I-95 BRIDGE REPLACEMENT OVER LAKE MARION

NOV 27, 2023

EXISTING PIPE HYDRAULIC ANALYSIS REPORT

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INTRODUCTION/BACKGROUND

SCDOT proposes to replace the bridges over Lake Marion on I-95 in Orangeburg and Clarendon Counties. The Design-Build preparation team is evaluating design alternatives in advance of more detailed future design efforts. As part of this effort, SCDOT has asked for an evaluation of the existing drainage system to determine the possible retention of all or portions of the existing drainage network. This report contains the results of this analysis. A separate condition assessment report of the existing drainage components has also been prepared along with video inspections and available for use in future design activities.

The list of pipes that were evaluated and included in this report are generally cross line pipes within the project area that may be impacted during final design and construction. Pipe networks or some portions thereof, that exist in the rest areas were also evaluated. This list of evaluated pipes does not include some pipes that were surveyed given their location outside the project area and expectation that existing flow conditions would not be altered. The Appendix of this report shows the pipes included in this evaluation.

GENERAL STATEMENT OF FINDINGS

As can be seen from HY-8 output of the cross lines, the existing pipes are performing at or above standards with a couple exceptions. HGLs for the pipe networks evaluated in the rest areas show that portions of both of these systems are undersized but are not creating an unfavorable ponding issue on the main line. In general, the structures in these systems need maintenance to remove debris, vegetation, and sediments. Pipe conditions is largely unknown for these networks.

SUMMARY of CROSSLINE PIPE ANALYSIS

The following table provides a summary of each of the crossline pipes within the project area. As shown, there are a few pipes that are not meeting the hydraulic standard for H/D = 1.20. Pipes 38 and 37 are the worst performing pipes and drain the NB side rest area to an outfall on the SB shoulder. However, Pipe 37 is low enough to not create ponding on the surface like Pipe 38 would along the NB shoulder next to the rest area. Pipe 23 appears to overtop thew exit ramp, however in actuality, available storage may be sufficient to prevent this occurrence. Additional analysis may be necessary. Finally, Pipe 56 also does not meet the hydraulic standard, however like Pipe 37, there is a low risk for surface ponding and impacting the main line roadway.

As seen in the HGL plots in Appendix D, there are some HGLs above the rims, namely in the SB and NB rest areas. While these do not affect the main line, they should be considered for possible upgrades. Additional topo in the rest areas will help refine the hydrologic and hydraulic analyses.

SUMMARY TABLE OF CROSSLINE HYDRAULIC ANALYSIS

Pipe	Diameter (in)	Q50 (cfs)	Head (ft)	Up Inv (ft)	H/D	Comments
22	18	5.91	85.88	84.08	1.20	
23	18	34.23	84.18	81.83	1.57	Exist Ramp overtopping
26	18	7.88	84.09	82.29	1.20	
28	18	4.61	102.64	101.49	0.77	
34	18	6.90	93.37	91.53	1.23	
35	18	6.42	95.81	94.2	1.07	
37	24	38.7	91.21	83.81	3.70	HGL below rim (median)
38	24	37.23	94.12	88.57	2.78	Potential for ponding above rim (NB shldr)
52	18	4.66	101.11	99.62	0.99	
56	18	7.22	102.39	100.072	1.55	HGL below rim (median)

IMPACT ON CHAPEL BRANCH

There are three SCDOT-owned crossline pipes within the scope of this report that currently drain toward Chapel Branch. These exists at approximate stations 5275+40 (48"), 5290+80 (24"), and 5302+00 (42"). D6 maintenance staff verified the existence of these discharge points. There are shown partially in plans through SCDOT online archive site, File #38.580. The available plans do not cover pipe construction under the old US Hwy 15/301, now called Bass Road. More detailed information may be available at D6 offices is needed.

Based on the analysis presented in this report and the condition assessment report, these crossline pipes meet SCDOT hydraulic design criteria and can be retained for continued use. While this report does not include analysis of proposed conditions, based on the four alternative bridge alignments and the small net increase in pavement/impervious area, these crosslines are expected to perform adequately in the proposed conditions. In addition, no negative impact is anticipated at the outfall for these pipes at Chapel Branch in terms of stormwater discharge rate, water quality, or volume. Final evaluation of the outfalls should be conducted during future proposed design efforts.

DATA PROVIDED

The appendices include the following evaluations:

A. **Hydrology and Time of Concentration output – for each crossline pipe evaluated**
B. **HY-8 output - for each crossline pipe evaluated**
C. **Rational Method Coefficients – used in crossline evaluation.**
D. **HGL plots of the pipe networks included in this report.**

Note: Rational method coefficients built in SCDOT version of GEOPAK were used and not presented here separately for network analysis.

APPENDIX A

I-95 Bridge Replacement over Lake Marion

DB PREP

Hydrology and Tc Output

PARRISH & PARTNERS

Job	*I-95 Lake Marion - Ex Pipe Analysis*		
Sheet	1	of	10
Calculated By:	MDA	Date:	5/15/2023

Location: **Pipe 22 - Crossline @ ~5161+50 NB I-95**

Q = CIA

Pre Construction Composite C Calculations			
Drainage Area Decription	**C**	**A**	**C*A**
Roadway Pavement	0.90	0.82	0.7380
			0.0000
			0.0000
Rolling Unimproved Areas	0.20	1.08	0.2160
			0.0000
	Σ	**1.90**	0.9540

C_{ave} = 0.9540 / 1.90 = 0.50

Pre Construction T_c:

T_c =	29.29	min.
I_{02} =	2.98	in / hr
I_{10} =	4.05	in / hr
I_{25} =	4.64	in / hr
I_{50} =	5.17	in / hr
I_{100} =	5.64	in / hr

Pre Construction Runoff:

	C		i		A		Factor			
Q_{02} =	0.50	x	2.98	x	1.90	x	1	=	**2.85**	cfs
Q_{10} =	0.50	x	4.05	x	1.90	x	1	=	**3.87**	cfs
Q_{25} =	0.50	x	4.64	x	1.90	x	1.1	=	**4.87**	cfs
Q_{50} =	0.50	x	5.17	x	1.90	x	1.2	=	**5.91**	cfs
Q_{100} =	0.50	x	5.64	x	1.90	x	1.25	=	**6.73**	cfs

PARRISH & PARTNERS

Job	*I-95 Lake Marion - Ex Pipe Analysis*		
Sheet	2	of	10
Calculated By:	MDA	Date:	5/15/2023

Location: **Pipe 23 - Crossline @ NB I-95 exit 102 ~ STA 5164+00**

Q = CIA

Pre Construction Composite C Calculations			
Drainage Area Decription	**C**	**A**	**C*A**
Roadway Pavement	0.90	5.48	4.9320
			0.0000
			0.0000
Rolling Unimproved Areas	0.20	14.68	2.9360
			0.0000
	Σ	**20.16**	7.8680

C_{ave} = 7.8680 / 20.16 = 0.39

Pre Construction T_c:

T_c =	58.65	min.
I_{02} =	1.89	in / hr
I_{10} =	2.71	in / hr
I_{25} =	3.19	in / hr
I_{50} =	3.63	in / hr
I_{100} =	4.05	in / hr

Pre Construction Runoff:

	C		i		A		Factor			
Q_{02} =	0.39	x	1.89	x	20.16	x	1	=	**14.89**	cfs
Q_{10} =	0.39	x	2.71	x	20.16	x	1	=	**21.33**	cfs
Q_{25} =	0.39	x	3.19	x	20.16	x	1.1	=	**27.64**	cfs
Q_{50} =	0.39	x	3.63	x	20.16	x	1.2	=	**34.23**	cfs
Q_{100} =	0.39	x	4.05	x	20.16	x	1.25	=	**39.79**	cfs

PARRISH & PARTNERS

Job	*I-95 Lake Marion - Ex Pipe Analysis*		
Sheet	3	of	10
Calculated By:	MDA	Date:	5/15/2023

Location: **Pipe 26 - Crossline @ SB I-95 ~ STA 5168+00**

Q = CIA

Pre Construction Composite C Calculations			
Drainage Area Decription	**C**	**A**	**C*A**
Roadway Pavement	0.90	1.50	1.3500
			0.0000
			0.0000
Rolling Unimproved Areas	0.20	1.41	0.2820
			0.0000
	Σ	**2.91**	1.6320

C_{ave} = 1.6320 / 2.91 = 0.56

Pre Construction T_c:

T_c =	48.02	min.
I_{02} =	2.17	in / hr
I_{10} =	3.06	in / hr
I_{25} =	3.57	in / hr
I_{50} =	4.03	in / hr
I_{100} =	4.46	in / hr

Pre Construction Runoff:

	C		i		A		Factor			
Q_{02} =	0.56	x	2.17	x	2.91	x	1	=	**3.54**	cfs
Q_{10} =	0.56	x	3.06	x	2.91	x	1	=	**4.99**	cfs
Q_{25} =	0.56	x	3.57	x	2.91	x	1.1	=	**6.41**	cfs
Q_{50} =	0.56	x	4.03	x	2.91	x	1.2	=	**7.88**	cfs
Q_{100} =	0.56	x	4.46	x	2.91	x	1.25	=	**9.10**	cfs

PARRISH & PARTNERS

Job	*I-95 Lake Marion - Ex Pipe Analysis*		
Sheet	4	of	10
Calculated By:	MDA	Date:	5/15/2023

Location: **Pipe 28 - Crossline @ SB I-95 ~ STA 5273+50**

Q = CIA

Pre Construction Composite C Calculations			
Drainage Area Decription	**C**	**A**	**C*A**
Roadway Pavement	0.90	0.56	0.5040
			0.0000
			0.0000
Rolling Unimproved Areas	0.20	0.65	0.1300
			0.0000
	Σ	**1.21**	0.6340

$C_{ave} = \frac{0.6340}{1.21} = 0.52$

Pre Construction T_c:

T_c =	19.64	min.
I_{02} =	3.67	in / hr
I_{10} =	4.82	in / hr
I_{25} =	5.45	in / hr
I_{50} =	6.06	in / hr
I_{100} =	6.59	in / hr

Pre Construction Runoff:

	C		i		A		Factor			
Q_{02} =	0.52	x	3.67	x	1.21	x	1	=	**2.33**	cfs
Q_{10} =	0.52	x	4.82	x	1.21	x	1	=	**3.06**	cfs
Q_{25} =	0.52	x	5.45	x	1.21	x	1.1	=	**3.80**	cfs
Q_{50} =	0.52	x	6.06	x	1.21	x	1.2	=	**4.61**	cfs
Q_{100} =	0.52	x	6.59	x	1.21	x	1.25	=	**5.22**	cfs

PARRISH & PARTNERS

Job	*I-95 Lake Marion - Ex Pipe Analysis*		
Sheet	5	of	10
Calculated By:	MDA	Date:	5/15/2023

Location: **Pipe 34 - Crossline @ SB I-95 ~ STA 5279+00**

Q = CIA

Pre Construction Composite C Calculations			
Drainage Area Decription	**C**	**A**	**C*A**
Roadway Pavement	0.90	0.89	0.8010
			0.0000
			0.0000
Rolling Unimproved Areas	0.20	1.11	0.2220
			0.0000
	Σ	**2.00**	1.0230

$C_{ave} = \frac{1.0230}{2.00} =$ 0.51

Pre Construction T_c:

T_c =	23.10	min.
I_{02} =	3.36	in / hr
I_{10} =	4.45	in / hr
I_{25} =	5.05	in / hr
I_{50} =	5.62	in / hr
I_{100} =	6.13	in / hr

Pre Construction Runoff:

	C		i		A		Factor			
Q_{02} =	0.51	x	3.36	x	2.00	x	1	=	**3.44**	cfs
Q_{10} =	0.51	x	4.45	x	2.00	x	1	=	**4.55**	cfs
Q_{25} =	0.51	x	5.05	x	2.00	x	1.1	=	**5.68**	cfs
Q_{50} =	0.51	x	5.62	x	2.00	x	1.2	=	**6.90**	cfs
Q_{100} =	0.51	x	6.13	x	2.00	x	1.25	=	**7.84**	cfs

PARRISH & PARTNERS

Job	*I-95 Lake Marion - Ex Pipe Analysis*		
Sheet	6	of	10
Calculated By:	MDA	Date:	5/15/2023

Location: **Pipe 35 - Crossline @ SB I-95 ~ STA 5285+00**

Q = CIA

Pre Construction Composite C Calculations			
Drainage Area Decription	**C**	**A**	**C*A**
Roadway Pavement	0.90	0.89	0.8010
			0.0000
			0.0000
Rolling Unimproved Areas	0.20	0.97	0.1940
			0.0000
	Σ	**1.86**	0.9950

C_{ave} = 0.9950 / 1.86 = 0.53

Pre Construction T_c:

T_c =	25.37	min.
I_{02} =	3.19	in / hr
I_{10} =	4.24	in / hr
I_{25} =	4.82	in / hr
I_{50} =	5.38	in / hr
I_{100} =	5.88	in / hr

Pre Construction Runoff:

	C		i		A		Factor			
Q_{02} =	0.53	x	3.19	x	1.86	x	1	=	**3.17**	cfs
Q_{10} =	0.53	x	4.24	x	1.86	x	1	=	**4.22**	cfs
Q_{25} =	0.53	x	4.82	x	1.86	x	1.1	=	**5.28**	cfs
Q_{50} =	0.53	x	5.38	x	1.86	x	1.2	=	**6.42**	cfs
Q_{100} =	0.53	x	5.88	x	1.86	x	1.25	=	**7.31**	cfs

PARRISH & PARTNERS

Job	*I-95 Lake Marion - Ex Pipe Analysis*		
Sheet	7	of	10
Calculated By:	MDA	Date:	5/15/2023

Location: **Pipe 37 - Crossline @ SB I-95 ~ STA 5291+00**

Q = CIA

Pre Construction Composite C Calculations			
Drainage Area Decription	**C**	**A**	**C*A**
Roadway Pavement	0.90	5.92	5.3280
			0.0000
			0.0000
Rolling Unimproved Areas	0.20	4.97	0.9940
			0.0000
	Σ	**10.89**	6.3220

$C_{ave} = \frac{6.3220}{10.89} = 0.58$

Pre Construction T_c:

T_c =	28.33	min.
I_{02} =	2.99	in / hr
I_{10} =	4.00	in / hr
I_{25} =	4.56	in / hr
I_{50} =	5.10	in / hr
I_{100} =	5.59	in / hr

Pre Construction Runoff:

	C		i		A		Factor			
Q_{02} =	0.58	x	2.99	x	10.89	x	1	=	**18.88**	cfs
Q_{10} =	0.58	x	4.00	x	10.89	x	1	=	**25.28**	cfs
Q_{25} =	0.58	x	4.56	x	10.89	x	1.1	=	**31.72**	cfs
Q_{50} =	0.58	x	5.10	x	10.89	x	1.2	=	**38.70**	cfs
Q_{100} =	0.58	x	5.59	x	10.89	x	1.25	=	**44.17**	cfs

PARRISH & PARTNERS

Job	*I-95 Lake Marion - Ex Pipe Analysis*		
Sheet	8	of	10
Calculated By:	MDA	Date:	5/15/2023

Location: **Pipe 38 - Crossline @ SB I-95 ~ STA 5291+00**

Q = CIA

Pre Construction Composite C Calculations			
Drainage Area Decription	**C**	**A**	**C*A**
Roadway Pavement	0.90	5.27	4.7430
			0.0000
			0.0000
Rolling Unimproved Areas	0.20	4.01	0.8020
			0.0000
	Σ	**9.28**	5.5450

C_{ave} = 5.5450 / 9.28 = 0.60

Pre Construction T_c:

T_c =	23.33	min.
I_{02} =	3.34	in / hr
I_{10} =	4.43	in / hr
I_{25} =	5.02	in / hr
I_{50} =	5.60	in / hr
I_{100} =	6.11	in / hr

Pre Construction Runoff:

	C		i		A		Factor			
Q_{02} =	0.60	x	3.34	x	9.28	x	1	=	**18.54**	cfs
Q_{10} =	0.60	x	4.43	x	9.28	x	1	=	**24.55**	cfs
Q_{25} =	0.60	x	5.02	x	9.28	x	1.1	=	**30.64**	cfs
Q_{50} =	0.60	x	5.60	x	9.28	x	1.2	=	**37.23**	cfs
Q_{100} =	0.60	x	6.11	x	9.28	x	1.25	=	**42.32**	cfs

PARRISH & PARTNERS

Job	*I-95 Lake Marion - Ex Pipe Analysis*		
Sheet	9	of	10
Calculated By:	MDA	Date:	5/15/2023

Location: **Pipe 56 - Crossline @ NB I-95 ~ STA 5298+10+00**

Q = CIA

Pre Construction Composite C Calculations			
Drainage Area Decription	**C**	**A**	**C*A**
Roadway Pavement	0.90	0.87	0.7830
			0.0000
			0.0000
Rolling Unimproved Areas	0.20	1.07	0.2140
			0.0000
	Σ	**1.94**	0.9970

C_{ave} = 0.9970 / 1.94 = 0.51

Pre Construction T_c:

T_c =	48.40	min.
I_{02} =	2.12	in / hr
I_{10} =	2.95	in / hr
I_{25} =	3.43	in / hr
I_{50} =	3.89	in / hr
I_{100} =	4.33	in / hr

Pre Construction Runoff:

	C		i		A		Factor			
Q_{02} =	0.51	x	2.12	x	1.94	x	1	=	**2.11**	cfs
Q_{10} =	0.51	x	2.95	x	1.94	x	1	=	**2.94**	cfs
Q_{25} =	0.51	x	3.43	x	1.94	x	1.1	=	**3.76**	cfs
Q_{50} =	0.51	x	3.89	x	1.94	x	1.2	=	**4.66**	cfs
Q_{100} =	0.51	x	4.33	x	1.94	x	1.25	=	**5.40**	cfs

PARRISH & PARTNERS

Job	*I-95 Lake Marion - Ex Pipe Analysis*		
Sheet	10	of	10
Calculated By:	MDA	Date:	5/15/2023

Location: **Pipe 56 - Crossline @ SB I-95 ~ STA 5305+40+00**

Q = CIA

Pre Construction Composite C Calculations			
Drainage Area Decription	**C**	**A**	**C*A**
Roadway Pavement	0.90	1.37	1.2330
			0.0000
			0.0000
Rolling Unimproved Areas	0.20	1.91	0.3820
			0.0000
	Σ	**3.28**	1.6150

C_{ave} = 1.6150 / 3.28 = 0.49

Pre Construction T_c:

T_c =	52.75	min.
I_{02} =	2.00	in / hr
I_{10} =	2.80	in / hr
I_{25} =	3.27	in / hr
I_{50} =	3.72	in / hr
I_{100} =	4.16	in / hr

Pre Construction Runoff:

	C		i		A		Factor			
Q_{02} =	0.49	x	2.00	x	3.28	x	1	=	**3.23**	cfs
Q_{10} =	0.49	x	2.80	x	3.28	x	1	=	**4.53**	cfs
Q_{25} =	0.49	x	3.27	x	3.28	x	1.1	=	**5.81**	cfs
Q_{50} =	0.49	x	3.72	x	3.28	x	1.2	=	**7.22**	cfs
Q_{100} =	0.49	x	4.16	x	3.28	x	1.25	=	**8.39**	cfs

PRE

Pipe 22

FLOW TYPE	LENGTH (feet)	SLOPE (ft./ft.)	SURFACE Code	MANNINGS "n"	AREA (sq.ft.)	WP (feet)	VELOCITY (ft./sec.)	TRAVEL TIME
SHEET	300	0.0167	e	**0.15**	n/a	n/a	n/a	0.399 hours
SHALLOW CONCENTRATED	451	0.0167	u	n/a	n/a	n/a	**2.08**	0.060 hours
SHALLOW CONCENTRATED								0.000 hours
SHALLOW CONCENTRATED								0.000 hours
PIPE	117.9	0.0003	n/a	0.011	1.33	3.53	**1.12**	0.029 hours
OPEN CHANNEL								0.000 hours
PIPE								0.000 hours
								0.000 hours
							Time of Concentration	**0.5 hours**
								29.3 min

Ditch depth 6 in outside slope 4
0.50 ft rd slope 4

Pipe 23

FLOW TYPE	LENGTH (feet)	SLOPE (ft./ft.)	SURFACE Code	MANNINGS "n"	AREA (sq.ft.)	WP (feet)	VELOCITY (ft./sec.)	TRAVEL TIME
SHEET	300	0.0051	e	**0.15**	n/a	n/a	n/a	0.640 hours
SHALLOW CONCENTRATED	1101	0.0052	u	n/a	n/a	n/a	**1.16**	0.263 hours
SHALLOW CONCENTRATED				n/a	n/a	n/a	----------	0.000 hours
SHALLOW CONCENTRATED				n/a	n/a	n/a	----------	0.000 hours
PIPE	90	0.0336	n/a	0.011	1.33	3.53	**12.86**	0.008 hours
OPEN CHANNEL	717	0.0105	n/a	0.035	1.00	4.12	**3.02**	0.066 hours
							----------	0.000 hours
								0.000 hours
							Time of Concentration	**0.977 hours**
								58.6 min

Ditch depth 6 in outside slope 4
0.50 ft rd slope 4

Pipe 26

FLOW TYPE	LENGTH (feet)	SLOPE (ft./ft.)	SURFACE Code	MANNINGS "n"	AREA (sq.ft.)	WP (feet)	VELOCITY (ft./sec.)	TRAVEL TIME
SHEET	300	0.004	e	**0.15**	n/a	n/a	n/a	0.706 hours
SHALLOW CONCENTRATED	315	0.004	u	n/a	n/a	n/a	**1.02**	0.086 hours
SHALLOW CONCENTRATED				n/a	n/a	n/a	----------	0.000 hours
SHALLOW CONCENTRATED				n/a	n/a	n/a	----------	0.000 hours
PIPE	82.3	0.006	n/a	0.011	1.33	3.53	**5.57**	0.004 hours
PIPE	118.2	0.010	n/a	0.011	1.33	3.53	**6.92**	0.005 hours
OPEN CHANNEL			n/a	0.035	1.00	4.12	**0.00**	0.000 hours
OPEN CHANNEL			n/a				----------	0.000 hours
							Time of Concentration	**0.800 hours**
								48.0 min

Ditch depth 6 in outside slope 4
0.50 ft rd slope 4

Pipe 28

FLOW TYPE	LENGTH (feet)	SLOPE (ft./ft.)	SURFACE Code	MANNINGS "n"	AREA (sq.ft.)	WP (feet)	VELOCITY (ft./sec.)	TRAVEL TIME
SHEET	300	0.0313	e	**0.15**	n/a	n/a	n/a	0.310 hours
SHALLOW CONCENTRATED	160	0.0256	u	n/a	n/a	n/a	**2.58**	0.017 hours
SHALLOW CONCENTRATED				n/a	n/a	n/a	----------	0.000 hours
SHALLOW CONCENTRATED				n/a	n/a	n/a	----------	0.000 hours
OPEN CHANNEL			n/a	0.035	1.00	4.12	**0.00**	0.000 hours
OPEN CHANNEL			n/a				----------	0.000 hours
OPEN CHANNEL			n/a				----------	0.000 hours
OPEN CHANNEL			n/a				----------	0.000 hours
							Time of Concentration	**0.327 hours**
								19.6 min

Ditch depth 6 in outside slope 4
0.50 ft rd slope 4

Pipe 34

FLOW TYPE	LENGTH (feet)	SLOPE (ft./ft.)	SURFACE Code	MANNINGS "n"	AREA (sq.ft.)	WP (feet)	VELOCITY (ft./sec.)	TRAVEL TIME
SHEET	300	0.0221	e	**0.15**	n/a	n/a	n/a	0.357 hours
SHALLOW CONCENTRATED	245	0.0221	u	n/a	n/a	n/a	**2.40**	0.028 hours
SHALLOW CONCENTRATED				n/a	n/a	n/a	----------	0.000 hours
SHALLOW CONCENTRATED				n/a	n/a	n/a	----------	0.000 hours
OPEN CHANNEL			n/a	0.035	1.00	4.12	**0.00**	0.000 hours
OPEN CHANNEL			n/a				----------	0.000 hours
OPEN CHANNEL			n/a		`		----------	0.000 hours
OPEN CHANNEL			n/a				----------	0.000 hours
							Time of Concentration	**0.385 hours**
								23.1 min

Ditch depth 6 in outside slope 4
0.50 ft rd slope 4

Pipe 35

FLOW TYPE	LENGTH (feet)	SLOPE (ft./ft.)	SURFACE Code	MANNINGS "n"	AREA (sq.ft.)	WP (feet)	VELOCITY (ft./sec.)	TRAVEL TIME
SHEET	300	0.0208	e	**0.15**	n/a	n/a	n/a	0.365 hours
SHALLOW CONCENTRATED	275	0.0066	u	n/a	n/a	n/a	**1.31**	0.058 hours
SHALLOW CONCENTRATED				n/a	n/a	n/a	----------	0.000 hours
SHALLOW CONCENTRATED				n/a	n/a	n/a	----------	0.000 hours
OPEN CHANNEL			n/a	0.035	1.00	4.12	**0.00**	0.000 hours
OPEN CHANNEL			n/a				----------	0.000 hours
OPEN CHANNEL			n/a		`		----------	0.000 hours
OPEN CHANNEL			n/a				----------	0.000 hours
							Time of Concentration	**0.423 hours**
								25.4 min

Ditch depth 6 in outside slope 4
0.50 ft rd slope 4

Pipe 38

FLOW TYPE	LENGTH (feet)	SLOPE (ft./ft.)	SURFACE Code	MANNINGS "n"	AREA (sq.ft.)	WP (feet)	VELOCITY (ft./sec.)	TRAVEL TIME
SHEET	300	0.0571	e	**0.15**	n/a	n/a	n/a	0.244 hours
SHALLOW CONCENTRATED	234	0.0055	u	n/a	n/a	n/a	**1.19**	0.054 hours
SHALLOW CONCENTRATED				n/a	n/a	n/a	----------	0.000 hours
SHALLOW CONCENTRATED				n/a	n/a	n/a	----------	0.000 hours
PIPE	98.3	0.0101	n/a	0.011	2.36	4.71	**8.54**	0.003 hours
OPEN CHANNEL	385	0.0073	n/a	0.02	0.50	2.24	**2.33**	0.046 hours
OPEN CHANNEL	245	0.0098	n/a	0.035	1.00	4.12	**1.63**	0.042 hours
OPEN CHANNEL			n/a				----------	0.000 hours
							Time of Concentration	**0.389 hours**
								23.3 min

Ditch depth 6 in outside slope 2 4
0.50 ft rd slope 2 4

Pipe 37

FLOW TYPE	LENGTH (feet)	SLOPE (ft./ft.)	SURFACE Code	MANNINGS "n"	AREA (sq.ft.)	WP (feet)	VELOCITY (ft./sec.)	TRAVEL TIME
SHEET			e	**0.15**	n/a	n/a	n/a	0.000 hours
SHALLOW CONCENTRATED			u	n/a	n/a	n/a	**0.00**	0.000 hours
SHALLOW CONCENTRATED				n/a	n/a	n/a	----------	0.000 hours
SHALLOW CONCENTRATED				n/a	n/a	n/a	----------	0.000 hours
PIPE	170.9	0.0047	n/a	0.011	2.36	4.71	**5.83**	0.008 hours
OPEN CHANNEL			n/a				----------	0.000 hours
OPEN CHANNEL			n/a				----------	0.000 hours
OPEN CHANNEL			n/a				----------	0.000 hours
							Time of Concentration	**0.472 hours**
								28.3 min

Ditch depth 6 in outside slope 4
0.50 ft rd slope 4

Pipe 56

FLOW TYPE	LENGTH (feet)	SLOPE (ft./ft.)	SURFACE Code	MANNINGS "n"	AREA (sq.ft.)	WP (feet)	VELOCITY (ft./sec.)	TRAVEL TIME
SHEET	300	0.0054	e	**0.15**	n/a	n/a	n/a	0.628 hours
SHALLOW CONCENTRATED	1095	0.0056	u	n/a	n/a	n/a	**1.21**	0.251 hours
SHALLOW CONCENTRATED				n/a	n/a	n/a	----------	0.000 hours
SHALLOW CONCENTRATED				n/a	n/a	n/a	----------	0.000 hours
PIPE			n/a	0.011	1.33	3.53	**0.00**	0.000 hours
OPEN CHANNEL			n/a				----------	0.000 hours
OPEN CHANNEL			n/a				----------	0.000 hours
OPEN CHANNEL			n/a				----------	0.000 hours
							Time of Concentration	**0.879 hours**
								52.7 min

Ditch depth	6 in	outside slope	2	4	
	0.50 ft	rd slope	2	4	

Pipe 52

FLOW TYPE	LENGTH (feet)	SLOPE (ft./ft.)	SURFACE Code	MANNINGS "n"	AREA (sq.ft.)	WP (feet)	VELOCITY (ft./sec.)	TRAVEL TIME
SHEET	300	0.0042	e	**0.15**	n/a	n/a	n/a	0.689 hours
SHALLOW CONCENTRATED	445	0.0042	u	n/a	n/a	n/a	**1.05**	0.118 hours
SHALLOW CONCENTRATED				n/a	n/a	n/a	----------	0.000 hours
SHALLOW CONCENTRATED				n/a	n/a	n/a	----------	0.000 hours
PIPE			n/a				----------	0.000 hours
OPEN CHANNEL			n/a				----------	0.000 hours
OPEN CHANNEL			n/a				----------	0.000 hours
OPEN CHANNEL			n/a				----------	0.000 hours
							Time of Concentration	**0.807 hours**
								48.4 min

Ditch depth	6 in	outside slope	2	4	
	0.50 ft	rd slope	2	4	

	Surface Codes	
a	a Smooth Surface	0.011
b	b fallow (no residue)	0.05
c	c cultivated < 20% Res.	0.06
d	d cultivated > 20% Res.	0.17
e	e grass - range, short	0.15
f	f grass, dense	0.24
g	g grass, bermuda	0.41
h	h woods, light	0.4
I	I woods, dense	0.8
j	j range, natural	0.13
	2yr 24hr rain event	3.6

Sheet Flow Surface Codes

a Smooth Surface
b fallow (no residue)
c cultivated < 20% Res.
d cultivated > 20% Res.
e grass - range, short
f grass, dense
g grass, bermuda
h woods, light
i woods, dense
j range, natural

Shallow Concentrated Surface Codes

u unpaved surface
p paved surface

APPENDIX B

I-95 Bridge Replacement over Lake Marion

DB PREP

HY-8 Output for Crossline Pipes

HY-8 Culvert Analysis Report

PIPE 22

Crossing Discharge Data

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

Minimum Flow: 3.87 cfs

Design Flow: 5.91 cfs

Maximum Flow: 6.73 cfs

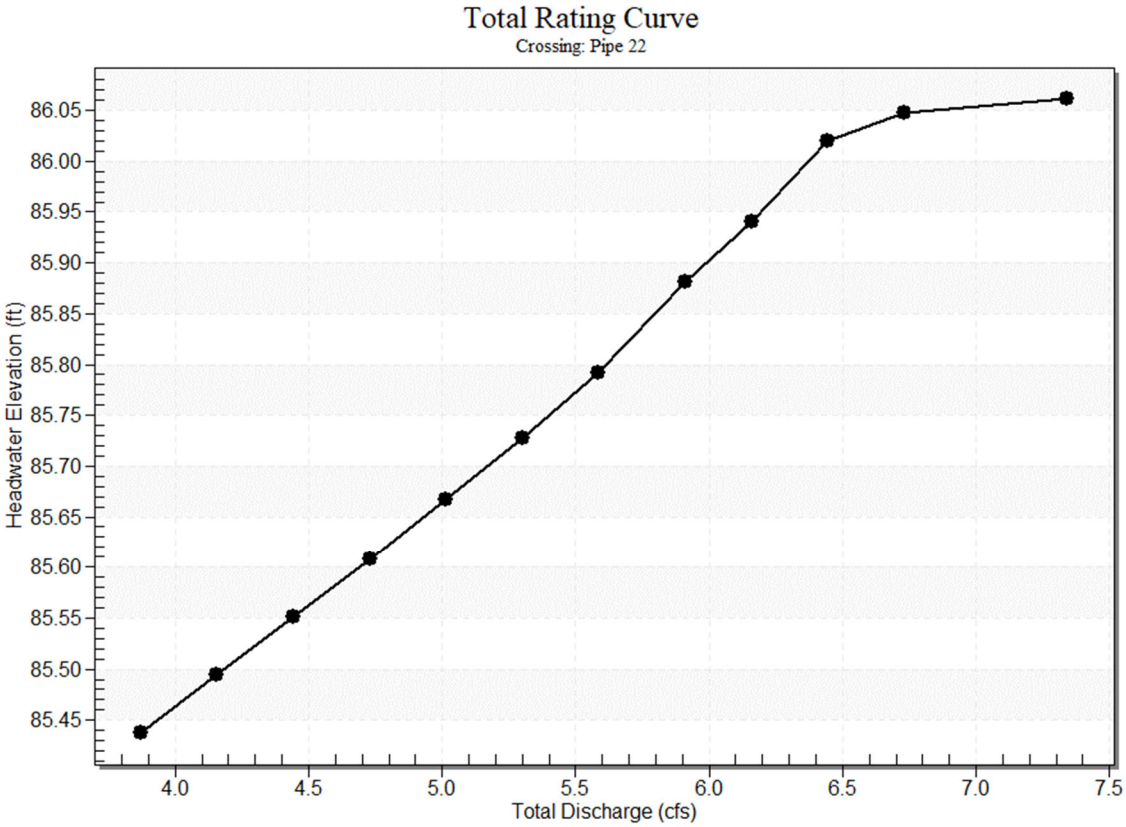
Table 1 - Summary of Culvert Flows at Crossing: Pipe 22

Headwater Elevation (ft)	Total Discharge (cfs)	Culvert 1 Discharge (cfs)	Roadway Discharge (cfs)	Iterations
85.44	3.87	3.87	0.00	1
85.49	4.16	4.16	0.00	1
85.55	4.44	4.44	0.00	1
85.61	4.73	4.73	0.00	1
85.67	5.01	5.01	0.00	1
85.73	5.30	5.30	0.00	1
85.79	5.59	5.59	0.00	1
85.88	5.91	5.91	0.00	1
85.94	6.16	6.16	0.00	1
86.02	6.44	6.44	0.00	1
86.05	6.73	6.51	0.17	10
86.04	6.50	6.50	0.00	Overtopping

NOTE: For each pipes in this evaluation:

Minimum Flow = 10-yr event
Design flow = 50-yr event
Maximum flow = 100-yr event

Rating Curve Plot for Crossing: Pipe 22



Culvert Data: Culvert 1

Table 1 - Culvert Summary Table: Culvert 1

Total Discharge (cfs)	Culvert Discharge (cfs)	Headwater Elevation (ft)	Inlet Control Depth (ft)	Outlet Control Depth (ft)	Flow Type	Normal Depth (ft)	Critical Depth (ft)	Outlet Depth (ft)	Tailwater Depth (ft)	Outlet Velocity (ft/s)	Tailwater Velocity (ft/s)
3.87 cfs	3.87 cfs	85.44	1.11	1.358	3-M2t	1.50	0.75	1.04	1.04	2.97	1.80
4.16 cfs	4.16 cfs	85.49	1.16	1.414	3-M2t	1.50	0.78	1.07	1.07	3.10	1.83
4.44 cfs	4.44 cfs	85.55	1.21	1.471	3-M2t	1.50	0.81	1.09	1.09	3.22	1.86
4.73 cfs	4.73 cfs	85.61	1.26	1.528	3-M2t	1.50	0.84	1.12	1.12	3.35	1.89

5.01 cfs	5.01 cfs	85.67	1.30	1.587	3-M2t	1.50	0.86	1.14	1.14	3.47	1.92
5.30 cfs	5.30 cfs	85.73	1.35	1.647	3-M2t	1.50	0.89	1.17	1.17	3.59	1.95
5.59 cfs	5.59 cfs	85.79	1.40	1.712	3-M2t	1.50	0.91	1.19	1.19	3.71	1.97
5.91 cfs	5.91 cfs	85.88	1.45	1.801	7-M2t	1.50	0.94	1.22	1.22	3.85	2.00
6.16 cfs	6.16 cfs	85.94	1.49	1.861	7-M2t	1.50	0.96	1.23	1.23	3.96	2.02
6.44 cfs	6.44 cfs	86.02	1.54	1.940	7-M2t	1.50	0.98	1.26	1.26	4.08	2.04
6.73 cfs	6.51 cfs	86.05	1.55	1.968	7-M2t	1.50	0.99	1.28	1.28	4.06	2.07

Culvert Barrel Data

Culvert Barrel Type Straight Culvert

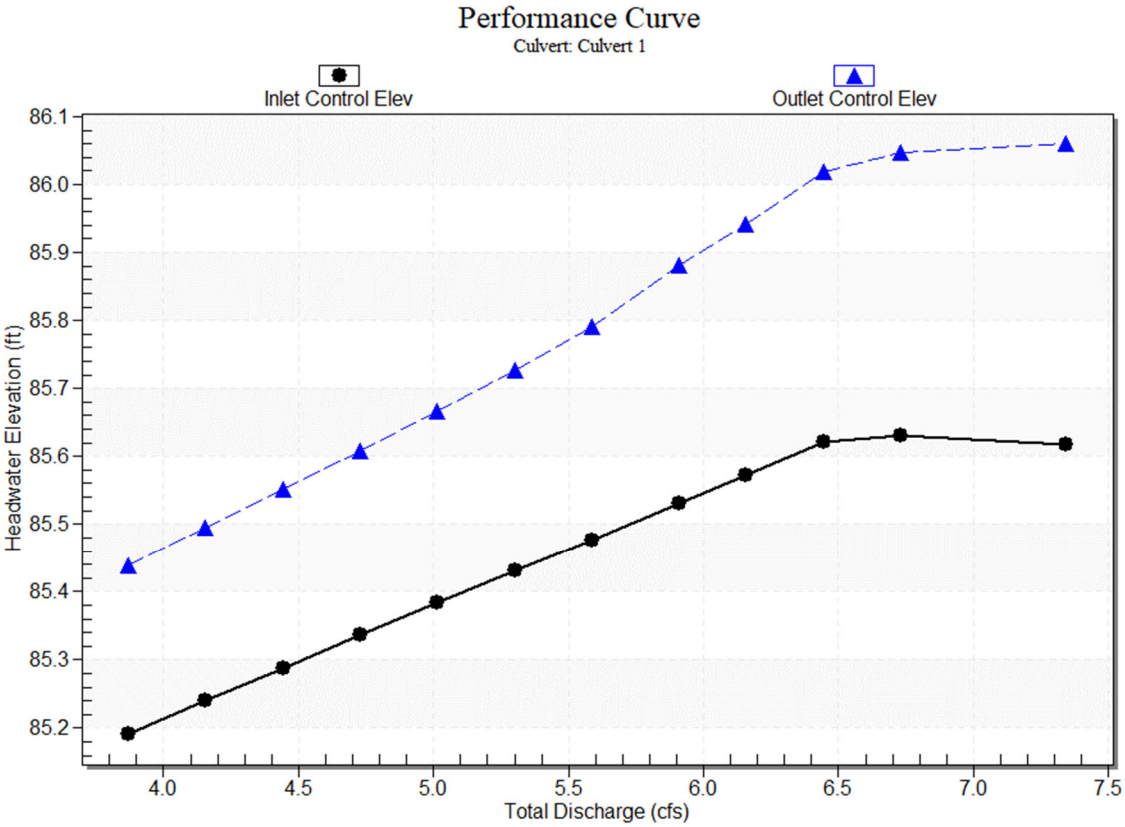
Inlet Elevation (invert): 84.08 ft,

Outlet Elevation (invert): 84.05 ft

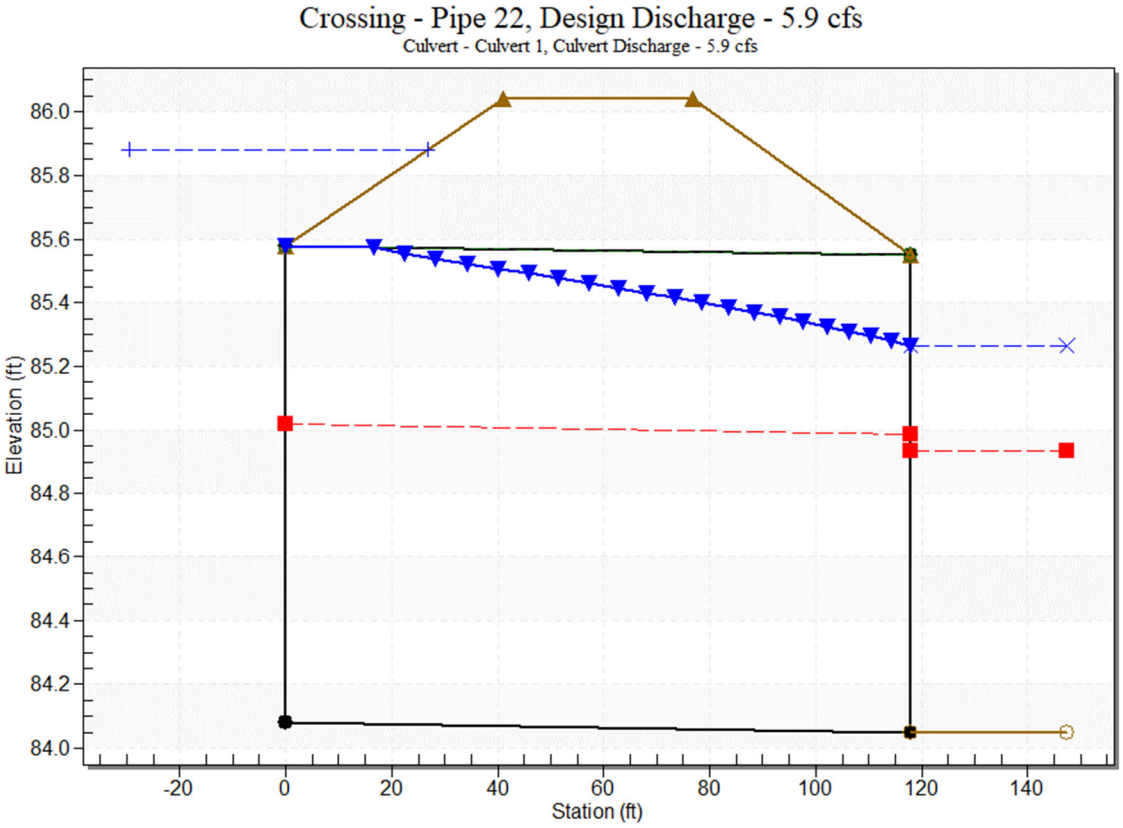
Culvert Length: 117.90 ft,

Culvert Slope: 0.0003

Culvert Performance Curve Plot: Culvert 1



Water Surface Profile Plot for Culvert: Culvert 1



Site Data - Culvert 1

Site Data Option: Culvert Invert Data

Inlet Station: 0.00 ft

Inlet Elevation: 84.08 ft

Outlet Station: 117.90 ft

Outlet Elevation: 84.05 ft

Number of Barrels: 1

Culvert Data Summary - Culvert 1

Barrel Shape: Circular

Barrel Diameter: 1.50 ft

Barrel Material:

Embedment: 0.00 in

Barrel Manning's n: 0.0120

Culvert Type: Straight

Inlet Configuration: Square Edge with Headwall (Ke=0.5)

Inlet Depression: None

Tailwater Data for Crossing: Pipe 22

Table 2 - Downstream Channel Rating Curve (Crossing: Pipe 22)

Flow (cfs)	Water Surface Elev (ft)	Velocity (ft/s)	Depth (ft)	Shear (psf)	Froude Number
3.87	85.09	1.04	1.80	0.32	0.44
4.16	85.12	1.07	1.83	0.33	0.44
4.44	85.14	1.09	1.86	0.34	0.44
4.73	85.17	1.12	1.89	0.35	0.45
5.01	85.19	1.14	1.92	0.36	0.45
5.30	85.22	1.17	1.95	0.36	0.45
5.59	85.24	1.19	1.97	0.37	0.45
5.91	85.27	1.22	2.00	0.38	0.45
6.16	85.28	1.23	2.02	0.39	0.45
6.44	85.31	1.26	2.04	0.39	0.45
6.73	85.33	1.28	2.07	0.40	0.46

Tailwater Channel Data - Pipe 22

Tailwater Channel Option: Triangular Channel

Side Slope (H:V): 2.00 (_:1)

Channel Slope: 0.0050

Channel Manning's n: 0.0350

Channel Invert Elevation: 84.05 ft

Roadway Data for Crossing: Pipe 22

Roadway Profile Shape: Constant Roadway Elevation

Crest Length: 100.00 ft

Crest Elevation: 86.04 ft

Roadway Surface: Paved

Roadway Top Width: 36.00 ft

PIPE 23

Crossing Discharge Data

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

Minimum Flow: 21.33 cfs

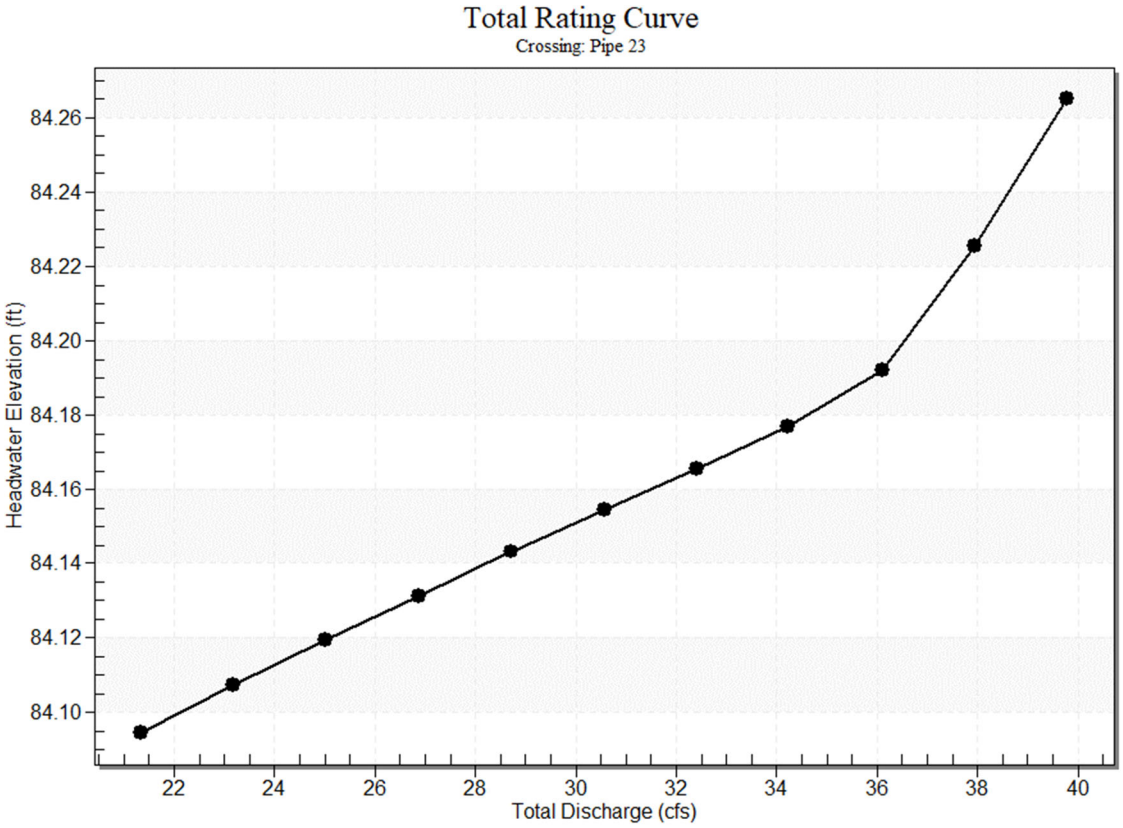
Design Flow: 34.23 cfs

Maximum Flow: 39.79 cfs

Table 3 - Summary of Culvert Flows at Crossing: Pipe 23

Headwater Elevation (ft)	Total Discharge (cfs)	Culvert 1 Discharge (cfs)	Roadway Discharge (cfs)	Iterations
84.09	21.33	4.82	16.39	7
84.11	23.18	4.48	18.54	3
84.12	25.02	4.13	20.75	3
84.13	26.87	3.77	22.98	3
84.14	28.71	3.39	25.22	3
84.15	30.56	2.99	27.49	3
84.17	32.41	2.54	29.80	3
84.18	34.23	2.02	32.15	3
84.19	36.10	1.43	34.75	4
84.23	37.94	1.10	37.20	9
84.27	39.79	0.91	39.15	4
83.95	7.41	7.41	0.00	Overtopping

Rating Curve Plot for Crossing: Pipe 23



Culvert Data: Culvert 1

Table 2 - Culvert Summary Table: Culvert 1

Total Discharge (cfs)	Culvert Discharge (cfs)	Headwater Elevation (ft)	Inlet Control Depth (ft)	Outlet Control Depth (ft)	Flow Type	Normal Depth (ft)	Critical Depth (ft)	Outlet Depth (ft)	Tailwater Depth (ft)	Outlet Velocity (ft/s)	Tailwater Velocity (ft/s)
21.33 cfs	4.82 cfs	84.09	1.27	2.265	4-FFf	1.50	0.84	1.50	2.05	2.73	2.54
23.18 cfs	4.48 cfs	84.11	1.21	2.277	4-FFf	1.28	0.81	1.50	2.12	2.53	2.59
25.02 cfs	4.13 cfs	84.12	1.15	2.290	4-FFf	1.17	0.78	1.50	2.18	2.34	2.64
26.87 cfs	3.77 cfs	84.13	1.09	2.301	4-FFf	1.08	0.74	1.50	2.24	2.13	2.69
28.71 cfs	3.39 cfs	84.14	1.02	2.313	4-FFf	1.00	0.70	1.50	2.29	1.92	2.73
30.56 cfs	2.99 cfs	84.15	0.95	2.325	4-FFf	0.92	0.66	1.50	2.35	1.69	2.77

32.41 cfs	2.54 cfs	84.17	0.85	2.336	4-FFf	0.83	0.60	1.50	2.40	1.43	2.81
34.23 cfs	2.02 cfs	84.18	0.74	2.347	4-FFf	0.72	0.54	1.50	2.45	1.14	2.85
36.10 cfs	1.43 cfs	84.19	0.62	2.362	4-FFf	0.59	0.45	1.50	2.50	0.81	2.89
37.94 cfs	1.10 cfs	84.23	0.54	2.396	4-FFf	0.52	0.39	1.50	2.55	0.62	2.93
39.79 cfs	0.91 cfs	84.27	0.49	2.435	4-FFf	0.47	0.36	1.50	2.59	0.51	2.96

Culvert Barrel Data

Culvert Barrel Type Straight Culvert

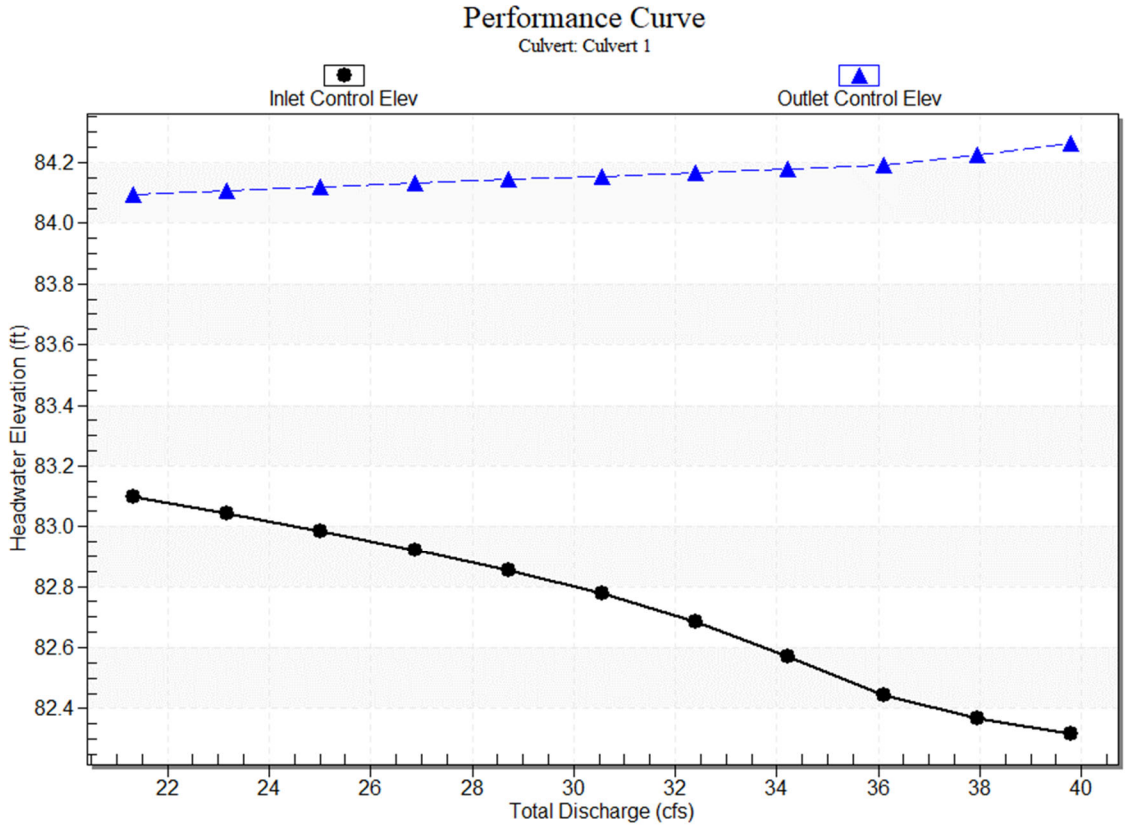
Inlet Elevation (invert): 81.83 ft,

Outlet Elevation (invert): 81.66 ft

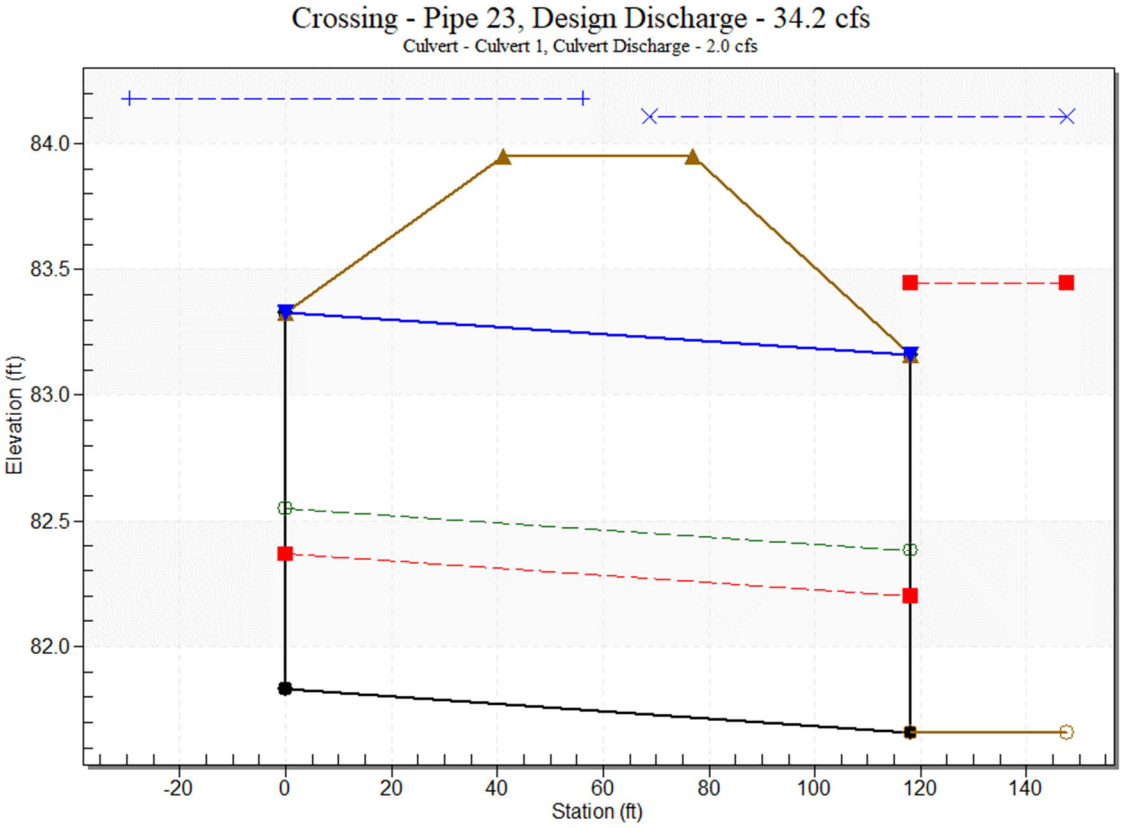
Culvert Length: 118.10 ft,

Culvert Slope: 0.0014

Culvert Performance Curve Plot: Culvert 1



Water Surface Profile Plot for Culvert: Culvert 1



Site Data - Culvert 1

Site Data Option: Culvert Invert Data

Inlet Station: 0.00 ft

Inlet Elevation: 81.83 ft

Outlet Station: 118.10 ft

Outlet Elevation: 81.66 ft

Number of Barrels: 1

Culvert Data Summary - Culvert 1

Barrel Shape: Circular

Barrel Diameter: 1.50 ft

Barrel Material:

Embedment: 0.00 in

Barrel Manning's n: 0.0120

Culvert Type: Straight

Inlet Configuration: Square Edge with Headwall (Ke=0.5)

Inlet Depression: None

Tailwater Data for Crossing: Pipe 23

Table 4 - Downstream Channel Rating Curve (Crossing: Pipe 23)

Flow (cfs)	Water Surface Elev (ft)	Velocity (ft/s)	Depth (ft)	Shear (psf)	Froude Number
21.33	83.71	2.05	2.54	0.51	0.44
23.18	83.78	2.12	2.59	0.53	0.44
25.02	83.84	2.18	2.64	0.54	0.45
26.87	83.90	2.24	2.69	0.56	0.45
28.71	83.95	2.29	2.73	0.57	0.45
30.56	84.01	2.35	2.77	0.59	0.45
32.41	84.06	2.40	2.81	0.60	0.45
34.23	84.11	2.45	2.85	0.61	0.45
36.10	84.16	2.50	2.89	0.62	0.46
37.94	84.21	2.55	2.93	0.64	0.46
39.79	84.25	2.59	2.96	0.65	0.46

Tailwater Channel Data - Pipe 23

Tailwater Channel Option: Triangular Channel

Side Slope (H:V): 2.00 (_:1)

Channel Slope: 0.0040

Channel Manning's n: 0.0350

Channel Invert Elevation: 81.66 ft

Roadway Data for Crossing: Pipe 23

Roadway Profile Shape: Constant Roadway Elevation

Crest Length: 100.00 ft

Crest Elevation: 83.95 ft

Roadway Surface: Paved

Roadway Top Width: 36.00 ft

PIPE 26

Crossing Discharge Data

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

Minimum Flow: 4.99 cfs

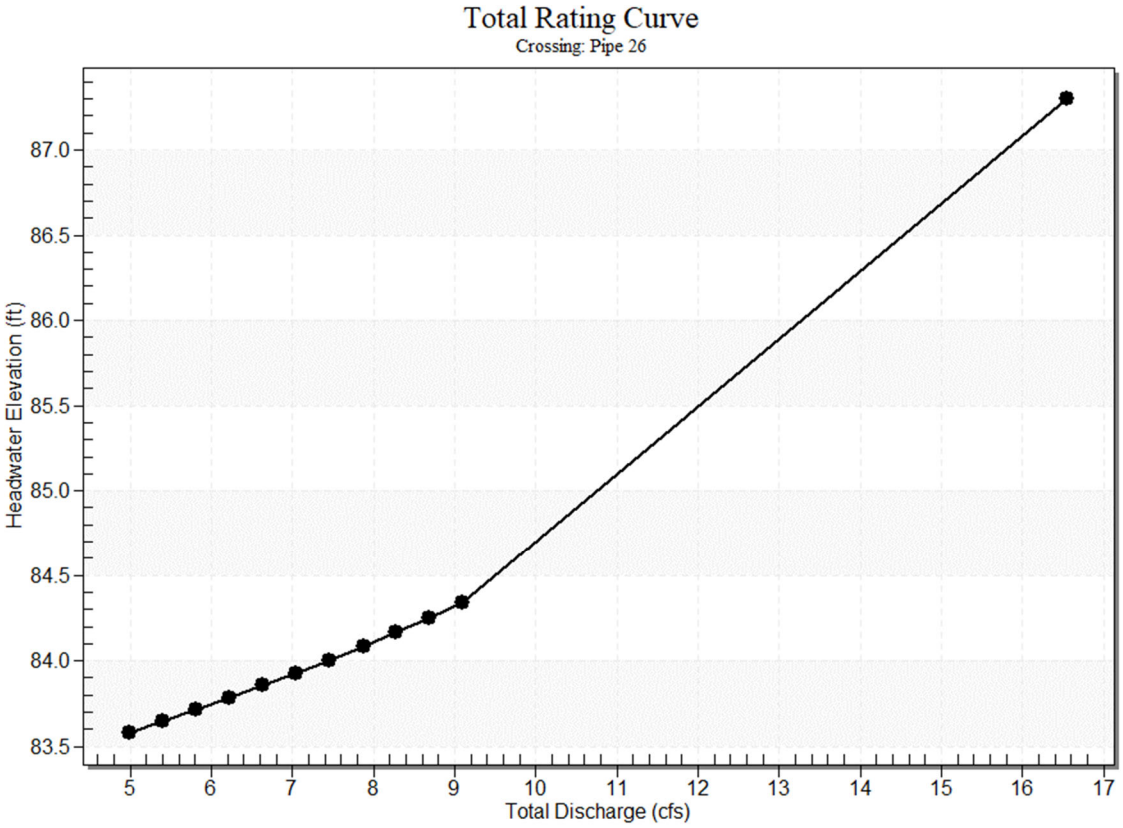
Design Flow: 7.88 cfs

Maximum Flow: 9.10 cfs

Table 5 - Summary of Culvert Flows at Crossing: Pipe 26

Headwater Elevation (ft)	Total Discharge (cfs)	Culvert 1 Discharge (cfs)	Roadway Discharge (cfs)	Iterations
83.58	4.99	4.99	0.00	1
83.65	5.40	5.40	0.00	1
83.72	5.81	5.81	0.00	1
83.79	6.22	6.22	0.00	1
83.86	6.63	6.63	0.00	1
83.93	7.04	7.04	0.00	1
84.00	7.46	7.46	0.00	1
84.09	7.88	7.88	0.00	1
84.17	8.28	8.28	0.00	1
84.25	8.69	8.69	0.00	1
84.34	9.10	9.10	0.00	1
87.28	16.12	16.12	0.00	Overtopping

Rating Curve Plot for Crossing: Pipe 26



Culvert Data: Culvert 1

Table 3 - Culvert Summary Table: Culvert 1

Total Discharge (cfs)	Culvert Discharge (cfs)	Headwater Elevation (ft)	Inlet Control Depth (ft)	Outlet Control Depth (ft)	Flow Type	Normal Depth (ft)	Critical Depth (ft)	Outlet Depth (ft)	Tailwater Depth (ft)	Outlet Velocity (ft/s)	Tailwater Velocity (ft/s)
4.99 cfs	4.99 cfs	83.58	1.29	0.451	1-JS1t	0.70	0.86	1.19	1.19	3.32	1.76
5.40 cfs	5.40 cfs	83.65	1.36	0.558	1-JS1t	0.73	0.90	1.23	1.23	3.49	1.80
5.81 cfs	5.81 cfs	83.72	1.43	0.668	1-JS1t	0.76	0.93	1.26	1.26	3.67	1.83
6.22 cfs	6.22 cfs	83.79	1.50	0.783	1-JS1t	0.80	0.96	1.29	1.29	3.84	1.86

6.63 cfs	6.63 cfs	83.86	1.57	0.901	5-JS1t	0.83	1.00	1.32	1.32	4.02	1.89
7.04 cfs	7.04 cfs	83.93	1.64	1.025	5-JS1t	0.86	1.03	1.35	1.35	4.20	1.92
7.46 cfs	7.46 cfs	84.00	1.71	1.152	5-JS1t	0.89	1.06	1.38	1.38	4.38	1.95
7.88 cfs	7.88 cfs	84.09	1.80	1.289	5-JS1t	0.93	1.09	1.41	1.41	4.57	1.98
8.28 cfs	8.28 cfs	84.17	1.88	1.421	5-JS1t	0.96	1.11	1.44	1.44	4.75	2.00
8.69 cfs	8.69 cfs	84.25	1.96	1.563	5-JS1t	0.99	1.14	1.50	1.46	4.92	2.03
9.10 cfs	9.10 cfs	84.34	2.05	1.710	5-JS1t	1.02	1.17	1.50	1.49	5.15	2.05

Culvert Barrel Data

Culvert Barrel Type Straight Culvert

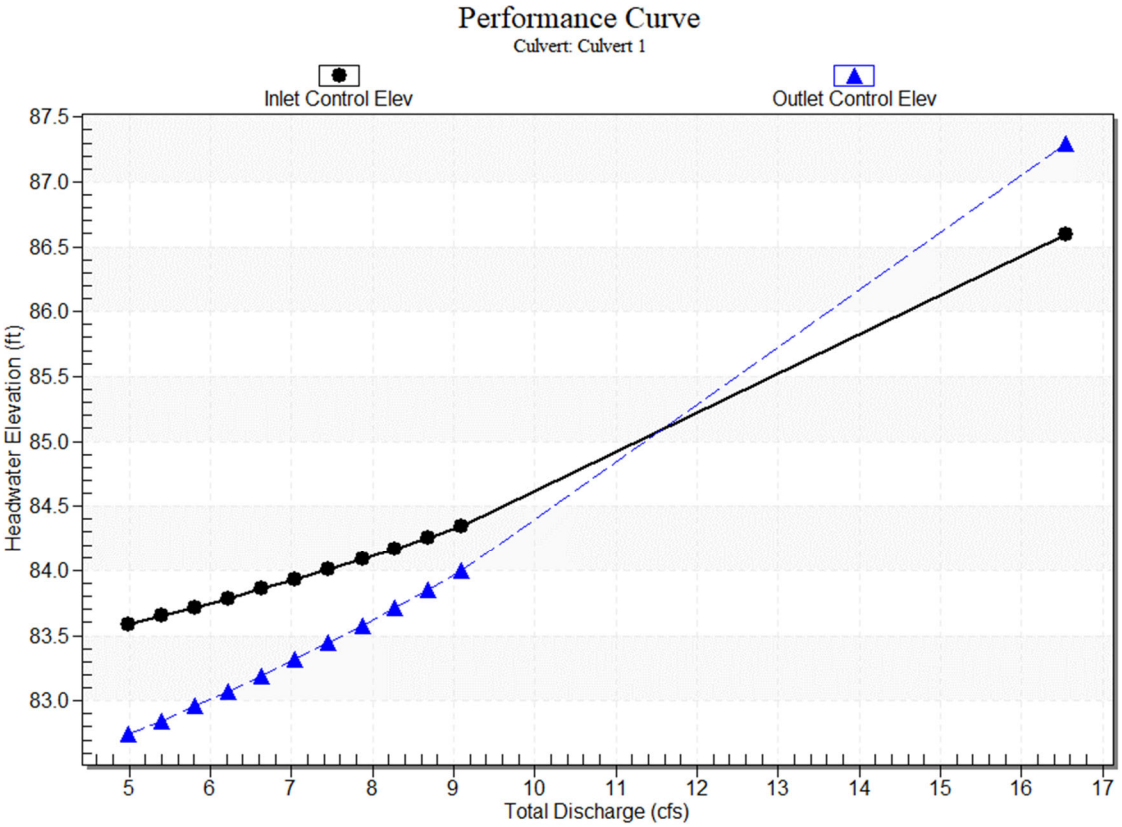
Inlet Elevation (invert): 82.29 ft,

Outlet Elevation (invert): 81.14 ft

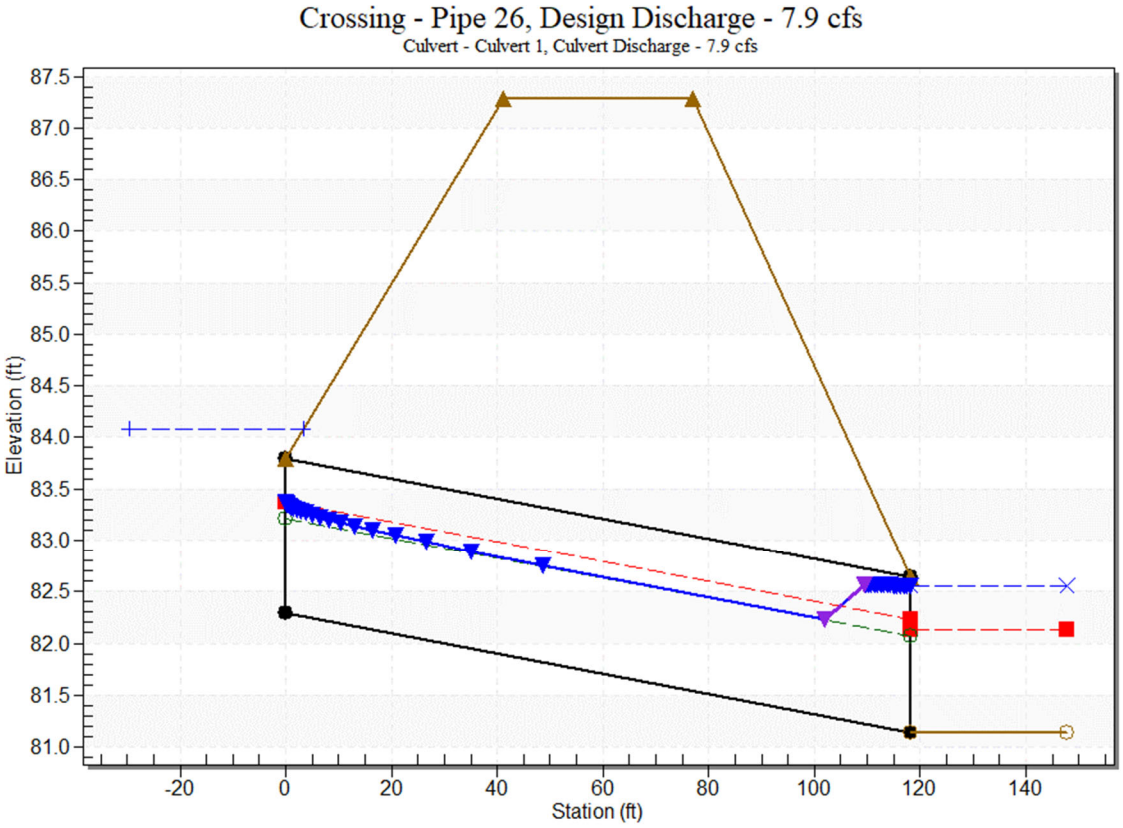
Culvert Length: 118.21 ft,

Culvert Slope: 0.0097

Culvert Performance Curve Plot: Culvert 1



Water Surface Profile Plot for Culvert: Culvert 1



Site Data - Culvert 1

Site Data Option: Culvert Invert Data

Inlet Station: 0.00 ft

Inlet Elevation: 82.29 ft

Outlet Station: 118.20 ft

Outlet Elevation: 81.14 ft

Number of Barrels: 1

Culvert Data Summary - Culvert 1

Barrel Shape: Circular

Barrel Diameter: 1.50 ft

Barrel Material:

Embedment: 0.00 in

Barrel Manning's n: 0.0120

Culvert Type: Straight

Inlet Configuration: Square Edge with Headwall (Ke=0.5)

Inlet Depression: None

Tailwater Data for Crossing: Pipe 26

Table 6 - Downstream Channel Rating Curve (Crossing: Pipe 26)

Flow (cfs)	Water Surface Elev (ft)	Velocity (ft/s)	Depth (ft)	Shear (psf)	Froude Number
4.99	82.33	1.19	1.76	0.30	0.40
5.40	82.37	1.23	1.80	0.31	0.40
5.81	82.40	1.26	1.83	0.31	0.41
6.22	82.43	1.29	1.86	0.32	0.41
6.63	82.46	1.32	1.89	0.33	0.41
7.04	82.49	1.35	1.92	0.34	0.41
7.46	82.52	1.38	1.95	0.35	0.41
7.88	82.55	1.41	1.98	0.35	0.41
8.28	82.58	1.44	2.00	0.36	0.42
8.69	82.60	1.46	2.03	0.37	0.42
9.10	82.63	1.49	2.05	0.37	0.42

Tailwater Channel Data - Pipe 26

Tailwater Channel Option: Triangular Channel

Side Slope (H:V): 2.00 (_:1)

Channel Slope: 0.0040

Channel Manning's n: 0.0350

Channel Invert Elevation: 81.14 ft

Roadway Data for Crossing: Pipe 26

Roadway Profile Shape: Constant Roadway Elevation

Crest Length: 50.00 ft

Crest Elevation: 87.28 ft

Roadway Surface: Paved

Roadway Top Width: 36.00 ft

PIPE 28

Crossing Discharge Data

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

Minimum Flow: 3.06 cfs

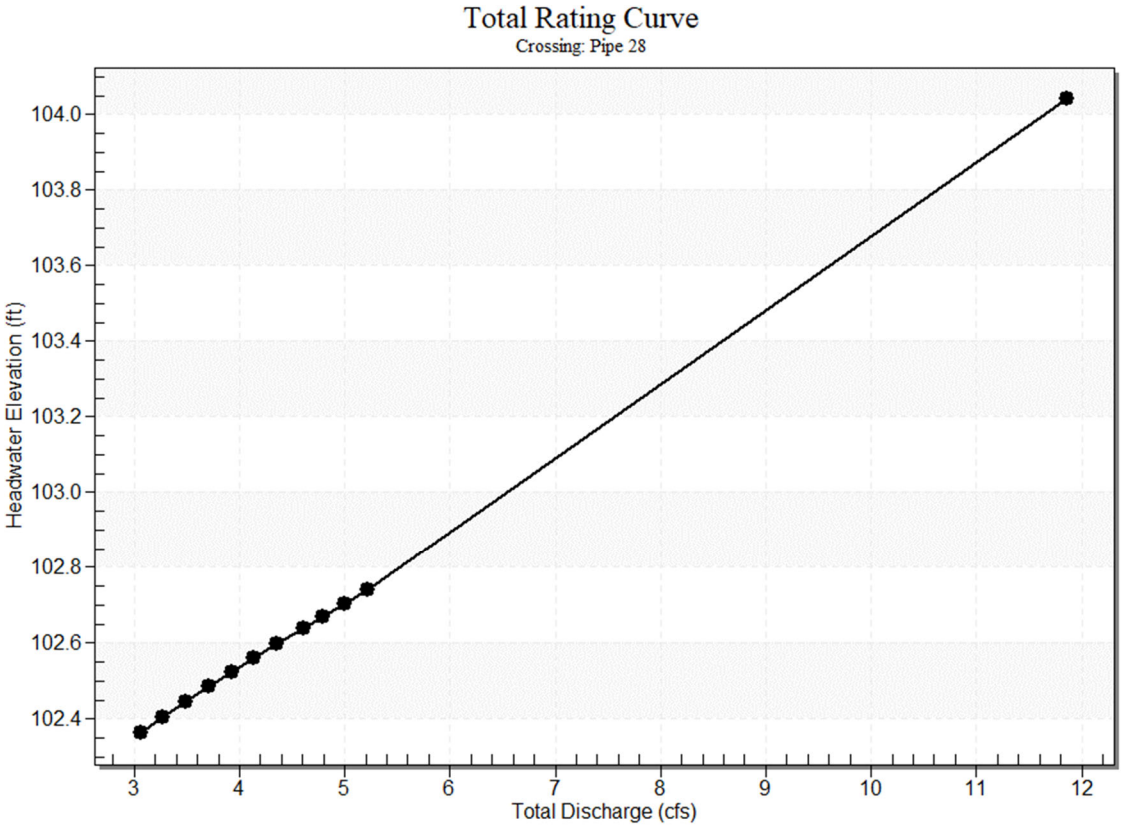
Design Flow: 4.61 cfs

Maximum Flow: 5.22 cfs

Table 7 - Summary of Culvert Flows at Crossing: Pipe 28

Headwater Elevation (ft)	Total Discharge (cfs)	Culvert 1 Discharge (cfs)	Roadway Discharge (cfs)	Iterations
102.36	3.06	3.06	0.00	1
102.41	3.28	3.28	0.00	1
102.45	3.49	3.49	0.00	1
102.48	3.71	3.71	0.00	1
102.52	3.92	3.92	0.00	1
102.56	4.14	4.14	0.00	1
102.60	4.36	4.36	0.00	1
102.64	4.61	4.61	0.00	1
102.67	4.79	4.79	0.00	1
102.70	5.00	5.00	0.00	1
102.74	5.22	5.22	0.00	1
104.02	11.30	11.30	0.00	Overtopping

Rating Curve Plot for Crossing: Pipe 28



Culvert Data: Culvert 1

Table 4 - Culvert Summary Table: Culvert 1

Total Discharge (cfs)	Culvert Discharge (cfs)	Headwater Elevation (ft)	Inlet Control Depth (ft)	Outlet Control Depth (ft)	Flow Type	Normal Depth (ft)	Critical Depth (ft)	Outlet Depth (ft)	Tailwater Depth (ft)	Outlet Velocity (ft/s)	Tailwater Velocity (ft/s)
3.06 cfs	3.06 cfs	102.36	0.87	0.0*	1-S2n	0.28	0.67	0.28	1.02	13.15	1.48
3.28 cfs	3.28 cfs	102.41	0.92	0.0*	1-S2n	0.29	0.69	0.29	1.04	13.41	1.51
3.49 cfs	3.49 cfs	102.45	0.96	0.0*	1-S2n	0.30	0.71	0.30	1.07	13.65	1.53
3.71 cfs	3.71 cfs	102.48	0.99	0.0*	1-S2n	0.31	0.74	0.31	1.09	13.90	1.56

3.92 cfs	3.92 cfs	102.52	1.03	0.0*	1-S2n	0.32	0.76	0.33	1.11	13.68	1.58
4.14 cfs	4.14 cfs	102.56	1.07	0.0*	1-S2n	0.33	0.78	0.33	1.14	14.36	1.60
4.36 cfs	4.36 cfs	102.60	1.11	0.0*	1-S2n	0.34	0.80	0.34	1.16	14.57	1.62
4.61 cfs	4.61 cfs	102.64	1.15	0.0*	1-S2n	0.35	0.82	0.35	1.18	14.80	1.64
4.79 cfs	4.79 cfs	102.67	1.18	0.0*	1-S2n	0.35	0.84	0.37	1.20	14.30	1.66
5.00 cfs	5.00 cfs	102.70	1.21	0.0*	1-S2n	0.36	0.86	0.36	1.22	15.17	1.68
5.22 cfs	5.22 cfs	102.74	1.25	0.0*	1-S2n	0.37	0.88	0.37	1.24	15.35	1.70

* Full Flow Headwater elevation is below inlet invert.

Culvert Barrel Data

Culvert Barrel Type Straight Culvert

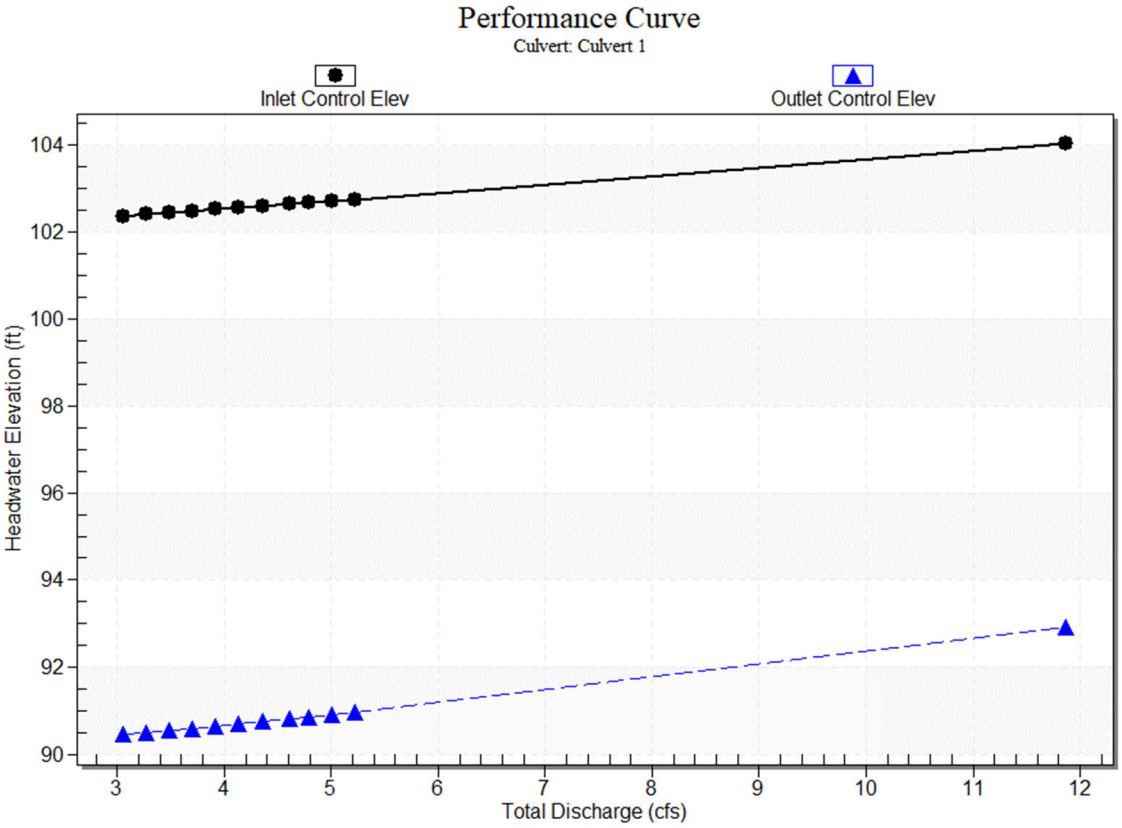
Inlet Elevation (invert): 101.49 ft,

Outlet Elevation (invert): 89.31 ft

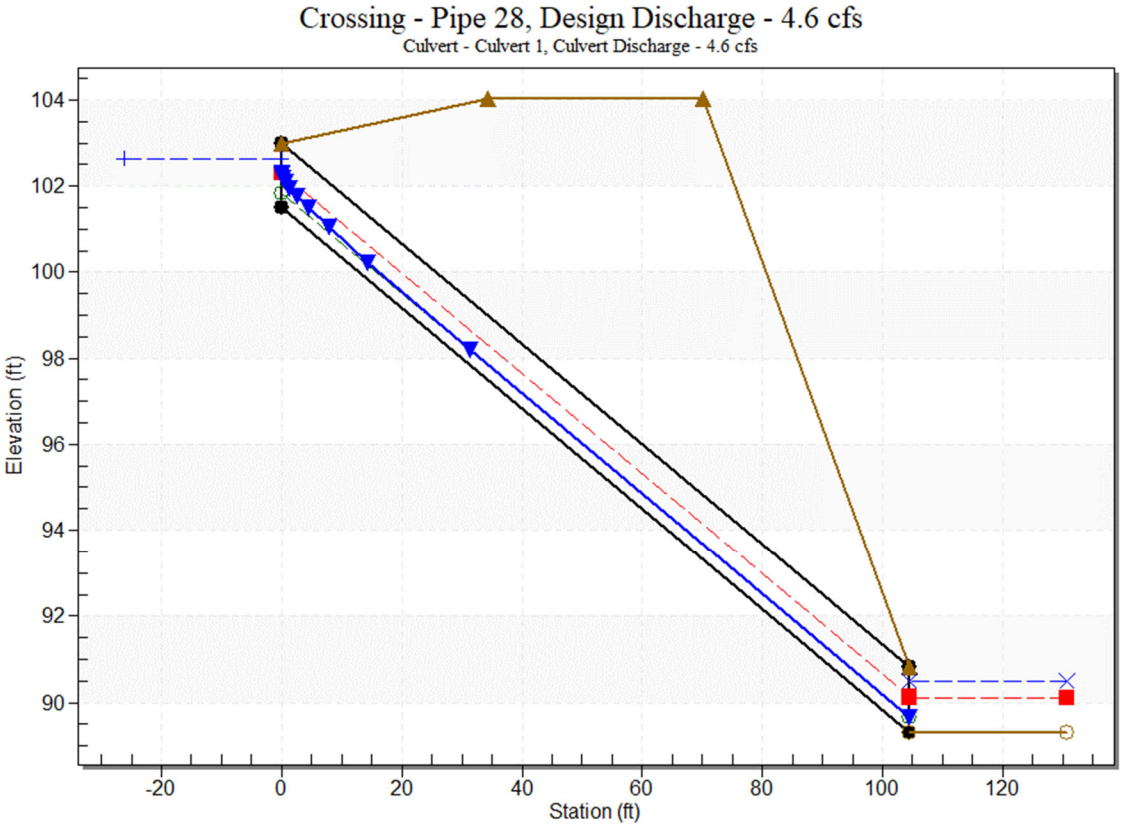
Culvert Length: 105.21 ft,

Culvert Slope: 0.1166

Culvert Performance Curve Plot: Culvert 1



Water Surface Profile Plot for Culvert: Culvert 1



Site Data - Culvert 1

Site Data Option: Culvert Invert Data

Inlet Station: 0.00 ft

Inlet Elevation: 101.49 ft

Outlet Station: 104.50 ft

Outlet Elevation: 89.31 ft

Number of Barrels: 1

Culvert Data Summary - Culvert 1

Barrel Shape: Circular

Barrel Diameter: 1.50 ft

Barrel Material:

Embedment: 0.00 in

Barrel Manning's n: 0.0120

Culvert Type: Straight

Inlet Configuration: Square Edge with Headwall (Ke=0.5)

Inlet Depression: None

Tailwater Data for Crossing: Pipe 28

Table 8 - Downstream Channel Rating Curve (Crossing: Pipe 28)

Flow (cfs)	Water Surface Elev (ft)	Velocity (ft/s)	Depth (ft)	Shear (psf)	Froude Number
3.06	90.33	1.02	1.48	0.22	0.37
3.28	90.35	1.04	1.51	0.23	0.37
3.49	90.38	1.07	1.53	0.23	0.37
3.71	90.40	1.09	1.56	0.24	0.37
3.92	90.42	1.11	1.58	0.24	0.37
4.14	90.45	1.14	1.60	0.25	0.37
4.36	90.47	1.16	1.62	0.25	0.38
4.61	90.49	1.18	1.64	0.26	0.38
4.79	90.51	1.20	1.66	0.26	0.38
5.00	90.53	1.22	1.68	0.27	0.38
5.22	90.55	1.24	1.70	0.27	0.38

Tailwater Channel Data - Pipe 28

Tailwater Channel Option: Triangular Channel

Side Slope (H:V): 2.00 (_:1)

Channel Slope: 0.0035

Channel Manning's n: 0.0350

Channel Invert Elevation: 89.31 ft

Roadway Data for Crossing: Pipe 28

Roadway Profile Shape: Constant Roadway Elevation

Crest Length: 50.00 ft

Crest Elevation: 104.02 ft

Roadway Surface: Paved

Roadway Top Width: 36.00 ft

PIPE 34

Crossing Discharge Data

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

Minimum Flow: 4.55 cfs

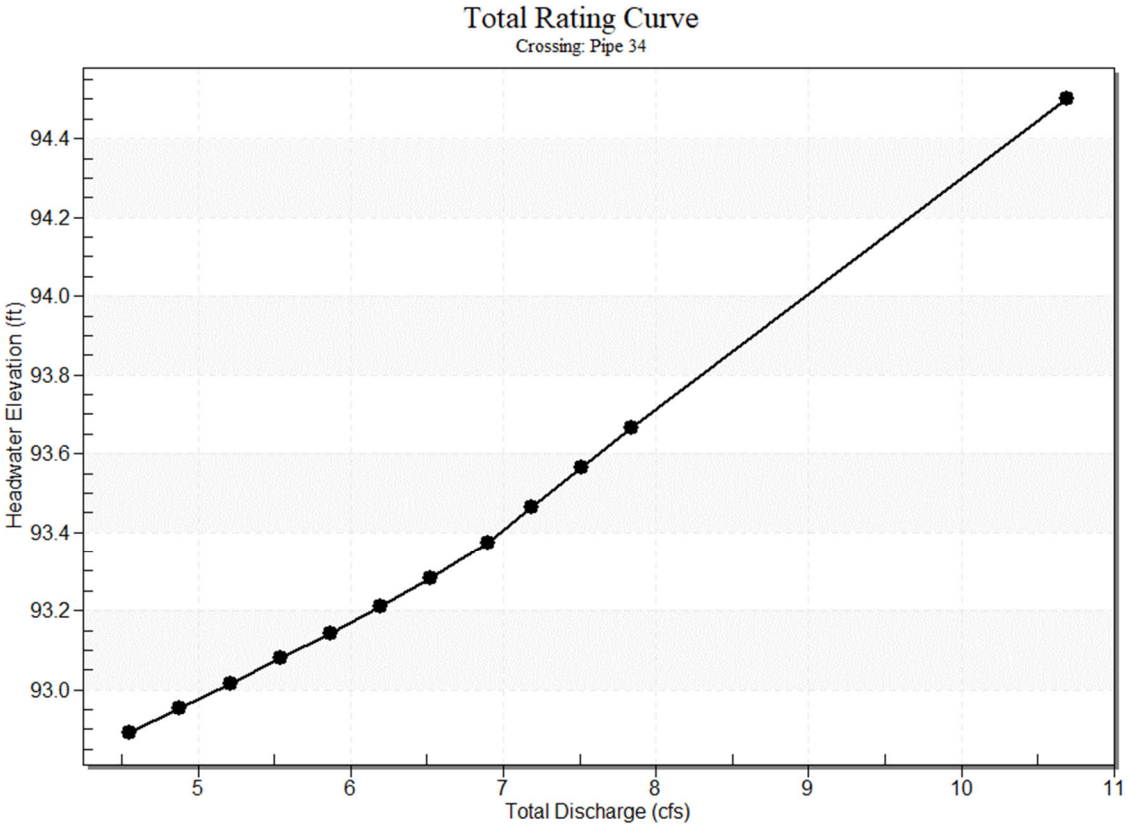
Design Flow: 6.90 cfs

Maximum Flow: 7.84 cfs

Table 9 - Summary of Culvert Flows at Crossing: Pipe 34

Headwater Elevation (ft)	Total Discharge (cfs)	Culvert 1 Discharge (cfs)	Roadway Discharge (cfs)	Iterations
92.89	4.55	4.55	0.00	1
92.95	4.88	4.88	0.00	1
93.02	5.21	5.21	0.00	1
93.08	5.54	5.54	0.00	1
93.14	5.87	5.87	0.00	1
93.21	6.20	6.20	0.00	1
93.28	6.52	6.52	0.00	1
93.37	6.90	6.90	0.00	1
93.46	7.18	7.18	0.00	1
93.57	7.51	7.51	0.00	1
93.67	7.84	7.84	0.00	1
94.48	10.25	10.25	0.00	Overtopping

Rating Curve Plot for Crossing: Pipe 34



Culvert Data: Culvert 1

Table 5 - Culvert Summary Table: Culvert 1

Total Discharge (cfs)	Culvert Discharge (cfs)	Headwater Elevation (ft)	Inlet Control Depth (ft)	Outlet Control Depth (ft)	Flow Type	Normal Depth (ft)	Critical Depth (ft)	Outlet Depth (ft)	Tailwater Depth (ft)	Outlet Velocity (ft/s)	Tailwater Velocity (ft/s)
4.55 cfs	4.55 cfs	92.89	1.23	1.362	3-M1t	1.09	0.82	1.14	1.14	3.15	1.74
4.88 cfs	4.88 cfs	92.95	1.28	1.424	3-M1t	1.16	0.85	1.17	1.17	3.29	1.77
5.21 cfs	5.21 cfs	93.02	1.33	1.486	3-M2t	1.24	0.88	1.20	1.20	3.43	1.80
5.54 cfs	5.54 cfs	93.08	1.39	1.549	3-M2t	1.50	0.91	1.23	1.23	3.57	1.83

5.87 cfs	5.87 cfs	93.14	1.44	1.614	3-M2t	1.50	0.93	1.26	1.26	3.71	1.85
6.20 cfs	6.20 cfs	93.21	1.50	1.681	3-M2t	1.50	0.96	1.28	1.28	3.85	1.88
6.52 cfs	6.52 cfs	93.28	1.55	1.752	3-M2t	1.50	0.99	1.31	1.31	3.99	1.90
6.90 cfs	6.90 cfs	93.37	1.62	1.844	3-M2t	1.50	1.02	1.34	1.34	4.15	1.93
7.18 cfs	7.18 cfs	93.46	1.67	1.934	7-M2t	1.50	1.04	1.36	1.36	4.27	1.95
7.51 cfs	7.51 cfs	93.57	1.73	2.035	7-M2t	1.50	1.06	1.38	1.38	4.42	1.97
7.84 cfs	7.84 cfs	93.67	1.79	2.137	7-M2t	1.50	1.08	1.40	1.40	4.56	1.99

Culvert Barrel Data

Culvert Barrel Type Straight Culvert

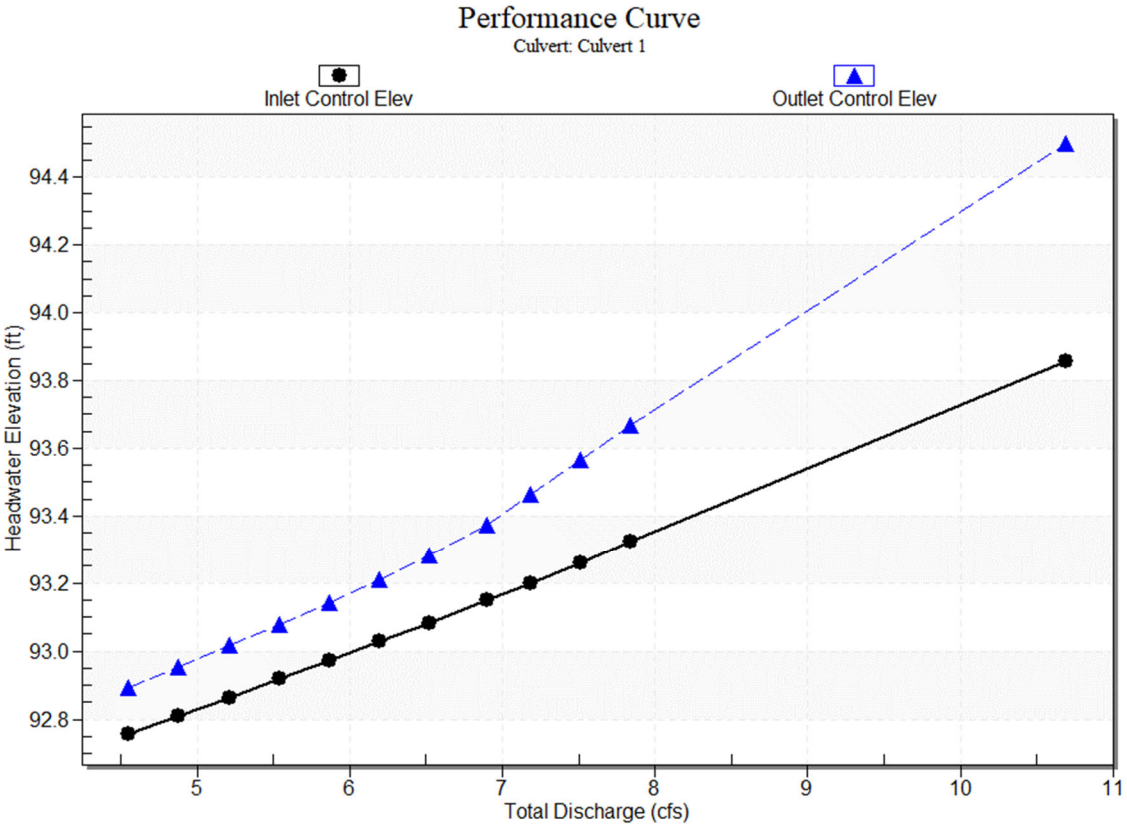
Inlet Elevation (invert): 91.53 ft,

Outlet Elevation (invert): 91.32 ft

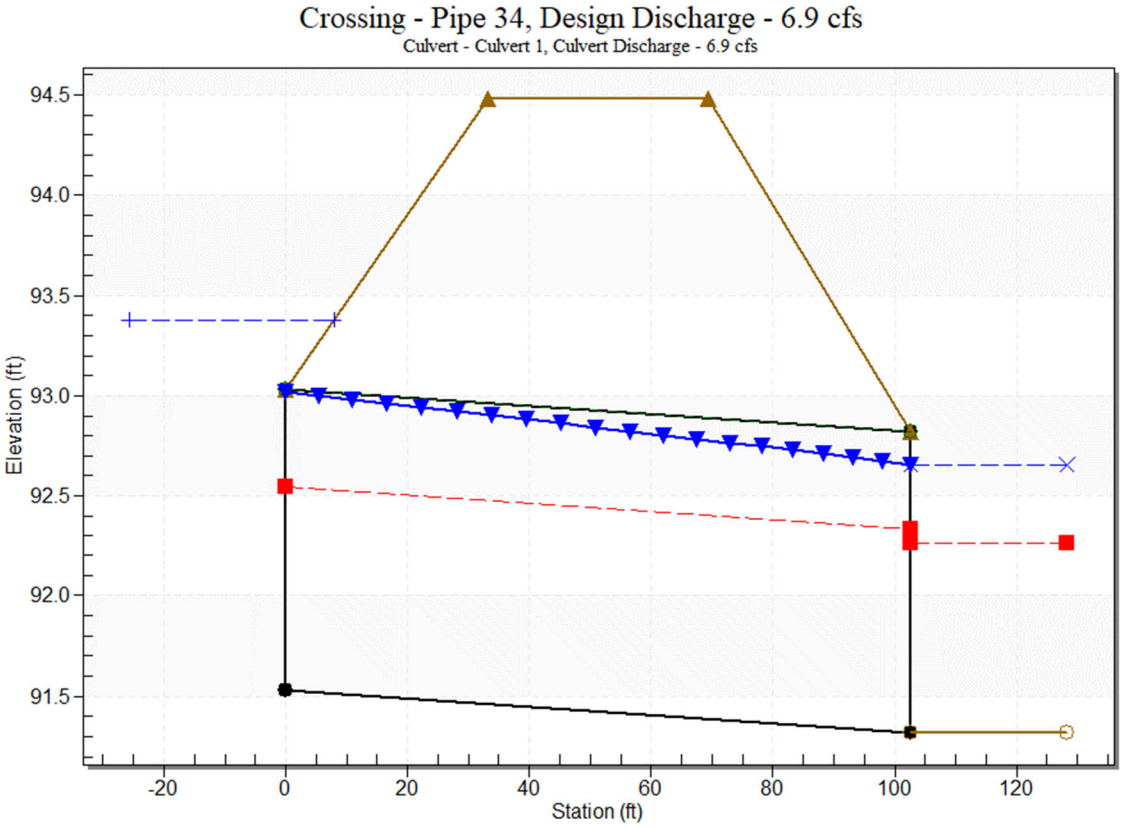
Culvert Length: 102.60 ft,

Culvert Slope: 0.0020

Culvert Performance Curve Plot: Culvert 1



Water Surface Profile Plot for Culvert: Culvert 1



Site Data - Culvert 1

Site Data Option: Culvert Invert Data

Inlet Station: 0.00 ft

Inlet Elevation: 91.53 ft

Outlet Station: 102.60 ft

Outlet Elevation: 91.32 ft

Number of Barrels: 1

Culvert Data Summary - Culvert 1

Barrel Shape: Circular

Barrel Diameter: 1.50 ft

Barrel Material:

Embedment: 0.00 in

Barrel Manning's n: 0.0120

Culvert Type: Straight

Inlet Configuration: Square Edge with Headwall (Ke=0.5)

Inlet Depression: None

Tailwater Data for Crossing: Pipe 34

Table 10 - Downstream Channel Rating Curve (Crossing: Pipe 34)

Flow (cfs)	Water Surface Elev (ft)	Velocity (ft/s)	Depth (ft)	Shear (psf)	Froude Number
4.55	92.46	1.14	1.74	0.29	0.41
4.88	92.49	1.17	1.77	0.30	0.41
5.21	92.52	1.20	1.80	0.31	0.41
5.54	92.55	1.23	1.83	0.31	0.41
5.87	92.58	1.26	1.85	0.32	0.41
6.20	92.60	1.28	1.88	0.33	0.41
6.52	92.63	1.31	1.90	0.33	0.41
6.90	92.66	1.34	1.93	0.34	0.42
7.18	92.68	1.36	1.95	0.35	0.42
7.51	92.70	1.38	1.97	0.35	0.42
7.84	92.72	1.40	1.99	0.36	0.42

Tailwater Channel Data - Pipe 34

Tailwater Channel Option: Triangular Channel

Side Slope (H:V): 2.00 (_:1)

Channel Slope: 0.0041

Channel Manning's n: 0.0350

Channel Invert Elevation: 91.32 ft

Roadway Data for Crossing: Pipe 34

Roadway Profile Shape: Constant Roadway Elevation

Crest Length: 50.00 ft

Crest Elevation: 94.48 ft

Roadway Surface: Paved

Roadway Top Width: 36.00 ft

PIPE 35

Crossing Discharge Data

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

Minimum Flow: 4.22 cfs

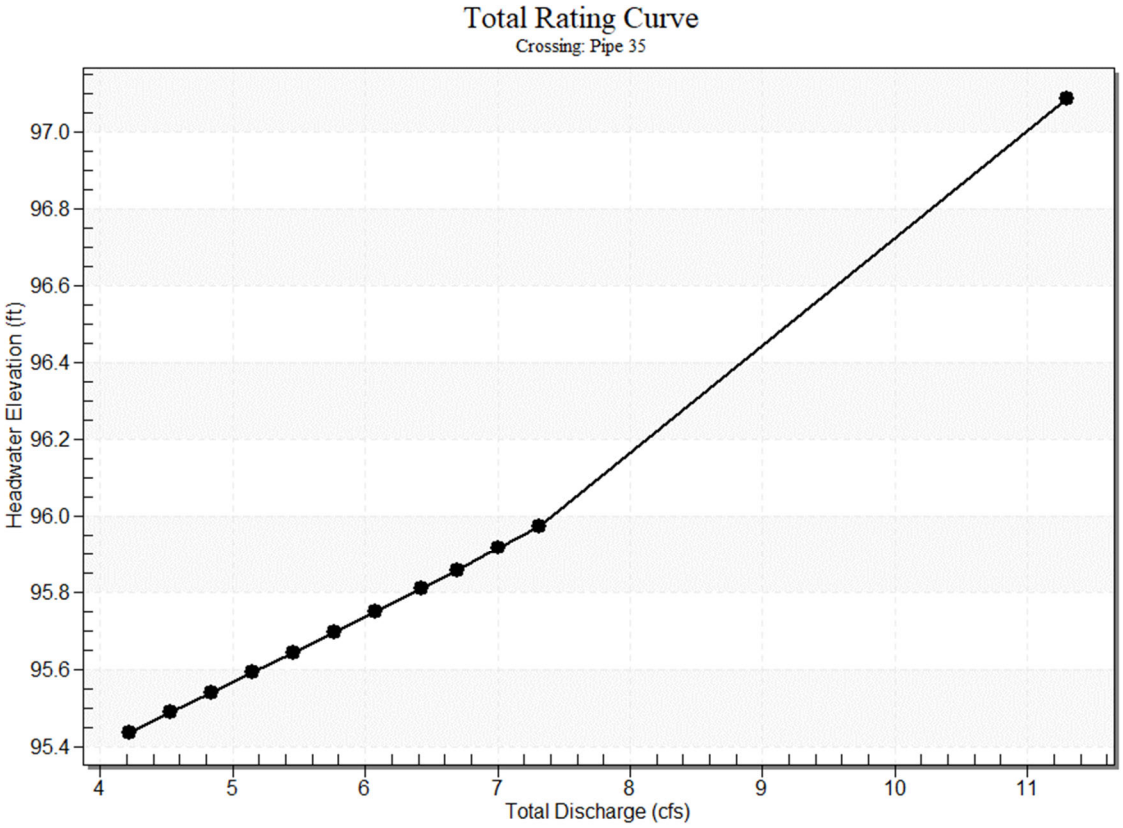
Design Flow: 6.42 cfs

Maximum Flow: 7.31 cfs

Table 11 - Summary of Culvert Flows at Crossing: Pipe 35

Headwater Elevation (ft)	Total Discharge (cfs)	Culvert 1 Discharge (cfs)	Roadway Discharge (cfs)	Iterations
95.44	4.22	4.22	0.00	1
95.49	4.53	4.53	0.00	1
95.54	4.84	4.84	0.00	1
95.59	5.15	5.15	0.00	1
95.65	5.46	5.46	0.00	1
95.70	5.76	5.76	0.00	1
95.75	6.07	6.07	0.00	1
95.81	6.42	6.42	0.00	1
95.86	6.69	6.69	0.00	1
95.91	7.00	7.00	0.00	1
95.97	7.31	7.31	0.00	1
97.06	10.70	10.70	0.00	Overtopping

Rating Curve Plot for Crossing: Pipe 35



Culvert Data: Culvert 1

Table 6 - Culvert Summary Table: Culvert 1

Total Discharge (cfs)	Culvert Discharge (cfs)	Headwater Elevation (ft)	Inlet Control Depth (ft)	Outlet Control Depth (ft)	Flow Type	Normal Depth (ft)	Critical Depth (ft)	Outlet Depth (ft)	Tailwater Depth (ft)	Outlet Velocity (ft/s)	Tailwater Velocity (ft/s)
4.22 cfs	4.22 cfs	95.44	1.17	1.238	3-M1t	0.84	0.79	1.06	1.06	3.15	1.87
4.53 cfs	4.53 cfs	95.49	1.22	1.290	3-M1t	0.88	0.82	1.09	1.09	3.29	1.90
4.84 cfs	4.84 cfs	95.54	1.27	1.342	3-M1t	0.92	0.85	1.12	1.12	3.42	1.93
5.15 cfs	5.15 cfs	95.59	1.32	1.393	3-M1t	0.96	0.87	1.15	1.15	3.55	1.96

5.46 cfs	5.46 cfs	95.65	1.37	1.445	3-M1t	1.00	0.90	1.17	1.17	3.69	1.99
5.76 cfs	5.76 cfs	95.70	1.42	1.497	3-M1t	1.04	0.93	1.20	1.20	3.82	2.02
6.07 cfs	6.07 cfs	95.75	1.48	1.550	7-M1t	1.08	0.95	1.22	1.22	3.95	2.04
6.42 cfs	6.42 cfs	95.81	1.53	1.610	7-M1t	1.14	0.98	1.24	1.24	4.10	2.07
6.69 cfs	6.69 cfs	95.86	1.58	1.658	7-M1t	1.18	1.00	1.26	1.26	4.21	2.09
7.00 cfs	7.00 cfs	95.91	1.64	1.715	7-M1t	1.24	1.02	1.29	1.29	4.34	2.12
7.31 cfs	7.31 cfs	95.97	1.69	1.774	3-M2t	1.31	1.05	1.31	1.31	4.47	2.14

Culvert Barrel Data

Culvert Barrel Type Straight Culvert

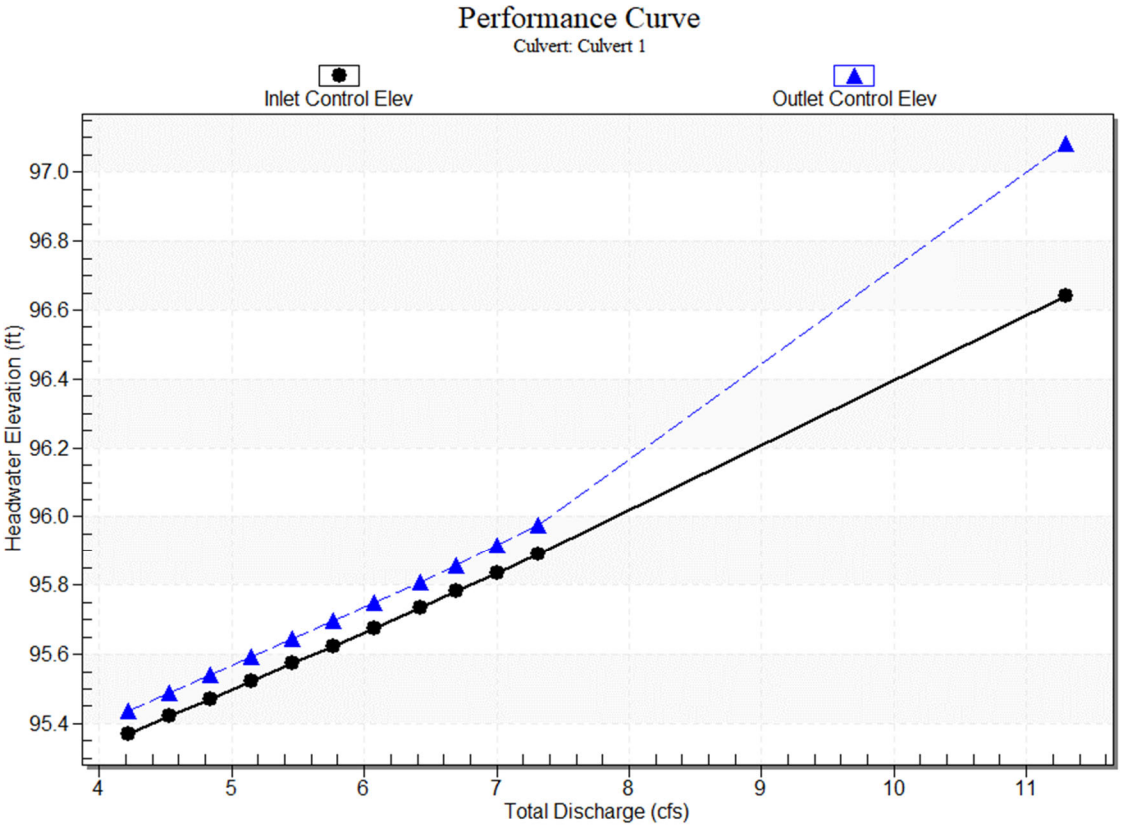
Inlet Elevation (invert): 94.20 ft,

Outlet Elevation (invert): 93.83 ft

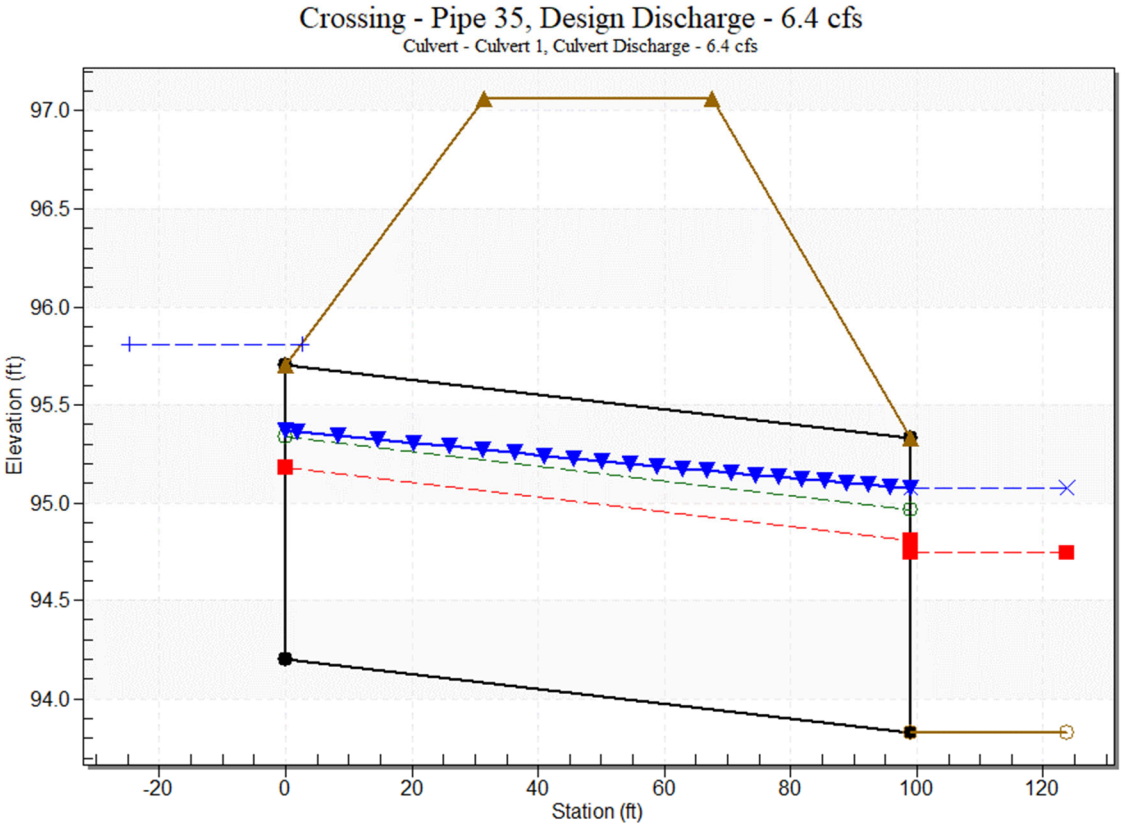
Culvert Length: 99.00 ft,

Culvert Slope: 0.0037

Culvert Performance Curve Plot: Culvert 1



Water Surface Profile Plot for Culvert: Culvert 1



Site Data - Culvert 1

Site Data Option: Culvert Invert Data

Inlet Station: 0.00 ft

Inlet Elevation: 94.20 ft

Outlet Station: 99.00 ft

Outlet Elevation: 93.83 ft

Number of Barrels: 1

Culvert Data Summary - Culvert 1

Barrel Shape: Circular

Barrel Diameter: 1.50 ft

Barrel Material:

Embedment: 0.00 in

Barrel Manning's n: 0.0120

Culvert Type: Straight

Inlet Configuration: Square Edge with Headwall (Ke=0.5)

Inlet Depression: None

Tailwater Data for Crossing: Pipe 35

Table 12 - Downstream Channel Rating Curve (Crossing: Pipe 35)

Flow (cfs)	Water Surface Elev (ft)	Velocity (ft/s)	Depth (ft)	Shear (psf)	Froude Number
4.22	94.89	1.06	1.87	0.35	0.45
4.53	94.92	1.09	1.90	0.35	0.45
4.84	94.95	1.12	1.93	0.36	0.45
5.15	94.98	1.15	1.96	0.37	0.46
5.46	95.00	1.17	1.99	0.38	0.46
5.76	95.03	1.20	2.02	0.39	0.46
6.07	95.05	1.22	2.04	0.40	0.46
6.42	95.07	1.24	2.07	0.40	0.46
6.69	95.09	1.26	2.09	0.41	0.46
7.00	95.12	1.29	2.12	0.42	0.47
7.31	95.14	1.31	2.14	0.42	0.47

Tailwater Channel Data - Pipe 35

Tailwater Channel Option: Triangular Channel

Side Slope (H:V): 2.00 (_:1)

Channel Slope: 0.0052

Channel Manning's n: 0.0350

Channel Invert Elevation: 93.83 ft

Roadway Data for Crossing: Pipe 35

Roadway Profile Shape: Constant Roadway Elevation

Crest Length: 50.00 ft

Crest Elevation: 97.06 ft

Roadway Surface: Paved

Roadway Top Width: 36.00 ft

PIPE 37

Crossing Discharge Data

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

Minimum Flow: 25.28 cfs

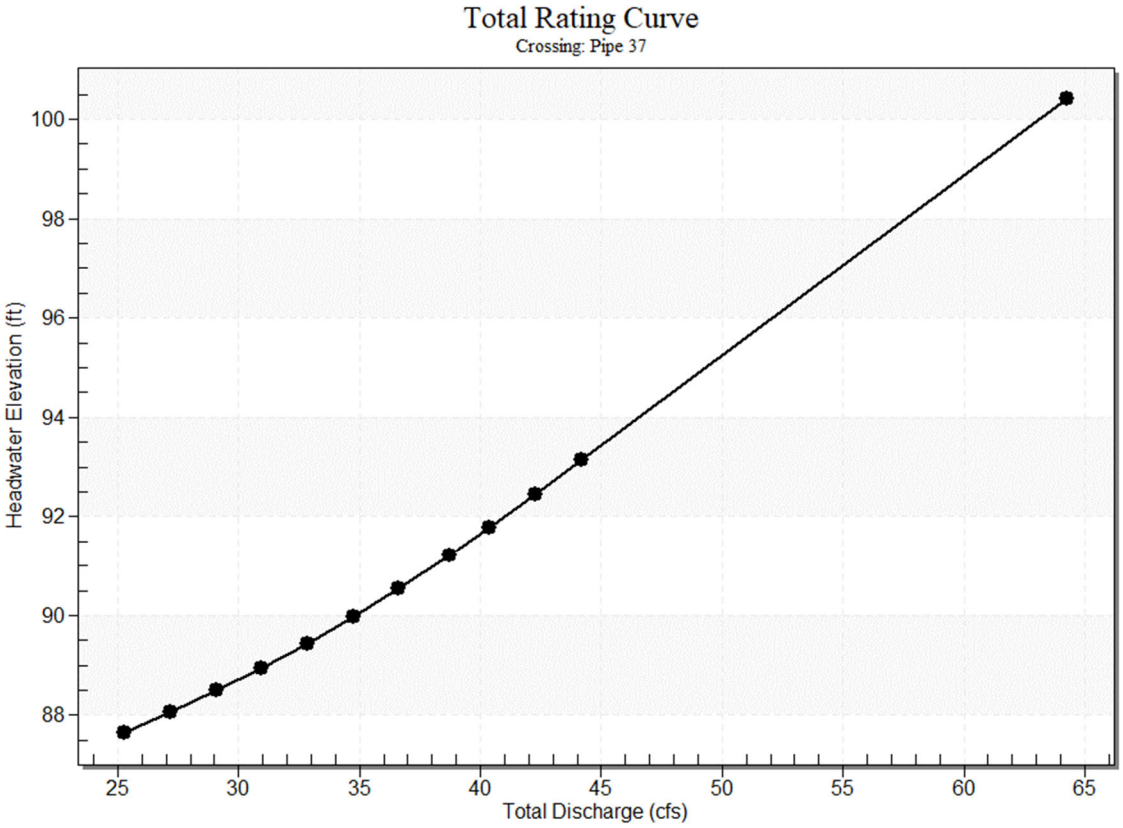
Design Flow: 38.70 cfs

Maximum Flow: 44.17 cfs

Table 13 - Summary of Culvert Flows at Crossing: Pipe 37

Headwater Elevation (ft)	Total Discharge (cfs)	Culvert 1 Discharge (cfs)	Roadway Discharge (cfs)	Iterations
87.66	25.28	25.28	0.00	1
88.06	27.17	27.17	0.00	1
88.49	29.06	29.06	0.00	1
88.95	30.95	30.95	0.00	1
89.44	32.84	32.84	0.00	1
89.97	34.73	34.73	0.00	1
90.54	36.61	36.61	0.00	1
91.21	38.70	38.70	0.00	1
91.79	40.39	40.39	0.00	1
92.45	42.28	42.28	0.00	1
93.15	44.17	44.17	0.00	1
100.32	60.23	60.23	0.00	Overtopping

Rating Curve Plot for Crossing: Pipe 37



Culvert Data: Culvert 1

Table 7 - Culvert Summary Table: Culvert 1

Total Discharge (cfs)	Culvert Discharge (cfs)	Headwater Elevation (ft)	Inlet Control Depth (ft)	Outlet Control Depth (ft)	Flow Type	Normal Depth (ft)	Critical Depth (ft)	Outlet Depth (ft)	Tailwater Depth (ft)	Outlet Velocity (ft/s)	Tailwater Velocity (ft/s)
25.28 cfs	25.28 cfs	87.66	3.85	0.0*	5-S2n	0.97	1.77	1.00	2.22	16.17	2.57
27.17 cfs	27.17 cfs	88.06	4.25	0.0*	5-S2n	1.01	1.81	1.04	2.28	16.44	2.62
29.06 cfs	29.06 cfs	88.49	4.68	0.0*	5-S2n	1.05	1.85	1.09	2.34	16.67	2.66
30.95 cfs	30.95 cfs	88.95	5.14	0.0*	5-S2n	1.09	1.88	1.13	2.39	17.00	2.70

32.84 cfs	32.84 cfs	89.44	5.63	0.0*	5-S2n	1.14	1.90	1.17	2.45	17.22	2.74
34.73 cfs	34.73 cfs	89.97	6.16	0.711	5-S2n	1.18	1.86	1.21	2.50	17.50	2.78
36.61 cfs	36.61 cfs	90.54	6.73	5.184	5-S1f	1.22	1.73	2.00	2.55	11.65	2.82
38.70 cfs	38.70 cfs	91.21	7.40	2.330	5-S2n	1.26	2.00	1.26	2.60	18.49	2.86
40.39 cfs	40.39 cfs	91.79	7.98	3.067	5-S2n	1.30	2.00	1.30	2.64	18.65	2.89
42.28 cfs	42.28 cfs	92.45	8.64	3.924	5-S2n	1.35	2.00	1.35	2.69	18.81	2.92
44.17 cfs	44.17 cfs	93.15	9.34	4.816	5-S2n	1.39	2.00	1.39	2.73	18.95	2.95

* Full Flow Headwater elevation is below inlet invert.

Culvert Barrel Data

Culvert Barrel Type Straight Culvert

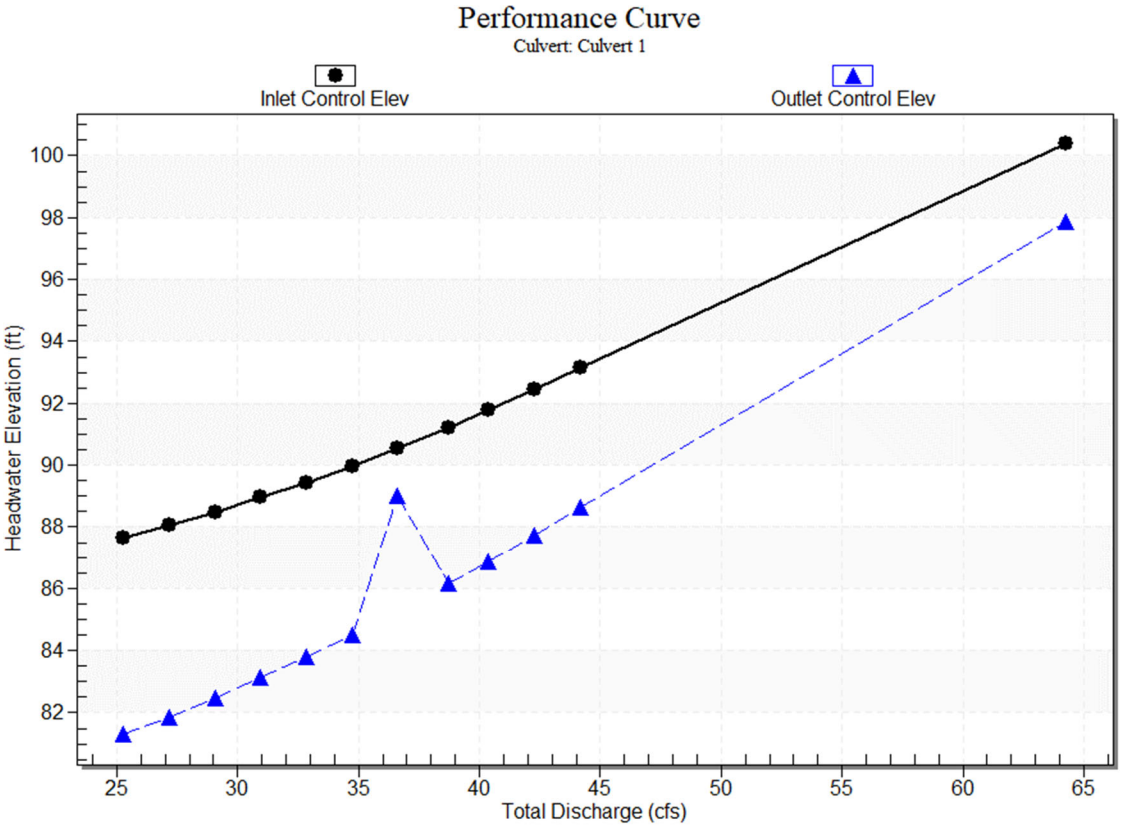
Inlet Elevation (invert): 83.81 ft,

Outlet Elevation (invert): 75.77 ft

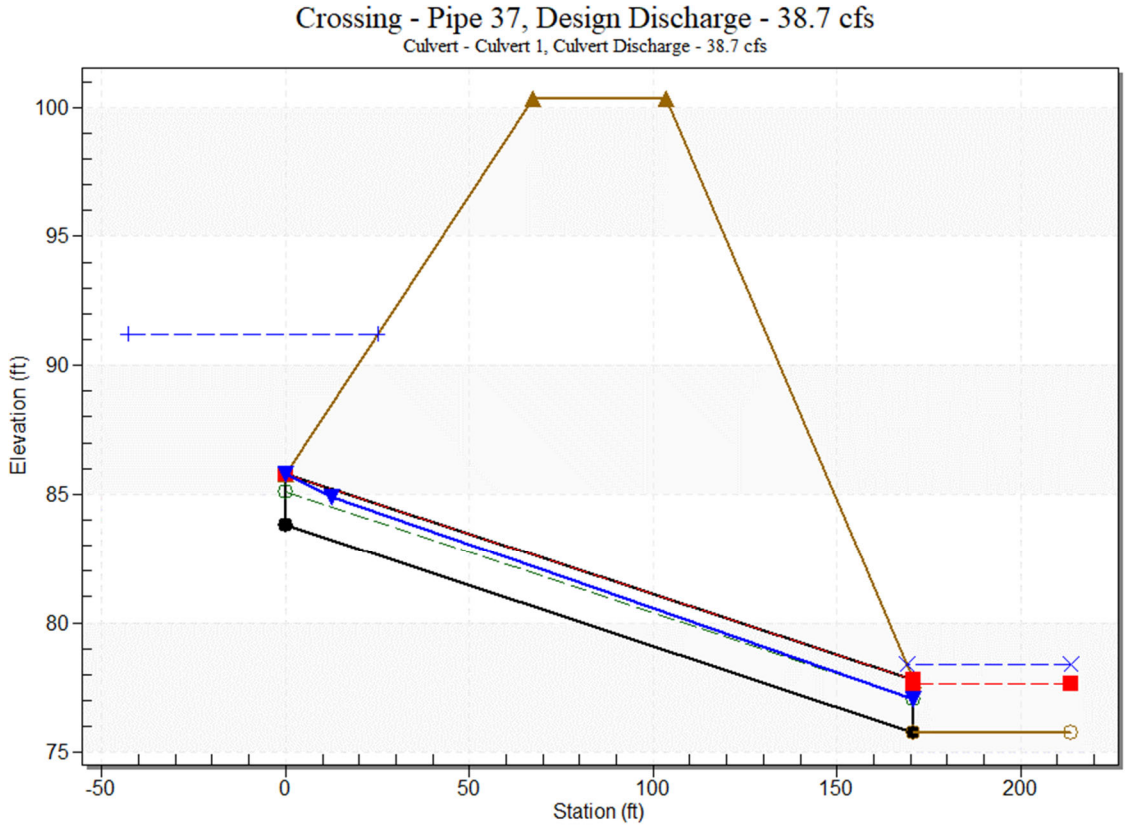
Culvert Length: 171.09 ft,

Culvert Slope: 0.0470

Culvert Performance Curve Plot: Culvert 1



Water Surface Profile Plot for Culvert: Culvert 1



Site Data - Culvert 1

Site Data Option: Culvert Invert Data

Inlet Station: 0.00 ft

Inlet Elevation: 83.81 ft

Outlet Station: 170.90 ft

Outlet Elevation: 75.77 ft

Number of Barrels: 1

Culvert Data Summary - Culvert 1

Barrel Shape: Circular

Barrel Diameter: 2.00 ft

Barrel Material:

Embedment: 0.00 in

Barrel Manning's n: 0.0120

Culvert Type: Straight

Inlet Configuration: Square Edge with Headwall (Ke=0.5)

Inlet Depression: None

Tailwater Data for Crossing: Pipe 37

Table 14 - Downstream Channel Rating Curve (Crossing: Pipe 37)

Flow (cfs)	Water Surface Elev (ft)	Velocity (ft/s)	Depth (ft)	Shear (psf)	Froude Number
25.28	77.99	2.22	2.57	0.51	0.43
27.17	78.05	2.28	2.62	0.53	0.43
29.06	78.11	2.34	2.66	0.54	0.43
30.95	78.16	2.39	2.70	0.55	0.44
32.84	78.22	2.45	2.74	0.56	0.44
34.73	78.27	2.50	2.78	0.58	0.44
36.61	78.32	2.55	2.82	0.59	0.44
38.70	78.37	2.60	2.86	0.60	0.44
40.39	78.41	2.64	2.89	0.61	0.44
42.28	78.46	2.69	2.92	0.62	0.44
44.17	78.50	2.73	2.95	0.63	0.45

Tailwater Channel Data - Pipe 37

Tailwater Channel Option: Triangular Channel

Side Slope (H:V): 2.00 (_:1)

Channel Slope: 0.0037

Channel Manning's n: 0.0350

Channel Invert Elevation: 75.77 ft

Roadway Data for Crossing: Pipe 37

Roadway Profile Shape: Constant Roadway Elevation

Crest Length: 50.00 ft

Crest Elevation: 100.32 ft

Roadway Surface: Paved

Roadway Top Width: 36.00 ft

PIPE 38

Crossing Discharge Data

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

Minimum Flow: 24.55 cfs

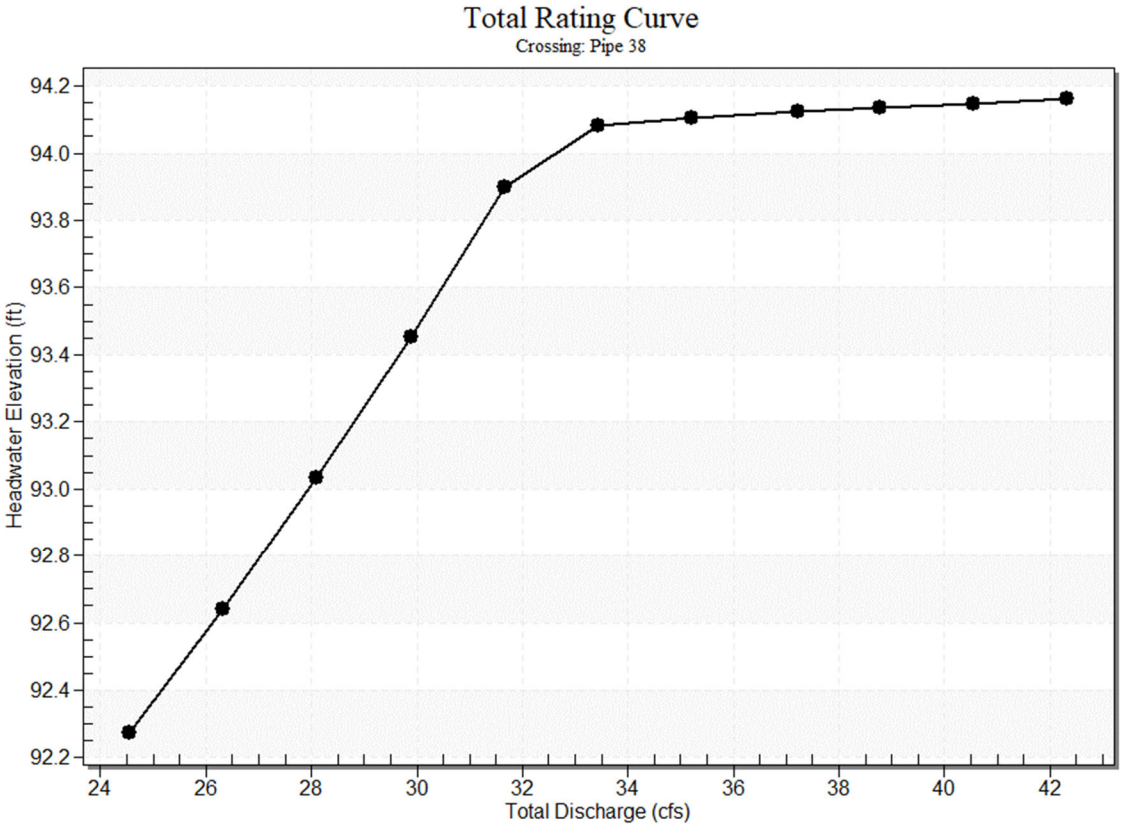
Design Flow: 37.23 cfs

Maximum Flow: 42.32 cfs

Table 15 - Summary of Culvert Flows at Crossing: Pipe 38

Headwater Elevation (ft)	Total Discharge (cfs)	Culvert 1 Discharge (cfs)	Roadway Discharge (cfs)	Iterations
92.28	24.55	24.55	0.00	1
92.64	26.33	26.33	0.00	1
93.03	28.10	28.10	0.00	1
93.45	29.88	29.88	0.00	1
93.90	31.66	31.66	0.00	1
94.08	33.44	32.36	0.91	20
94.10	35.21	32.45	2.64	5
94.12	37.23	32.52	4.56	4
94.14	38.77	32.57	6.11	4
94.15	40.54	32.62	7.74	3
94.16	42.32	32.67	9.48	3
94.06	32.28	32.28	0.00	Overtopping

Rating Curve Plot for Crossing: Pipe 38



Culvert Data: Culvert 1

Table 8 - Culvert Summary Table: Culvert 1

Total Discharge (cfs)	Culvert Discharge (cfs)	Headwater Elevation (ft)	Inlet Control Depth (ft)	Outlet Control Depth (ft)	Flow Type	Normal Depth (ft)	Critical Depth (ft)	Outlet Depth (ft)	Tailwater Depth (ft)	Outlet Velocity (ft/s)	Tailwater Velocity (ft/s)
24.55 cfs	24.55 cfs	92.28	3.71	0.0*	5-S2n	0.98	1.75	1.03	2.04	15.03	2.94
26.33 cfs	26.33 cfs	92.64	4.07	0.246	5-S2n	1.02	1.79	1.08	2.10	15.27	2.99
28.10 cfs	28.10 cfs	93.03	4.46	0.704	5-S2n	1.06	1.83	1.12	2.15	15.51	3.04
29.88 cfs	29.88 cfs	93.45	4.88	1.187	5-S2n	1.10	1.86	1.16	2.20	15.80	3.09

31.66 cfs	31.66 cfs	93.90	5.33	1.694	5-S2n	1.14	1.89	1.21	2.25	15.92	3.13
33.44 cfs	32.36 cfs	94.08	5.51	1.931	5-S2n	1.16	1.89	1.23	2.29	15.99	3.17
35.21 cfs	32.45 cfs	94.10	5.53	1.999	5-S2n	1.16	1.90	1.23	2.34	16.00	3.22
37.23 cfs	32.52 cfs	94.12	5.55	2.068	5-S2n	1.16	1.90	1.23	2.39	16.01	3.26
38.77 cfs	32.57 cfs	94.14	5.57	2.118	5-S2n	1.16	1.90	1.23	2.43	16.02	3.29
40.54 cfs	32.62 cfs	94.15	5.58	2.172	5-S2n	1.16	1.90	1.23	2.47	16.03	3.33
42.32 cfs	32.67 cfs	94.16	5.59	2.226	5-S2n	1.17	1.90	1.24	2.51	16.03	3.37

* Full Flow Headwater elevation is below inlet invert.

Culvert Barrel Data

Culvert Barrel Type Straight Culvert

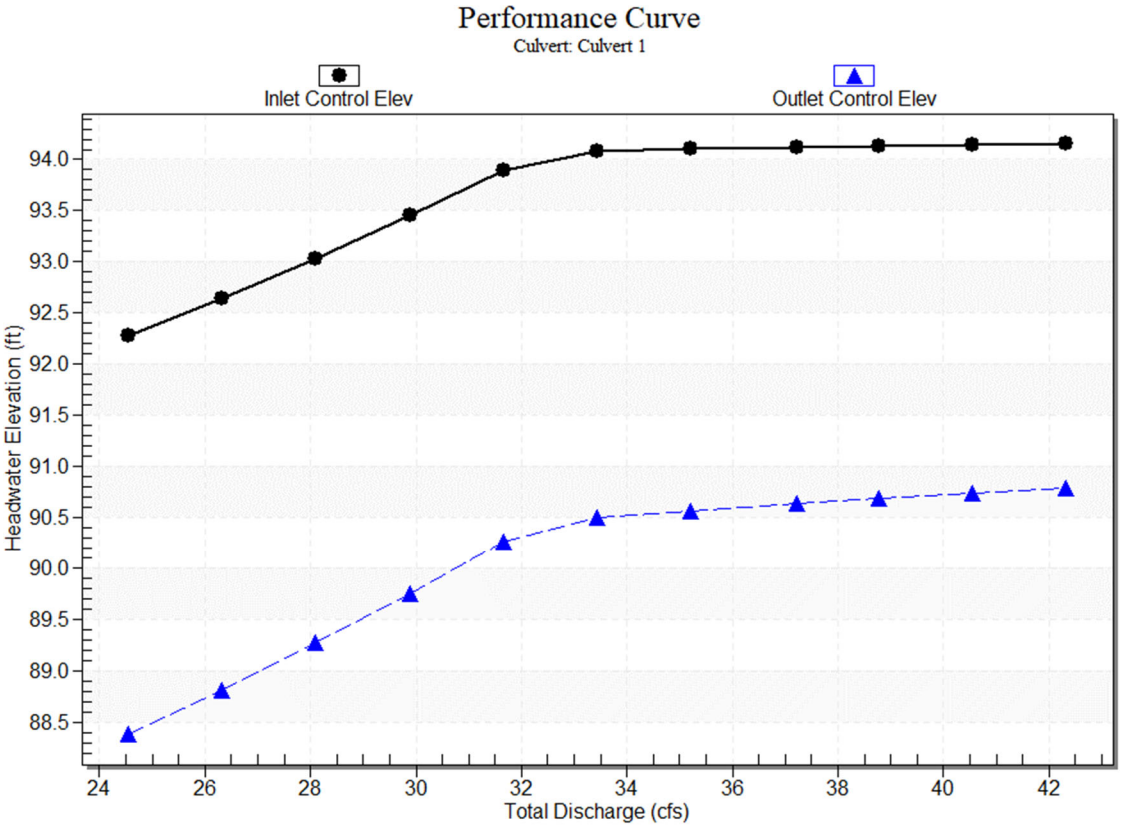
Inlet Elevation (invert): 88.57 ft,

Outlet Elevation (invert): 83.81 ft

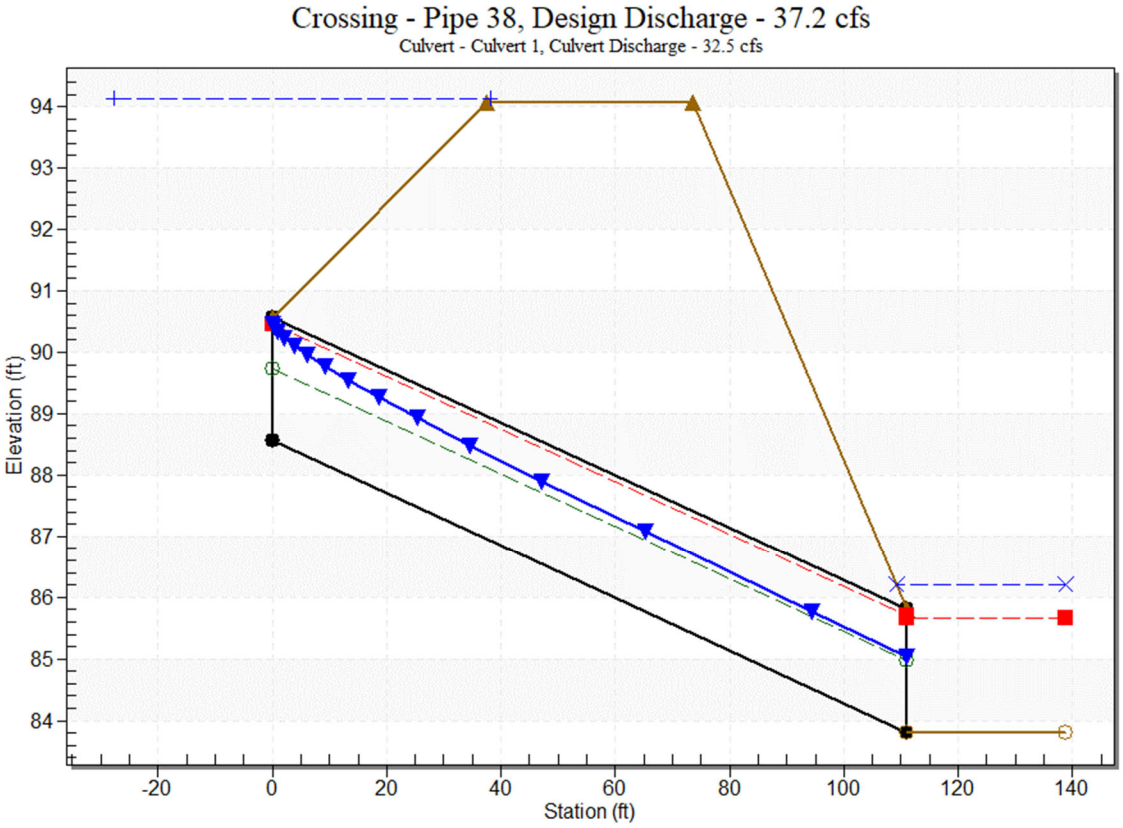
Culvert Length: 111.20 ft,

Culvert Slope: 0.0428

Culvert Performance Curve Plot: Culvert 1



Water Surface Profile Plot for Culvert: Culvert 1



Site Data - Culvert 1

Site Data Option: Culvert Invert Data

Inlet Station: 0.00 ft

Inlet Elevation: 88.57 ft

Outlet Station: 111.10 ft

Outlet Elevation: 83.81 ft

Number of Barrels: 1

Culvert Data Summary - Culvert 1

Barrel Shape: Circular

Barrel Diameter: 2.00 ft

Barrel Material:

Embedment: 0.00 in

Barrel Manning's n: 0.0120

Culvert Type: Straight

Inlet Configuration: Square Edge with Headwall (Ke=0.5)

Inlet Depression: None

Tailwater Data for Crossing: Pipe 38

Table 16 - Downstream Channel Rating Curve (Crossing: Pipe 38)

Flow (cfs)	Water Surface Elev (ft)	Velocity (ft/s)	Depth (ft)	Shear (psf)	Froude Number
24.55	85.85	2.04	2.94	0.69	0.51
26.33	85.91	2.10	2.99	0.71	0.51
28.10	85.96	2.15	3.04	0.72	0.52
29.88	86.01	2.20	3.09	0.74	0.52
31.66	86.06	2.25	3.13	0.76	0.52
33.44	86.10	2.29	3.17	0.77	0.52
35.21	86.15	2.34	3.22	0.79	0.52
37.23	86.20	2.39	3.26	0.81	0.53
38.77	86.24	2.43	3.29	0.82	0.53
40.54	86.28	2.47	3.33	0.83	0.53
42.32	86.32	2.51	3.37	0.84	0.53

Tailwater Channel Data - Pipe 38

Tailwater Channel Option: Triangular Channel

Side Slope (H:V): 2.00 (_:1)

Channel Slope: 0.0054

Channel Manning's n: 0.0350

Channel Invert Elevation: 83.81 ft

Roadway Data for Crossing: Pipe 38

Roadway Profile Shape: Constant Roadway Elevation

Crest Length: 100.00 ft

Crest Elevation: 94.06 ft

Roadway Surface: Paved

Roadway Top Width: 36.00 ft

PIPE 52

Crossing Discharge Data

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

Minimum Flow: 2.94 cfs

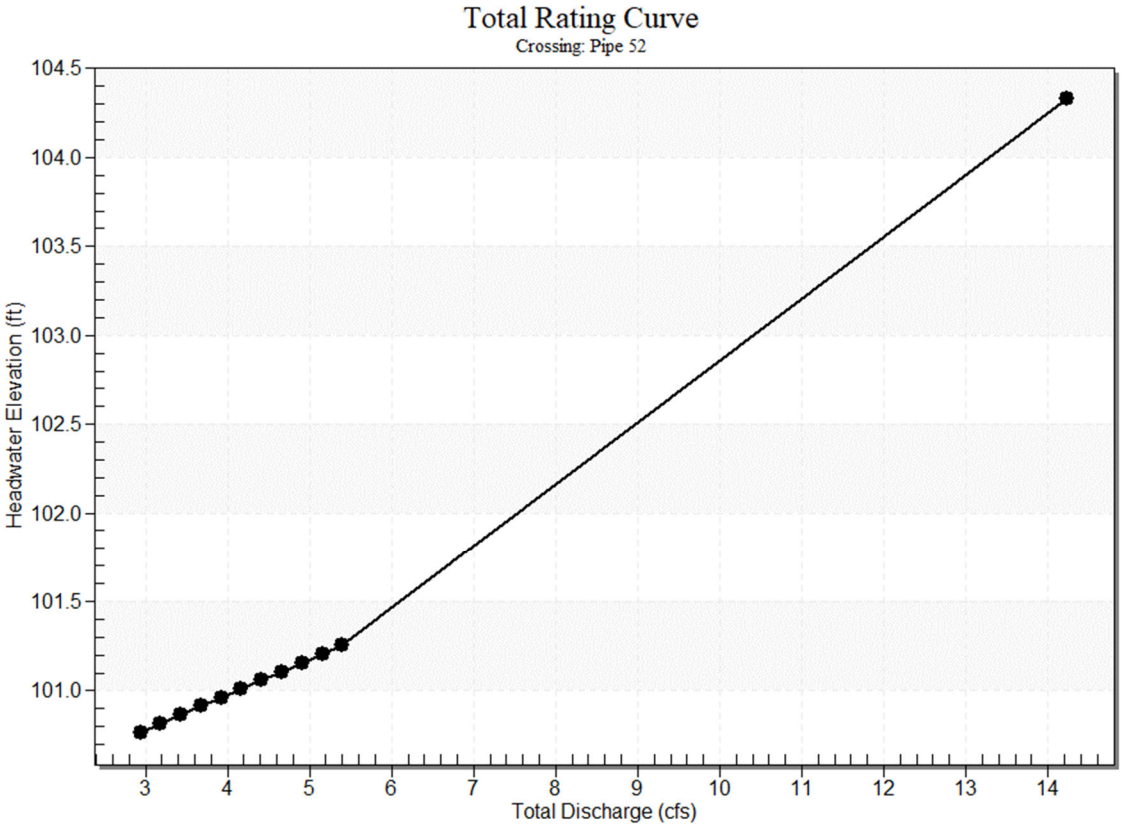
Design Flow: 4.66 cfs

Maximum Flow: 5.40 cfs

Table 17 - Summary of Culvert Flows at Crossing: Pipe 52

Headwater Elevation (ft)	Total Discharge (cfs)	Culvert 1 Discharge (cfs)	Roadway Discharge (cfs)	Iterations
100.77	2.94	2.94	0.00	1
100.82	3.19	3.19	0.00	1
100.87	3.43	3.43	0.00	1
100.91	3.68	3.68	0.00	1
100.96	3.92	3.92	0.00	1
101.01	4.17	4.17	0.00	1
101.06	4.42	4.42	0.00	1
101.11	4.66	4.66	0.00	1
101.15	4.91	4.91	0.00	1
101.20	5.15	5.15	0.00	1
101.25	5.40	5.40	0.00	1
104.32	13.90	13.90	0.00	Overtopping

Rating Curve Plot for Crossing: Pipe 52



Culvert Data: Culvert 1

Table 9 - Culvert Summary Table: Culvert 1

Total Discharge (cfs)	Culvert Discharge (cfs)	Headwater Elevation (ft)	Inlet Control Depth (ft)	Outlet Control Depth (ft)	Flow Type	Normal Depth (ft)	Critical Depth (ft)	Outlet Depth (ft)	Tailwater Depth (ft)	Outlet Velocity (ft/s)	Tailwater Velocity (ft/s)
2.94 cfs	2.94 cfs	100.77	0.94	1.147	3-M2t	1.50	0.65	0.95	0.95	2.50	1.64
3.19 cfs	3.19 cfs	100.82	0.99	1.197	3-M2t	1.50	0.68	0.98	0.98	2.62	1.67
3.43 cfs	3.43 cfs	100.87	1.03	1.246	3-M2t	1.50	0.71	1.00	1.00	2.73	1.71
3.68 cfs	3.68 cfs	100.91	1.08	1.294	3-M2t	1.50	0.73	1.03	1.03	2.85	1.74

3.92 cfs	3.92 cfs	100.96	1.12	1.342	3-M2t	1.50	0.76	1.05	1.05	2.96	1.76
4.17 cfs	4.17 cfs	101.01	1.16	1.390	3-M2t	1.50	0.78	1.08	1.08	3.06	1.79
4.42 cfs	4.42 cfs	101.06	1.20	1.438	3-M2t	1.50	0.81	1.10	1.10	3.17	1.82
4.66 cfs	4.66 cfs	101.11	1.24	1.485	3-M2t	1.50	0.83	1.12	1.12	3.28	1.84
4.91 cfs	4.91 cfs	101.15	1.29	1.534	3-M2t	1.50	0.85	1.15	1.15	3.38	1.87
5.15 cfs	5.15 cfs	101.20	1.33	1.584	3-M2t	1.50	0.87	1.17	1.17	3.49	1.89
5.40 cfs	5.40 cfs	101.25	1.37	1.634	3-M2t	1.50	0.90	1.19	1.19	3.59	1.91

Culvert Barrel Data

Culvert Barrel Type Straight Culvert

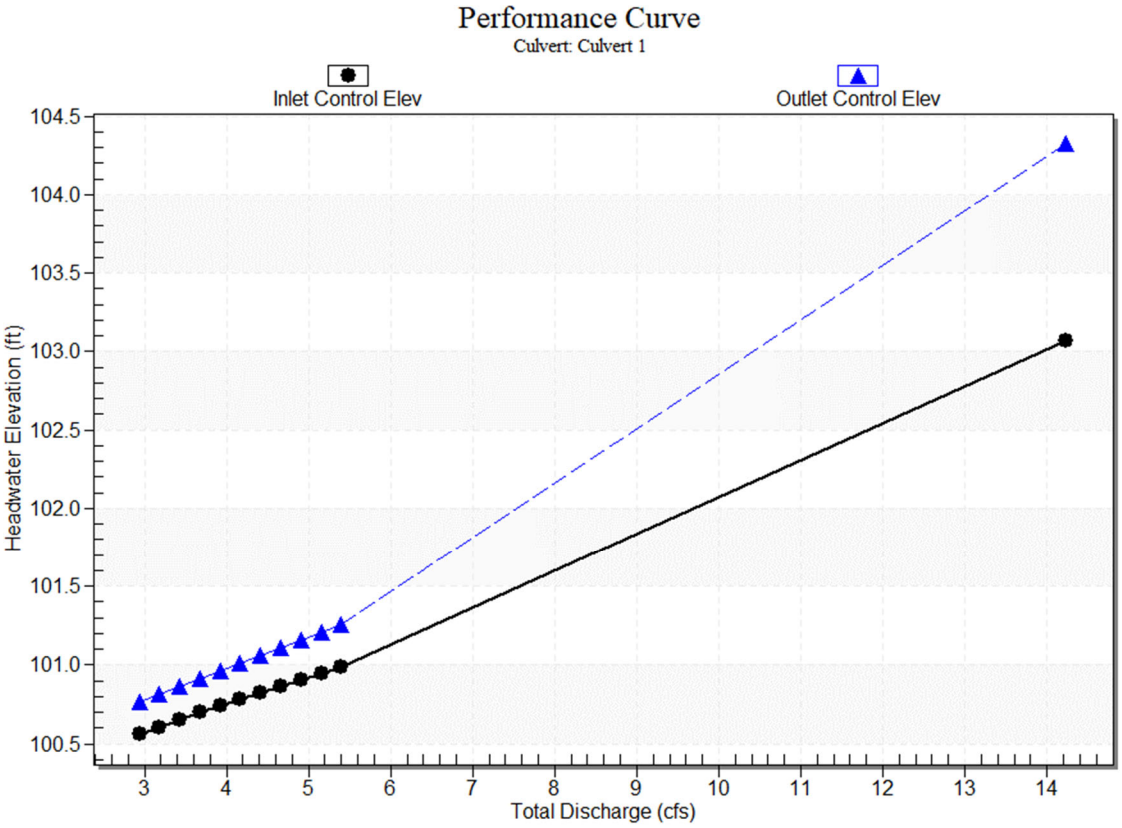
Inlet Elevation (invert): 99.62 ft,

Outlet Elevation (invert): 99.56 ft

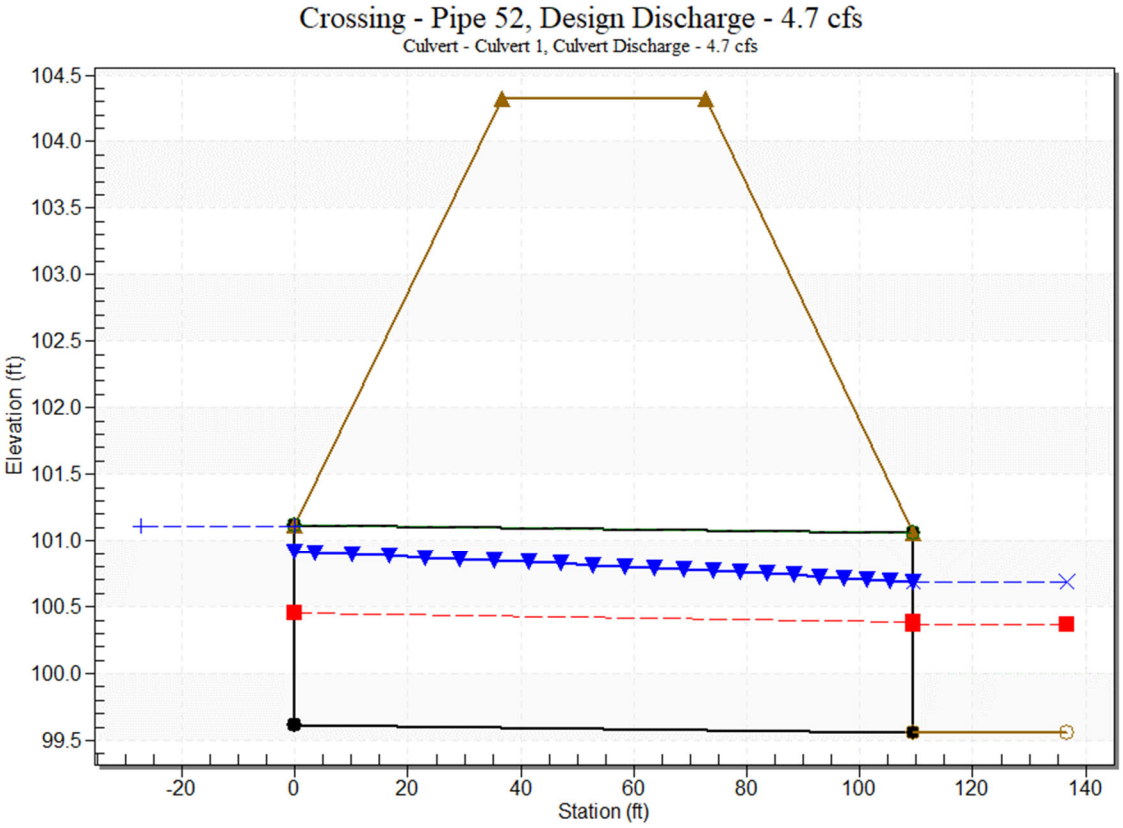
Culvert Length: 109.40 ft,

Culvert Slope: 0.0005

Culvert Performance Curve Plot: Culvert 1



Water Surface Profile Plot for Culvert: Culvert 1



Site Data - Culvert 1

Site Data Option: Culvert Invert Data

Inlet Station: 0.00 ft

Inlet Elevation: 99.62 ft

Outlet Station: 109.40 ft

Outlet Elevation: 99.56 ft

Number of Barrels: 1

Culvert Data Summary - Culvert 1

Barrel Shape: Circular

Barrel Diameter: 1.50 ft

Barrel Material:

Embedment: 0.00 in

Barrel Manning's n: 0.0120

Culvert Type: Straight

Inlet Configuration: Square Edge with Headwall (Ke=0.5)

Inlet Depression: None

Tailwater Data for Crossing: Pipe 52

Table 18 - Downstream Channel Rating Curve (Crossing: Pipe 52)

Flow (cfs)	Water Surface Elev (ft)	Velocity (ft/s)	Depth (ft)	Shear (psf)	Froude Number
2.94	100.51	0.95	1.64	0.28	0.42
3.19	100.54	0.98	1.67	0.29	0.42
3.43	100.56	1.00	1.71	0.29	0.42
3.68	100.59	1.03	1.74	0.30	0.43
3.92	100.61	1.05	1.76	0.31	0.43
4.17	100.64	1.08	1.79	0.32	0.43
4.42	100.66	1.10	1.82	0.32	0.43
4.66	100.68	1.12	1.84	0.33	0.43
4.91	100.71	1.15	1.87	0.34	0.43
5.15	100.73	1.17	1.89	0.34	0.44
5.40	100.75	1.19	1.91	0.35	0.44

Tailwater Channel Data - Pipe 52

Tailwater Channel Option: Triangular Channel

Side Slope (H:V): 2.00 (_:1)

Channel Slope: 0.0047

Channel Manning's n: 0.0350

Channel Invert Elevation: 99.56 ft

Roadway Data for Crossing: Pipe 52

Roadway Profile Shape: Constant Roadway Elevation

Crest Length: 100.00 ft

Crest Elevation: 104.32 ft

Roadway Surface: Paved

Roadway Top Width: 36.00 ft

PIPE 56

Crossing Discharge Data

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

Minimum Flow: 4.53 cfs

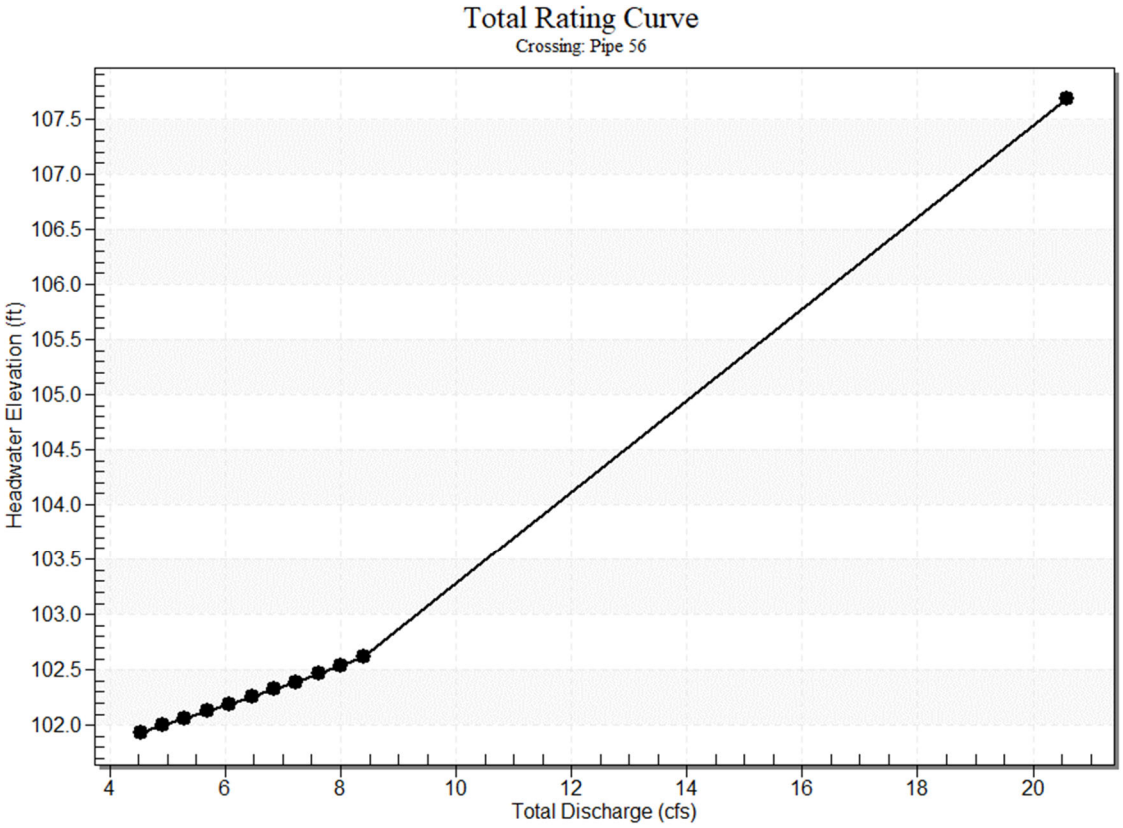
Design Flow: 7.22 cfs

Maximum Flow: 8.39 cfs

Table 19 - Summary of Culvert Flows at Crossing: Pipe 56

Headwater Elevation (ft)	Total Discharge (cfs)	Culvert 1 Discharge (cfs)	Roadway Discharge (cfs)	Iterations
101.94	4.53	4.53	0.00	1
102.00	4.92	4.92	0.00	1
102.06	5.30	5.30	0.00	1
102.13	5.69	5.69	0.00	1
102.19	6.07	6.07	0.00	1
102.26	6.46	6.46	0.00	1
102.32	6.85	6.85	0.00	1
102.39	7.22	7.22	0.00	1
102.46	7.62	7.62	0.00	1
102.54	8.00	8.00	0.00	1
102.62	8.39	8.39	0.00	1
107.66	19.74	19.74	0.00	Overtopping

Rating Curve Plot for Crossing: Pipe 56



Culvert Data: Culvert 1

Table 10 - Culvert Summary Table: Culvert 1

Total Discharge (cfs)	Culvert Discharge (cfs)	Headwater Elevation (ft)	Inlet Control Depth (ft)	Outlet Control Depth (ft)	Flow Type	Normal Depth (ft)	Critical Depth (ft)	Outlet Depth (ft)	Tailwater Depth (ft)	Outlet Velocity (ft/s)	Tailwater Velocity (ft/s)
4.53 cfs	4.53 cfs	101.94	1.22	0.392	1-JS1t	0.66	0.82	1.11	1.11	3.22	1.83
4.92 cfs	4.92 cfs	102.00	1.28	0.483	1-JS1t	0.69	0.85	1.15	1.15	3.39	1.87
5.30 cfs	5.30 cfs	102.06	1.34	0.577	1-JS1t	0.72	0.89	1.18	1.18	3.55	1.90
5.69 cfs	5.69 cfs	102.13	1.41	0.674	1-JS1t	0.75	0.92	1.21	1.21	3.72	1.94

6.07 cfs	6.07 cfs	102.19	1.47	0.775	1-JS1t	0.78	0.95	1.24	1.24	3.88	1.97
6.46 cfs	6.46 cfs	102.26	1.54	0.879	5-JS1t	0.81	0.98	1.27	1.27	4.04	2.00
6.85 cfs	6.85 cfs	102.32	1.60	0.987	5-JS1t	0.84	1.01	1.30	1.30	4.21	2.03
7.22 cfs	7.22 cfs	102.39	1.67	1.095	5-JS1t	0.87	1.04	1.33	1.33	4.37	2.05
7.62 cfs	7.62 cfs	102.46	1.74	1.213	5-JS1t	0.90	1.07	1.35	1.35	4.54	2.08
8.00 cfs	8.00 cfs	102.54	1.82	1.332	5-JS1t	0.93	1.10	1.38	1.38	4.71	2.11
8.39 cfs	8.39 cfs	102.62	1.90	1.455	5-JS1t	0.96	1.12	1.40	1.40	4.88	2.13

Culvert Barrel Data

Culvert Barrel Type Straight Culvert

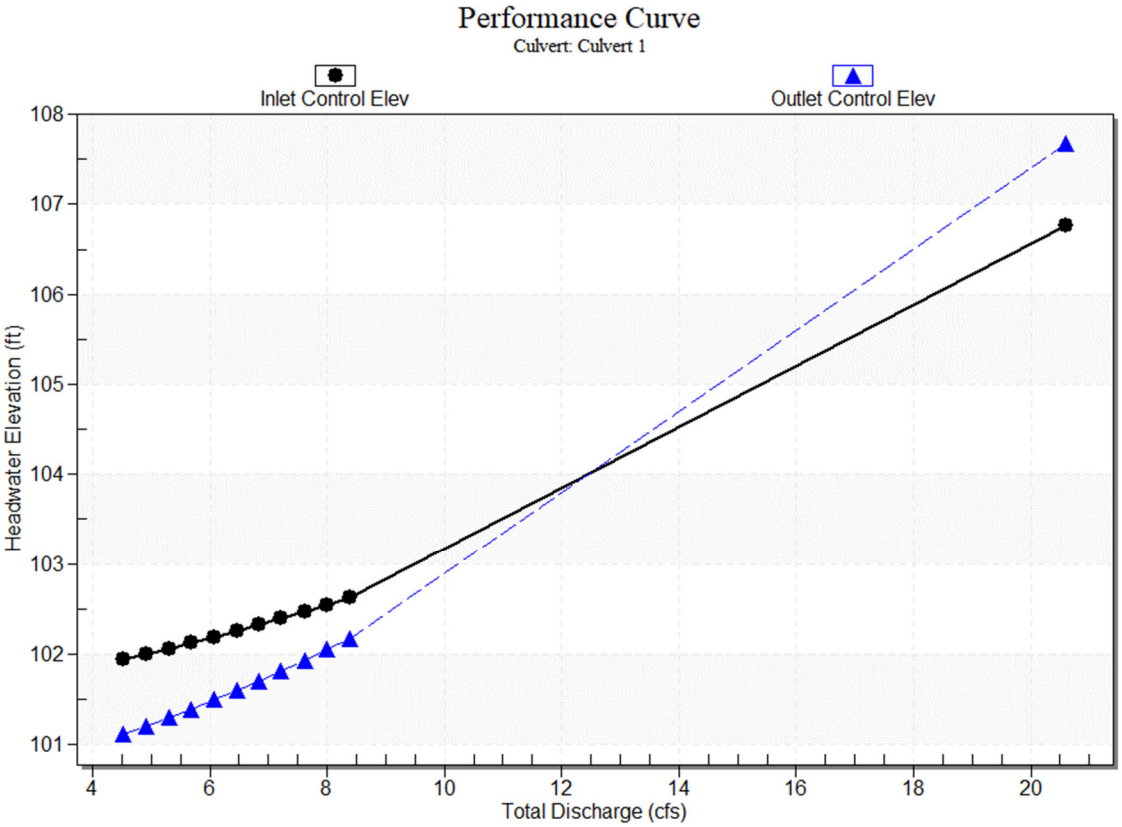
Inlet Elevation (invert): 100.72 ft,

Outlet Elevation (invert): 99.68 ft

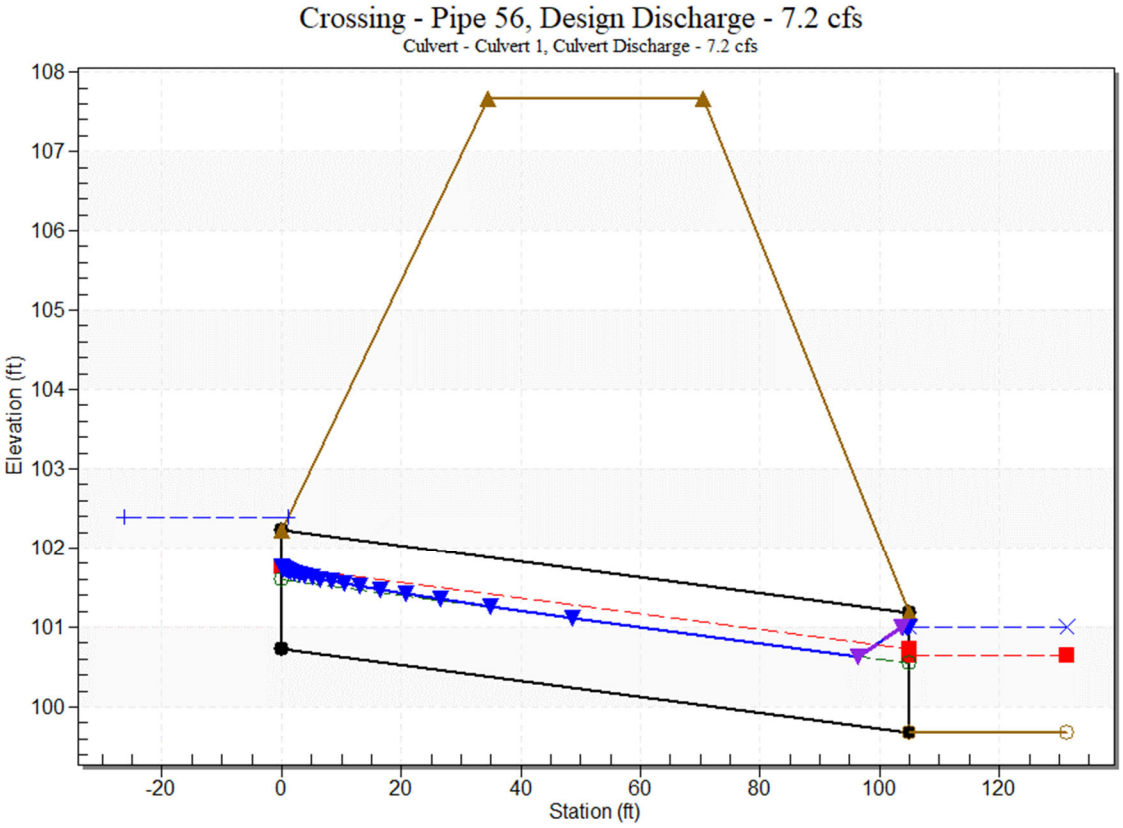
Culvert Length: 105.01 ft,

Culvert Slope: 0.0099

Culvert Performance Curve Plot: Culvert 1



Water Surface Profile Plot for Culvert: Culvert 1



Site Data - Culvert 1

Site Data Option: Culvert Invert Data

Inlet Station: 0.00 ft

Inlet Elevation: 100.72 ft

Outlet Station: 105.00 ft

Outlet Elevation: 99.68 ft

Number of Barrels: 1

Culvert Data Summary - Culvert 1

Barrel Shape: Circular

Barrel Diameter: 1.50 ft

Barrel Material:

Embedment: 0.00 in

Barrel Manning's n: 0.0120

Culvert Type: Straight

Inlet Configuration: Square Edge with Headwall (Ke=0.5)

Inlet Depression: None

Tailwater Data for Crossing: Pipe 56

Table 20 - Downstream Channel Rating Curve (Crossing: Pipe 56)

Flow (cfs)	Water Surface Elev (ft)	Velocity (ft/s)	Depth (ft)	Shear (psf)	Froude Number
4.53	100.79	1.11	1.83	0.33	0.43
4.92	100.83	1.15	1.87	0.34	0.43
5.30	100.86	1.18	1.90	0.35	0.44
5.69	100.89	1.21	1.94	0.36	0.44
6.07	100.92	1.24	1.97	0.36	0.44
6.46	100.95	1.27	2.00	0.37	0.44
6.85	100.98	1.30	2.03	0.38	0.44
7.22	101.01	1.33	2.05	0.39	0.44
7.62	101.03	1.35	2.08	0.40	0.45
8.00	101.06	1.38	2.11	0.40	0.45
8.39	101.08	1.40	2.13	0.41	0.45

Tailwater Channel Data - Pipe 56

Tailwater Channel Option: Triangular Channel

Side Slope (H:V): 2.00 (_:1)

Channel Slope: 0.0047

Channel Manning's n: 0.0350

Channel Invert Elevation: 99.68 ft

Roadway Data for Crossing: Pipe 56

Roadway Profile Shape: Constant Roadway Elevation

Crest Length: 100.00 ft

Crest Elevation: 107.66 ft

Roadway Surface: Paved

Roadway Top Width: 36.00 ft

APPENDIX C

I-95 Bridge Replacement over Lake Marion

DB PREP

Rational Method Coefficients

CLARENDON								
Frequency	Rational Coefficients			Rainfall Intensity (“/hr) for Time of Concentration (T_c)				
(years)	a	b	c	$T_c = 5$	$T_c = 10$	$T_c = 15$	$T_c = 30$	$T_c = 60$
2	66.5400	11.3400	0.8380	6.40	5.12	4.29	2.94	1.86
5	57.3800	9.9650	0.7600	7.34	5.90	4.97	3.48	2.27
10	51.3800	8.4830	0.6994	8.33	6.68	5.65	4.00	2.67
25	43.4700	6.6400	0.6248	9.38	7.50	6.37	4.58	3.15
50	40.6400	5.6410	0.5805	10.30	8.24	7.01	5.11	3.58
100	36.0600	4.1400	0.5284	11.20	8.89	7.58	5.58	4.00

ORANGEBURG								
Frequency	Rational Coefficients			Rainfall Intensity (“/hr) for Time of Concentration (T_c)				
(years)	a	b	c	$T_c = 5$	$T_c = 10$	$T_c = 15$	$T_c = 30$	$T_c = 60$
2	65.7300	11.5000	0.8390	6.26	5.01	4.20	2.89	1.83
5	54.9500	9.9720	0.7593	7.04	5.66	4.77	3.34	2.18
10	49.5900	8.4860	0.6983	8.06	6.47	5.47	3.88	2.59
25	42.5200	6.6960	0.6278	9.08	7.26	6.16	4.43	3.04
50	39.7100	5.7030	0.5818	10.00	8.00	6.81	4.96	3.48
100	35.3200	4.2150	0.5294	10.90	8.66	7.39	5.44	3.90

APPENDIX D

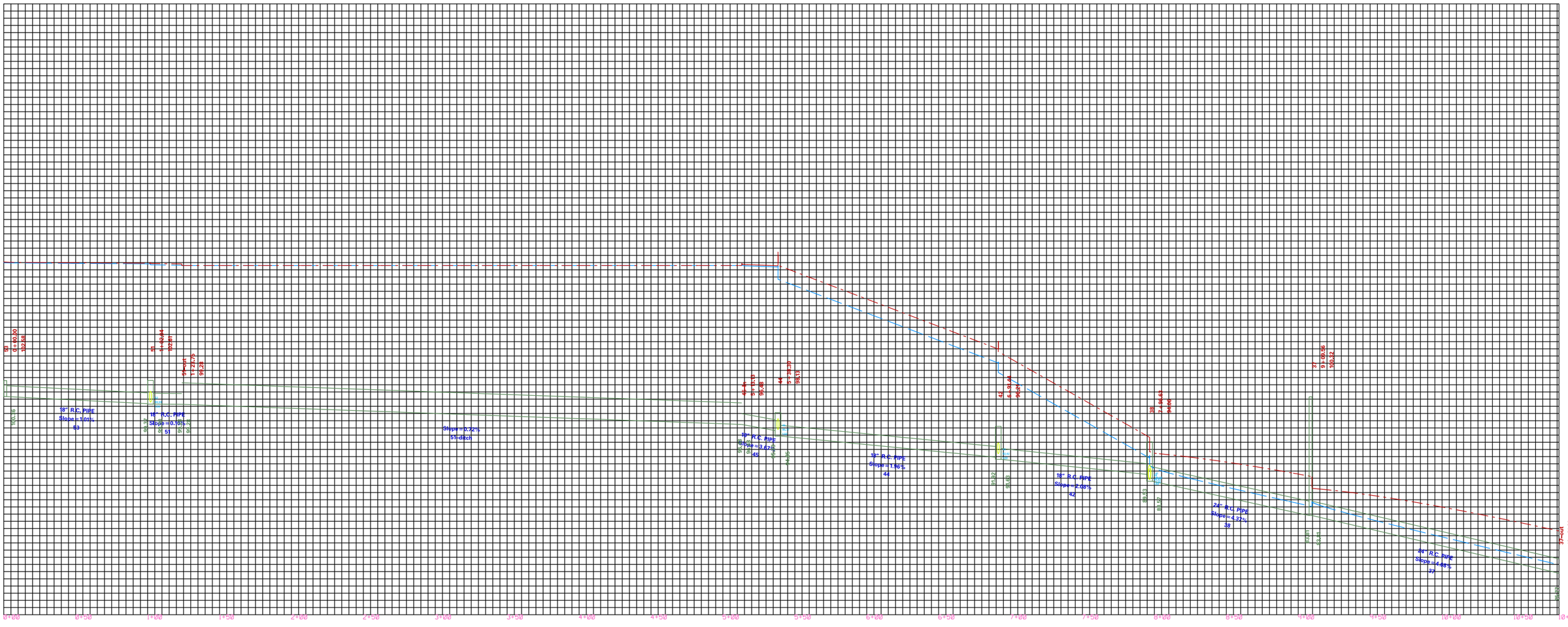
I-95 Bridge Replacement over Lake Marion

DB PREP

HGL Plots for Rest Area Pipe Networks

NB REST AREA

10-yr Event



SB REST AREA

10-yr Event