Cold Stream starts at Northern Ave in Farmingdale and flows south, eventually ending north of Route 126 in West Gardiner and flowing into the Cobbosseecontee Stream. The Flood Insurance Study for Kennebec County did not determine base flood elevations for Cold Stream at the existing culvert. The discharges were estimated by using Peak flow regression equations for small, ungaged streams in Maine (SIR 2015-4059).

SUMMARY

Drainage Area	3.7	mi^2
Q1.1	58.7	ft^3/s
Q10	234.7	ft^3/s
Q50	356.4	ft^3/s
Q100	417.4	ft^3/s
Q500	558.4	ft^3/s

Reported by: Nash, Kendra
Date: March 17, 2020

The existing culvert carries Cold Stream below High Street in West Gardiner. When this culvert was constructed in 1955, the extreme high water had been at the top of the previous road, which was raised approximately 2 feet at the stream crossing. On September 18th, 2019, the stream was moving slowly with a depth of about 2 feet, which is an elevation of approximately 164', just a little higher than the Q1.1 flood elevation. On July 14, 2017, during a field inspection, the bottom of the stream could be seen due to the low water on the upstream side (see Appendix B).

The proposed culvert will be embedded into the stream by placing the proposed culvert bottom about 17 inches below the streambed thalweg on the upstream side and about 24 inches below the streambed on the downstream thalweg side. Embedding the culvert will create a push bar downstream, so that the downstream will act like a weir. The weir will help maintain the water depth at all flow conditions, and this will maintain fish passage. Embedding a culvert into a stream only works in low gradient streams, like Cold Stream. A riprap apron will be placed in the stream, which will lock in the streambed elevation and prevent downcutting. The riprap apron should consist of plain riprap washed in with granular borrow to fill the voids. The bottom channel consists mainly of gravel. The channel has little to no grade.

The hydraulics of the existing and proposed culverts were evaluated using HY-8 7.60 software. The proposed culvert is a precast concrete box culvert. The complete HY-8 reports for the existing culvert and the box culvert are provided in Appendix E.

Below is a list of parameters used in the hydraulic model for the stream and for the existing culvert. The results of the analysis for the existing culvert are summarized at the end of this section. The downstream slope of 0.7% was used in the model, which was measured from the Microstation survey of the stream. Increasing or decreasing the downstream slope to 7% and 0.07% respectively have little to no effect on the flood elevations and tailwater velocities.

<u>Stream</u>

- Cross Section: Irregular; survey data was used to input stations and elevations of 29 points that represent the downstream.
- Downstream Slope: 0.007
- Downstream Invert Elevation: 160'

<u>Culvert</u>

- Single span steel structural plate arch on timber grillage: 17'-0" span by 7'-2" rise
- Pipe Length: 58'-0"
- Straight Culvert with Mitered Ends
- Manning's n: 0.035 Top/sides
  0.012 Bottom

- Inlet Elevation: 162.25’
- Outlet Elevation: 162.00’

Below is a list of parameters used in the hydraulic model for the proposed culvert. The results of the analysis for the proposed culvert are summarized at the end of this section.

Concrete Box Culvert

- 18’ Span by 7’ Rise
- Culvert Length: 70’
- Straight Culvert with 0° flare Wingwall
- Manning’s n: 0.012
- Inlet Elevation: 160.64’
- Outlet Elevation: 160.46’

SUMMARY

		Existing Structure	Recommended Structure
		Steel Arch on Timber Grillage 17'-0" Span by 7'-2" Rise	Precast Concrete Box Culvert 18'-0" Span by 7'-0" Rise
Total Area of Waterway Opening	ft^2	92	126
Headwater elevation @ $Q_{1.1}$	ft	163.6	162
Headwater elevation @ Q_{10}	ft	165.7	163.8
Headwater elevation @ Q_{25}	ft	166.3	164.4
Headwater elevation @ Q_{50}	ft	166.7	164.8
Headwater elevation @ Q_{100}	ft	167.2	165.2
Headwater elevation @ Q_{500}	ft	168.4	166.2
Culvert Freeboard @ $Q_{1.1}$	ft	5.9	5.6
Culvert Freeboard @ Q_{50}	ft	2.8	2.8
Culvert Freeboard @ Q_{100}	ft	2.3	2.4
Outlet Velocity @ $Q_{1.1}$	ft/s	5.0	2.4
Outlet Velocity @ Q_{10}	ft/s	7.8	5.1
Outlet Velocity @ Q_{25}	ft/s	8.6	5.9
Outlet Velocity @ Q_{50}	ft/s	9.1	6.4
Outlet Velocity @ Q_{100}	ft/s	9.6	7
Outlet Velocity @ Q_{500}	ft/s	10.8	8.3

Reported by: Nash, Kendra
Date: July 6, 2020

Note: All elevations based on North American Vertical Datum (NAVD) of 1988.

WIN:	23090.00	**Project Name:**	West Gardiner Gosline Br
Town:	West Gardiner	**Stream Name:**	Cold Stream
Route No.	High Street	**Bridge Name:**	Gosline
Asset ID:	2321	**Analysis by:**	CSH
Lat:	44.22623 **Long:** 69.84547	**Date:**	1/3/2020

Peak Flow Calculations by USGS Regression Equations (Hodgkins, 1999 & Lombard/Hodgkins, 2015)

Enter data in blue cells only!

ver. 2018 Jul 09

	km^2	mi^2	ac	*Enter data in [mi^2]*
A	9.58	3.70	2368.0	Watershed Area *DRNAREA*
W	1.18	0.5	292.0	Wetlands area (by NWI)
P_c	432756	4900073		watershed centroid (E, N; UTM 19N; meters)
County	Kennebec			*choose county from drop-down menu*
pptA				mean annual precipitation (inches; by look-up)
A (km^2)	9.58	**Conf Lvl**	0.67	
W (%)	12.33			NWI Wetlands % *STORNWI*

Worksheet prepared by:
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Environmental Office
Maine Dept. Transportation
Augusta, ME 04333-0016
207-557-1052
Charles.Hebson@maine.gov

References:

Hodgkins, G.A., 1999.
Estimating the magnitude of peak flows for streams in Maine for selected recurrence intervals
WRIR 99-4008, USGS Augusta, ME

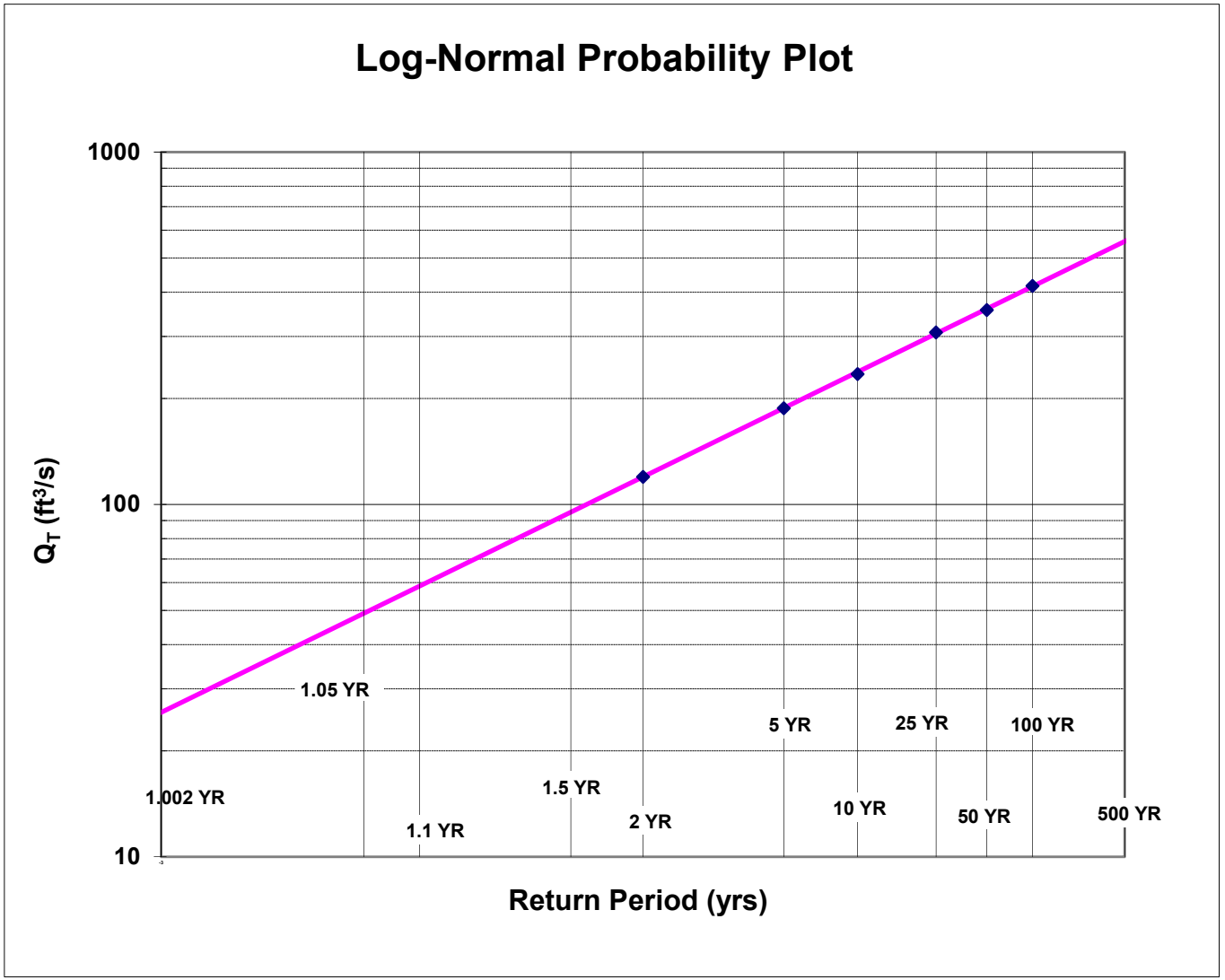
Watershed Characteristics for Monthly & Daily Flows

EAVG	264.8	mean basin elevation (ft)
SLOPE	6.64	mean basin slope (%)
EMAX	468.2	maximum basin elevation (ft)
WATER	0	percent of drainage basin land cover classified as open water
PRECIP	43.2	mean annual precipitation
SG	0.00	sand & gravel aquifer as decimal fraction of watershed A
HGA	2	mean basin percentage of hydrological soil group A
DIST	59.00	distance from the coast (mi)

Ret Pd T (yr)	Peak Flow Estimate Lower	Q_T (m^3/s)	Upper	Q_T (ft^3/s)
1.1		1.66		58.7
2		3.39		119.8
5		5.32		187.8
10		6.65		234.7
25		8.72		307.7
50		10.09		356.4
100		11.82		417.4
500		15.81		558.4

Lombard, P.J. & G.A. Hodgkins, 2015.
Peak flow regression equations for small, ungaged streams in Maine - Comparing map-based to field-based variables
SIR 2015-4059, USGS, Augusta, ME

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


Log-Normal Probability Plot
1000
100
10
Q_T (ft³/s)
1.05 YR
5 YR
25 YR
100 YR
1.002 YR
1.5 YR
10 YR
1.1 YR
2 YR
50 YR
500 YR
Return Period (yrs)

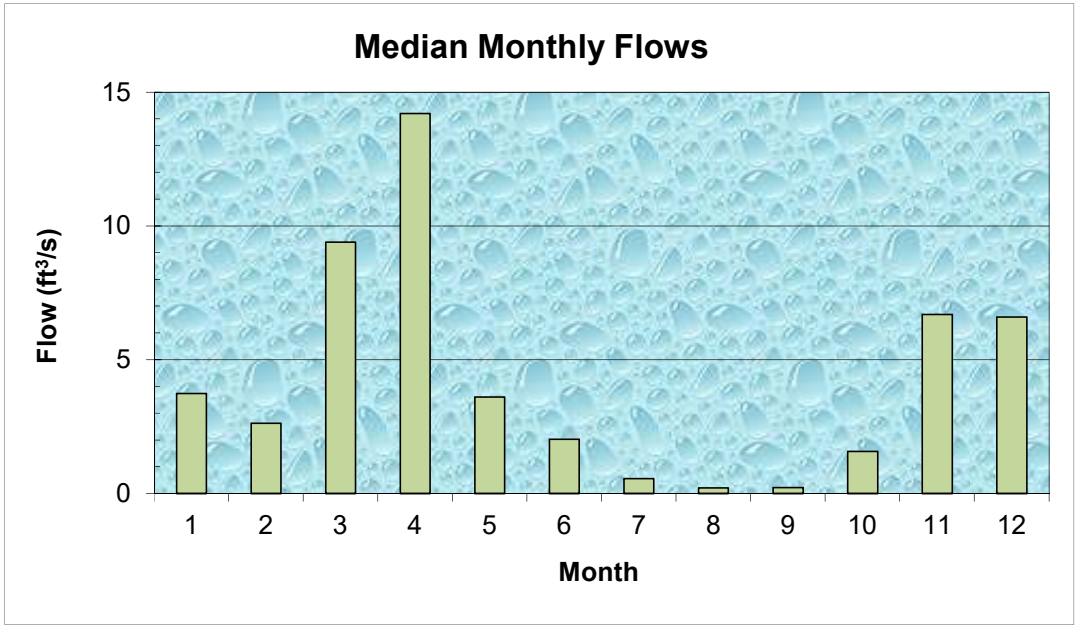
WIN:	23090.00	**Project Name:**	West Gardiner Gosline Br
Town:	West Gardiner	**Stream Name:**	Cold Stream
Route No.	High Street	**Bridge Name:**	Gosline
Asset ID:	2321	**Analysis by:**	CSH
Lat:	44.22623 **Long:** 69.84547	**Date:**	1/3/2020

DO NOT ENTER ANY DATA ON THIS PAGE; EVERYTHING IS CALCULATED

MAINE MONTHLY MEDIAN FLOWS and HYDRAULIC GEOMETRY BY USGS REGRESSION EQUATIONS (2004, 2013, 2015)

	Value	Variable	Explanation
	3.70	*A*	Area (mi^2)
432756	4900073	P_c	Watershed centroid (E,N; UTM; Zone 19; meters)
	58.46	*DIST*	Distance from Coastal reference line (mi)
	43.2	*pptA*	Mean Annual Precipitation (inches)
	0.00	*SG*	Sand & Gravel Aquifer (decimal fraction of watershed area)

Month	Q_{median} (ft3/s)	(m^3/s)
Jan	**3.74**	0.1061
Feb	**2.62**	0.0743
Mar	**9.40**	0.2664
Apr	**14.20**	0.4025
May	**3.61**	0.1022
Jun	**2.03**	0.0575
Jul	**0.56**	0.0159
Aug	**0.21**	0.0059
Sep	**0.22**	0.0063
Oct	**1.57**	0.0445
Nov	**6.70**	0.1899
Dec	**6.60**	0.1869



Q_{bf}	**20.5**	
ann avg	**8.0**	
ann med	**3.3**	
$Q_{1.002}$	**25.7**	
$Q_{1.01}$	**34.5**	
$Q_{1.05}$	**49.1**	
Q_{bf}	**68.8**	assume v = 4ft/s

W_{bf}	**18.6**	estimated bankfull width (ft)
d_{bf}	**0.9**	estimated bankfull depth (ft)
A_{bf}	**14.0**	estimated bankfull flow area (ft^2)

References

Dudley, R.W., 2013. FY2013 Progress Report - Phase 1 …, USFWS QRP Project

Dudley, R.W., 2004. Estimating Monthly Streamflows … , SIR 2004-5026

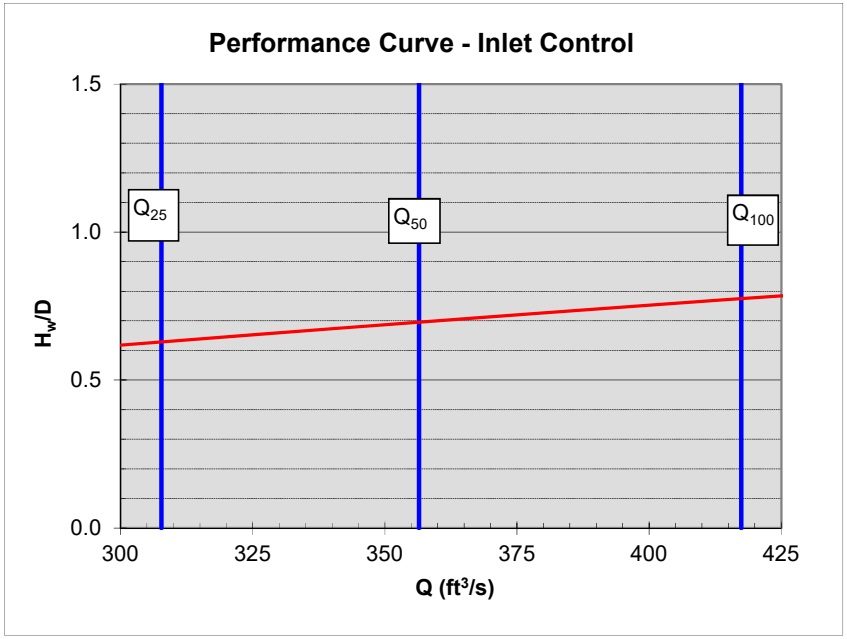
Dudley, R.W., 2015. Regression Equations for Monthly and Annual Mean..., USGS SIR 2015-515

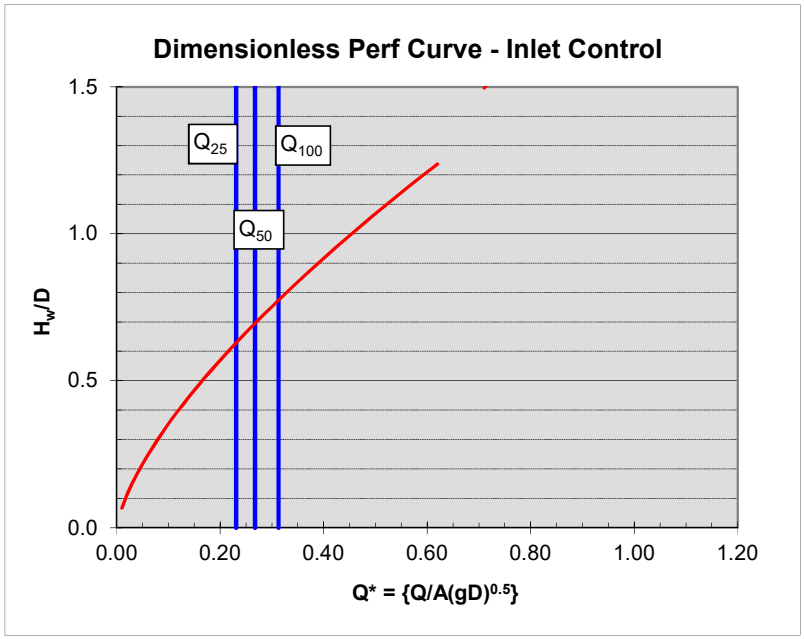
NOTE: ***This page is for preliminary sizing only.***
Final design should be done with HY8 or HDS-5

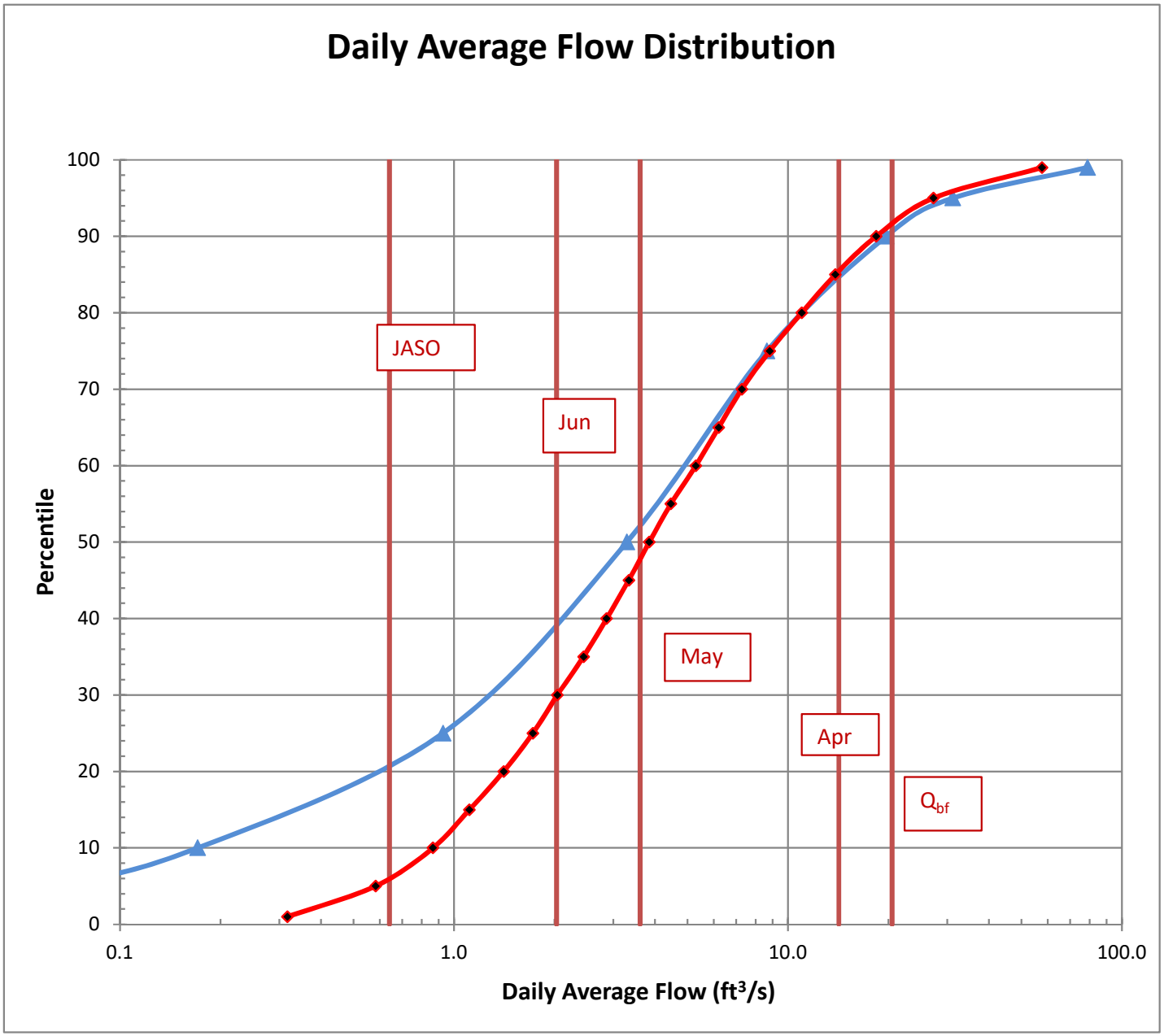
Preliminary Culvert Sizing - Round & Box Culverts

Shape:	Box						
Type:	Box 0 ww		Q_{25}	307.7			
D or R (ft)	6		Q_{50}	356.4	trial D / R =	8.7	
w (ft)	*16*	*box width*	Q_{100}	417.4	trial w: BFW =	18.6	
Slope (ft/ft)	0.02						
A (ft^2)	96.00						
g (ft/s^2)	32.2						

Note:
culvert dimensions are for open flow area; adjust for lost capacity due to embedding / backfilling (min {2' / 25% rise} embedment)





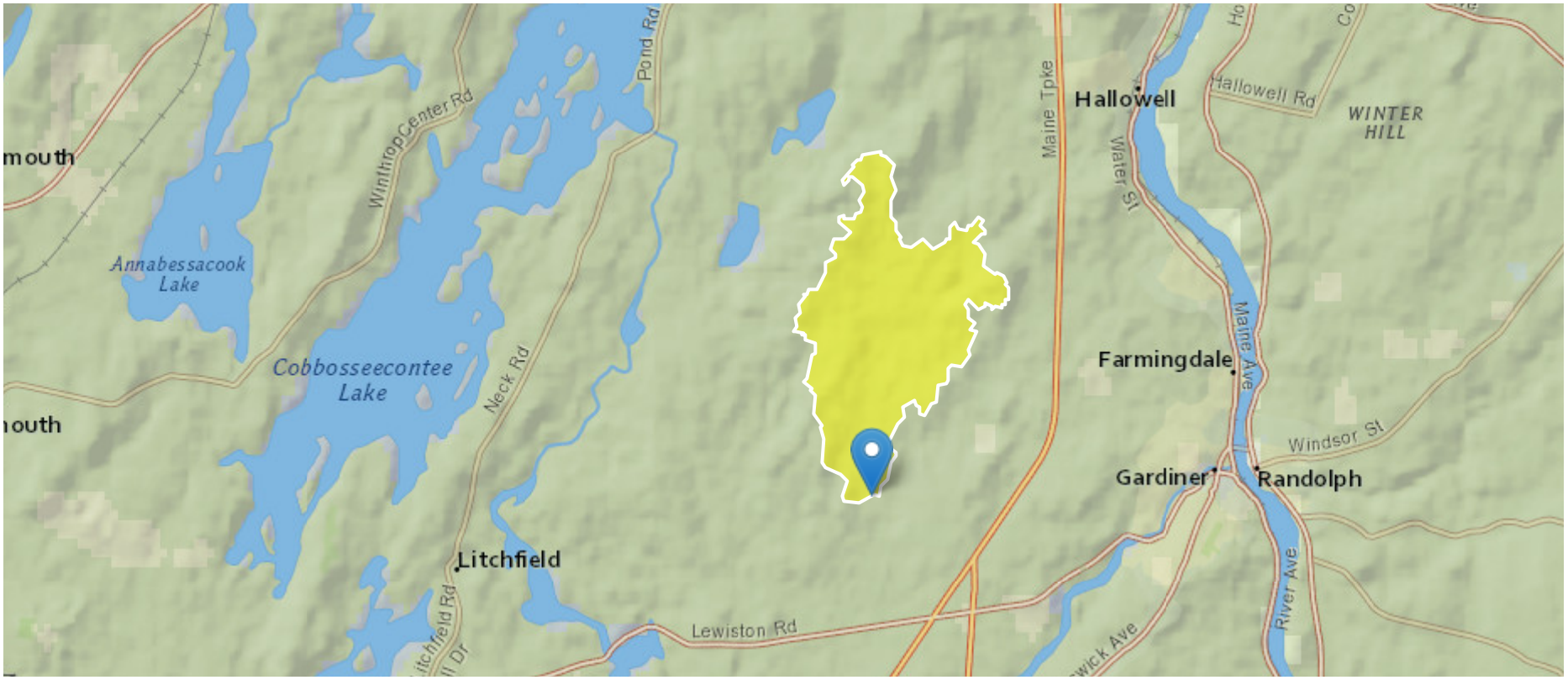


Daily Avg Flow Dist		
A_{ws} = (mi^2)		3.7
Q (ft^3/s)		
Pctl	Median	84th pctl
1	0.32	0.56
5	0.58	0.94
10	0.87	1.30
15	1.11	1.62
20	1.41	1.97
25	1.72	2.31
30	2.04	2.63
35	2.44	3.01
40	2.86	3.46
45	3.34	3.91
50	3.84	4.61
55	4.46	5.37
60	5.30	6.30
65	6.20	7.34
70	7.27	8.57
75	8.82	10.30
80	11.00	12.30
85	13.88	15.76
90	18.38	21.17
95	27.28	32.92
99	57.69	75.95

Q_{bf}	20.5
$Q_{1.002}$	25.7
$Q_{1.1}$	58.7
Q_2	119.8

W Gardiner 23090 Gosline Bridge - High St @ Cold Stream

Region ID: ME
Workspace ID: ME20190903172954997000
Clicked Point (Latitude, Longitude): 44.22623, -69.84547
Time: 2019-09-03 13:30:12 -0400



Basin Characteristics

Parameter Code	Parameter Description	Value	Unit
DRNAREA	Area that drains to a point on a stream	3.7	square miles
STORNWI	Percentage of storage (combined water bodies and wetlands) from the National Wetlands Inventory	12.33	percent
SANDGRAVAF	Fraction of land surface underlain by sand and gravel aquifers	0	dimensionless
ELEV	Mean Basin Elevation	264.8	feet
BSLDEM10M	Mean basin slope computed from 10 m DEM	6.64	percent
CENTROIDX	Basin centroid horizontal (x) location in state plane coordinates	432756.08	feet
CENTROIDY	Basin centroid vertical (y) location in state plane units	4900072.95	feet
COASTDIST	Shortest distance from the coastline to the basin centroid	59	miles
ELEVMAX	Maximum basin elevation	468.2	feet
LC06WATER	Percent of open water, class 11, from NLCD 2006	0	percent
LC11DEV	Percentage of developed (urban) land from NLCD 2011 classes 21-24	4.53	percent
LC11IMP	Average percentage of impervious area determined from NLCD 2011 impervious dataset	0.7	percent
PRECIP	Mean Annual Precipitation	43.2	inches
SANDGRAVAP	Percentage of land surface underlain by sand and gravel aquifers	0	percent
STATSGOA	Percentage of area of Hydrologic Soil Type A from STATSGO	2	percent

Bankfull Statistics Parameters[Central and Coastal Bankfull 2004 5042]

Parameter Code	Parameter Name	Value	Units	Min Limit	Max Limit
DRNAREA	Drainage Area	3.7	square miles	2.92	298

Bankfull Statistics Flow Report[Central and Coastal Bankfull 2004 5042]

Statistic	Value	Unit
Bankfull Streamflow	20.5	ft^3/s
Bankfull Width	15.1	ft
Bankfull Depth	0.927	ft
Bankfull Area	14	ft^2

Bankfull Statistics Citations

Dudley, R.W.,2004, Hydraulic-Geometry Relations for Rivers in Coastal and Central Maine: U.S. Geological Survey Scientific Investigations Report 2004-5042, 30 p (http://pubs.usgs.gov/sir/2004/5042/pdf/sir2004-5042.pdf)

Peak-Flow Statistics Parameters[Statewide Peak Flow DA LT 12sqmi 2015 5049]

Parameter Code	Parameter Name	Value	Units	Min Limit	Max Limit
DRNAREA	Drainage Area	3.7	square miles	0.31	12
STORNWI	Percentage of Storage from NWI	12.33	percent	0	22.2

Peak-Flow Statistics Flow Report[Statewide Peak Flow DA LT 12sqmi 2015 5049]

PIl: Prediction Interval-Lower, PIu: Prediction Interval-Upper, SEp: Standard Error of Prediction, SE: Standard Error (other -- see report)

Statistic	Value	Unit	SEp
1.01 Year Peak Flood	35.7	ft^3/s	38
2 Year Peak Flood	120	ft^3/s	34
5 Year Peak Flood	188	ft^3/s	35
10 Year Peak Flood	234	ft^3/s	37
25 Year Peak Flood	308	ft^3/s	39

Statistic	Value	Unit	SEp
50 Year Peak Flood	356	ft^3/s	41
100 Year Peak Flood	417	ft^3/s	42
250 Year Peak Flood	468	ft^3/s	44
500 Year Peak Flood	558	ft^3/s	47

Peak-Flow Statistics Citations

Lombard, P.J., and Hodgkins, G.A.,2015, Peak flow regression equations for small, ungaged streams in Maine— Comparing map-based to field-based variables: U.S. Geological Survey Scientific Investigations Report 2015–5049, 12 p. (http://dx.doi.org/10.3133/sir20155049)

Flow-Duration Statistics Parameters[Statewide Annual SIR 2015 5151]

Parameter Code	Parameter Name	Value	Units	Min Limit	Max Limit
DRNAREA	Drainage Area	3.7	square miles	14.9	1419
SANDGRAVAF	Fraction of Sand and Gravel Aquifers	0	dimensionless	0	0.212
ELEV	Mean Basin Elevation	264.8	feet	239	2120

Flow-Duration Statistics Disclaimers[Statewide Annual SIR 2015 5151]

One or more of the parameters is outside the suggested range. Estimates were extrapolated with unknown errors

Flow-Duration Statistics Flow Report[Statewide Annual SIR 2015 5151]

Statistic	Value	Unit
1 Percent Duration	0.00891	ft^3/s
5 Percent Duration	0.0591	ft^3/s

Statistic	Value	Unit
10 Percent Duration	0.171	ft^3/s
25 Percent Duration	0.927	ft^3/s
50 Percent Duration	3.29	ft^3/s
75 Percent Duration	8.65	ft^3/s
90 Percent Duration	19.7	ft^3/s
95 Percent Duration	31.1	ft^3/s
99 Percent Duration	78.9	ft^3/s

Flow-Duration Statistics Citations

Dudley, R.W.,2015, Regression equations for monthly and annual mean and selected percentile streamflows for ungaged rivers in Maine: U.S. Geological Survey Scientific Investigations Report 2015–5151, 35 p. (http://dx.doi.org/10.3133/sir20155151)

Annual Flow Statistics Parameters[Statewide Annual SIR 2015 5151]

Parameter Code	Parameter Name	Value	Units	Min Limit	Max Limit
DRNAREA	Drainage Area	3.7	square miles	14.9	1419
SANDGRAVAF	Fraction of Sand and Gravel Aquifers	0	dimensionless	0	0.212
ELEV	Mean Basin Elevation	264.8	feet	239	2120

Annual Flow Statistics Disclaimers[Statewide Annual SIR 2015 5151]

One or more of the parameters is outside the suggested range. Estimates were extrapolated with unknown errors

Annual Flow Statistics Flow Report[Statewide Annual SIR 2015 5151]

Statistic	Value	Unit
Mean Annual Flow	8.04	ft^3/s

Annual Flow Statistics Citations

Dudley, R.W.,2015, Regression equations for monthly and annual mean and selected percentile streamflows for ungaged rivers in Maine: U.S. Geological Survey Scientific Investigations Report 2015–5151, 35 p. (http://dx.doi.org/10.3133/sir20155151)

Application Version: 4.3.8

HY-8 Culvert Analysis Report

Crossing Discharge Data

Discharge Selection Method: User Defined

Table 1 - Summary of Culvert Flows at Crossing: Existing Culvert

Headwater Elevation (ft)	Discharge Names	Total Discharge (cfs)	Existing Culvert Discharge (cfs)	Roadway Discharge (cfs)	Iterations
163.59	Q1.1	58.70	58.70	0.00	1
164.42	Q2	119.80	119.80	0.00	1
165.19	Q5	187.80	187.80	0.00	1
165.68	Q10	234.70	234.70	0.00	1
166.31	Q25	307.70	307.70	0.00	1
166.72	Q50	356.40	356.40	0.00	1
167.24	Q100	417.40	417.40	0.00	1
168.39	Q500	558.40	558.40	0.00	1
172.00	Overtopping	920.93	920.93	0.00	Overtopping

Table 2 - Culvert Summary Table: Existing Culvert

Discharge Names	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)
Q1.1	58.70	58.70	163.59	1.339	0.482	1-S2n	0.694	0.721	0.697	1.848	5.013	2.499
Q2	119.80	119.80	164.42	2.167	0.961	1-S2n	1.155	1.162	1.155	2.362	6.217	3.072
Q5	187.80	187.80	165.19	2.943	2.913	2-M2c	1.628	1.570	1.570	2.775	7.224	3.537
Q10	234.70	234.70	165.68	3.430	3.372	2-M2c	1.947	1.823	1.823	3.017	7.815	3.787
Q25	307.70	307.70	166.31	4.057	4.043	2-M2c	2.445	2.188	2.188	3.343	8.606	4.126
Q50	356.40	356.40	166.72	4.458	4.469	2-M2c	2.792	2.415	2.415	3.540	9.077	4.319
Q100	417.40	417.40	167.24	4.960	4.987	2-M2c	3.244	2.682	2.682	3.768	9.634	4.533
Q500	558.40	558.40	168.39	6.099	6.137	2-M2c	4.480	3.259	3.259	4.206	10.782	5.011

****

Straight Culvert

Inlet Elevation (invert): 162.25 ft, Outlet Elevation (invert): 162.00 ft

Culvert Length: 58.00 ft, Culvert Slope: 0.0043

****

Site Data - Existing Culvert

Site Data Option: Culvert Invert Data

Inlet Station: 0.00 ft

Inlet Elevation: 162.25 ft

Outlet Station: 58.00 ft

Outlet Elevation: 162.00 ft

Number of Barrels: 1

Culvert Data Summary - Existing Culvert

Barrel Shape: Arch, Open Bottom

Barrel Span: 17.00 ft

Barrel Rise: 7.17 ft

Barrel Material: Corrugated Steel

Embedment: 0.00 in

Barrel Manning's n: 0.0350 (top and sides)

Manning's n: 0.0120 (bottom)

Culvert Type: Straight

Inlet Configuration: Mitered to Conform to Slope

Inlet Depression: None

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

Flow (cfs)	Water Surface Elev (ft)	Depth (ft)	Velocity (ft/s)	Shear (psf)	Froude Number
58.70	161.85	1.85	2.50	0.81	0.47
119.80	162.36	2.36	3.07	1.03	0.49
187.80	162.78	2.78	3.54	1.21	0.51
234.70	163.02	3.02	3.79	1.32	0.52
307.70	163.34	3.34	4.13	1.46	0.53
356.40	163.54	3.54	4.32	1.55	0.54
417.40	163.77	3.77	4.53	1.65	0.54
558.40	164.21	4.21	5.01	1.84	0.57

Tailwater Channel Data - Existing Culvert

Tailwater Channel Option: Irregular Channel

Channel Slope: 0.0070

User Defined Channel Cross-Section:

Coord No.	Station (ft)	Elevation (ft)	Manning's n
1	0.00	175.00	0.0350
2	11.83	174.00	0.0350
3	20.85	173.00	0.0350
4	29.07	172.00	0.0350
5	44.83	171.00	0.0350
6	52.13	170.00	0.0350
7	55.01	169.00	0.0350
8	57.80	168.00	0.0350
9	59.47	167.00	0.0350
10	61.20	166.00	0.0350
11	63.02	165.00	0.0350
12	69.83	164.00	0.0450
13	71.99	163.00	0.0450
14	74.07	162.00	0.0450
15	76.24	161.00	0.0450
16	78.86	160.00	0.0450
17	84.52	160.00	0.0450
18	86.37	161.00	0.0450
19	103.69	162.00	0.0450
20	109.48	163.00	0.0450
21	113.91	164.00	0.0350
22	117.37	165.00	0.0350
23	120.14	166.00	0.0350
24	122.91	167.00	0.0350
25	125.68	168.00	0.0350
26	128.77	169.00	0.0350
27	133.46	170.00	0.0350
28	177.51	170.00	0.0350
29	199.27	169.00	0.0000

Roadway Data for Crossing: Existing Culvert

Roadway Profile Shape: Irregular Roadway Shape (coordinates)

Irregular Roadway Cross-Section:

Coord No.	Station (ft)	Elevation (ft)
0	0.00	174.00
1	37.00	173.00
2	76.00	172.00

Roadway Surface: Paved

Roadway Top Width: 22.00 ft

HY-8 Culvert Analysis Report

Crossing Discharge Data

Discharge Selection Method: User Defined

Table 1 - Summary of Culvert Flows at Crossing: Proposed Culvert

Headwater Elevation (ft)	Discharge Names	Total Discharge (cfs)	Proposed Culvert Discharge (cfs)	Roadway Discharge (cfs)	Iterations
162.04	Q1.1	58.70	58.70	0.00	1
162.75	Q2	119.80	119.80	0.00	1
163.40	Q5	187.80	187.80	0.00	1
163.81	Q10	234.70	234.70	0.00	1
164.40	Q25	307.70	307.70	0.00	1
164.77	Q50	356.40	356.40	0.00	1
165.22	Q100	417.40	417.40	0.00	1
166.21	Q500	558.40	558.40	0.00	1
172.00	Overtopping	1452.74	1452.74	0.00	Overtopping

Table 2 - Culvert Summary Table: Proposed Culvert

Discharge Names	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)
Q1.1	58.70	58.70	162.04	1.172	1.398	3-M1t	0.693	0.691	1.388	1.848	2.350	2.499
Q2	119.80	119.80	162.75	1.886	2.112	1-S1t	1.082	1.112	1.902	2.362	3.500	3.072
Q5	187.80	187.80	163.40	2.545	2.761	1-S1t	1.437	1.501	2.315	2.775	4.507	3.537
Q10	234.70	234.70	163.81	2.953	3.167	1-S1t	1.656	1.741	2.557	3.017	5.099	3.787
Q25	307.70	307.70	164.40	3.535	3.755	1-S1t	1.972	2.086	2.883	3.343	5.929	4.126
Q50	356.40	356.40	164.77	3.874	4.128	1-S1t	2.169	2.301	3.080	3.540	6.429	4.319
Q100	417.40	417.40	165.22	4.284	4.578	1-S1t	2.404	2.556	3.308	3.768	7.009	4.533
Q500	558.40	558.40	166.21	5.186	5.573	1-S1t	2.913	3.103	3.746	4.206	8.281	5.011

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Straight Culvert

Inlet Elevation (invert): 160.64 ft, Outlet Elevation (invert): 160.46 ft

Culvert Length: 70.00 ft, Culvert Slope: 0.0026

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Site Data - Proposed Culvert

Site Data Option: Culvert Invert Data

Inlet Station: 0.00 ft

Inlet Elevation: 160.64 ft

Outlet Station: 70.00 ft

Outlet Elevation: 160.46 ft

Number of Barrels: 1

Culvert Data Summary - Proposed Culvert

Barrel Shape: Concrete Box

Barrel Span: 18.00 ft

Barrel Rise: 7.00 ft

Barrel Material: Concrete

Embedment: 0.00 in

Barrel Manning's n: 0.0120

Culvert Type: Straight

Inlet Configuration: Square Edge (0º flare) Wingwall

Inlet Depression: None

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

Flow (cfs)	Water Surface Elev (ft)	Depth (ft)	Velocity (ft/s)	Shear (psf)	Froude Number
58.70	161.85	1.85	2.50	0.81	0.47
119.80	162.36	2.36	3.07	1.03	0.49
187.80	162.78	2.78	3.54	1.21	0.51
234.70	163.02	3.02	3.79	1.32	0.52
307.70	163.34	3.34	4.13	1.46	0.53
356.40	163.54	3.54	4.32	1.55	0.54
417.40	163.77	3.77	4.53	1.65	0.54
558.40	164.21	4.21	5.01	1.84	0.57

Tailwater Channel Data - Proposed Culvert

Tailwater Channel Option: Irregular Channel

Channel Slope: 0.0070

User Defined Channel Cross-Section:

Coord No.	Station (ft)	Elevation (ft)	Manning's n
1	0.00	175.00	0.0350
2	11.83	174.00	0.0350
3	20.85	173.00	0.0350
4	29.07	172.00	0.0350
5	44.83	171.00	0.0350
6	52.13	170.00	0.0350
7	55.01	169.00	0.0350
8	57.80	168.00	0.0350
9	59.47	167.00	0.0350
10	61.20	166.00	0.0350
11	63.02	165.00	0.0350
12	69.83	164.00	0.0450
13	71.99	163.00	0.0450
14	74.07	162.00	0.0450
15	76.24	161.00	0.0450
16	78.86	160.00	0.0450
17	84.52	160.00	0.0450
18	86.37	161.00	0.0450
19	103.69	162.00	0.0450
20	109.48	163.00	0.0450
21	113.91	164.00	0.0350
22	117.37	165.00	0.0350
23	120.14	166.00	0.0350
24	122.91	167.00	0.0350
25	125.68	168.00	0.0350
26	128.77	169.00	0.0350
27	133.46	170.00	0.0350
28	177.51	170.00	0.0350
29	199.27	169.00	0.0000

Roadway Data for Crossing: Proposed Culvert

Roadway Profile Shape: Irregular Roadway Shape (coordinates)

Irregular Roadway Cross-Section:

Coord No.	Station (ft)	Elevation (ft)
0	0.00	174.00
1	37.00	173.00
2	76.00	172.00

Roadway Surface: Paved

Roadway Top Width: 22.00 ft