

Mays Bridge (#2527) carries Route 189 (County Road) over Mays Brook in Lubec, Maine.

The drainage basin characteristics for this culvert/ buried bridge were provided by the Maine DOT Environmental Group, Hydrology Section. Peak flows were calculated with techniques described in the United States Geological Survey (USGS) Water-Resources Investigations Report 99-4008 (Hodgkins, 1999 & Lombard/Hodgkins, 2015). These are shown in the table below. The bridge is located in an inland region, and Mays Brook has no tidal influence at this location.

The watershed area for this project is small at 2.30 square miles with 0.1 square miles of wetlands. The watershed is located primarily to the south and west of the bridge location. Mays Brook flows northerly into the Atlantic Ocean.

<u>Return Period (yr.)</u>	<u>Flow (ft³/s)</u>
1.1	48
2	100
5	159
10	201
25	263
50	309
100	361
500	489

The hydrology report indicates a bankfull width (BFW) of 11.8 feet. However, at the project kickoff meeting, the project team indicated that a BFW of 20' was measured at the bridge site. The proposed structure will be designed considering the 20' BFW. The proposed structure is to have a span of at least 1.2*BFW (24 ft).

At the project kickoff meeting on 4/28/2017, it was determined that Habitat Connectivity Design (HCD) is to be incorporated into this project due to the new Programmatic Biological Opinion (PBO) with the US Fish and Wildlife Service that was approved in January 2017. Before learning of this requirement, this project's scoping agreement had been finalized, and survey information had already been obtained. Neither of these included the extra resources, or additional information, that is needed to complete HCD.

Therefore, this hydraulic study is based on the available information, and acknowledges that additional design elements developed during Habitat Connectivity Design may require revision of the proposed hydraulic model. See the following for information that needs to be acquired or developed to complete the HCD component of design.

HABITAT CONNECTIVITY DESIGN (HCD)

Training on HCD provided by MaineDOT in June 2017 indicates that there is a great deal of information to acquire and develop for this project. The typical HCD design process involves looking at many elements of fluvial geomorphology "to preserve the essentials of stream function", and then the new structure is designed around the stream. The following flowchart from Chapter 5 of Caltrans' Fish Passage Design for Road Crossings illustrates the design process that is needed to complete HCD. As can be seen, the hydraulic flood capacity check occurs after an iterative habitat connectivity design process.

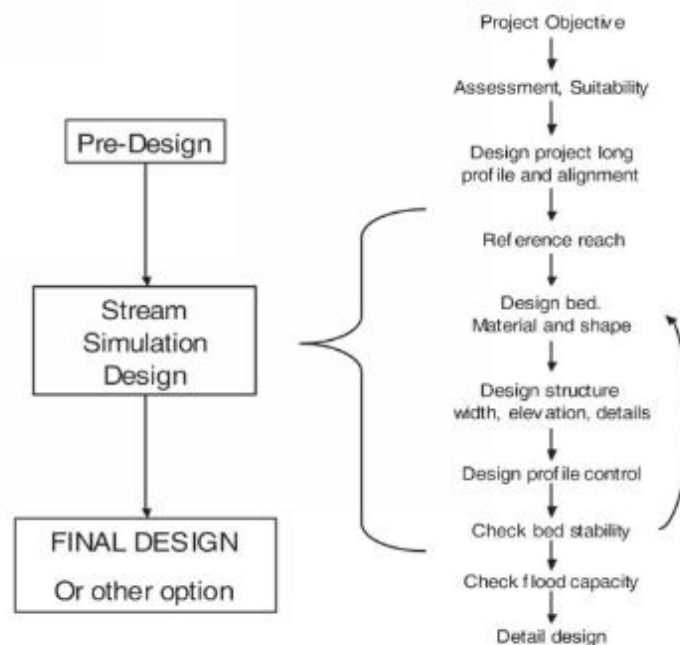


Figure 5.1. Stream Simulation Design Process

To conduct HCD, additional field surveys are needed to generate the following information:

- Additional ground survey of the stream is required. Recent Maine DOT HCD training indicates that a minimum of 20 bankfull widths (20x20' bankfull width = 400'), both upstream and downstream, beyond the existing structure limits, shall be acquired to generate a meaningful profile of the channel thalweg along the main flow path. The

provided survey files contain stream topography data that extends only 160 +/- ft upstream and downstream of the existing culvert, significantly less than required.

- Additional channel information also needs to be obtained to understand the existing channel controls and overall channel stability. Based on photos from a preliminary site visit, channel controls appear to be large rock(s) that are not currently shown in the survey files, as well as remnants of a beaver dam, that roughen and slow stream flow. Possible additional controls may be “Old Bridge Corners” that are shown on the 1956 existing bridge plans. Channel incision does not appear to have occurred. The stability of all channel controls will need to be documented, especially the beaver dam remnants since it is unknown how stable they are.
- A site sketch of the stream reach will be necessary to document channel bends, exposed roots, overhanging banks, bank irregularities, large wood, bank erosion, sediment storage, sediment inputs, etc.
- A reference reach upstream or downstream of the culvert will need to be established as the basis for HCD. The following information is needed:
 - o Documentation of the active/bankfull channel width and bankfull depth shall be established.
 - o Mapping of the streambed geomorphology, stream banks, and profile forcing features should all be documented.
 - o Pebble counts of the streambed materials need to be conducted.

Once the above information is obtained, the following channel design features can be determined:

- Project stream profile, as well as the expected high and low vertical adjustment potential (VAP) profiles.
- Channel dimensions and bedforms
- Composition of the streambed materials, including the size and depth of the materials
- Simulated streambed features (feature rocks, etc.)
- Bank lines (transition the in-structure bank lines to the natural banks)

After the habitat connectivity design is completed, the proposed hydraulic model can be finalized.

HYDRAULIC MODELING

The FEMA Flood Insurance Study (FIS) that covers the Town of Lubec, Maine was published in July 18, 2017, and is a comprehensive report covering communities in Washington County. The FIS and Maine Flood Hazard Map indicate that Mays Brook is located in a Zone A floodplain. Zone A is “the flood insurance rate zone that corresponds to the 1% annual chance floodplains. No base (1% annual chance) flood elevations (BFEs) or depths are shown within this zone.” (FEMA FIS, 2017). Therefore, 100-year BFEs have not been established.

While there is no known flood elevation information at this bridge, the Maine Flood Hazard Map indicates that no overtopping of the roadway is expected to occur (see Figure 1). Discussion at the 4/28/2017 Preliminary Design Kickoff Meeting indicated no knowledge of past flooding at this structure. Abutters attending the Public Meeting on 1/09/2018 also indicated they were unaware of previous flooding (See Appendix H for meeting minutes.)

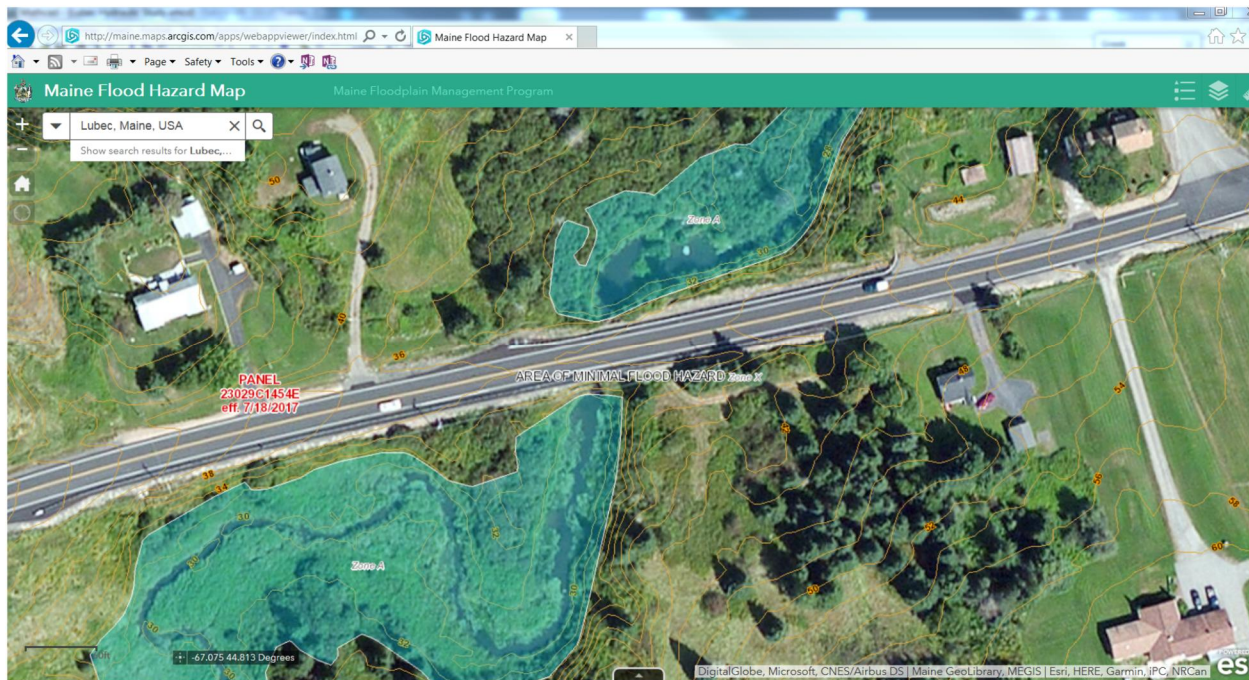


Figure 1 – Maine Flood Hazard Map showing the culvert in a Zone A floodway

The existing and proposed culverts were analyzed using HEC-RAS 5.0.3 (September 2016), a one-dimensional hydraulics software program developed by the United States Army Corps of Engineers.

A hydraulic model of the stream was generated with 3 cross sections located upstream of the culvert, and 6 located downstream. Closely spaced cross sections were needed downstream of the culvert to model the significant variability in stream width and cross-section geometry, partially due to remnants of a beaver dam. The cross sections were developed using ground survey provided by Maine DOT. The ground survey data was supplemented with aerial LiDAR survey (2-ft contours).

Based on the surveyed culvert invert elevations in comparison with the invert elevation shown on the existing plans, there appears to be less roadway materials over the culvert crown than shown in the existing plans. The thickness of roadway materials based on survey information is estimated to be 2 to 2.5 ft, whereas the depth based on the existing plans is 3.45 +/- feet at the centerline of the roadway over the crown of the existing pipe arch.

The following parameters were used for the existing conditions and proposed conditions hydraulic models:

- Steady flow analysis method
- Roughness factors (Manning's "n") of 0.05 for the channel and 0.12 for the overbank areas
- Expansion and contraction values of 0.3 and 0.1, respectively
- Ineffective flow areas upstream of the culvert were set based on a contraction ratio of approximately 1:1, and an expansion ratio of approximately 2:1 to 4:1 was used on the downstream side, taking into account topography and stream meander.
- Flow regime was set to "mixed" to account for the hydraulic jump that occurs downstream of the culvert.

- Boundary conditions upstream and downstream were set to “normal depth”.

The existing and proposed structures were modeled as bridges since this allows greater flexibility to more accurately model the channel and benches within the existing and proposed culverts.

Typically, a hydraulic model for the existing condition is calibrated with known water surface elevations for a given flow rate. However, this information is not known, so the model was checked for reasonableness using the following considerations:

1. The model indicates that overtopping of the road doesn't occur for any of the flows. This is corroborated by the Maine Flood Hazard Map in Figure 1.
2. Water surface elevations from the existing conditions hydraulic model were compared against a measured water surface elevation obtained during a site visit on May 11, 2017. Additionally, this measured water surface elevation was used in conjunction with approximate locations of rust staining on the existing culvert to estimate the approximate ordinary high water elevation.

For the proposed replacement structure, a 24 foot span precast concrete box with a 9 foot rise was selected. The top of the box culvert is set level at El 34.17 ft, and is assumed to have a top slab thickness of 16". This results in a proposed bottom of structure elevation at El 32.83, approximately 1.1 feet lower than the estimated existing crown elevation of El 33.93. Although it generally isn't desirable to lower a crown elevation, it is unavoidable due to the following:

- Based on the culvert invert elevations from survey, the depth of roadway materials over the existing culvert is only 2 ft +/- near the edge of the roadway shoulder, and the proposed minimum depth of fill will be approximately 1'-9" over the proposed box culvert at the face of the guardrail at the southwest end of the culvert.
- Inability to raise the existing roadway profile due to the intersection with Crows Neck Road, and due to the project scope which restricts the related approach work.
- Proposed structure thickness is 16 inches whereas existing structure thickness is minimal.

HABITAT CONNECTIVITY CONSIDERATIONS

Since Habitat Connectivity Design (HCD) is being incorporated into this project, the channel will be reconstructed with banks continuous through the proposed culvert. See the proposed cross sections in Figures 2 and 3.

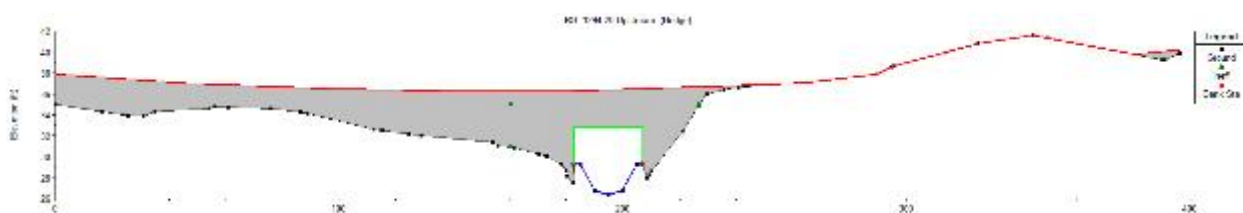


Figure 2 – Upstream Bridge Cross Section with banks continuous through proposed culvert

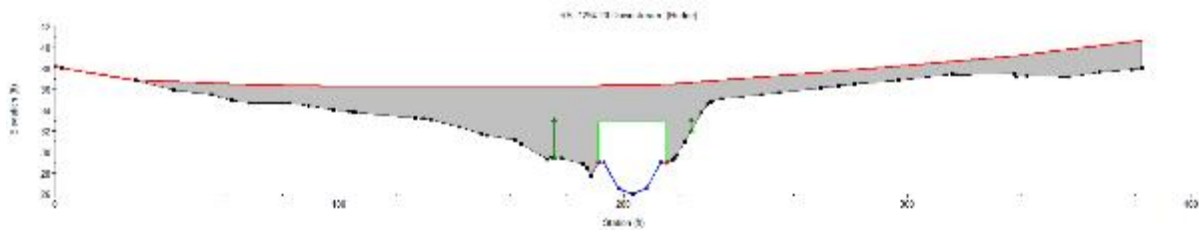


Figure 3 – Downstream Bridge Cross Section with banks continuous through proposed culvert

The bank elevations within the proposed culvert were established based on a review of the existing terrain in combination with hydraulic analysis results for the existing conditions:

- From survey, S_Drainage_Waterway is located at approximately El 28 (upstream of existing culvert) and approximately El 27 - 28 (downstream of existing culvert). This is assumed to delineate the waterway at the time of survey.
- The left bank at HEC-RAS cross section STA 1220.346 (downstream of existing culvert) appears to be a fairly well defined floodplain at around El 29.87 ft. In general, bank elevations appear to be approximately El 29.5 to El 30 (+) or so. According to the August 2008 US Forest Service manual titled, "Stream Simulation: An Ecological Approach to Providing Passage for Aquatic Organisms at Road Stream Crossings", "Bankfull elevation is the point where water fills the channel just before beginning to spill onto the flood plain." Additionally, a bankfull elevation is often bracketed by the water surface elevations for the 1.1 and 2-year return periods.
- From HEC-RAS analysis of existing culvert, upstream Q1.1 El = 29.28 ft & Q2 El = 30.16 ft
- From HEC-RAS analysis of existing culvert, downstream Q1.1 El = 29.17 ft & Q2 El = 29.91 ft
- In evaluating the grading of the stream through the culvert, the elevation of the top of bank was limited for two reasons:
 - o Higher top of bank elevations cause the contours to be narrowed or pinched inside the box culvert, when compared to the upstream and downstream channel.
 - o If the top of bank elevation is set too high, it will be difficult to construct them inside the culvert due to limited headroom.

Based on the above information, the top of bank elevations in the culvert were set at El 29.3 in the upstream end of the culvert and at El 29.0 in the downstream end. and El 29.0 (downstream). The elevation drop of 0.3 ft is based on the existing Q2 elevation difference from upstream to downstream. The channel slopes in the box culvert were set at 2:1 in the upper portion of the channel and 10:1 in the lower portion (See previous Figures 2 & 3). Proposed thalweg elevations were set at El 26.30 ft upstream and at El 26.00 ft downstream. These elevations were incorporated into the proposed conditions hydraulic model, and they result in a streambed slope of 0.0041 ft/ft over the proposed 73' culvert length. The culvert itself is set level and has a streambed thickness that varies in depth to provide the stream slope.

As discussed at the beginning of this hydraulic report, there was not sufficient survey data to develop a streambed profile, along with the associated Vertical Adjustment Profiles (VAP's). VAP's estimate the range of possible channel profiles due to normal stable channel variability over the life of the project. A low VAP estimates changes in the channel profile due to sediment transport out of the streambed (often represented by a straight line connecting the

average elevation of the bottoms of natural streambed pools in a given stream segment). A high VAP estimates the changes in the channel profile due to the potential for sediment aggradation. Typically, a hydraulic analysis would use the high VAP since this produces the least hydraulic area available. However, since sufficient information to determine VAP's was unavailable, the proposed conditions hydraulic model maintained channel thalweg elevations very similar to the existing conditions.

HYDRAULIC RESULTS

As discussed above, the hydraulic model for the proposed conditions may need to be revisited after completion of the habitat connectivity design. However, based on available information, results of the existing and proposed conditions models indicate that the proposed structure is hydraulically improved when compared to the existing structure. The existing structure has a hydraulic opening of 70.03 square feet, whereas the new structure has an increased hydraulic opening of 125.13 sq ft. The new structure is expected to pass all flows up to and including the 500-year return period, similar to the existing culvert, although with enhanced performance as indicated in Figure 5 below.

Hydraulic improvement is achieved with the proposed structure as evidenced by reductions in the water surface elevations in the upstream reach. See Figures 4 and 5 for a comparison between the existing and proposed water surface profiles. Concurrent with lower water surface elevations, the discharge velocities in the upstream reach are somewhat higher for the new structure since it doesn't restrict the flows as much as the existing structure does. Water surface elevations and discharge velocities in the downstream reach are substantially unaffected by the proposed structure. For more details, see the Summary of Hydraulic Analysis Results table that follows.

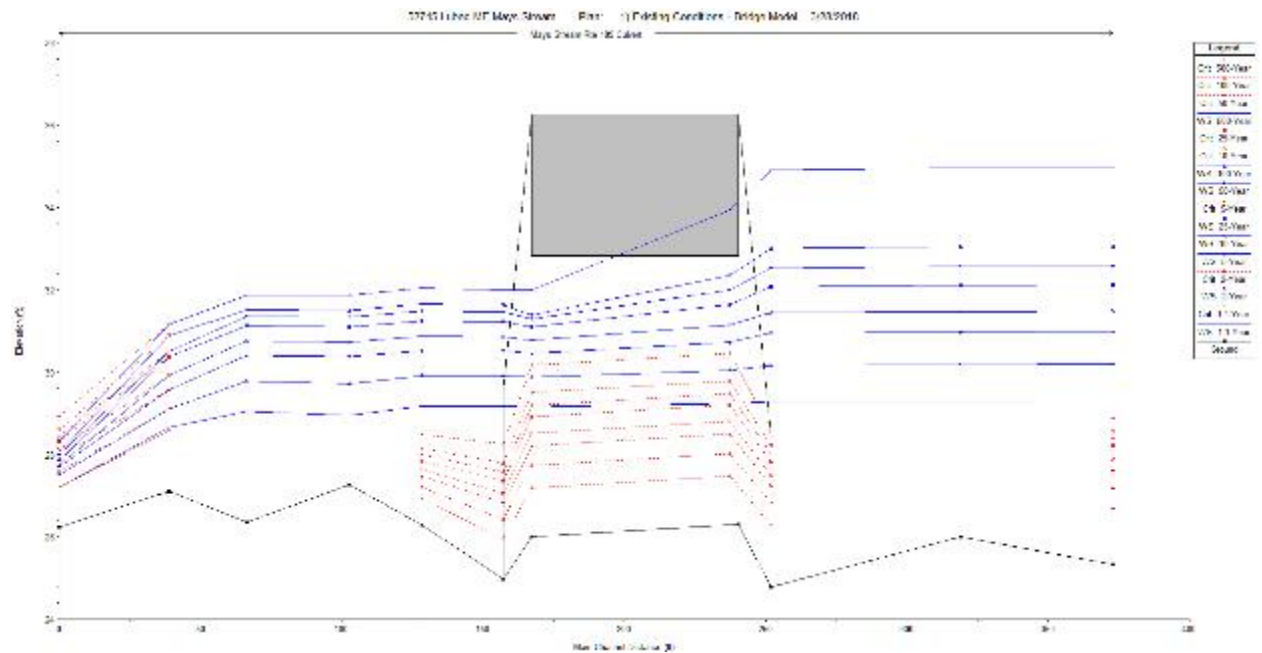


Figure 4 – Existing Conditions Flow Profiles – Note that downstream flow is from right to left.

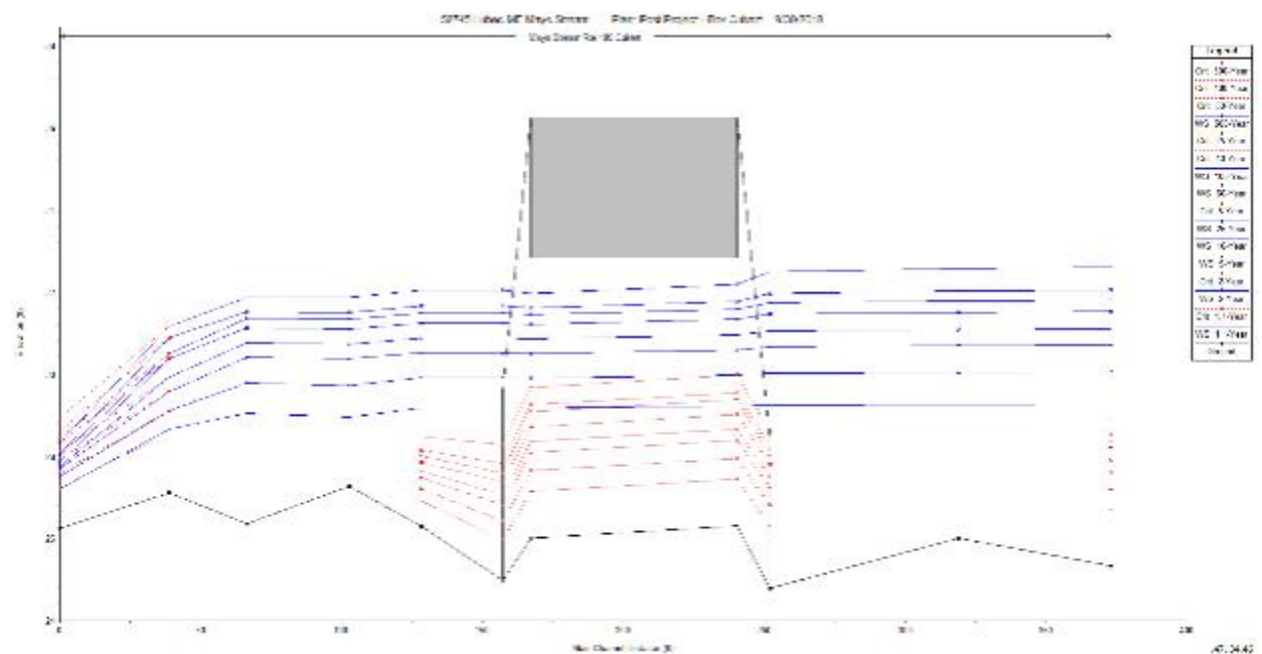


Figure 5 – Post Project Flow Profiles

Summary of Hydraulic Analysis Results

Return Period (Years)	Proposed Structure	Existing Structure
Water Surface Elevations (ft.)		
1.1	29.24 (US) / 29.17 (DS)	29.28 (US) / 29.17 (DS)
2	30.02 (US) / 29.91 (DS)	30.16 (US) / 29.91 (DS)
50	31.74 (US) / 31.48 (DS)	32.52 (US) / 31.46 (DS)
100	31.96 (US) / 31.65 (DS)	33.00 (US) / 31.63 (DS)
Discharge Velocity (ft./s)		
1.1	0.60 (US) / 0.61 (DS)	0.59 (US) / 0.67 (DS)
2	0.96 (US) / 1.02 (DS)	0.92 (US) / 1.14 (DS)
50	1.88 (US) / 2.13 (DS)	1.68 (US) / 2.57 (DS)
100	2.09 (US) / 2.40 (DS)	1.81 (US) / 2.91 (DS)
500	2.53 (US) / 3.01 (DS)	1.87 (US) / 3.71 (DS)
Freeboard (ft.)		
50	1.09	1.41
100	0.87	0.93
Hydraulic Opening (square feet)		
N/A	125.13	70.03

US = Culvert Upstream at RS 1343.914

DS = Culvert Downstream at RS 1249.223

The proposed structure achieves 1.09 feet of freeboard at the 50-year return period, which is less than the desired 2 feet. For the 100-year return period, the proposed structure provides 0.87 feet of freeboard, which is slightly less than the preferred 1 foot criteria. It is noted that while the freeboard is reduced, the hydraulic opening is increased by almost 80%. Figures 4 & 5 also show the improved hydraulic performance for the new box culvert.

At the 01/09/2018 Public Meeting, there was discussion regarding beaver dams near this project. As evidenced by its remnants, a beaver dam used to be located just downstream of the existing culvert. Town resident, Ricky Bradley, also indicated that there is a very large beaver dam upstream. The beaver dam at the upstream limit of Mays Brook is large enough to be easily visible on satellite imagery. See Figure 6. As can be seen, the dam is storing a significant wet area in the upstream reach of Mays Brook. It is noted that the hydrology data used in this hydraulic study is based on parameters such as watershed area and percentage of NWI (National Wetland Inventory) wetland areas. See Figure 7 for NWI map of wetland areas. Given that these wetland areas appear to be maintained by this large beaver dam, and they are shown in the NWI map, it is assumed that the hydrology data accurately reflects the existing conditions, and is appropriate for use in this hydraulic study.

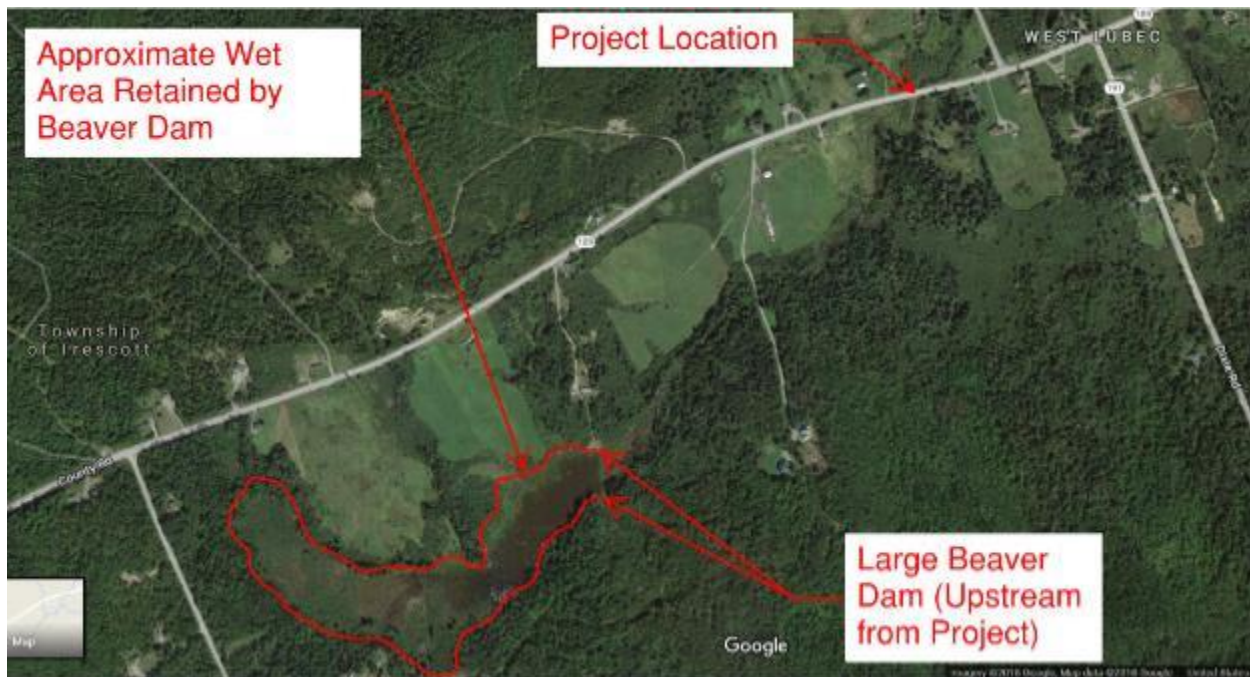


Figure 6 – Very Large Upstream Beaver Dam

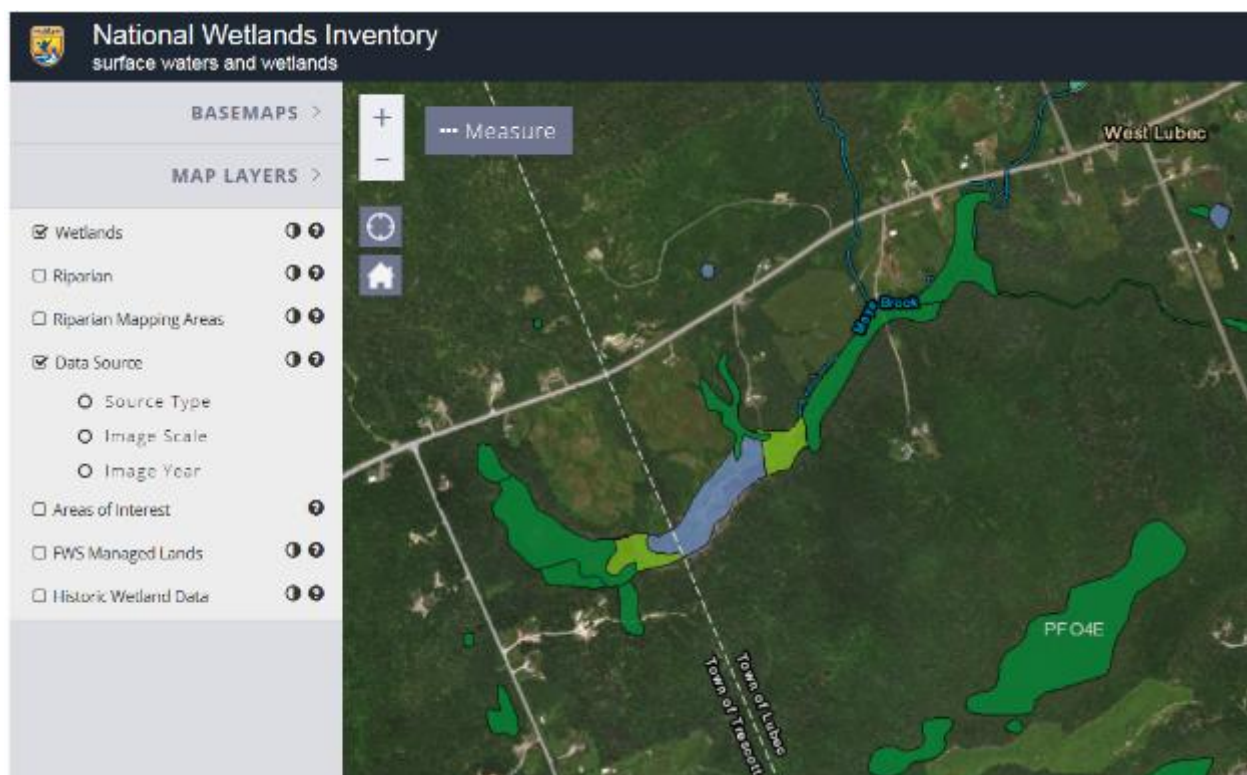


Figure 7 – National Wetland Inventory map for Mays Brook in Vicinity of Very Large Upstream Beaver Dam

At the Public Meeting, Ricky Bradley also expressed a question about how much this project might increase the flow of water to another culvert downstream of this project under Crows Neck Road. While this hydraulic study does not include the Crows Neck Road culvert, results show that the water surface elevations in the reach downstream of the proposed culvert will be largely unchanged from those determined for the existing culvert. The results also show that

the downstream velocities are expected to be a little lower for the proposed culvert in comparison to the existing culvert.

SCOUR ANALYSIS

The proposed culvert is a four-sided box culvert, and is therefore not susceptible to scour. The downstream channel velocities are low and not expected to increase due to the proposed project. Plain riprap aprons will be placed under the streambed materials at the culvert entrance and exit. Additionally, a 2 foot deep concrete toewall will be installed both upstream and downstream, providing additional protection against undermining of the box culvert..

Appendix E

Hydraulics Data

WIN: 21697.00
 Town: Lubec
 Route No. ME 189
 Asset ID: 2527
 Lat: 44.8139 Long: -67.07394

Project Name: Lubec Mays Bridge
 Stream Name: Mays Brook
 Bridge Name: Mays Bridge
 Analysis by: CSH
 Date: 4/26/2017

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

Enter data in blue cells only!

	km ²	mi ²	ac
A	5.96	2.30	1472.0
W	0.38	0.1	94.8

P _c	651716	4963320
County	Washington	
pptA	44.2	
SG	0.00	

A (km ²)	5.96
W (%)	6.44

Conf Lvl 0.67

Enter data in [mi²]

Watershed Area *DRNAREA*

Wetlands area (by NWI)

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

Worksheet prepared by:

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 Environmental Office
 Maine Dept. Transportation
 Augusta, ME 04333-0016
 207-557-1052
Charles.Hebson@maine.gov
 ver. 2016 Feb 05

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

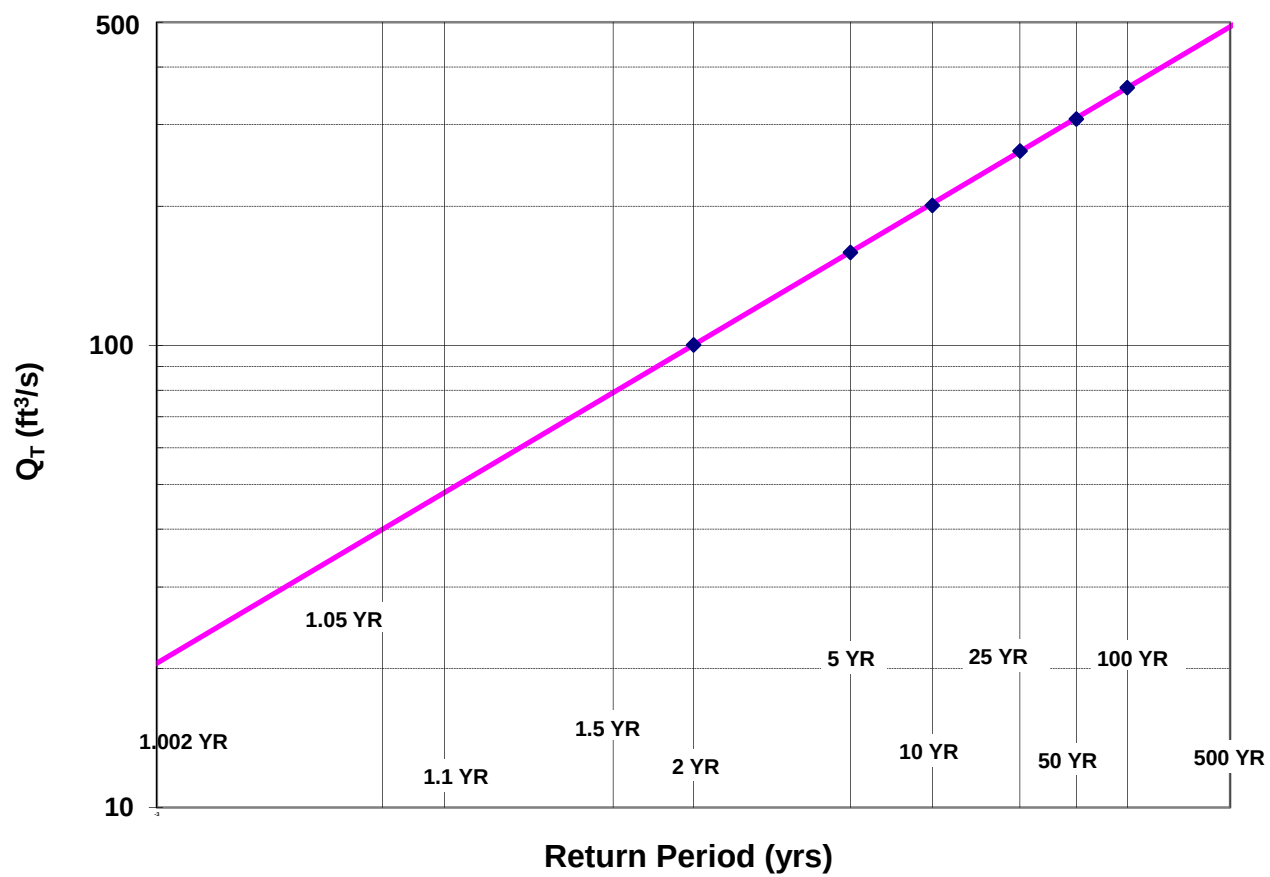
Lombard, P.J. & G.A. Hodgkins, 2015.
 Peak flow regression equations for small, ungaged streams in
 Maine - Comparing map-based to field-based variables
SIR 2015-4059, USGS, Augusta, ME

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

Ret Pd	Peak Flow Estimate		
T (yr)	Lower	Q _T (m ³ /s)	Upper
1.1		1.36	
2		2.84	
5		4.50	
10		5.69	
25		7.45	
50		8.74	
100		10.23	
500		13.86	

Q _T (ft ³ /s)
48.1
100.3
158.8
201.0
263.2
308.7
361.3
489.2

Log-Normal Probability Plot



WIN: 21697.00
 Town: Lubec
 Route No. ME 189
 Asset ID: 2527
 Lat: 44.81392 Long: -67.07394

Project Name: Lubec Mays Bridge
 Stream Name: Mays Brook
 Bridge Name: Mays Bridge
 Analysis by: CSH
 Date: 4/26/2017

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

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

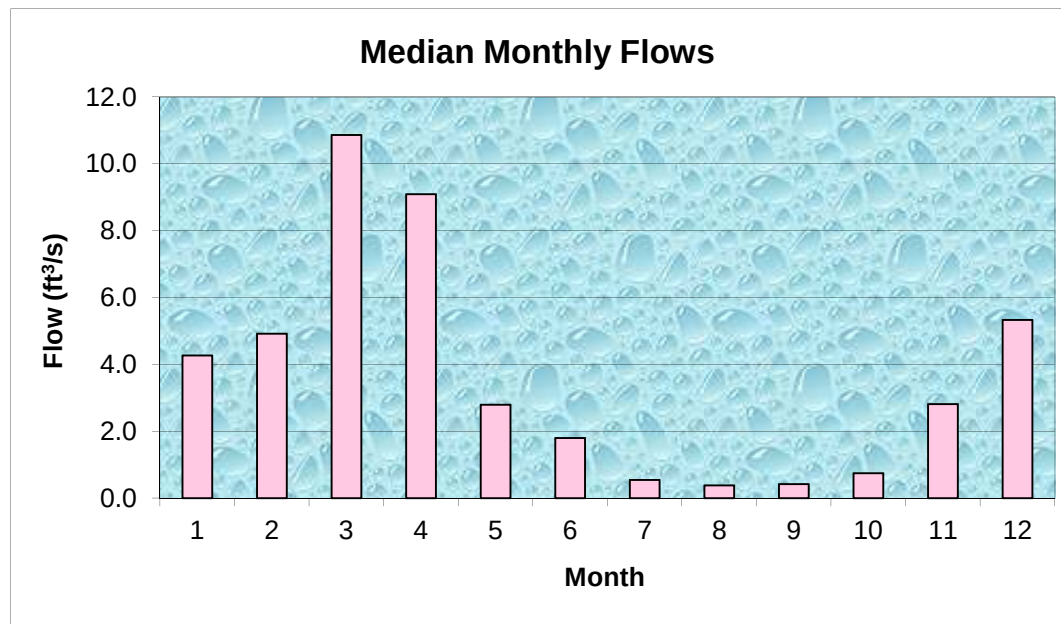
	Value	Variable	Explanation
	2.30	A	Area (mi ²)
651715.9	4963320	P_c	Watershed centroid (E,N; UTM; Zone 19; meters)
	24.65	DIST	Distance from Coastal reference line (mi)
	44.2	pptA	Mean Annual Precipitation (inches)
	0.00	SG	Sand & Gravel Aquifer (decimal fraction of watershed area)

Month	Q_{median} (ft ³ /s)	(m ³ /s)
Jan	4.27	0.1210
Feb	4.92	0.1394
Mar	10.86	0.3079
Apr	9.10	0.2578
May	2.80	0.0793
Jun	1.80	0.0510
Jul	0.55	0.0155
Aug	0.39	0.0109
Sep	0.42	0.0119
Oct	0.75	0.0213
Nov	2.82	0.0799
Dec	5.33	0.1511

Q_{bf}	12.4
ann avg	4.7
ann med	2.4
$Q_{1.002}$	20.5
$Q_{1.01}$	27.8
$Q_{1.05}$	40.0
Q_{bf}	37.3

assume v = 4ft/s

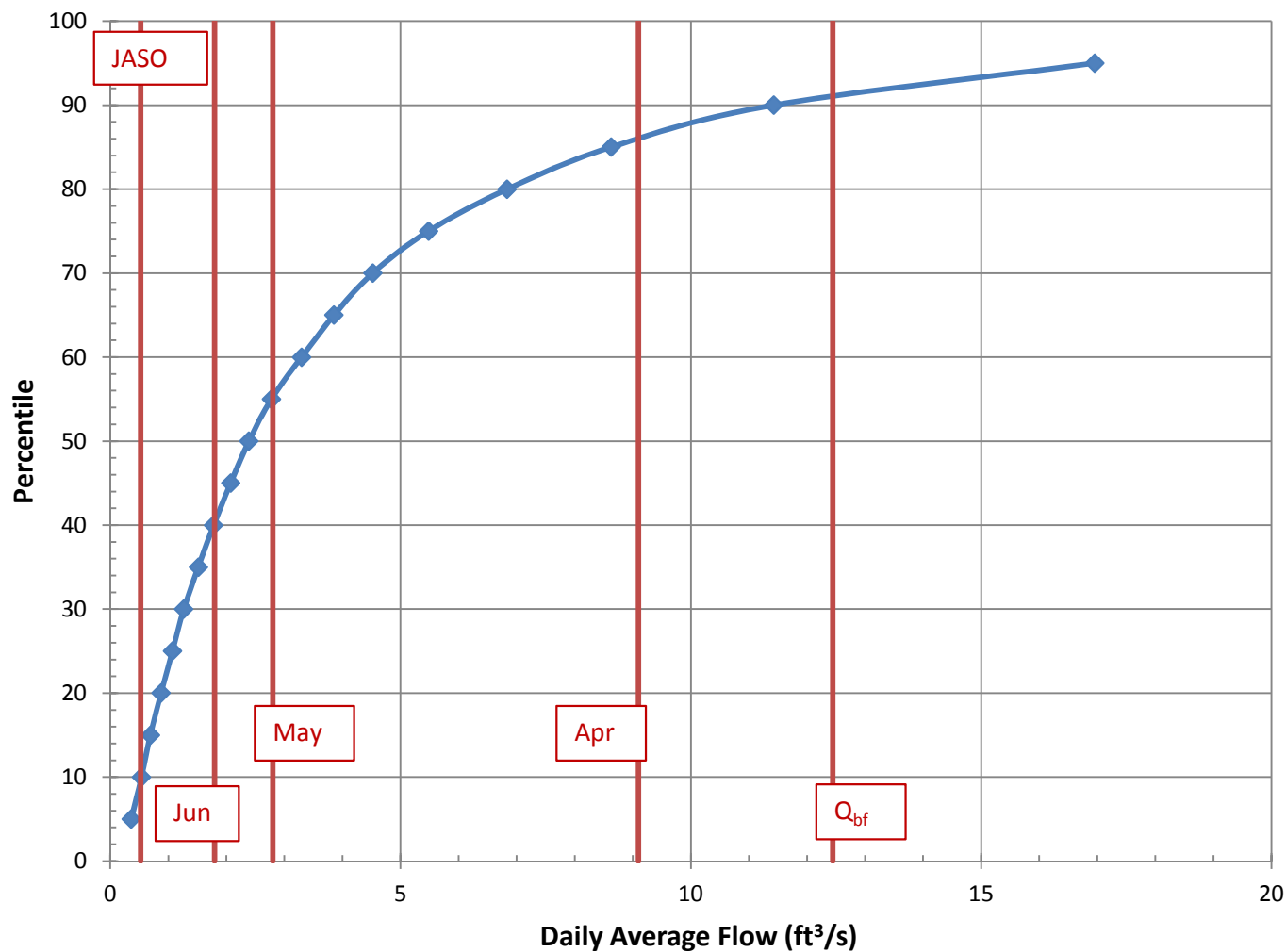
W_{bf}	11.8	estimated bankfull width (ft)
d_{bf}	0.8	estimated bankfull depth (ft)
A_{bf}	9.3	estimated bankfull flow area (ft ²)



References

Dudley, R.W., 2004. Hydraulic Geometry Relations ..., SIR 2004-5042
 Dudley, R.W., 2004. Estimating Monthly Streamflows ... , SIR 2004-5026

Daily Average Flow Distribution



Daily Avg Flow Dist

$A_{ws} = (mi^2)$ 2.3

$Q (ft^3/s)$

Pctl	Median	84 th pctl
5	0.36	0.58
10	0.54	0.81
15	0.69	1.01
20	0.88	1.22
25	1.07	1.44
30	1.27	1.63
35	1.52	1.87
40	1.78	2.15
45	2.08	2.43
50	2.39	2.87
55	2.77	3.34
60	3.30	3.92
65	3.85	4.56
70	4.52	5.33
75	5.48	6.40
80	6.84	7.65
85	8.63	9.80
90	11.43	13.16
95	16.96	20.46

Q_{bf} 12.4

$Q_{1.002}$ 20.5

$Q_{1.1}$ 48.1

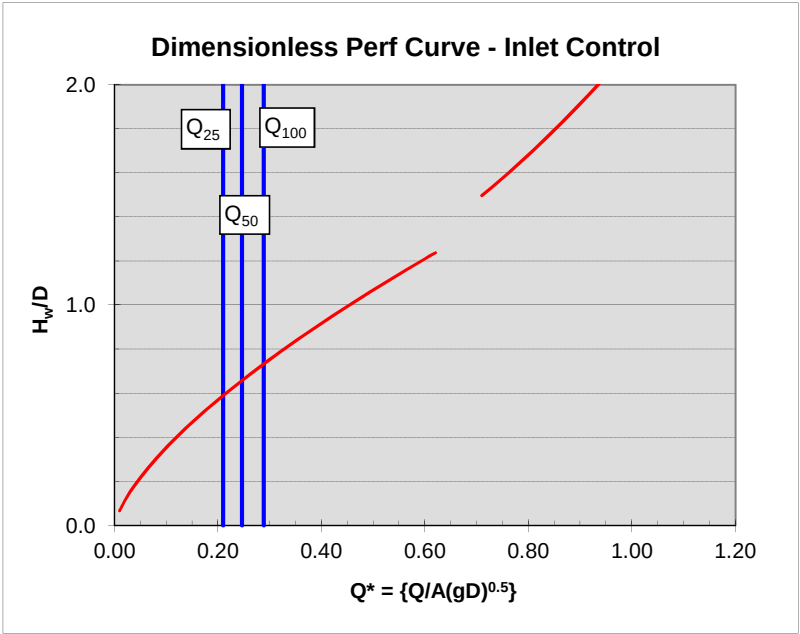
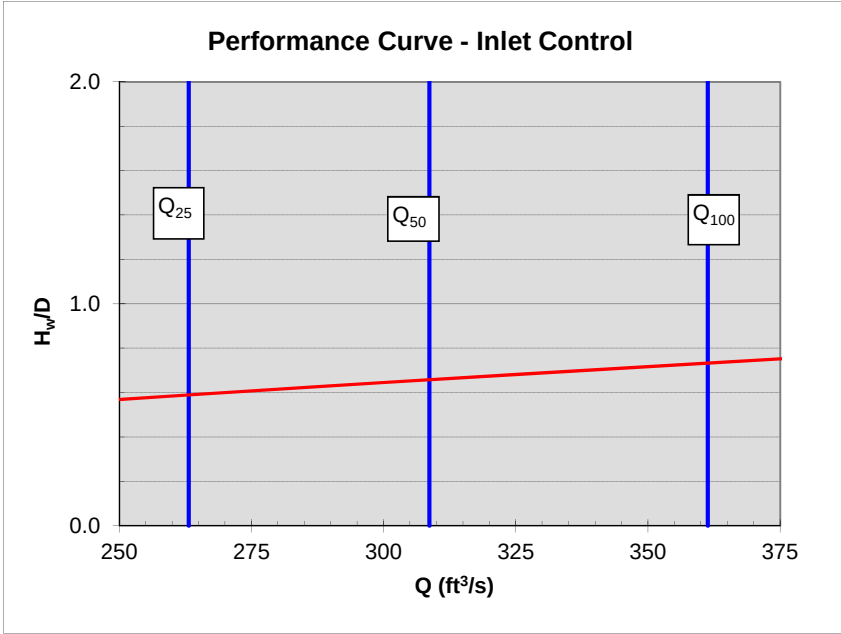
Q_2 100.3

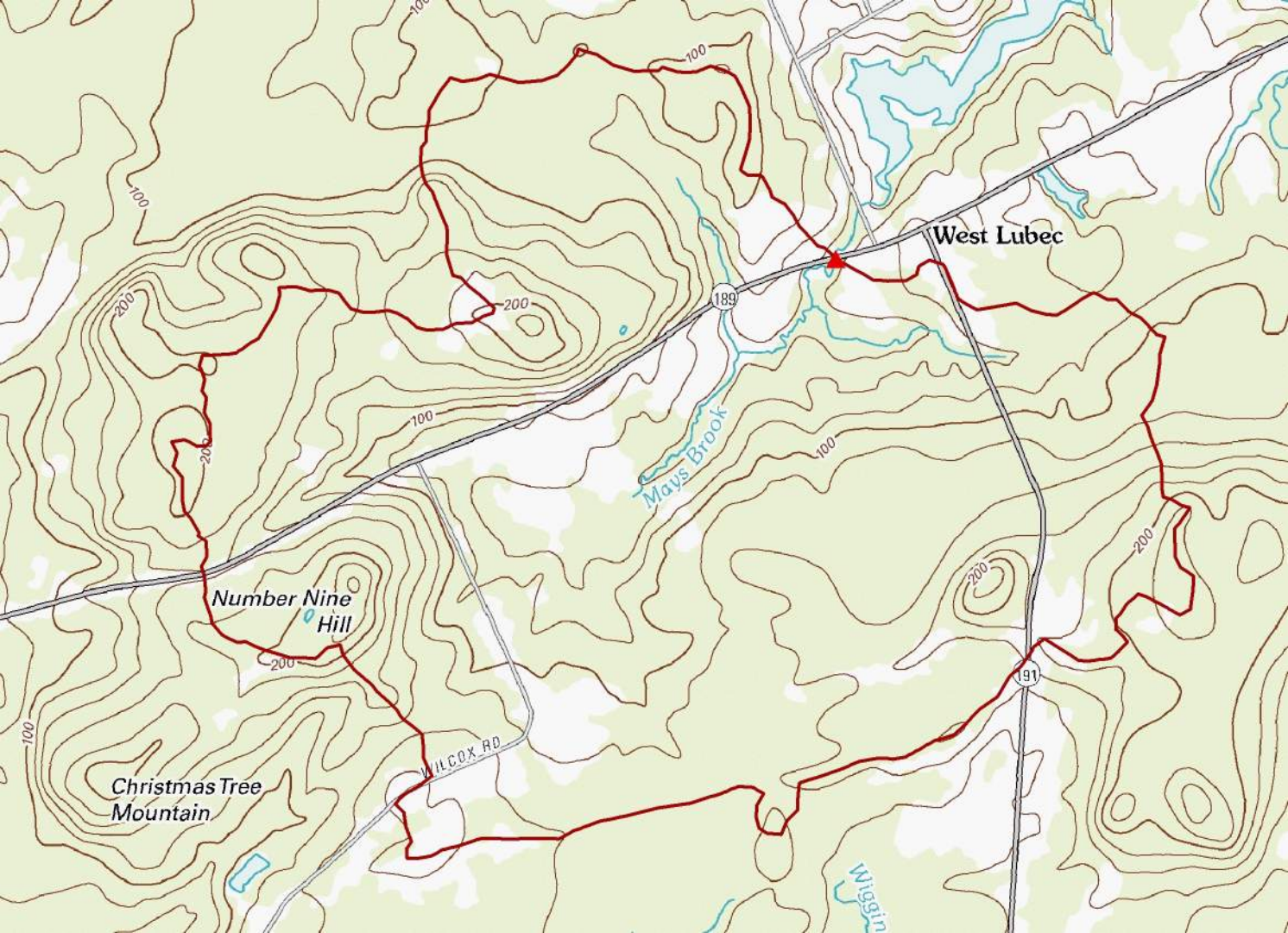
NOTE: This page is for preliminary sizing only.
Final design should be done with HY8 or HDS-5

Preliminary Culvert Sizing - Round & Box Culverts

Shape:	Box			
Type:	Box 0 ww			
D or R (ft)	6	Q ₂₅	263.2	trial D / R = 8.2
w (ft)	15 box width	Q ₅₀	308.7	
Slope (ft/ft)	0.02	Q ₁₀₀	361.3	trial w: BFW = 11.8
A (ft ²)	90.00			
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)





Lubec 21697 Mays Bridge #2527

Region ID:

ME

Workspace ID:

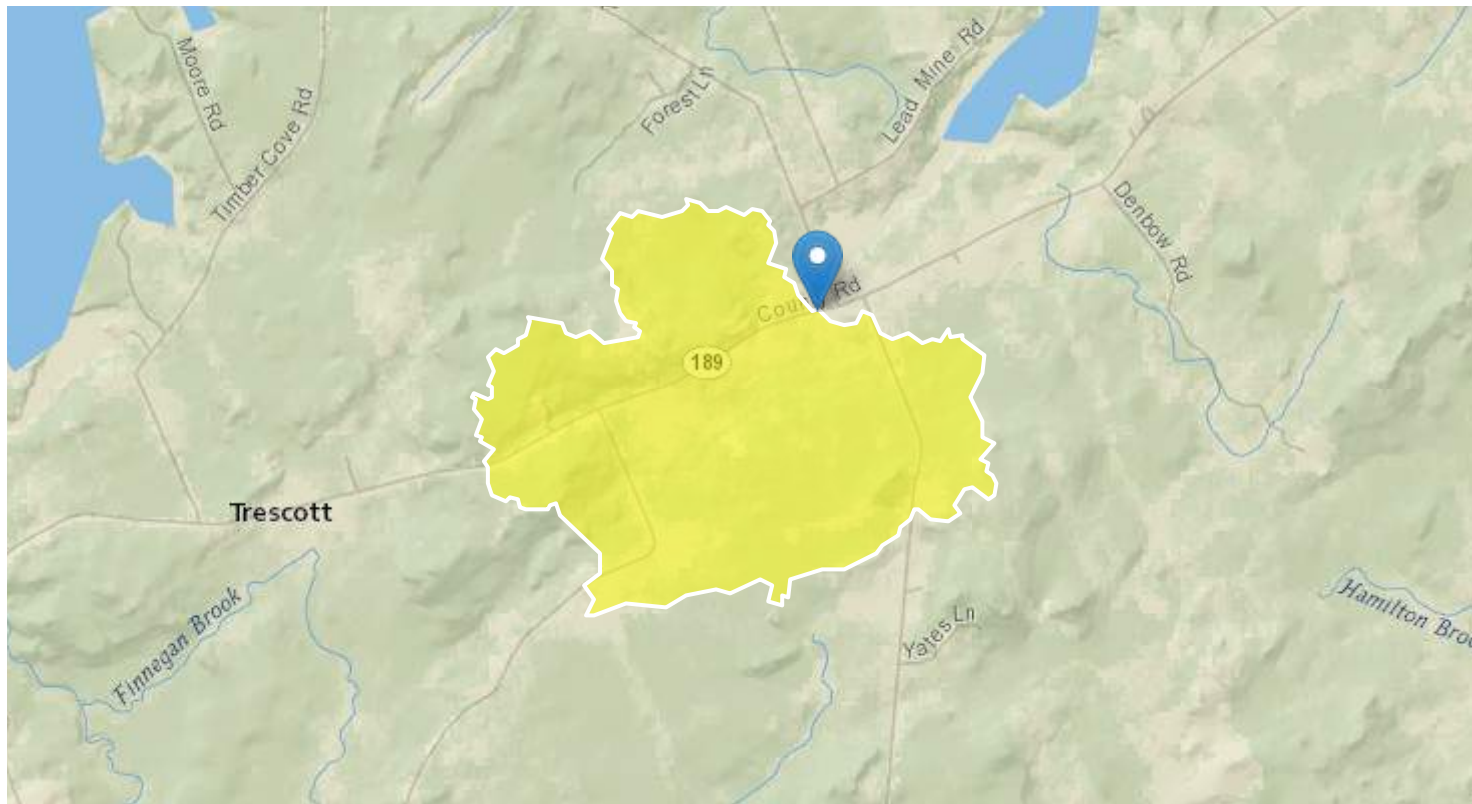
ME20170418123448937000

Clicked Point (Latitude, Longitude):

44.81392, -67.07394

Time:

2017-04-18 14:38:21 -0400



Basin Characteristics

Parameter Code	Parameter Description	Value	Unit
DRNAREA	Area that drains to a point on a stream	2.3	square miles
STORNWI	Percentage of storage (combined water bodies and wetlands) from the National Wetlands Inventory	6.44	percent
ELEV	Mean Basin Elevation	116.3	feet
PRECIP	Mean Annual Precipitation	43.7	inches
SANDGRAVAP	Percentage of land surface underlain by sand and gravel aquifers	0	percent
COASTDIST	Shortest distance from the coastline to the basin centroid	25.3	miles
CENTROIDX	Basin centroid horizontal (x) location in state plane coordinates	651715.87	State plane coordinates
CENTROIDY	Basin centroid vertical (y) location in state plane units	4963319.5	State plane coordinates
SANDGRAVAF	Fraction of land surface underlain by sand and gravel aquifers	0	dimensionless
LC11IMP	Average percentage of impervious area determined from NLCD 2011 impervious dataset	0.78	percent
LC11DEV	Percentage of developed (urban) land from NLCD 2011 classes 21-24	4.24	percent
LC06WATER	Percent of open water, class 11, from NLCD 2006	0	percent
ELEVMAX	Maximum basin elevation	251.4	feet
BSLDEM10M	Mean basin slope computed from 10 m DEM	6.63	percent
STATSGOA	Percentage of area of Hydrologic Soil Type A from STATSGO	11	percent

Parameter Code	Parameter Name	Value	Units	Min Limit	Max Limit
DRNAREA	Drainage Area	2.3	square miles	2.92	298

Bankfull Statistics Disclaimers [100 Percent (2.34 square miles) Central and Coastal Bankfull 2004 5042]

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

Bankfull Statistics Flow Report [100 Percent (2.34 square miles) Central and Coastal Bankfull 2004 5042]

Statistic	Value	Unit
Bankfull Streamflow	12.4	ft ³ /s
Bankfull Width	11.8	ft
Bankfull Depth	0.788	ft
Bankfull Area	9.31	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 [100 Percent (2.34 square miles) Statewide Peak Flow DA LT 12sqmi 2015 5049]

Parameter Code	Parameter Name	Value	Units	Min Limit	Max Limit
DRNAREA	Drainage Area	2.3	square miles	0.31	12
STORNWI	Percentage of Storage from NWI	6.44	percent	0	22.2

Peak-Flow Statistics Flow Report [100 Percent (2.34 square miles) Statewide Peak Flow DA LT 12sqmi 2015 5049]

Statistic	Value	Unit	Average standard error of prediction
-----------	-------	------	--------------------------------------

1.01 Year Peak Flood	29.5	ft ³ /s	38
2 Year Peak Flood	100	ft ³ /s	34
5 Year Peak Flood	159	ft ³ /s	35
10 Year Peak Flood	201	ft ³ /s	37
25 Year Peak Flood	263	ft ³ /s	39
50 Year Peak Flood	309	ft ³ /s	41
100 Year Peak Flood	361	ft ³ /s	42
250 Year Peak Flood	411	ft ³ /s	44
500 Year Peak Flood	489	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>)



650 Elm St. Suite 402
Manchester, NH 03101
wsp.com

Project: Lubec ME - Mays Bridge - Rte 189 /
County Road over Mays Stream
Task: **Hydraulic Study**
Client: Maine DOT

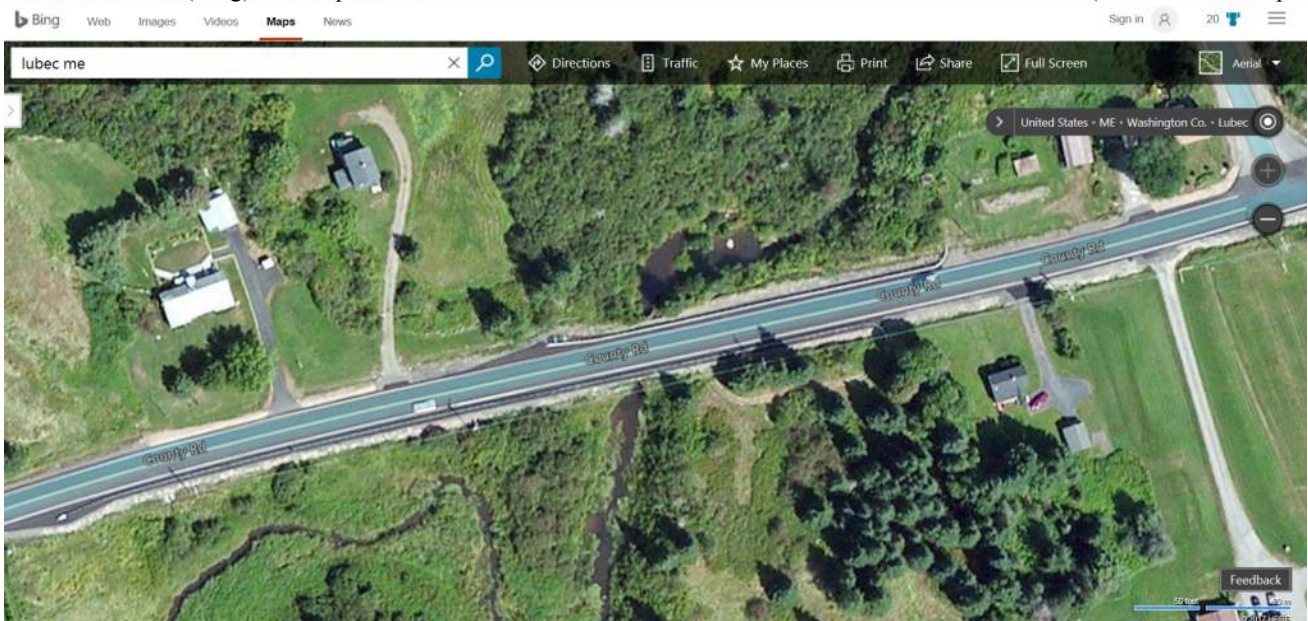
Calculated by: K. James
Date: 10/1/2018
Checked by:
Date:

Hydraulic Model:

Overhead View (Google) - Newer photo because trees near downstream end of culvert at east side have been removed (no shadows)



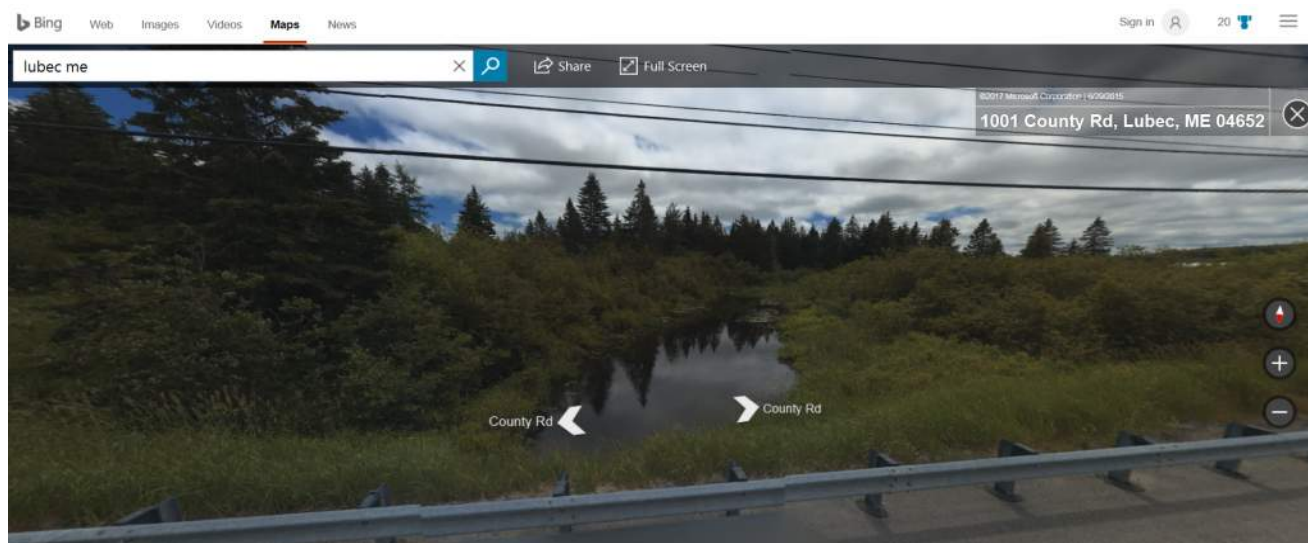
Overhead View (Bing) - Older photo because trees are shown near downstream end of culvert at east side (shadows indicate presence)



Upstream (Google - may be older based on downstream and aerial photos)



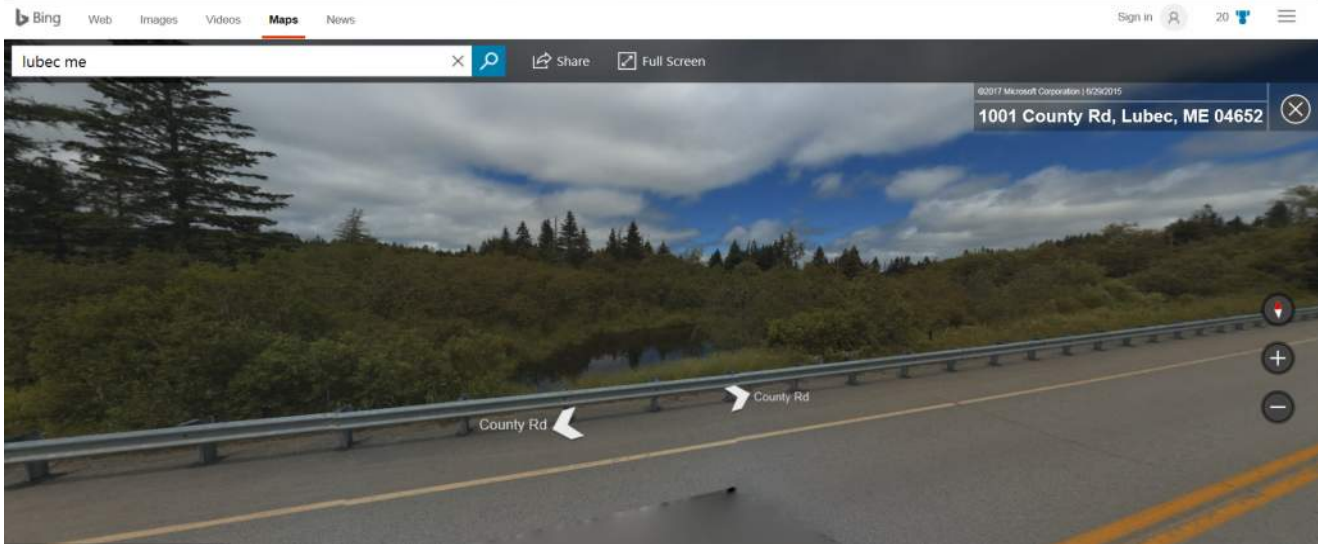
Upstream (Bing - may be newer based on downstream and aerial photos)



Downstream (Google - older because big trees on the right are gone in Bing image)



Downstream (Bing - image is newer than Google image because big trees on the right are gone)



Manning's "n" Values:

(HEC-RAS Reference Manual Table 3-1)

Manning's n for overbank:

The existing channel on either side of the culvert has grass and medium to dense brush in the overbank areas. There are a few isolated trees in the floodplain as well. From Table 3-1 of HEC-RAS Reference Manual for Natural Streams, under Flood Plains, select value for "Medium to Dense Brush, in Summer":

Assume $n = 0.12$ (ranges from 0.07 to 0.16)

Manning's n for channel:

There is no discussion or notes in the existing plans regarding the composition of the existing channel bed. There is a note requiring that the streambed be excavated below the pipe arch if deemed necessary by the Engineer. The 9/17/2013 Underwater Dive Inspection Report describes the streambed as having "fist sized riprap in ends". During 5-11-2017 site visit by WSP personnel, streambed was observed to be "mucky" upstream and downstream, though cobbles were observed at stream contraction.

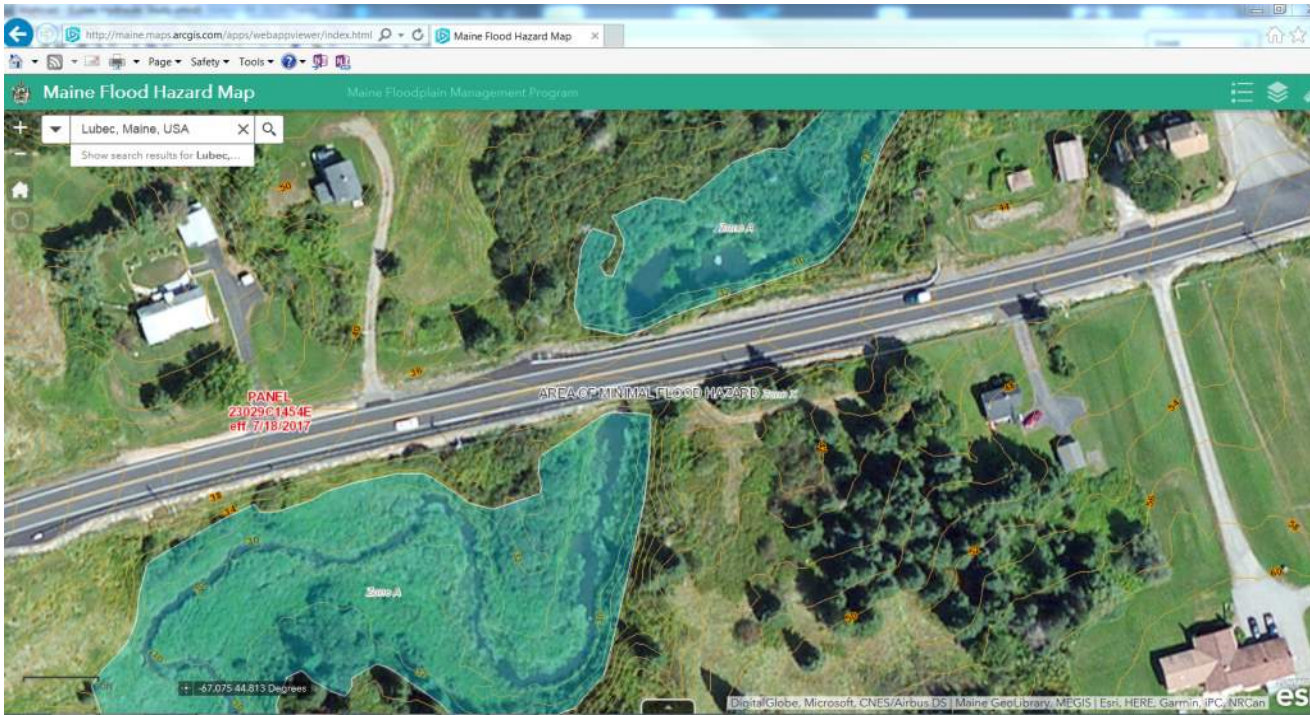
From Table 3-1, for Natural Streams, Main Channels, select Clean, winding, some pools and shoals, but some weeds and stones"

Assume $n = 0.050$ for substantial quantities of weeds and grass in channel

Table 3-1 Manning's 'n' Values

Type of Channel and Description	Minimum	Normal	Maximum
A. Natural Streams			
1. Main Channels			
a. Clean, straight, full, no rifts or deep pools			
b. Same as above, but more stones and weeds	0.025	0.030	0.033
c. Clean, winding, some pools and shoals	0.030	0.035	0.040
d. Same as above, but some weeds and stones	0.033	0.040	0.045
e. Same as above, lower stages, more ineffective slopes and sections	0.035	0.045	0.050
f. Same as "d" but more stones	0.040	0.048	0.055
g. Sluggish reaches, weedy, deep pools	0.045	0.050	0.060
h. Very weedy reaches, deep pools, or floodways with heavy stands of timber and brush	0.050	0.070	0.080
	0.070	0.100	0.150
2. Flood Plains			
a. Pasture no brush			
1. Short grass	0.025	0.030	0.035
2. High grass	0.030	0.035	0.050
b. Cultivated areas			
1. No crop	0.020	0.030	0.040
2. Mature row crops	0.025	0.035	0.045
3. Mature field crops	0.030	0.040	0.050
c. Brush			
1. Scattered brush, heavy weeds	0.035	0.050	0.070
2. Light brush and trees, in winter	0.035	0.050	0.060
3. Light brush and trees, in summer	0.040	0.060	0.080
4. Medium to dense brush, in winter	0.045	0.070	0.110
5. Medium to dense brush, in summer	0.070	0.100	0.160
d. Trees			
1. Cleared land with tree stumps, no sprouts	0.030	0.040	0.050
2. Same as above, but heavy sprouts	0.050	0.060	0.080
3. Heavy stand of timber, few down trees, little undergrowth, flow below branches	0.080	0.100	0.120
4. Same as above, but with flow into branches	0.100	0.120	0.160
5. Dense willows, summer, straight	0.110	0.150	0.200

Maine Flood Hazard Map: Culvert is in Zone A, and the flood hazard map does not indicate overtopping of roadway.



The Flood Insurance Study (FIS) dated July 18, 2017 for Washington County, ME (contains the Town of Lubec) was obtained for this project. The FIRM for Lubec indicates that Mays Brook is in Zone A. Therefore, no flood elevation profiles are available for Mays Brook.

Existing Pipe Arch Rise:

The existing plans indicate that the culvert at this site is composed of one 11'-10" span x 7'-7" rise pipe arch. The pipe is deteriorated and will be replaced.

7'-7" Arch rise from existing plans dated January, 1956. Note that this rise may not be accurate because there is a note allowing a slight variation in arch rise, if approved by the Engineer.

7.5' Arch crown to streambed measured at upstream end of culvert on 5/11/2017

7.0' Arch crown to streambed measured at downstream end of culvert on 5/11/2017

The upstream measurement from the arch crown to the streambed is very close to the arch rise given in the existing plans (within 1"). Therefore, it is likely that the installed pipe arch was built with an arch rise very similar to, or the same as, that indicated on the existing plans.

The downstream measurement from arch crown to streambed is 0.5' lower than at the upstream end. This difference may be due to an accumulation of sediment in the pipe arch at the downstream end.

For the purpose of this study, the existing pipe arch rise is assumed to be 7'-7"

Comparison of Existing Culvert Invert Elevations:

From the ground survey, survey shot #1216 is at El 36.40 (over the side of the culvert pipe arch near the center of the road). Estimate the theoretical culvert invert based on this elevation in combination with geometry from the existing plans. Note that the existing plans indicate a roadway profile with a sag curve over the culvert and a constant invert elevation (no slope) for the pipe arch:

$El_{road} := 36.4 \text{ ft}$	Survey data point near center of the road near edge of culvert
$d_{cover} := 3.45 \text{ ft}$	Existing cover over top of pipe arch per Side Elevation in existing plans (F.G. El 36.55 - El 33.10 +/- = 3.45 ft)
$rise_{pipe} := 7 \cdot ft + 7 \cdot in = 7.58 \text{ ft}$	Approximate rise of pipe arch per existing plans
$El_{invert} := El_{road} - d_{cover} - rise_{pipe} = 25.37 \text{ ft}$	Estimated pipe arch invert based on existing plans
$El_{invert.upstream} := 26.35 \text{ ft}$	Actual invert elevation from survey, on S_Drainage_Invert layer
$El_{invert.downstream} := 26.06 \text{ ft}$	Actual invert elevation from survey, on S_Drainage_Invert layer
$length_{exist} := 70 \cdot ft$	Length of existing pipe arch
$slope_{exist} := \frac{El_{invert.upstream} - El_{invert.downstream}}{length_{exist}} = 0.0041$	Approximate slope of existing pipe arch. Note that the existing plans show a constant invert elevation of El 25.50 +/- (i.e. no slope).
$Invert_{diff.up} := El_{invert.upstream} - El_{invert} = 0.98 \text{ ft}$	Difference between actual inverts and theoretical inverts based on existing plans
$Invert_{diff.down} := El_{invert.downstream} - El_{invert} = 0.69 \text{ ft}$	Difference between actual inverts and theoretical inverts based on existing plans

As can be seen, the invert elevations do not agree very well with the estimated theoretical invert elevation based on the plans. Therefore, it appears that the pipe culvert was not built at the elevation indicated on the existing plans. (It is noted that the culvert invert and top of culvert elevations are marked with a +/- on the existing plans.) However, it does appear that the upstream invert elevation is reasonable to use since the measured arch rise matches well with the plans.

Determine the approximate depth of actual roadway materials over the culvert:

$$t_{cover} := El_{road} - rise_{pipe} - \left(\frac{El_{invert.upstream} + El_{invert.downstream}}{2} \right) = 2.61 \text{ ft}$$

Therefore, assume actual depth of roadway materials over the existing culvert is approximately 2' - 2.5'.

Ordinary High Water Elevation Estimate Based on Survey: (Used to validate existing conditions hydraulic model)

Based on the site inspection photos, there is rust staining associated with the ordinary high water elevation, and this staining is estimated from site visit photos to be approximately 18" higher than the water elevations measured during the 5/11/2017 site visit:



$$El_{\text{crown.up}} := El_{\text{invert.upstream}} + \text{rise}_{\text{pipe}} = 33.93 \text{ ft}$$

Estimated elevation of crown at upstream end of existing pipe arch

$$El_{\text{crown.down}} := El_{\text{invert.downstream}} + \text{rise}_{\text{pipe}} = 33.64 \text{ ft}$$

Estimated elevation of crown at downstream end of existing pipe arch

$$d_{\text{measure}} := 4 \cdot \text{ft} + 10 \cdot \text{in} = 4.83 \text{ ft}$$

Approximate measurement from top of pipe arch crown to water surface during 5/11/2017 site inspection

$$57 \cdot \text{in} = 4.75 \text{ ft}$$

Note that the distance measured to the water surface on 5-11-2017 is only 1" different than the 57 inches that was measured during the 2010 inspection (see Substructure Description in Underwater Dive Inspection Report dated 9-17-2013).

$$El_{\text{OHW}} := El_{\text{crown.up}} - d_{\text{measure}} + 18 \cdot \text{in} = 30.6 \text{ ft}$$

Estimated elevation of ordinary high water (OHW) based on rust staining in pipe arch

Estimated Water Surface Elevation at 5/11/2017:

$$El_{\text{h20.up}} := El_{\text{crown.up}} - d_{\text{measure}} = 29.1 \text{ ft}$$

Upstream estimated water elevation at 5/11/2017. From the site visit photos, it appears that the flow is below bankfull flow.

$$El_{\text{h20.down}} := El_{\text{crown.down}} - d_{\text{measure}} = 28.81 \text{ ft}$$

Downstream estimated water elevation at 5/11/2017. From the site visit photos, it appears that the flow is below bankfull flow.

CONCLUSION:

For the existing conditions hydraulic model, Q1.1 is 29.28 ft and Q2 is 30.16 at the upstream end of the existing culvert. Typically, the OHW elevation is in the range of elevations between the Q1.1 and Q2 flows. Since the estimated OHW is only 5.5" higher than the Q2 elevation, the model appears reasonable.

Proposed Streambed Elevations for Hydraulic Analysis:

Upstream survey spot elevations near the center of the channel are around El 25 +/-, and the downstream survey spot elevations near the center of the channel are around El 26 +/- (and higher as the Beaver Dam remnants are approached farther downstream). Therefore, the channel bottom is sloped against the flow of the stream at both ends of the culvert (i.e. the streambed elevation increases as Mays Brook approaches the culvert inlet, and as Mays Brook exits the culvert outlet.) Therefore, the streambed elevations beyond the limits of culvert replacement are not conducive to regrading the proposed streambed within the culvert to anything other than a minimum 0.5% +/- downstream slope.

Set proposed streambed elevations to be approximately the same as the existing elevations to limit the extent of streambed construction. Limits of streambed work are expected to be roughly the length needed to remove the existing pipe arch culvert and install the new box culvert, plus additional area needed for equipment at each end.

Boundary Conditions:

Set the boundary conditions to normal depth and provide actual streambed slopes at each end of the reach:

Slope of streambed at upstream end is determined using survey points 1748 and 1751:

$$El_{1748} := 25.42 \cdot \text{ft}$$

$$El_{1751} := 25.22 \cdot \text{ft}$$

$$\text{dist}_{\text{pts.up}} := 21.94 \cdot \text{ft}$$

$$\text{Boundary}_{\text{upstream}} := \frac{El_{1748} - El_{1751}}{\text{dist}_{\text{pts.up}}} = 0.00912$$

Slope of streambed at downstream end is determined using survey points 1393 and 1404:

$$El_{1393} := 25.82 \cdot \text{ft}$$

$$El_{1404} := 26.82 \cdot \text{ft}$$

$$\text{dist}_{\text{pts.down}} := 20.76 \cdot \text{ft}$$

$$\text{Boundary}_{\text{downstream}} := \frac{El_{1404} - El_{1393}}{\text{dist}_{\text{pts.down}}} = 0.04817$$

Presence of turbulence during low flow at this downstream boundary condition is consistent with HEC-RAS output in hydraulic profile.



Bankfull Elevations:

The following definition of bankfull elevation is from the August 2008 US Forest Service manual titled "Stream Simulation: An Ecological Approach to Providing Passage for Aquatic Organisms at Road Stream Crossings"

Identifying Bankfull Elevation

Bankfull elevation is the point where water fills the channel just before beginning to spill onto the flood plain. Bankfull discharge is the flow in the channel (cubic feet per second) when the water surface is at bankfull elevation. Bankfull discharge typically occurs every 1 to 2 years (Leopold et al. 1964), but its frequency of occurrence can vary depending on channel type, hydrologic regime, and watershed conditions. Bankfull is recognized as a surrogate for the range of flows that maintain channel shape and size (Emmett 2004). It is often referred to as the effective discharge of a stream: the flow responsible for moving the most sediment (Dunne and Leopold 1978) and maintaining channel form. This is why bankfull flow width is the minimum structure width required for simulating and maintaining channel form and functions through a crossing.

Strictly speaking, bankfull applies only to alluvial streams with flood plains. In alluvial stream types, use some or all of the following indicators for recognizing bankfull elevation, depending on the situation (Harrelson et al. 1994):

- Elevation of the edge of an active flood plain (flood plain may be present as discontinuous patches).
- Elevation associated with the top of the highest depositional features such as point- and mid-channel bars.
- Changes in slope on the banks [figure 5.5(a)].
- Changes in particle size of bank materials (from coarser to finer).
- Changes in vegetation types (from moss to lichens, from grass to alder, etc.).
- Stain lines on rock and scour lines in moss and lichens.

Be careful when using vegetation as a geomorphic indicator as vegetation in some channels is inundated by bankfull flows. Depositional features should be the primary geomorphic indicator for identifying bankfull flow in alluvial channels.

Not all indicators will be present at each cross section. They vary with channel type, and false or confusing indicators have to be sorted out at each site. Flagging and surveying many bankfull elevations along a substantial length of channel helps to eliminate misleading indicators and is essential for accurate identification. The ideal method for consistently identifying bankfull elevations is to plot the bankfull longitudinal profile using points where bankfull was confidently identified. Then—where the profile crosses any cross section—that is the bankfull elevation at that cross section (Emmett 2004).

Maine DOT provided a measured bankfull width of 20' in 4-28-2017 meeting, and requested that the culvert span be set to at least 1.2*bankfull width = 24' clear span. Determine approximate bankfull elevations at the proposed culvert:

1. From survey, S_Drainage_Waterway is located at approximately El 28 (upstream of existing culvert) and approximately El 27 - 28 (downstream of existing culvert). This is assumed to delineate the waterway at the time of survey.
2. From HEC-RAS cross section STA 1220.346 (downstream of existing culvert), left bank elevation is El 29.87 (looking downstream) & the right bank is not definitive. Bank elevations vary, but appear to be near El 29.5 to El 30 (+) or so.
3. From HEC-RAS analysis of existing culvert, upstream Q1.1 El = 29.28 & Q2 El = 30.16
4. From HEC-RAS analysis of existing culvert, downstream Q1.1 El = 29.17 & Q2 El = 29.91
5. In evaluating the grading of the stream through the culvert, the top of bank elevations need to not be set too high for two reasons:
 - Higher top of bank elevations cause the contours to be narrowed or pinched inside the box culvert, when compared to the upstream and downstream channel.
 - Higher top of bank elevations would be difficult to construct inside the culvert due to limited headroom. The headroom over the tops of the banks varies from roughly 3.5' to 3.83'. Headroom over the thalweg is roughly 6.5' to 6.83'.

Based on the above information, set the top of bank elevations at approximately El 29.3 in the upstream end of the culvert and approximately El 29.0 in the downstream end. The elevation drop of 0.3 ft is based on the existing Q2 elevation difference from upstream to downstream. This results in a channel cross-section under the structure with constant sideslopes. Setting the stream thalweg inverts to match closely the existing pipe arch elevations from survey, results in an upstream thalweg invert elevation at El 26.3 and a downstream thalweg invert elevation at El 26.0. This provides a streambed slope of approximately 0.0041 ft/ft over the estimated 73' culvert length.

Consideration was given to setting the thalweg elevations lower based on the low pool elevations immediately upstream and downstream of the existing culvert. However, this would essentially create a large pool, and might interrupt the natural undulation of the streambed. It would also create a larger disturbed area of work. Since Habitat Connectivity Design elements are being incorporated, it was decided that it would be best to minimize the disturbed area for environmental reasons, as well as to stay within the existing ROW.

Maximum channel slopes of 2:1 are proposed so that riprap isn't required. Flatter slopes of approximately 3.2:1 to 3.4:1 are located in the natural channel upstream where the stream width appears to be much wider than 20 feet. However, since Habitat Connectivity Design dictates that banks at the estimated BFW and bankfull elevation be continuous under the new structure, slopes steeper than existing are required to transition from the banks to the channel invert within the box culvert.

The proposed box was modeled for hydraulics based on the following information provided by T. Polson:

1. Top of box culvert located at El 34.17 (constant)
2. 16" top slab thickness
3. 9' rise (interior of culvert)

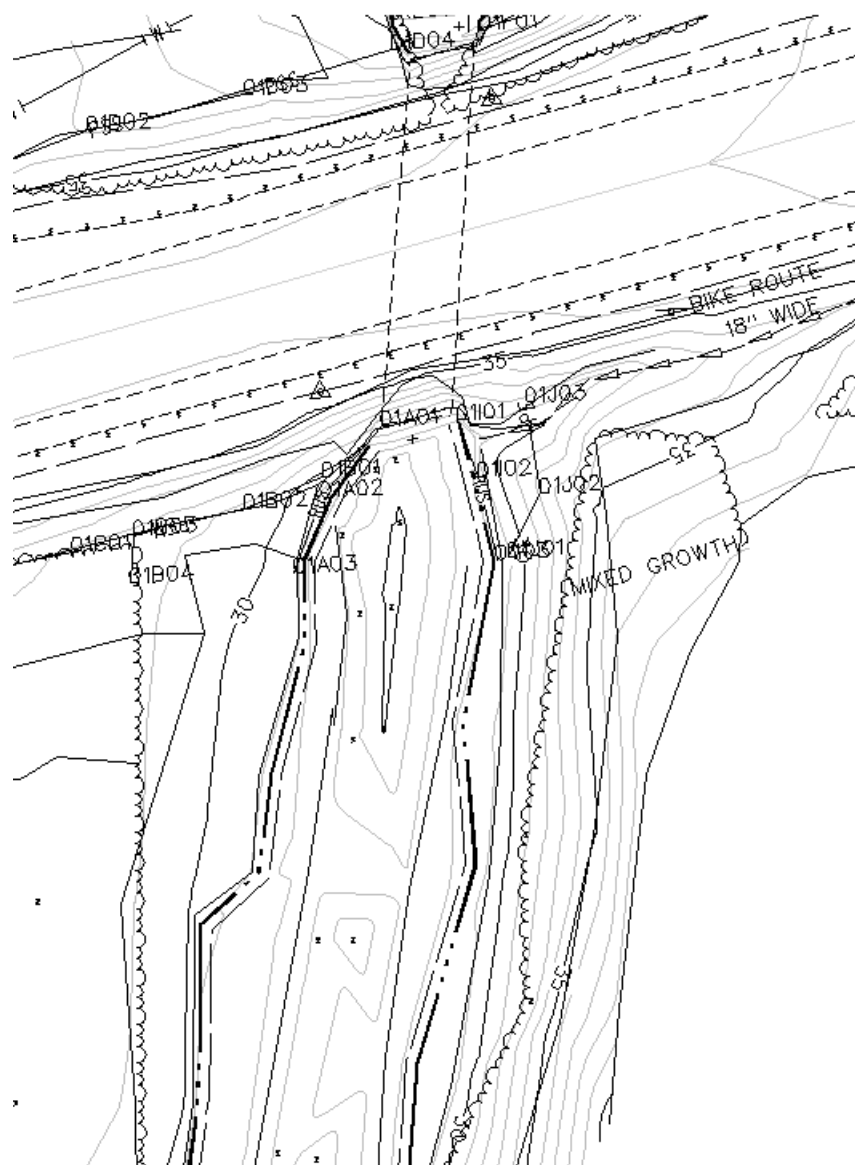
Geometric Input for HEC-RAS Analysis:

Geometric data (stream alignment and channel cross-sections) for HEC-RAS was prepared by Craig Sharp, and checked by Royd Benjamin.

Then the following data was added for the existing conditions:

1. Manning's n values for channel and overbank regions
2. Main channel bank stations were set based on controlling cross section topography.
3. Expansion and contraction coefficients, as well as ineffective flow areas, for sections just up and downstream of the culvert.
4. Reference Manual page 6-37 recommends weir coefficient = 3.0 for flow over elevated roadway approach embankments.
5. The existing culvert was modeled in HEC-RAS as a bridge structure since one of the new culvert options was modeled as a bridge. (HEC-RAS culvert models don't include the O-Series 3-sided structure, which was considered previously.)
6. Deck/Roadway Data Editor - High chord elevations were determined using contours and spot elevations along the high points of the roadway. Low chord elevations were based on the existing and proposed structures.
7. The preferred alternative is a precast concrete box 24' wide and 9' deep, with a natural streambed.

Existing Survey Information (Upstream of Culvert):



Lubec, Maine

Existing Culvert Arch Geometry for HEC-RAS

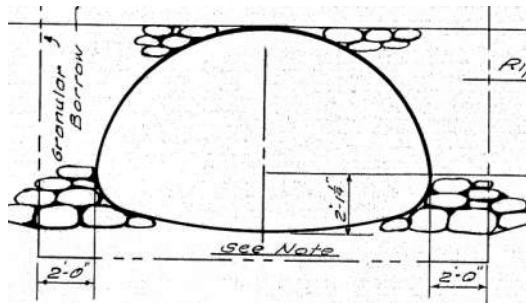
Calculated by K James 1/8/2018

Checked by:

Deck/Roadway Data Editor

High Chord / Roadway elevations are from contours and spot elevations

Upstream (ft)			Downstream (ft)		
Station	High Chord Elevation	Low Chord Elevation	Station	High Chord Elevation	Low Chord Elevation
0	37.9		0	37.4	
46.1	37.02		16.79	37.02	
96.27	36.47		66.9	36.47	
135.71	36.27		106.31	36.27	
173.9	36.25		144.71	36.25	
199.77	36.4		211.53	36.4	
268.08	37.06		242.52	37.06	
317.44	38.05		291.88	38.05	
364.58	39.2		339.01	39.2	
379.34	39.71		353.77	39.71	
396.3	40.2		382.52	40.6	



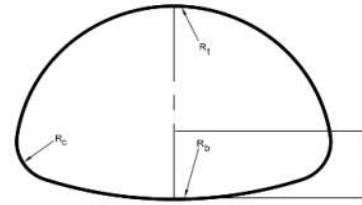
END ELEVATION

Required:

One Structural Plate Pipe Arch
11'-10" Span - 7'-7" Rise

MULTI-PLATE®

R_c Corner Radius = 18"



Pipe-Arch

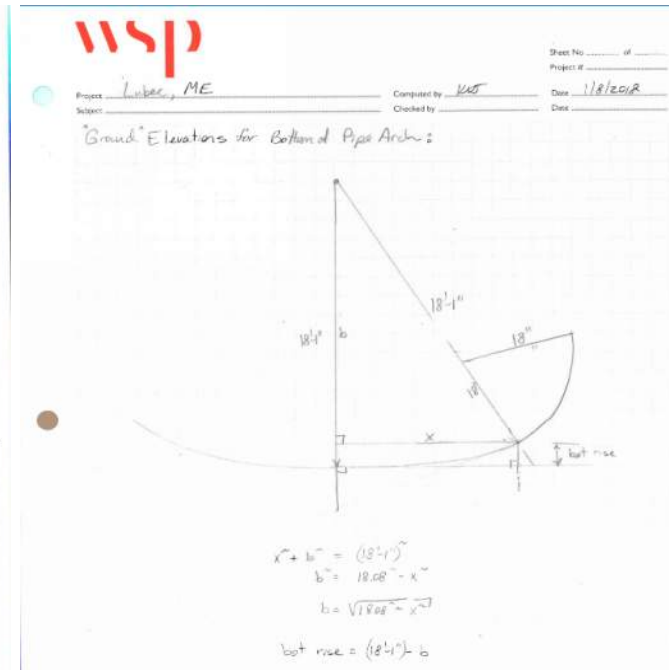
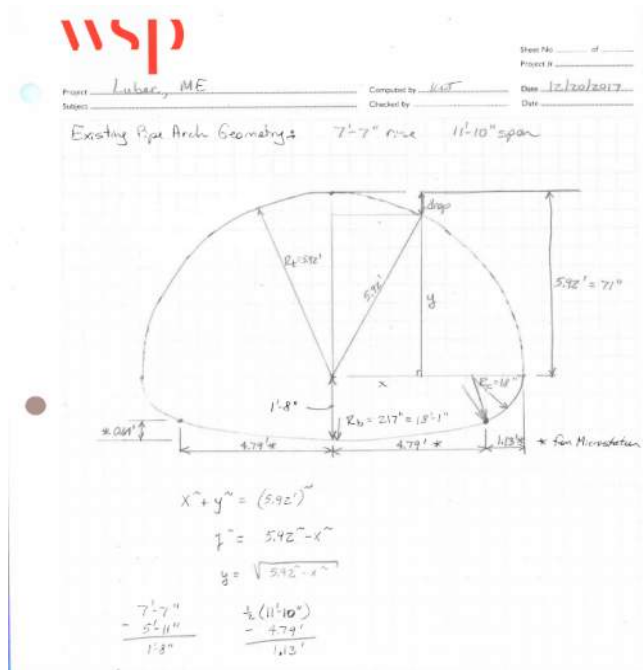
TABLE 19. MULTI-PLATE® PIPE-ARCH

Span Ft.-In.	Rise Ft.-In.	Area Sq. Ft.	R ₁ Inches	R ₂ Inches	C Inches**
6-1	4-7	22	37	77	27
6-4	4-9	24	38	99	25
6-9	4-11	26	41	84	29
7-0	5-1	29	42	105	27
7-3	5-3	31	44	137	25
7-8	5-5	33	47	110	28
7-11	5-7	36	48	139	27
8-2	5-9	38	49	183	25
8-7	5-11	41	52	141	28
8-10	6-1	43	53	179	26
9-4	6-3	46	56	145	30
9-6	6-5	49	57	178	28
9-9	6-7	52	58	228	26
10-3	6-9	55	62	179	29
10-8	6-11	58	65	153	33
10-11	7-1	61	66	181	31
11-5	7-3	64	69	158	34
11-7	7-5	68	70	184	32
11-10	7-7	71	71	217	30

Geometry data from Multi-Plate Pipe-Arch by Contech Engineered Solutions

Low Chord Elevations

26.35 ft	Upstream Invert Elevation - based on surveyed invert elevation
26.06 ft	Downstream Invert Elevation - based on surveyed invert elevation
7.58 ft	Pipe Arch Rise
33.93 ft	Estimated Upstream Top of Pipe Arch Crown Elevation
33.64 ft	Estimated Downstream Top of Pipe Arch Crown Elevation
11.83 ft	Pipe Arch Span
5.92 ft	Pipe Arch Top Radius
20	# of Sections for Stationing
0.296 ft	Station Increment



<u>Station</u>			
<u>Increment</u>		<u>Drop from Pipe Arch</u>	
<u>"x" (ft)</u>	<u>Vertical Offset "y" (ft)</u>	<u>Crown (ft)</u>	
0.00	5.92	0.00	At center of existing pipe
0.30	5.91	0.01	
0.59	5.89	0.03	
0.89	5.85	0.07	
1.18	5.80	0.12	
1.48	5.73	0.19	
1.78	5.64	0.27	
2.07	5.54	0.37	
2.37	5.42	0.49	
2.66	5.28	0.63	
2.96	5.12	0.79	
3.25	4.94	0.98	
3.55	4.73	1.18	
3.85	4.50	1.42	
4.14	4.23	1.69	
4.44	3.91	2.00	
4.73	3.55	2.37	
5.03	3.12	2.80	
5.33	2.58	3.34	
5.62	1.85	4.07	
5.92	0.00	5.92	At edge of existing pipe

"Ground" Elevations for Bottom of Pipe Arch

Because the replacement structure is expected to be a Conspan O Series structure, it must be modeled as a bridge in HEC-RAS. Therefore, the existing culvert must also be modeled as a bridge, and not as a culvert. This will be accomplished by modeling the ground elevations to be the shape of the bottom of the pipe arch.

18.083 ft Radius of Bottom of Pipe Arch

<u>Station</u>			
<u>Increment</u>		<u>Bottom Rise from</u>	
<u>"x" (ft)</u>	<u>Vertical Offset "b" (ft)</u>	<u>Invert (ft)</u>	
0.00	18.08	0.00	At center of existing pipe
0.30	18.08	0.00	
0.59	18.07	0.01	
0.89	18.06	0.02	
1.18	18.04	0.04	
1.48	18.02	0.06	
1.78	18.00	0.09	
2.07	17.96	0.12	
2.37	17.93	0.16	
2.66	17.89	0.20	
2.96	17.84	0.24	
3.25	17.79	0.30	
3.55	17.73	0.35	
3.85	17.67	0.41	
4.14	17.60	0.48	
4.44	17.53	0.55	
4.73	17.45	0.63	
5.03		0.73	
5.33		0.91	
5.62		1.22	
5.92		2.10	At edge of existing pipe, Rise measured in Microstation

Bridge Low Chord and "Ground" Elevations

194.91 ft Distance Along Upstream Station to Centerline of Existing Culvert (measured in Microstation)
 201.81 ft Distance Along Downstream Station to Centerline of Existing Culvert (measured in Microstation)

Upstream Station	Distance from Center of Pipe Arch (ft)	Drop from Pipe Arch Crown (ft)	Upstream Bridge Low Chord Elevation (ft)	Bottom Rise from Invert (ft)	Upstream "Ground" Elevations (ft)	Downstream Station	Downstream Bridge Low Chord Elevation (ft)	Downstream "Ground" Elevations (ft)	
188.99	-5.92	5.92	28.02	2.10	28.45	195.89	27.73	28.16	Begin Pipe Arch
189.29	-5.62	4.07	29.86	1.22	27.57	196.19	29.57	27.28	
189.59	-5.33	3.34	30.60	0.91	27.26	196.49	30.31	26.97	
189.88	-5.03	2.80	31.13	0.73	27.08	196.78	30.84	26.79	
190.18	-4.73	2.37	31.57	0.63	26.98	197.08	31.28	26.69	
190.47	-4.44	2.00	31.93	0.55	26.90	197.37	31.64	26.61	
190.77	-4.14	1.69	32.24	0.48	26.83	197.67	31.95	26.54	
191.06	-3.85	1.42	32.51	0.41	26.76	197.96	32.22	26.47	
191.36	-3.55	1.18	32.75	0.35	26.70	198.26	32.46	26.41	
191.66	-3.25	0.98	32.96	0.30	26.65	198.56	32.67	26.36	
191.95	-2.96	0.79	33.14	0.24	26.59	198.85	32.85	26.30	
192.25	-2.66	0.63	33.30	0.20	26.55	199.15	33.01	26.26	
192.54	-2.37	0.49	33.44	0.16	26.51	199.44	33.15	26.22	
192.84	-2.07	0.37	33.56	0.12	26.47	199.74	33.27	26.18	
193.14	-1.78	0.27	33.66	0.09	26.44	200.04	33.37	26.15	
193.43	-1.48	0.19	33.75	0.06	26.41	200.33	33.46	26.12	Center of Pipe Arch
193.73	-1.18	0.12	33.81	0.04	26.39	200.63	33.52	26.10	
194.02	-0.89	0.07	33.87	0.02	26.37	200.92	33.58	26.08	
194.32	-0.59	0.03	33.90	0.01	26.36	201.22	33.61	26.07	
194.61	-0.30	0.01	33.93	0.00	26.35	201.51	33.64	26.06	
194.91	0.00	0.00	33.93	0.00	26.35	201.81	33.64	26.06	
195.21	0.30	0.01	33.93	0.00	26.35	202.11	33.64	26.06	
195.50	0.59	0.03	33.90	0.01	26.36	202.40	33.61	26.07	
195.80	0.89	0.07	33.87	0.02	26.37	202.70	33.58	26.08	
196.09	1.18	0.12	33.81	0.04	26.39	202.99	33.52	26.10	
196.39	1.48	0.19	33.75	0.06	26.41	203.29	33.46	26.12	
196.69	1.78	0.27	33.66	0.09	26.44	203.59	33.37	26.15	
196.98	2.07	0.37	33.56	0.12	26.47	203.88	33.27	26.18	
197.28	2.37	0.49	33.44	0.16	26.51	204.18	33.15	26.22	
197.57	2.66	0.63	33.30	0.20	26.55	204.47	33.01	26.26	End Pipe Arch
197.87	2.96	0.79	33.14	0.24	26.59	204.77	32.85	26.30	
198.16	3.25	0.98	32.96	0.30	26.65	205.06	32.67	26.36	
198.46	3.55	1.18	32.75	0.35	26.70	205.36	32.46	26.41	
198.76	3.85	1.42	32.51	0.41	26.76	205.66	32.22	26.47	
199.05	4.14	1.69	32.24	0.48	26.83	205.95	31.95	26.54	
199.35	4.44	2.00	31.93	0.55	26.90	206.25	31.64	26.61	
199.64	4.73	2.37	31.57	0.63	26.98	206.54	31.28	26.69	
199.94	5.03	2.80	31.13	0.73	27.08	206.84	30.84	26.79	
200.24	5.33	3.34	30.60	0.91	27.26	207.14	30.31	26.97	
200.53	5.62	4.07	29.86	1.22	27.57	207.43	29.57	27.28	
200.83	5.92	5.92	28.02	2.10	28.45	207.73	27.73	28.16	

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HEC-RAS HEC-RAS 5.0.3 September 2016
U.S. Army Corps of Engineers
Hydrologic Engineering Center
609 Second Street
Davis, California

```

X      X  XXXXXX      XXXX      XXXX      XX      XXXX
X      X  X          X      X      X      X      X
X      X  X          X      X      X      X      X
XXXXXXXX XXXX      X      XXX XXXX      XXXXXX      XXXX
X      X  X          X      X      X      X      X
X      X  X          X      X      X      X      X
X      X  XXXXXX      XXXX      X      X      X      XXXXX

```

PROJECT DATA

Project Title: 52745 Lubec ME Mays Stream
Project File : 52745_Lubec_Rev1.prj
Run Date and Time: 3/28/2018 11:11:24 AM

Project in English units

Project Description:
Rte 189 Culvert over Mays Stream

PLAN DATA

Plan Title: Existing Conditions - Bridge Model
Plan File : j:\52745 MaineDOT Structures GEC\52745TSK08 - Lubec, Mays BR
2527\Hydraulic Information\HEC RAS\52745_Lubec_Rev1.p02

Geometry Title: Existing Pipe Arch Culvert - Bridge Mode
Geometry File : j:\52745 MaineDOT Structures GEC\52745TSK08 - Lubec, Mays
BR 2527\Hydraulic Information\HEC RAS\52745_Lubec_Rev1.g01

Flow Title : All Flows
Flow File : j:\52745 MaineDOT Structures GEC\52745TSK08 - Lubec, Mays
BR 2527\Hydraulic Information\HEC RAS\52745_Lubec_Rev1.f01

Plan Description:
Existing Conditions with Existing Pipe Arch Culvert

Plan Summary Information:

Number of:	Cross Sections =	9	Multiple Openings =	0
	Culverts =	0	Inline Structures =	0
	Bridges =	1	Lateral Structures =	0

Computational Information

Water surface calculation tolerance	=	0.01
Critical depth calculation tolerance	=	0.01
Maximum number of iterations	=	20
Maximum difference tolerance	=	0.3
Flow tolerance factor	=	0.001

Computation Options

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Critical depth computed only where necessary
Conveyance Calculation Method: At breaks in n values only
Friction Slope Method: Average Conveyance
Computational Flow Regime: Mixed Flow

FLOW DATA

Flow Title: All Flows
Flow File : j:\52745 MaineDOT Structures GEC\52745TSK08 - Lubec, Mays BR
2527\Hydraulic Information\HEC RAS\52745_Lubec_Rev1.f01

Flow Data (cfs)

River 5-Year 500-Year	Reach 10-Year	RS 25-Year	1.1-Year 50-Year	2-Year 100-Year
Mays Stream 159 489	Rte 189 Culvert 201	1464.915 263	48 309	100 361

Boundary Conditions

River Downstream	Reach	Profile	Upstream
Mays Stream Normal S = 0.048	Rte 189 Culvert	1.1-Year	Normal S = 0.009
Mays Stream Normal S = 0.048	Rte 189 Culvert	2-Year	Normal S = 0.009
Mays Stream Normal S = 0.048	Rte 189 Culvert	5-Year	Normal S = 0.009
Mays Stream Normal S = 0.048	Rte 189 Culvert	10-Year	Normal S = 0.009
Mays Stream Normal S = 0.048	Rte 189 Culvert	25-Year	Normal S = 0.009
Mays Stream Normal S = 0.048	Rte 189 Culvert	50-Year	Normal S = 0.009
Mays Stream Normal S = 0.048	Rte 189 Culvert	100-Year	Normal S = 0.009
Mays Stream Normal S = 0.048	Rte 189 Culvert	500-Year	Normal S = 0.009

GEOMETRY DATA

Geometry Title: Existing Pipe Arch Culvert - Bridge Mode
Geometry File : j:\52745 MaineDOT Structures GEC\52745TSK08 - Lubec, Mays BR
2527\Hydraulic Information\HEC RAS\52745_Lubec_Rev1.g01

CROSS SECTION

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RIVER: Mays Stream
REACH: Rte 189 Culvert RS: 1464.915

INPUT

Description:

Station Elevation Data			num= 35								
Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev
0	34.37	9.24	33.77	13.7	33.46	27.5	33.04	30.43	32.97		
36.6	32.74	44.2	32.19	52.29	32.03	80.2	31.82	90.94	31.84		
92.98	31.82	98.81	31.59	118.92	30.49	123.51	30	124.28	29.9		
127.28	29.57	127.87	28.8	128.1	28.41	132.52	28.18	139.12	27.69		
141.34	27.1	142.96	26.55	146.02	25.87	148.78	25.45	149.55	25.33		
159.21	27.39	160.76	27.68	164.5	28.2	164.86	28.73	166.32	29.11		
179.31	32.73	184.78	34.54	186.16	35.12	188.16	36	192.95	38		

Manning's n Values			num= 3		
Sta	n Val	Sta	n Val	Sta	n Val
0	.12	127.28	.05	166.32	.12

Bank Sta:	Left	Right	Lengths:	Left Channel	Right	Coeff	Contr.	Expan.
	127.28	166.32		54	54		.1	.3

CROSS SECTION

RIVER: Mays Stream
REACH: Rte 189 Culvert RS: 1410.913

INPUT

Description:

Station Elevation Data			num= 34								
Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev
0	34	7.74	33.34	10.35	33.11	10.9	33.07	25.74	31.83		
44.5	31.87	44.71	31.88	44.87	31.87	51.14	31.63	57.95	31.49		
66.47	31.18	68.28	31.07	72.91	30.68	78.81	30.07	79.5	30		
84.62	29.45	85.84	29.13	86.48	28.69	89.91	28.58	96.71	27.88		
98.42	27.78	100.45	27.16	104.13	26.2	111.16	26.01	116.11	27.34		
117.24	27.48	124.95	28.35	126.81	28.9	128.82	29.03	134.5	30.9		
141.27	33.18	145.11	35.52	151.93	37.33	153.3	38				

Manning's n Values			num= 3		
Sta	n Val	Sta	n Val	Sta	n Val
0	.12	84.62	.05	128.82	.12

Bank Sta:	Left	Right	Lengths:	Left Channel	Right	Coeff	Contr.	Expan.
	84.62	128.82		67	67		.3	.5

CROSS SECTION

RIVER: Mays Stream
REACH: Rte 189 Culvert RS: 1343.914

INPUT

Description: Upstream at Rte 189

Station Elevation Data			num= 53								
Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev
0	35	16.24	34.31	23.76	34	25.61	33.92	30.9	33.85		
35.14	34.35	54.32	34.56	56.28	34.8	61.09	34.74	75.85	34.58		
86.52	34.23	88.97	34.13	112.14	32.65	114.94	32.48	115.45	32.47		
124.68	32.14	129.1	32.06	153.95	31.4	155.97	31.07	161.57	30.87		

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170.56	30.29	172.99	30.08	173.57	30	178.03	29.33	179.85	28.66
180.35	28.19	182.66	27.52	189.52	25.79	192.1	25.05	193.7	24.79
194.51	24.97	194.91	25.07	205.74	27.7	208.51	27.96	209.48	28.26
210.25	28.64	221.06	32.42	229.32	35.95	229.65	35.99	235.68	36.4
240.78	36.61	252.28	36.88	264.88	37.1	289.42	37.85	294.66	38.59
295.48	38.65	313.84	39.99	325.25	40.83	344.42	41.59	349.47	41.33
390.27	39.25	391.08	39.27	396.3	39.91				

Manning's n Values num= 3

Sta	n Val	Sta	n Val	Sta	n Val
0	.12	179.85	.05	210.25	.12

Bank Sta: Left Right Lengths: Left Channel Right Coeff Contr. Expan.

179.85	210.25	94.69	94.69	94.69	.3	.5
--------	--------	-------	-------	-------	----	----

Ineffective Flow num= 2

Sta L	Sta R	Elev	Permanent
0	179.3	35	F
215	396.3	35	F

BRIDGE

RIVER: Mays Stream
 REACH: Rte 189 Culvert RS: 1294.20

INPUT

Description: Existing Pipe Arch Culvert

Distance from Upstream XS = 14.7

Deck/Roadway width = 70

Weir Coefficient = 3

Upstream Deck/Roadway Coordinates

num= 51

Sta	Hi	Cord	Lo	Cord	Sta	Hi	Cord	Lo	Cord	Sta	Hi	Cord	Lo	Cord
0	37.9				46.1	37.02				96.27	36.47			
135.71	36.27				173.9	36.25				188.99	36.3		28.02	
189.29	36.3	29.86			189.59	36.3	30.6			189.88	36.3		31.13	
190.18	36.3	31.57			190.47	36.3	31.93			190.77	36.3		32.24	
191.06	36.3	32.51			191.36	36.3	32.75			191.66	36.3		32.96	
191.95	36.3	33.14			192.25	36.3	33.3			192.54	36.3		33.44	
192.84	36.3	33.56			193.14	36.3	33.66			193.43	36.3		33.75	
193.73	36.3	33.81			194.02	36.3	33.87			194.32	36.4		33.9	
194.61	36.4	33.93			194.91	36.4	33.93			195.21	36.4		33.93	
195.5	36.4	33.9			195.8	36.4	33.87			196.09	36.4		33.81	
196.39	36.4	33.75			196.69	36.4	33.66			196.98	36.4		33.56	
197.28	36.4	33.44			197.57	36.4	33.3			197.87	36.4		33.14	
198.16	36.4	32.96			198.46	36.4	32.75			198.76	36.4		32.51	
199.05	36.4	32.24			199.35	36.4	31.93			199.64	36.4		31.57	
199.94	36.4	31.13			200.24	36.4	30.6			200.53	36.4		29.86	
200.83	36.4	28.02			268.08	37.06				317.44	38.05			
364.58	39.2				379.34	39.71				396.3	40.2			

Upstream Bridge Cross Section Data

Station Elevation Data num= 89

Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev
0	35	16.24	34.31	23.76	34	25.61	33.92	30.9	33.85
35.14	34.35	54.32	34.56	56.28	34.8	61.09	34.74	75.85	34.58
86.52	34.23	88.97	34.13	112.14	32.65	114.94	32.48	115.45	32.47
124.68	32.14	129.1	32.06	153.95	31.4	155.97	31.07	161.57	30.87
170.56	30.29	172.99	30.08	173.57	30	178.03	29.33	179.85	28.66
180.35	28.19	182.66	27.52	188.99	28.45	189.29	27.57	189.59	27.26
189.88	27.08	190.18	26.98	190.47	26.9	190.77	26.83	191.06	26.76
191.36	26.7	191.66	26.65	191.95	26.59	192.25	26.55	192.54	26.51
192.84	26.47	193.14	26.44	193.43	26.41	193.73	26.39	194.02	26.37

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194.32	26.36	194.61	26.35	194.91	26.35	195.21	26.35	195.5	26.36
195.8	26.37	196.09	26.39	196.39	26.41	196.69	26.44	196.98	26.47
197.28	26.51	197.57	26.55	197.87	26.59	198.16	26.65	198.46	26.7
198.76	26.76	199.05	26.83	199.35	26.9	199.64	26.98	199.94	27.08
200.24	27.26	200.53	27.57	200.83	28.45	205.74	27.7	208.51	27.96
209.48	28.26	210.25	28.64	221.06	32.42	229.32	35.95	229.65	35.99
235.68	36.4	240.78	36.61	252.28	36.88	264.88	37.1	289.42	37.85
294.66	38.59	295.48	38.65	313.84	39.99	325.25	40.83	344.42	41.59
349.47	41.33	390.27	39.25	391.08	39.27	396.3	39.91		

Manning's n Values num= 3

Sta	n Val	Sta	n Val	Sta	n Val
0	.12	179.85	.05	210.25	.12

Bank Sta: Left Right Coeff Contr. Expan.

Left	Right	Coeff	Contr.	Expan.
179.85	210.25	.3	.5	

Ineffective Flow num= 2

Sta L	Sta R	Elev	Permanent
0	179.3	35	F
215	396.3	35	F

Downstream Deck/Roadway Coordinates

num= 52											
Sta	Hi	Cord	Lo Cord	Sta	Hi	Cord	Lo Cord	Sta	Hi	Cord	Lo Cord
0	37.4			16.79	37.02			66.9	36.47		
106.31	36.27			144.71	36.25			195.89	36.4		27.73
196.19	36.4	29.57		196.49	36.4	30.31		196.78	36.4		30.84
197.08	36.4	31.28		197.37	36.4	31.64		197.67	36.4		31.95
197.96	36.4	32.22		198.26	36.4	32.46		198.56	36.4		32.67
198.85	36.4	32.85		199.15	36.4	33.01		199.44	36.4		33.15
199.74	36.4	33.27		200.04	36.4	33.37		200.33	36.4		33.46
200.63	36.4	33.52		200.92	36.4	33.58		201.22	36.4		33.61
201.51	36.4	33.64		201.81	36.4	33.64		202.11	36.4		33.64
202.4	36.4	33.61		202.7	36.4	33.58		202.99	36.4		33.52
203.29	36.4	33.46		203.59	36.4	33.37		203.88	36.4		33.27
204.18	36.4	33.15		204.47	36.4	33.01		204.77	36.4		32.85
205.06	36.4	32.67		205.36	36.4	32.46		205.66	36.4		32.22
205.95	36.4	31.95		206.25	36.4	31.64		206.54	36.4		31.28
206.84	36.4	30.84		207.14	36.4	30.31		207.43	36.4		29.57
207.73	36.4	27.73		211.53	36.4			242.52	37.06		
291.88	38.05			339.01	39.2			353.77	39.71		
382.52	40.6										

Downstream Bridge Cross Section Data

num= 100									
Station	Elevation	Data	num=	100					
Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev
0	38.14	2.06	38.04	16.93	37.35	28.07	36.84	41.6	35.92
54.77	35.49	54.92	35.48	61.9	34.92	68.14	34.7	82.26	34.7
89.13	34.44	98.08	34.01	103.41	33.9	104.85	33.84	105.94	33.8
126.58	33.28	129.67	33.2	132.17	33.11	141.94	32.37	150.27	31.76
151.8	31.64	161.78	31.15	163.83	30.78	173.33	29.36	174.7	29.51
178.29	29.38	185.66	28.89	187.17	28.47	188.38	27.76	188.4	27.84
188.44	27.77	188.47	27.73	192.05	24.97	195.89	28.16	196.19	27.28
196.49	26.97	196.78	26.79	197.08	26.69	197.37	26.61	197.67	26.54
197.96	26.47	198.26	26.41	198.56	26.36	198.85	26.3	199.15	26.26
199.44	26.22	199.74	26.18	200.04	26.15	200.33	26.12	200.63	26.1
200.92	26.08	201.22	26.07	201.51	26.06	201.81	26.06	202.11	26.06
202.4	26.07	202.7	26.08	202.99	26.1	203.29	26.12	203.59	26.15
203.88	26.18	204.18	26.22	204.47	26.26	204.77	26.3	205.06	26.36
205.36	26.41	205.66	26.47	205.95	26.54	206.25	26.61	206.54	26.69
206.84	26.79	207.14	26.97	207.43	27.28	207.73	28.16	211.06	27.72
212.43	27.93	217.11	29.26	217.86	29.45	218.94	29.73	221.6	30.96
227.58	33.76	229.66	34.55	230.98	34.81	234.42	35.09	248.66	35.44

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254.81	35.68	269.33	36.14	275.76	36.29	281.4	36.52	296.85	36.86
313.42	37.34	315.68	37.43	317.4	37.35	337.86	37.52	338.24	37.19
342.15	37.32	356.68	37.18	367.49	37.61	378.96	37.88	382.52	38

Manning's n values num= 3

Sta	n Val	Sta	n Val	Sta	n Val
0	.12	188.44	.05	212.43	.12

Bank Sta: Left Right Coeff Contr. Expan.
188.44 212.43 .3 .5

Ineffective Flow num= 2

Sta L	Sta R	Elev	Permanent
0	186	33	F
208.8	382.52	33	F

Upstream Embankment side slope = 1.4 horiz. to 1.0 vertical
Downstream Embankment side slope = 1.4 horiz. to 1.0 vertical
Maximum allowable submergence for weir flow = .95
Elevation at which weir flow begins =
Energy head used in spillway design =
Spillway height used in design =
Weir crest shape = Broad Crested

Number of Bridge Coefficient Sets = 1

Low Flow Methods and Data

Energy

Selected Low Flow Methods = Highest Energy Answer

High Flow Method

Pressure and weir flow

Submerged Inlet Cd	=
Submerged Inlet + Outlet Cd	= .8
Max Low Cord	=

Additional Bridge Parameters

Add Friction component to Momentum

Do not add weight component to Momentum

Class B flow critical depth computations use critical depth
inside the bridge at the upstream end

Criteria to check for pressure flow = Upstream energy grade line

CROSS SECTION

RIVER: Mays Stream

REACH: Rte 189 Culvert RS: 1249.223

INPUT

Description: Downstream at Rte 189

Station Elevation Data num= 63

Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev
0	38.14	2.06	38.04	16.93	37.35	28.07	36.84	41.6	35.92
54.77	35.49	54.92	35.48	61.9	34.92	68.14	34.7	82.26	34.7
89.13	34.44	98.08	34.01	103.41	33.9	104.85	33.84	105.94	33.8
126.58	33.28	129.67	33.2	132.17	33.11	141.94	32.37	150.27	31.76
151.8	31.64	161.78	31.15	163.83	30.78	173.33	29.36	174.7	29.51
178.29	29.38	185.66	28.89	187.17	28.47	188.38	27.76	188.4	27.84
188.44	27.77	188.47	27.73	192.05	24.97	202.06	25.36	202.93	25.4
204.16	25.51	204.31	25.51	211.06	27.72	212.43	27.93	217.11	29.26
217.86	29.45	218.94	29.73	221.6	30.96	227.58	33.76	229.66	34.55
230.98	34.81	234.42	35.09	248.66	35.44	254.81	35.68	269.33	36.14
275.76	36.29	281.4	36.52	296.85	36.86	313.42	37.34	315.68	37.43

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317.4	37.35	337.86	37.52	338.24	37.19	342.15	37.32	356.68	37.18
367.49	37.61	378.96	37.88	382.52	38				

Manning's n Values			num=	3	
Sta	n Val	Sta	n Val	Sta	n Val
0	.12	188.44	.05	212.43	.12

Bank Sta:	Left	Right	Lengths:	Left	Channel	Right	Coeff	Contr.	Expan.
	188.44	212.43		28.88	28.88	28.88		.3	.5
Ineffective Flow			num=	2					
Sta L	Sta R	Elev	Permanent						
0	186	33	F						
208.8	382.52	33	F						

CROSS SECTION

RIVER: Mays Stream
 REACH: Rte 189 Culvert RS: 1220.346

INPUT

Description:

Station Elevation Data			num=	34	
Sta	Elev	Sta	Elev	Sta	Elev
0	34.49	1.89	34.27	4.14	34
19.6	32.26	21.97	32	43.67	29.71
44.37	29.65	44.48	29.64	45.02	29.64
67.45	29.85	74.08	29.87	76.65	28.69
81.32	26.29	82.42	26.44	94.08	26.41
113.19	27.97	114.88	29.41	116.92	29.9
124.76	31.39	130.69	34.53	131.98	34.88

Manning's n Values			num=	3	
Sta	n Val	Sta	n Val	Sta	n Val
0	.12	74.08	.05	114.88	.12

Bank Sta:	Left	Right	Lengths:	Left	Channel	Right	Coeff	Contr.	Expan.
	74.08	114.88		25.65	25.65	25.65		.1	.3
Ineffective Flow			num=	1					
Sta L	Sta R	Elev	Permanent						
122	132.97	33	F						

CROSS SECTION

RIVER: Mays Stream
 REACH: Rte 189 Culvert RS: 1194.694

INPUT

Description:

Station Elevation Data			num=	35	
Sta	Elev	Sta	Elev	Sta	Elev
0	32.28	2.92	32.02	3.23	32
9.46	31.98	10.15	31.92	11.77	31.43
37.47	30.33	47.47	29.6	51.91	29.45
66.6	29.22	67.81	29.64	73.65	29.21
83.29	27.27	84.78	27.26	86.13	27.35
92.28	29.93	94.03	29.9	96.33	29.43
109.42	30.3	112.86	31.3	114.5	31.92

Manning's n Values			num=	3	
Sta	n Val	Sta	n Val	Sta	n Val
0	.12	75.85	.05	92.11	.12

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Bank Sta:	Left	Right	Lengths:	Left	Channel	Right	Coeff	Contr.	Expan.
	75.85	92.11		36.45	36.45	36.45		.1	.3

CROSS SECTION

RIVER: Mays Stream
REACH: Rte 189 Culvert RS: 1158.246

INPUT

Description:

Station Elevation Data			num=	29					
Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev
0	32.02	.26	32	16.9	31.08	17.02	31.08	17.89	31.05
18.18	31.03	19.25	31	27.51	30.92	27.95	30.91	32.7	31.13
37.83	30.4	42.79	29.43	48.72	29.18	52.61	29.24	59.69	28.62
72.5	27.97	76.01	27.51	76.81	27.39	87.02	26.35	96.45	26.96
99.85	27.27	102.32	27.48	102.35	27.52	107.06	29.62	107.34	29.74
111.85	31.74	112.42	32.03	118.5	35.27	122.84	36		

Manning's n Values			num=	3
Sta	n Val	Sta	n Val	Sta
0	.12	72.5	.05	102.35
				.12

Bank Sta:	Left	Right	Lengths:	Left	Channel	Right	Coeff	Contr.	Expan.
	72.5	102.35		27.38	27.38	27.38		.1	.3

CROSS SECTION

RIVER: Mays Stream
REACH: Rte 189 Culvert RS: 1130.865

INPUT

Description:

Station Elevation Data			num=	28					
Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev
0	32.04	.41	32	2.46	31.8	18.76	30.49	32.34	30
39.2	29.74	41.91	29.62	45.5	29.78	55.68	30.11	65.58	30.52
71.9	30.56	82.98	30.66	88.32	30.74	90.96	30.66	92.42	30.49
93.25	28.66	94.29	28.39	99.29	27.11	99.73	27.14	102.8	27.61
103.72	28.32	105.52	28.69	113.06	31.11	113.91	31.33	114.68	31.75
120.78	36.3	126.67	36.87	128.26	37.07				

Manning's n Values			num=	3
Sta	n Val	Sta	n Val	Sta
0	.12	92.42	.05	113.06
				.12

Bank Sta:	Left	Right	Lengths:	Left	Channel	Right	Coeff	Contr.	Expan.
	92.42	113.06		38.87	38.87	38.87		.1	.3

CROSS SECTION

RIVER: Mays Stream
REACH: Rte 189 Culvert RS: 1091.992

INPUT

Description:

Station Elevation Data			num=	32					
Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev
0	32.27	1.99	32	13.86	31.02	20.66	30.43	21.68	30.34

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23.4	30.17	25.07	30.03	26.09	29.99	31.27	29.72	74.76	27.49
78.63	27.24	79.5	27.25	80.46	27.2	87.91	27.89	89.44	28.04
92.22	27.92	92.62	27.84	93.55	26.93	101.86	26.34	102.98	26.24
110.7	26.88	111.85	26.97	112.08	27.08	117.74	28.09	118.63	28.25
122.56	29.19	128.89	33.03	135.1	34.96	140.02	37.09	140.36	36.93
144.23	36.31	144.66	36.45						

Manning's n Values num= 3

Sta	n Val	Sta	n Val	Sta	n Val
0	.12	92.62	.05	117.74	.12

Bank Sta: Left Right Coeff Contr. Expan.

92.62	117.74	.1	.3
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Lubec, Maine

Proposed Culvert Geometry for HEC-RAS

Calculated by K James 9/30/2018

Checked by:

HEC-RAS Deck/Roadway Data Editor

High Chord / Roadway elevations are from contours and spot elevations

<u>Upstream (ft)</u>			<u>Downstream (ft)</u>		
Station	High Chord Elevation	Low Chord Elevation	Station	High Chord Elevation	Low Chord Elevation
0	37.9		0	37.4	
46.1	37.02		16.79	37.02	
96.27	36.47		66.9	36.47	
135.71	36.27		106.31	36.27	
173.9	36.25		144.71	36.25	
199.77	36.4		211.53	36.4	
268.08	37.06		242.52	37.06	
317.44	38.05		291.88	38.05	
364.58	39.2		339.01	39.2	
379.34	39.71		353.77	39.71	
396.3	40.2		382.52	40.6	

Low Chord Elevations - Upstream

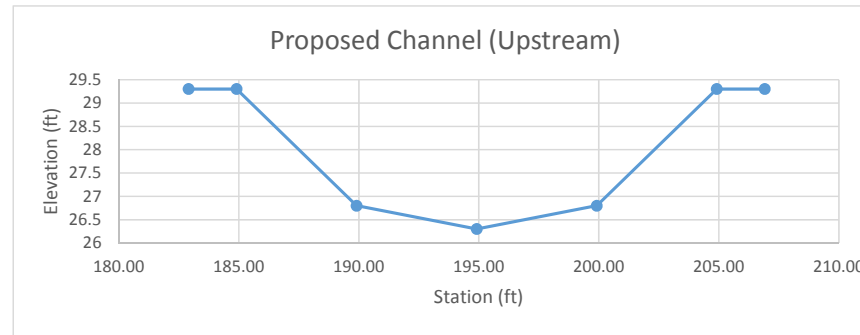
34.1666667 ft	Proposed box culvert top of box elevation is at 34.17
1.33333333 ft	Thickness of box top slab
32.8333333 ft	Crown elevation inside box culvert
9 ft	Rise of box culvert
23.8333333 ft	Box culvert invert elevation
2.17 ft	Min. thickness of stream materials in culvert (downstream)
2.46666667 ft	Min. thickness of stream materials in culvert (upstream)
194.91	Upstream station at midspan of proposed culvert
203.15	Downstream station at midspan of proposed culvert

HEC-RAS Internal Bridge Cross Sections - Proposed Channel Geometry under New Structure

Upstream

Station	Channel Elevation	Slope
182.91	29.3	
184.91	29.3	
189.91	26.8	2
194.91	26.3	10
199.91	26.8	10
204.91	29.3	2
206.91	29.3	

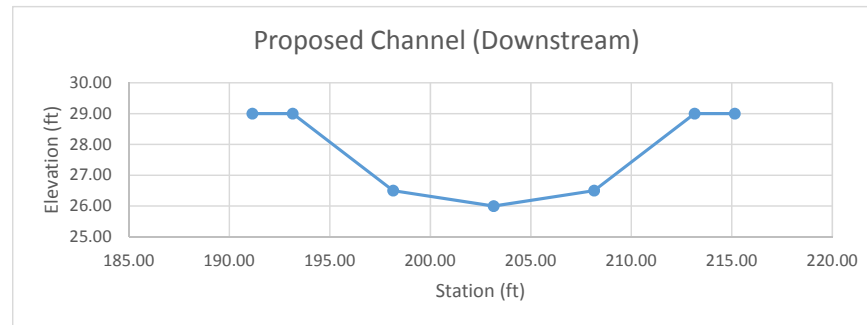
24.00 ft
20 ft
1.2*BFW
BFW



Downstream

Station	Channel Elevation	Slope
191.15	29.00	
193.15	29.00	
198.15	26.50	2
203.15	26.00	10
208.15	26.50	10
213.15	29.00	2
215.15	29.00	

24.00 ft
20 ft
1.2*BFW
BFW



Lubec, Maine

Post Project - Deck & Roadway Data

Calculated by K James 9/30/2018

Checked by:

<u>Upstream (ft)</u>			<u>Downstream (ft)</u>		
Station	High Chord	Low Chord	Station	High Chord	Low Chord
0	37.9		0	37.4	
46.1	37.02		16.79	37.02	
96.27	36.47		66.9	36.47	
135.71	36.27		106.31	36.27	
173.9	36.25		144.71	36.25	
182.92	36.3	32.83	191.15	36.35	32.83
199.77	36.4	32.83	193.15	36.36	32.83
206.91	36.47	32.83	198.15	36.37	32.83
268.08	37.06		203.15	36.38	32.83
317.44	38.05		208.15	36.39	32.83
364.58	39.2		211.53	36.4	32.83
379.34	39.71		213.15	36.43	32.83
396.3	40.2		215.15	36.48	32.83
			242.52	37.06	
			291.88	38.05	
			339.01	39.2	
			353.77	39.71	
			382.52	40.6	

Post Project - Internal Bridge Cross Sections

Upstream Raw Data				Upstream Final Data				Downstream Raw Data				Downstream Final Data			
prior to adding prop. channel				with proposed channel				prior to adding prop. channel				with proposed channel			
Station	Elevation	n		Station	Elevation	n		Station	Elevation	n		Station	Elevation	n	
0	35	0.12		0	35	0.12		0	38.14	0.12		0	38.14	0.12	
16.24	34.31			16.24	34.31			2.06	38.04			2.06	38.04		
23.76	34			23.76	34			16.93	37.35			16.93	37.35		
25.61	33.92			25.61	33.92			28.07	36.84			28.07	36.84		
30.9	33.85			30.9	33.85			41.6	35.92			41.6	35.92		
35.14	34.35			35.14	34.35			54.77	35.49			54.77	35.49		
54.32	34.56			54.32	34.56			54.92	35.48			54.92	35.48		
56.28	34.8			56.28	34.8			61.9	34.92			61.9	34.92		
61.09	34.74			61.09	34.74			68.14	34.7			68.14	34.7		
75.85	34.58			75.85	34.58			82.26	34.7			82.26	34.7		
86.52	34.23			86.52	34.23			89.13	34.44			89.13	34.44		
88.97	34.13			88.97	34.13			98.08	34.01			98.08	34.01		
112.14	32.65			112.14	32.65			103.41	33.9			103.41	33.9		
114.94	32.48			114.94	32.48			104.85	33.84			104.85	33.84		
115.45	32.47			115.45	32.47			105.94	33.8			105.94	33.8		
124.68	32.14			124.68	32.14			126.58	33.28			126.58	33.28		
129.1	32.06			129.1	32.06			129.67	33.2			129.67	33.2		
153.95	31.4			153.95	31.4			132.17	33.11			132.17	33.11		
155.97	31.07			155.97	31.07			141.94	32.37			141.94	32.37		
161.57	30.87			161.57	30.87			150.27	31.76			150.27	31.76		
170.56	30.29			170.56	30.29			151.8	31.64			151.8	31.64		
172.99	30.08			172.99	30.08			161.78	31.15			161.78	31.15		
173.57	30			173.57	30			163.83	30.78			163.83	30.78		
178.03	29.33			178.03	29.33			173.33	29.36			173.33	29.36		
179.85	28.66	0.05		179.85	28.66			174.7	29.51			174.7	29.51		
180.35	28.19			180.35	28.19			178.29	29.38			178.29	29.38		
182.66	27.52			182.66	27.52			185.66	28.89			185.66	28.89		
189.52	25.79			182.91	29.3	0.05		187.17	28.47			187.17	28.47		
192.1	25.05			184.91	29.3			188.38	27.76			188.38	27.76		
193.7	24.79			189.91	26.8			188.4	27.84			188.4	27.84		
194.51	24.97			194.91	26.3			188.44	27.77	0.05		188.44	27.77		
194.91	25.07			199.91	26.8			188.47	27.73			188.47	27.73		
205.74	27.7			204.91	29.3			192.05	24.97			191.15	29	0.05	
208.51	27.96			206.91	29.3			202.06	25.36			193.15	29		
209.48	28.26			208.51	27.96	0.12		202.93	25.4			198.15	26.5		
210.25	28.64	0.12		209.48	28.26			204.16	25.51			203.15	26		
221.06	32.42			210.25	28.64			204.31	25.51			208.15	26.5		
229.32	35.95			221.06	32.42			211.06	27.72			213.15	29		
229.65	35.99			229.32	35.95			212.43	27.93	0.12		215.15	29		
235.68	36.4			229.65	35.99			217.11	29.26			217.11	29.26	0.12	
240.78	36.61			235.68	36.4			217.86	29.45			217.86	29.45		
252.28	36.88			240.78	36.61			218.94	29.73			218.94	29.73		
264.88	37.1			252.28	36.88			221.6	30.96			221.6	30.96		
289.42	37.85			264.88	37.1			227.58	33.76			227.58	33.76		
294.66	38.59			289.42	37.85			229.66	34.55			229.66	34.55		
295.48	38.65			294.66	38.59			230.98	34.81			230.98	34.81		
313.84	39.99			295.48	38.65			234.42	35.09			234.42	35.09		
325.25	40.83			313.84	39.99			248.66	35.44			248.66	35.44		
344.42	41.59			325.25	40.83			254.81	35.68			254.81	35.68		
349.47	41.33			344.42	41.59			269.33	36.14			269.33	36.14		
390.27	39.25			349.47	41.33			275.76	36.29			275.76	36.29		
391.08	39.27			390.27	39.25			281.4	36.52			281.4	36.52		
396.3	39.91			391.08	39.27			296.85	36.86			296.85	36.86		
				396.3	39.91			313.42	37.34			313.42	37.34		
								315.68	37.43			315.68	37.43		
								317.4	37.35			317.4	37.35		
								337.86	37.52			337.86	37.52		
								338.24	37.19			338.24	37.19		
								342.15	37.32			342.15	37.32		
								356.68	37.18			356.68	37.18		
								367.49	37.61			367.49	37.61		
								378.96	37.88			378.96	37.88		
								382.52	38			382.52	38		

52745_Lubec_Box.rep

HEC-RAS HEC-RAS 5.0.3 September 2016
U.S. Army Corps of Engineers
Hydrologic Engineering Center
609 Second Street
Davis, California

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X      X  XXXXXX      XXXX      XXXX      XX      XXXX
X      X  X          X      X      X      X      X
X      X  X          X          X      X      X
XXXXXXXX XXXX      X      XXX XXXX      XXXXXX      XXXX
X      X  X          X          X      X      X
X      X  X          X      X      X      X      X
X      X  XXXXXX      XXXX      X      X      X      XXXXX

```

PROJECT DATA

Project Title: 52745 Lubec ME Mays Stream
Project File : 52745_Lubec_Box.prj
Run Date and Time: 9/30/2018 5:22:52 PM

Project in English units

Project Description:
Rte 189 Culvert over Mays Stream

PLAN DATA

Plan Title: Post Project - Box Culvert
Plan File : j:\52745 MaineDOT Structures GEC\52745TSK08 - Lubec, Mays BR
2527\Hydraulic Information\HEC RAS\52745_Lubec_Box.p01

Geometry Title: Proposed 24 ft Box Culvert Bridge Model
Geometry File : j:\52745 MaineDOT Structures GEC\52745TSK08 - Lubec, Mays
BR 2527\Hydraulic Information\HEC RAS\52745_Lubec_Box.g03

Flow Title : All Flows
Flow File : j:\52745 MaineDOT Structures GEC\52745TSK08 - Lubec, Mays
BR 2527\Hydraulic Information\HEC RAS\52745_Lubec_Box.f01

Plan Summary Information:

Number of:	Cross Sections =	9	Multiple Openings =	0
	Culverts =	0	Inline Structures =	0
	Bridges =	1	Lateral Structures =	0

Computational Information

Water surface calculation tolerance	=	0.01
Critical depth calculation tolerance	=	0.01
Maximum number of iterations	=	20
Maximum difference tolerance	=	0.3
Flow tolerance factor	=	0.001

Computation Options

Critical depth computed only where necessary
Conveyance Calculation Method: At breaks in n values only
Friction Slope Method: Average Conveyance
Computational Flow Regime: Mixed Flow

52745_Lubec_Box.rep

FLOW DATA

Flow Title: All Flows

Flow File : j:\52745 MaineDOT Structures GEC\52745TSK08 - Lubec, Mays BR
2527\Hydraulic Information\HEC RAS\52745_Lubec_Box.f01

Flow Data (cfs)

River 5-Year 500-Year	Reach 10-Year	RS 25-Year	1.1-Year 50-Year	2-Year 100-Year
Mays Stream 159 489	Rte 189 Culvert 201	1464.915 263	309 48	361 100

Boundary Conditions

River Downstream	Reach	Profile	Upstream
Mays Stream Normal S = 0.048	Rte 189 Culvert	1.1-Year	Normal S = 0.009
Mays Stream Normal S = 0.048	Rte 189 Culvert	2-Year	Normal S = 0.009
Mays Stream Normal S = 0.048	Rte 189 Culvert	5-Year	Normal S = 0.009
Mays Stream Normal S = 0.048	Rte 189 Culvert	10-Year	Normal S = 0.009
Mays Stream Normal S = 0.048	Rte 189 Culvert	25-Year	Normal S = 0.009
Mays Stream Normal S = 0.048	Rte 189 Culvert	50-Year	Normal S = 0.009
Mays Stream Normal S = 0.048	Rte 189 Culvert	100-Year	Normal S = 0.009
Mays Stream Normal S = 0.048	Rte 189 Culvert	500-Year	Normal S = 0.009

GEOMETRY DATA

Geometry Title: Proposed 24 ft Box Culvert Bridge Model

Geometry File : j:\52745 MaineDOT Structures GEC\52745TSK08 - Lubec, Mays BR
2527\Hydraulic Information\HEC RAS\52745_Lubec_Box.g03

CROSS SECTION

RIVER: Mays Stream

REACH: Rte 189 Culvert RS: 1464.915

52745_Lubec_Box.rep

INPUT

Description:

Station Elevation Data				num=	35				
Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev
0	34.37	9.24	33.77	13.7	33.46	27.5	33.04	30.43	32.97
36.6	32.74	44.2	32.19	52.29	32.03	80.2	31.82	90.94	31.84
92.98	31.82	98.81	31.59	118.92	30.49	123.51	30	124.28	29.9
127.28	29.57	127.87	28.8	128.1	28.41	132.52	28.18	139.12	27.69
141.34	27.1	142.96	26.55	146.02	25.87	148.78	25.45	149.55	25.33
159.21	27.39	160.76	27.68	164.5	28.2	164.86	28.73	166.32	29.11
179.31	32.73	184.78	34.54	186.16	35.12	188.16	36	192.95	38

Manning's n Values				num=	3	
Sta	n Val	Sta	n Val	Sta	n Val	
0	.12	127.28	.05	166.32	.12	

Bank Sta:	Left	Right	Lengths:	Left Channel	Right	Coeff	Contr.	Expan.
	127.28	166.32		54	54		.1	.3

CROSS SECTION

RIVER: Mays Stream

REACH: Rte 189 Culvert RS: 1410.913

INPUT

Description:

Station Elevation Data				num=	34				
Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev
0	34	7.74	33.34	10.35	33.11	10.9	33.07	25.74	31.83
44.5	31.87	44.71	31.88	44.87	31.87	51.14	31.63	57.95	31.49
66.47	31.18	68.28	31.07	72.91	30.68	78.81	30.07	79.5	30
84.62	29.45	85.84	29.13	86.48	28.69	89.91	28.58	96.71	27.88
98.42	27.78	100.45	27.16	104.13	26.2	111.16	26.01	116.11	27.34
117.24	27.48	124.95	28.35	126.81	28.9	128.82	29.03	134.5	30.9
141.27	33.18	145.11	35.52	151.93	37.33	153.3	38		

Manning's n Values				num=	3	
Sta	n Val	Sta	n Val	Sta	n Val	
0	.12	84.62	.05	128.82	.12	

Bank Sta:	Left	Right	Lengths:	Left Channel	Right	Coeff	Contr.	Expan.
	84.62	128.82		67	67		.3	.5

CROSS SECTION

RIVER: Mays Stream

REACH: Rte 189 Culvert RS: 1343.914

INPUT

Description: Upstream at Rte 189

Station Elevation Data				num=	53				
Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev
0	35	16.24	34.31	23.76	34	25.61	33.92	30.9	33.85
35.14	34.35	54.32	34.56	56.28	34.8	61.09	34.74	75.85	34.58
86.52	34.23	88.97	34.13	112.14	32.65	114.94	32.48	115.45	32.47
124.68	32.14	129.1	32.06	153.95	31.4	155.97	31.07	161.57	30.87
170.56	30.29	172.99	30.08	173.57	30	178.03	29.33	179.85	28.66
180.35	28.19	182.66	27.52	189.52	25.79	192.1	25.05	193.7	24.79
194.51	24.97	194.91	25.07	205.74	27.7	208.51	27.96	209.48	28.26
210.25	28.64	221.06	32.42	229.32	35.95	229.65	35.99	235.68	36.4

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240.78	36.61	252.28	36.88	264.88	37.1	289.42	37.85	294.66	38.59
295.48	38.65	313.84	39.99	325.25	40.83	344.42	41.59	349.47	41.33
390.27	39.25	391.08	39.27	396.3	39.91				

Manning's n values num= 3

Sta	n Val	Sta	n Val	Sta	n Val
0	.12	179.85	.05	210.25	.12

Bank Sta: Left Right Lengths: Left Channel Right Coeff Contr. Expan.
179.85 210.25 94.69 94.69 94.69 .3 .5

Ineffective Flow num= 2

Sta L	Sta R	Elev	Permanent
0	160.6	35	F
226.8	396.3	35	F

BRIDGE

RIVER: Mays Stream
REACH: Rte 189 Culvert RS: 1294.20

INPUT

Description:

Distance from Upstream XS = 11.72

Deck/Roadway Width = 73

Weir Coefficient = 3

Upstream Deck/Roadway Coordinates

num= 13

Sta	Hi	Cord	Lo	Cord	Sta	Hi	Cord	Lo	Cord	Sta	Hi	Cord	Lo	Cord
0	37.9				46.1	37.02				96.27	36.47			
135.71	36.27				173.9	36.25				182.92	36.3		32.83	
199.77	36.4	32.83			206.91	36.47	32.83			268.08	37.06			
317.44	38.05				364.58	39.2				379.34	39.71			
396.3	40.2													

Upstream Bridge Cross Section Data

Station Elevation Data num= 54

Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev
0	35	16.24	34.31	23.76	34	25.61	33.92	30.9	33.85
35.14	34.35	54.32	34.56	56.28	34.8	61.09	34.74	75.85	34.58
86.52	34.23	88.97	34.13	112.14	32.65	114.94	32.48	115.45	32.47
124.68	32.14	129.1	32.06	153.95	31.4	155.97	31.07	161.57	30.87
170.56	30.29	172.99	30.08	173.57	30	178.03	29.33	179.85	28.66
180.35	28.19	182.66	27.52	182.91	29.3	184.91	29.3	189.91	26.8
194.91	26.3	199.91	26.8	204.91	29.3	206.91	29.3	208.51	27.96
209.48	28.26	210.25	28.64	221.06	32.42	229.32	35.95	229.65	35.99
235.68	36.4	240.78	36.61	252.28	36.88	264.88	37.1	289.42	37.85
294.66	38.59	295.48	38.65	313.84	39.99	325.25	40.83	344.42	41.59
349.47	41.33	390.27	39.25	391.08	39.27	396.3	39.91		

Manning's n values num= 3

Sta	n Val	Sta	n Val	Sta	n Val
0	.12	182.91	.05	208.51	.12

Bank Sta: Left Right Coeff Contr. Expan.
182.91 206.91 .3 .5

Ineffective Flow num= 2

Sta L	Sta R	Elev	Permanent
0	160.6	35	F
226.8	396.3	35	F

Downstream Deck/Roadway Coordinates
num= 18

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Sta	Hi	Cord	Lo	Cord	Sta	Hi	Cord	Lo	Cord	Sta	Hi	Cord	Lo	Cord
0		37.4			16.79	37.02				66.9	36.47			
106.31	36.27				144.71	36.25				191.15	36.35	32.83		
193.15	36.36	32.83			198.15	36.37	32.83			203.15	36.38	32.83		
208.15	36.39	32.83			211.53	36.4	32.83			213.15	36.43	32.83		
215.15	36.48	32.83			242.52	37.06				291.88	38.05			
339.01	39.2				353.77	39.71				382.52	40.6			

Downstream Bridge Cross Section Data

Station Elevation		Data		num=		63			
Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev
0	38.14	2.06	38.04	16.93	37.35	28.07	36.84	41.6	35.92
54.77	35.49	54.92	35.48	61.9	34.92	68.14	34.7	82.26	34.7
89.13	34.44	98.08	34.01	103.41	33.9	104.85	33.84	105.94	33.8
126.58	33.28	129.67	33.2	132.17	33.11	141.94	32.37	150.27	31.76
151.8	31.64	161.78	31.15	163.83	30.78	173.33	29.36	174.7	29.51
178.29	29.38	185.66	28.89	187.17	28.47	188.38	27.76	188.4	27.84
188.44	27.77	188.47	27.73	191.15	29	193.15	29	198.15	26.5
203.15	26	208.15	26.5	213.15	29	215.15	29	217.11	29.26
217.86	29.45	218.94	29.73	221.6	30.96	227.58	33.76	229.66	34.55
230.98	34.81	234.42	35.09	248.66	35.44	254.81	35.68	269.33	36.14
275.76	36.29	281.4	36.52	296.85	36.86	313.42	37.34	315.68	37.43
317.4	37.35	337.86	37.52	338.24	37.19	342.15	37.32	356.68	37.18
367.49	37.61	378.96	37.88	382.52	38				

Manning's n Values

Sta	n Val	Sta	n Val	Sta	n Val
0	.12	191.15	.05	217.11	.12

Bank Sta: Left Right Coeff Contr. Expan.
191.15 215.15 .3 .5

Ineffective Flow		num=		2	
Sta L	Sta R	Elev	Permanent		
0	175.5	33	F		
223.8	382.52	33	F		

Upstream Embankment side slope = 1.5 horiz. to 1.0 vertical
 Downstream Embankment side slope = 1.5 horiz. to 1.0 vertical
 Maximum allowable submergence for weir flow = .95
 Elevation at which weir flow begins =
 Energy head used in spillway design =
 Spillway height used in design =
 Weir crest shape = Broad Crested

Number of Bridge Coefficient Sets = 1

Low Flow Methods and Data

Energy
 Selected Low Flow Methods = Highest Energy Answer

High Flow Method
 Energy Only

Additional Bridge Parameters

Add Friction component to Momentum
 Do not add weight component to Momentum
 Class B flow critical depth computations use critical depth
 inside the bridge at the upstream end
 Criteria to check for pressure flow = Upstream energy grade line

CROSS SECTION

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RIVER: Mays Stream
REACH: Rte 189 Culvert RS: 1249.223

INPUT

Description: Downstream at Rte 189

Station Elevation Data num= 63									
Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev
0	38.14	2.06	38.04	16.93	37.35	28.07	36.84	41.6	35.92
54.77	35.49	54.92	35.48	61.9	34.92	68.14	34.7	82.26	34.7
89.13	34.44	98.08	34.01	103.41	33.9	104.85	33.84	105.94	33.8
126.58	33.28	129.67	33.2	132.17	33.11	141.94	32.37	150.27	31.76
151.8	31.64	161.78	31.15	163.83	30.78	173.33	29.36	174.7	29.51
178.29	29.38	185.66	28.89	187.17	28.47	188.38	27.76	188.4	27.84
188.44	27.77	188.47	27.73	192.05	24.97	202.06	25.36	202.93	25.4
204.16	25.51	204.31	25.51	211.06	27.72	212.43	27.93	217.11	29.26
217.86	29.45	218.94	29.73	221.6	30.96	227.58	33.76	229.66	34.55
230.98	34.81	234.42	35.09	248.66	35.44	254.81	35.68	269.33	36.14
275.76	36.29	281.4	36.52	296.85	36.86	313.42	37.34	315.68	37.43
317.4	37.35	337.86	37.52	338.24	37.19	342.15	37.32	356.68	37.18
367.49	37.61	378.96	37.88	382.52	38				

Manning's n Values num= 3					
Sta	n Val	Sta	n Val	Sta	n Val
0	.12	188.44	.05	212.43	.12

Bank Sta:	Left	Right	Lengths:	Left	Channel	Right	Coeff	Contr.	Expan.
	188.44	212.43		28.88	28.88	28.88		.3	.5
Ineffective Flow num= 2									
Sta L	Sta R	Elev	Permanent						
0	175.5	33	F						
223.8	382.52	33	F						

CROSS SECTION

RIVER: Mays Stream
REACH: Rte 189 Culvert RS: 1220.346

INPUT

Description:

Station Elevation Data num= 34									
Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev
0	34.49	1.89	34.27	4.14	34	9.22	33.36	18.15	32.43
19.6	32.26	21.97	32	43.67	29.71	43.73	29.7	44.17	29.66
44.37	29.65	44.48	29.64	45.02	29.64	45.41	29.64	60.72	29.77
67.45	29.85	74.08	29.87	76.65	28.69	77.52	27.73	80	26.36
81.32	26.29	82.42	26.44	94.08	26.41	104.19	26.48	109.95	27.42
113.19	27.97	114.88	29.41	116.92	29.9	123.06	30.99	124.06	31.08
124.76	31.39	130.69	34.53	131.98	34.88	132.97	35.05		

Manning's n Values num= 3					
Sta	n Val	Sta	n Val	Sta	n Val
0	.12	74.08	.05	114.88	.12

Bank Sta:	Left	Right	Lengths:	Left	Channel	Right	Coeff	Contr.	Expan.
	74.08	114.88		25.65	25.65	25.65		.1	.3
Ineffective Flow num= 1									
Sta L	Sta R	Elev	Permanent						
122	132.97	33	F						

CROSS SECTION

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RIVER: Mays Stream

REACH: Rte 189 Culvert

RS: 1194.694

INPUT

Description:

Station	Elevation	Data	num=	35						
Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev	
0	32.28	2.92	32.02	3.23	32	3.35	32	4.1	32	
9.46	31.98	10.15	31.92	11.77	31.43	12.46	31.15	19	31.09	
37.47	30.33	47.47	29.6	51.91	29.45	58.51	28.87	64.57	28.66	
66.6	29.22	67.81	29.64	73.65	29.21	75.85	29.21	76.6	28.73	
83.29	27.27	84.78	27.26	86.13	27.35	87.45	28.26	92.11	29.92	
92.28	29.93	94.03	29.9	96.33	29.43	99.51	29.26	105.25	29.34	
109.42	30.3	112.86	31.3	114.5	31.92	120.99	34.69	123.3	35.04	

Manning's n Values

Sta	n Val	Sta	n Val	Sta	n Val
0	.12	75.85	.05	92.11	.12

Bank Sta:	Left	Right	Lengths:	Left	Channel	Right	Coeff	Contr.	Expan.
	75.85	92.11		36.45	36.45	36.45		.1	.3

CROSS SECTION

RIVER: Mays Stream

REACH: Rte 189 Culvert

RS: 1158.246

INPUT

Description:

Station	Elevation	Data	num=	29						
Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev	
0	32.02	.26	32	16.9	31.08	17.02	31.08	17.89	31.05	
18.18	31.03	19.25	31	27.51	30.92	27.95	30.91	32.7	31.13	
37.83	30.4	42.79	29.43	48.72	29.18	52.61	29.24	59.69	28.62	
72.5	27.97	76.01	27.51	76.81	27.39	87.02	26.35	96.45	26.96	
99.85	27.27	102.32	27.48	102.35	27.52	107.06	29.62	107.34	29.74	
111.85	31.74	112.42	32.03	118.5	35.27	122.84	36			

Manning's n Values

Sta	n Val	Sta	n Val	Sta	n Val
0	.12	72.5	.05	102.35	.12

Bank Sta:	Left	Right	Lengths:	Left	Channel	Right	Coeff	Contr.	Expan.
	72.5	102.35		27.38	27.38	27.38		.1	.3

CROSS SECTION

RIVER: Mays Stream

REACH: Rte 189 Culvert

RS: 1130.865

INPUT

Description:

Station	Elevation	Data	num=	28						
Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev	
0	32.04	.41	32	2.46	31.8	18.76	30.49	32.34	30	
39.2	29.74	41.91	29.62	45.5	29.78	55.68	30.11	65.58	30.52	
71.9	30.56	82.98	30.66	88.32	30.74	90.96	30.66	92.42	30.49	
93.25	28.66	94.29	28.39	99.29	27.11	99.73	27.14	102.8	27.61	
103.72	28.32	105.52	28.69	113.06	31.11	113.91	31.33	114.68	31.75	
120.78	36.3	126.67	36.87	128.26	37.07					

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Manning's n Values num= 3

Sta	n Val	Sta	n Val	Sta	n Val
0	.12	92.42	.05	113.06	.12

Bank Sta: Left Right Lengths: Left Channel Right Coeff Contr. Expan.

92.42	113.06	38.87	38.87	38.87	.1	.3
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CROSS SECTION

RIVER: Mays Stream
 REACH: Rte 189 Culvert RS: 1091.992

INPUT

Description:

Station Elevation Data num= 32

Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev	Sta	Elev
0	32.27	1.99	32	13.86	31.02	20.66	30.43	21.68	30.34
23.4	30.17	25.07	30.03	26.09	29.99	31.27	29.72	74.76	27.49
78.63	27.24	79.5	27.25	80.46	27.2	87.91	27.89	89.44	28.04
92.22	27.92	92.62	27.84	93.55	26.93	101.86	26.34	102.98	26.24
110.7	26.88	111.85	26.97	112.08	27.08	117.74	28.09	118.63	28.25
122.56	29.19	128.89	33.03	135.1	34.96	140.02	37.09	140.36	36.93
144.23	36.31	144.66	36.45						

Manning's n Values num= 3

Sta	n Val	Sta	n Val	Sta	n Val
0	.12	92.62	.05	117.74	.12

Bank Sta: Left Right Coeff Contr. Expan.

92.62	117.74	.1	.3
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HEC-RAS River: Mays Stream Reach: Rte 189 Culvert

Reach	River Sta	Profile	Plan	Q Total (cfs)	Min Ch El (ft)	W.S. Elev (ft)	Crit W.S. (ft)	E.G. Elev (ft)	E.G. Slope (ft/ft)	Vel Chnl (ft/s)	Flow Area (sq ft)	Top Width (ft)	Froude # Chl
Rte 189 Culvert	1464.915	1.1-Year	Existing Conditions - Bridge Model	48.00	25.33	29.30	26.70	29.31	0.000152	0.59	81.79	39.54	0.07
Rte 189 Culvert	1464.915	1.1-Year	Post Project - Box Culvert	48.00	25.33	29.27	26.70	29.27	0.000161	0.60	80.22	39.36	0.07
Rte 189 Culvert	1464.915	2-Year	Existing Conditions - Bridge Model	100.00	25.33	30.19	27.19	30.20	0.000204	0.86	120.21	48.50	0.09
Rte 189 Culvert	1464.915	2-Year	Post Project - Box Culvert	100.00	25.33	30.06	27.19	30.07	0.000239	0.90	113.69	46.73	0.09
Rte 189 Culvert	1464.915	5-Year	Existing Conditions - Bridge Model	159.00	25.33	30.98	27.60	31.00	0.000230	1.06	163.62	63.12	0.10
Rte 189 Culvert	1464.915	5-Year	Post Project - Box Culvert	159.00	25.33	30.71	27.60	30.73	0.000298	1.15	147.17	57.14	0.11
Rte 189 Culvert	1464.915	10-Year	Existing Conditions - Bridge Model	201.00	25.33	31.48	27.89	31.50	0.000237	1.17	197.79	74.02	0.10
Rte 189 Culvert	1464.915	10-Year	Post Project - Box Culvert	201.00	25.33	31.09	27.89	31.12	0.000332	1.30	170.70	65.53	0.12
Rte 189 Culvert	1464.915	25-Year	Existing Conditions - Bridge Model	263.00	25.33	32.12	28.21	32.14	0.000247	1.31	258.58	129.30	0.10
Rte 189 Culvert	1464.915	25-Year	Post Project - Box Culvert	263.00	25.33	31.52	28.21	31.56	0.000391	1.52	201.06	74.98	0.13
Rte 189 Culvert	1464.915	50-Year	Existing Conditions - Bridge Model	309.00	25.33	32.58	28.38	32.60	0.000237	1.37	320.69	139.89	0.10
Rte 189 Culvert	1464.915	50-Year	Post Project - Box Culvert	309.00	25.33	31.81	28.38	31.85	0.000430	1.66	223.18	82.66	0.14
Rte 189 Culvert	1464.915	100-Year	Existing Conditions - Bridge Model	361.00	25.33	33.06	28.54	33.09	0.000226	1.41	390.68	153.36	0.10
Rte 189 Culvert	1464.915	100-Year	Post Project - Box Culvert	361.00	25.33	32.05	28.54	32.10	0.000493	1.84	249.27	125.34	0.15
Rte 189 Culvert	1464.915	500-Year	Existing Conditions - Bridge Model	489.00	25.33	34.96	28.88	34.98	0.000119	1.24	725.30	185.79	0.08
Rte 189 Culvert	1464.915	500-Year	Post Project - Box Culvert	489.00	25.33	32.60	28.88	32.67	0.000582	2.15	324.12	140.32	0.16
Rte 189 Culvert	1410.913	1.1-Year	Existing Conditions - Bridge Model	48.00	26.01	29.29		29.30	0.000223	0.63	75.77	44.41	0.08
Rte 189 Culvert	1410.913	1.1-Year	Post Project - Box Culvert	48.00	26.01	29.25		29.26	0.000241	0.65	73.98	44.13	0.09
Rte 189 Culvert	1410.913	2-Year	Existing Conditions - Bridge Model	100.00	26.01	30.18		30.19	0.000244	0.87	119.31	54.58	0.09
Rte 189 Culvert	1410.913	2-Year	Post Project - Box Culvert	100.00	26.01	30.04		30.05	0.000294	0.92	111.83	52.80	0.10
Rte 189 Culvert	1410.913	5-Year	Existing Conditions - Bridge Model	159.00	26.01	30.97		30.99	0.000248	1.04	166.45	65.24	0.10
Rte 189 Culvert	1410.913	5-Year	Post Project - Box Culvert	159.00	26.01	30.69		30.71	0.000333	1.14	148.89	61.10	0.11
Rte 189 Culvert	1410.913	10-Year	Existing Conditions - Bridge Model	201.00	26.01	31.47		31.49	0.000246	1.14	201.64	77.65	0.10
Rte 189 Culvert	1410.913	10-Year	Post Project - Box Culvert	201.00	26.01	31.07		31.10	0.000356	1.28	173.36	66.82	0.12
Rte 189 Culvert	1410.913	25-Year	Existing Conditions - Bridge Model	263.00	26.01	32.11		32.13	0.000244	1.26	263.48	115.65	0.10
Rte 189 Culvert	1410.913	25-Year	Post Project - Box Culvert	263.00	26.01	31.50		31.54	0.000408	1.48	204.45	79.05	0.13
Rte 189 Culvert	1410.913	50-Year	Existing Conditions - Bridge Model	309.00	26.01	32.56		32.59	0.000232	1.31	318.05	122.50	0.10
Rte 189 Culvert	1410.913	50-Year	Post Project - Box Culvert	309.00	26.01	31.78		31.82	0.000441	1.61	228.31	90.01	0.14
Rte 189 Culvert	1410.913	100-Year	Existing Conditions - Bridge Model	361.00	26.01	33.05		33.07	0.000220	1.35	378.78	129.69	0.10
Rte 189 Culvert	1410.913	100-Year	Post Project - Box Culvert	361.00	26.01	32.02		32.07	0.000496	1.77	253.67	114.38	0.15
Rte 189 Culvert	1410.913	500-Year	Existing Conditions - Bridge Model	489.00	26.01	34.96		34.98	0.000119	1.22	645.85	144.19	0.08
Rte 189 Culvert	1410.913	500-Year	Post Project - Box Culvert	489.00	26.01	32.57		32.63	0.000578	2.06	318.98	122.61	0.16
Rte 189 Culvert	1343.914	1.1-Year	Existing Conditions - Bridge Model	48.00	24.79	29.28	26.29	29.29	0.000112	0.59	82.08	33.94	0.06
Rte 189 Culvert	1343.914	1.1-Year	Post Project - Box Culvert	48.00	24.79	29.24	26.29	29.25	0.000118	0.60	80.93	33.71	0.07
Rte 189 Culvert	1343.914	2-Year	Existing Conditions - Bridge Model	100.00	24.79	30.16	26.81	30.18	0.000186	0.92	112.06	42.60	0.09
Rte 189 Culvert	1343.914	2-Year	Post Project - Box Culvert	100.00	24.79	30.02	26.81	30.04	0.000212	0.96	109.87	40.80	0.09
Rte 189 Culvert	1343.914	5-Year	Existing Conditions - Bridge Model	159.00	24.79	30.95	27.24	30.97	0.000239	1.19	139.97	57.43	0.10
Rte 189 Culvert	1343.914	5-Year	Post Project - Box Culvert	159.00	24.79	30.67	27.24	30.69	0.000295	1.27	139.17	51.30	0.11
Rte 189 Culvert	1343.914	10-Year	Existing Conditions - Bridge Model	201.00	24.79	31.44	27.49	31.47	0.000264	1.35	157.60	65.85	0.11
Rte 189 Culvert	1343.914	10-Year	Post Project - Box Culvert	201.00	24.79	31.04	27.49	31.07	0.000344	1.45	159.73	60.37	0.12
Rte 189 Culvert	1343.914	25-Year	Existing Conditions - Bridge Model	263.00	24.79	32.07	27.81	32.11	0.000297	1.55	180.11	91.60	0.12
Rte 189 Culvert	1343.914	25-Year	Post Project - Box Culvert	263.00	24.79	31.46	27.81	31.51	0.000423	1.71	183.76	66.74	0.14
Rte 189 Culvert	1343.914	50-Year	Existing Conditions - Bridge Model	309.00	24.79	32.52	28.02	32.57	0.000313	1.68	196.25	107.08	0.12
Rte 189 Culvert	1343.914	50-Year	Post Project - Box Culvert	309.00	24.79	31.74	28.02	31.79	0.000477	1.88	199.62	77.79	0.15
Rte 189 Culvert	1343.914	100-Year	Existing Conditions - Bridge Model	361.00	24.79	33.00	28.22	33.05	0.000329	1.81	213.18	115.72	0.13
Rte 189 Culvert	1343.914	100-Year	Post Project - Box Culvert	361.00	24.79	31.96	28.22	32.03	0.000555	2.09	213.01	87.02	0.16
Rte 189 Culvert	1343.914	500-Year	Existing Conditions - Bridge Model	489.00	24.79	34.90	28.61	34.95	0.000248	1.87	281.13	224.54	0.11
Rte 189 Culvert	1343.914	500-Year	Post Project - Box Culvert	489.00	24.79	32.49	28.61	32.58	0.000720	2.53	244.49	106.43	0.18
Rte 189 Culvert	1294.20			Bridge									
Rte 189 Culvert	1249.223	1.1-Year	Existing Conditions - Bridge Model	48.00	24.97	29.17	25.97	29.18	0.000101	0.67	73.78	35.36	0.06
Rte 189 Culvert	1249.223	1.1-Year	Post Project - Box Culvert	48.00	24.97	29.17	25.97	29.18	0.000095	0.61	83.17	35.37	0.06
Rte 189 Culvert	1249.223	2-Year	Existing Conditions - Bridge Model	100.00	24.97	29.91	26.42	29.93	0.000231	1.14	90.57	49.65	0.10
Rte 189 Culvert	1249.223	2-Year	Post Project - Box Culvert	100.00	24.97	29.91	26.42	29.92	0.000200	1.02	113.59	49.67	0.09
Rte 189 Culvert	1249.223	5-Year	Existing Conditions - Bridge Model	159.00	24.97	30.51	26.82	30.55	0.000372	1.59	104.36	55.01	0.13
Rte 189 Culvert	1249.223	5-Year	Post Project - Box Culvert	159.00	24.97	30.52	26.82	30.54	0.000300	1.37	140.61	55.05	0.11
Rte 189 Culvert	1249.223	10-Year	Existing Conditions - Bridge Model	201.00	24.97	30.86	27.05	30.92	0.000471	1.87	112.34	58.01	0.14
Rte 189 Culvert	1249.223	10-Year	Post Project - Box Culvert	201.00	24.97	30.87	27.06	30.91	0.000365	1.59	156.67	58.07	0.13
Rte 189 Culvert	1249.223	25-Year	Existing Conditions - Bridge Model	263.00	24.97	31.23	27.36	31.31	0.000640	2.28	120.74	62.04	0.17
Rte 189 Culvert	1249.223	25-Year	Post Project - Box Culvert	263.00	24.97	31.24	27.38	31.29	0.000478	1.91	173.96	62.30	0.15
Rte 189 Culvert	1249.223	50-Year	Existing Conditions - Bridge Model	309.00	24.97	31.46	27.56	31.56	0.000769	2.57	126.04	67.27	0.19
Rte 189 Culvert	1249.223	50-Year	Post Project - Box Culvert	309.00	24.97	31.48	27.59	31.54	0.000562	2.13	185.06	67.63	0.16
Rte 189 Culvert	1249.223	100-Year	Existing Conditions - Bridge Model	361.00	24.97	31.63	27.79	31.76	0.000954	2.91	129.85	71.02	0.21
Rte 189 Culvert	1249.223	100-Year	Post Project - Box Culvert	361.00	24.97	31.65	27.83	31.73	0.000685	2.40	193.23	71.42	0.18
Rte 189 Culvert	1249.223	500-Year	Existing Conditions - Bridge Model	489.00	24.97	32.00	28.27	32.21	0.001431	3.71	138.22	76.78	0.26
Rte 189 Culvert	1249.223	500-Year	Post Project - Box Culvert	489.00	24.97	32.03	28.28	32.16	0.000989	3.01	211.63	77.38	0.21
Rte 189 Culvert	1220.346	1.1-Year	Existing Conditions - Bridge Model	48.00	26.29	29.17	26.91	29.17	0.000106	0.53	91.13	38.99	0.06
Rte 189 Culvert	1220.346	1.1-Year	Post Project - Box Culvert	48.00	26.29	29.17	26.91	29.17	0.000106	0.53	91.13	38.99	0.06
Rte 189 Culvert	1220.346	2-Year	Existing Conditions - Bridge Model	100.00	26.29	29.91	27.20	29.92	0.000193	0.83	125.76	75.13	0.08
Rte 189 Culvert	1220.346	2-Year	Post Project - Box Culvert	100.00	26.29	29.91	27.20	29.92	0.000193	0.83	125.76	75.13	0.08
Rte 189 Culvert	1220.346	5-Year	Existing Conditions - Bridge Model	159.00	26.29	30.51	27.47	30.53	0.000249	1.06	174.24	84.32	0.10
Rte 189 Culvert	1220.346	5-Year	Post Project - Box Culvert	159.00	26.29	30.51	27.47	30.53	0.000249	1.06	174.24	84.32	0.10
Rte 189 Culvert	1220.346	10-Year	Existing Conditions - Bridge Model	201.00	26.29	30.87	27.63	30.89	0.000279	1.20	205.00	89.67	0.11
Rte 189 Culvert	1220.346	10-Year	Post Project - Box Culvert	201.00	26.29	30.87	27.63	30.89	0.000279	1.20	205.00	89.67	0.11
Rte 189 Culvert	1220.346	25-Year	Existing Conditions - Bridge Model	263.00	26.29	31.24	27.85	31.27	0.000339	1.41	239.17	95.28	0.12
Rte 189 Culvert	1220.346	25-Year	Post Project - Box Culvert	263.00	26.29	31.24	27.85	31.27	0.000339	1.41	239.17	95.28	0.12
Rte 189 Culvert	1220.346	50-Year	Existing Conditions - Bridge Model	309.00	26.29	31.48	28.00	31.52	0.000381	1.55	261.56	98.04	0.13
Rte 189 Culvert	1220.346	50-Year	Post Project - Box Culvert	309.00	26.29	31.48	28.00	31.52	0.000381	1.55	261.56	98.04	0.13
Rte 189 Culvert	1220.346	100-Year	Existing Conditions - Bridge Model	361.00	26.29	31.66	28.14	31.70	0.000450	1.72	278.29	100.02	0.14
Rte 189 Culvert	1220.346	100-Year	Post Project - Box Culvert	361.00	26.29	31.66	28.14	31.70	0.000450	1.72	278.29	100.02	0.14
Rte 189 Culvert	1220.346	500-Year	Existing Conditions - Bridge Model	489.00	26.29	32.05	28.48	32.11	0.000609	2.11	316.74	104.44	0.17
Rte 189 Culvert	1220.346	500-Year	Post Project - Box Culvert	489.00	26.29	32.05	28.48	32.11	0.000609	2.11	316.74	104.44	0.17

HEC-RAS River: Mays Stream Reach: Rte 189 Culvert (Continued)

Reach	River Sta	Profile	Plan	Q Total (cfs)	Min Ch El (ft)	W.S. Elev (ft)	Crit W.S. (ft)	E.G. Elev (ft)	E.G. Slope (ft/ft)	Vel Chnl (ft/s)	Flow Area (sq ft)	Top Width (ft)	Froude # Chl
Rte 189 Culvert	1194.694	1.1-Year	Existing Conditions - Bridge Model	48.00	27.26	28.95		29.15	0.015027	3.56	14.62	21.16	0.62
Rte 189 Culvert	1194.694	1.1-Year	Post Project - Box Culvert	48.00	27.26	28.95		29.15	0.015027	3.56	14.62	21.16	0.62
Rte 189 Culvert	1194.694	2-Year	Existing Conditions - Bridge Model	100.00	27.26	29.71		29.89	0.008570	3.57	43.40	57.51	0.50
Rte 189 Culvert	1194.694	2-Year	Post Project - Box Culvert	100.00	27.26	29.71		29.89	0.008570	3.57	43.40	57.51	0.50
Rte 189 Culvert	1194.694	5-Year	Existing Conditions - Bridge Model	159.00	27.26	30.37		30.50	0.004840	3.33	87.08	73.25	0.40
Rte 189 Culvert	1194.694	5-Year	Post Project - Box Culvert	159.00	27.26	30.37		30.50	0.004840	3.33	87.08	73.25	0.40
Rte 189 Culvert	1194.694	10-Year	Existing Conditions - Bridge Model	201.00	27.26	30.73		30.86	0.004045	3.38	115.41	83.29	0.38
Rte 189 Culvert	1194.694	10-Year	Post Project - Box Culvert	201.00	27.26	30.73		30.86	0.004045	3.38	115.41	83.29	0.38
Rte 189 Culvert	1194.694	25-Year	Existing Conditions - Bridge Model	263.00	27.26	31.10		31.24	0.003911	3.64	147.83	94.45	0.38
Rte 189 Culvert	1194.694	25-Year	Post Project - Box Culvert	263.00	27.26	31.10		31.24	0.003911	3.64	147.83	94.45	0.38
Rte 189 Culvert	1194.694	50-Year	Existing Conditions - Bridge Model	309.00	27.26	31.34		31.48	0.003829	3.79	171.29	100.96	0.38
Rte 189 Culvert	1194.694	50-Year	Post Project - Box Culvert	309.00	27.26	31.34		31.48	0.003829	3.79	171.29	100.96	0.38
Rte 189 Culvert	1194.694	100-Year	Existing Conditions - Bridge Model	361.00	27.26	31.50		31.66	0.004134	4.07	187.53	101.83	0.40
Rte 189 Culvert	1194.694	100-Year	Post Project - Box Culvert	361.00	27.26	31.50		31.66	0.004134	4.07	187.53	101.83	0.40
Rte 189 Culvert	1194.694	500-Year	Existing Conditions - Bridge Model	489.00	27.26	31.86		32.06	0.004692	4.65	224.80	103.99	0.43
Rte 189 Culvert	1194.694	500-Year	Post Project - Box Culvert	489.00	27.26	31.86		32.06	0.004692	4.65	224.80	103.99	0.43
Rte 189 Culvert	1158.246	1.1-Year	Existing Conditions - Bridge Model	48.00	26.35	29.05		29.06	0.000245	0.75	74.85	51.00	0.09
Rte 189 Culvert	1158.246	1.1-Year	Post Project - Box Culvert	48.00	26.35	29.05		29.06	0.000245	0.75	74.85	51.00	0.09
Rte 189 Culvert	1158.246	2-Year	Existing Conditions - Bridge Model	100.00	26.35	29.78		29.80	0.000350	1.10	119.69	66.46	0.12
Rte 189 Culvert	1158.246	2-Year	Post Project - Box Culvert	100.00	26.35	29.78		29.80	0.000350	1.10	119.69	66.46	0.12
Rte 189 Culvert	1158.246	5-Year	Existing Conditions - Bridge Model	159.00	26.35	30.41		30.44	0.000413	1.37	162.68	71.09	0.13
Rte 189 Culvert	1158.246	5-Year	Post Project - Box Culvert	159.00	26.35	30.41		30.44	0.000413	1.37	162.68	71.09	0.13
Rte 189 Culvert	1158.246	10-Year	Existing Conditions - Bridge Model	201.00	26.35	30.76		30.80	0.000457	1.53	188.40	74.37	0.14
Rte 189 Culvert	1158.246	10-Year	Post Project - Box Culvert	201.00	26.35	30.76		30.80	0.000457	1.53	188.40	74.37	0.14
Rte 189 Culvert	1158.246	25-Year	Existing Conditions - Bridge Model	263.00	26.35	31.13		31.17	0.000553	1.79	218.17	94.28	0.16
Rte 189 Culvert	1158.246	25-Year	Post Project - Box Culvert	263.00	26.35	31.13		31.17	0.000553	1.79	218.17	94.28	0.16
Rte 189 Culvert	1158.246	50-Year	Existing Conditions - Bridge Model	309.00	26.35	31.35		31.41	0.000648	2.01	240.13	99.01	0.17
Rte 189 Culvert	1158.246	50-Year	Post Project - Box Culvert	309.00	26.35	31.35		31.41	0.000648	2.01	240.13	99.01	0.17
Rte 189 Culvert	1158.246	100-Year	Existing Conditions - Bridge Model	361.00	26.35	31.51		31.58	0.000770	2.25	255.88	102.20	0.19
Rte 189 Culvert	1158.246	100-Year	Post Project - Box Culvert	361.00	26.35	31.51		31.58	0.000770	2.25	255.88	102.20	0.19
Rte 189 Culvert	1158.246	500-Year	Existing Conditions - Bridge Model	489.00	26.35	31.86		31.96	0.001047	2.75	293.01	109.31	0.22
Rte 189 Culvert	1158.246	500-Year	Post Project - Box Culvert	489.00	26.35	31.86		31.96	0.001047	2.75	293.01	109.31	0.22
Rte 189 Culvert	1130.865	1.1-Year	Existing Conditions - Bridge Model	48.00	27.11	28.66	28.58	29.00	0.032609	4.67	10.28	12.14	0.90
Rte 189 Culvert	1130.865	1.1-Year	Post Project - Box Culvert	48.00	27.11	28.66	28.58	29.00	0.032609	4.67	10.28	12.14	0.90
Rte 189 Culvert	1130.865	2-Year	Existing Conditions - Bridge Model	100.00	27.11	29.11	29.11	29.71	0.038499	6.21	16.11	13.79	1.01
Rte 189 Culvert	1130.865	2-Year	Post Project - Box Culvert	100.00	27.11	29.11	29.11	29.71	0.038499	6.21	16.11	13.79	1.01
Rte 189 Culvert	1130.865	5-Year	Existing Conditions - Bridge Model	159.00	27.11	29.58	29.58	30.33	0.035606	6.93	22.95	15.46	1.00
Rte 189 Culvert	1130.865	5-Year	Post Project - Box Culvert	159.00	27.11	29.58	29.58	30.33	0.035606	6.93	22.95	15.46	1.00
Rte 189 Culvert	1130.865	10-Year	Existing Conditions - Bridge Model	201.00	27.11	29.93	29.93	30.68	0.030328	6.98	30.92	32.69	0.94
Rte 189 Culvert	1130.865	10-Year	Post Project - Box Culvert	201.00	27.11	29.93	29.93	30.68	0.030328	6.98	30.92	32.69	0.94
Rte 189 Culvert	1130.865	25-Year	Existing Conditions - Bridge Model	263.00	27.11	30.37	30.37	31.06	0.024051	6.82	51.30	58.43	0.85
Rte 189 Culvert	1130.865	25-Year	Post Project - Box Culvert	263.00	27.11	30.37	30.37	31.06	0.024051	6.82	51.30	58.43	0.85
Rte 189 Culvert	1130.865	50-Year	Existing Conditions - Bridge Model	309.00	27.11	30.50	30.50	31.28	0.026696	7.37	59.15	65.37	0.90
Rte 189 Culvert	1130.865	50-Year	Post Project - Box Culvert	309.00	27.11	30.50	30.50	31.28	0.026696	7.37	59.15	65.37	0.90
Rte 189 Culvert	1130.865	100-Year	Existing Conditions - Bridge Model	361.00	27.11	30.89	30.89	31.47	0.018378	6.61	93.03	98.58	0.77
Rte 189 Culvert	1130.865	100-Year	Post Project - Box Culvert	361.00	27.11	30.89	30.89	31.47	0.018378	6.61	93.03	98.58	0.77
Rte 189 Culvert	1130.865	500-Year	Existing Conditions - Bridge Model	489.00	27.11	31.16	31.16	31.83	0.020324	7.34	120.83	102.91	0.82
Rte 189 Culvert	1130.865	500-Year	Post Project - Box Culvert	489.00	27.11	31.16	31.16	31.83	0.020324	7.34	120.83	102.91	0.82
Rte 189 Culvert	1091.992	1.1-Year	Existing Conditions - Bridge Model	48.00	26.24	27.20	27.20	27.49	0.046181	4.35	11.04	19.46	1.02
Rte 189 Culvert	1091.992	1.1-Year	Post Project - Box Culvert	48.00	26.24	27.20	27.20	27.49	0.046181	4.35	11.04	19.46	1.02
Rte 189 Culvert	1091.992	2-Year	Existing Conditions - Bridge Model	100.00	26.24	27.51	27.59	28.00	0.048965	5.65	19.04	30.98	1.11
Rte 189 Culvert	1091.992	2-Year	Post Project - Box Culvert	100.00	26.24	27.51	27.59	28.00	0.048964	5.65	19.04	30.98	1.11
Rte 189 Culvert	1091.992	5-Year	Existing Conditions - Bridge Model	159.00	26.24	27.69	27.92	28.47	0.064476	7.17	25.31	37.72	1.30
Rte 189 Culvert	1091.992	5-Year	Post Project - Box Culvert	159.00	26.24	27.69	27.92	28.47	0.064476	7.17	25.31	37.72	1.30
Rte 189 Culvert	1091.992	10-Year	Existing Conditions - Bridge Model	201.00	26.24	27.75	28.12	28.82	0.084211	8.45	27.71	40.00	1.50
Rte 189 Culvert	1091.992	10-Year	Post Project - Box Culvert	201.00	26.24	27.75	28.12	28.82	0.084211	8.45	27.71	40.00	1.50
Rte 189 Culvert	1091.992	25-Year	Existing Conditions - Bridge Model	263.00	26.24	27.86	28.32	29.29	0.102614	9.81	32.31	44.13	1.67
Rte 189 Culvert	1091.992	25-Year	Post Project - Box Culvert	263.00	26.24	27.86	28.32	29.29	0.102614	9.81	32.31	44.13	1.67
Rte 189 Culvert	1091.992	50-Year	Existing Conditions - Bridge Model	309.00	26.24	28.00	28.45	29.46	0.094690	10.01	38.80	51.15	1.63
Rte 189 Culvert	1091.992	50-Year	Post Project - Box Culvert	309.00	26.24	28.00	28.45	29.46	0.094690	10.01	38.80	51.15	1.63
Rte 189 Culvert	1091.992	100-Year	Existing Conditions - Bridge Model	361.00	26.24	28.05	28.60	29.87	0.114860	11.23	41.14	53.57	1.81
Rte 189 Culvert	1091.992	100-Year	Post Project - Box Culvert	361.00	26.24	28.05	28.60	29.87	0.114860	11.23	41.14	53.57	1.81
Rte 189 Culvert	1091.992	500-Year	Existing Conditions - Bridge Model	489.00	26.24	28.33	28.93	30.24	0.094974	11.71	57.52	60.64	1.70
Rte 189 Culvert	1091.992	500-Year	Post Project - Box Culvert	489.00	26.24	28.33	28.93	30.24	0.094974	11.71	57.52	60.64	1.70