

# Appendix F

## Hydrology and Hydraulics

### Data

Content:

- Culvert Data Table
- HY8 Culvert Analysis Report

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Table C.1

Lynn Creek				Evaluate	GIS Contour Data			Overtopping Evaluation					
OBJECTID *	Shape *	Point_X	Point_Y	Note	Evaluate_(yes/no/in_sufficient_data)	Road_elevation	Channel_elevation_Upstream	Channel_depth_at_Road	Approx_Dist_between_DNR_Xsect	DS_Backwater	Approx_100yr_WSE_at_Road	Road_Overtopped_per_DNR_Data	Depth_Overtopped
1	Point	156686.7	21868.72	DS Xsect only	Yes	1164	1159	5	0	No	1159.0	No	-5.0
2	Point	15459.84	223558.6	DS Xsect only	Yes	1201	1193	8	0	No	1193.0	No	-8.0
3	Line	153757.1	220043.5	No Xsect, unmodeled Tributary	Insufficient	1207	1202	5	0	No	1202.0	No	-5.0
4	Line	157427.5	217080	In FEMA Effective Model	No								
5	Line	155371.5	219047	No Xsect, unmodeled Tributary	Insufficient	1179.75	1176	3.75	0	No	1176.0	No	-3.8
6	Line	158953.5	213476.1	In FEMA Effective Model	No								
7	Line	158486.9	214378.4	In FEMA Effective Model	No								
8	Line	158550.4	214019.8	In FEMA Effective Model	No								
9	Line	153305.1	227168.2	Outside of Zone A	No	1230	1219	11	0	No	1219.0	No	-11.0
10	Line	153452.9	228514.9	Outside of Zone A	No	1249	1244	5			1244.0	No	-5.0
11	Line	158711.2	213691.8	In FEMA Effective Model	No	1146	1139	7	0	No	1139.0	No	-7.0
12	Line	158534.5	213975.6	In FEMA Effective Model	No								
13	Line	158322.2	214526.3	In FEMA Effective Model	No								
14	Line	157996.3	216010.1	In FEMA Effective Model	No								
15	Line	156097.6	220509.4	DS Xsect only	Yes	1186	1178	8	0	No	1178.0	No	-8.0
16	Line	155406.5	222029.1	DS Xsect only	Yes	1200	1190	10	0	No	1190.0	No	-10.0
17	Point	155632.1	221836	DS Xsect only	Yes	1200	1181	19	0	No	1181.0	No	-19.0

Culverts to Evaluate

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Table C.1

DNR HYDRAULIC STUDY DATA								County Culvert Data						
OBJECTID *	US_100yr_depth	US_100yr_Elevation	US_Q100	US_Distance_to_point_(ft)	DS_100yr_depth	DS_100yr_Elevation	DS_Q100	DS_Distance_to_point_(ft)	County_Longitude	County_Latitude	Known_WSE_100yr	Road_Name	Culvert_Description	Culvert_Openings
1						1163.5	4500	1100	156686.65	21868.725		Pedestrian Crossing 1	6'	SINGLE
2						1163.5	4500	7033	15459.839	223558.59		Northwest 1st Street	8'x6'	TWIN
3													12'x6'	SINGLE
4														
5													9'x6'	TWIN
6														
7														
8														
9						1163.5	4500	10777	153305.13	227168.18			10'x6'	SINGLE
10						1163.5	4500	12490	153452.9	228514.87			9'x4'	SINGLE
11						1163.5	4500	455	158711.19	213691.82			11'x.5.5'	TWIN
12														
13														
14														
15						1163.5	4500	3039	156097.59	220509.38		Superior Street	8'x12'	TWIN
16						1163.5	4500	4894	155406.55	222029.15		Interstate 80	10'x8'	TWIN
17						1163.5	4500	4700	155632.08	221836		Pedestrian Crossing 2	8'x2'x10'	SINGLE

Table C.1

Modeled Culvert - per As-Built data from County																
OBJECTID *	Structure Type		Downstream Flowline (ft)	Tailwater Elevation (ft)	Assumed Crest Length (ft)	Embedment depth (in)	Culvert type	Inlet Configuration	Number of barrels	Inlet Elevation (ft)	Outlet Elevation (ft)	Crest Elevation (ft)	Extra	Roadway Overtopped?	Overtopping Elevation (ft)	Overtopping Depth (ft)
1	CMP			1167.52	1171	0		Square Edge with Headwall	1	1159	1154	1164		Yes	1164	3.52
2	CBC		90.6	1204.23	1174	0		Square Edge (30 - 70 degree flared) Wingwall	2	1192	1191.38	1201.5		Yes	1201.5	2.73
3	CBC		85.29													
4																
5	CBC		69.53													
6																
7																
8																
9	CBC															
10	CBC		140.93													
11	CBC		37.78													
12																
13																
14																
15	CBC		64.35	1187.77	1070	0		Square Edge 90 Degree Headwall	2	1169	1165.3	1185.5	Single broken back structure at 1168.67 elevation	Yes	1185.5	2.27
16	CBC		79.2	1201.4	1302.54	0		Square Edge 90 Degree Headwall	2	1182	1179.89	1199		Yes	1199	2.4
17	CBC		78.53	1187.88	673.07	0		Square Edge (30 - 70 degree flared) Wingwall	1	1178.79	1178.72	1181.4		Yes	1181.4	6.48

# HY-8 Culvert Analysis Report

## Crossing Discharge Data

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

Minimum Flow: 0 cfs

Design Flow: 4500 cfs

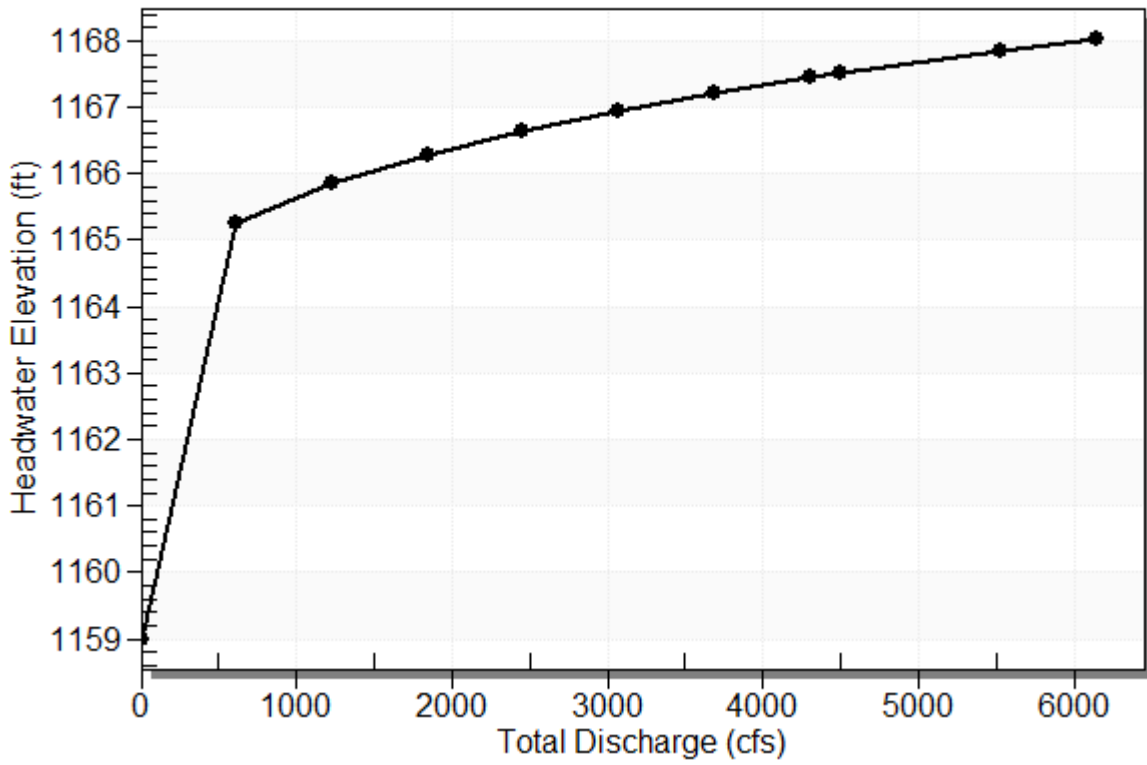
Maximum Flow: 6140 cfs

**Table 1 - Summary of Culvert Flows at Crossing: Pedestrian Crossing 1**

Headwater Elevation (ft)	Total Discharge (cfs)	Culvert 1 Discharge (cfs)	Roadway Discharge (cfs)	Iterations
1159.00	0.00	0.00	0.00	1
1165.26	614.00	217.24	396.20	11
1165.85	1228.00	243.26	983.70	4
1166.29	1842.00	261.35	1580.37	5
1166.65	2456.00	275.16	2180.51	5
1166.95	3070.00	286.30	2781.19	4
1167.22	3684.00	295.74	3385.76	4
1167.45	4298.00	303.92	3992.20	4
1167.52	4500.00	306.26	4191.93	3
1167.86	5526.00	317.48	5205.56	3
1168.04	6140.00	323.41	5816.39	3
1164.00	157.15	157.15	0.00	Overtopping

Rating Curve Plot for Crossing: Pedestrian Crossing 1

Total Rating Curve  
Crossing: Pedestrian Crossing 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)
0.00	0.00	1159.00	0.000	0.000	0-NF	0.000	0.000	0.000	0.000	0.000	0.000
614.00	217.24	1165.26	6.258	0.634	5-S2n	1.838	4.030	2.339	2.473	20.567	12.806
1228.00	243.26	1165.85	6.852	1.280	5-S2n	1.950	4.267	2.509	3.564	20.985	15.611
1842.00	261.35	1166.29	7.294	1.749	5-S2n	2.025	4.426	2.623	4.382	21.263	17.454
2456.00	275.16	1166.65	7.651	2.632	5-S2n	2.081	4.540	2.709	5.057	21.464	18.864
3070.00	286.30	1166.95	7.951	3.429	5-S2n	2.126	4.627	2.776	5.642	21.637	20.020
3684.00	295.74	1167.22	8.216	4.130	5-S2n	2.164	4.699	2.833	6.161	21.770	21.008
4298.00	303.92	1167.45	8.452	4.768	5-S2n	2.195	4.760	2.882	6.633	21.889	21.876
4500.00	306.26	1167.52	8.521	4.963	5-S2n	2.204	4.777	2.896	6.779	21.923	22.140
5526.00	317.48	1167.86	8.859	5.891	5-S2n	2.248	4.856	2.961	7.469	22.091	23.357
6140.00	323.41	1168.04	9.043	6.397	5-JS1f	2.270	4.897	6.000	7.845	11.438	24.004

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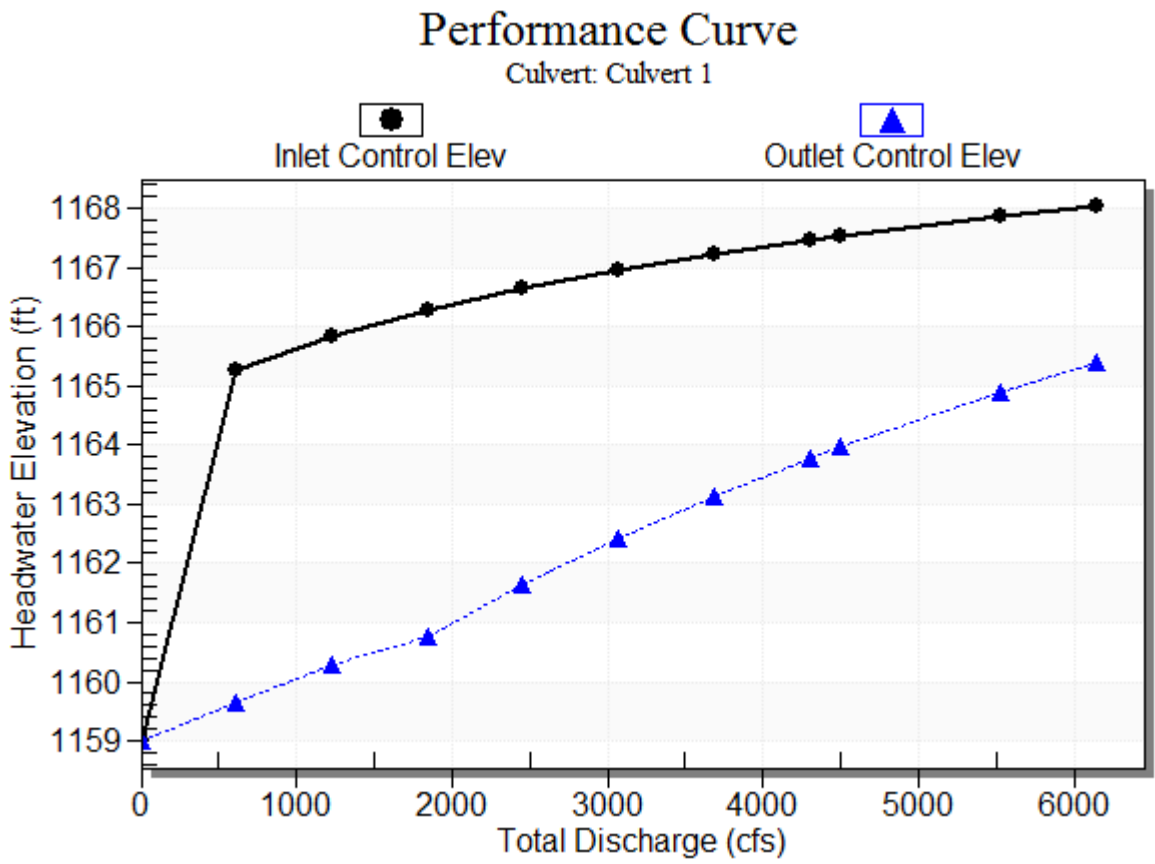
Straight Culvert

Inlet Elevation (invert): 1159.00 ft, Outlet Elevation (invert): 1154.00 ft

Culvert Length: 103.16 ft, Culvert Slope: 0.0485

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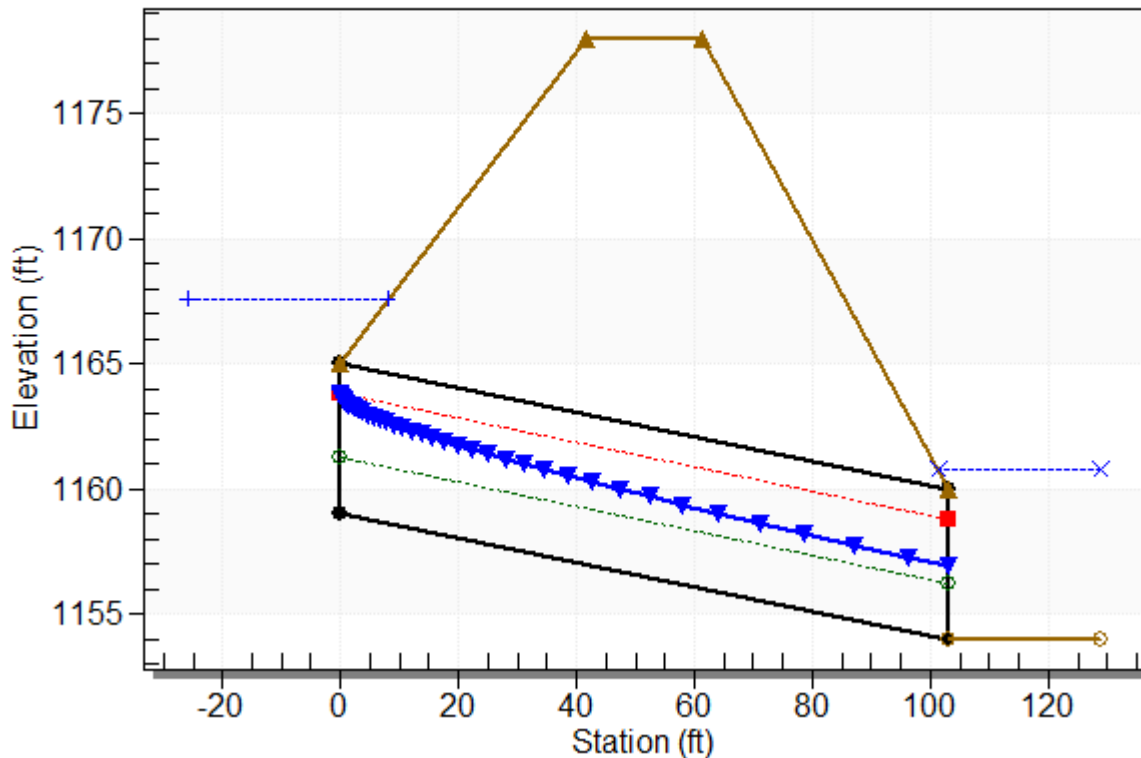
### Culvert Performance Curve Plot: Culvert 1



## Water Surface Profile Plot for Culvert: Culvert 1

Crossing - Pedestrian Crossing 1, Design Discharge - 4500.0 cfs

Culvert - Culvert 1, Culvert Discharge - 306.3 cfs



### Site Data - Culvert 1

Site Data Option: Culvert Invert Data

Inlet Station: 0.00 ft

Inlet Elevation: 1159.00 ft

Outlet Station: 103.04 ft

Outlet Elevation: 1154.00 ft

Number of Barrels: 1

### Culvert Data Summary - Culvert 1

Barrel Shape: Circular

Barrel Diameter: 6.00 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: Pedestrian Crossing 1)**

Flow (cfs)	Water Surface Elev (ft)	Depth (ft)	Velocity (ft/s)	Shear (psf)	Froude Number
0.00	1154.00	0.00	0.00	0.00	0.00
614.00	1156.47	2.47	12.81	7.48	1.64
1228.00	1157.56	3.56	15.61	10.79	1.72
1842.00	1158.38	4.38	17.45	13.26	1.77
2456.00	1159.06	5.06	18.86	15.31	1.80
3070.00	1159.64	5.64	20.02	17.07	1.83
3684.00	1160.16	6.16	21.01	18.65	1.85
4298.00	1160.63	6.63	21.88	20.07	1.86
4500.00	1160.78	6.78	22.14	20.52	1.87
5526.00	1161.47	7.47	23.36	22.60	1.89
6140.00	1161.85	7.85	24.00	23.74	1.91

### **Tailwater Channel Data - Pedestrian Crossing 1**

Tailwater Channel Option: Trapezoidal Channel

Bottom Width: 13.30 ft

Side Slope (H:V): 2.46 (1:1)

Channel Slope: 0.0485

Channel Manning's n: 0.0380

Channel Invert Elevation: 1154.00 ft

### **Roadway Data for Crossing: Pedestrian Crossing 1**

Roadway Profile Shape: Irregular Roadway Shape (coordinates)

Roadway Surface: Paved

Roadway Top Width: 20.00 ft

# HY-8 Culvert Analysis Report

## Crossing Discharge Data

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

Minimum Flow: 0 cfs

Design Flow: 4500 cfs

Maximum Flow: 6140 cfs

**Table 1 - Summary of Culvert Flows at Crossing: Northwest 1st St**

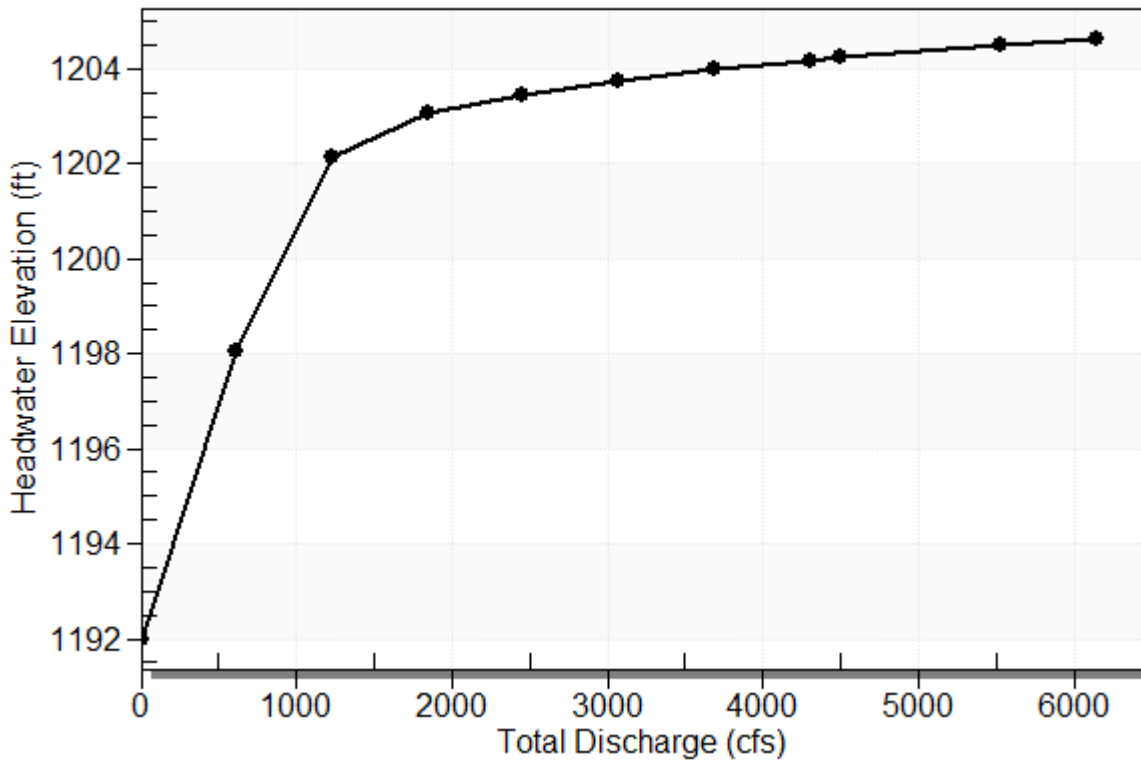
Headwater Elevation (ft)	Total Discharge (cfs)	Twin 8'x6' Box Culverts Discharge (cfs)	Roadway Discharge (cfs)	Iterations
1192.00	0.00	0.00	0.00	1
1198.05	614.00	614.00	0.00	1
1202.13	1228.00	1199.98	27.63	13
1203.07	1842.00	1302.79	539.17	4
1203.46	2456.00	1343.10	1112.23	6
1203.75	3070.00	1369.09	1697.78	5
1203.98	3684.00	1389.83	2291.74	5
1204.17	4298.00	1406.42	2887.65	4
1204.23	4500.00	1411.54	3087.48	4
1204.50	5526.00	1434.81	4090.13	4
1204.65	6140.00	1447.36	4690.08	3
1201.50	1041.84	1041.84	0.00	Overtopping



Rating Curve Plot for Crossing: Northwest 1st St

### Total Rating Curve

Crossing: Northwest 1st St



**Table 2 - Culvert Summary Table: Twin 8'x6' Box Culverts**

Total Discharge (cfs)	Culvert Discharge (cfs)	Headwater Elevation (ft)	Inlet Control Depth (ft)	Outlet Control Depth (ft)	Flow Type	Normal Depth (ft)	Critical Depth (ft)	Outlet Depth (ft)	Tailwater Depth (ft)	Outlet Velocity (ft/s)	Tailwater Velocity (ft/s)
0.00	0.00	1192.00	0.000	0.000	0-NF	0.000	0.000	0.000	0.000	0.000	0.000
614.00	614.00	1198.05	5.540	6.048	1-S1t	3.006	3.576	5.116	5.116	7.501	5.417
1228.00	1199.98	1202.13	9.997	10.191	4-FFf	6.000	5.590	6.000	6.775	12.500	6.445
1842.00	1302.79	1203.07	11.033	12.104	4-FFf	6.000	5.905	6.000	7.967	13.571	7.134
2456.00	1343.10	1203.46	11.464	13.366	4-FFf	6.000	6.000	6.000	8.930	13.991	7.667
3070.00	1369.09	1203.75	11.751	14.386	4-FFf	6.000	6.000	6.000	9.753	14.261	8.107
3684.00	1389.83	1203.98	11.983	15.271	4-FFf	6.000	6.000	6.000	10.478	14.477	8.485
4298.00	1406.42	1204.17	12.172	16.054	4-FFf	6.000	6.000	6.000	11.131	14.650	8.818
4500.00	1411.54	1204.23	12.231	16.296	4-FFf	6.000	6.000	6.000	11.333	14.703	8.920
5526.00	1434.81	1204.50	12.502	17.429	4-FFf	6.000	6.000	6.000	12.280	14.946	9.390
6140.00	1447.36	1204.65	12.649	18.046	4-FFf	6.000	6.000	6.000	12.795	15.077	9.641

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Straight Culvert

Inlet Elevation (invert): 1192.00 ft, Outlet Elevation (invert): 1191.38 ft

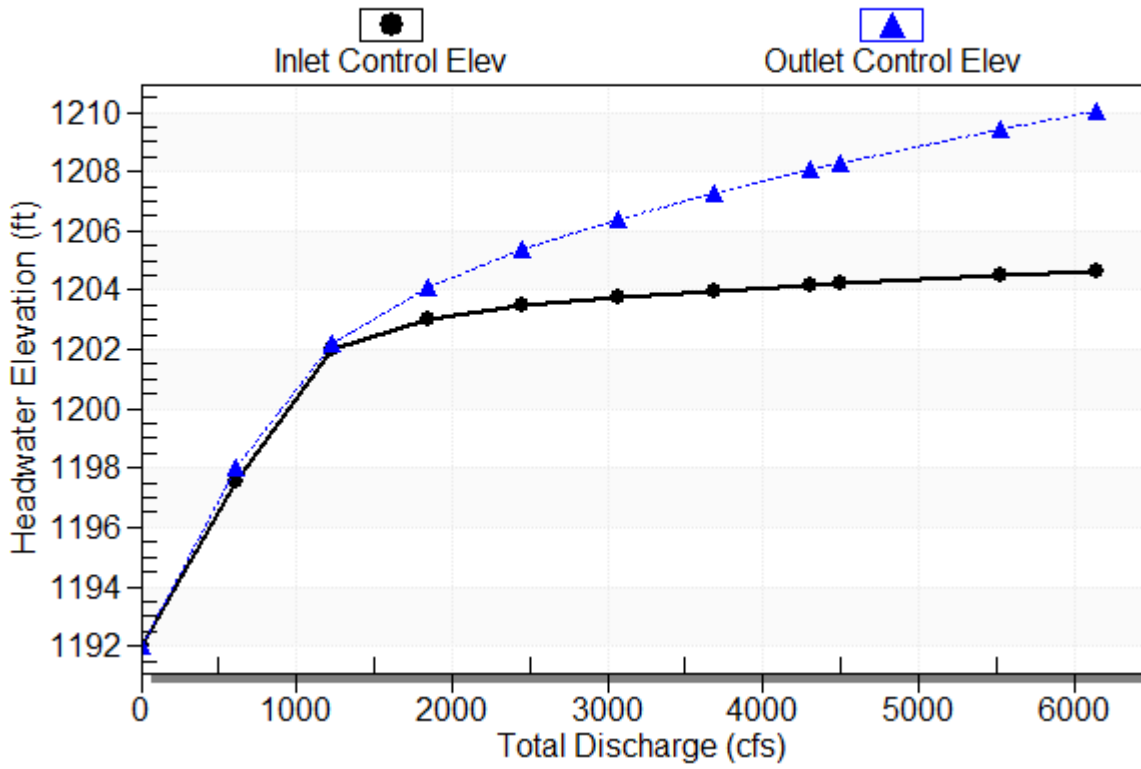
Culvert Length: 129.33 ft, Culvert Slope: 0.0048

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# Culvert Performance Curve Plot: Twin 8'x6' Box Culverts

## Performance Curve

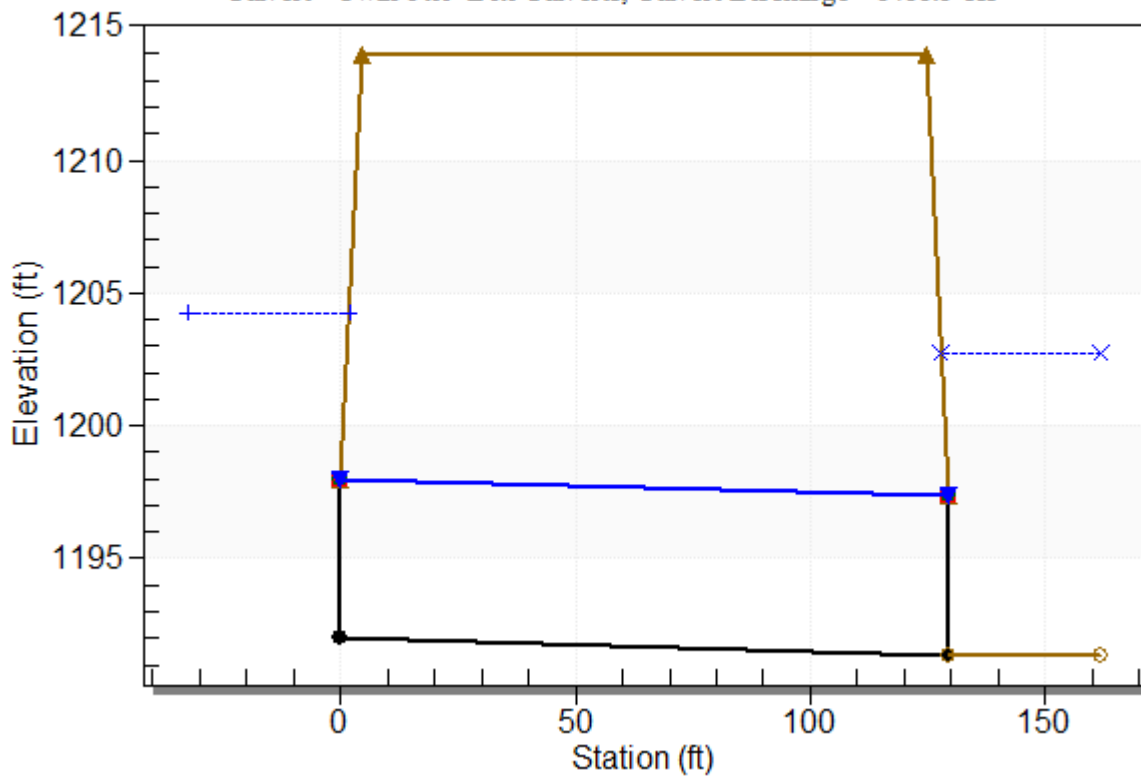
Culvert: Twin 8'x6' Box Culverts



## Water Surface Profile Plot for Culvert: Twin 8'x6' Box Culverts

Crossing - Northwest 1st St, Design Discharge - 4500.0 cfs

Culvert - Twin 8'x6' Box Culverts, Culvert Discharge - 1411.5 cfs



### Site Data - Twin 8'x6' Box Culverts

Site Data Option: Culvert Invert Data

Inlet Station: 0.00 ft

Inlet Elevation: 1192.00 ft

Outlet Station: 129.33 ft

Outlet Elevation: 1191.38 ft

Number of Barrels: 2

### Culvert Data Summary - Twin 8'x6' Box Culverts

Barrel Shape: Concrete Box

Barrel Span: 8.00 ft

Barrel Rise: 6.00 ft

Barrel Material: Concrete

Embedment: 0.00 in

Barrel Manning's n: 0.0120

Culvert Type: Straight

Inlet Configuration: Square Edge (30-75° flare) Wingwall

Inlet Depression: None

**Table 3 - Downstream Channel Rating Curve (Crossing: Northwest 1st St)**

Flow (cfs)	Water Surface Elev (ft)	Depth (ft)	Velocity (ft/s)	Shear (psf)	Froude Number
0.00	1191.38	0.00	0.00	0.00	0.00
614.00	1196.50	5.12	5.42	1.63	0.57
1228.00	1198.16	6.78	6.45	2.16	0.60
1842.00	1199.35	7.97	7.13	2.54	0.61
2456.00	1200.31	8.93	7.67	2.84	0.62
3070.00	1201.13	9.75	8.11	3.10	0.63
3684.00	1201.86	10.48	8.48	3.33	0.64
4298.00	1202.51	11.13	8.82	3.54	0.64
4500.00	1202.71	11.33	8.92	3.61	0.65
5526.00	1203.66	12.28	9.39	3.91	0.65
6140.00	1204.18	12.80	9.64	4.07	0.66

### **Tailwater Channel Data - Northwest 1st St**

Tailwater Channel Option: Trapezoidal Channel

Bottom Width: 3.75 ft

Side Slope (H:V): 3.60 (3:1)

Channel Slope: 0.0051

Channel Manning's n: 0.0380

Channel Invert Elevation: 1191.38 ft

### **Roadway Data for Crossing: Northwest 1st St**

Roadway Profile Shape: Irregular Roadway Shape (coordinates)

Roadway Surface: Paved

Roadway Top Width: 119.75 ft

# HY-8 Culvert Analysis Report

## Crossing Discharge Data

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

Minimum Flow: 0 cfs

Design Flow: 4500 cfs

Maximum Flow: 6140 cfs



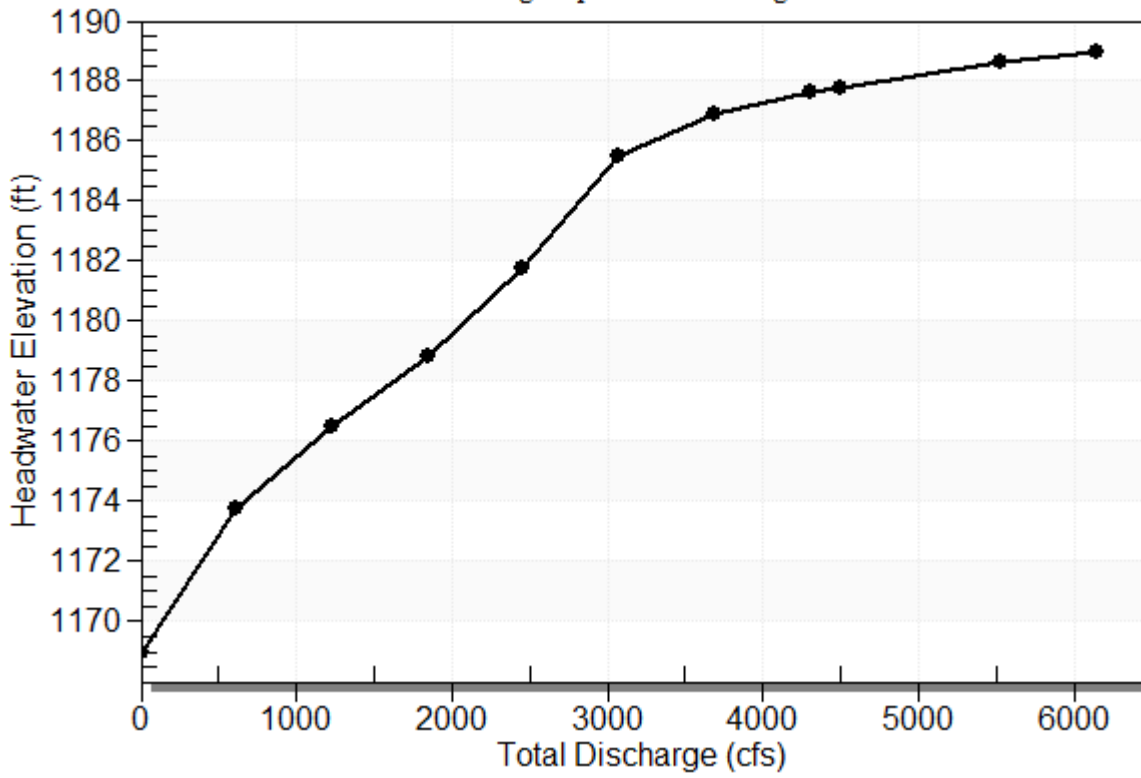
**Table 1 - Summary of Culvert Flows at Crossing: Superior St Crossing**

Headwater Elevation (ft)	Total Discharge (cfs)	Culvert 1 Discharge (cfs)	Roadway Discharge (cfs)	Iterations
1169.00	0.00	0.00	0.00	1
1173.75	614.00	614.00	0.00	1
1176.49	1228.00	1228.00	0.00	1
1178.79	1842.00	1842.00	0.00	1
1181.75	2456.00	2456.00	0.00	1
1185.47	3070.00	3070.00	0.00	1
1186.88	3684.00	3272.33	411.55	6
1187.58	4298.00	3366.95	930.89	4
1187.77	4500.00	3392.21	1107.23	4
1188.57	5526.00	3497.03	2027.82	3
1188.97	6140.00	3547.70	2591.95	4
1185.50	3074.87	3074.87	0.00	Overtopping

### Rating Curve Plot for Crossing: Superior St Crossing

## Total Rating Curve

Crossing: Superior St Crossing

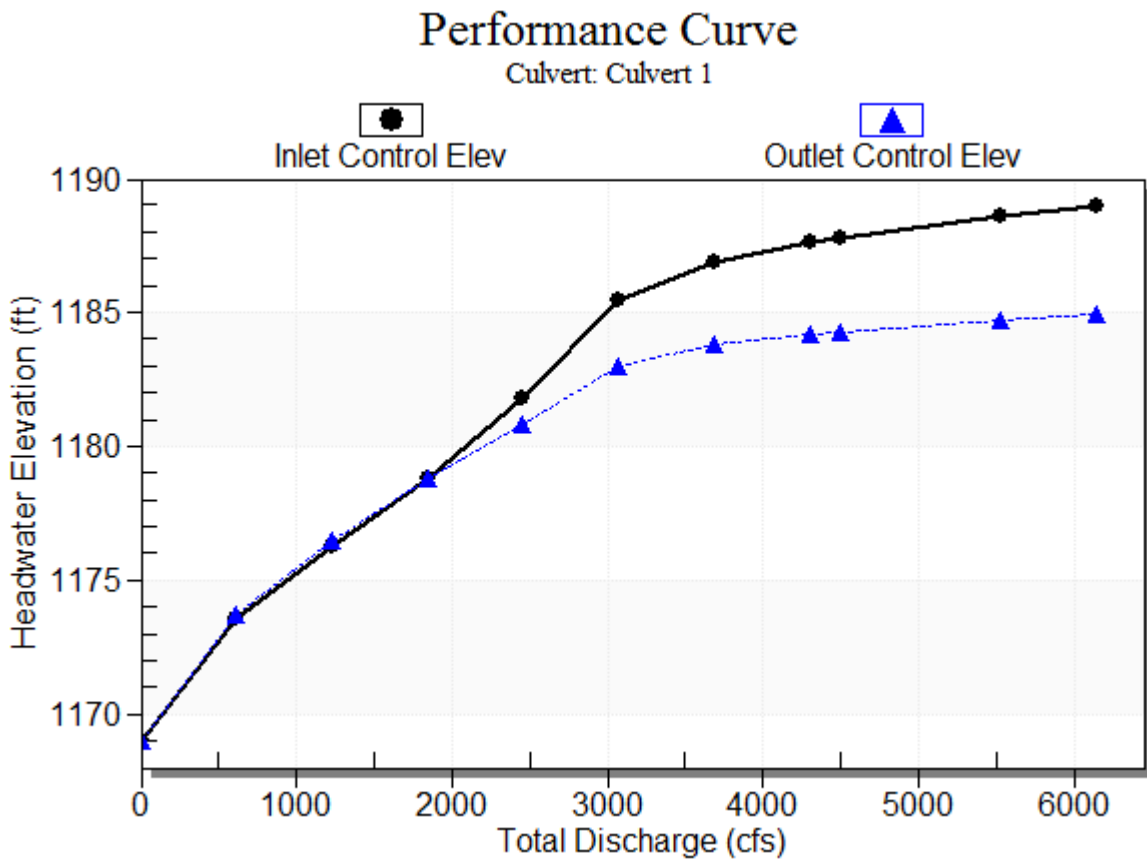


**Table 2 - Culvert Summary Table: Culvert 1**

Total Discharge (cfs)	Culvert Discharge (cfs)	Headwater Elevation (ft)	Inlet Control Depth (ft)	Outlet Control Depth (ft)	Flow Type	Normal Depth (ft)	Critical Depth (ft)	Outlet Depth (ft)	Tailwater Depth (ft)	Outlet Velocity (ft/s)	Tailwater Velocity (ft/s)
0.00	0.00	1169.00	0.000	0.000	0-NF	0.000	0.000	0.000	0.000	0.000	0.000
614.00	614.00	1173.75	4.590	4.747	2-M2c	0.000	0.000	3.566	3.566	18.732	9.843
1228.00	1228.00	1176.49	7.261	7.493	2-M2c	0.000	0.000	4.992	4.992	21.170	11.823
1842.00	1842.00	1178.79	9.793	9.783	7-M2c	0.000	0.000	6.036	6.036	22.808	13.133
2456.00	2456.00	1181.75	12.754	11.841	7-M2c	0.000	0.000	6.888	6.888	24.097	14.140
3070.00	3070.00	1185.47	16.467	13.960	7-M2c	0.000	0.000	7.619	7.619	25.185	14.969
3684.00	3272.33	1186.88	17.883	14.771	5-M1f	0.000	0.000	8.267	8.267	25.540	15.680
4298.00	3366.95	1187.58	18.579	15.168	5-M1f	0.000	0.000	8.851	8.851	25.726	16.306
4500.00	3392.21	1187.77	18.769	15.276	5-M1f	0.000	0.000	9.032	9.032	25.776	16.496
5526.00	3497.03	1188.57	19.572	15.733	5-M1f	0.000	0.000	9.883	9.883	26.000	17.377
6140.00	3547.70	1188.97	19.970	15.959	5-M1f	0.000	0.000	10.346	10.346	26.112	17.845

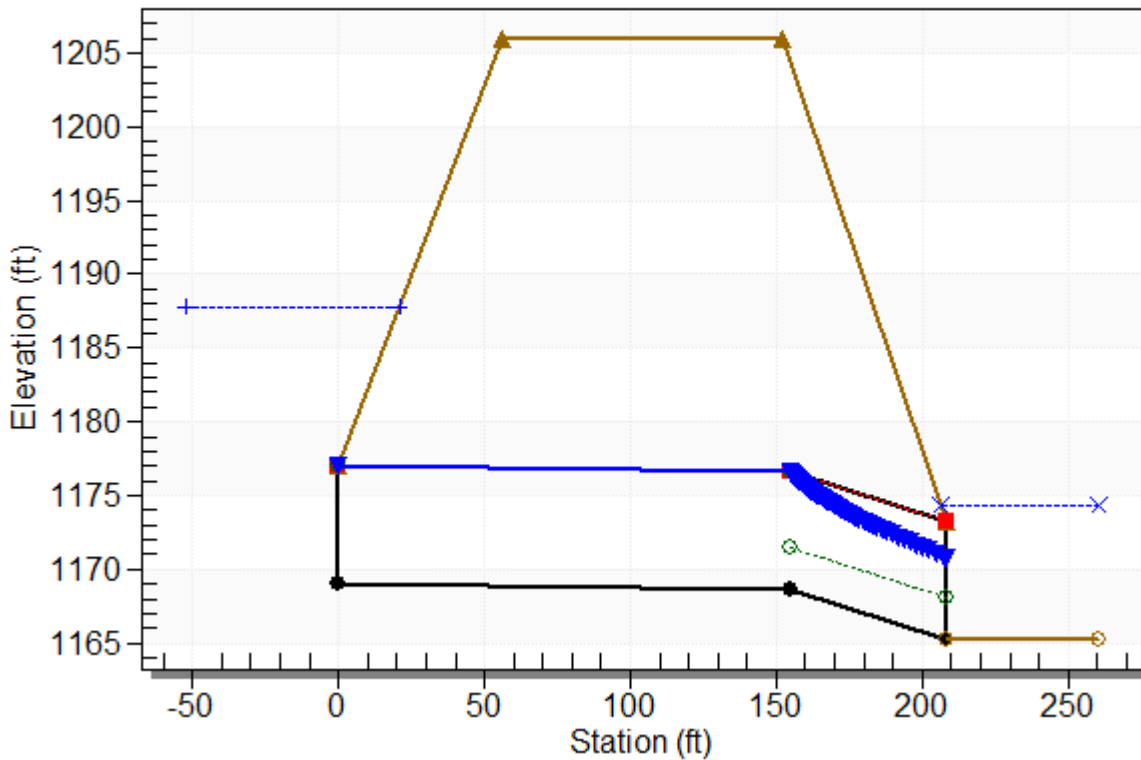
\*\*\*\*\*  
Single Broken-back Culvert  
Inlet Elevation (invert): 1169.00 ft  
Break Elevation (invert): 1168.67 ft  
Culvert Length: 208.27 ft  
Upper Culvert Section Slope: 0.0021  
Steep Culvert Section Slope: 0.0633  
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### Culvert Performance Curve Plot: Culvert 1



### Water Surface Profile Plot for Culvert: Culvert 1

Crossing - Superior St Crossing, Design Discharge - 4500.0 cfs  
Culvert - Culvert 1, Culvert Discharge - 3392.2 cfs



### Site Data - Culvert 1

Site Data Option: Culvert Invert Data

Inlet Station: 0.00 ft

Inlet Elevation: 1169.00 ft

Break Station: 155.00 ft

Break Elevation: 1168.67 ft

Outlet Station: 208.23 ft

Outlet Elevation: 1165.30 ft

Number of Barrels: 2

## **Culvert Data Summary - Culvert 1**

Barrel Shape: Concrete Box

Barrel Span: 12.00 ft

Barrel Rise: 8.00 ft

Upper Section Material: Concrete

Lower Section Material: Concrete

Embedment: 0.00 in

Upper Section Manning's n: 0.0120

Lower Section Manning's n: 0.0120

Culvert Type: Single Broken-back

Inlet Configuration: Square Edge (90°) Headwall

Inlet Depression: None

**Table 3 - Downstream Channel Rating Curve (Crossing: Superior St Crossing)**

Flow (cfs)	Water Surface Elev (ft)	Depth (ft)	Velocity (ft/s)	Shear (psf)	Froude Number
0.00	1165.30	0.00	0.00	0.00	0.00
614.00	1168.87	3.57	9.84	4.67	1.12
1228.00	1170.29	4.99	11.82	6.54	1.16
1842.00	1171.34	6.04	13.13	7.91	1.19
2456.00	1172.19	6.89	14.14	9.03	1.21
3070.00	1172.92	7.62	14.97	9.98	1.23
3684.00	1173.57	8.27	15.68	10.83	1.24
4298.00	1174.15	8.85	16.31	11.60	1.26
4500.00	1174.33	9.03	16.50	11.84	1.26
5526.00	1175.18	9.88	17.38	12.95	1.28
6140.00	1175.65	10.35	17.85	13.56	1.28



### **Tailwater Channel Data - Superior St Crossing**

Tailwater Channel Option: Trapezoidal Channel

Bottom Width: 9.20 ft

Side Slope (H:V): 2.33 (1:1)

Channel Slope: 0.0210

Channel Manning's n: 0.0380

Channel Invert Elevation: 1165.30 ft

### **Roadway Data for Crossing: Superior St Crossing**

Roadway Profile Shape: Irregular Roadway Shape (coordinates)

Roadway Surface: Paved

Roadway Top Width: 96.00 ft

# HY-8 Culvert Analysis Report

## Crossing Discharge Data

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

Minimum Flow: 0 cfs

Design Flow: 4500 cfs

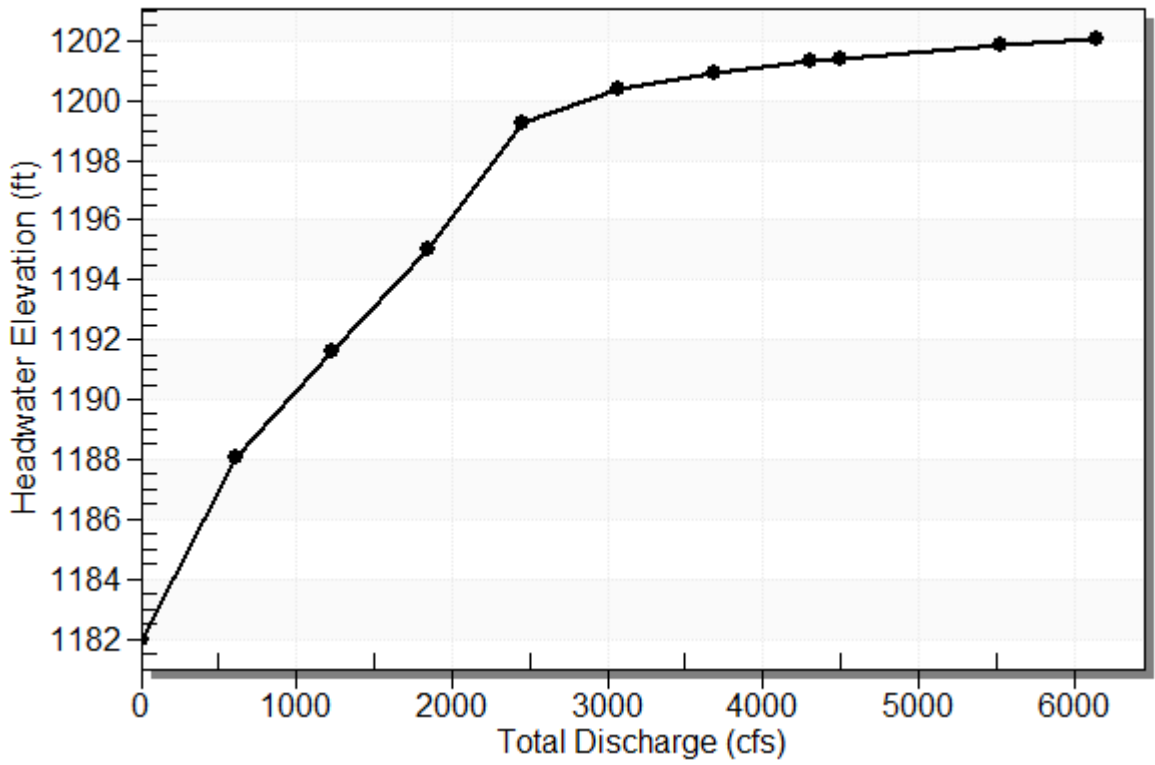
Maximum Flow: 6140 cfs

**Table 1 - Summary of Culvert Flows at Crossing: Interstate 80 Crossing**

Headwater Elevation (ft)	Total Discharge (cfs)	8'x10' Box Culverts Discharge (cfs)	Roadway Discharge (cfs)	Iterations
1182.00	0.00	0.00	0.00	1
1188.06	614.00	614.00	0.00	1
1191.58	1228.00	1228.00	0.00	1
1195.04	1842.00	1842.00	0.00	1
1199.21	2456.00	2451.79	3.96	13
1200.41	3070.00	2602.01	467.59	7
1200.92	3684.00	2664.02	1019.51	5
1201.29	4298.00	2708.08	1589.34	5
1201.40	4500.00	2720.33	1777.45	4
1201.86	5526.00	2773.09	2750.56	4
1202.09	6140.00	2799.19	3338.14	4
1199.00	2424.18	2424.18	0.00	Overtopping

Rating Curve Plot for Crossing: Interstate 80 Crossing

Total Rating Curve  
Crossing: Interstate 80 Crossing



**Table 2 - Culvert Summary Table: 8'x10' Box Culverts**

Total Discharge (cfs)	Culvert Discharge (cfs)	Headwater Elevation (ft)	Inlet Control Depth (ft)	Outlet Control Depth (ft)	Flow Type	Normal Depth (ft)	Critical Depth (ft)	Outlet Depth (ft)	Tailwater Depth (ft)	Outlet Velocity (ft/s)	Tailwater Velocity (ft/s)
0.00	0.00	1182.00	0.000	0.000	0-NF	0.000	0.000	0.000	0.000	0.000	0.000
614.00	614.00	1188.06	6.060	2.094	1-S2n	2.521	3.576	2.688	3.862	14.278	5.904
1228.00	1228.00	1191.58	9.580	5.294	1-S2n	4.193	5.677	4.519	5.264	16.985	7.054
1842.00	1842.00	1195.04	13.040	9.216	5-S2n	5.734	7.439	6.164	6.278	18.677	7.820
2456.00	2451.79	1199.21	17.211	14.278	5-S2n	7.206	9.001	7.692	7.100	19.922	8.411
3070.00	2602.01	1200.41	18.406	15.329	5-S2n	7.563	9.365	8.057	7.803	20.185	8.899
3684.00	2664.02	1200.92	18.920	15.778	5-S2n	7.710	9.513	8.206	8.424	20.290	9.318
4298.00	2708.08	1201.29	19.293	16.101	5-S2n	7.814	9.618	8.312	8.984	20.363	9.687
4500.00	2720.33	1201.40	19.398	16.192	5-S2n	7.843	9.647	8.341	9.157	20.383	9.800
5526.00	2773.09	1201.86	19.856	16.580	5-S2n	7.967	9.771	8.467	9.970	20.469	10.320
6140.00	2799.19	1202.09	20.086	17.189	5-JS1f	8.029	9.832	10.000	10.412	17.495	10.597

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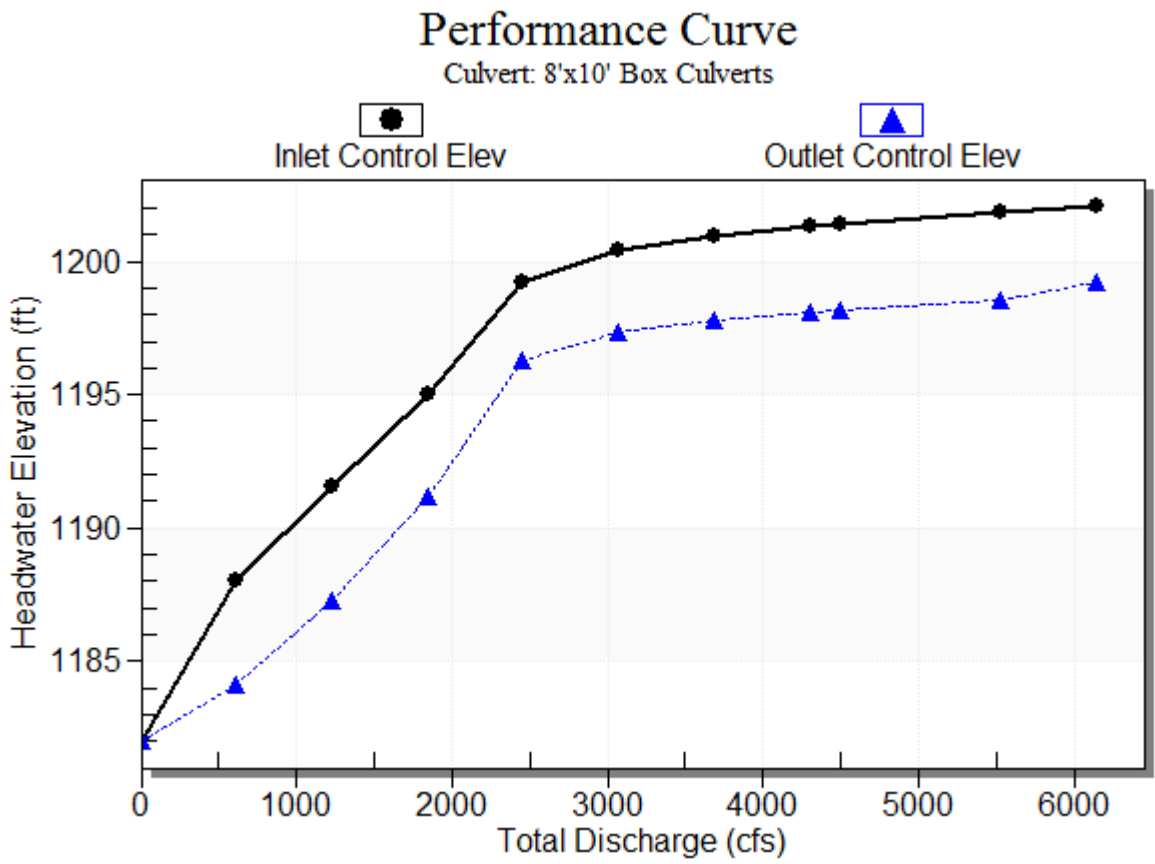
Straight Culvert

Inlet Elevation (invert): 1182.00 ft, Outlet Elevation (invert): 1179.89 ft

Culvert Length: 270.01 ft, Culvert Slope: 0.0078

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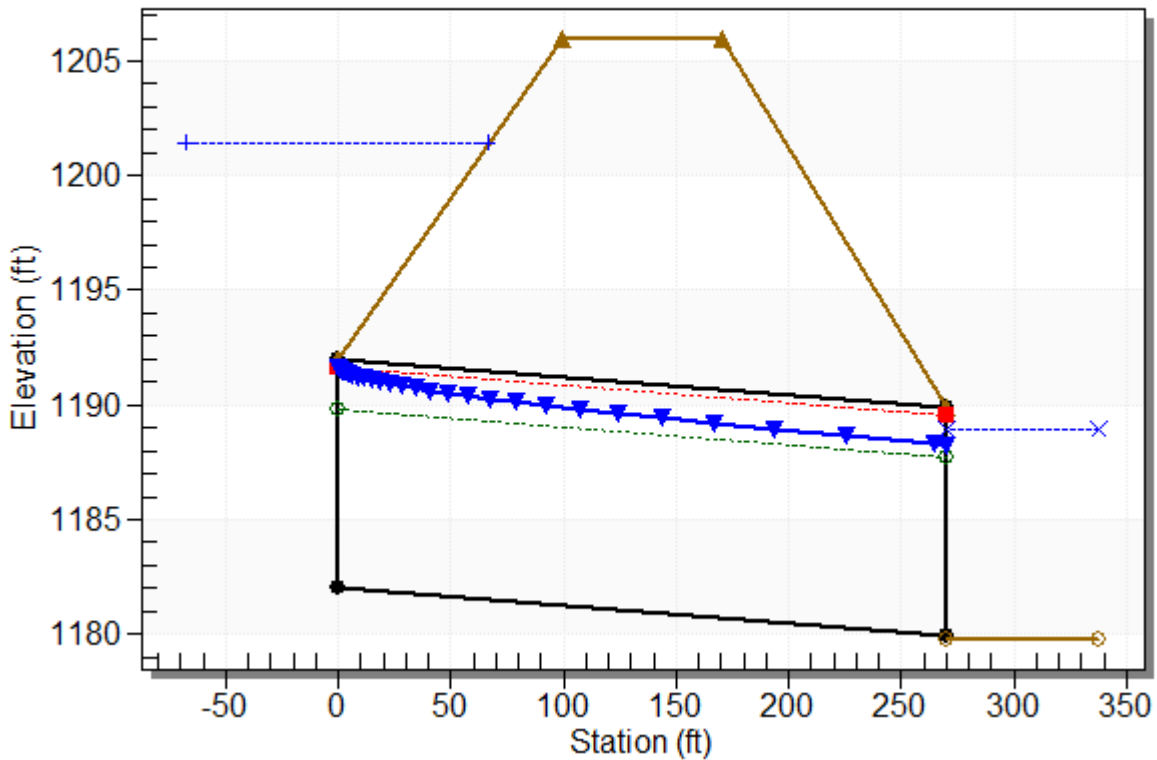
### Culvert Performance Curve Plot: 8'x10' Box Culverts



## Water Surface Profile Plot for Culvert: 8'x10' Box Culverts

Crossing - Interstate 80 Crossing, Design Discharge - 4500.0 cfs

Culvert - 8'x10' Box Culverts, Culvert Discharge - 2720.3 cfs



### Site Data - 8'x10' Box Culverts

Site Data Option: Culvert Invert Data

Inlet Station: 0.00 ft

Inlet Elevation: 1182.00 ft

Outlet Station: 270.00 ft

Outlet Elevation: 1179.89 ft

Number of Barrels: 2

### Culvert Data Summary - 8'x10' Box Culverts

Barrel Shape: Concrete Box

Barrel Span: 8.00 ft

Barrel Rise: 10.00 ft

Barrel Material: Concrete

Embedment: 0.00 in

Barrel Manning's n: 0.0120

Culvert Type: Straight

Inlet Configuration: Square Edge (90°) Headwall

Inlet Depression: None



**Table 3 - Downstream Channel Rating Curve (Crossing: Interstate 80 Crossing)**

Flow (cfs)	Water Surface Elev (ft)	Depth (ft)	Velocity (ft/s)	Shear (psf)	Froude Number
0.00	1179.80	0.00	0.00	0.00	0.00
614.00	1183.66	3.86	5.90	1.78	0.68
1228.00	1185.06	5.26	7.05	2.43	0.71
1842.00	1186.08	6.28	7.82	2.90	0.72
2456.00	1186.90	7.10	8.41	3.28	0.74
3070.00	1187.60	7.80	8.90	3.60	0.75
3684.00	1188.22	8.42	9.32	3.89	0.76
4298.00	1188.78	8.98	9.69	4.15	0.76
4500.00	1188.96	9.16	9.80	4.23	0.77
5526.00	1189.77	9.97	10.32	4.60	0.78
6140.00	1190.21	10.41	10.60	4.81	0.78

### **Tailwater Channel Data - Interstate 80 Crossing**

Tailwater Channel Option: Trapezoidal Channel

Bottom Width: 10.00 ft

Side Slope (H:V): 4.38 (1:1)

Channel Slope: 0.0074

Channel Manning's n: 0.0380

Channel Invert Elevation: 1179.80 ft

### **Roadway Data for Crossing: Interstate 80 Crossing**

Roadway Profile Shape: Irregular Roadway Shape (coordinates)

Roadway Surface: Paved

Roadway Top Width: 72.00 ft

# HY-8 Culvert Analysis Report

## Crossing Discharge Data

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

Minimum Flow: 0 cfs

Design Flow: 4500 cfs

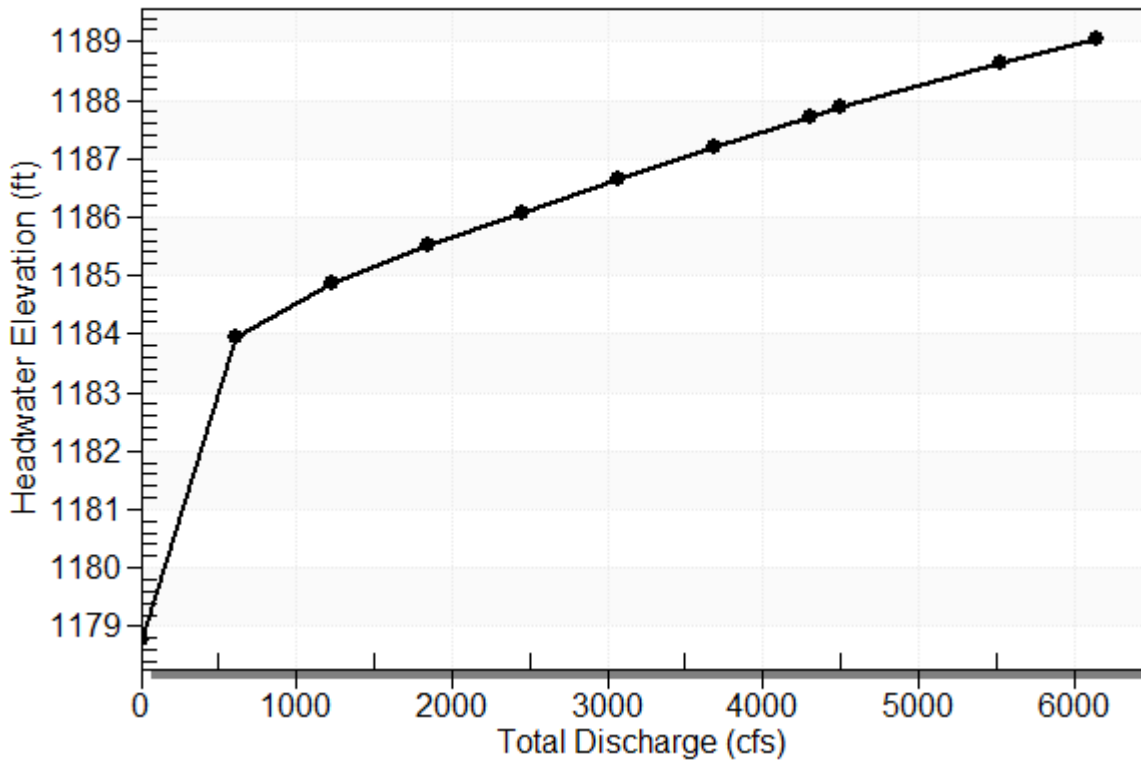
Maximum Flow: 6140 cfs

**Table 1 - Summary of Culvert Flows at Crossing: Pedestrian Crossing 2**

Headwater Elevation (ft)	Total Discharge (cfs)	8'x2' Box Culvert Discharge (cfs)	Roadway Discharge (cfs)	Iterations
1178.79	0.00	0.00	0.00	1
1183.94	614.00	160.40	453.33	4
1184.87	1228.00	178.51	1049.14	3
1185.50	1842.00	189.38	1653.51	3
1186.08	2456.00	198.66	2258.58	6
1186.66	3070.00	207.65	2871.26	12
1187.21	3684.00	215.75	3478.36	8
1187.71	4298.00	223.02	4064.99	6
1187.88	4500.00	225.34	4295.68	11
1188.64	5526.00	235.75	5290.24	5
1189.06	6140.00	241.25	5932.70	7
1181.40	91.29	91.29	0.00	Overtopping

### Rating Curve Plot for Crossing: Pedestrian Crossing 2

Total Rating Curve  
Crossing: Pedestrian Crossing 2



**Table 2 - Culvert Summary Table: 8'x2' Box Culvert**

Total Discharge (cfs)	Culvert Discharge (cfs)	Headwater Elevation (ft)	Inlet Control Depth (ft)	Outlet Control Depth (ft)	Flow Type	Normal Depth (ft)	Critical Depth (ft)	Outlet Depth (ft)	Tailwater Depth (ft)	Outlet Velocity (ft/s)	Tailwater Velocity (ft/s)
0.00	0.00	1178.79	0.000	0.000	0-NF	0.000	0.000	0.000	0.000	0.000	0.000
614.00	160.40	1183.94	5.153	6.129	4-FFf	1.668	2.000	2.000	3.926	10.025	4.376
1228.00	178.51	1184.87	6.076	8.028	4-FFf	1.794	2.000	2.000	5.283	11.157	5.218
1842.00	189.38	1185.50	6.713	9.359	4-FFf	1.869	2.000	2.000	6.261	11.836	5.780
2456.00	198.66	1186.08	7.287	10.469	4-FFf	1.931	2.000	2.000	7.053	12.416	6.215
3070.00	207.65	1186.66	7.868	11.468	4-FFf	2.000	2.000	2.000	7.729	12.978	6.574
3684.00	215.75	1187.21	8.415	12.367	4-FFf	2.000	2.000	2.000	8.326	13.485	6.882
4298.00	223.02	1187.71	8.923	13.186	4-FFf	2.000	2.000	2.000	8.863	13.939	7.153
4500.00	225.34	1187.88	9.089	13.445	4-FFf	2.000	2.000	2.000	9.030	14.084	7.236
5526.00	235.75	1188.64	9.853	14.649	4-FFf	2.000	2.000	2.000	9.810	14.734	7.619
6140.00	241.25	1189.06	10.271	15.305	4-FFf	2.000	2.000	2.000	10.234	15.078	7.823

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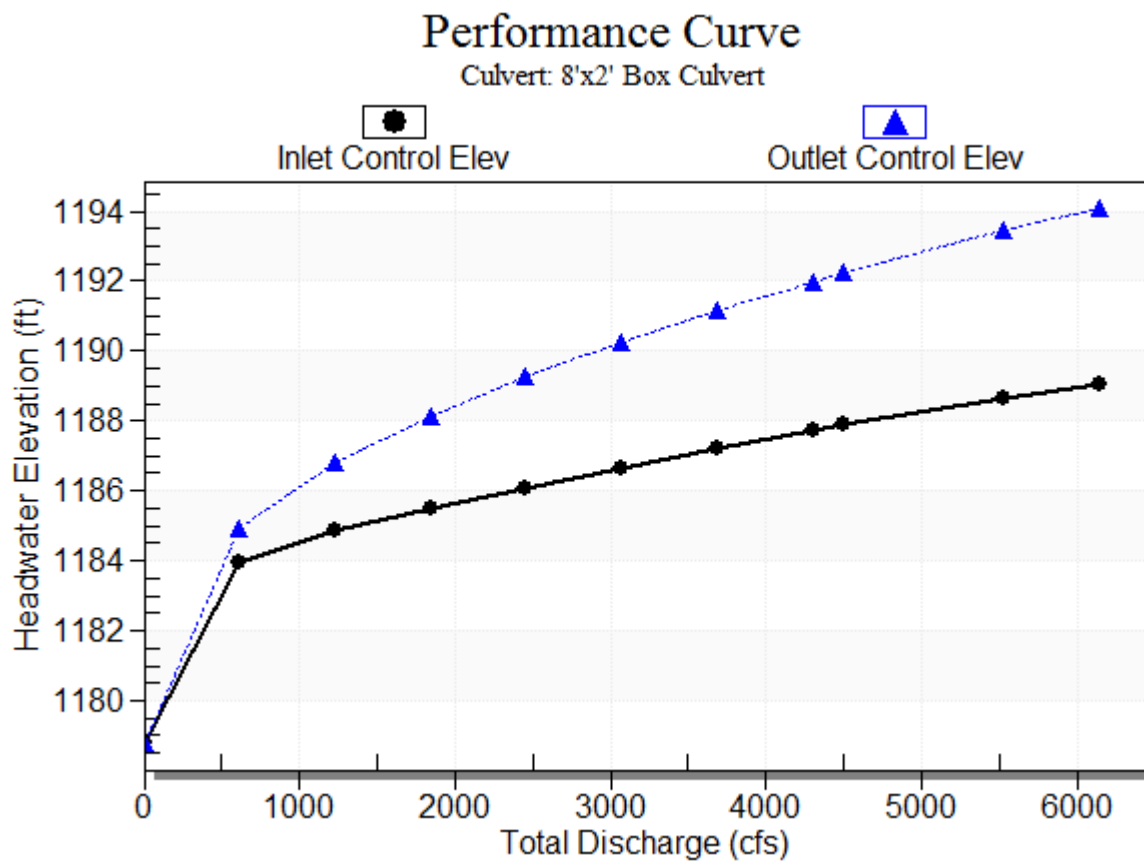
Straight Culvert

Inlet Elevation (invert): 1178.79 ft, Outlet Elevation (invert): 1178.72 ft

Culvert Length: 10.00 ft, Culvert Slope: 0.0070

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### Culvert Performance Curve Plot: 8'x2' Box Culvert

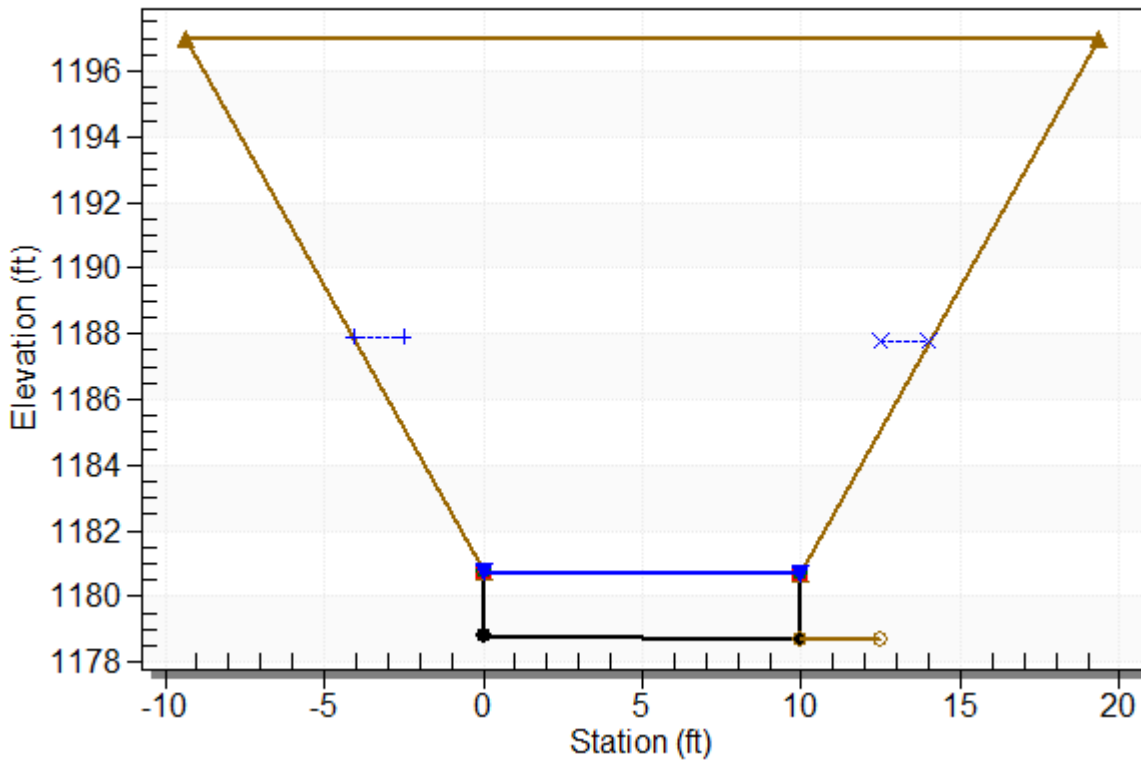




## Water Surface Profile Plot for Culvert: 8'x2' Box Culvert

Crossing - Pedestrian Crossing 2, Design Discharge - 4500.0 cfs

Culvert - 8'x2' Box Culvert, Culvert Discharge - 225.3 cfs



### Site Data - 8'x2' Box Culvert

Site Data Option: Culvert Invert Data

Inlet Station: 0.00 ft

Inlet Elevation: 1178.79 ft

Outlet Station: 10.00 ft

Outlet Elevation: 1178.72 ft

Number of Barrels: 1

### Culvert Data Summary - 8'x2' Box Culvert

Barrel Shape: Concrete Box

Barrel Span: 8.00 ft

Barrel Rise: 2.00 ft

Barrel Material: Concrete

Embedment: 0.00 in

Barrel Manning's n: 0.0120

Culvert Type: Straight

Inlet Configuration: Square Edge (30-75° flare) Wingwall

Inlet Depression: None

**Table 3 - Downstream Channel Rating Curve (Crossing: Pedestrian Crossing 2)**

Flow (cfs)	Water Surface Elev (ft)	Depth (ft)	Velocity (ft/s)	Shear (psf)	Froude Number
0.00	1178.72	0.00	0.00	0.00	0.00
614.00	1182.65	3.93	4.38	1.03	0.51
1228.00	1184.00	5.28	5.22	1.38	0.53
1842.00	1184.98	6.26	5.78	1.64	0.55
2456.00	1185.77	7.05	6.21	1.85	0.56
3070.00	1186.45	7.73	6.57	2.03	0.56
3684.00	1187.05	8.33	6.88	2.18	0.57
4298.00	1187.58	8.86	7.15	2.32	0.58
4500.00	1187.75	9.03	7.24	2.37	0.58
5526.00	1188.53	9.81	7.62	2.57	0.58
6140.00	1188.95	10.23	7.82	2.68	0.59

## **Tailwater Channel Data - Pedestrian Crossing 2**

Tailwater Channel Option: Trapezoidal Channel

Bottom Width: 10.24 ft

Side Slope (H:V): 6.49 (1:1)

Channel Slope: 0.0042

Channel Manning's n: 0.0380

Channel Invert Elevation: 1178.72 ft

## **Roadway Data for Crossing: Pedestrian Crossing 2**

Roadway Profile Shape: Irregular Roadway Shape (coordinates)

Roadway Surface: Paved

Roadway Top Width: 28.65 ft

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