

HYDROLOGY REPORT

There is no streamgage data available for Black Stream. The MaineDOT Environmental Office prepared the hydrologic evaluation for this crossing using USGS Maine regression equations for ungaged streams. Peak flow estimates from this hydrologic analysis were applied for hydraulic modeling. The following table presents a summary of peak flows at the crossing; detailed hydrologic analysis is included in Appendix E.

SUMMARY			
Drainage Area	20.30	mi ²	
Q1.1	220.3	ft ³ /s	
Q10	788.9	ft ³ /s	
Q25	992.2	ft ³ /s	
Q50	1149.1	ft ³ /s	
Q100	1317.5	ft ³ /s	
Q500	1724.1	ft ³ /s	

Reported by: CSH (MaineDOT)

Date: June 9, 2017

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

HYDRAULIC REPORT

Hydraulic modeling was conducted using the US Army Corps of Engineers (USACE) HEC-RAS software, version 5.0.3, to evaluate hydraulic performance of existing conditions and of the proposed design. Hydraulic analysis included evaluation of the bankfull 1.1-year (Q1.1), design discharge 50-year (Q50), and check discharge 100-year (Q100) flood events. HEC-RAS model geometry is based on topographic and bathymetric field survey performed in June 2018, supplemented by USGS 2015 LiDAR topographic data, field measurements, and proposed structure geometry.

Under existing conditions, water elevations at the crossing are controlled by backwater from a dam located 3.8 miles downstream on the Carrabassett Stream. Due to this backwater influence, the bankfull channel width at the crossing is nearly 50% wider than expected based on regression analysis, and model results indicate that the dam backwater increases median low-flow water depth by 3.4 feet compared to free tailwater discharge. To account for this backwater condition, hydraulic modeling was evaluated for two scenarios: with the dam in place and with no dam.

For the dam-in-place model, the downstream boundary condition is represented by an additional downstream cross-section representing the dam spillway geometry and dimensions based on field measurements; the no-dam downstream boundary condition assumes normal depth based on the average longitudinal slope of Black Stream calculated from LiDAR topographic data. The dam-in-place model was calibrated so that modeled low-flow and Q1.1 water elevations at the bridge were consistent with surveyed water and top of bank elevations, respectively. Model sensitivity analysis indicates that the dam-in-place scenario results in a higher bridge tailwater elevation compared to the no-dam scenario: 2.1 feet for the Q1.1 discharge, 0.4 feet for the Q10 discharge, and less than 0.1 feet for the design Q50 and check Q100 discharges. Given the role of the dam maintaining Sibley Pond, the dam-in-place scenario is assumed to be more likely for the design life of the proposed bridge and therefore was used for this analysis. A summary of HEC-RAS model results is presented in the table below; detailed model results are included in Appendix E.

SUMMARY

		Existing Structure	Recommended Structure
		100' 3-Span Steel	113' Single Span Steel
Total Area of Waterway Opening	ft ²	647	688
Headwater elevation @ Q _{1.1}	ft	226.2	226.2
Headwater elevation @ Q ₁₀	ft	228.8	228.7
Headwater elevation @ Q ₂₅	ft	229.5	229.5
Headwater elevation @ Q ₅₀	ft	230.0	230.0
Headwater elevation @ Q ₁₀₀	ft	230.5	230.4
Headwater elevation @ Q ₅₀₀	ft	231.5	231.5
Freeboard @ Q ₅₀	ft	2.9	2.0
Freeboard @ Q ₁₀₀	ft	2.4	1.5
Flood Of Record (Unknown)			
Outlet Velocity @ Q _{1.1}	ft/s	1.3	1.2
Outlet Velocity @ Q ₁₀	ft/s	2.6	2.3
Outlet Velocity @ Q ₂₅	ft/s	2.8	2.6
Outlet Velocity @ Q ₅₀	ft/s	3.0	2.7
Outlet Velocity @ Q ₁₀₀	ft/s	3.2	2.9
Outlet Velocity @ Q ₅₀₀	ft/s	3.7	3.3

Reported by: Cloutier, Dave

Date: September 28, 2018

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

WIN:	22226.00
Town:	Canaan
Route No.	ME 23
Asset ID:	3159
Lat:	44.79761
Long:	-69.5455

Project Name:	Canaan - Hall Bridge
Stream Name:	Black Stream
Bridge Name:	Hall Bridge
Analysis by:	CSH
Date:	4/13/2018

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

Enter data in blue cells only!

	km ²	mi ²	ac
A	52.58	20.30	12992.0
W	8.15	3.1	2013.8

P _c	454527	4965043
County	Somerset S	
pptA	39.5	
SG	0.00	

A (km ²)	52.58
W (%)	15.50

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

NWI Wetlands % *STORNWI*

Worksheet prepared by:

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Environmental Office

Maine Dept. Transportation

Augusta, ME 04333-0016

207-557-1052

Charles.Hebson@maine.gov

ver. 2017 Jun. 09

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

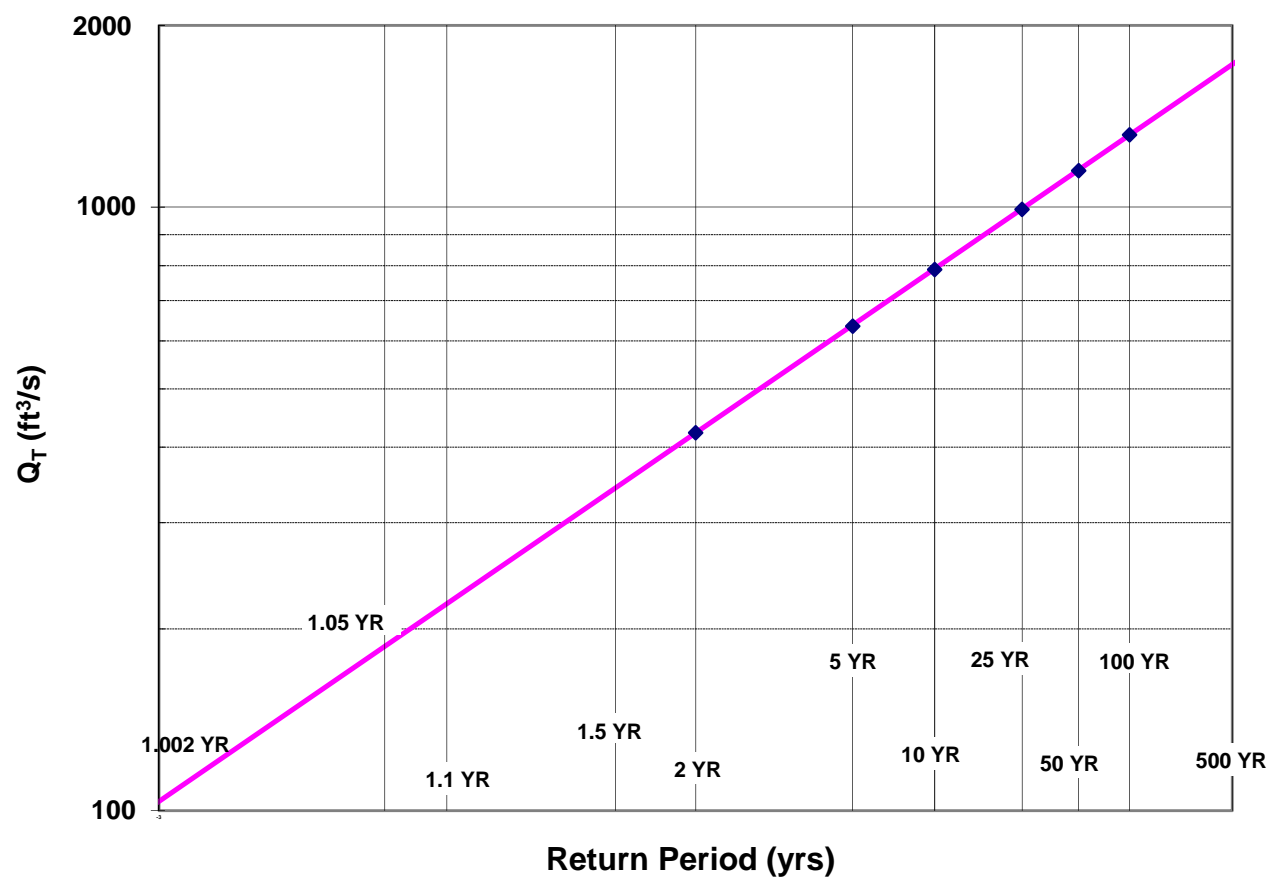
SIR 2015-4059, USGS, Augusta, ME

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

Ret Pd	Peak Flow Estimate		
T (yr)	Lower	Q _T (m ³ /s)	Upper
1.1		6.24	
2		11.98	
5		17.99	
10		22.34	
25		28.10	
50		32.54	
100		37.31	
500		48.83	

Q _T (ft ³ /s)
220.3
422.9
635.4
788.9
992.2
1149.1
1317.5
1724.1

Log-Normal Probability Plot

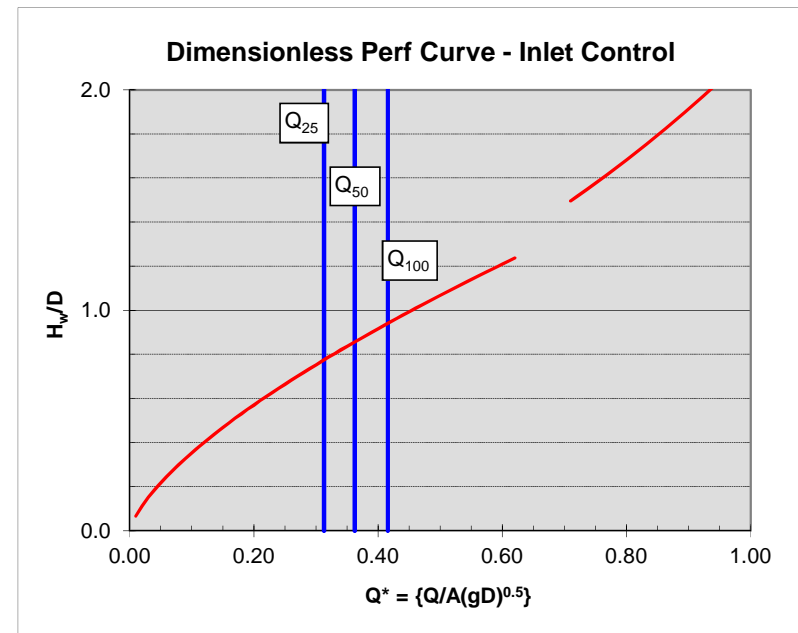
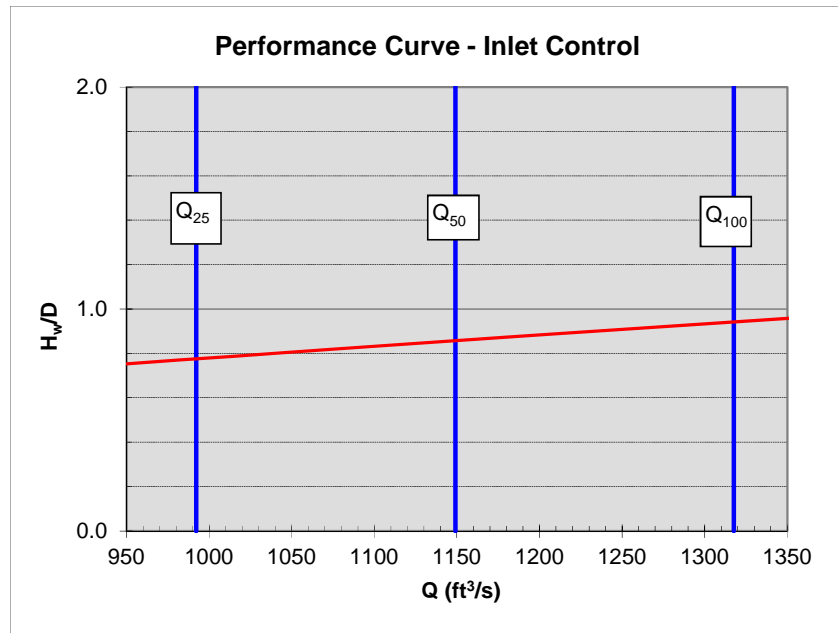


NOTE: This page is for preliminary sizing only.
Final design should be done with HY8 or HDS-5

Preliminary Culvert Sizing - Round & Box Culverts

Shape:	Box			
Type:	Box 0 ww			
D or R (ft)	6	Q_{25}	992.2	trial D / R = 13.8 trial w: BFW = 38.6
w (ft)	38 box width	Q_{50}	1149.1	
Slope (ft/ft)	0.02	Q_{100}	1317.5	
A (ft ²)	228.00			
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)



WIN: 22226.00
 Town: Canaan
 Route No. ME 23
 Asset ID: 3159
 Lat: 44.79761 Long: -69.54548

Project Name: Canaan - Hall Bridge
 Stream Name: Black Stream
 Bridge Name: Hall Bridge
 Analysis by: CSH
 Date: 4/13/2018

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

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

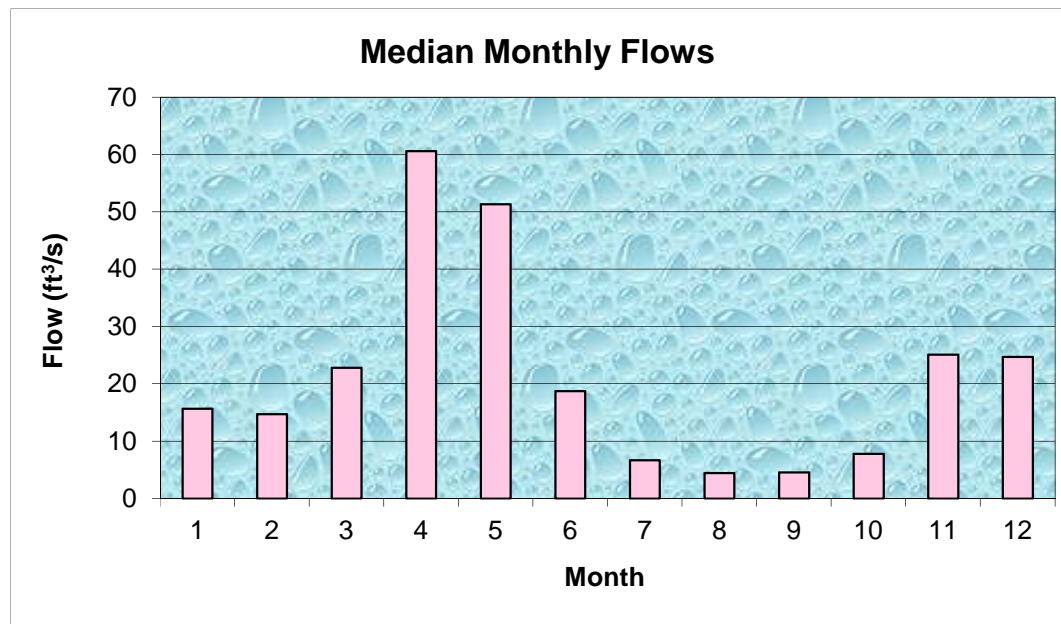
	Value	Variable	Explanation
	20.30	A	Area (mi ²)
454526.9	4965043	P_c	Watershed centroid (E,N; UTM; Zone 19; meters)
	86.46	DIST	Distance from Coastal reference line (mi)
	39.5	pptA	Mean Annual Precipitation (inches)
	0.00	SG	Sand & Gravel Aquifer (decimal fraction of watershed area)

Month	Q_{median} (ft ³ /s)	(m ³ /s)
Jan	15.66	0.4439
Feb	14.75	0.4179
Mar	22.83	0.6469
Apr	60.62	1.7178
May	51.31	1.4540
Jun	18.73	0.5308
Jul	6.68	0.1892
Aug	4.43	0.1255
Sep	4.54	0.1286
Oct	7.79	0.2207
Nov	25.11	0.7115
Dec	24.72	0.7006

Q_{bf}	122.5
ann avg	38.4
ann med	18.1
$Q_{1.002}$	103.6
$Q_{1.01}$	135.5
$Q_{1.05}$	187.1
Q_{bf}	255.3

assume v = 4ft/s

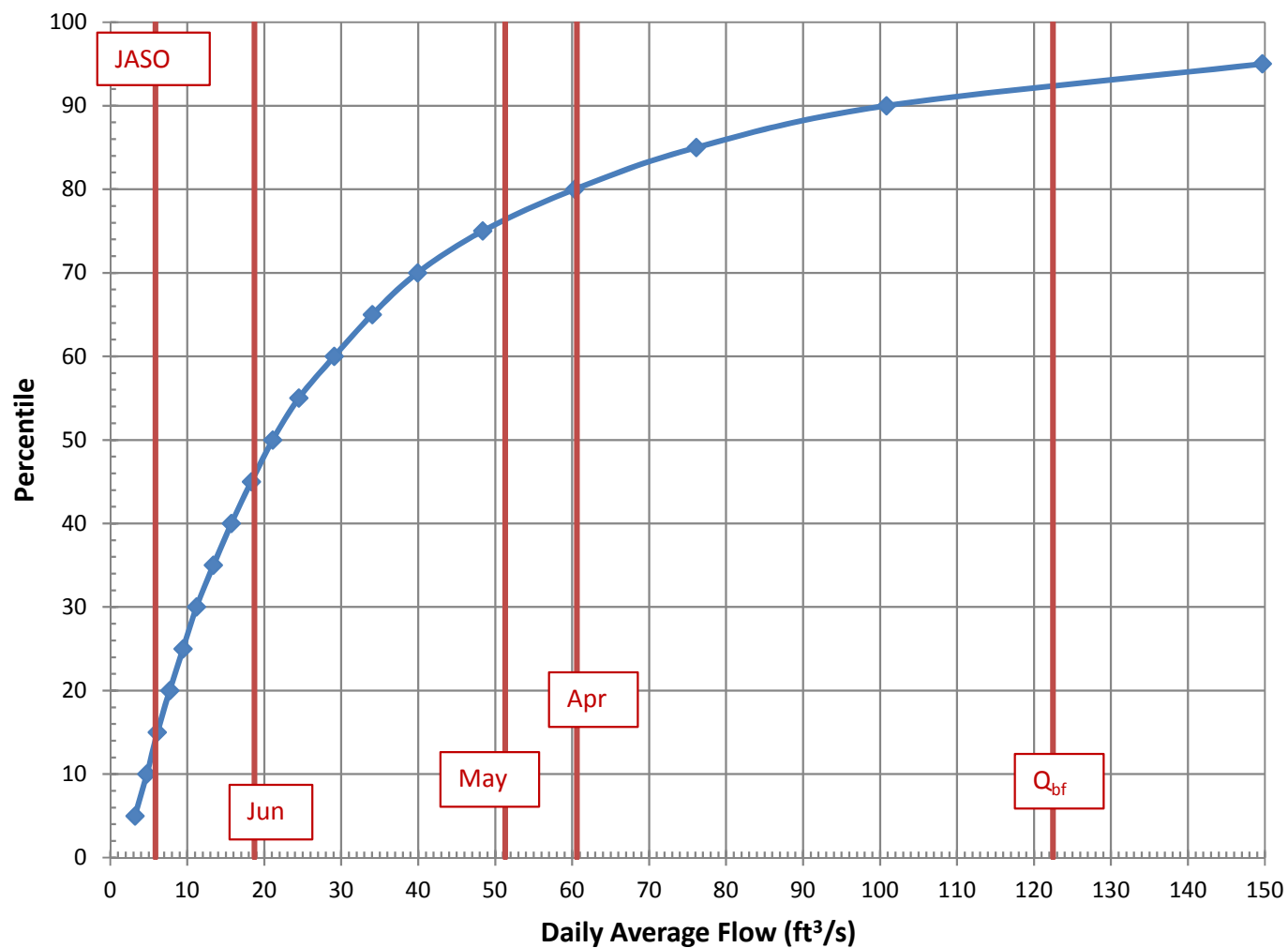
W_{bf}	38.6	estimated bankfull width (ft)
d_{bf}	1.7	estimated bankfull depth (ft)
A_{bf}	60.6	estimated bankfull flow area (ft ²)



References

Dudley, R.W., 2013. FY2013 Progress Report - Phase 1 ..., USFWS QRP Project
 Dudley, R.W., 2004. Estimating Monthly Streamflows ..., SIR 2004-5026

Daily Average Flow Distribution



Daily Avg Flow Dist

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

20.3

$Q (ft^3/s)$

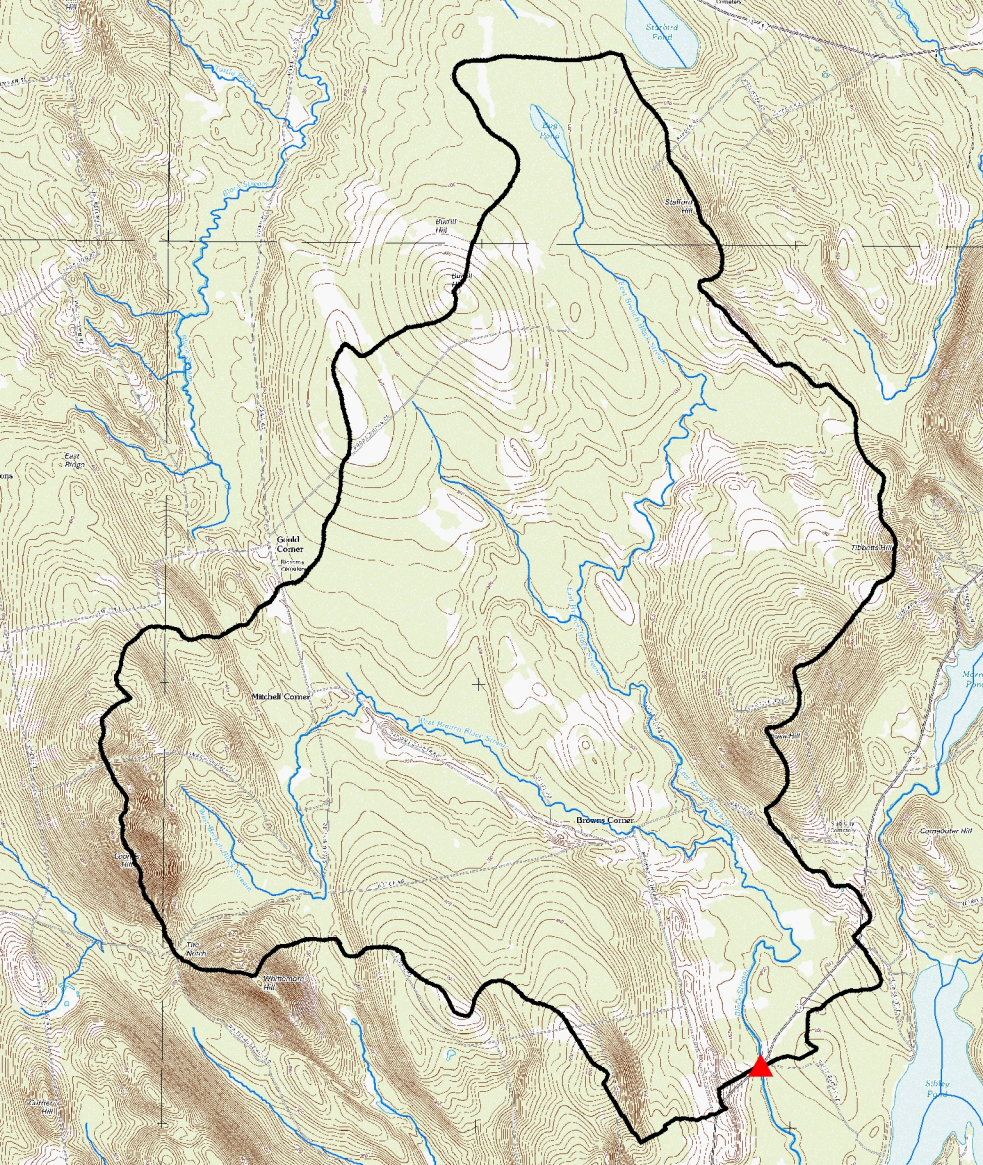
Pctl	Median	84 th pctl
5	3.20	5.14
10	4.75	7.14
15	6.10	8.91
20	7.73	10.81
25	9.45	12.67
30	11.18	14.43
35	13.40	16.49
40	15.71	18.96
45	18.32	21.44
50	21.09	25.31
55	24.49	29.46
60	29.08	34.58
65	34.02	40.29
70	39.91	47.01
75	48.38	56.53
80	60.34	67.49
85	76.13	86.49
90	100.85	116.14
95	149.67	180.60

Q_{bf} 122.5

$Q_{1.002}$ 103.6

$Q_{1.1}$ 220.3

Q_2 422.9



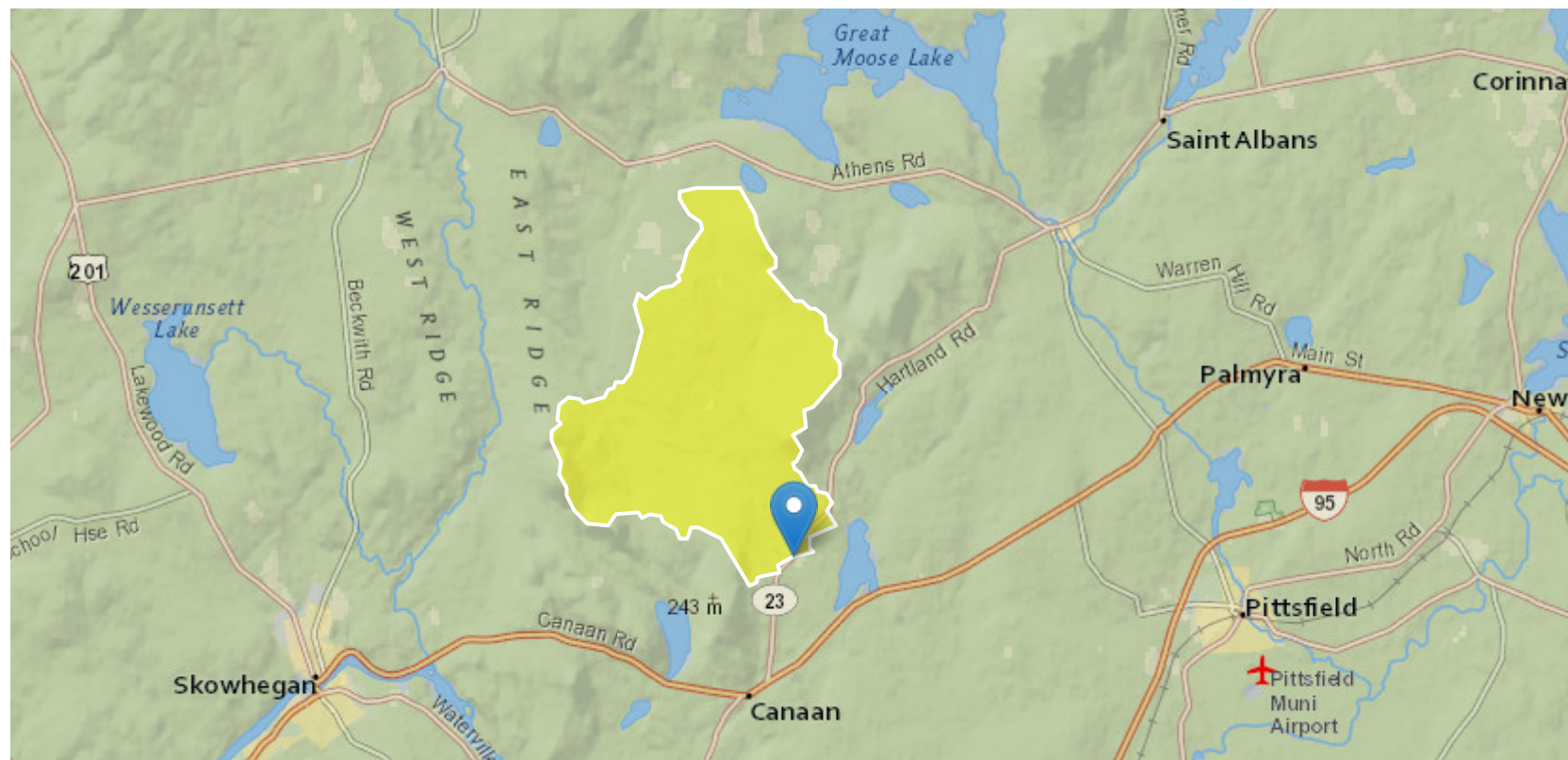
Canaan 22226 Hall Br (#3159) - Black Stream

Region ID: ME

Workspace ID: ME20180413131822566000

Clicked Point (Latitude, Longitude): 44.79763, -69.54552

Time: 2018-04-13 09:18:39 -0400



Basin Characteristics

Parameter Code	Parameter Description	Value	Unit
DRNAREA	Area that drains to a point on a stream	20.3	square miles
STORNWI	Percentage of storage (combined water bodies and wetlands) from the National Wetlands Inventory	15.47	percent
SANDGRAVAF	Fraction of land surface underlain by sand and gravel aquifers	0.065	dimensionless
ELEV	Mean Basin Elevation	376.5	feet
BSLDEM10M	Mean basin slope computed from 10 m DEM	4.93	percent
CENTROIDX	Basin centroid horizontal (x) location in state plane coordinates	454526.9	
CENTROIDY	Basin centroid vertical (y) location in state plane units	4965042.56	
COASTDIST	Shortest distance from the coastline to the basin centroid	87	miles
ELEVMAX	Maximum basin elevation	874.1	feet
LC06WATER	Percent of open water, class 11, from NLCD 2006	0.19	percent
LC11DEV	Percentage of developed (urban) land from NLCD 2011 classes 21-24	2.13	percent
LC11IMP	Average percentage of impervious area determined from NLCD 2011 impervious dataset	0.37	percent
PRECIP	Mean Annual Precipitation	42	inches
SANDGRAVAP	Percentage of land surface underlain by sand and gravel aquifers	6.54	percent
STATSGOA	Percentage of area of Hydrologic Soil Type A from STATSGO	4.22	percent

Bankfull Statistics Parameters [Central and Coastal Bankfull 2004 5042]

Parameter Code	Parameter Name	Value	Units	Min Limit	Max Limit
DRNAREA	Drainage Area	20.3	square miles	2.92	298

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

Statistic	Value	Unit
Bankfull Streamflow	122	ft^3/s
Bankfull Width	36.7	ft
Bankfull Depth	1.65	ft
Bankfull Area	60.6	ft^2

Bankfull Statistics Citations

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

Peak-Flow Statistics Parameters [Statewide Peak Flow Full GT 12sqmi WRI 99 4008]

Parameter Code	Parameter Name	Value	Units	Min Limit	Max Limit
DRNAREA	Drainage Area	20.3	square miles	0.93	1653
STORNWI	Percentage of Storage from NWI	15.47	percent	0.7	26.7

Peak-Flow Statistics Flow Report [Statewide Peak Flow Full GT 12sqmi WRI 99 4008]

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

Statistic	Value	Unit	PII	Plu	SE	SEp	Equiv. Yrs.
2 Year Peak Flood	424	ft^3/s	236	760	35.1	35.1	1.8
5 Year Peak Flood	637	ft^3/s	351	1150	36.1	36.1	2.5
10 Year Peak Flood	791	ft^3/s	429	1460	36.8	36.8	3.2
25 Year Peak Flood	994	ft^3/s	526	1880	38.6	38.6	4.1
50 Year Peak Flood	1150	ft^3/s	597	2220	39.9	39.9	4.8

Statistic	Value	Unit	PII	Plu	SE	SEp	Equiv. Yrs.
100 Year Peak Flood	1320	ft ³ /s	670	2600	41.2	41.2	5.4
500 Year Peak Flood	1730	ft ³ /s	828	3610	44.9	44.9	6.4

Peak-Flow Statistics Citations

Hodgkins, G. A.,1999, Estimating the Magnitude of Peak Flows for Streams in Maine for Selected Recurrence Intervals: U.S. Geological Survey Water-Resources Investigations Report 99-4008, 45 p. (<http://me.water.usgs.gov/99-4008.pdf>)

Annual Flow Statistics Parameters [Statewide Annual SIR 2015 5151]

Parameter Code	Parameter Name	Value	Units	Min Limit	Max Limit
DRNAREA	Drainage Area	20.3	square miles	14.9	1419
SANDGRAVAF	Fraction of Sand and Gravel Aquifers	0.065	dimensionless	0	0.212
ELEV	Mean Basin Elevation	376.5	feet	239	2120

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

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

Statistic	Value	Unit	SEp
Mean Annual Flow	43.5	ft ³ /s	16

Annual Flow Statistics Citations

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