Preliminary Design Report

Haskell Bridge #3496
Over
Haskell Brook

Canaan, Maine

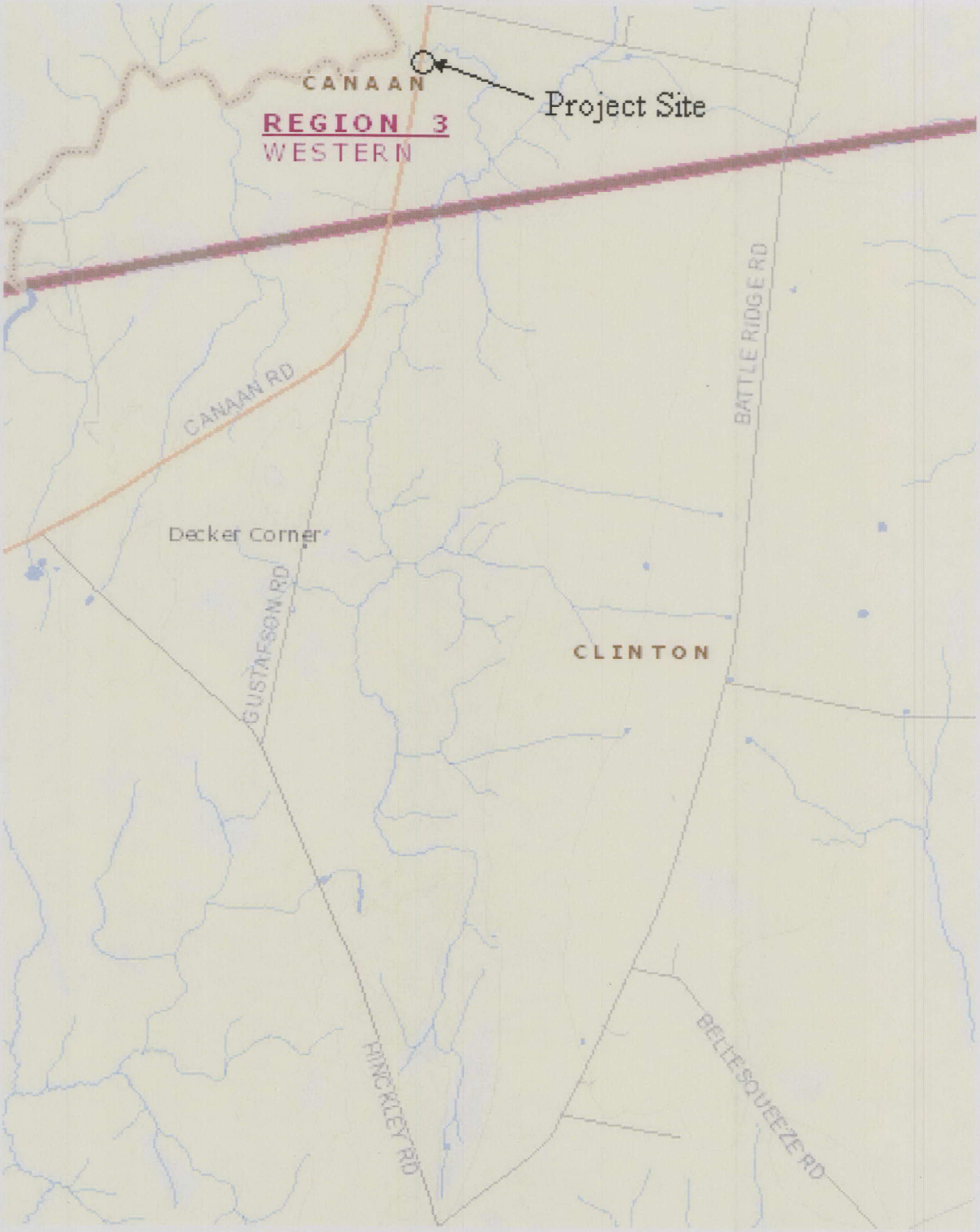
BR-1699(200)X
PIN 16692.00

Maine Department of Transportation

Bridge Program

LOCATION MAP

Canaan, Maine
Haskell Bridge
Bridge No. 3496
PIN 16692.00



HYDROLOGY REPORT

The drainage basin characteristics for Haskell Bridge #3496 in Canaan on Route 23 over Haskell Brook were provided by the Maine Department of Transportation Office of the Environmental Hydrology. The flows were computed based on the 1999 USGS full regression equation. Neither Ray Small (Road Commissioner) nor Herb Noyes (MDOT Maintenance Manager) recalls any problems with flooding at the site. No other flow data was available from either gage data or existing studies, therefore the hydrology data was used as provided. Provided Data is as follows:

Summary

Drainage Area	=	6.8 mi^2
Fish Passage Flow	=	1.3 cfs
Ordinary High Water ($Q_{1.1}$)	=	138.4 cfs
Design Discharge (Q_{50})	=	988.7 cfs
Check Discharge (Q_{100})	=	1159.9 cfs
Q_{500}	=	1594.3 cfs

Reported By: Brian Reeves
Date: June 18, 2010

HYDRAULICS REPORT
(Existing Bridge)

Haskell Bridge #3496 is located in the town of Canaan on Route 23 over Haskell Brook. The existing bridge consists of 2-10'diameter, 5% elliptical steel structural plate pipes built in 1959. Riprap aprons are positioned at either end of the pipes to prevent scour and undermining problems. Ponding exists at both ends of the structure. Site inspection found that water levels are controlled by Carrabassett Stream about 550' downstream from Haskell Bridge.

The existing bridge was analyzed using the HY-8 program version 7.2. The existing structure was modeled as two 72.6' long 10' circular corrugated steel pipes with tail water based on an irregular channel. There were no elliptical sections of a similar size available for analysis in the program. The existing bridge is adequate in terms of hydraulics. The ratio of headwater to depth of structure Hw/D is 0.87 at Q50 flows, which is below the 0.9 design standard criteria.

Summary

		Existing Structure
Total Area of Waterway Opening	=	157 ft^2
Headwater elevation @ $Q_{1.1}$	=	147.40 ft
Headwater elevation @ Q_{50}	=	153.08 ft
Headwater elevation @ Q_{100}	=	153.96 ft
Hw/D @ Q_{50}	=	0.87
Outlet Velocity @ $Q_{1.1}$	=	6.57 ft/s
Outlet Velocity @ Q_{50}	=	11.68 ft/s
Outlet Velocity @ Q_{100}	=	12.36 ft/s
Water Depth @ $Q_{1.1}$	=	3.0 ft.
Water Depth @ Fish Flow	=	1.5 ft

*elevations based on assumed vertical datum

*elevations based on assumed vertical datum

Reported By: Brian Reeves
Date: June 18, 2010

HYDRAULIC REPORT
(Proposed Bridge)

Haskell Bridge #3496 is located in Canaan on Route 23 over Haskell Brook. The proposed bridge was analyzed using the HY-8 program version 7.2. Due to the small drainage area and low flows several culvert alternatives were available.

The existing straight alignment matches stream alignment well, no change is required. The culvert is about 73' feet long, with two steel structural plate pipes. Approximately 1.5' to 2' of water exists at low flow conditions during summer months. Three alternatives for replacement were considered.

The first alternative is to replace in kind with 2-11' diameter steel structural plate pipes (total opening area 157 ft^2). To analyze this, two 10' diameter circular pipes with an invert elevation of 144.34' were used to account for 1' embedment. The Hw/D ratio at Q50 is 0.87, which is below the 0.90 Hw/D design criteria. The headwater depth and outlet velocities would be the similar as existing.

The second alternative selected is to slipline the existing pipes with 9' diameter aluminum pipes (total opening area 127 ft^2). Sliplining was analyzed based on no embedment and an invert elevation of 144.84. The Hw/D ratio at Q50 is 0.99 which is above the 0.90 design criteria. The headwater depth and outlet velocity increases when compared with existing. At the Q100 flow, headwater elevation increases by .88' or 10.5" which is below the desired maximum of 1' of headwater increase.

The third alternative is to use a concrete box culvert. A precast concrete box culvert with 20' span, 9' rise (opening area 180 ft^2), no embedment and an invert elevation of 144.34 was analyzed. The Hw/D ratio at Q50 was 0.84 which is below the required 0.90 design criteria. The headwater depth decreases while the outlet velocity increases when compared with existing. To accommodate a 2 foot embedment, the concrete box culvert rise would need to be increased by 2 feet.

Plain riprap will be adequate for slope protection and aprons at each end.

The preferred alternative in terms of hydraulics is #3, replacement with 20' span, 9' rise concrete box culvert. The increased opening area allows for greater flow and lower headwater elevations. At Q50 outlet velocity is similar, while Hw/D ratio is decreased. The final decision on what alternative to use will be based on other factors besides hydraulics such as initial cost, constructability, traffic control and life cycle cost.

Summary

	Existing Structure	2-10' Diameter Steel pipes	2-9' Diameter Aluminum pipes	20' Span, 9' rise Concrete box culvert
Total Area of Waterway Opening	157 ft^2	157 ft^2	127 ft^2	180 ft^2
Headwater elevation @ $Q_{1.1}$	147.40 ft	147.40 ft	147.59 ft	146.39 ft
Headwater elevation @ Q_{50}	153.08 ft	153.08 ft	153.78 ft	151.94 ft
Headwater elevation @ Q_{100}	153.96 ft	153.96 ft	154.85 ft	152.80 ft
Headwater elevation @ Fish Flow	145.84 ft	145.84 ft	144.85 ft	144.98 ft
Hw/D @ Q_{50}	0.874	0.874	0.993	0.844
Outlet Velocity @ Fish Flow	0.09 ft/s	0.09 ft/s	0.46 ft/s	0.13 ft/s
Outlet Velocity @ $Q_{1.1}$	6.57 ft/s	6.57 ft/s	6.69 ft/s	6.08 ft/s
Outlet Velocity @ Q_{50}	11.68 ft/s	11.68 ft/s	12.19 ft/s	11.67 ft/s
Outlet Velocity @ Q_{100}	12.36 ft/s	12.36 ft/s	12.99 ft/s	12.32 ft/s

*elevations based on North American Vertical Datum (NAVD) of 1988

Reported by: Brian Reeves
Date: July 7, 2010

Canaan, Haskel Bridges #3496 Site Inspection for hydraulics 6/18/10

North Pipe:

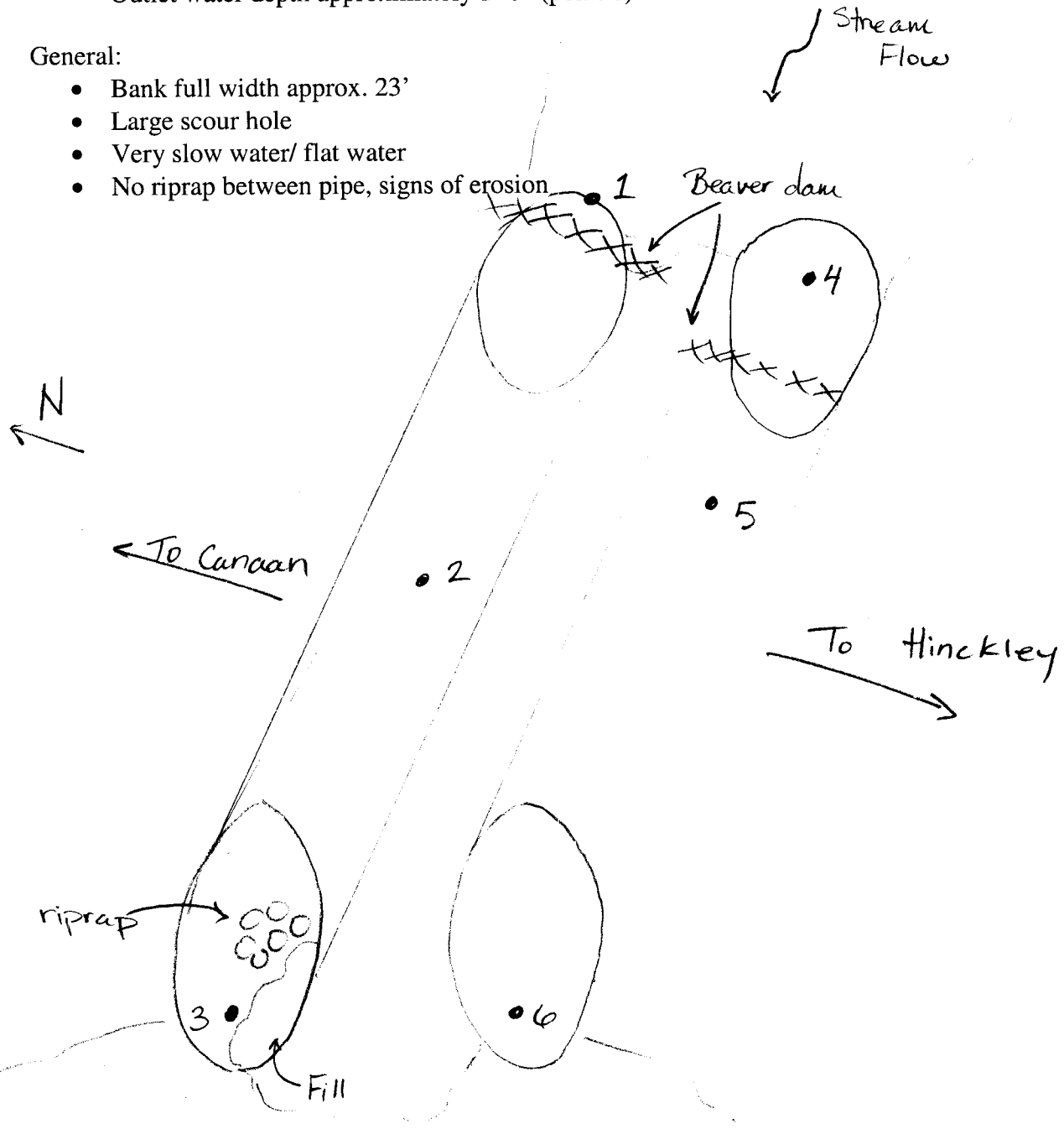
- Beaver damn at inlet (see illustration)
- Inlet water depth approximately 2' (point 1)
- Mid pipe water depth approximately 2' 6" (point 2)
- Outlet water depth approximately 1' 6" (point 3)
- Inside the pipe at outlet stone riprap and fill material
- Pipe about 80% clean, no material on bottom

South Pipe:

- Beaver damn 3'-5' feet inside the inlet (see illustration)
- Inlet water depth approximately 1' 7" (point 4)
- 20'-25' inside pipe water depth approximately 2' 7" (point 5)
- Outlet water depth approximately 1' 8" (point 6)

General:

- Bank full width approx. 23'
- Large scour hole
- Very slow water/ flat water
- No riprap between pipe, signs of erosion



Appendix C

Hydrology/Hydraulics Data

Project Name:	Canaan - Haskell Br	**PIN:**	16692
Stream Name:	Haskell Brook	**Town:**	Canaan
Bridge Name:	Haskell Brook	**Bridge No.**	3496
Route No.	SR 23	**USGS Quad:**	
Analysis by:	CSH	**Date:**	2/2/2010

Peak Flow Calculations by USGS Regression Equations (Hodgkins, 1999)

Enter data in blue cells only!

	km²	mi²	ac
A	17.30	6.678	4274.2
W	1.04	0.403	257.9

Enter data in [mi²]
Watershed Area
Wetlands area (by NWI)

P_c	455075	4950625
County	Somerset S	
pptA	39.5	
SG	0.00	

watershed centroid (E, N; UTM 19N; meters)
choose county from drop-down menu
mean annual precipitation (inches; by look-up)
sand & gravel aquifer as decimal fraction of watershed A

A (km²)	17.30
W (%)	6.03

Conf Lvl 0.67

Worksheet prepared by:
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Ret Pd T (yr)	Peak Flow Estimate Lower	Q_T (m³/s)	Upper	Q_T (ft³/s)
1.1		3.84		135.5
2	5.93	8.33	11.70	294.2
5	9.60	13.55	19.13	478.4
10	12.30	17.54	25.01	619.3
25	15.92	23.05	33.38	813.8
50	18.73	27.47	40.27	969.8
100	21.70	32.23	47.86	1138.0
500	28.85	44.31	68.05	1564.6

Reference:

Hodgkins, G., 1999.
Estimating the magnitude of peak flows for streams in Maine for selected recurrence intervals
Water-Resources Investigations Report 99-4008
US Geological Survey, Augusta, Maine

$Q_T = b \times A^a \times 10^{-wW}$

HY-8 Analysis Results

Culvert Summary Table - Existing/Replace in kind

Culvert Crossing: 10' Diameter Steel Pipe

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)
138.40	138.40	147.40	2.70	3.06	2-M2c	5.91	1.90	1.92	0.84	6.57	5.26
240.55	240.55	148.39	3.60	4.05	2-M2c	10.00	2.50	2.55	1.16	7.63	6.49
342.70	342.70	149.21	4.36	4.87	2-M2c	10.00	3.05	3.06	1.43	8.43	7.40
444.85	444.85	149.93	5.00	5.59	2-M2c	10.00	3.47	3.50	1.66	9.09	8.14
547.00	547.00	150.59	5.63	6.25	2-M2c	10.00	3.88	3.89	1.87	9.67	8.78
649.15	649.15	151.21	6.21	6.87	2-M2c	10.00	4.24	4.26	2.07	10.19	9.34
751.30	751.30	151.80	6.74	7.46	2-M2c	10.00	4.57	4.59	2.25	10.67	9.84
853.45	853.45	152.36	7.25	8.02	2-M2c	10.00	4.90	4.91	2.42	11.12	10.29
955.60	955.60	152.91	7.75	8.57	2-M2c	10.00	5.20	5.21	2.59	11.55	10.71
988.70	988.70	153.08	7.91	8.74	2-M2c	10.00	5.29	5.30	2.64	11.68	10.83
1159.90	1159.90	153.96	8.76	9.62	2-M2c	10.00	5.75	5.77	2.89	12.36	11.45

HY-8 Analysis Results

Culvert Summary Table - Existing Fish Check

Culvert Crossing: 10' Steel Pipe

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)
1.33	1.33	145.84	0.14	1.50	3-M1t	0.30	0.03	1.51	1.50	0.09	0.00
100.07	100.07	146.94	2.27	2.60	2-M2c	4.85	1.55	1.63	1.50	6.02	0.00
138.40	138.40	147.40	2.70	3.06	2-M2c	5.91	1.90	1.92	1.50	6.57	0.00
297.54	297.54	148.86	4.03	4.52	2-M2c	10.00	2.82	2.84	1.50	8.10	0.00
396.28	396.28	149.60	4.70	5.26	2-M2c	10.00	3.27	3.29	1.50	8.79	0.00
495.01	495.01	150.26	5.32	5.92	2-M2c	10.00	3.67	3.70	1.50	9.38	0.00
593.75	593.75	150.88	5.90	6.54	2-M2c	10.00	4.06	4.06	1.50	9.91	0.00
692.49	692.49	151.46	6.44	7.12	2-M2c	10.00	4.38	4.40	1.50	10.40	0.00
791.23	791.23	152.02	6.94	7.68	2-M2c	10.00	4.70	4.72	1.50	10.85	0.00
889.96	889.96	152.56	7.43	8.22	2-M2c	10.00	5.02	5.02	1.50	11.27	0.00
988.70	988.70	153.08	7.91	8.74	2-M2c	10.00	5.29	5.30	1.50	11.68	0.00

HY-8 Analysis Results

Culvert Summary Table - slipline

Culvert Crossing: 9' Diameter Alum Pipe

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)
138.40	138.40	147.59	2.79	3.25	2-M2c	9.00	1.95	1.98	0.84	6.69	5.26
240.55	240.55	148.63	3.73	4.29	2-M2c	9.00	2.61	2.62	1.16	7.79	6.49
342.70	342.70	149.50	4.51	5.16	2-M2c	9.00	3.12	3.15	1.43	8.63	7.40
444.85	444.85	150.27	5.24	5.93	2-M2c	9.00	3.61	3.61	1.66	9.33	8.14
547.00	547.00	150.98	5.88	6.64	2-M2c	9.00	4.00	4.02	1.87	9.95	8.78
649.15	649.15	151.66	6.49	7.32	2-M2c	9.00	4.39	4.40	2.07	10.51	9.34
751.30	751.30	152.31	7.07	7.97	2-M2c	9.00	4.73	4.75	2.25	11.04	9.84
853.45	853.45	152.95	7.66	8.61	2-M2c	9.00	5.06	5.07	2.42	11.55	10.29
955.60	955.60	153.57	8.28	9.23	2-M2c	9.00	5.38	5.38	2.59	12.04	10.71
988.70	988.70	153.78	8.49	9.44	2-M2c	9.00	5.47	5.48	2.64	12.19	10.83
1159.90	1159.90	154.85	9.65	10.51	2-M2c	9.00	5.93	5.95	2.89	12.99	11.45

HY-8 Analysis Results

Culvert Summary Table - Slipline Fish Check

Culvert Crossing: 9' Diameter Alum Pipe

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)
1.33	1.33	144.85	0.14	0.51	3-M1t	0.47	0.04	0.51	0.00	0.46	0.00
100.07	100.07	147.06	2.35	2.72	2-M2c	6.17	1.64	1.67	0.00	6.13	0.00
138.40	138.40	147.59	2.79	3.25	2-M2c	9.00	1.95	1.98	0.00	6.69	0.00
297.54	297.54	149.13	4.18	4.79	2-M2c	9.00	2.91	2.93	0.00	8.28	0.00
396.28	396.28	149.91	4.90	5.57	2-M2c	9.00	3.38	3.40	0.00	9.01	0.00
495.01	495.01	150.63	5.56	6.29	2-M2c	9.00	3.80	3.82	0.00	9.64	0.00
593.75	593.75	151.30	6.16	6.96	2-M2c	9.00	4.18	4.20	0.00	10.21	0.00
692.49	692.49	151.94	6.73	7.60	2-M2c	9.00	4.54	4.55	0.00	10.74	0.00
791.23	791.23	152.56	7.30	8.22	2-M2c	9.00	4.86	4.88	0.00	11.24	0.00
889.96	889.96	153.17	7.88	8.83	2-M2c	9.00	5.17	5.19	0.00	11.72	0.00
988.70	988.70	153.78	8.49	9.44	2-M2c	9.00	5.47	5.48	0.00	12.19	0.00

HY-8 Analysis Results

Culvert Summary Table - Concrete Box Culvert

Culvert Crossing: 20' Span x 9' rise

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)
138.40	138.40	146.39	1.96	2.05	2-M2c	2.69	1.14	1.14	0.84	6.08	5.26
240.55	240.55	147.29	2.82	2.95	2-M2c	3.88	1.65	1.65	1.16	7.29	6.49
342.70	342.70	148.08	3.56	3.74	2-M2c	4.95	2.09	2.09	1.43	8.20	7.40
444.85	444.85	148.79	4.24	4.45	2-M2c	5.94	2.49	2.49	1.66	8.94	8.14
547.00	547.00	149.45	4.83	5.11	2-M2c	6.88	2.86	2.86	1.87	9.58	8.78
649.15	649.15	150.08	5.38	5.74	2-M2c	7.79	3.21	3.20	2.07	10.14	9.34
751.30	751.30	150.66	5.91	6.32	2-M2c	9.00	3.53	3.53	2.25	10.65	9.84
853.45	853.45	151.23	6.42	6.89	2-M2c	9.00	3.85	3.84	2.42	11.11	10.29
955.60	955.60	151.77	6.93	7.43	2-M2c	9.00	4.15	4.14	2.59	11.54	10.71
988.70	988.70	151.94	7.09	7.60	2-M2c	9.00	4.24	4.23	2.64	11.67	10.83
1159.90	1159.90	152.80	7.93	8.46	2-M2c	9.00	4.72	4.71	2.89	12.32	11.45

HY-8 Analysis Results

Culvert Summary Table - Concrete Box Fish Check

Culvert Crossing: 20' Span x 9' Rise

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)
1.33	1.33	144.98	0.64	0.50	1-S1t	0.05	0.05	0.51	0.50	0.13	0.00
100.07	100.07	146.00	1.57	1.66	2-M2c	2.25	0.92	0.92	0.50	5.45	0.00
138.40	138.40	146.39	1.96	2.05	2-M2c	2.80	1.14	1.14	0.50	6.08	0.00
297.54	297.54	147.74	3.24	3.40	2-M2c	4.69	1.91	1.90	0.50	7.82	0.00
396.28	396.28	148.46	3.92	4.12	2-M2c	5.72	2.31	2.30	0.50	8.60	0.00
495.01	495.01	149.12	4.54	4.78	2-M2c	6.70	2.68	2.67	0.50	9.26	0.00
593.75	593.75	149.74	5.08	5.40	2-M2c	7.64	3.02	3.02	0.50	9.84	0.00
692.49	692.49	150.32	5.61	5.98	2-M2c	9.00	3.35	3.34	0.50	10.36	0.00
791.23	791.23	150.88	6.11	6.54	2-M2c	9.00	3.66	3.65	0.50	10.83	0.00
889.96	889.96	151.42	6.61	7.08	2-M2c	9.00	3.96	3.95	0.50	11.27	0.00
988.70	988.70	151.94	7.09	7.60	2-M2c	9.00	4.24	4.23	0.50	11.67	0.00