3.894	3-M1f	1.785	1.599	4.000	3.640	2.868	0.000
90.41	90.41	25.11	2.931	3.962	3-M1f	1.937	1.730	4.000	3.640	3.229	0.000
100.52	100.52	25.19	3.141	4.038	3-M1f	2.088	1.857	4.000	3.640	3.590	0.000
106.70	106.70	25.24	3.266	4.088	3-M1f	2.180	1.932	4.000	3.640	3.811	0.000
120.74	120.74	25.36	3.546	4.212	3-M1f	2.379	2.098	4.000	3.640	4.312	0.000
130.85	130.85	25.46	3.744	4.311	3-M1f	2.522	2.214	4.000	3.640	4.673	0.000
140.96	140.96	25.57	3.942	4.417	3-M1f	2.660	2.327	4.000	3.640	5.034	0.000
151.07	151.07	25.68	4.140	4.531	3-M1f	2.798	2.437	4.000	3.640	5.395	0.000
161.18	161.18	25.81	4.340	4.655	3-M1f	2.935	2.544	4.000	3.640	5.756	0.000
171.29	171.29	25.94	4.542	4.793	3-M1f	3.068	2.649	4.000	3.640	6.118	0.000
181.40	181.40	26.13	4.749	4.977	4-FFf	3.202	2.753	4.000	3.640	6.479	0.000

****

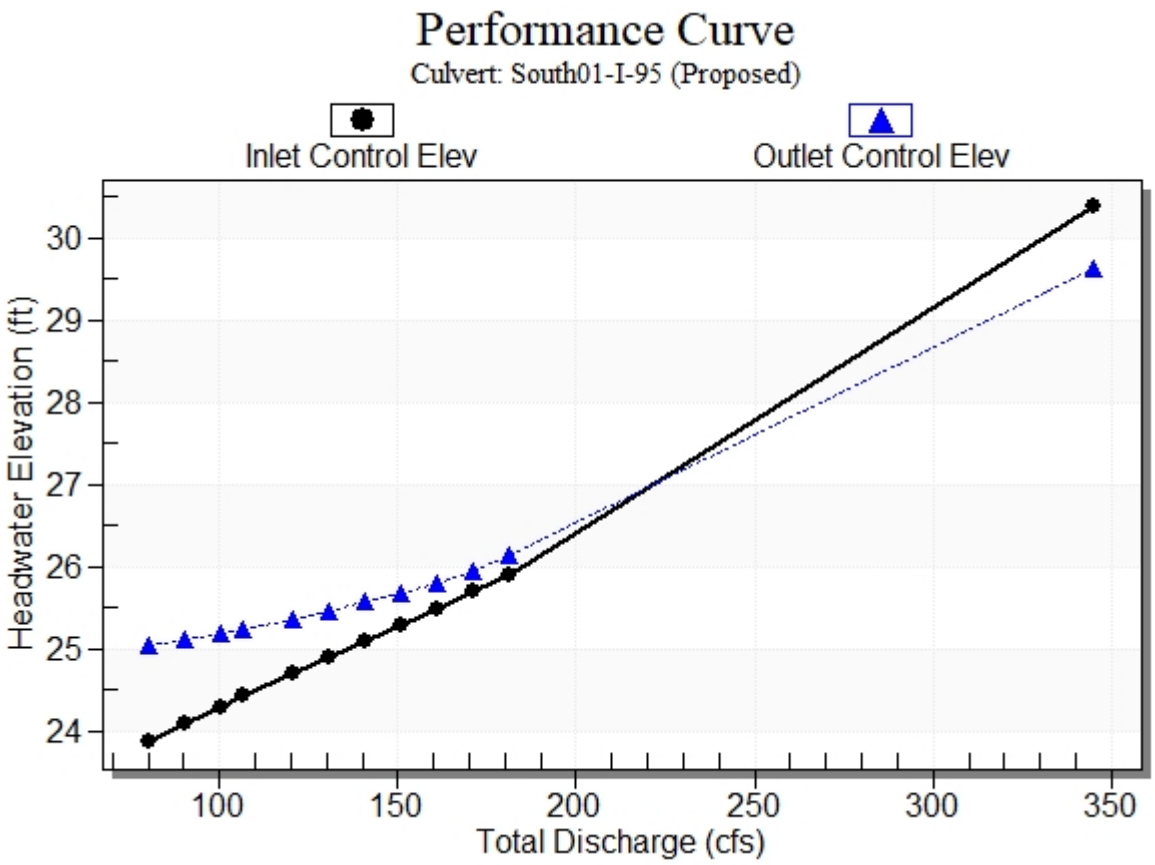
Straight Culvert

Inlet Elevation (invert): 21.15 ft, Outlet Elevation (invert): 20.76 ft

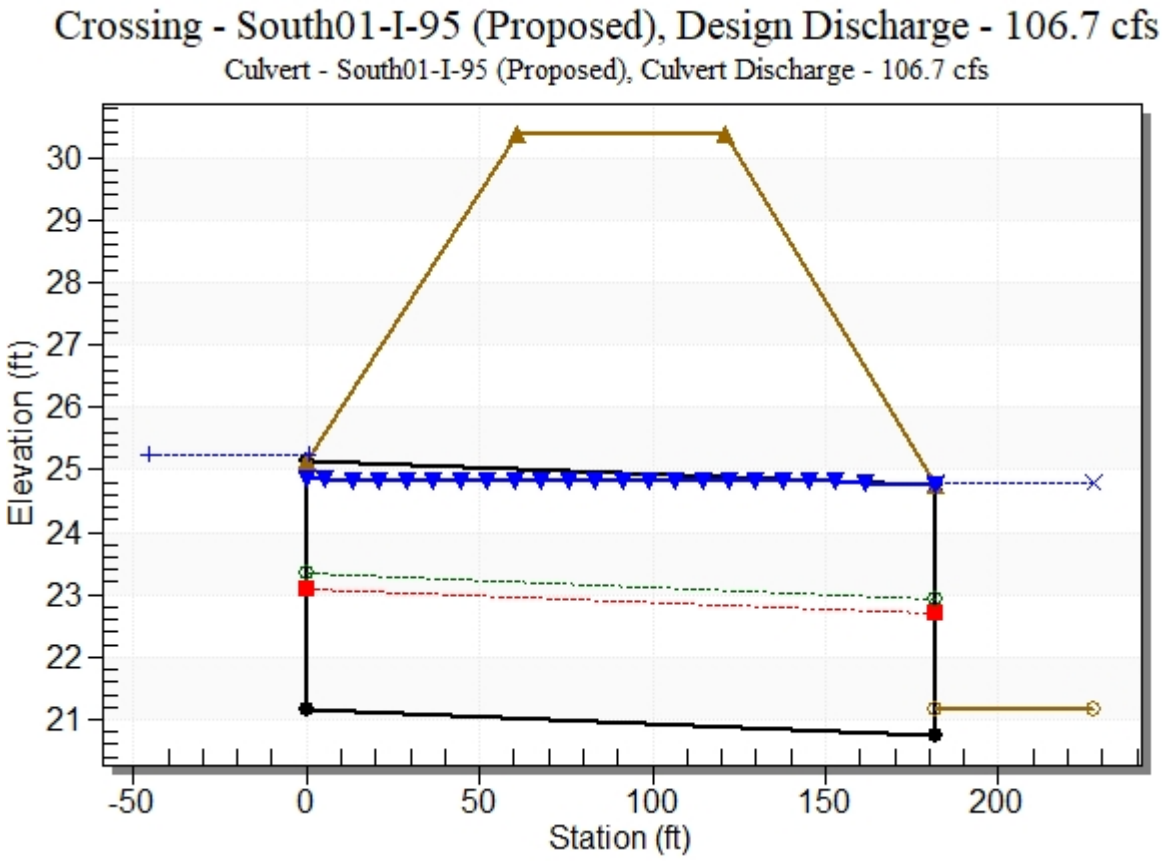
Culvert Length: 182.00 ft, Culvert Slope: 0.0021

****

Culvert Performance Curve Plot: South01-I-95 (Proposed)



Water Surface Profile Plot for Culvert: South01-I-95 (Proposed)



Site Data - South01-I-95 (Proposed)

Site Data Option: Culvert Invert Data

Inlet Station: 0.00 ft

Inlet Elevation: 21.15 ft

Outlet Station: 182.00 ft

Outlet Elevation: 20.76 ft

Number of Barrels: 1

Culvert Data Summary - South01-I-95 (Proposed)

Barrel Shape: Concrete Box

Barrel Span: 7.00 ft

Barrel Rise: 4.00 ft

Barrel Material: Concrete

Embedment: 0.00 in

Barrel Manning's n: 0.0120

Culvert Type: Straight

Inlet Configuration: Square Edge (90º) Headwall

Inlet Depression: NONE

Table 3 - Downstream Channel Rating Curve (Crossing: South01-I-95 (Proposed))

Flow (cfs)	Water Surface Elev (ft)	Depth (ft)
80.30	24.79	3.64
90.41	24.79	3.64
100.52	24.79	3.64
106.70	24.79	3.64
120.74	24.79	3.64
130.85	24.79	3.64
140.96	24.79	3.64
151.07	24.79	3.64
161.18	24.79	3.64
171.29	24.79	3.64
181.40	24.79	3.64

Tailwater Channel Data - South01-I-95 (Proposed)

Tailwater Channel Option: Enter Constant Tailwater Elevation

Constant Tailwater Elevation: 24.79 ft

Roadway Data for Crossing: South01-I-95 (Proposed)

Roadway Profile Shape: Constant Roadway Elevation

Crest Length: 250.00 ft

Crest Elevation: 30.39 ft

Roadway Surface: Paved

Roadway Top Width: 60.00 ft

HY-8 Culvert Analysis Report

Crossing Discharge Data

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

Minimum Flow: 80.3 cfs

Design Flow: 106.7 cfs

Maximum Flow: 181.4 cfs

Table 1 - Summary of Culvert Flows at Crossing: South01-I-95 (Proposed)

Headwater Elevation (ft)	Total Discharge (cfs)	South01-I-95 (Proposed) Discharge (cfs)	Roadway Discharge (cfs)	Iterations
25.04	80.30	80.30	0.00	1
25.11	90.41	90.41	0.00	1
25.19	100.52	100.52	0.00	1
25.24	106.70	106.70	0.00	1
25.36	120.74	120.74	0.00	1
25.46	130.85	130.85	0.00	1
25.57	140.96	140.96	0.00	1
25.68	151.07	151.07	0.00	1
25.81	161.18	161.18	0.00	1
25.94	171.29	171.29	0.00	1
26.13	181.40	181.40	0.00	1
30.39	344.96	344.96	0.00	Overtopping

Rating Curve Plot for Crossing: South01-I-95 (Proposed)

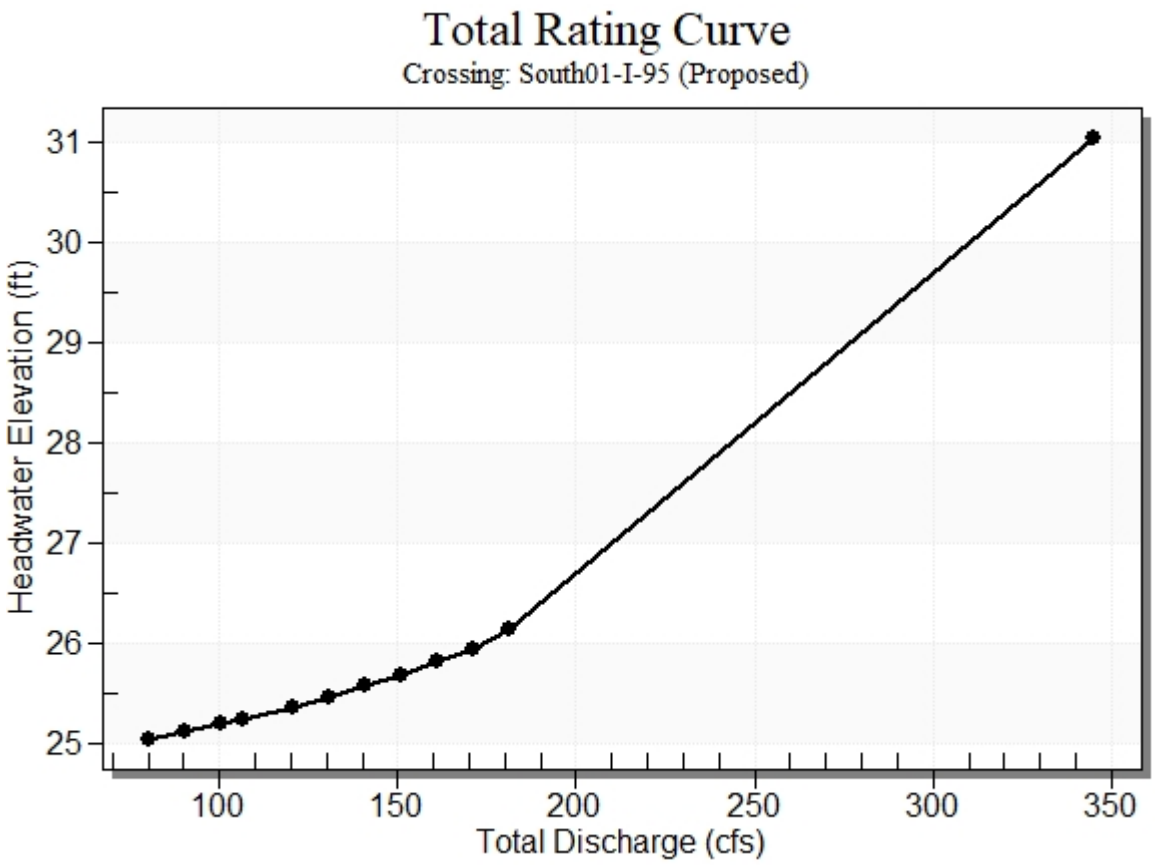


Table 2 - Culvert Summary Table: South01-I-95 (Proposed)

Total Discharge (cfs)	Culvert Discharge (cfs)	Headwater Elevation (ft)	Inlet Control Depth (ft)	Outlet Control Depth (ft)	Flow Type	Normal Depth (ft)	Critical Depth (ft)	Outlet Depth (ft)	Tailwater Depth (ft)	Outlet Velocity (ft/s)	Tailwater Velocity (ft/s)
80.30	80.30	25.04	2.713	3.894	3-M1f	1.785	1.599	4.000	3.640	2.868	0.000
90.41	90.41	25.11	2.931	3.962	3-M1f	1.937	1.730	4.000	3.640	3.229	0.000
100.52	100.52	25.19	3.141	4.038	3-M1f	2.088	1.857	4.000	3.640	3.590	0.000
106.70	106.70	25.24	3.266	4.088	3-M1f	2.180	1.932	4.000	3.640	3.811	0.000
120.74	120.74	25.36	3.546	4.212	3-M1f	2.379	2.098	4.000	3.640	4.312	0.000
130.85	130.85	25.46	3.744	4.311	3-M1f	2.522	2.214	4.000	3.640	4.673	0.000
140.96	140.96	25.57	3.942	4.417	3-M1f	2.660	2.327	4.000	3.640	5.034	0.000
151.07	151.07	25.68	4.140	4.531	3-M1f	2.798	2.437	4.000	3.640	5.395	0.000
161.18	161.18	25.81	4.340	4.655	3-M1f	2.935	2.544	4.000	3.640	5.756	0.000
171.29	171.29	25.94	4.542	4.793	3-M1f	3.068	2.649	4.000	3.640	6.118	0.000
181.40	181.40	26.13	4.749	4.977	4-FFf	3.202	2.753	4.000	3.640	6.479	0.000

****

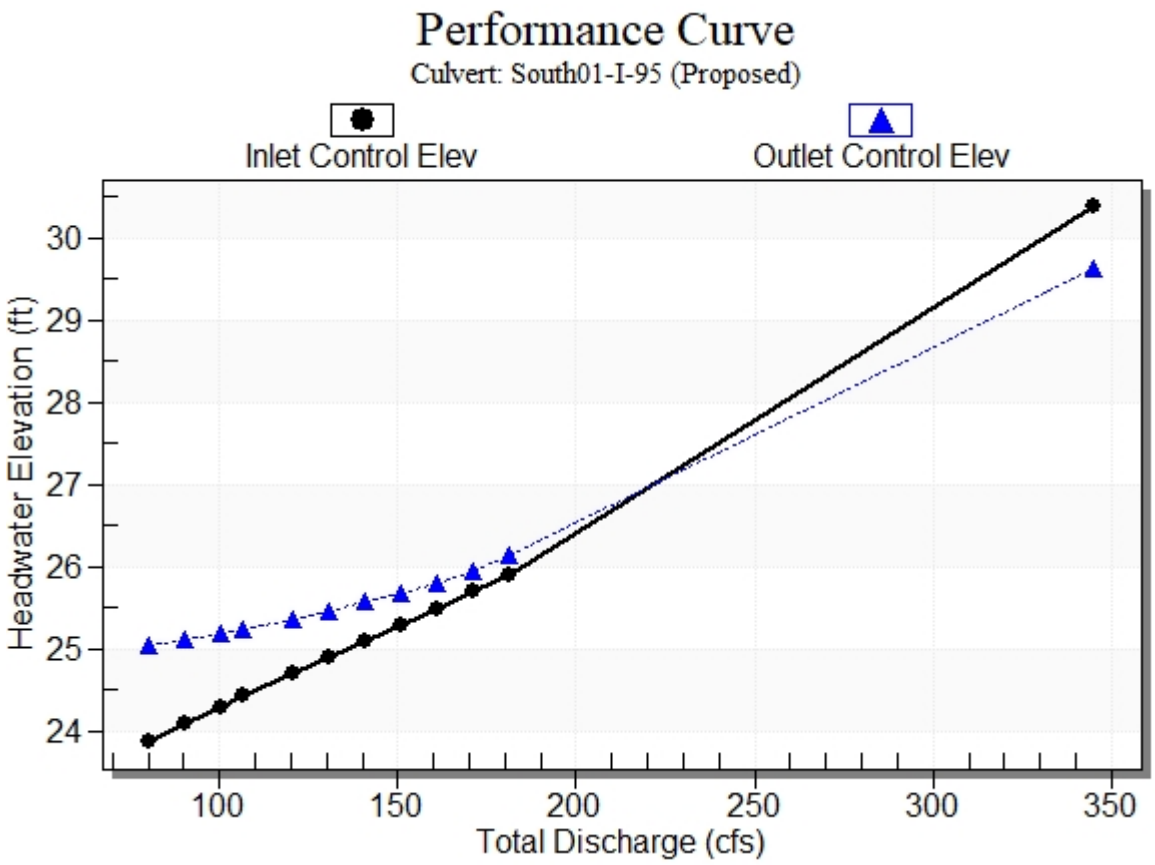
Straight Culvert

Inlet Elevation (invert): 21.15 ft, Outlet Elevation (invert): 20.76 ft

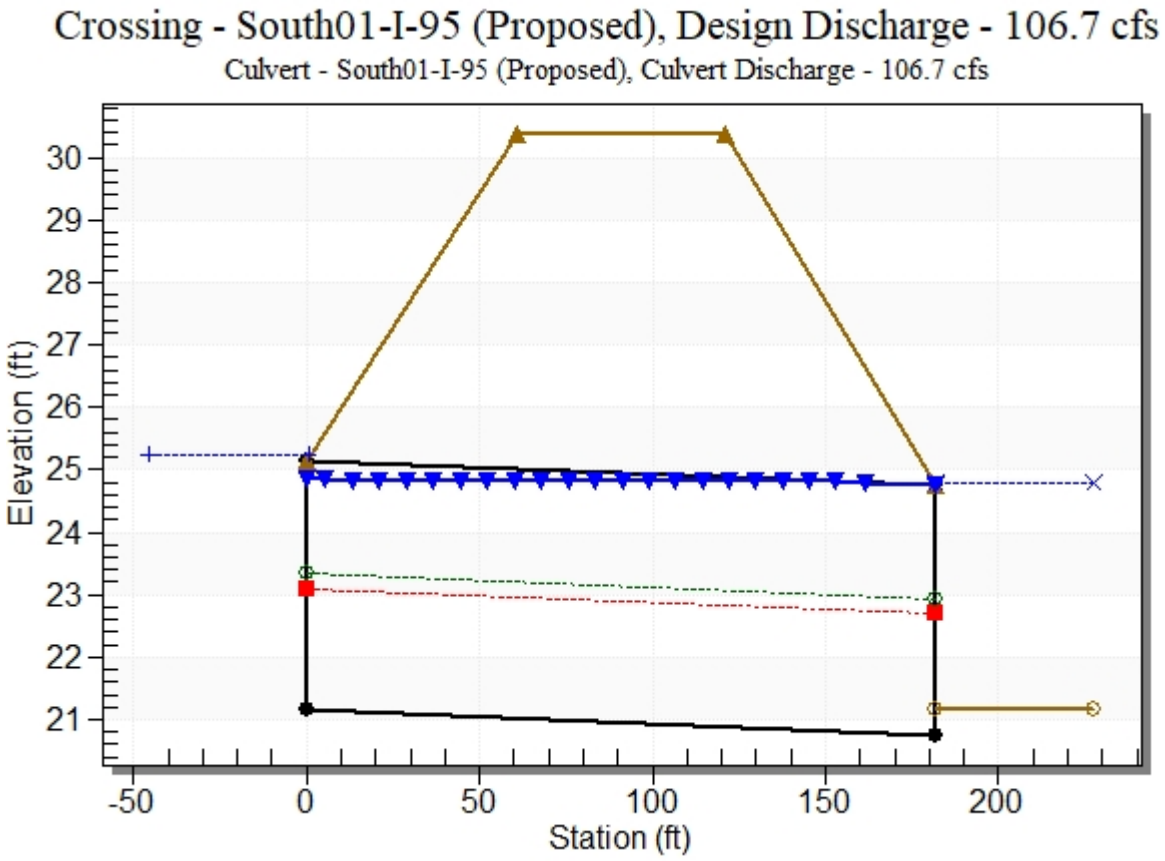
Culvert Length: 182.00 ft, Culvert Slope: 0.0021

****

Culvert Performance Curve Plot: South01-I-95 (Proposed)



Water Surface Profile Plot for Culvert: South01-I-95 (Proposed)



Site Data - South01-I-95 (Proposed)

Site Data Option: Culvert Invert Data

Inlet Station: 0.00 ft

Inlet Elevation: 21.15 ft

Outlet Station: 182.00 ft

Outlet Elevation: 20.76 ft

Number of Barrels: 1

Culvert Data Summary - South01-I-95 (Proposed)

Barrel Shape: Concrete Box

Barrel Span: 7.00 ft

Barrel Rise: 4.00 ft

Barrel Material: Concrete

Embedment: 0.00 in

Barrel Manning's n: 0.0120

Culvert Type: Straight

Inlet Configuration: Square Edge (90º) Headwall

Inlet Depression: NONE

Table 3 - Downstream Channel Rating Curve (Crossing: South01-I-95 (Proposed))

Flow (cfs)	Water Surface Elev (ft)	Depth (ft)
80.30	24.79	3.64
90.41	24.79	3.64
100.52	24.79	3.64
106.70	24.79	3.64
120.74	24.79	3.64
130.85	24.79	3.64
140.96	24.79	3.64
151.07	24.79	3.64
161.18	24.79	3.64
171.29	24.79	3.64
181.40	24.79	3.64

Tailwater Channel Data - South01-I-95 (Proposed)

Tailwater Channel Option: Enter Constant Tailwater Elevation

Constant Tailwater Elevation: 24.79 ft

Roadway Data for Crossing: South01-I-95 (Proposed)

Roadway Profile Shape: Constant Roadway Elevation

Crest Length: 250.00 ft

Crest Elevation: 30.39 ft

Roadway Surface: Paved

Roadway Top Width: 60.00 ft

HYDROLOGIC ANALYSIS

		DATE
made by:	DHR	11-Jul-20
checked by:		
Stantec job #:		

PROJECT: I-95 Pioneer Trail Interchange

LOCATION: South02-I-95

Rational Equation: $Q_T = X_T * C_T * i_{tc} * A_T$

Q_T = Peak Runoff for Return Period T (cfs).

X_T = Frequency Factor for Return Period T.

C_T = Average Runoff Coefficient for Return Period T.

i_{tc} = Average Rainfall Intensity for Return Period T (in/hr).

A_T = Total Watershed Drainage Area (ac).

$$C_T = \frac{C_1*A_1 + C_2*A_2 + C_3*A_3}{A_T}$$

A_1= 5.06 ac	C_1 = 0.95	Rooftops and Pavement
A_2= 423.18 ac	C_2 = 0.15	Woodlands (Rolling with Sandy Soils)
A_3= 0.00 ac	C_3 = 0.25	Grass (Rolling with Sandy Soils)

A_T= 428.24 ac (per previous permit, 118421-2)

C_T = 0.16

$X_{25\ yr}$ = 1.1	$X_{50\ yr}$ = 1.2	$X_{100\ yr}$ = 1.25
$i_{25\ yr}$ = 0.9 in/hr	$i_{50\ yr}$ = 1.0 in/hr	$i_{100\ yr}$ = 1.3 in/hr

i = based on time of concentration from Ditch Calculations -> t_c = 385 min (per previous permit, 118421-2)

$Q_{25\ yr}$ = 65.3 cfs	**$Q_{50\ yr}$ = 80.3 cfs**	**$Q_{100\ yr}$ = 106.7 cfs**

$Q_{500\ yr}$ = 1.7 x $Q_{100\ yr}$ = **181.4 cfs**

HY-8 Culvert Analysis Report

Crossing Discharge Data

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

Minimum Flow: 80.3 cfs

Design Flow: 106.7 cfs

Maximum Flow: 181.4 cfs

Table 1 - Summary of Culvert Flows at Crossing: South02-I-95 (Proposed)

Headwater Elevation (ft)	Total Discharge (cfs)	South02-I-95 (Proposed) Discharge (cfs)	Roadway Discharge (cfs)	Iterations
25.05	80.30	80.30	0.00	1
25.12	90.41	90.41	0.00	1
25.20	100.52	100.52	0.00	1
25.25	106.70	106.70	0.00	1
25.38	120.74	120.74	0.00	1
25.49	130.85	130.85	0.00	1
25.60	140.96	140.96	0.00	1
25.72	151.07	151.07	0.00	1
25.85	161.18	161.18	0.00	1
25.98	171.29	171.29	0.00	1
26.13	181.40	181.40	0.00	1
30.39	359.12	359.12	0.00	Overtopping

Rating Curve Plot for Crossing: South02-I-95 (Proposed)

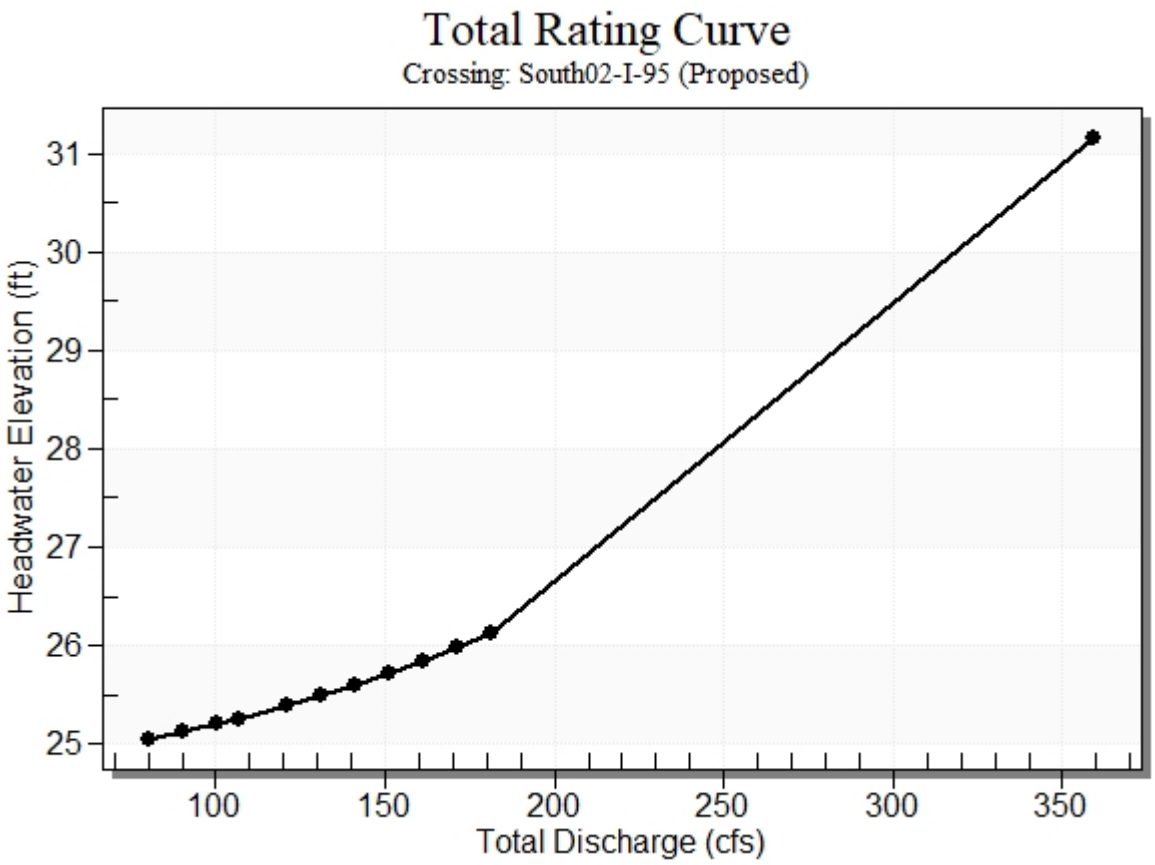


Table 2 - Culvert Summary Table: South02-I-95 (Proposed)

Total Discharge (cfs)	Culvert Discharge (cfs)	Headwater Elevation (ft)	Inlet Control Depth (ft)	Outlet Control Depth (ft)	Flow Type	Normal Depth (ft)	Critical Depth (ft)	Outlet Depth (ft)	Tailwater Depth (ft)	Outlet Velocity (ft/s)	Tailwater Velocity (ft/s)
80.30	80.30	25.05	2.712	4.422	4-FFf	1.635	1.599	4.000	4.160	2.868	0.000
90.41	90.41	25.12	2.929	4.492	4-FFf	1.778	1.730	4.000	4.160	3.229	0.000
100.52	100.52	25.20	3.139	4.570	4-FFf	1.913	1.857	4.000	4.160	3.590	0.000
106.70	106.70	25.25	3.265	4.622	4-FFf	1.994	1.932	4.000	4.160	3.811	0.000
120.74	120.74	25.38	3.545	4.752	4-FFf	2.179	2.098	4.000	4.160	4.312	0.000
130.85	130.85	25.49	3.743	4.856	4-FFf	2.305	2.214	4.000	4.160	4.673	0.000
140.96	140.96	25.60	3.941	4.967	4-FFf	2.432	2.327	4.000	4.160	5.034	0.000
151.07	151.07	25.72	4.139	5.087	4-FFf	2.557	2.437	4.000	4.160	5.395	0.000
161.18	161.18	25.85	4.339	5.215	4-FFf	2.679	2.544	4.000	4.160	5.756	0.000
171.29	171.29	25.98	4.541	5.352	4-FFf	2.801	2.649	4.000	4.160	6.118	0.000
181.40	181.40	26.13	4.748	5.497	4-FFf	2.922	2.753	4.000	4.160	6.479	0.000

****

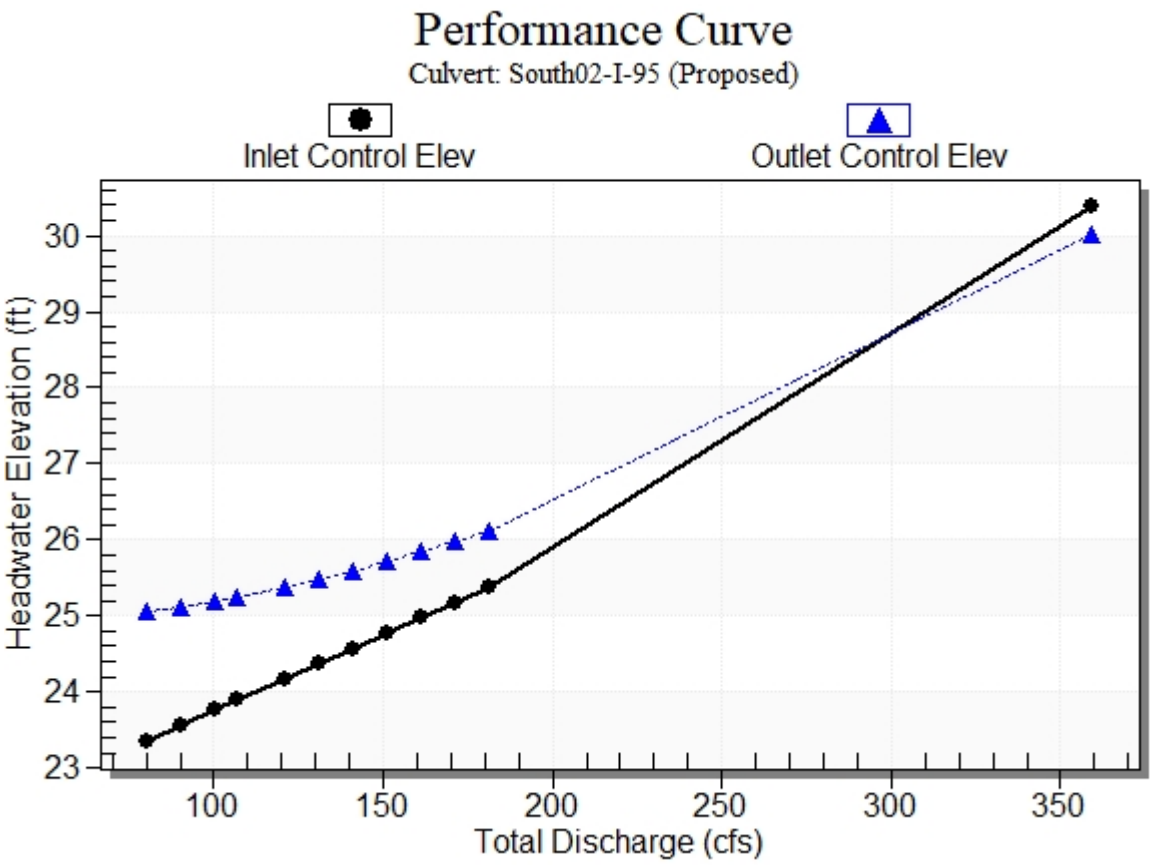
Straight Culvert

Inlet Elevation (invert): 20.63 ft, Outlet Elevation (invert): 20.13 ft

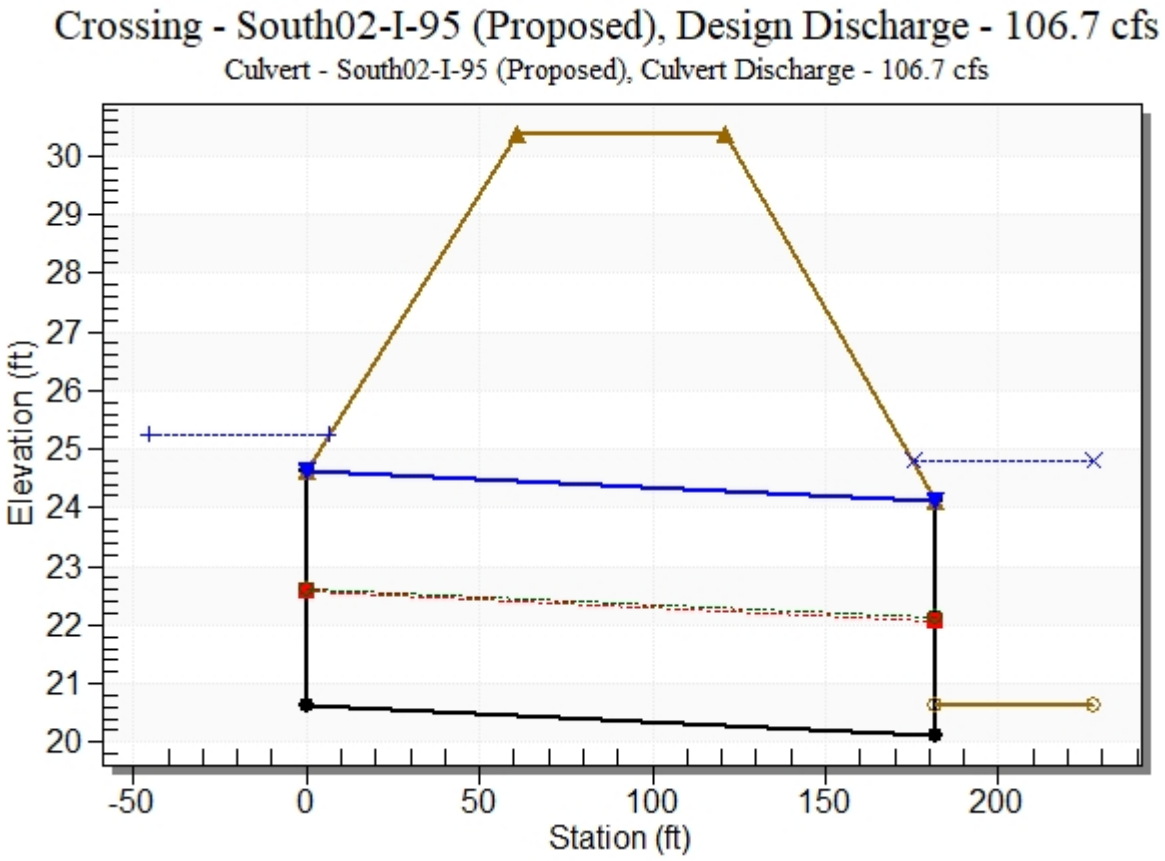
Culvert Length: 182.00 ft, Culvert Slope: 0.0027

****

Culvert Performance Curve Plot: South02-I-95 (Proposed)



Water Surface Profile Plot for Culvert: South02-I-95 (Proposed)



Site Data - South02-I-95 (Proposed)

Site Data Option: Culvert Invert Data

Inlet Station: 0.00 ft

Inlet Elevation: 20.63 ft

Outlet Station: 182.00 ft

Outlet Elevation: 20.13 ft

Number of Barrels: 1

Culvert Data Summary - South02-I-95 (Proposed)

Barrel Shape: Concrete Box

Barrel Span: 7.00 ft

Barrel Rise: 4.00 ft

Barrel Material: Concrete

Embedment: 0.00 in

Barrel Manning's n: 0.0120

Culvert Type: Straight

Inlet Configuration: Square Edge (90º) Headwall

Inlet Depression: NONE

Table 3 - Downstream Channel Rating Curve (Crossing: South02-I-95 (Proposed))

Flow (cfs)	Water Surface Elev (ft)	Depth (ft)
80.30	24.79	4.16
90.41	24.79	4.16
100.52	24.79	4.16
106.70	24.79	4.16
120.74	24.79	4.16
130.85	24.79	4.16
140.96	24.79	4.16
151.07	24.79	4.16
161.18	24.79	4.16
171.29	24.79	4.16
181.40	24.79	4.16

Tailwater Channel Data - South02-I-95 (Proposed)

Tailwater Channel Option: Enter Constant Tailwater Elevation

Constant Tailwater Elevation: 24.79 ft

Roadway Data for Crossing: South02-I-95 (Proposed)

Roadway Profile Shape: Constant Roadway Elevation

Crest Length: 250.00 ft

Crest Elevation: 30.39 ft

Roadway Surface: Paved

Roadway Top Width: 60.00 ft

HY-8 Culvert Analysis Report

Crossing Discharge Data

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

Minimum Flow: 80.3 cfs

Design Flow: 106.7 cfs

Maximum Flow: 181.4 cfs

Table 1 - Summary of Culvert Flows at Crossing: South02-I-95 (Proposed)

Headwater Elevation (ft)	Total Discharge (cfs)	South02-I-95 (Proposed) Discharge (cfs)	Roadway Discharge (cfs)	Iterations
25.05	80.30	80.30	0.00	1
25.12	90.41	90.41	0.00	1
25.20	100.52	100.52	0.00	1
25.25	106.70	106.70	0.00	1
25.38	120.74	120.74	0.00	1
25.49	130.85	130.85	0.00	1
25.60	140.96	140.96	0.00	1
25.72	151.07	151.07	0.00	1
25.85	161.18	161.18	0.00	1
25.98	171.29	171.29	0.00	1
26.13	181.40	181.40	0.00	1
30.39	359.12	359.12	0.00	Overtopping

Rating Curve Plot for Crossing: South02-I-95 (Proposed)

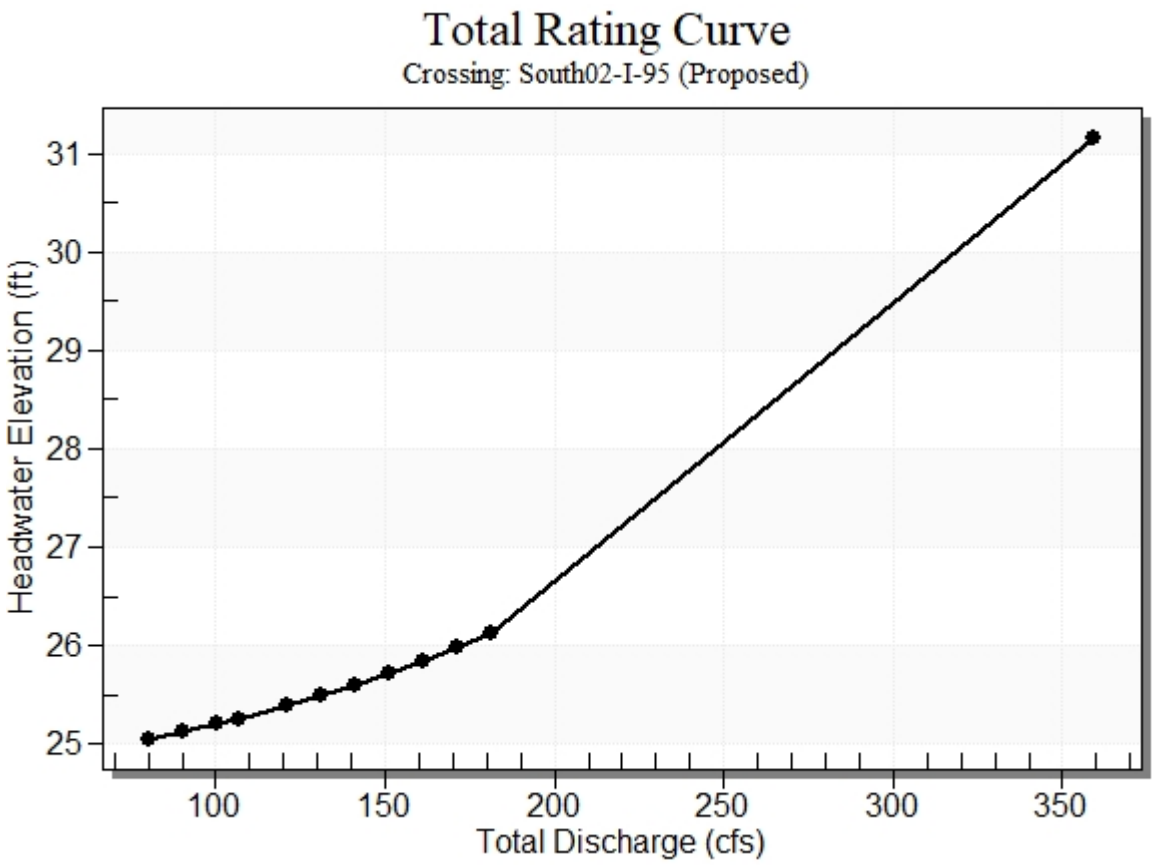


Table 2 - Culvert Summary Table: South02-I-95 (Proposed)

Total Discharge (cfs)	Culvert Discharge (cfs)	Headwater Elevation (ft)	Inlet Control Depth (ft)	Outlet Control Depth (ft)	Flow Type	Normal Depth (ft)	Critical Depth (ft)	Outlet Depth (ft)	Tailwater Depth (ft)	Outlet Velocity (ft/s)	Tailwater Velocity (ft/s)
80.30	80.30	25.05	2.712	4.422	4-FFf	1.635	1.599	4.000	4.160	2.868	0.000
90.41	90.41	25.12	2.929	4.492	4-FFf	1.778	1.730	4.000	4.160	3.229	0.000
100.52	100.52	25.20	3.139	4.570	4-FFf	1.913	1.857	4.000	4.160	3.590	0.000
106.70	106.70	25.25	3.265	4.622	4-FFf	1.994	1.932	4.000	4.160	3.811	0.000
120.74	120.74	25.38	3.545	4.752	4-FFf	2.179	2.098	4.000	4.160	4.312	0.000
130.85	130.85	25.49	3.743	4.856	4-FFf	2.305	2.214	4.000	4.160	4.673	0.000
140.96	140.96	25.60	3.941	4.967	4-FFf	2.432	2.327	4.000	4.160	5.034	0.000
151.07	151.07	25.72	4.139	5.087	4-FFf	2.557	2.437	4.000	4.160	5.395	0.000
161.18	161.18	25.85	4.339	5.215	4-FFf	2.679	2.544	4.000	4.160	5.756	0.000
171.29	171.29	25.98	4.541	5.352	4-FFf	2.801	2.649	4.000	4.160	6.118	0.000
181.40	181.40	26.13	4.748	5.497	4-FFf	2.922	2.753	4.000	4.160	6.479	0.000

****

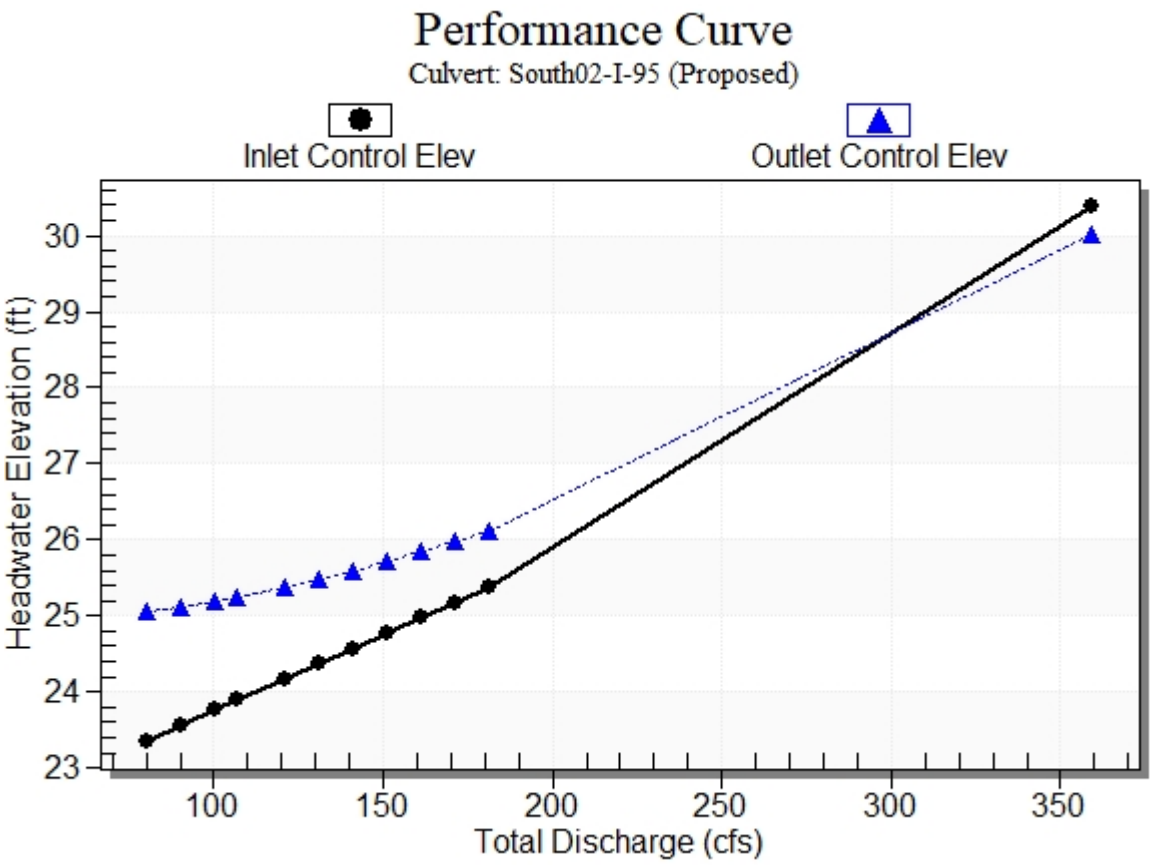
Straight Culvert

Inlet Elevation (invert): 20.63 ft, Outlet Elevation (invert): 20.13 ft

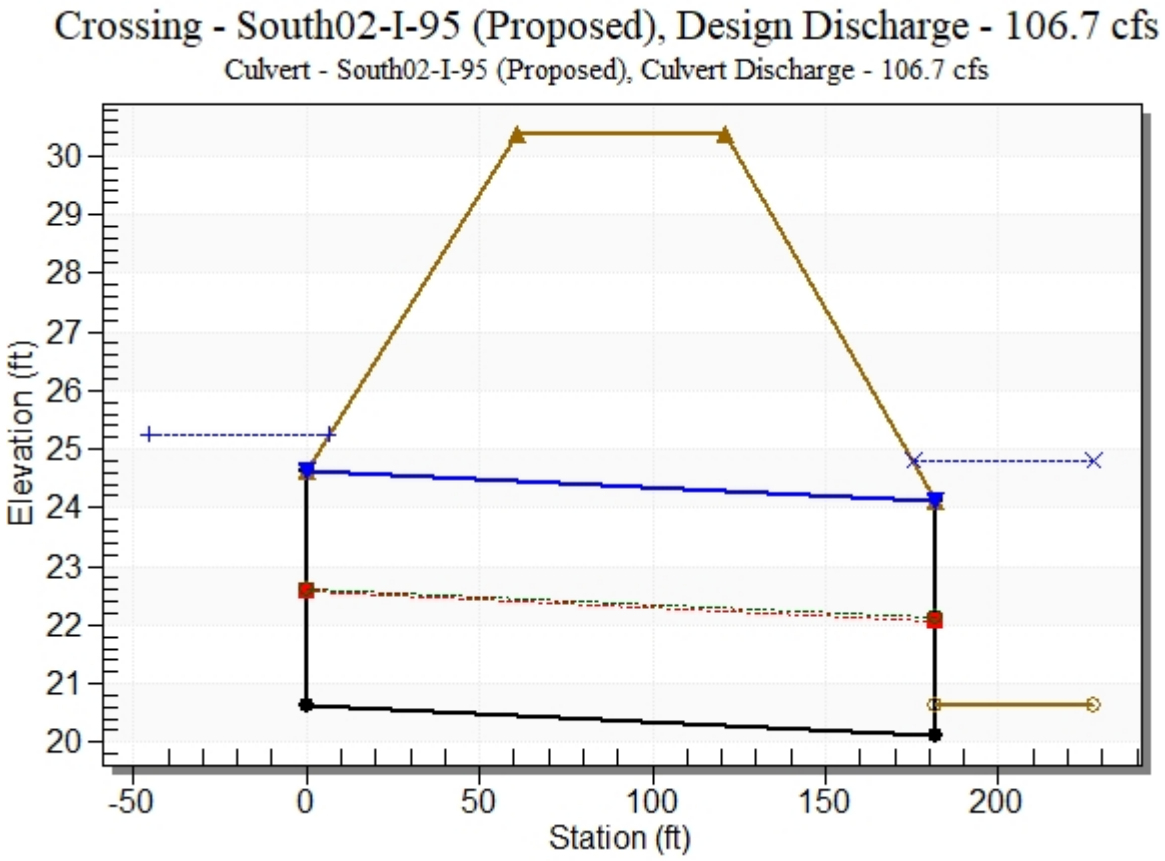
Culvert Length: 182.00 ft, Culvert Slope: 0.0027

****

Culvert Performance Curve Plot: South02-I-95 (Proposed)



Water Surface Profile Plot for Culvert: South02-I-95 (Proposed)



Site Data - South02-I-95 (Proposed)

Site Data Option: Culvert Invert Data

Inlet Station: 0.00 ft

Inlet Elevation: 20.63 ft

Outlet Station: 182.00 ft

Outlet Elevation: 20.13 ft

Number of Barrels: 1

Culvert Data Summary - South02-I-95 (Proposed)

Barrel Shape: Concrete Box

Barrel Span: 7.00 ft

Barrel Rise: 4.00 ft

Barrel Material: Concrete

Embedment: 0.00 in

Barrel Manning's n: 0.0120

Culvert Type: Straight

Inlet Configuration: Square Edge (90º) Headwall

Inlet Depression: NONE

Table 3 - Downstream Channel Rating Curve (Crossing: South02-I-95 (Proposed))

Flow (cfs)	Water Surface Elev (ft)	Depth (ft)
80.30	24.79	4.16
90.41	24.79	4.16
100.52	24.79	4.16
106.70	24.79	4.16
120.74	24.79	4.16
130.85	24.79	4.16
140.96	24.79	4.16
151.07	24.79	4.16
161.18	24.79	4.16
171.29	24.79	4.16
181.40	24.79	4.16

Tailwater Channel Data - South02-I-95 (Proposed)

Tailwater Channel Option: Enter Constant Tailwater Elevation

Constant Tailwater Elevation: 24.79 ft

Roadway Data for Crossing: South02-I-95 (Proposed)

Roadway Profile Shape: Constant Roadway Elevation

Crest Length: 250.00 ft

Crest Elevation: 30.39 ft

Roadway Surface: Paved

Roadway Top Width: 60.00 ft

HYDROLOGIC ANALYSIS

		DATE
made by:	DHR	11-Jul-20
checked by:		
Stantec job #:		

PROJECT: I-95 Pioneer Trail Interchange

LOCATION: South03-I-95

Rational Equation: $Q_T = X_T * C_T * i_{tc} * A_T$

Q_T = Peak Runoff for Return Period T (cfs).

X_T = Frequency Factor for Return Period T.

C_T = Average Runoff Coefficient for Return Period T.

i_{tc} = Average Rainfall Intensity for Return Period T (in/hr).

A_T = Total Watershed Drainage Area (ac).

$$C_T = \frac{C_1*A_1 + C_2*A_2 + C_3*A_3}{A_T}$$

A_1=	1.44 ac	C_1 = 0.95	Rooftops and Pavement
A_2=	10.16 ac	C_2 = 0.15	Woodlands (Rolling with Sandy Soils)
A_3=	0.00 ac	C_3 = 0.25	Grass (Rolling with Sandy Soils)

A_T= 11.60 ac (per previous permit, 118421-2)

C_T = 0.25

$X_{25\ yr}$ = 1.1	$X_{50\ yr}$ = 1.2	$X_{100\ yr}$ = 1.25
$i_{25\ yr}$ = 2.6 in/hr	$i_{50\ yr}$ = 2.9 in/hr	$i_{100\ yr}$ = 4.0 in/hr

i = based on time of concentration from Ditch Calculations -> t_c = 103 min (per previous permit, 118421-2)

$Q_{25\ yr}$ = 8.2 cfs	**$Q_{50\ yr}$ = 9.9 cfs**	**$Q_{100\ yr}$ = 14.5 cfs**

$Q_{500\ yr}$ = 1.7 x $Q_{100\ yr}$ = **24.6 cfs**

HY-8 Culvert Analysis Report

Crossing Discharge Data

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

Minimum Flow: 9.9 cfs

Design Flow: 14.5 cfs

Maximum Flow: 24.6 cfs

Table 1 - Summary of Culvert Flows at Crossing: South03-I-95 (Existing)

Headwater Elevation (ft)	Total Discharge (cfs)	South03-I-95 (Existing) Discharge (cfs)	Roadway Discharge (cfs)	Iterations
25.54	9.90	9.90	0.00	1
25.54	11.37	11.37	0.00	1
25.55	12.84	12.84	0.00	1
25.56	14.31	14.31	0.00	1
25.56	14.50	14.50	0.00	1
25.57	17.25	17.25	0.00	1
25.58	18.72	18.72	0.00	1
25.59	20.19	20.19	0.00	1
25.60	21.66	21.66	0.00	1
25.61	23.13	23.13	0.00	1
25.63	24.60	24.60	0.00	1
30.31	165.84	165.84	0.00	Overtopping

Rating Curve Plot for Crossing: South03-I-95 (Existing)

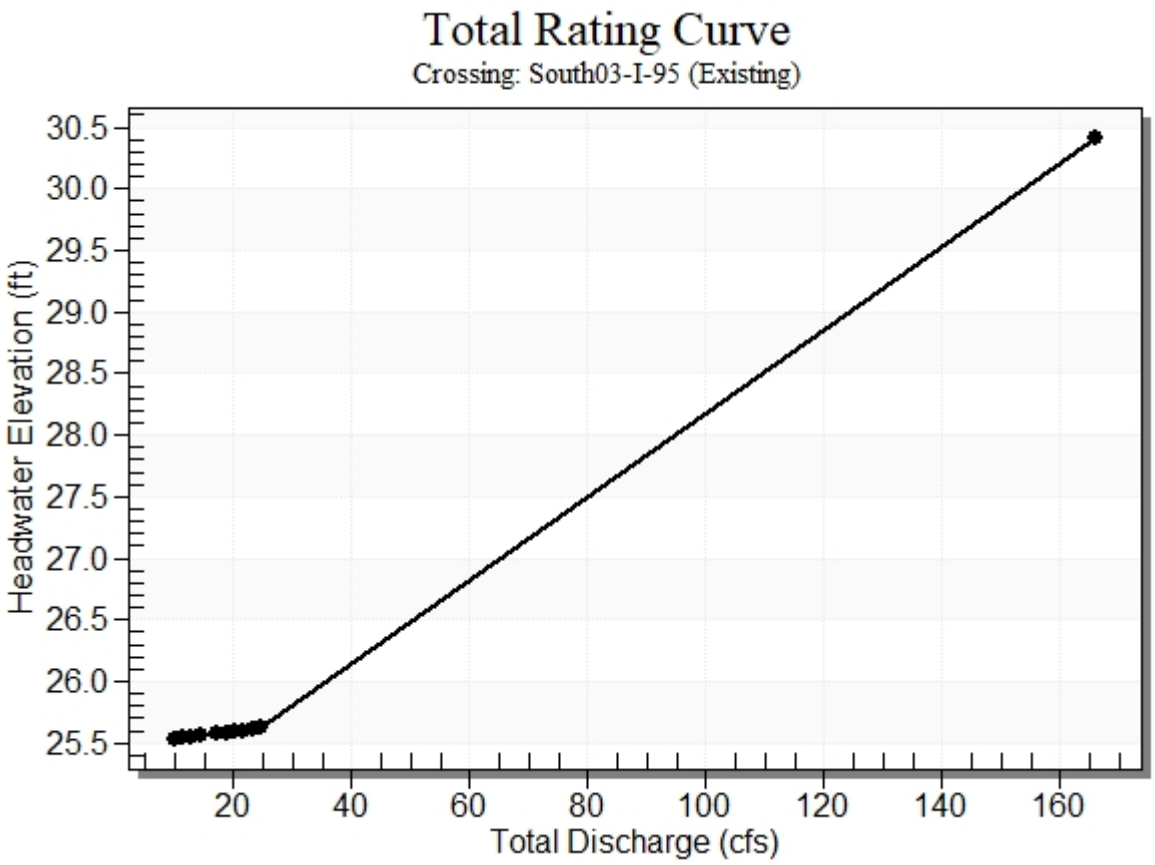


Table 2 - Culvert Summary Table: South03-I-95 (Existing)

Total Discharge (cfs)	Culvert Discharge (cfs)	Headwater Elevation (ft)	Inlet Control Depth (ft)	Outlet Control Depth (ft)	Flow Type	Normal Depth (ft)	Critical Depth (ft)	Outlet Depth (ft)	Tailwater Depth (ft)	Outlet Velocity (ft/s)	Tailwater Velocity (ft/s)
9.90	9.90	25.54	0.947	3.017	4-FFf	0.822	0.693	3.000	3.000	0.700	0.000
11.37	11.37	25.54	1.020	3.023	4-FFf	0.877	0.745	3.000	3.000	0.804	0.000
12.84	12.84	25.55	1.090	3.029	4-FFf	0.932	0.793	3.000	3.000	0.908	0.000
14.31	14.31	25.56	1.157	3.036	4-FFf	0.988	0.839	3.000	3.000	1.012	0.000
14.50	14.50	25.56	1.165	3.037	4-FFf	0.995	0.842	3.000	3.000	1.026	0.000
17.25	17.25	25.57	1.273	3.052	4-FFf	1.098	0.923	3.000	3.000	1.220	0.000
18.72	18.72	25.58	1.329	3.061	4-FFf	1.145	0.963	3.000	3.000	1.324	0.000
20.19	20.19	25.59	1.385	3.071	4-FFf	1.191	1.002	3.000	3.000	1.428	0.000
21.66	21.66	25.60	1.439	3.082	4-FFf	1.238	1.040	3.000	3.000	1.532	0.000
23.13	23.13	25.61	1.491	3.093	4-FFf	1.285	1.073	3.000	3.000	1.636	0.000
24.60	24.60	25.63	1.550	3.105	4-FFf	1.332	1.109	3.000	3.000	1.740	0.000

****

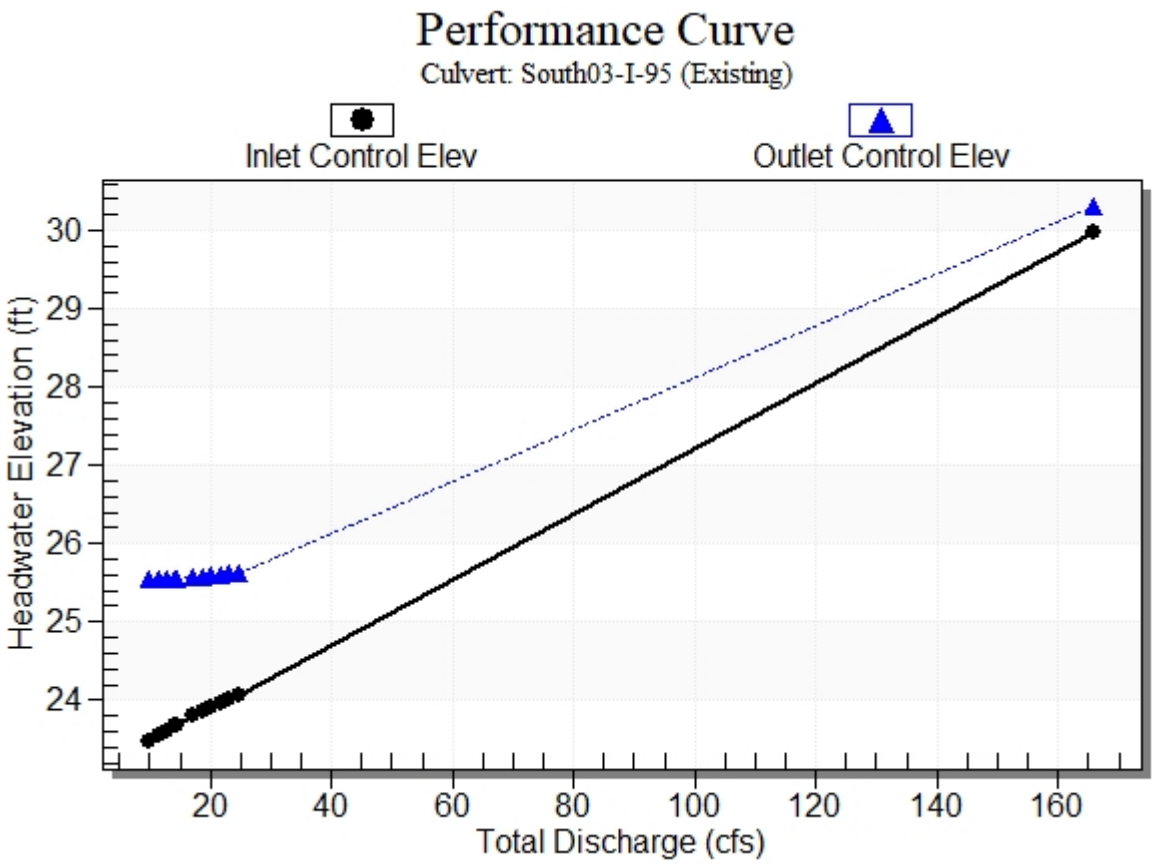
Straight Culvert

Inlet Elevation (invert): 22.52 ft, Outlet Elevation (invert): 22.31 ft

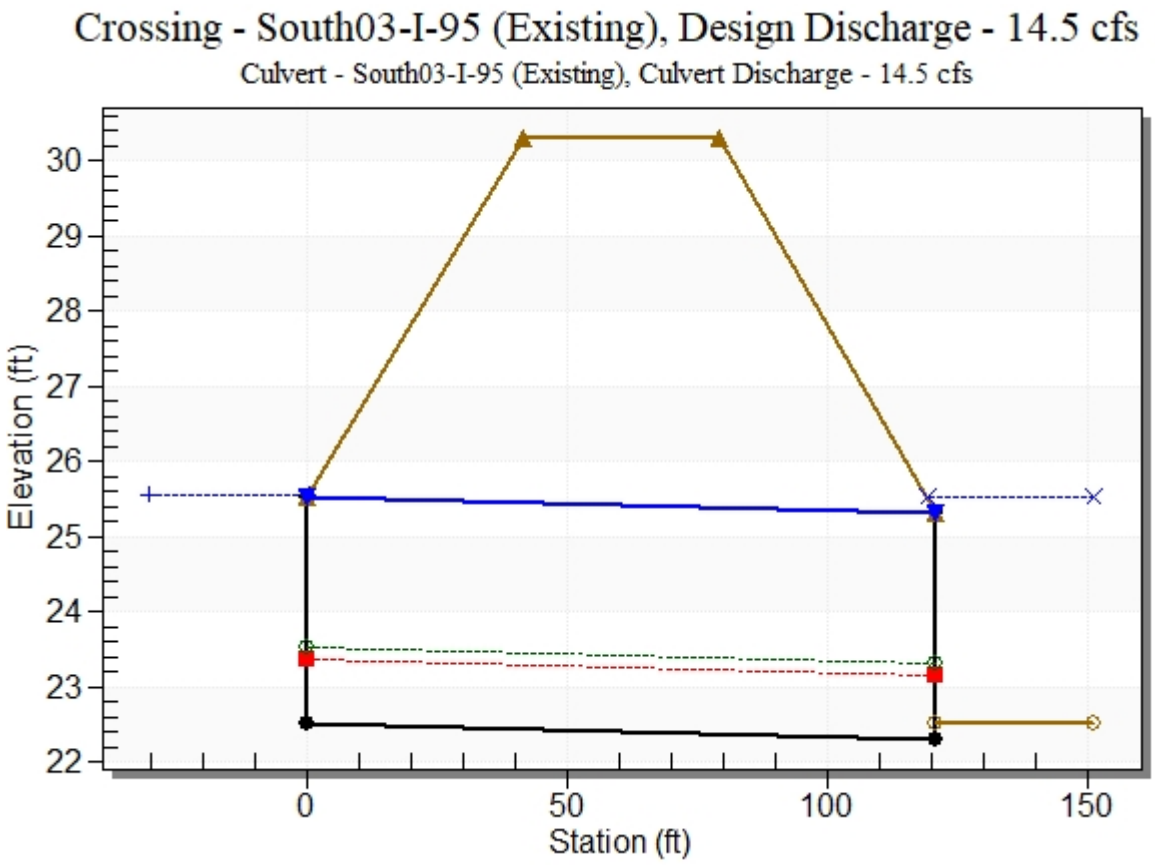
Culvert Length: 121.00 ft, Culvert Slope: 0.0017

****

Culvert Performance Curve Plot: South03-I-95 (Existing)



Water Surface Profile Plot for Culvert: South03-I-95 (Existing)



Site Data - South03-I-95 (Existing)

Site Data Option: Culvert Invert Data

Inlet Station: 0.00 ft

Inlet Elevation: 22.52 ft

Outlet Station: 121.00 ft

Outlet Elevation: 22.31 ft

Number of Barrels: 2

Culvert Data Summary - South03-I-95 (Existing)

Barrel Shape: Circular

Barrel Diameter: 3.00 ft

Barrel Material: Concrete

Embedment: 0.00 in

Barrel Manning's n: 0.0120

Culvert Type: Straight

Inlet Configuration: Square Edge with Headwall

Inlet Depression: NONE

Table 3 - Downstream Channel Rating Curve (Crossing: South03-I-95 (Existing))

Flow (cfs)	Water Surface Elev (ft)	Depth (ft)
9.90	25.52	3.00
11.37	25.52	3.00
12.84	25.52	3.00
14.31	25.52	3.00
14.50	25.52	3.00
17.25	25.52	3.00
18.72	25.52	3.00
20.19	25.52	3.00
21.66	25.52	3.00
23.13	25.52	3.00
24.60	25.52	3.00

Tailwater Channel Data - South03-I-95 (Existing)

Tailwater Channel Option: Enter Constant Tailwater Elevation

Constant Tailwater Elevation: 25.52 ft

Roadway Data for Crossing: South03-I-95 (Existing)

Roadway Profile Shape: Constant Roadway Elevation

Crest Length: 250.00 ft

Crest Elevation: 30.31 ft

Roadway Surface: Paved

Roadway Top Width: 38.00 ft

HY-8 Culvert Analysis Report

Crossing Discharge Data

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

Minimum Flow: 9.9 cfs

Design Flow: 14.5 cfs

Maximum Flow: 24.6 cfs

Table 1 - Summary of Culvert Flows at Crossing: South03-I-95 (Proposed)

Headwater Elevation (ft)	Total Discharge (cfs)	South03-I-95 (Proposed) Discharge (cfs)	Roadway Discharge (cfs)	Iterations
25.54	9.90	9.90	0.00	1
25.54	11.37	11.37	0.00	1
25.55	12.84	12.84	0.00	1
25.56	14.31	14.31	0.00	1
25.56	14.50	14.50	0.00	1
25.57	17.25	17.25	0.00	1
25.58	18.72	18.72	0.00	1
25.59	20.19	20.19	0.00	1
25.61	21.66	21.66	0.00	1
25.62	23.13	23.13	0.00	1
25.63	24.60	24.60	0.00	1
30.31	161.70	161.70	0.00	Overtopping

Rating Curve Plot for Crossing: South03-I-95 (Proposed)

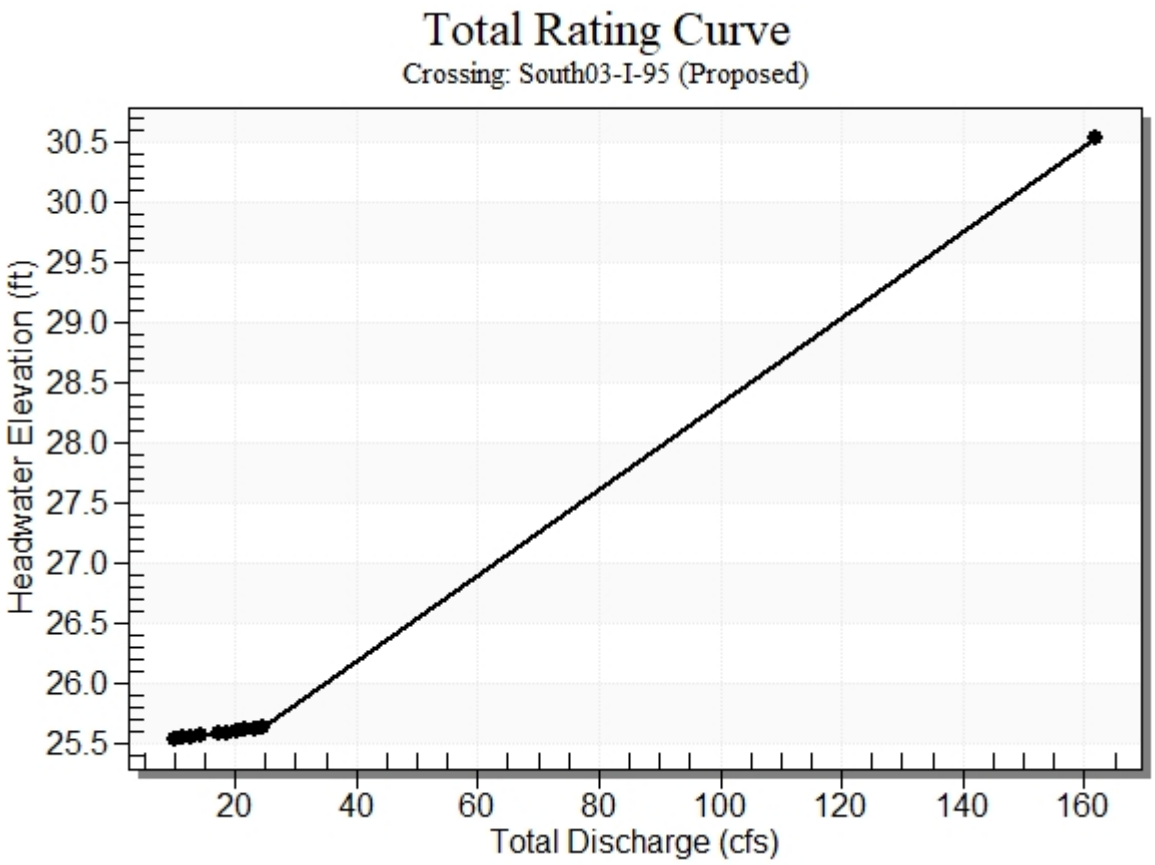


Table 2 - Culvert Summary Table: South03-I-95 (Proposed)

Total Discharge (cfs)	Culvert Discharge (cfs)	Headwater Elevation (ft)	Inlet Control Depth (ft)	Outlet Control Depth (ft)	Flow Type	Normal Depth (ft)	Critical Depth (ft)	Outlet Depth (ft)	Tailwater Depth (ft)	Outlet Velocity (ft/s)	Tailwater Velocity (ft/s)
9.90	9.90	25.54	0.948	2.998	3-M1f	0.870	0.693	3.000	2.980	0.700	0.000
11.37	11.37	25.54	1.020	3.004	3-M1f	0.933	0.745	3.000	2.980	0.804	0.000
12.84	12.84	25.55	1.090	3.010	3-M1f	0.996	0.793	3.000	2.980	0.908	0.000
14.31	14.31	25.56	1.157	3.018	3-M1f	1.058	0.839	3.000	2.980	1.012	0.000
14.50	14.50	25.56	1.165	3.019	3-M1f	1.067	0.842	3.000	2.980	1.026	0.000
17.25	17.25	25.57	1.273	3.035	3-M1f	1.170	0.923	3.000	2.980	1.220	0.000
18.72	18.72	25.58	1.330	3.044	4-FFf	1.223	0.963	3.000	2.980	1.324	0.000
20.19	20.19	25.59	1.385	3.055	4-FFf	1.276	1.002	3.000	2.980	1.428	0.000
21.66	21.66	25.61	1.439	3.066	4-FFf	1.329	1.040	3.000	2.980	1.532	0.000
23.13	23.13	25.62	1.492	3.078	4-FFf	1.381	1.073	3.000	2.980	1.636	0.000
24.60	24.60	25.63	1.551	3.091	4-FFf	1.430	1.109	3.000	2.980	1.740	0.000

****

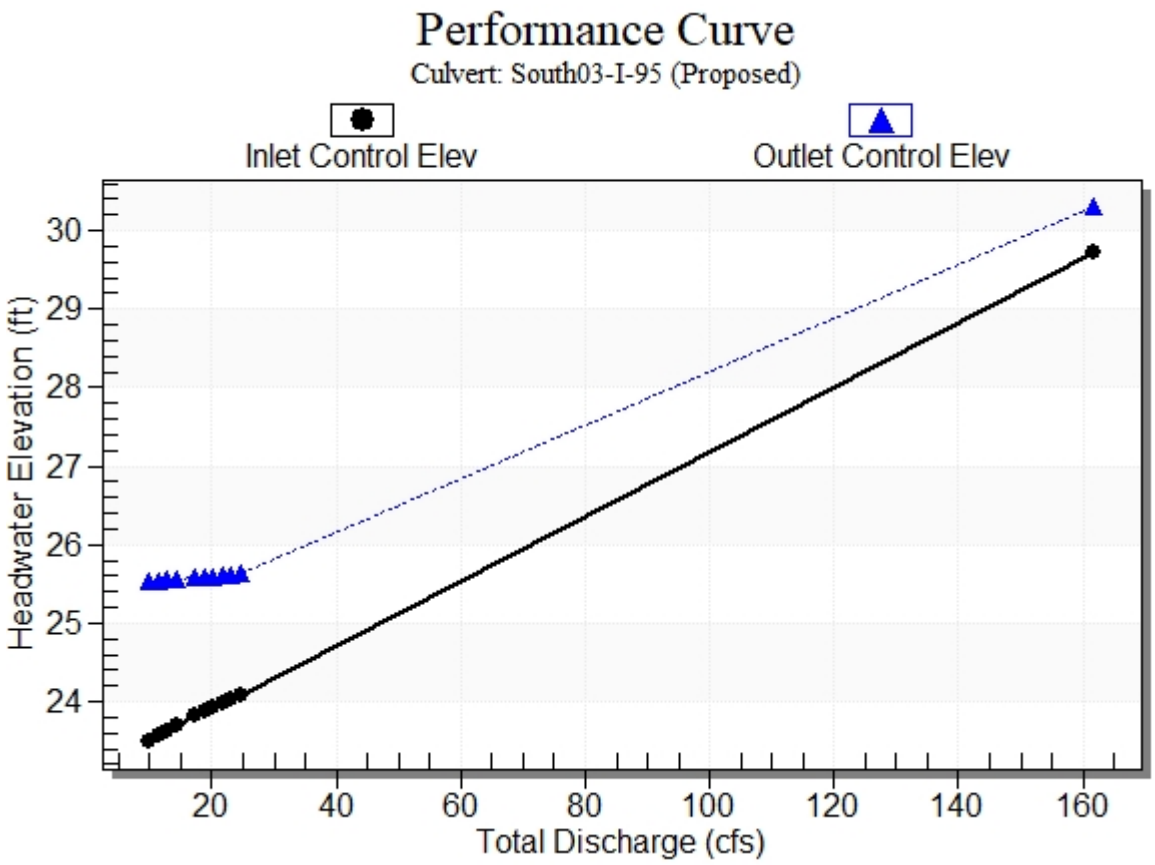
Straight Culvert

Inlet Elevation (invert): 22.54 ft, Outlet Elevation (invert): 22.35 ft

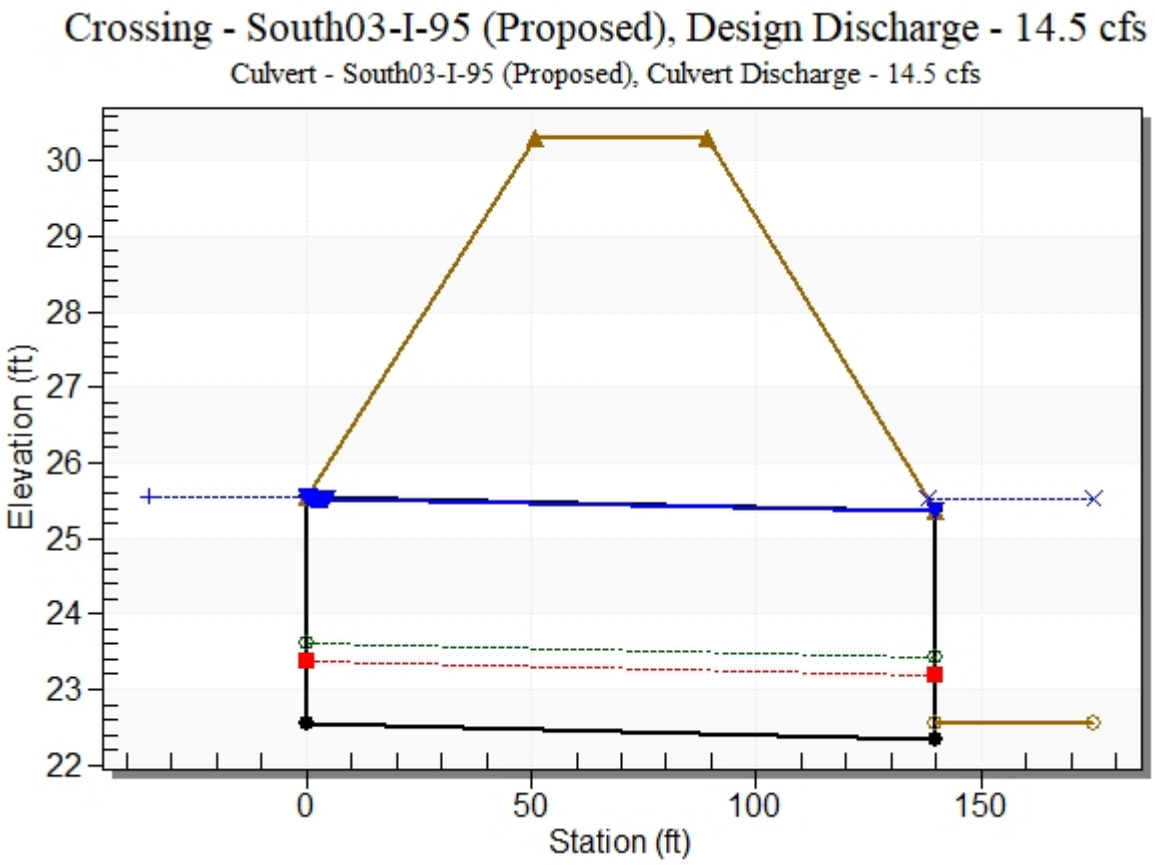
Culvert Length: 140.00 ft, Culvert Slope: 0.0014

****

Culvert Performance Curve Plot: South03-I-95 (Proposed)



Water Surface Profile Plot for Culvert: South03-I-95 (Proposed)



Site Data - South03-I-95 (Proposed)

Site Data Option: Culvert Invert Data

Inlet Station: 0.00 ft

Inlet Elevation: 22.54 ft

Outlet Station: 140.00 ft

Outlet Elevation: 22.35 ft

Number of Barrels: 2

Culvert Data Summary - South03-I-95 (Proposed)

Barrel Shape: Circular

Barrel Diameter: 3.00 ft

Barrel Material: Concrete

Embedment: 0.00 in

Barrel Manning's n: 0.0120

Culvert Type: Straight

Inlet Configuration: Square Edge with Headwall

Inlet Depression: NONE

Table 3 - Downstream Channel Rating Curve (Crossing: South03-I-95 (Proposed))

Flow (cfs)	Water Surface Elev (ft)	Depth (ft)
9.90	25.52	2.98
11.37	25.52	2.98
12.84	25.52	2.98
14.31	25.52	2.98
14.50	25.52	2.98
17.25	25.52	2.98
18.72	25.52	2.98
20.19	25.52	2.98
21.66	25.52	2.98
23.13	25.52	2.98
24.60	25.52	2.98

Tailwater Channel Data - South03-I-95 (Proposed)

Tailwater Channel Option: Enter Constant Tailwater Elevation

Constant Tailwater Elevation: 25.52 ft

Roadway Data for Crossing: South03-I-95 (Proposed)

Roadway Profile Shape: Constant Roadway Elevation

Crest Length: 250.00 ft

Crest Elevation: 30.31 ft

Roadway Surface: Paved

Roadway Top Width: 38.00 ft

HYDROLOGIC ANALYSIS

		DATE
made by:	DHR	11-Jul-20
checked by:		
Stantec job #:		

PROJECT: I-95 Pioneer Trail Interchange

LOCATION: South04-I-95

Rational Equation: $Q_T = X_T * C_T * i_{tc} * A_T$

Q_T = Peak Runoff for Return Period T (cfs).

X_T = Frequency Factor for Return Period T.

C_T = Average Runoff Coefficient for Return Period T.

i_{tc} = Average Rainfall Intensity for Return Period T (in/hr).

A_T = Total Watershed Drainage Area (ac).

$$C_T = \frac{C_1*A_1 + C_2*A_2 + C_3*A_3}{A_T}$$

A_1= 0.10 ac	C_1 = 0.95	Rooftops and Pavement
A_2= 1.86 ac	C_2 = 0.15	Woodlands (Rolling with Sandy Soils)
A_3= 0.00 ac	C_3 = 0.25	Grass (Rolling with Sandy Soils)

A_T= 1.96 ac (per previous permit, 118421-2)

C_T = 0.19

$X_{25\ yr}$ = 1.1	$X_{50\ yr}$ = 1.2	$X_{100\ yr}$ = 1.25
$i_{25\ yr}$ = 7.2 in/hr	$i_{50\ yr}$ = 7.8 in/hr	$i_{100\ yr}$ = 8.5 in/hr

i = based on time of concentration from Ditch Calculations -> t_c = 15 min (per previous permit, 118421-2)

$Q_{25\ yr}$ = 3.0 cfs	**$Q_{50\ yr}$ = 3.5 cfs**	**$Q_{100\ yr}$ = 4.0 cfs**

$Q_{500\ yr}$ = 1.7 x $Q_{100\ yr}$ = **6.8 cfs**

HY-8 Culvert Analysis Report

Crossing Discharge Data

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

Minimum Flow: 3 cfs

Design Flow: 7.8 cfs

Maximum Flow: 8.5 cfs

Table 1 - Summary of Culvert Flows at Crossing: South04-I-95 (Existing)

Headwater Elevation (ft)	Total Discharge (cfs)	South04-I-95 (Existing) Discharge (cfs)	Roadway Discharge (cfs)	Iterations
25.98	3.00	3.00	0.00	1
25.98	3.55	3.55	0.00	1
25.98	4.10	4.10	0.00	1
25.98	4.65	4.65	0.00	1
25.98	5.20	5.20	0.00	1
25.99	5.75	5.75	0.00	1
25.99	6.30	6.30	0.00	1
25.99	6.85	6.85	0.00	1
25.99	7.40	7.40	0.00	1
25.99	7.80	7.80	0.00	1
25.99	8.50	8.50	0.00	1
30.39	159.12	159.12	0.00	Overtopping

Rating Curve Plot for Crossing: South04-I-95 (Existing)

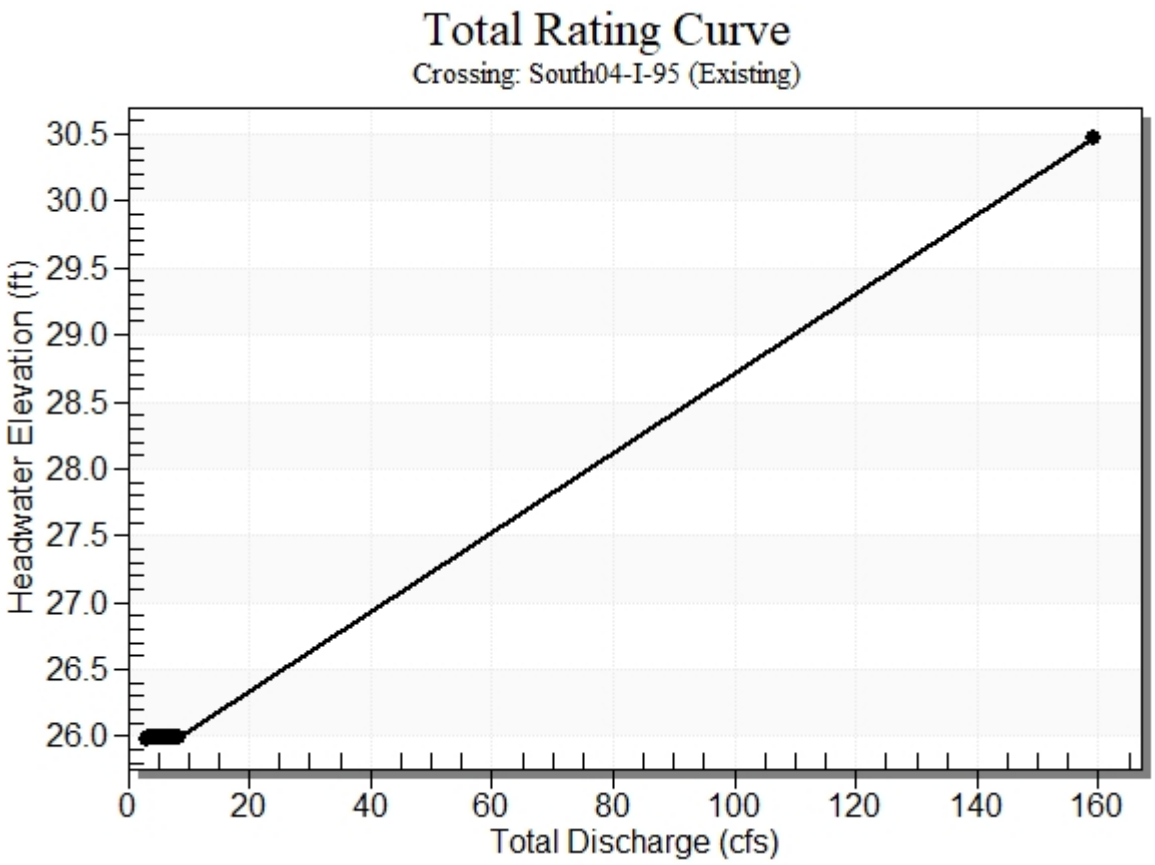


Table 2 - Culvert Summary Table: South04-I-95 (Existing)

Total Discharge (cfs)	Culvert Discharge (cfs)	Headwater Elevation (ft)	Inlet Control Depth (ft)	Outlet Control Depth (ft)	Flow Type	Normal Depth (ft)	Critical Depth (ft)	Outlet Depth (ft)	Tailwater Depth (ft)	Outlet Velocity (ft/s)	Tailwater Velocity (ft/s)
3.00	3.00	25.98	0.505	3.002	4-FFf	0.409	0.375	3.000	3.000	0.212	0.000
3.55	3.55	25.98	0.551	3.002	4-FFf	0.450	0.409	3.000	3.000	0.251	0.000
4.10	4.10	25.98	0.595	3.003	4-FFf	0.491	0.441	3.000	3.000	0.290	0.000
4.65	4.65	25.98	0.637	3.004	4-FFf	0.531	0.471	3.000	3.000	0.329	0.000
5.20	5.20	25.98	0.677	3.005	4-FFf	0.561	0.499	3.000	3.000	0.368	0.000
5.75	5.75	25.99	0.716	3.006	4-FFf	0.586	0.525	3.000	3.000	0.407	0.000
6.30	6.30	25.99	0.753	3.007	4-FFf	0.611	0.551	3.000	3.000	0.446	0.000
6.85	6.85	25.99	0.790	3.008	4-FFf	0.636	0.572	3.000	3.000	0.485	0.000
7.40	7.40	25.99	0.825	3.010	4-FFf	0.660	0.595	3.000	3.000	0.523	0.000
7.80	7.80	25.99	0.837	3.011	4-FFf	0.678	0.612	3.000	3.000	0.552	0.000
8.50	8.50	25.99	0.874	3.013	4-FFf	0.710	0.640	3.000	3.000	0.601	0.000

****

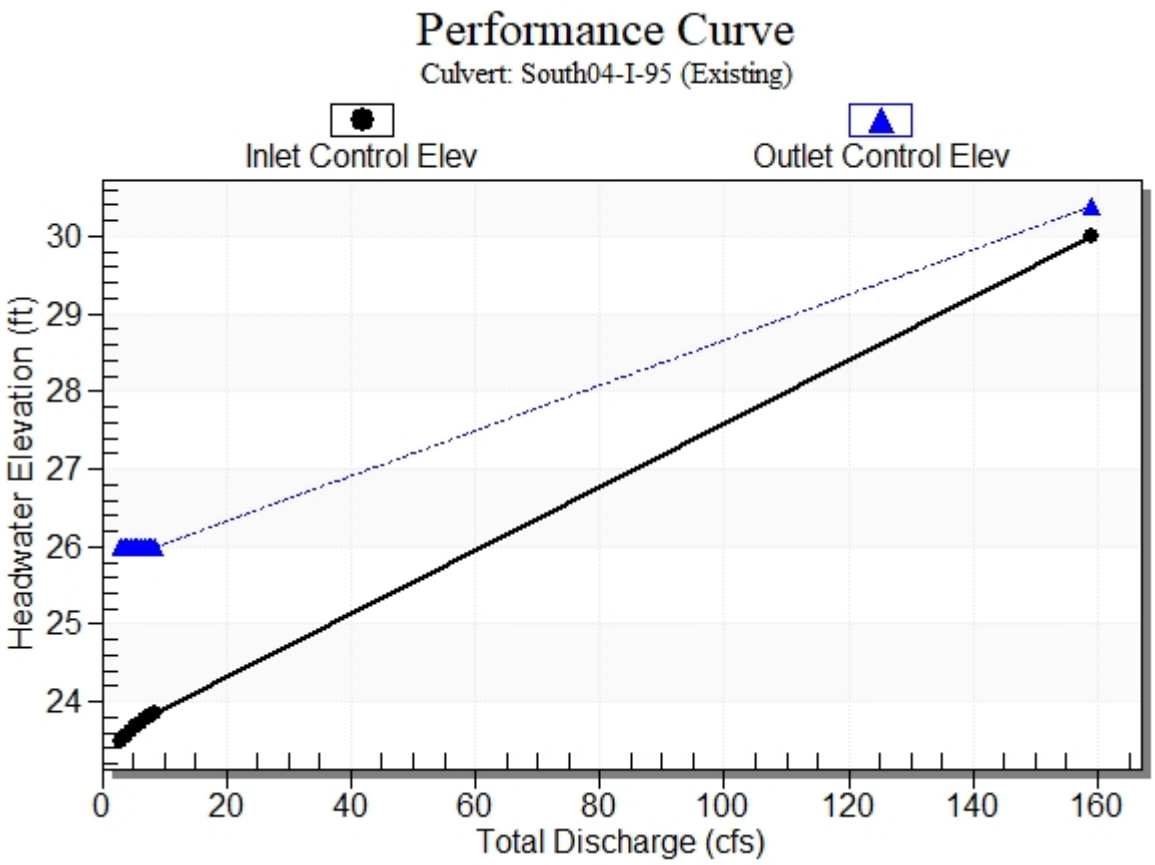
Straight Culvert

Inlet Elevation (invert): 22.98 ft, Outlet Elevation (invert): 22.72 ft

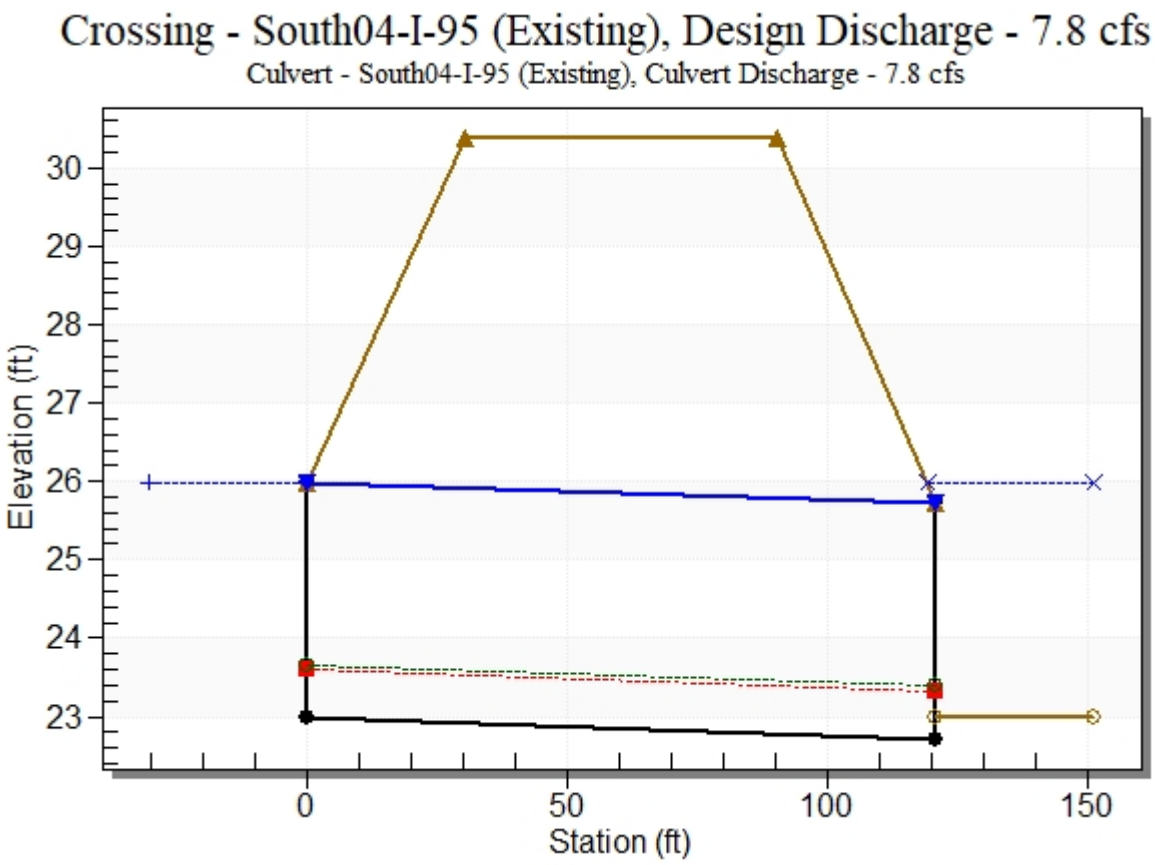
Culvert Length: 121.00 ft, Culvert Slope: 0.0021

****

Culvert Performance Curve Plot: South04-I-95 (Existing)



Water Surface Profile Plot for Culvert: South04-I-95 (Existing)



Site Data - South04-I-95 (Existing)

Site Data Option: Culvert Invert Data

Inlet Station: 0.00 ft

Inlet Elevation: 22.98 ft

Outlet Station: 121.00 ft

Outlet Elevation: 22.72 ft

Number of Barrels: 2

Culvert Data Summary - South04-I-95 (Existing)

Barrel Shape: Circular

Barrel Diameter: 3.00 ft

Barrel Material: Concrete

Embedment: 0.00 in

Barrel Manning's n: 0.0120

Culvert Type: Straight

Inlet Configuration: Square Edge with Headwall

Inlet Depression: NONE

Table 3 - Downstream Channel Rating Curve (Crossing: South04-I-95 (Existing))

Flow (cfs)	Water Surface Elev (ft)	Depth (ft)
3.00	25.98	3.00
3.55	25.98	3.00
4.10	25.98	3.00
4.65	25.98	3.00
5.20	25.98	3.00
5.75	25.98	3.00
6.30	25.98	3.00
6.85	25.98	3.00
7.40	25.98	3.00
7.80	25.98	3.00
8.50	25.98	3.00

Tailwater Channel Data - South04-I-95 (Existing)

Tailwater Channel Option: Enter Constant Tailwater Elevation

Constant Tailwater Elevation: 25.98 ft

Roadway Data for Crossing: South04-I-95 (Existing)

Roadway Profile Shape: Constant Roadway Elevation

Crest Length: 250.00 ft

Crest Elevation: 30.39 ft

Roadway Surface: Paved

Roadway Top Width: 60.00 ft

HY-8 Culvert Analysis Report

Crossing Discharge Data

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

Minimum Flow: 3 cfs

Design Flow: 7.8 cfs

Maximum Flow: 8.5 cfs

Table 1 - Summary of Culvert Flows at Crossing: South04-I-95 (Proposed)

Headwater Elevation (ft)	Total Discharge (cfs)	South04-I-95 (Proposed) Discharge (cfs)	Roadway Discharge (cfs)	Iterations
25.98	3.00	3.00	0.00	1
25.98	3.55	3.55	0.00	1
25.98	4.10	4.10	0.00	1
25.98	4.65	4.65	0.00	1
25.98	5.20	5.20	0.00	1
25.99	5.75	5.75	0.00	1
25.99	6.30	6.30	0.00	1
25.99	6.85	6.85	0.00	1
25.99	7.40	7.40	0.00	1
25.99	7.80	7.80	0.00	1
25.99	8.50	8.50	0.00	1
30.39	159.12	159.12	0.00	Overtopping

Rating Curve Plot for Crossing: South04-I-95 (Proposed)

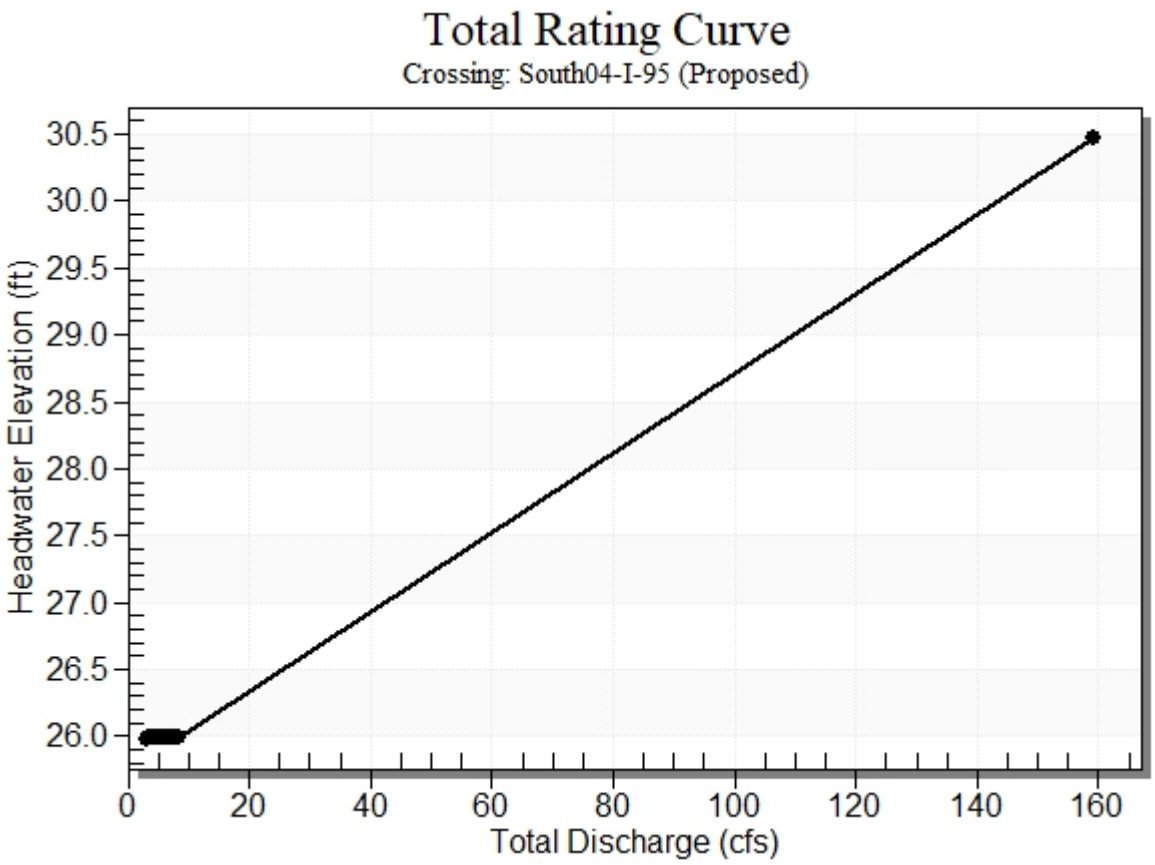


Table 2 - Culvert Summary Table: South04-I-95 (Proposed)

Total Discharge (cfs)	Culvert Discharge (cfs)	Headwater Elevation (ft)	Inlet Control Depth (ft)	Outlet Control Depth (ft)	Flow Type	Normal Depth (ft)	Critical Depth (ft)	Outlet Depth (ft)	Tailwater Depth (ft)	Outlet Velocity (ft/s)	Tailwater Velocity (ft/s)
3.00	3.00	25.98	0.505	3.002	4-FFf	0.409	0.375	3.000	3.000	0.212	0.000
3.55	3.55	25.98	0.551	3.002	4-FFf	0.450	0.409	3.000	3.000	0.251	0.000
4.10	4.10	25.98	0.595	3.003	4-FFf	0.491	0.441	3.000	3.000	0.290	0.000
4.65	4.65	25.98	0.637	3.004	4-FFf	0.531	0.471	3.000	3.000	0.329	0.000
5.20	5.20	25.98	0.677	3.005	4-FFf	0.561	0.499	3.000	3.000	0.368	0.000
5.75	5.75	25.99	0.716	3.006	4-FFf	0.586	0.525	3.000	3.000	0.407	0.000
6.30	6.30	25.99	0.753	3.007	4-FFf	0.611	0.551	3.000	3.000	0.446	0.000
6.85	6.85	25.99	0.790	3.008	4-FFf	0.636	0.572	3.000	3.000	0.485	0.000
7.40	7.40	25.99	0.825	3.010	4-FFf	0.660	0.595	3.000	3.000	0.523	0.000
7.80	7.80	25.99	0.837	3.011	4-FFf	0.678	0.612	3.000	3.000	0.552	0.000
8.50	8.50	25.99	0.874	3.013	4-FFf	0.710	0.640	3.000	3.000	0.601	0.000

****

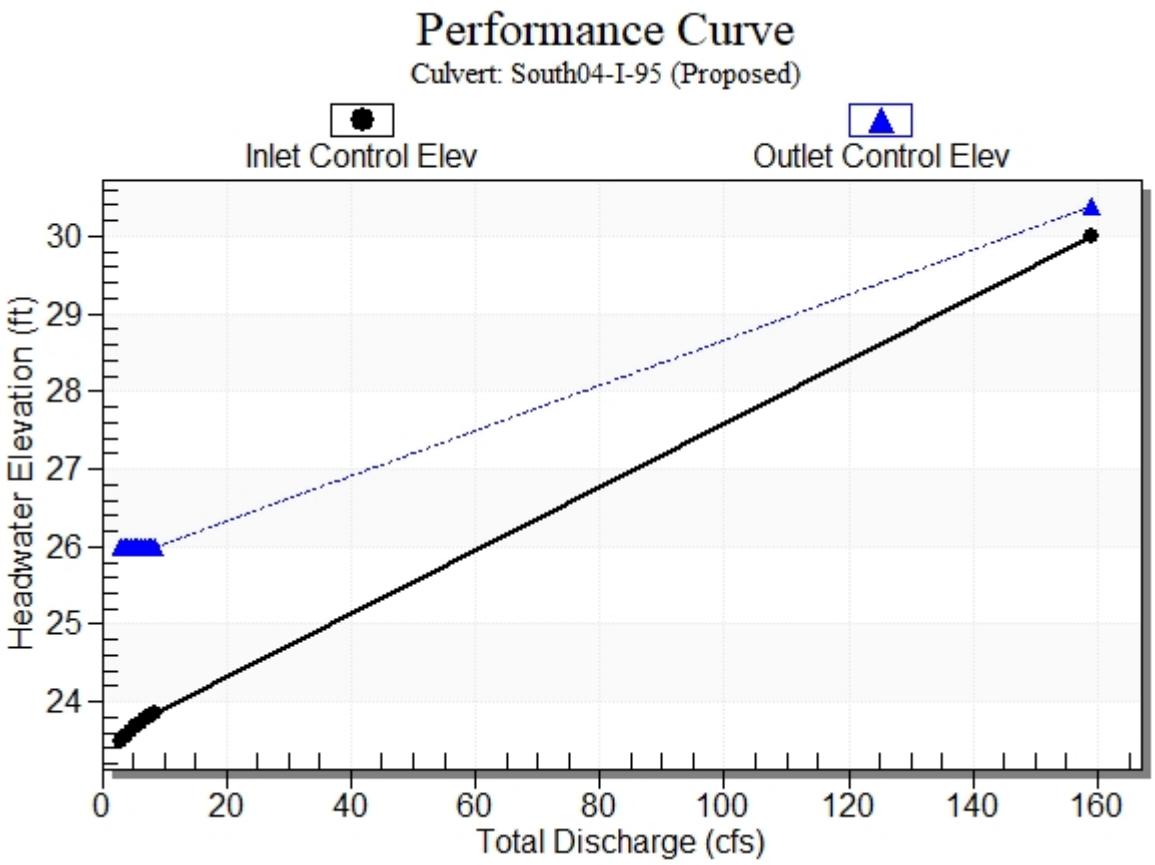
Straight Culvert

Inlet Elevation (invert): 22.98 ft, Outlet Elevation (invert): 22.72 ft

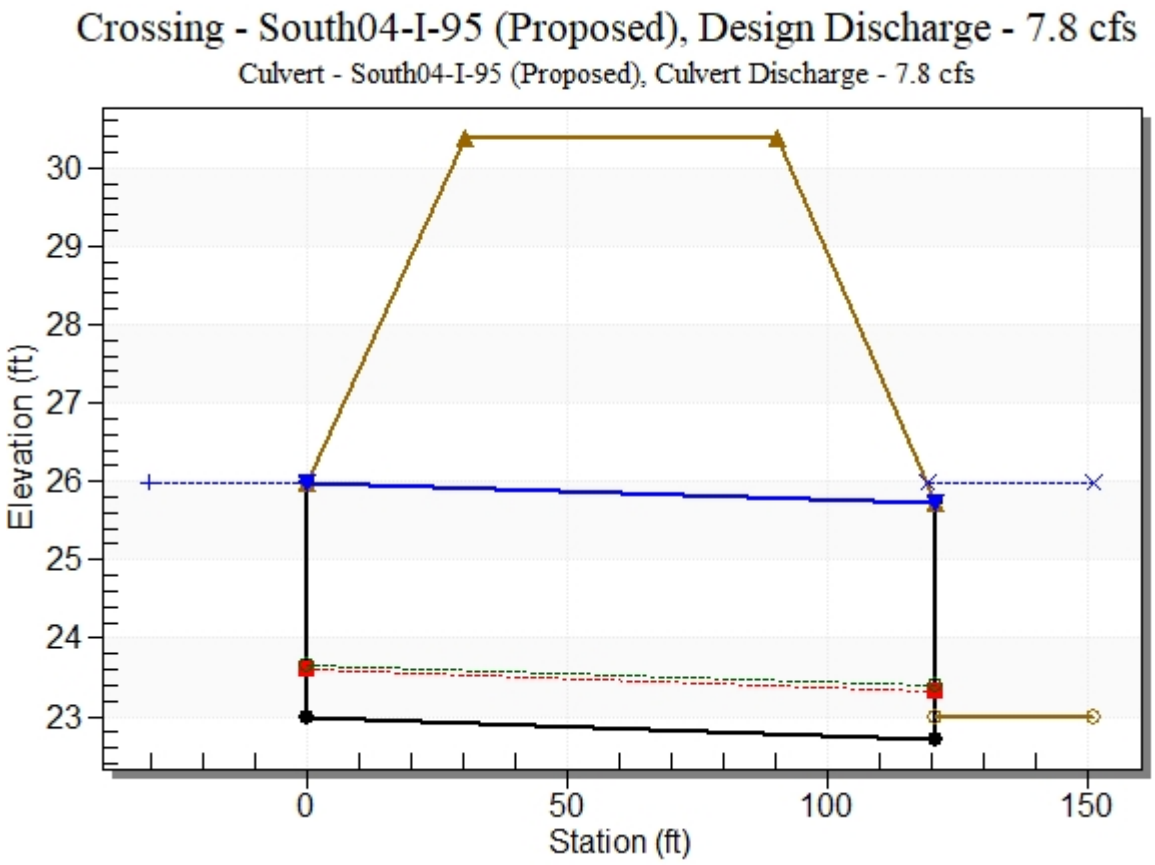
Culvert Length: 121.00 ft, Culvert Slope: 0.0021

****

Culvert Performance Curve Plot: South04-I-95 (Proposed)



Water Surface Profile Plot for Culvert: South04-I-95 (Proposed)



Site Data - South04-I-95 (Proposed)

Site Data Option: Culvert Invert Data

Inlet Station: 0.00 ft

Inlet Elevation: 22.98 ft

Outlet Station: 121.00 ft

Outlet Elevation: 22.72 ft

Number of Barrels: 2

Culvert Data Summary - South04-I-95 (Proposed)

Barrel Shape: Circular

Barrel Diameter: 3.00 ft

Barrel Material: Concrete

Embedment: 0.00 in

Barrel Manning's n: 0.0120

Culvert Type: Straight

Inlet Configuration: Square Edge with Headwall

Inlet Depression: NONE

Table 3 - Downstream Channel Rating Curve (Crossing: South04-I-95 (Proposed))

Flow (cfs)	Water Surface Elev (ft)	Depth (ft)
3.00	25.98	3.00
3.55	25.98	3.00
4.10	25.98	3.00
4.65	25.98	3.00
5.20	25.98	3.00
5.75	25.98	3.00
6.30	25.98	3.00
6.85	25.98	3.00
7.40	25.98	3.00
7.80	25.98	3.00
8.50	25.98	3.00

Tailwater Channel Data - South04-I-95 (Proposed)

Tailwater Channel Option: Enter Constant Tailwater Elevation

Constant Tailwater Elevation: 25.98 ft

Roadway Data for Crossing: South04-I-95 (Proposed)

Roadway Profile Shape: Constant Roadway Elevation

Crest Length: 250.00 ft

Crest Elevation: 30.39 ft

Roadway Surface: Paved

Roadway Top Width: 60.00 ft

HYDROLOGIC ANALYSIS

		DATE
made by:	DHR	11-Jul-20
checked by:		
Stantec job #:		

PROJECT: I-95 Pioneer Trail Interchange

LOCATION: North01-I-95

Rational Equation: $Q_T = X_T * C_T * i_{tc} * A_T$

Q_T = Peak Runoff for Return Period T (cfs).

X_T = Frequency Factor for Return Period T.

C_T = Average Runoff Coefficient for Return Period T.

i_{tc} = Average Rainfall Intensity for Return Period T (in/hr).

A_T = Total Watershed Drainage Area (ac).

$$C_T = \frac{C_1*A_1 + C_2*A_2 + C_3*A_3}{A_T}$$

A_1= 9.37 ac	C_1 = 0.95	Rooftops and Pavement
A_2= 284.41 ac	C_2 = 0.15	Woodlands (Rolling with Sandy Soils)
A_3= 0.00 ac	C_3 = 0.25	Grass (Rolling with Sandy Soils)

A_T= 293.78 ac (per previous permit, 118421-2)

C_T = 0.18

$X_{25\ yr}$ = 1.1	$X_{50\ yr}$ = 1.2	$X_{100\ yr}$ = 1.25
$i_{25\ yr}$ = 1.4 in/hr	$i_{50\ yr}$ = 1.5 in/hr	$i_{100\ yr}$ = 1.8 in/hr

i = based on time of concentration from Ditch Calculations -> t_c = 225 min (per previous permit, 118421-2)

$Q_{25\ yr}$ = 77.1 cfs	**$Q_{50\ yr}$ = 93.4 cfs**	**$Q_{100\ yr}$ = 116.0 cfs**

$Q_{500\ yr}$ = 1.7 x $Q_{100\ yr}$ = **197.2 cfs**

HY-8 Culvert Analysis Report

Crossing Discharge Data

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

Minimum Flow: 93.4 cfs

Design Flow: 116 cfs

Maximum Flow: 197.2 cfs

Table 1 - Summary of Culvert Flows at Crossing: North01-I-95 (Existing)

Headwater Elevation (ft)	Total Discharge (cfs)	North01-I-95 (Existing) Discharge (cfs)	Roadway Discharge (cfs)	Iterations
26.39	93.40	93.40	0.00	1
26.47	103.78	103.78	0.00	1
26.55	114.16	114.16	0.00	1
26.57	116.00	116.00	0.00	1
26.77	134.92	134.92	0.00	1
26.90	145.30	145.30	0.00	1
27.07	155.68	155.68	0.00	1
27.16	166.06	166.06	0.00	1
27.35	176.44	176.44	0.00	1
27.53	186.82	186.82	0.00	1
27.71	197.20	197.20	0.00	1
30.48	340.49	340.49	0.00	Overtopping

Rating Curve Plot for Crossing: North01-I-95 (Existing)

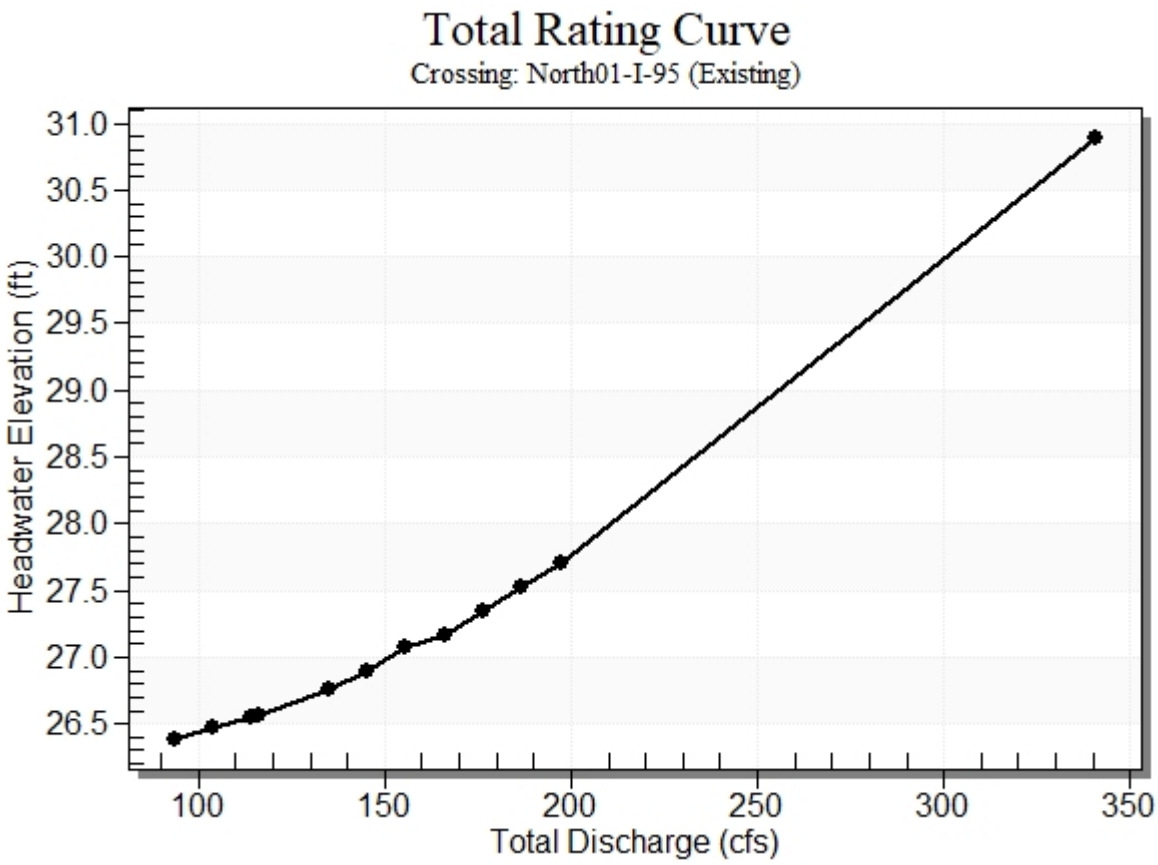


Table 2 - Culvert Summary Table: North01-I-95 (Existing)

Total Discharge (cfs)	Culvert Discharge (cfs)	Headwater Elevation (ft)	Inlet Control Depth (ft)	Outlet Control Depth (ft)	Flow Type	Normal Depth (ft)	Critical Depth (ft)	Outlet Depth (ft)	Tailwater Depth (ft)	Outlet Velocity (ft/s)	Tailwater Velocity (ft/s)
93.40	93.40	26.39	2.989	3.590	1-S1t	1.130	1.768	4.620	3.280	2.888	0.000
103.78	103.78	26.47	3.202	3.666	1-S1t	1.214	1.897	4.620	3.280	3.209	0.000
114.16	114.16	26.55	3.407	3.753	1-S1t	1.299	2.021	4.620	3.280	3.530	0.000
116.00	116.00	26.57	3.443	3.770	1-S1t	1.314	2.043	4.620	3.280	3.587	0.000
134.92	134.92	26.77	3.801	3.965	1-S1t	1.455	2.260	4.620	3.280	4.172	0.000
145.30	145.30	26.90	3.992	4.099	1-S1t	1.529	2.374	4.620	3.280	4.493	0.000
155.68	155.68	27.07	4.179	4.272	1-S1t	1.603	2.486	4.620	3.280	4.814	0.000
166.06	166.06	27.16	4.363	3.913	1-JS1t	1.677	2.595	4.620	3.280	5.135	0.000
176.44	176.44	27.35	4.546	3.994	1-JS1t	1.752	2.702	4.620	3.280	5.456	0.000
186.82	186.82	27.53	4.728	4.081	1-JS1t	1.825	2.807	4.620	3.280	5.777	0.000
197.20	197.20	27.71	4.909	4.173	1-JS1t	1.893	2.910	4.620	3.280	6.098	0.000

****

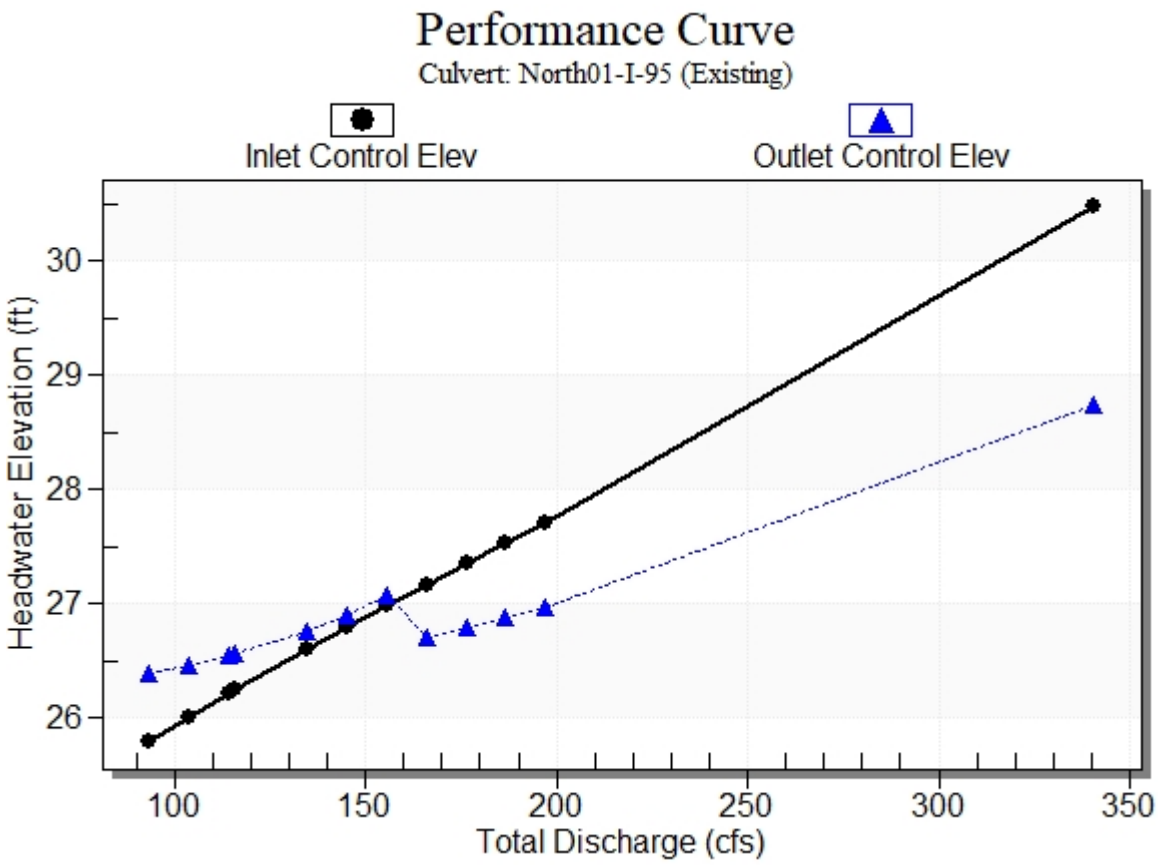
Straight Culvert

Inlet Elevation (invert): 22.80 ft, Outlet Elevation (invert): 21.46 ft

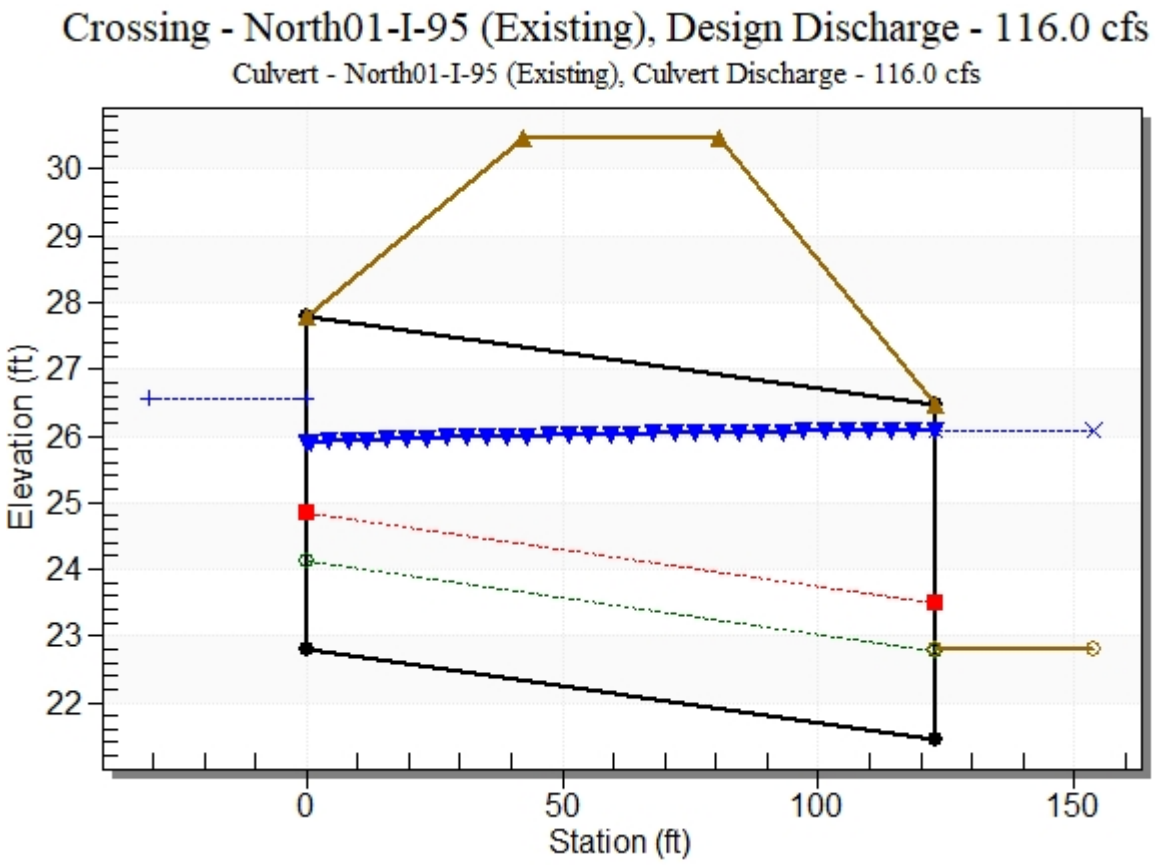
Culvert Length: 123.01 ft, Culvert Slope: 0.0109

****

Culvert Performance Curve Plot: North01-I-95 (Existing)



Water Surface Profile Plot for Culvert: North01-I-95 (Existing)



Site Data - North01-I-95 (Existing)

Site Data Option: Culvert Invert Data

Inlet Station: 0.00 ft

Inlet Elevation: 22.80 ft

Outlet Station: 123.00 ft

Outlet Elevation: 21.46 ft

Number of Barrels: 1

Culvert Data Summary - North01-I-95 (Existing)

Barrel Shape: Concrete Box

Barrel Span: 7.00 ft

Barrel Rise: 5.00 ft

Barrel Material: Concrete

Embedment: 0.00 in

Barrel Manning's n: 0.0120

Culvert Type: Straight

Inlet Configuration: Square Edge (90º) Headwall

Inlet Depression: NONE

Table 3 - Downstream Channel Rating Curve (Crossing: North01-I-95 (Existing))

Flow (cfs)	Water Surface Elev (ft)	Depth (ft)
93.40	26.08	3.28
103.78	26.08	3.28
114.16	26.08	3.28
116.00	26.08	3.28
134.92	26.08	3.28
145.30	26.08	3.28
155.68	26.08	3.28
166.06	26.08	3.28
176.44	26.08	3.28
186.82	26.08	3.28
197.20	26.08	3.28

Tailwater Channel Data - North01-I-95 (Existing)

Tailwater Channel Option: Enter Constant Tailwater Elevation

Constant Tailwater Elevation: 26.08 ft

Roadway Data for Crossing: North01-I-95 (Existing)

Roadway Profile Shape: Constant Roadway Elevation

Crest Length: 250.00 ft

Crest Elevation: 30.48 ft

Roadway Surface: Paved

Roadway Top Width: 38.00 ft

HY-8 Culvert Analysis Report

Crossing Discharge Data

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

Minimum Flow: 93.4 cfs

Design Flow: 116 cfs

Maximum Flow: 197.2 cfs

Table 1 - Summary of Culvert Flows at Crossing: North01-I-95 (Proposed)

Headwater Elevation (ft)	Total Discharge (cfs)	North01-I-95 (Proposed) Discharge (cfs)	Roadway Discharge (cfs)	Iterations
26.39	93.40	93.40	0.00	1
26.47	103.78	103.78	0.00	1
26.55	114.16	114.16	0.00	1
26.57	116.00	116.00	0.00	1
26.77	134.92	134.92	0.00	1
26.90	145.30	145.30	0.00	1
27.07	155.68	155.68	0.00	1
27.16	166.06	166.06	0.00	1
27.35	176.44	176.44	0.00	1
27.53	186.82	186.82	0.00	1
27.71	197.20	197.20	0.00	1
30.48	340.49	340.49	0.00	Overtopping

Rating Curve Plot for Crossing: North01-I-95 (Proposed)

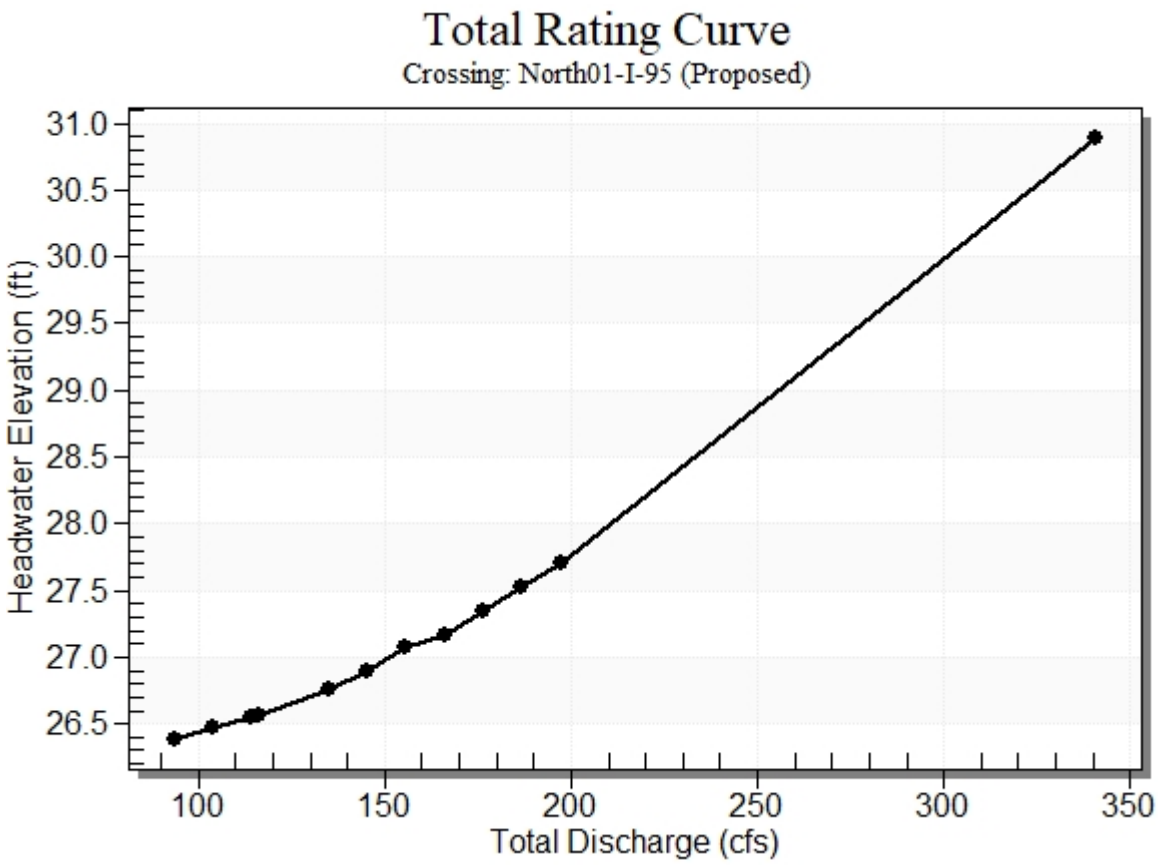


Table 2 - Culvert Summary Table: North01-I-95 (Proposed)

Total Discharge (cfs)	Culvert Discharge (cfs)	Headwater Elevation (ft)	Inlet Control Depth (ft)	Outlet Control Depth (ft)	Flow Type	Normal Depth (ft)	Critical Depth (ft)	Outlet Depth (ft)	Tailwater Depth (ft)	Outlet Velocity (ft/s)	Tailwater Velocity (ft/s)
93.40	93.40	26.39	2.989	3.590	1-S1t	1.130	1.768	4.620	3.280	2.888	0.000
103.78	103.78	26.47	3.202	3.666	1-S1t	1.214	1.897	4.620	3.280	3.209	0.000
114.16	114.16	26.55	3.407	3.753	1-S1t	1.299	2.021	4.620	3.280	3.530	0.000
116.00	116.00	26.57	3.443	3.770	1-S1t	1.314	2.043	4.620	3.280	3.587	0.000
134.92	134.92	26.77	3.801	3.965	1-S1t	1.455	2.260	4.620	3.280	4.172	0.000
145.30	145.30	26.90	3.992	4.099	1-S1t	1.529	2.374	4.620	3.280	4.493	0.000
155.68	155.68	27.07	4.179	4.272	1-S1t	1.603	2.486	4.620	3.280	4.814	0.000
166.06	166.06	27.16	4.363	3.913	1-JS1t	1.677	2.595	4.620	3.280	5.135	0.000
176.44	176.44	27.35	4.546	3.994	1-JS1t	1.752	2.702	4.620	3.280	5.456	0.000
186.82	186.82	27.53	4.728	4.081	1-JS1t	1.825	2.807	4.620	3.280	5.777	0.000
197.20	197.20	27.71	4.909	4.173	1-JS1t	1.893	2.910	4.620	3.280	6.098	0.000

****

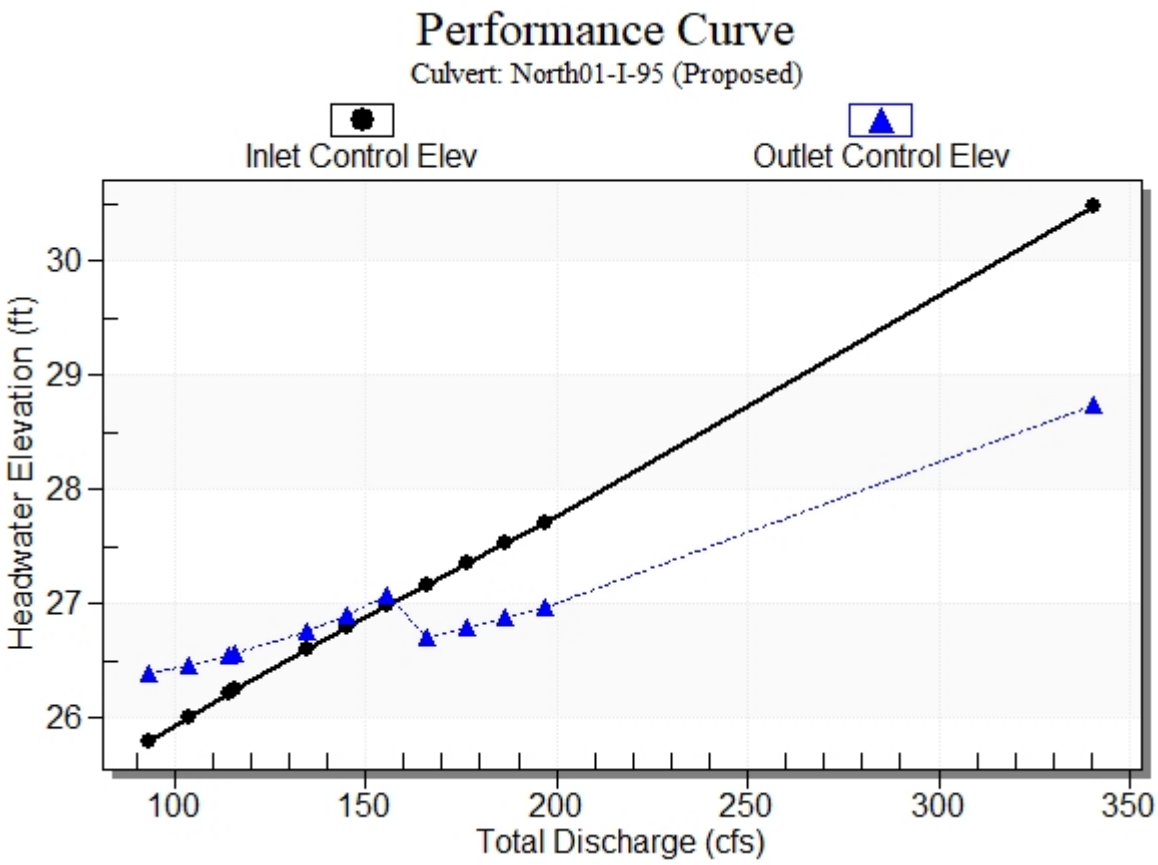
Straight Culvert

Inlet Elevation (invert): 22.80 ft, Outlet Elevation (invert): 21.46 ft

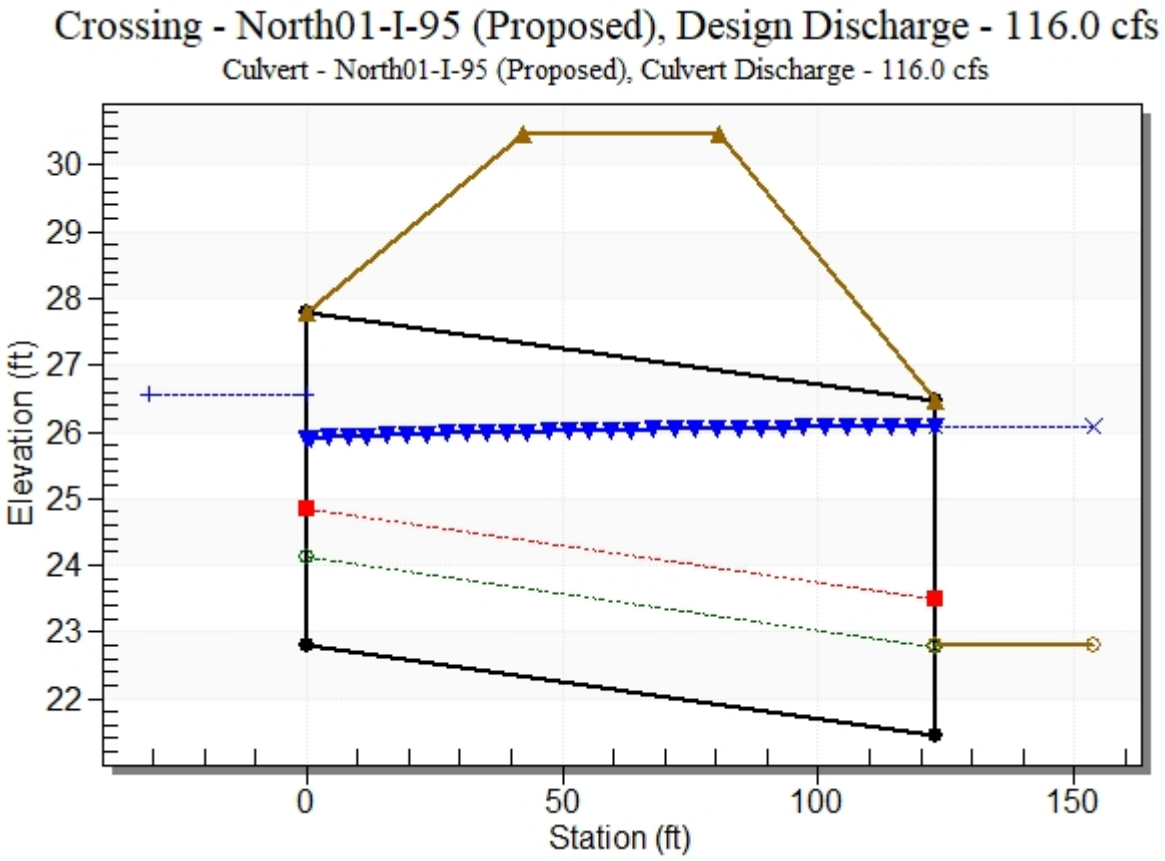
Culvert Length: 123.01 ft, Culvert Slope: 0.0109

****

Culvert Performance Curve Plot: North01-I-95 (Proposed)



Water Surface Profile Plot for Culvert: North01-I-95 (Proposed)



Site Data - North01-I-95 (Proposed)

Site Data Option: Culvert Invert Data

Inlet Station: 0.00 ft

Inlet Elevation: 22.80 ft

Outlet Station: 123.00 ft

Outlet Elevation: 21.46 ft

Number of Barrels: 1

Culvert Data Summary - North01-I-95 (Proposed)

Barrel Shape: Concrete Box

Barrel Span: 7.00 ft

Barrel Rise: 5.00 ft

Barrel Material: Concrete

Embedment: 0.00 in

Barrel Manning's n: 0.0120

Culvert Type: Straight

Inlet Configuration: Square Edge (90º) Headwall

Inlet Depression: NONE

Table 3 - Downstream Channel Rating Curve (Crossing: North01-I-95 (Proposed))

Flow (cfs)	Water Surface Elev (ft)	Depth (ft)
93.40	26.08	3.28
103.78	26.08	3.28
114.16	26.08	3.28
116.00	26.08	3.28
134.92	26.08	3.28
145.30	26.08	3.28
155.68	26.08	3.28
166.06	26.08	3.28
176.44	26.08	3.28
186.82	26.08	3.28
197.20	26.08	3.28

Tailwater Channel Data - North01-I-95 (Proposed)

Tailwater Channel Option: Enter Constant Tailwater Elevation

Constant Tailwater Elevation: 26.08 ft

Roadway Data for Crossing: North01-I-95 (Proposed)

Roadway Profile Shape: Constant Roadway Elevation

Crest Length: 250.00 ft

Crest Elevation: 30.48 ft

Roadway Surface: Paved

Roadway Top Width: 38.00 ft

HYDROLOGIC ANALYSIS

		DATE
made by:	DHR	11-Jul-20
checked by:		
Stantec job #:		

PROJECT: I-95 Pioneer Trail Interchange

LOCATION: North02-I-95

Rational Equation: $Q_T = X_T * C_T * i_{tc} * A_T$

Q_T = Peak Runoff for Return Period T (cfs).

X_T = Frequency Factor for Return Period T.

C_T = Average Runoff Coefficient for Return Period T.

i_{tc} = Average Rainfall Intensity for Return Period T (in/hr).

A_T = Total Watershed Drainage Area (ac).

$$C_T = \frac{C_1*A_1 + C_2*A_2 + C_3*A_3}{A_T}$$

A_1= 9.37 ac	C_1 = 0.95	Rooftops and Pavement
A_2= 284.41 ac	C_2 = 0.15	Woodlands (Rolling with Sandy Soils)
A_3= 0.00 ac	C_3 = 0.25	Grass (Rolling with Sandy Soils)

A_T= 293.78 ac (per previous permit, 118421-2)

C_T = 0.18

$X_{25\ yr}$ = 1.1	$X_{50\ yr}$ = 1.2	$X_{100\ yr}$ = 1.25
$i_{25\ yr}$ = 1.4 in/hr	$i_{50\ yr}$ = 1.5 in/hr	$i_{100\ yr}$ = 1.8 in/hr

i = based on time of concentration from Ditch Calculations -> t_c = 225 min (per previous permit, 118421-2)

$Q_{25\ yr}$ = 77.1 cfs	**$Q_{50\ yr}$ = 93.4 cfs**	**$Q_{100\ yr}$ = 116.0 cfs**

$Q_{500\ yr}$ = 1.7 x $Q_{100\ yr}$ = **197.2 cfs**

HY-8 Culvert Analysis Report

Crossing Discharge Data

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

Minimum Flow: 93.4 cfs

Design Flow: 116 cfs

Maximum Flow: 197.2 cfs

Table 1 - Summary of Culvert Flows at Crossing: North02-I-95 (Existing)

Headwater Elevation (ft)	Total Discharge (cfs)	North02-I-95 (Existing) Discharge (cfs)	Roadway Discharge (cfs)	Iterations
26.36	93.40	93.40	0.00	1
26.44	103.78	103.78	0.00	1
26.52	114.16	114.16	0.00	1
26.53	116.00	116.00	0.00	1
26.72	134.92	134.92	0.00	1
26.85	145.30	145.30	0.00	1
27.05	155.68	155.68	0.00	1
27.11	166.06	166.06	0.00	1
27.30	176.44	176.44	0.00	1
27.48	186.82	186.82	0.00	1
27.66	197.20	197.20	0.00	1
30.48	342.65	342.65	0.00	Overtopping

Rating Curve Plot for Crossing: North02-I-95 (Existing)

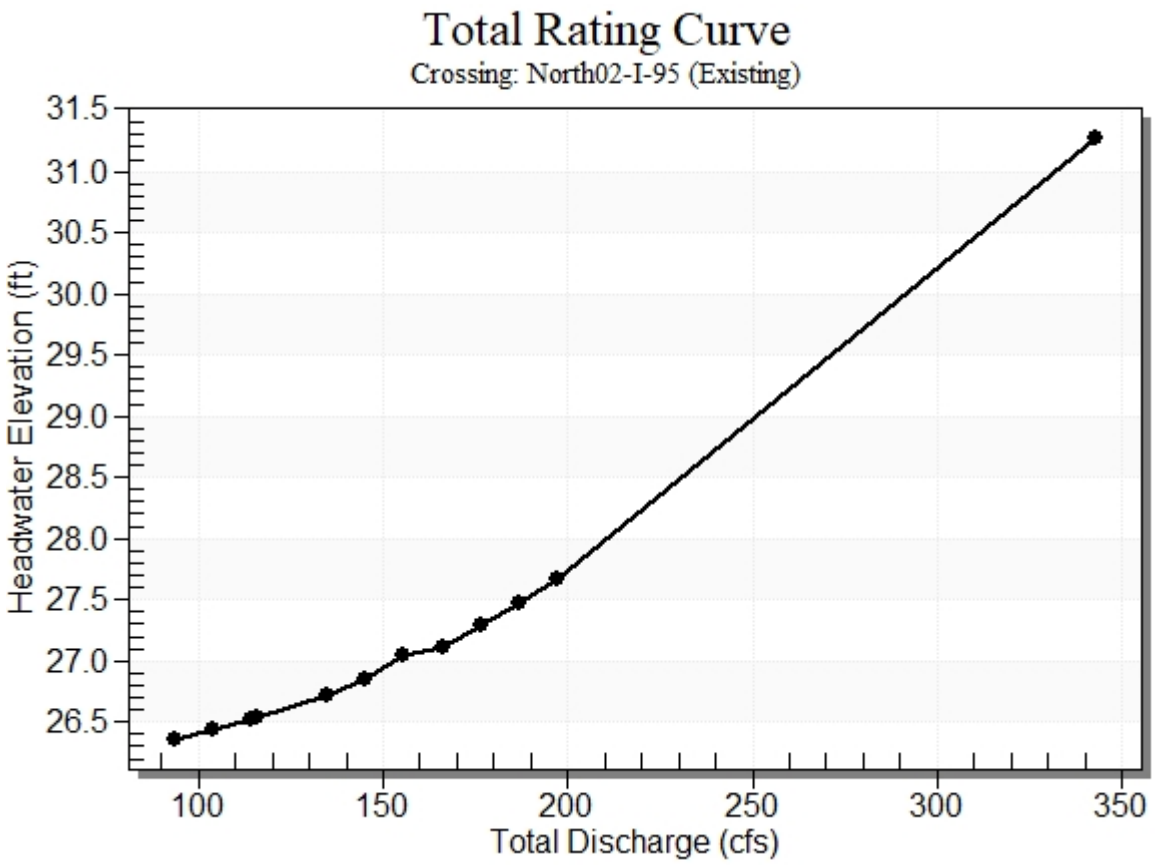


Table 2 - Culvert Summary Table: North02-I-95 (Existing)

Total Discharge (cfs)	Culvert Discharge (cfs)	Headwater Elevation (ft)	Inlet Control Depth (ft)	Outlet Control Depth (ft)	Flow Type	Normal Depth (ft)	Critical Depth (ft)	Outlet Depth (ft)	Tailwater Depth (ft)	Outlet Velocity (ft/s)	Tailwater Velocity (ft/s)
93.40	93.40	26.36	2.980	3.605	1-S1f	1.029	1.768	5.000	3.320	2.669	0.000
103.78	103.78	26.44	3.193	3.676	1-S1f	1.103	1.897	5.000	3.320	2.965	0.000
114.16	114.16	26.52	3.398	3.757	1-S1f	1.176	2.021	5.000	3.320	3.262	0.000
116.00	116.00	26.53	3.434	3.773	1-S1f	1.189	2.043	5.000	3.320	3.314	0.000
134.92	134.92	26.72	3.793	3.960	1-S1f	1.323	2.260	5.000	3.320	3.855	0.000
145.30	145.30	26.85	3.983	4.092	1-S1f	1.392	2.374	5.000	3.320	4.151	0.000
155.68	155.68	27.05	4.170	4.285	1-S1f	1.456	2.486	5.000	3.320	4.448	0.000
166.06	166.06	27.11	4.354	3.953	1-JS1f	1.521	2.595	5.000	3.320	4.745	0.000
176.44	176.44	27.30	4.537	4.034	1-JS1f	1.585	2.702	5.000	3.320	5.041	0.000
186.82	186.82	27.48	4.719	4.121	1-JS1f	1.649	2.807	5.000	3.320	5.338	0.000
197.20	197.20	27.66	4.900	4.212	1-JS1f	1.713	2.910	5.000	3.320	5.634	0.000

****

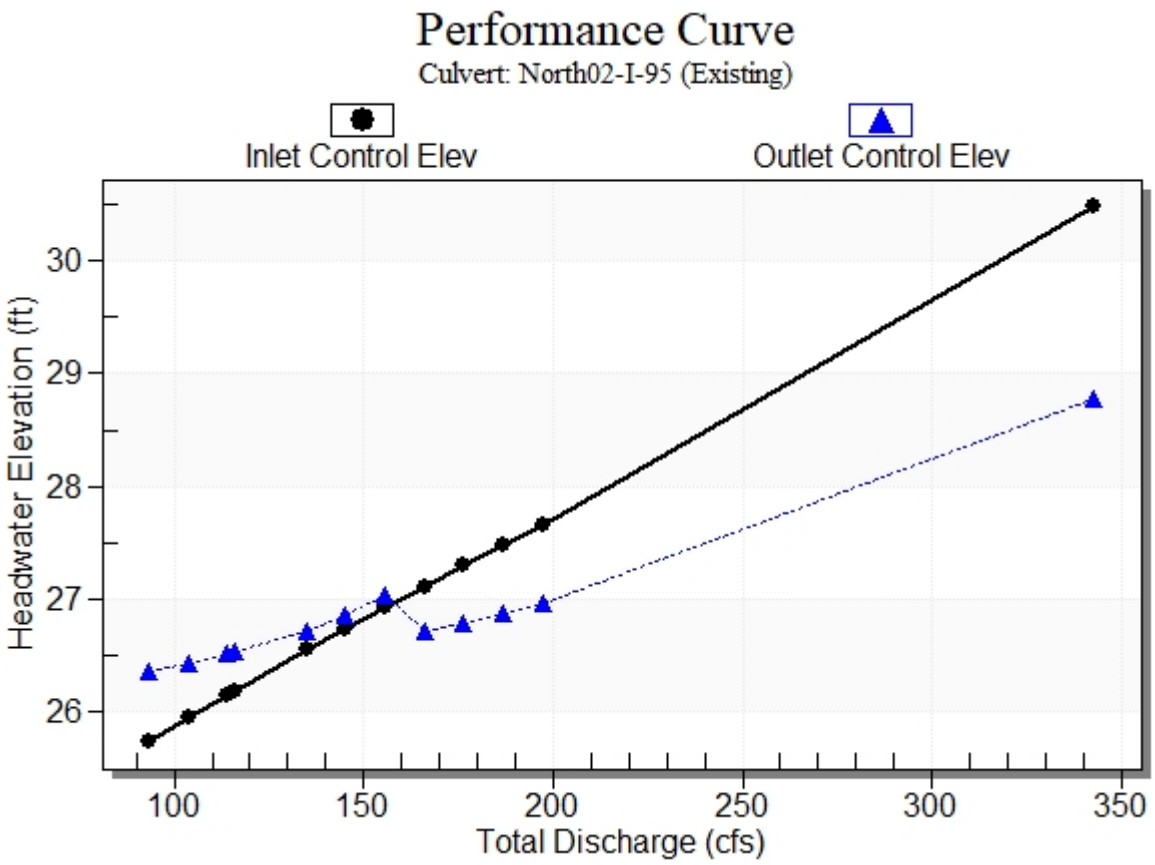
Straight Culvert

Inlet Elevation (invert): 22.76 ft, Outlet Elevation (invert): 20.98 ft

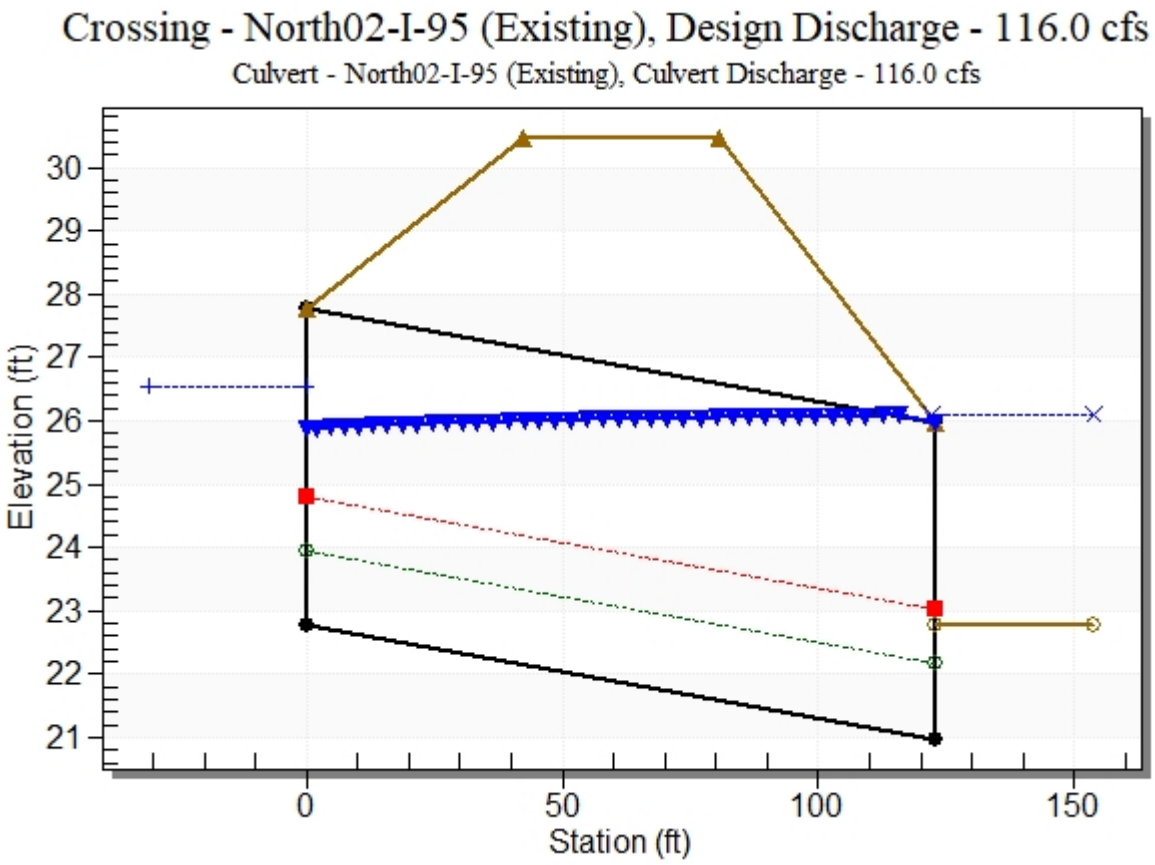
Culvert Length: 123.01 ft, Culvert Slope: 0.0145

****

Culvert Performance Curve Plot: North02-I-95 (Existing)



Water Surface Profile Plot for Culvert: North02-I-95 (Existing)



Site Data - North02-I-95 (Existing)

Site Data Option: Culvert Invert Data

Inlet Station: 0.00 ft

Inlet Elevation: 22.76 ft

Outlet Station: 123.00 ft

Outlet Elevation: 20.98 ft

Number of Barrels: 1

Culvert Data Summary - North02-I-95 (Existing)

Barrel Shape: Concrete Box

Barrel Span: 7.00 ft

Barrel Rise: 5.00 ft

Barrel Material: Concrete

Embedment: 0.00 in

Barrel Manning's n: 0.0120

Culvert Type: Straight

Inlet Configuration: Square Edge (90º) Headwall

Inlet Depression: NONE

Table 3 - Downstream Channel Rating Curve (Crossing: North02-I-95 (Existing))

Flow (cfs)	Water Surface Elev (ft)	Depth (ft)
93.40	26.08	3.32
103.78	26.08	3.32
114.16	26.08	3.32
116.00	26.08	3.32
134.92	26.08	3.32
145.30	26.08	3.32
155.68	26.08	3.32
166.06	26.08	3.32
176.44	26.08	3.32
186.82	26.08	3.32
197.20	26.08	3.32

Tailwater Channel Data - North02-I-95 (Existing)

Tailwater Channel Option: Enter Constant Tailwater Elevation

Constant Tailwater Elevation: 26.08 ft

Roadway Data for Crossing: North02-I-95 (Existing)

Roadway Profile Shape: Constant Roadway Elevation

Crest Length: 250.00 ft

Crest Elevation: 30.48 ft

Roadway Surface: Paved

Roadway Top Width: 38.00 ft

HY-8 Culvert Analysis Report

Crossing Discharge Data

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

Minimum Flow: 93.4 cfs

Design Flow: 116 cfs

Maximum Flow: 197.2 cfs

Table 1 - Summary of Culvert Flows at Crossing: North02-I-95 (Proposed)

Headwater Elevation (ft)	Total Discharge (cfs)	North02-I-95 (Proposed) Discharge (cfs)	Roadway Discharge (cfs)	Iterations
26.36	93.40	93.40	0.00	1
26.44	103.78	103.78	0.00	1
26.52	114.16	114.16	0.00	1
26.53	116.00	116.00	0.00	1
26.72	134.92	134.92	0.00	1
26.85	145.30	145.30	0.00	1
27.05	155.68	155.68	0.00	1
27.11	166.06	166.06	0.00	1
27.30	176.44	176.44	0.00	1
27.48	186.82	186.82	0.00	1
27.66	197.20	197.20	0.00	1
30.48	342.65	342.65	0.00	Overtopping

Rating Curve Plot for Crossing: North02-I-95 (Proposed)

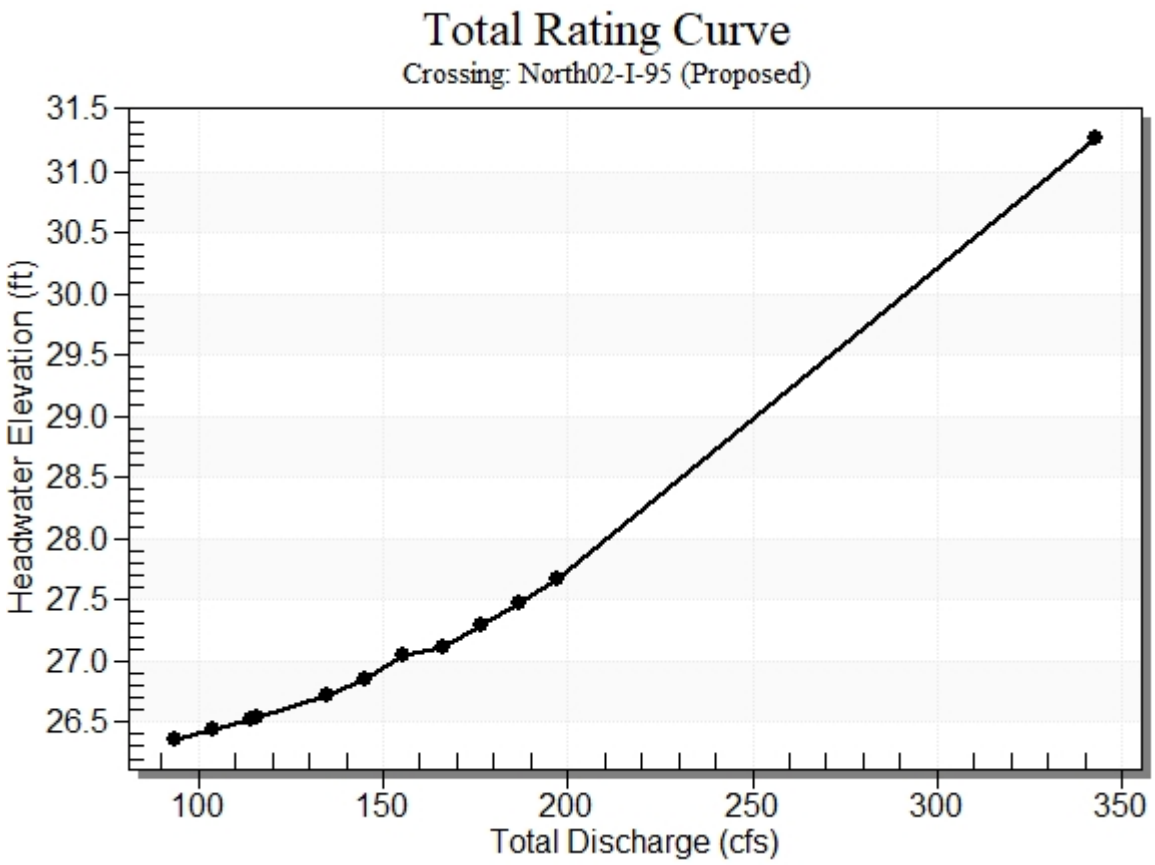


Table 2 - Culvert Summary Table: North02-I-95 (Proposed)

Total Discharge (cfs)	Culvert Discharge (cfs)	Headwater Elevation (ft)	Inlet Control Depth (ft)	Outlet Control Depth (ft)	Flow Type	Normal Depth (ft)	Critical Depth (ft)	Outlet Depth (ft)	Tailwater Depth (ft)	Outlet Velocity (ft/s)	Tailwater Velocity (ft/s)
93.40	93.40	26.36	2.980	3.605	1-S1f	1.029	1.768	5.000	3.320	2.669	0.000
103.78	103.78	26.44	3.193	3.676	1-S1f	1.103	1.897	5.000	3.320	2.965	0.000
114.16	114.16	26.52	3.398	3.757	1-S1f	1.176	2.021	5.000	3.320	3.262	0.000
116.00	116.00	26.53	3.434	3.773	1-S1f	1.189	2.043	5.000	3.320	3.314	0.000
134.92	134.92	26.72	3.793	3.960	1-S1f	1.323	2.260	5.000	3.320	3.855	0.000
145.30	145.30	26.85	3.983	4.092	1-S1f	1.392	2.374	5.000	3.320	4.151	0.000
155.68	155.68	27.05	4.170	4.285	1-S1f	1.456	2.486	5.000	3.320	4.448	0.000
166.06	166.06	27.11	4.354	3.953	1-JS1f	1.521	2.595	5.000	3.320	4.745	0.000
176.44	176.44	27.30	4.537	4.034	1-JS1f	1.585	2.702	5.000	3.320	5.041	0.000
186.82	186.82	27.48	4.719	4.121	1-JS1f	1.649	2.807	5.000	3.320	5.338	0.000
197.20	197.20	27.66	4.900	4.212	1-JS1f	1.713	2.910	5.000	3.320	5.634	0.000

****

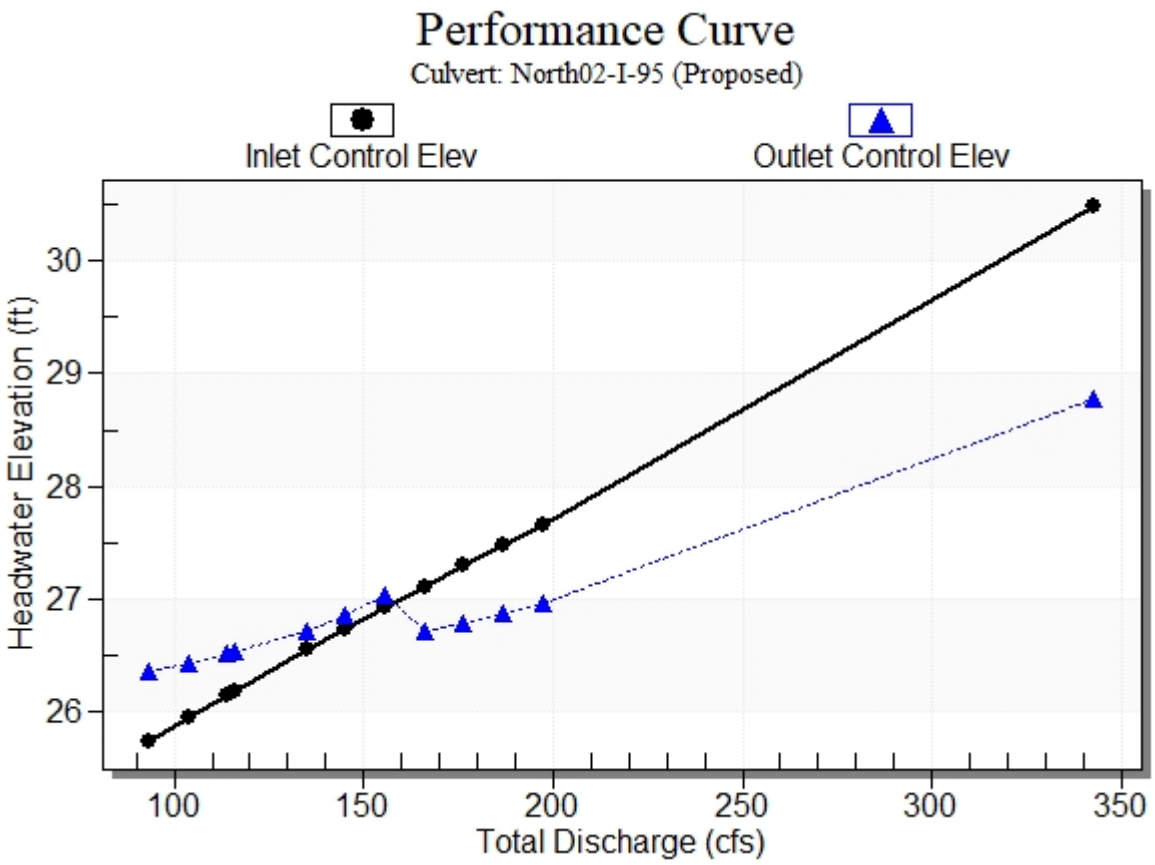
Straight Culvert

Inlet Elevation (invert): 22.76 ft, Outlet Elevation (invert): 20.98 ft

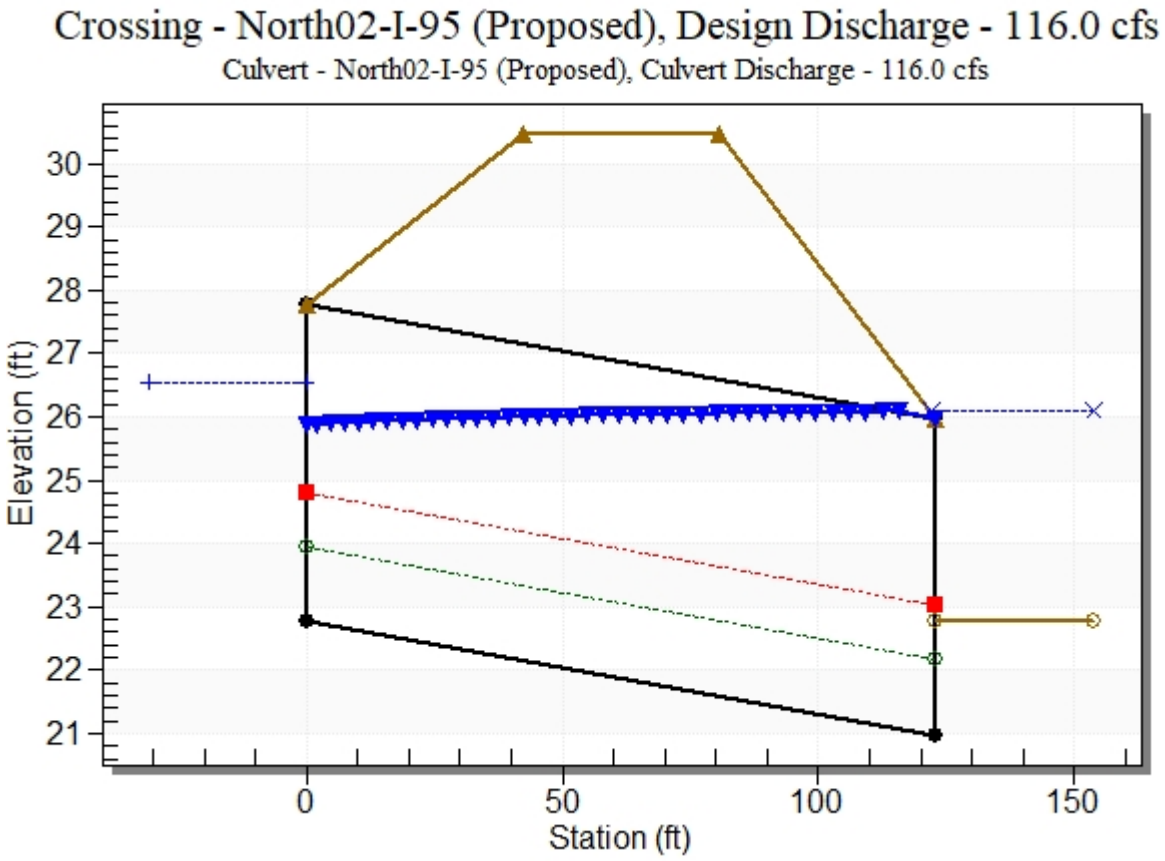
Culvert Length: 123.01 ft, Culvert Slope: 0.0145

****

Culvert Performance Curve Plot: North02-I-95 (Proposed)



Water Surface Profile Plot for Culvert: North02-I-95 (Proposed)



Site Data - North02-I-95 (Proposed)

Site Data Option: Culvert Invert Data

Inlet Station: 0.00 ft

Inlet Elevation: 22.76 ft

Outlet Station: 123.00 ft

Outlet Elevation: 20.98 ft

Number of Barrels: 1

Culvert Data Summary - North02-I-95 (Proposed)

Barrel Shape: Concrete Box

Barrel Span: 7.00 ft

Barrel Rise: 5.00 ft

Barrel Material: Concrete

Embedment: 0.00 in

Barrel Manning's n: 0.0120

Culvert Type: Straight

Inlet Configuration: Square Edge (90º) Headwall

Inlet Depression: NONE

Table 3 - Downstream Channel Rating Curve (Crossing: North02-I-95 (Proposed))

Flow (cfs)	Water Surface Elev (ft)	Depth (ft)
93.40	26.08	3.32
103.78	26.08	3.32
114.16	26.08	3.32
116.00	26.08	3.32
134.92	26.08	3.32
145.30	26.08	3.32
155.68	26.08	3.32
166.06	26.08	3.32
176.44	26.08	3.32
186.82	26.08	3.32
197.20	26.08	3.32

Tailwater Channel Data - North02-I-95 (Proposed)

Tailwater Channel Option: Enter Constant Tailwater Elevation

Constant Tailwater Elevation: 26.08 ft

Roadway Data for Crossing: North02-I-95 (Proposed)

Roadway Profile Shape: Constant Roadway Elevation

Crest Length: 250.00 ft

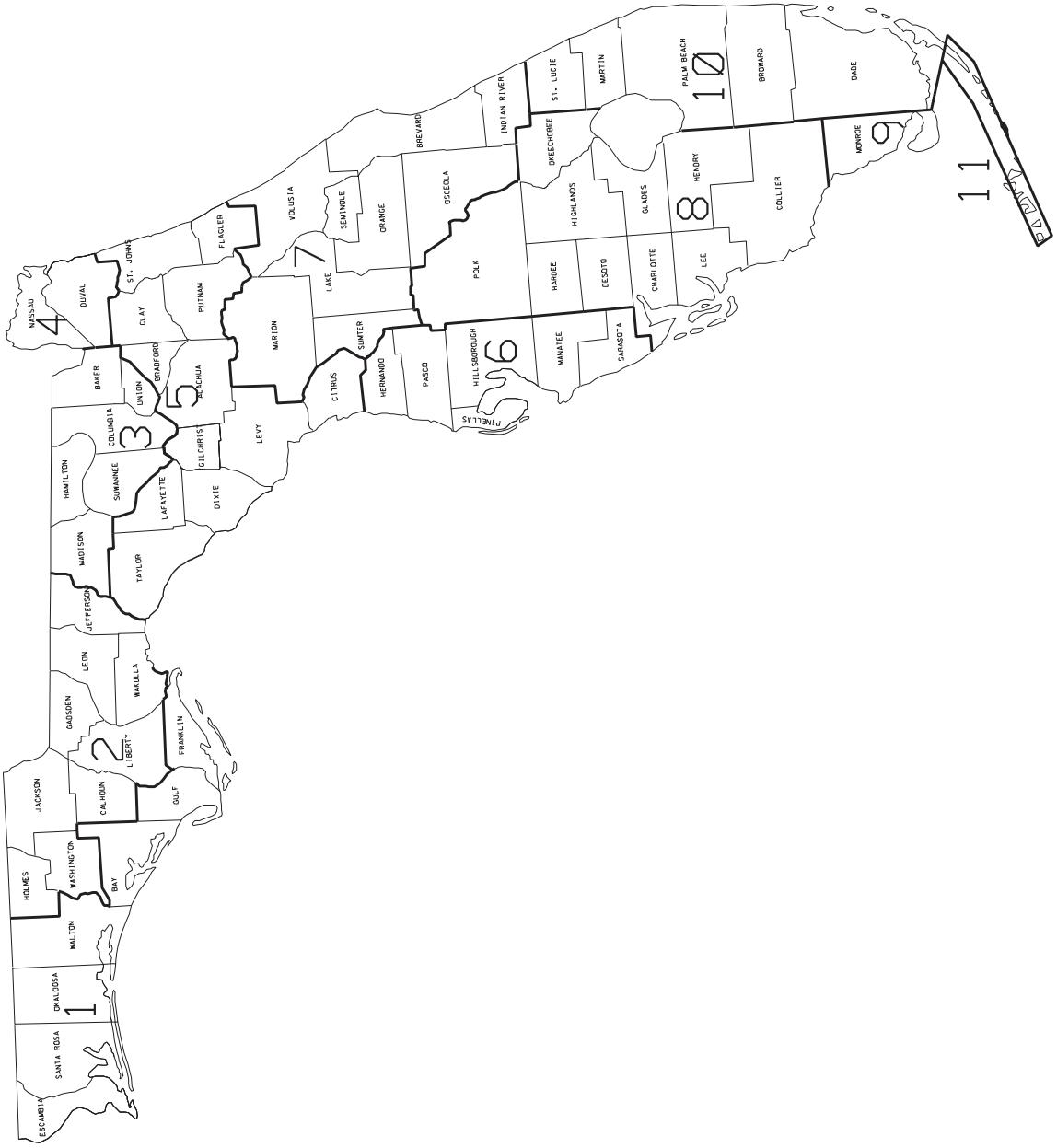
Crest Elevation: 30.48 ft

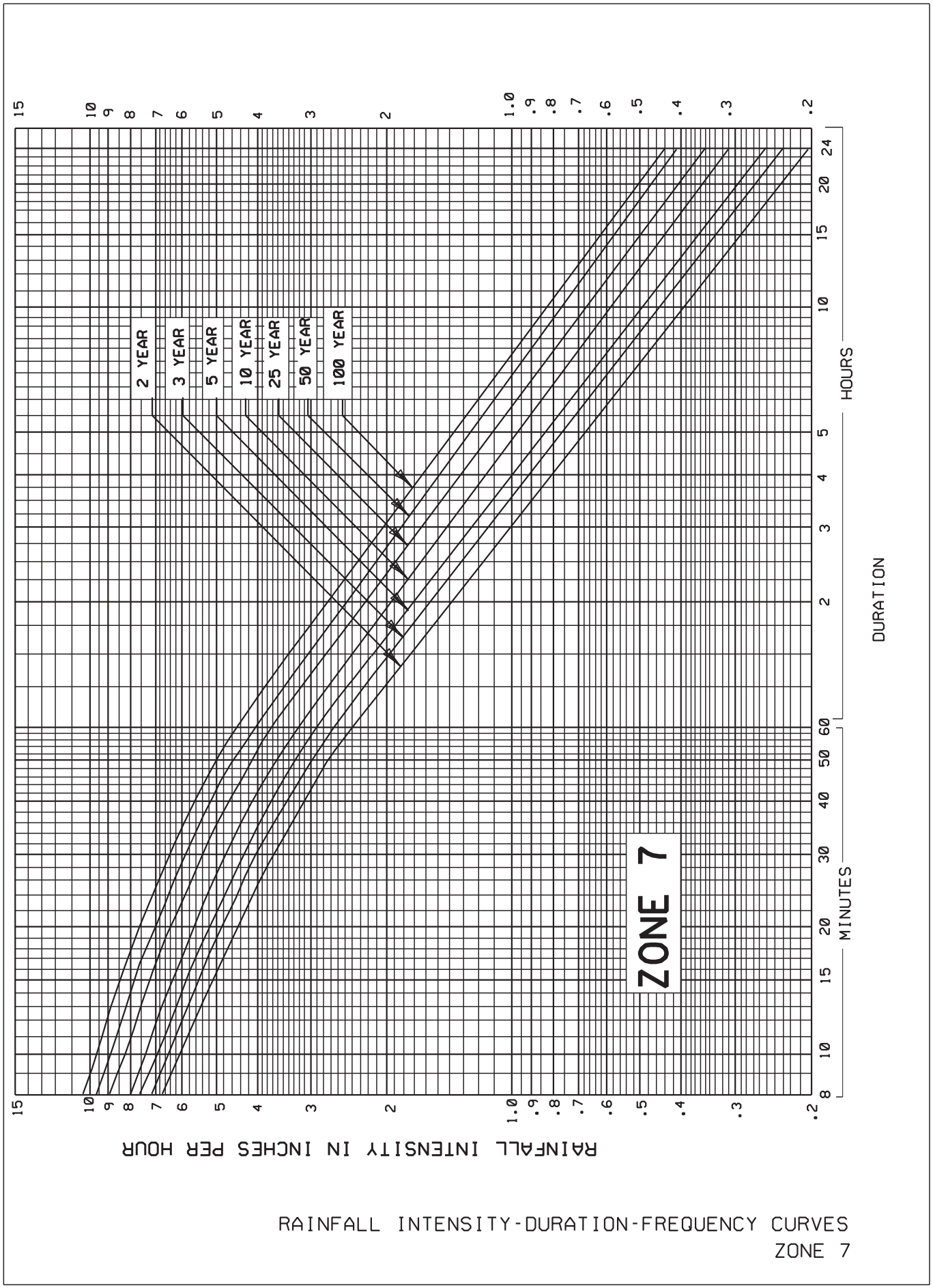
Roadway Surface: Paved

Roadway Top Width: 38.00 ft

APPENDIX D – REFERENCES

ZONES FOR PRECIPITATION IDF CURVES DEVELOPED BY THE DEPARTMENT





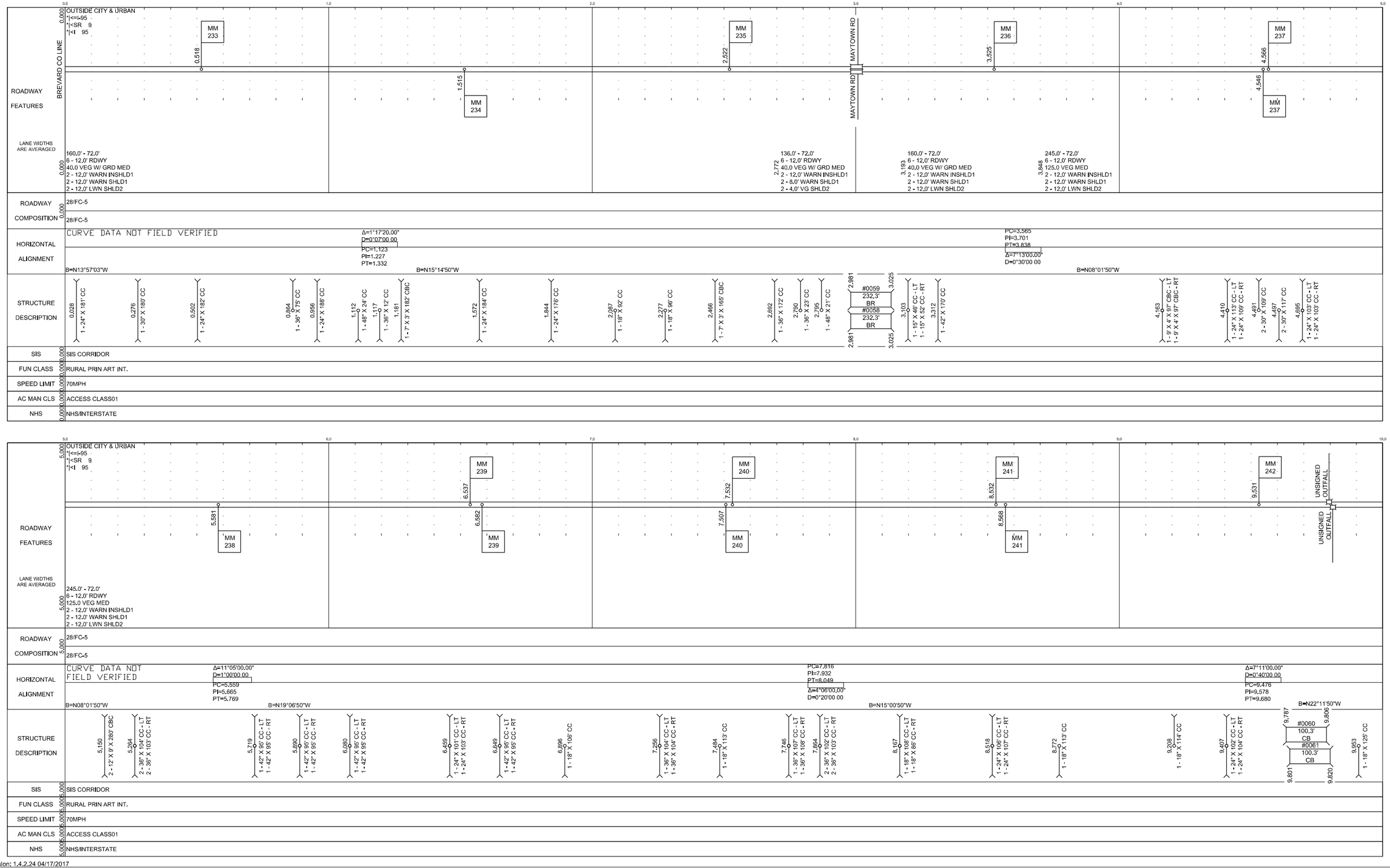
RAINFALL INTENSITY-DURATION-FREQUENCY CURVES
ZONE 7

	5 YR INV	SLD REV	BMP	EMP	INV	SLD REV
DATE	06/02/2011	06/23/2011	011.095	027.336	06/22/2018 CB	07/25/2018 GD
BY	Treva Fitz	Michael Register	000.000	045.742	04/17/2017 MP	04/17/2017 GD
			000.000	045.742	03/20/2017 DP	03/27/2017 GD

FLORIDA DEPARTMENT OF TRANSPORTATION

STRAIGHT LINE DIAGRAM OF ROAD INVENTORY

SECTION STATUS	INT. or US ROUTE NO.	STATE ROAD NO.	COUNTY	DISTRICT	ROADWAY ID	SHEET NO:
02	I 95	SR 9	VOLUSIA	05	79002000	1 OF 6



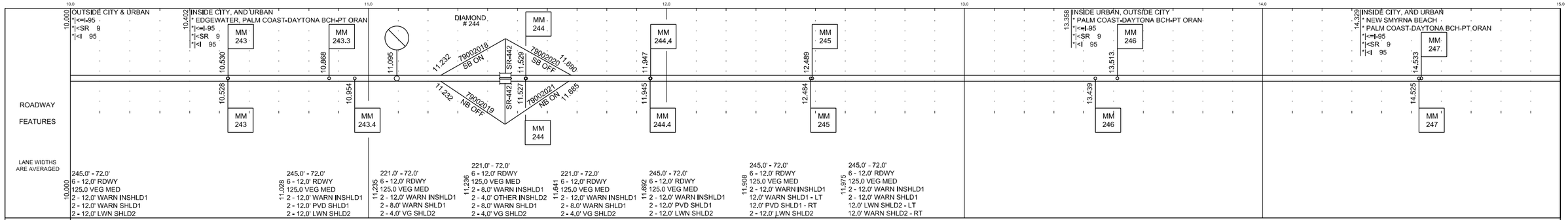
Version: 1.4.2.24 04/17/2017

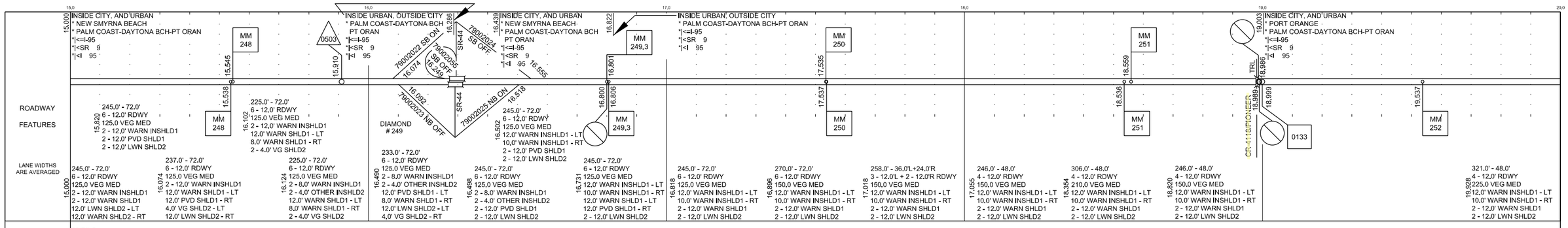
	5 YR INV	SLD REV	BMP	EMP	INV	SLD REV
DATE	06/02/2011	06/23/2011	011.095	027.336	06/22/2018 CB	07/25/2018 GD
			000.000	045.742	04/17/2017 MP	04/17/2017 GD
BY	Treva Fitz	Michael Register	000.000	045.742	03/20/2017 DP	03/27/2017 GD

FLORIDA DEPARTMENT OF TRANSPORTATION

STRAIGHT LINE DIAGRAM OF ROAD INVENTORY

SECTION STATUS	INT. or US ROUTE NO.	STATE ROAD NO.	COUNTY	DISTRICT	ROADWAY ID	SHEET NO:
02	I 95	SR 9	VOLUSIA	05	79002000	2 OF 6





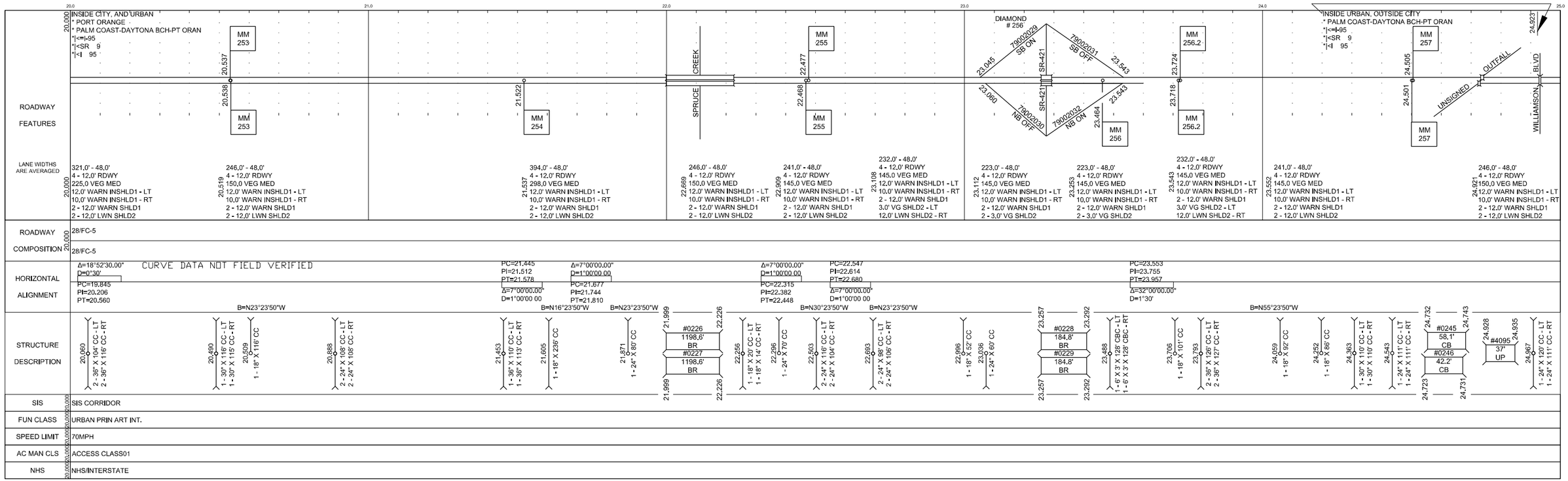
Version: 1.4.2.24 04/17/2017

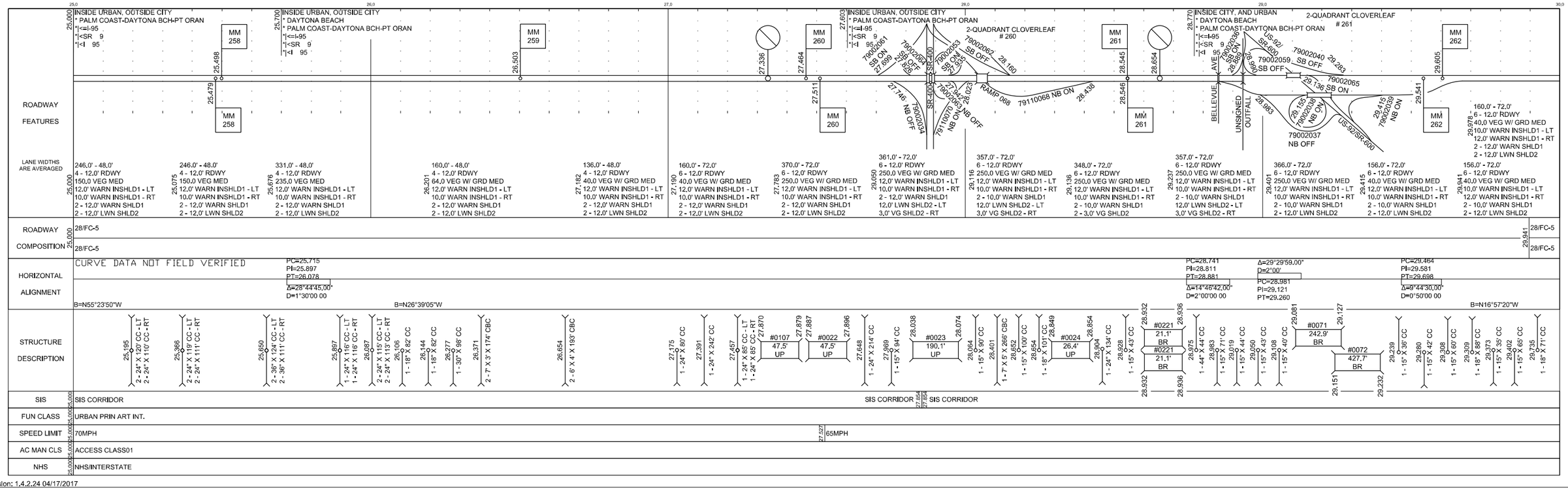
	5 YR INV	SLD REV	BMP	EMP	INV	SLD REV
DATE	06/02/2011	06/23/2011	011.095	027.336	06/22/2018 CB	07/25/2018 GD
BY	Treva Fitz	Michael Register	000.000	045.742	04/17/2017 MP	04/17/2017 GD
			000.000	045.742	03/20/2017 DP	03/27/2017 GD

FLORIDA DEPARTMENT OF TRANSPORTATION

STRAIGHT LINE DIAGRAM OF ROAD INVENTORY

SECTION STATUS	INT. or US ROUTE NO.	STATE ROAD NO.	COUNTY	DISTRICT	ROADWAY ID	SHEET NO:
02	I 95	SR 9	VOLUSIA	05	79002000	3 OF 6





Version: 1.4.2.24 04/17/2017

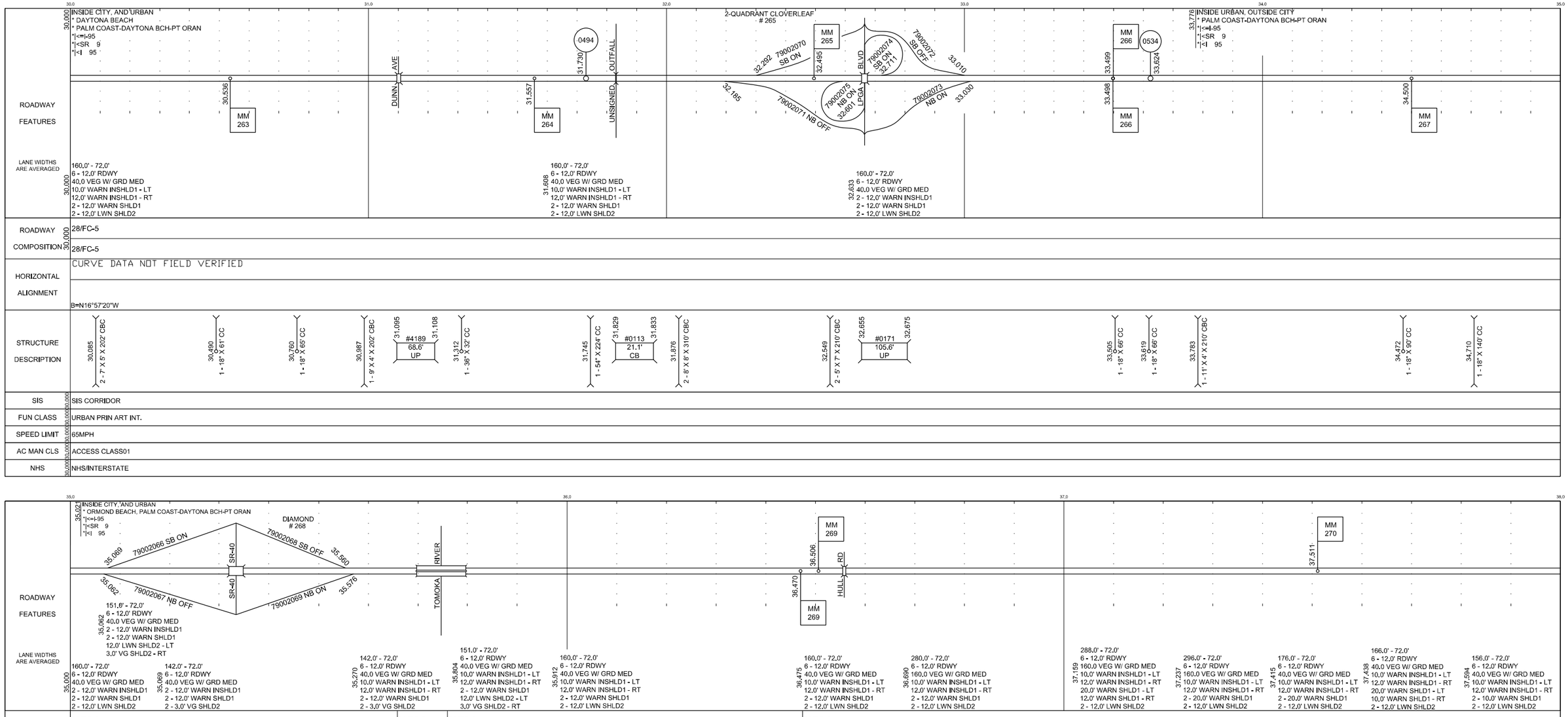
	5 YR INV	SLD REV
DATE	06/02/2011	06/23/2011
BY	Treva Fitz	Michael Register

BMP	EMP	INV	SLD REV
011.095	027.336	06/22/2018 CB	07/25/2018 GD
000.000	045.742	04/17/2017 MP	04/17/2017 GD
000.000	045.742	03/20/2017 DP	03/27/2017 GD

FLORIDA DEPARTMENT OF TRANSPORTATION

STRAIGHT LINE DIAGRAM OF ROAD INVENTORY

SECTION STATUS	INT. or US ROUTE NO.	STATE ROAD NO.	COUNTY	DISTRICT	ROADWAY ID	SHEET NO:
02	I 95	SR 9	VOLUSIA	05	79002000	4 OF 6



Version: 1.4.2.24 04/17/2017

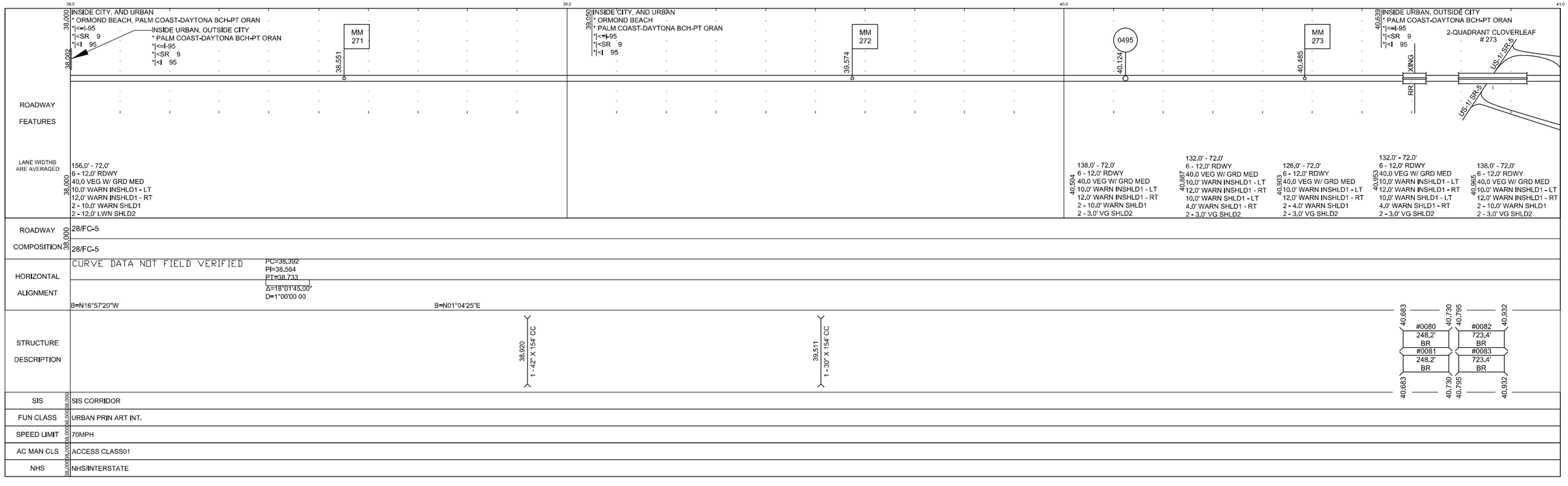
	5 YR INV	SLD REV
DATE	06/02/2011	06/23/2011
BY	Treva Fitz	Michael Register

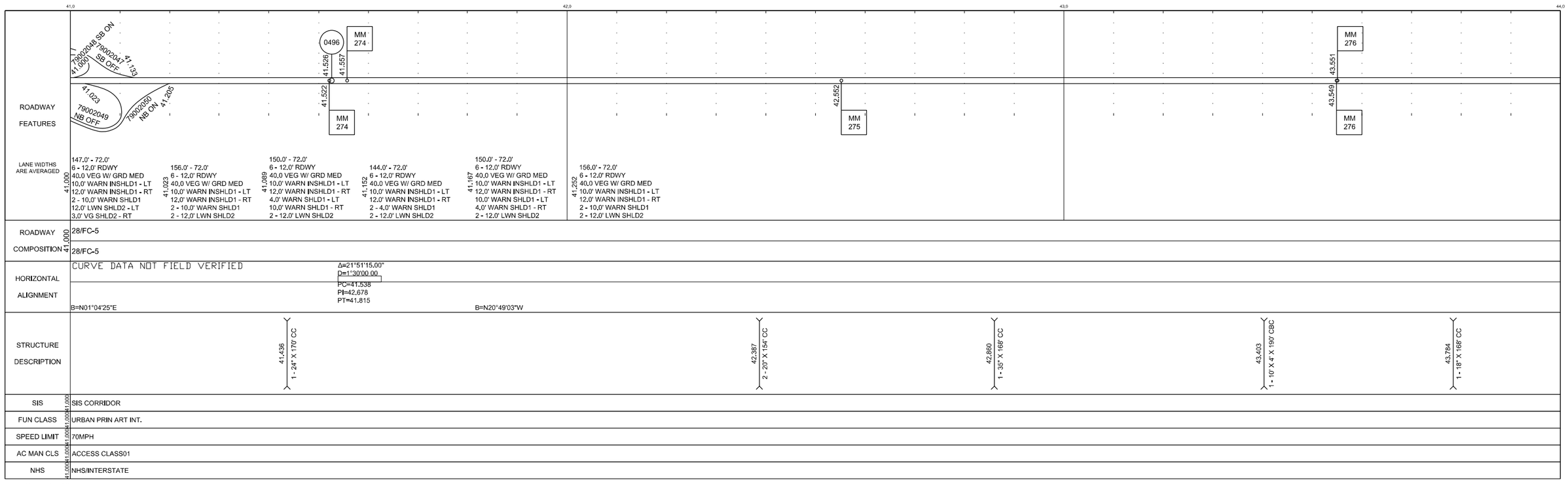
BMP	EMP	INV	SLD REV
011.095	027.336	06/22/2018 CB	07/25/2018 GD
000.000	045.742	04/17/2017 MP	04/17/2017 GD
000.000	045.742	03/20/2017 DP	03/27/2017 GD

FLORIDA DEPARTMENT OF TRANSPORTATION

STRAIGHT LINE DIAGRAM OF ROAD INVENTORY

SECTION STATUS	INT. or US ROUTE NO.	STATE ROAD NO.	COUNTY	DISTRICT	ROADWAY ID	SHEET NO:
02	I 95	SR 9	VOLUSIA	05	79002000	5 OF 6





Version: 1.4.2.24 04/17/2017

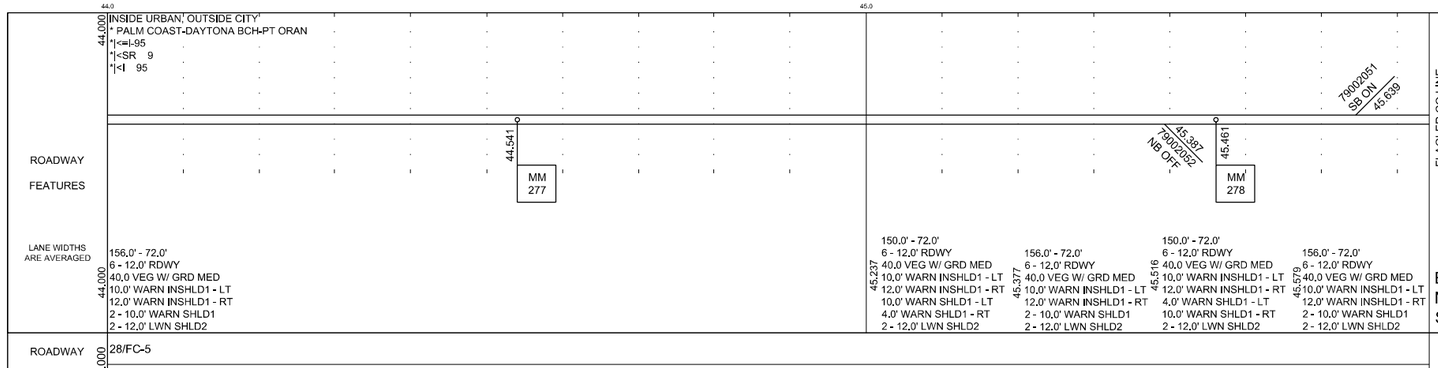
	5 YR INV	SLD REV
DATE	06/02/2011	06/23/2011
BY	Treva Fitz	Michael Register

BMP	EMP	INV	SLD REV
011.095	027.336	06/22/2018 CB	07/25/2018 GD
000.000	045.742	04/17/2017 MP	04/17/2017 GD
000.000	045.742	03/20/2017 DP	03/27/2017 GD

FLORIDA DEPARTMENT OF TRANSPORTATION

STRAIGHT LINE DIAGRAM OF ROAD INVENTORY

SECTION STATUS	INT. or US ROUTE NO.	STATE ROAD NO.	COUNTY	DISTRICT	ROADWAY ID	SHEET NO:
02	I 95	SR 9	VOLUSIA	05	79002000	6 OF 6



Version: 1.4.2.24 04/17/2017