Northstar Hydro, Inc.

Memorandum

To: Kris Constanzer, Mathew Steele, P.E., SEA/Kleinfelder Assoc

From: Ellen O'Brien, P.E., Northstar Hydro, Inc.

Date: April 27, 2011

Re: Little Bridge, Westbrook, ME. Supplemental Hydraulic Analysis, 26' X 12' Box Culvert

Preliminary design for Little Bridge on Mill Brook in Westbrook, ME was prepared to replace the twin CMP culverts with a single arch. The PDR H/H report was submitted in September of 2010. Since that time, MDOT and the SEA/Kleinfelder reassessed the site relative to temporary detour, traffic constraints, and budget and elected to evaluate single box culvert alternatives. A memo in January summarized the results of the hydraulic analysis for two sizes of box culvert, 20' X 12' and 24' X 9'. This memo addresses a 26' X 12' box.

Using model HECRAS, the 26' X 12' box was analyzed and compared to existing conditions. As with other options, this alternative was modeled "with" and "without" backwater from the Presumpscot River.

Final modeled configuration of the box culvert is 26' X 12', with 2' of embedment. Length is 86' and skew is 15^{o}. Entrance and exit of the culvert have angled wing walls.

The following table summarizes existing and proposed conditions for this box culvert. Attached to this memorandum is a table summarizing HECRAS results.

Existing Culverts

Without Backwater from Presumpscot River					
	Frequency	Elevation Upstream	downstream	Velocity, upstream	Downstream
	1.1 yr	17.2	15.9	3.7	4
	10 yr	20	17.5	6.5	7
	25 yr	20.9	17.7	7.6	8.3
	50 yr	21.5	17.8	8.6	9.3
	100 yr	22.1	17.8	9.9	10.7
	500 yr	23.6	18.4	10.9	11.8
With Backwater	Frequency	Elevation Upstream	downstream	Velocity, upstream	Downstream
	1.1 yr	17.8	17.5	2.1	2.4
	10 yr	22.8	22.5	2.2	2.6
	25 yr	28.9	28.3	1.2	1.4
	50 yr	34.3	33.7	0.9	1
	100 yr	36.2	36.1	0.9	1
	500 yr	42.1	42.1	0.8	0.9

26' X 12' box, length = 86', skew = 15 degrees

No Backwater				
Frequency		Elev, US	Elev DS	Max Culvert Velocity, fps
	1.1 yr	16.1	15.9	3.0
	10 yr	17.9	17.5	6.2
	25 yr	18.3	17.7	7.3
	50 yr	18.5	17.8	8.3
	100 yr	18.9	17.9	9.5
	500 yr	19.8	18.3	11.2
With Backwater				
	1.1 yr	17.5	17.5	1.8
	10 yr	22.6	22.5	2.6
	25 yr	28.5	28.3	2.7
	50 yr	33.9	33.7	3.2
	100 yr	36.2	36.1	1.9
	500 yr	42.1	42.1	0.8

The HECRAS analysis shows that the proposed 26’ X 12’ box culvert is not expected to cause a rise in water surface elevations above existing conditions under either backwater or no-backwater conditions.

Scour was not recalculated for this design as the box will have an integral base embedded 2’ in the stream bed.

Little Bridge # 3987 over Mill Brook
Westbrook, ME

Preliminary Design Report
Hydraulic and Scour Analysis

Northstar Hydro, Inc.

For

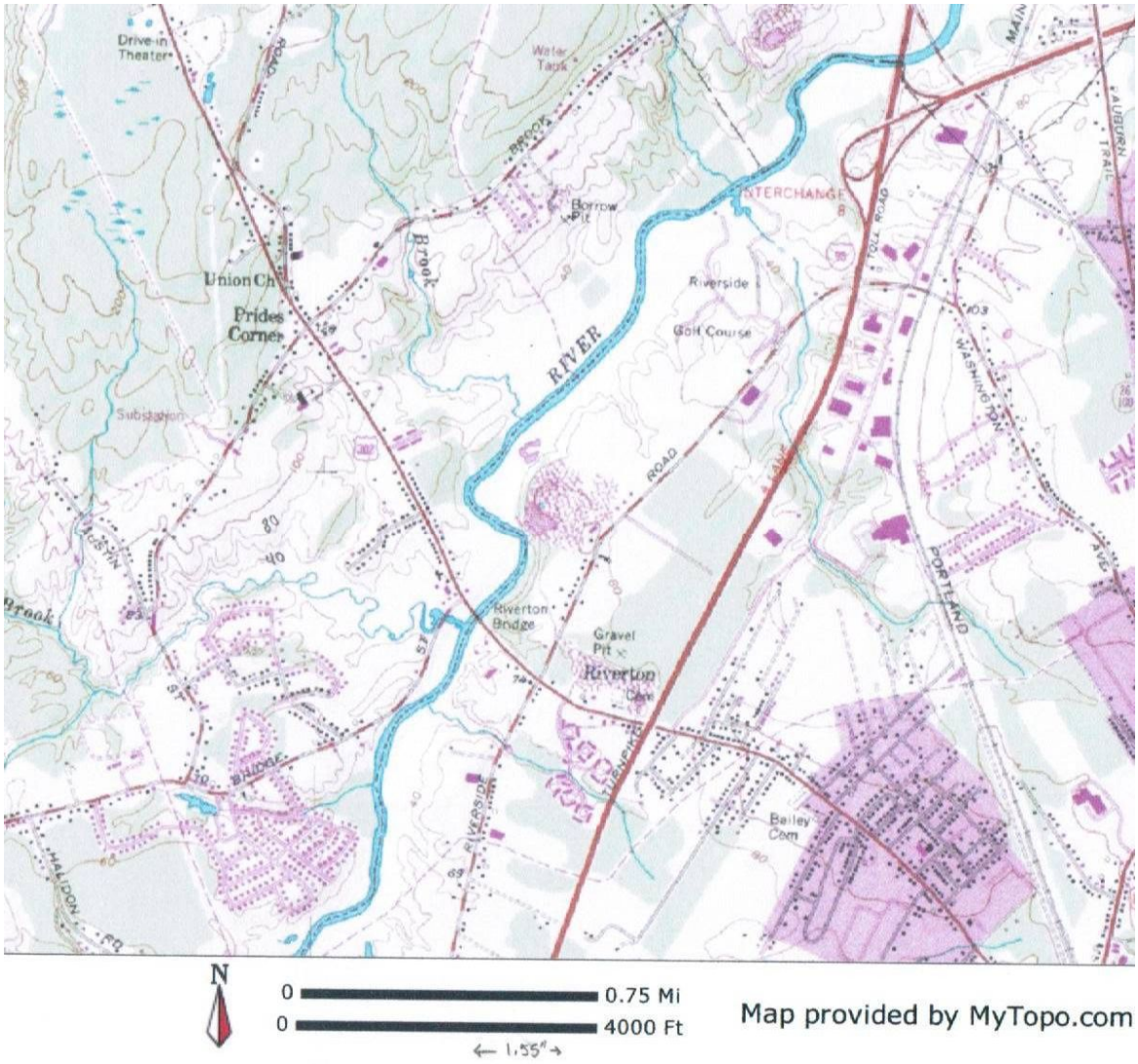
Kleinfelder/SEA Consultants, Inc.

September 7, 2010

Little Bridge # 3987 over Mill Brook, Westbrook, ME
Preliminary Design Report, Hydraulic and Scour Analysis

Introduction:

It is proposed to replace the existing Little Bridge over Mill Brook in Westbrook. The existing bridge is composed of two twin 11' culverts just upstream from the Presumpscot River. The replacement bridge is a "bridge in a backpack" arch, with a 30'11" span at the base and an 8'6" rise. The bridge is impacted by backwater from the Presumpscot River. The site location is shown in figure 1. Mill Brook enters from the center left, flows under Austin St. towards the Presumpscot River near Route 302, at Bridge Street.



Review of Existing Data:

Existing data related to this bridge was reviewed, including but not limited to

- MDOT file information including inspection reports related to scour
- FEMA Flood Maps and FIS report (see Appendix)
- Air photos
- Topographic Maps
- Historical Flood Information
- Study information from work for HNTB on the Turnpike Bridges over the Presumpscot River in Falmouth.

***Presumpscot River, Backwater*:** Backwater from the Presumpscot River affects Mill Brook at Little Bridge, and is therefore a critical design component. The confluence of Mill Brook and the Presumpscot River is just upstream of the Route 302 Bridge. According to the USGS's report on the flood that occurred in October of 1996, the following flood elevations were recorded "Upstream of the Route 302 Bridge, Westbrook". The 1996 flood is recorded as a 250-year event by the USGS. The other historic events are in the range of a 25-year event.

Date	Elev. - ft. NGVD	ft. NAVD
1996	43.8'	43.2'
1954	36.5'	35.9'
1916	34.1'	33.5'
1896	36.6'	36.0'

Flow frequency data for the Presumpscot River was developed by the USGS at the Westbrook Dam, based on recorded flow data. FEMA also published flow-frequency data in the Flood Insurance Study of Westbrook. The following table summarizes flows on the Presumpscot River as calculated by USGS and as published by FEMA.

	USGS gage at Westbrook	**Data from FEMA FIS at Westbrook**	**Calculated Flows at Turnpike Bridge according to USGS 1999 report methodology – Sec. 4, in cfs**
Drainage Area, sq. mi.	**577**		**600**
Frequency –1.1-yr			2500
2-yr	5295		5400
10-yr	9890	8500	10160
1954	12,400		
1916	12,400		
1896	13,800		
50-yr	15700	11800	16024
100-yr	18900	13300	19270
1996	23300		27400
500-yr	28000	17000	28340

The flow data developed by FEMA neither agrees with the USGS frequency curve at the gage, nor with the experience of the flood that occurred in 1996. Historic floods also suggest that the FEMA flows are lower than occur on the Presumpscot River.

For the study of the turnpike bridges, the following flood elevation-frequency data was developed at the Falmouth/Westbrook town line. FEMA FIS elevations are listed for comparison.

Frequency	Turnpike Bridge Study Elevation (NAVD)	FEMA Elevation (NGVD/NAVD)	
1.1-year	16.2		
2-year	21.2		
10-year	27.0	28.8	28.2
50-year	32.4	31.5	30.9
100-year	34.8	32.5	31.9
500-year	40.8	35.0	34.6

Mill Brook: FEMA published the following flows for Mill Brook, listing a drainage area of 4.5 square miles.

10-year	480
50-year	630
100-year	700
500-year	860

Hydrologic Analysis:

MDOT provided hydrologic calculations, prepared in accordance with the USGS 1999 report for estimation of peak discharges. The following table summarizes hydrologic calculations for the Little Bridge, with a drainage area of 13.7 square miles.

1.1 year	153 cfs
10-year	564 cfs
25-year	713 cfs
50-year	829 cfs
100-year	954 cfs
500-year	1255 cfs

Hydraulic Analysis:

The goal of the hydraulic analysis is to provide information on water levels, and flow velocities at Little Bridge. The hydraulic information will assist in design of bridge elevations and foundation components.

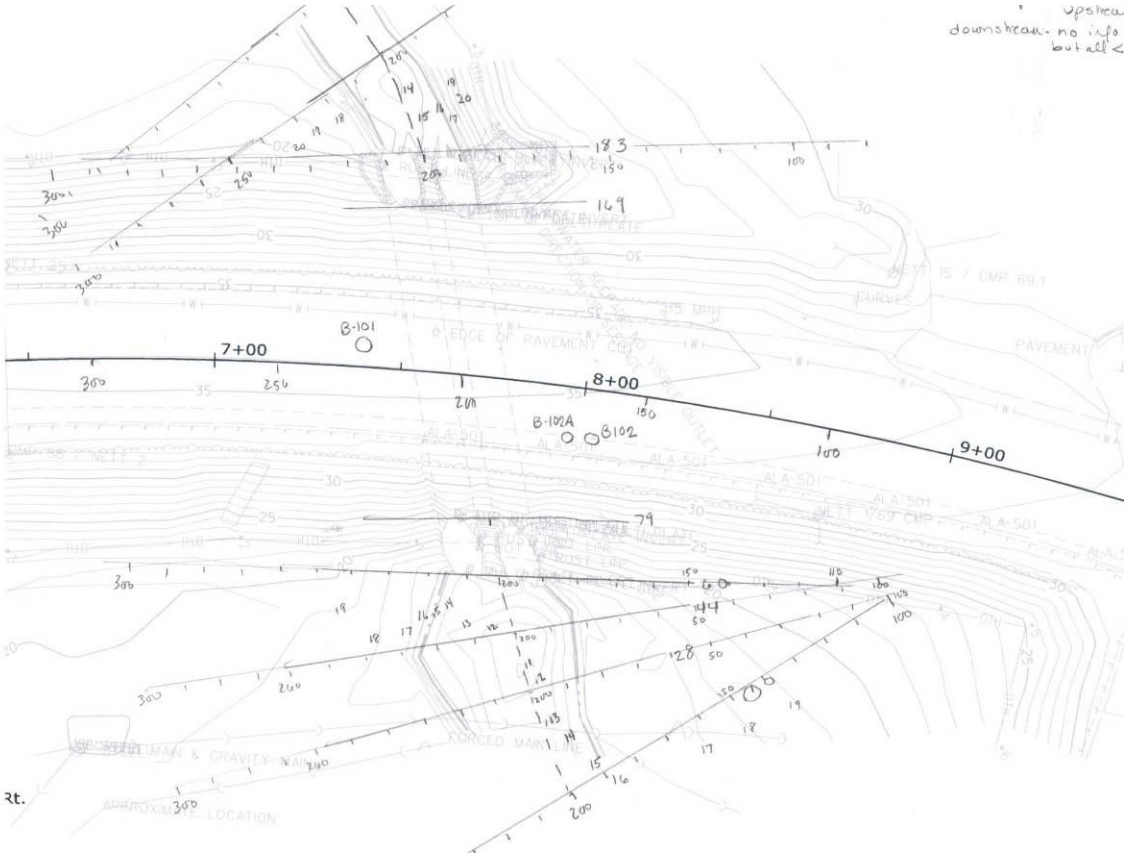
The Little Bridge is affected by backwater from the Presumpscot River. As discussed under existing data review, the data developed by FEMA in 1981 does not agree well with data developed by USGS and recorded for historical floods. Therefore, for the Presumpscot River, data from the study of the turnpike bridges was used for water surface elevations on the Presumpscot River. Elevations were adjusted from the town-line to Mill Brook, by approximately 1.3' based on FEMA profile estimates of stream gradient.

The following backwater elevations apply to the Presumpscot River at its confluence with Mill Brook. (NAVD).

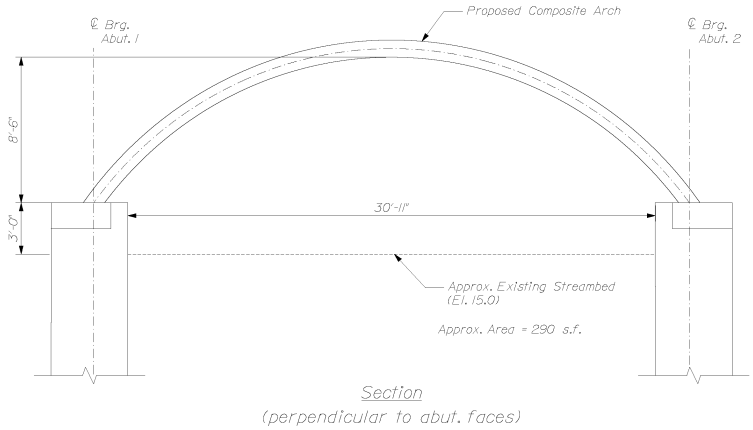
	Town Line	At Mill Brook	FEMA at Mill Brook
1.1-year	16.2	17.5	
2-year	21.2	22.5	
10-year	27.0	28.3	29.4
50-year	32.4	33.7	32.4
100-year	34.8	36.1	33.3
500-year	40.8	42.1	35.7

A hydraulic model of the Little River Bridge was developed to simulate existing and proposed conditions at the bridge. Model HECRAS was used to model flow conditions though the bridge. Model cross sections were compiled using data from field survey, project plans and USGS topographic maps. Cross section locations are shown below.

Existing topography is shown below. In this plot, the stream flows from top of picture to bottom.



The existing condition model consisted of twin cmp culverts 11' in diameter. Sections at the bridge were modified to simulate the proposed condition of a 30'11" base arch with 8.5' rise.



Section
(perpendicular to abut. faces)

Models were run with and without backwater from the Presumpscot River. The following table summarizes model results.

	Elevation		Velocity	
	Upstream	Downstream	Ave.	Max.
Without Backwater from Presumpscot River				
Existing				
1.1 yr	17.2	15.9	3.7	4.0
10 yr	20.0	17.5	6.5	7.0
25 yr	20.9	17.7	7.6	8.3
50 yr	21.5	17.8	8.6	9.3
100 yr	22.1	17.8	9.9	10.7
500 yr	23.6	18.4	10.9	11.8
Proposed				
1.1 yr	16.3	15.9	3.0	3.4
10 yr	18.2	17.5	5.9	6.2
25 yr	18.6	17.8	6.8	7.6
50 yr	18.9	17.9	7.4	8.4
100 yr	19.2	17.9	8.0	8.5
500 yr	19.9	18.5	9.1	9.7
With Backwater from Presumpscot River				
Existing				
1.1 yr	17.8	17.5	2.1	2.4
10 yr	22.8	22.5	2.2	2.6
25 yr	28.9	28.3	1.2	1.4
50 yr	34.3	33.7	0.9	1.0
100 yr	36.2	36.1	0.9	1.0
500 yr	42.1	42.1	0.8	0.9
Proposed				
1.1 yr	17.6	17.5	1.8	1.9
10 yr	22.5	22.5	2.4	2.7
25 yr	28.3	28.3	1.9	2.7
50 yr	33.7	33.7	2.1	2.6
100 yr	36.2	36.1	2.2	2.6
500 yr	42.1	42.1	1.0	1.1

Scour:

The existing bridge is subject to contraction scour, which can cause scour holes to develop at the entrance and exit from the culverts. Because the culverts have a bottom, abutment scour is not an issue, but contraction scour is causing a scour hole to develop at the downstream end of the twin culverts. This type of scour can undermine the base of the culvert if not addressed with scour protection measures.

The proposed bridge is subject to scour conditions when the bridge experiences backwater flow from the Presumpscot River. With only runoff from the Mill Brook watershed, flood elevations are not expected to be above the top of abutment footings, with the new bridge, and therefore only minor scour due to contraction is expected to occur. However, with backwater from the Presumpscot River, the bridge would be subject to flow in both directions during high water, first as the river backs up through the bridge, and second, as the high water again drains downstream.

Scour computations were done using model HECRAS. The default model variables were checked for reasonableness compared to plotted cross sections and were found to adequately represent potential scour conditions. The bridge experiences a significant contraction in both directions, even with the newer structure. Abutments encroach on the normal flood plain, so abutment scour potential remains. The new bridge causes a small contraction than the existing culverts and therefore will experience lower flow velocities. Scour was computed with the Froehlich equation which is known for overly conservative results. Scour protection for the abutments is recommended. Base of abutments or piles should be placed such that the foundation component is stable under fully scoured conditions. The following table summarizes potential scour at the new bridge, at the Left, Center and Right stream channel locations, measured when facing downstream.

Flood Event	Abutment/Contraction Scour		Total Scour	Scour Elevation
Existing Base of Stream				
Left Abutment				15.0
Center				15.0
Right Abutment				15.0
10-year				
Left Abutment	6.0		6.4	8.6
Center		0.3	0.3	14.7
Right Abutment	4.1		4.4	10.6
100-year				
Left Abutment	16.1		19.6	-4.6
Center		3.6	3.6	11.4
Right Abutment	17.5		21.1	-6.1
500-year				
Left Abutment	22.4		22.4	-7.4
Center		0.0	0.0	15.0
Right Abutment	23.8		23.8	-8.8

These computations assume a bed material D50 of 0.2mm. Larger material would provide some protection. Scour protection measures such as riprap, or cable mats at abutments would provide protection against abutment scour.

Summary and Conclusions:

Little Bridge on Mill Brook is subject to flooding from upstream flows and from backwater from the Presumpscot River. While the culverts do allow flood waters from upstream to pass without overtopping, high velocities and scour due to contraction are expected to occur during any type of flooding. The proposed bridge provides a wider and higher opening that would assist in drainage of upstream floodwaters and in improved conveyance of backwater which results from flooding on the Presumpscot River.

Flood elevations are expected to remain at or below current predicted levels with the new bridge in place. Velocities are expected to decrease with the new bridge. Scour protection is recommended for the abutments.

References:

1. U.S. Dept. of the Interior, Geological Survey. Flood of October 1996 in Southern Maine. WRIR 97-4189. Augusta, ME

2. Northstar Hydro, Inc. for HNTB, Inc. for Maine Turnpike Authority. Design Report, Hydrologic, Hydraulic and Scour Analysis. Turnpike Bridges at Presumpscot River – Falmouth/Portland. March 3, 2010.

4. Federal Emergency Management Agency. Flood Insurance Study, Town of Westbrook, ME. January 2, 1981, Community No. 230054

5. U. S. Dept. of the Interior, Geological Survey, with Maine Dept. of Transportation. Estimating the Magnitude and Frequency of Peak Flows for Streams in Maine for Selected Recurrence Intervals. Water Resources Investigations Report 99-4008.

6. U.S. Army Corps of Engineers, Hydrologic Engineering Center. HEC-RAS River Analysis System. Version 3.1.3. May, 2005. Davis, CA

12. U.S. Department of Transportation. Federal Highway Administration. Evaluating Scour at Bridges, 4th edition. HEC-18. May, 2001

13. U.S. Department of Transportation. Federal Highway Administration. Bridge Scour and Stream Instability Countermeasures. HEC-23. March, 2001.

Little Bridge # 3987 over Mill Brook
Westbrook, ME

Preliminary Design Report
Hydraulic and Scour Analysis

Appendix

Hydrologic Calculations, MDOT
FEMA/FIS and FIRM Selected pages
Grain Size Analyses
HECRAS model section of existing bridge
HECRAS model section of proposed bridge
HECRAS model section of upstream section
HECRAS output-
- Stream Profile, Table 1, and Velocity Distributions
  - Existing Conditions w/Backwater
  - Proposed Conditions w/Backwater
  - Existing Conditions w/o Backwater
  - Proposed Conditions w/o Backwater
- Scour Computations, Proposed Conditions w/Backwater, Plot and Computations
  - 10-yr
  - 100-yr
  - 500-yr

Project Name:	Westbrook	**PIN:**	16761.00
Stream Name:	Mill Brook	**Town:**	Westbrook
Bridge Name:	Little Bridge	**Bridge No.**	3987
Route No.	town rd	**USGS Quad:**	
Analysis by:	AWMann	**Date:**	12/14/2009

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

Enter data in blue cells only!

	km²	mi²	ac	*Enter data in [mi²]*
A	35.37	13.655	8739.4	Watershed Area
W	5.57	2.149	1375.2	Wetlands area (by NWI)

P_c	391500	4845347	watershed centroid (E, N; UTM 19N; meters)
County	Cumberland SE		*choose county from drop-down menu*
pptA	44.4		mean annual precipitation (inches; by look-up)
SG	0.00		sand & gravel aquifer as decimal fraction of watershed A

A (km²)	35.37	**Conf Lvl**	0.67
W (%)	15.74		

Worksheet prepared by:

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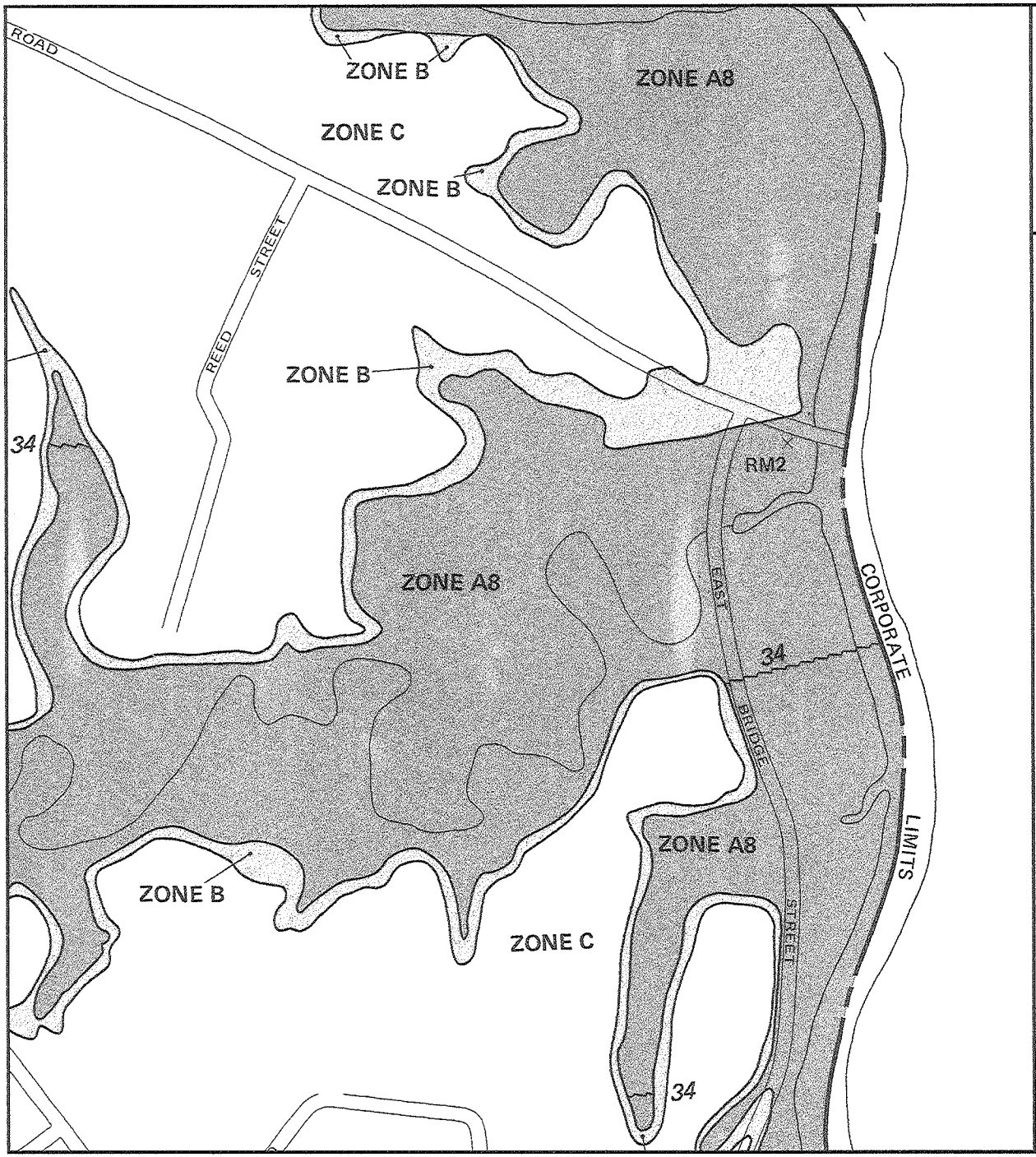
Chief Hydrologist
Maine Dept. Transportation
Augusta, ME 04333-0016
207-287-1105
Charles.Hebson@maine.gov

Ret Pd T (yr)	Peak Flow Estimate Lower	Q_T (m³/s)	Upper	Q_T (ft³/s)
1.1		4.33		152.8
2	6.03	8.43	11.80	297.8
5	9.13	12.80	17.95	451.9
10	11.26	15.97	22.64	563.8
25	14.04	20.20	29.05	713.2
50	16.13	23.47	34.16	828.9
100	18.33	27.00	39.78	953.5
500	23.37	35.55	54.08	1255.2

Reference:

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

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



APPROXIMATE SCALE

400 0 400 FEET

NATIONAL FLOOD INSURANCE PROGRAM

FIRM

FLOOD INSURANCE RATE MAP

CITY OF
WESTBROOK,
MAINE
CUMBERLAND COUNTY

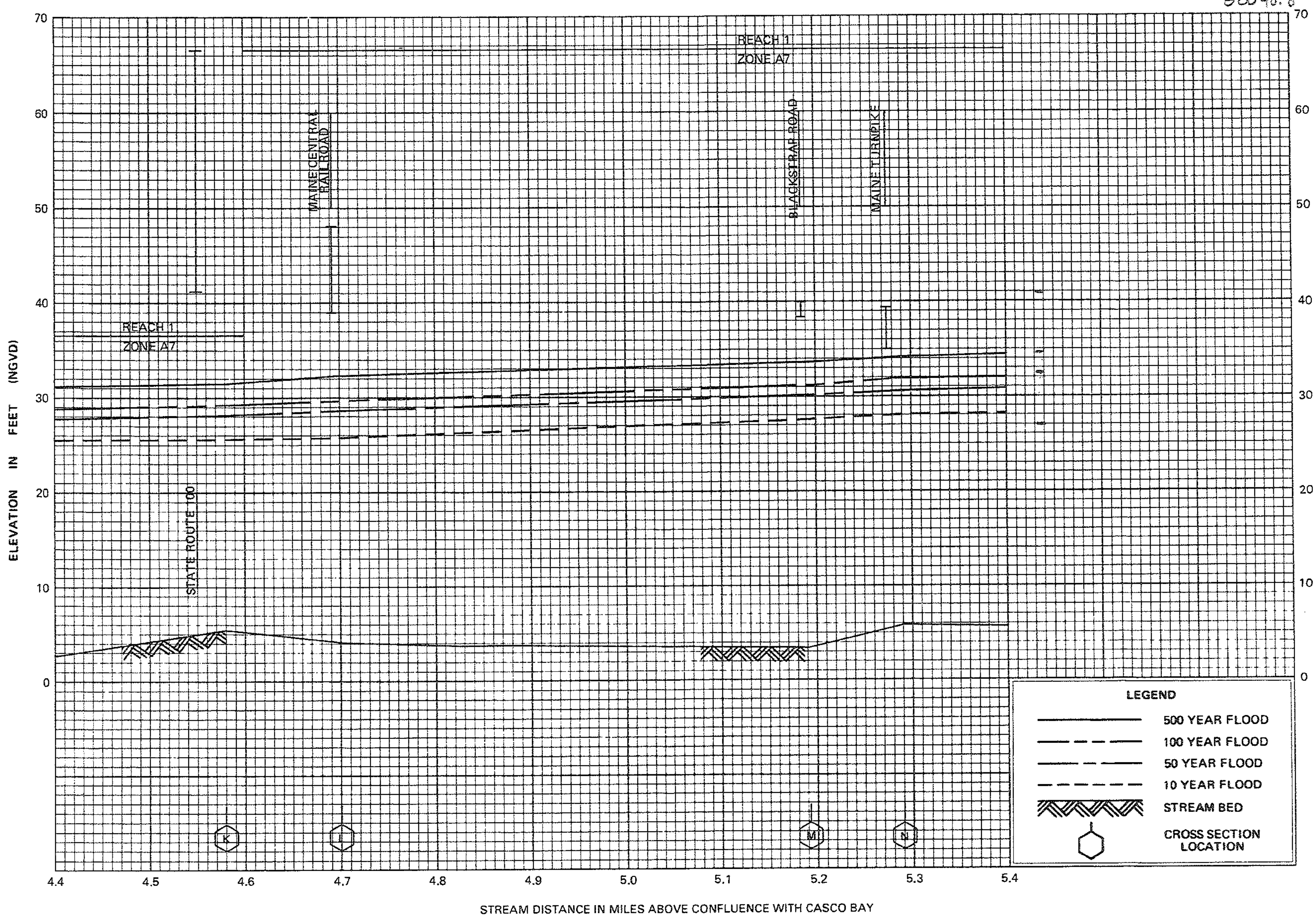
PANEL 4 OF 8

COMMUNITY-PANEL NUMBER
230054 0004 B

EFFECTIVE DATE:
JANUARY 2, 1981

federal emergency management agency
federal insurance administration

Presumpscot - Turnpike Bridge Report:
1.1 14.2
2 21.2
10 27
50 32.4
100 34.8
500 40.8



FLOOD PROFILES

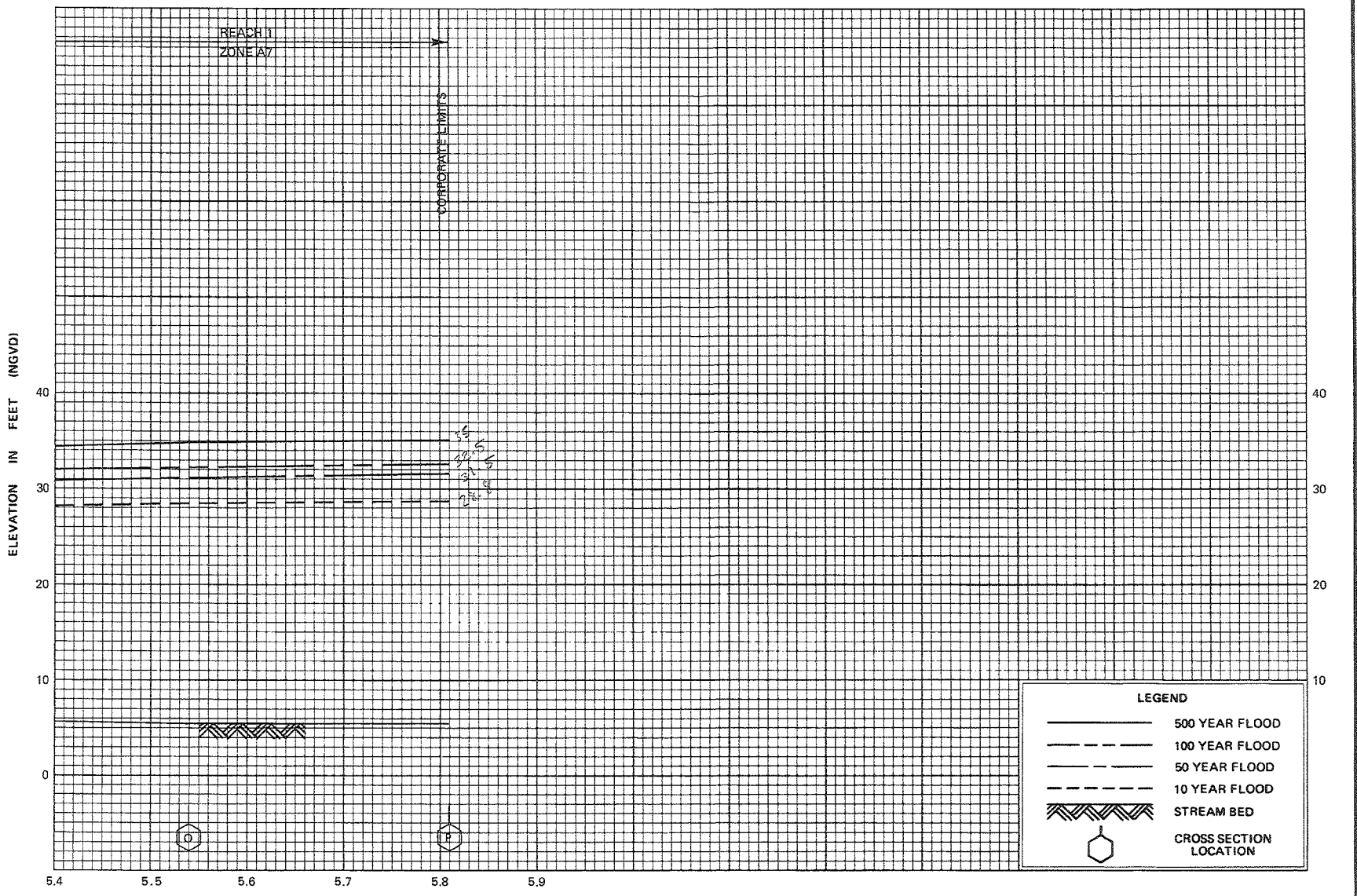
PRESUMPSCOT RIVER

FEDERAL EMERGENCY MANAGEMENT AGENCY

TOWN OF FALMOUTH, ME
(CUMBERLAND CO.)

03P

Flows - Turnpike Bridge Report
1.1 - 2500
2 - 5400
10 10160
50 16024
100 19270
1996 27400
500 28340



FLOOD PROFILES

PRESUMPSCOT RIVER

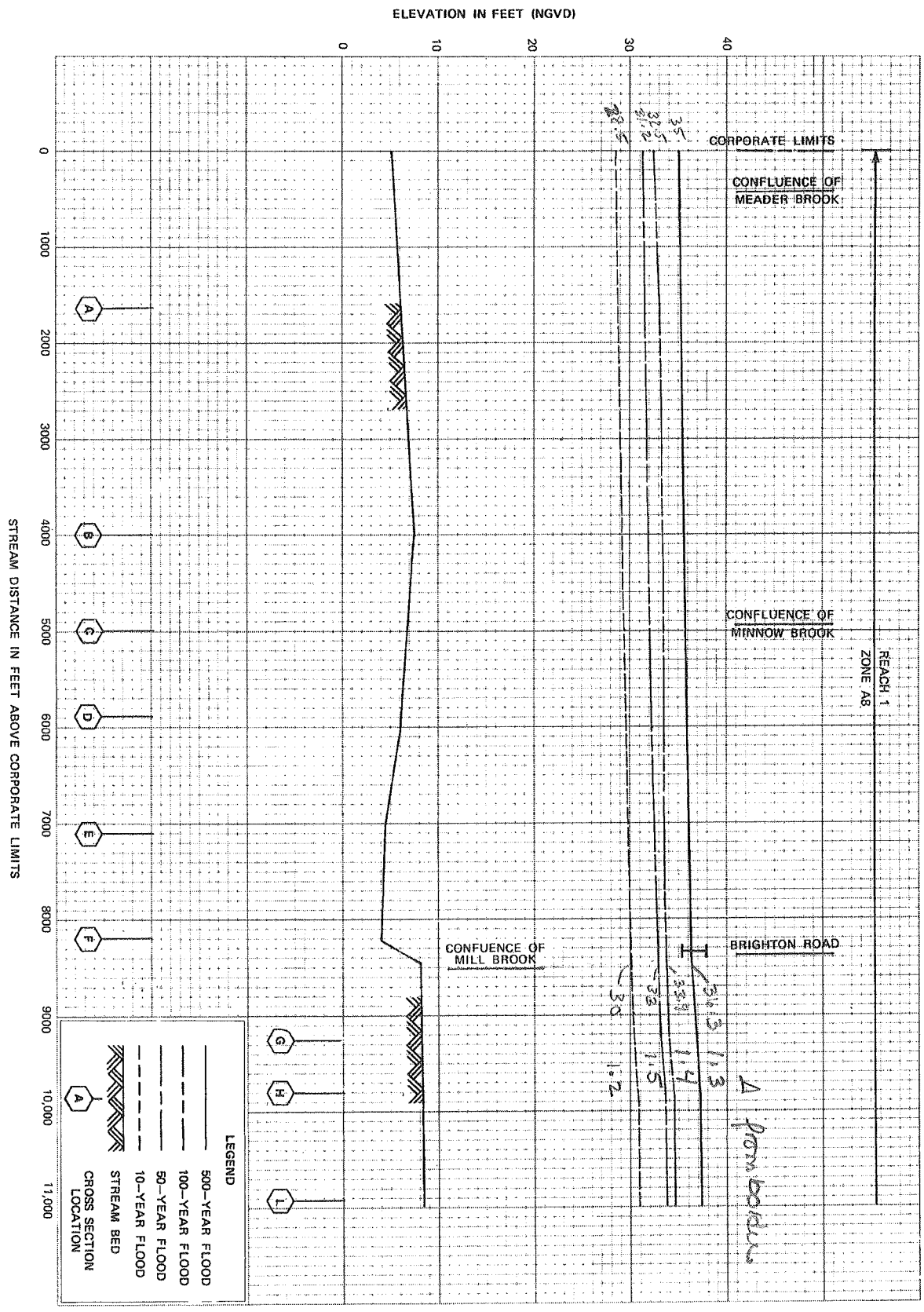
FEDERAL EMERGENCY MANAGEMENT AGENCY

TOWN OF FALMOUTH, ME
(CUMBERLAND CO.)

04P

Flows: (town line)
9300
12900
14500
18600

Westbrook dam
8500
11800
13300
17050



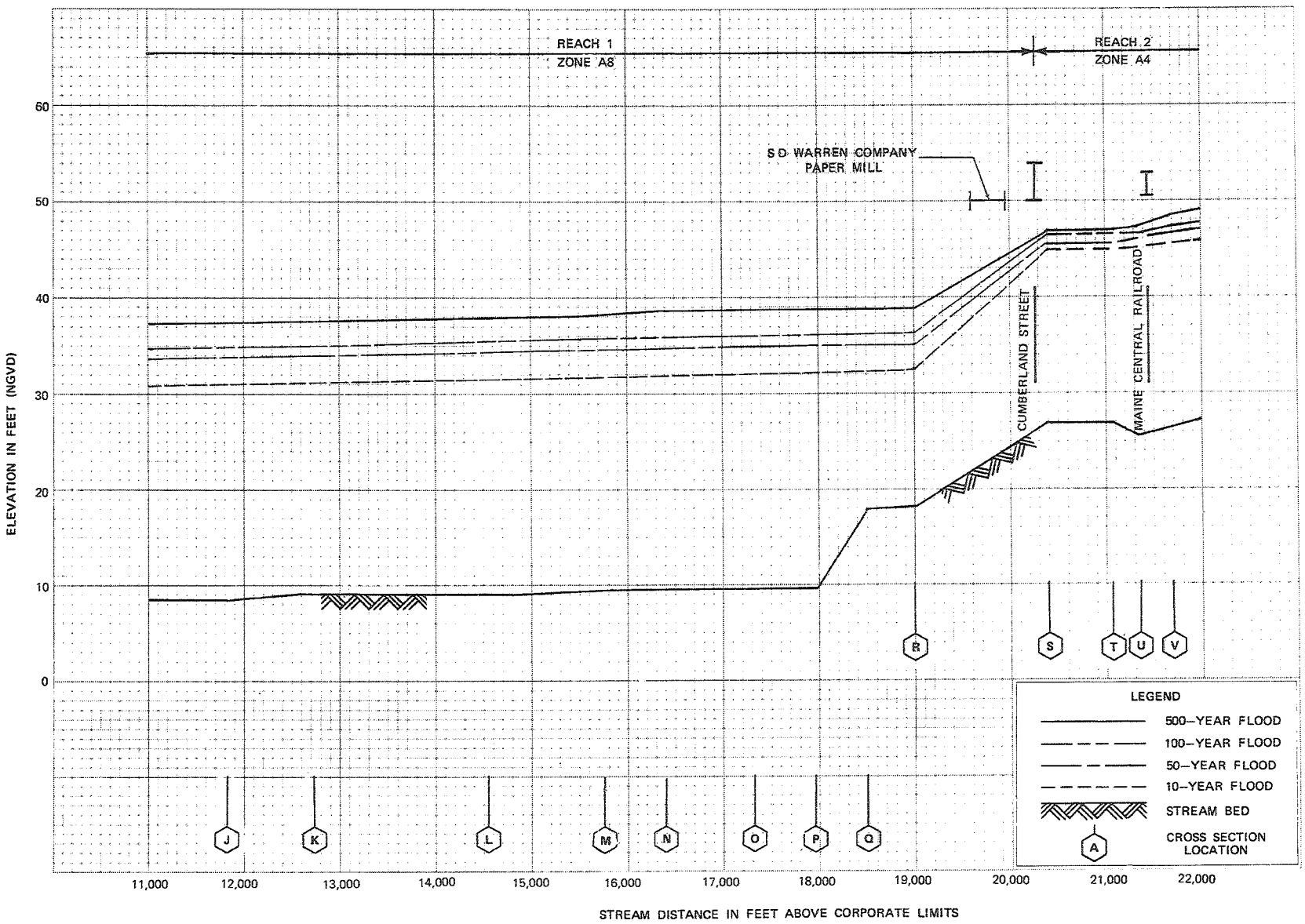
05P

FEDERAL EMERGENCY MANAGEMENT AGENCY
Federal Insurance Administration

CITY OF WESTBROOK, ME
(CUMBERLAND CO.)

FLOOD PROFILES

PRESUMPSCOT RIVER



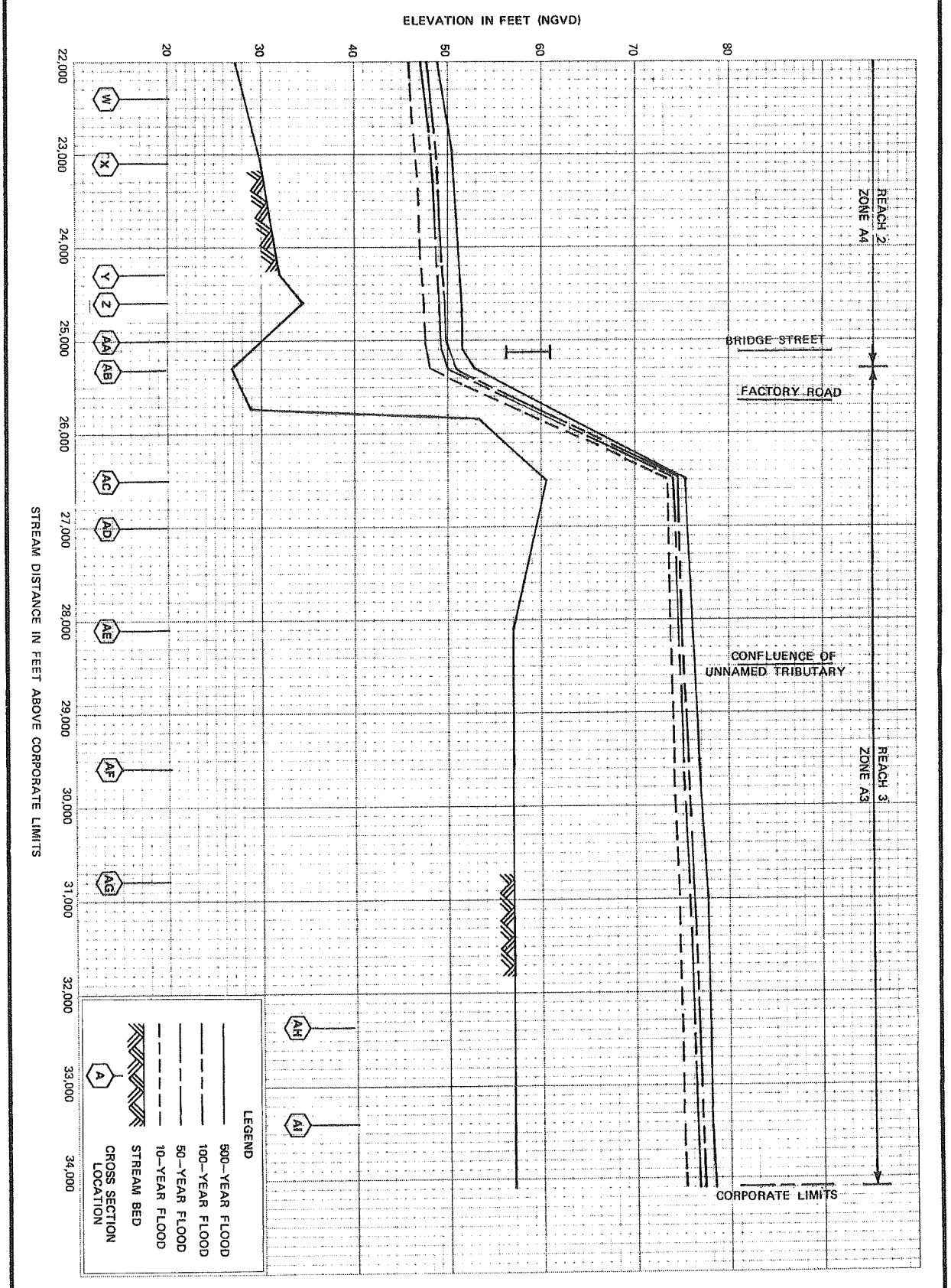
FLOOD PROFILES

PRESUMPSCOT RIVER

FEDERAL EMERGENCY MANAGEMENT AGENCY
Federal Insurance Administration

CITY OF WESTBROOK, ME
(CUMBERLAND CO.)

06P



07P

FEDERAL EMERGENCY MANAGEMENT AGENCY
Federal Insurance Administration

CITY OF WESTBROOK, ME
(CUMBERLAND CO.)

FLOOD PROFILES

PRESUMPSCOT RIVER

FLOODING SOURCE		FLOODWAY			BASE FLOOD WATER SURFACE ELEVATION			
CROSS SECTION	DISTANCE[1]	WIDTH (FEET)	SECTION AREA (SQ. FEET)	MEAN VELOCITY (FEET/SEC.)	REGULATORY (NGVD)	WITHOUT FLOODWAY (NGVD)	WITH FLOODWAY (NGVD)	INCREASE (FEET)
MILL BROOK								
A	850	45	200	3.5	33.8	21.8[2]	22.3	0.5
B	2780	319	950	0.7	33.8	22.3[2]	23.3	1.0
C	3850	19	112	6.3	33.8	22.9[2]	23.4	0.5
D	5380	127	287	2.4	33.8	24.5[2]	25.2	0.7
E	6290	188	540	1.3	33.8	25.7[2]	26.5	0.8
F	6720	79	289	2.4	33.8	26.2[2]	26.9	0.7
G	7400	68	249	2.8	33.8	27.1[2]	28.0	0.9
H	8630	77	332	2.1	33.8	29.4[2]	30.3	0.9
I	9070	17	63	11.0	33.8	31.4[2]	31.6	0.2
MINNOW BROOK								
A	1520	94	313	1.7	33.2	23.7[2]	24.7	1.0
B	2430	30	81	6.4	33.2	31.2[2]	31.3	0.1
C	4250	53	76	6.9	82.8	82.8	82.8	0.0
D	5300	23	85	6.2	97.8	97.8	98.3	0.5
E	5540	87	730	0.5	115.6	115.6	116.6	1.0
F	7530	27	57	6.8	163.5	163.5	163.9	0.4
G	9740	34	77	3.9	217.6	217.6	218.4	0.8
H	10,550	20	42	7.1	237.0	237.0	237.4	0.4
I	11,580	87	70	4.3	267.6	267.6	267.6	0.0
J	12,530	70	78	3.8	279.8	279.8	279.9	0.1

[1]FEET ABOVE MOUTH
[2]ELEVATIONS WITHOUT CONSIDERING BACKWATER EFFECT FROM PRESUMPSCOT RIVER

TABLE 2

FEDERAL EMERGENCY MANAGEMENT AGENCY
Federal Insurance Administration
CITY OF WESTBROOK, ME
(CUMBERLAND CO.)

FLOODWAY DATA

MILL BROOK - MINNOW BROOK

There are two dams on the Presumpscot River within the city limits of Westbrook. These are the Cumberland Mills Dam and the Saccarappa Dam. Both dams were constructed to produce power but only the latter, upstream of the former, continues to be used for this purpose. Both structures provide minimal flood control protection as an auxiliary function. There are six other dams on the Presumpscot River upstream of Westbrook which, though intended for power, also serve a secondary flood control function and thereby provide a measure of protection to the study community. Additionally, the Presumpscot River's source, Sebago Lake, with a water-surface of 45 square miles, has a capacity to store large volumes of floodwaters from the upper drainage areas.

3.0 ENGINEERING METHODS

For the flooding sources studied in detail in the community, standard hydrologic and hydraulic study methods were used to determine the flood hazard data required for this study. Flood events of a magnitude which are expected to be equalled or exceeded once on the average during any 10-, 50-, 100-, or 500-year period (recurrence interval) have been selected as having special significance for flood plain management and for flood insurance premium rates. These events, commonly termed the 10-, 50-, 100-, and 500-year floods, have a 10, 2, 1, and 0.2 percent chance, respectively, of being equalled or exceeded during any year. Although the recurrence interval represents the long term average period between floods of a specific magnitude, rare floods could occur at short intervals or even within the same year. The risk of experiencing a rare flood increases when periods greater than one year are considered. For example, the risk of having a flood which equals or exceeds the 100-year flood (one percent chance of annual occurrence) in any 50-year period is about 40 percent (four in ten), and for any 90-year period, the risk increases to about 60 percent (six in ten). The analyses reported here reflect flooding potentials based on conditions existing in the community at the time of completion of this study. Maps and flood elevations will be amended periodically to reflect future changes.

3.1 Hydrologic Analyses

Hydrologic analyses were carried out to establish the peak discharge-frequency relationships for floods of the selected recurrence intervals for each flooding source studied in detail affecting the community.

Discharges from Sebago Lake to the Presumpscot River have been recorded continuously since 1887 by the S. D. Warren Company and published by the USGS. In 1975, the USGS installed a stream gage on the Presumpscot River in Falmouth at the Maine Turnpike bridge crossing, just downstream of the study area. The only other flow data available for the lower Presumpscot River are miscellaneous peak discharges computed at the Cumberland Mills Dam in Westbrook. Extensive regulation of Sebago Lake has greatly attenuated peak flows from the upper 436 square miles of the Presumpscot River watershed. Runoff from the lower 154-square mile drainage area is

the primary contributor to flood flows in Westbrook. The Royal River at Yarmouth, Maine, located adjacent to the Presumpscot River basin, has a drainage area of 141 square miles and is considered somewhat indicative of the runoff characteristics of the lower Presumpscot River. Analysis of 28 years of USGS flow data for this stream was therefore used as a basis for estimating discharge-frequencies for the lower Presumpscot River. A frequency curve was developed for the Royal River using a standard log-Pearson Type III statistical distribution (Reference 3). Discharge frequencies for the Presumpscot River watershed, between Sebago Lake and Cumberland Mills Dam, were developed by multiplying the Royal River curve by the ratio of peak flows experienced at Cumberland Mills Dam and the Royal River during the floods of March 1936, September 1954, and March 1977.

An assumed coincident baseflow contribution of 600 cfs from Segabo Lake was then added to the Presumpscot River discharges, reflecting the desynchronization accomplished through regulation at the Eel Weir Canal by the S. D. Warren Company. Frequency data for the Presumpscot River were then transferred downstream to the Falmouth town line by ratio of net drainage areas taken to the 0.7 exponential power, assuming the same continuous baseflow contribution of 600 cfs from Sebago Lake. The resulting peak discharges exceeded those values of the Flood Plain Information, Presumpscot River Study (Reference 4), by approximately 20 percent, due mainly to the inclusion of the significant March 1977 event in the discharge-frequency analysis.

There being no discharge records for either Mill Brook or Minnow Brook, the runoff characteristics of the watersheds were assumed to be equivalent to those for the lower Presumpscot River basin as a whole, and flows were determined on a direct drainage area relationship. In the case of Mill Brook, the additional effect of storage at Highland Lake in the upper watershed was also considered in the selection of peak flows from the lower 4.5-square mile drainage area. Several significant flood events were recently recorded on the Stroudwater River by the USGS, suggesting the need for some modification of the discharge-frequency relationship previously published in the Flood Hazard Analysis Stroudwater River Study (Reference 5). The discharges developed by the SCS for the 100-year frequency flood were retained, but values in the more frequent range were increased due to the recent frequency of high flows, particularly the events of April 1975, April 1976, and March 1977. Discharges for the ungaged Clark Brook and Tributary to Clark Brook, were established on the basis of the Stroudwater River discharge-frequency curve, making appropriate adjustments for differences in drainage areas.

The drainage area for the Presumpscot River at Cumberland Mills Dam and at Westbrook - Falmouth Boundary is 436 square miles above Sebago Lake. The drainage area for Mill Brook at its mouth is 7.9 square miles above Highland Lake.

Peak discharges for the 10-, 50-, 100-, and 500-year floods of each flooding source studied in detail in the community are shown in Table 1.

3.2 Hydraulic Analyses

Analyses of the hydraulic characteristics of the streams in the community were carried out to provide estimates of the elevations of the floods of the selected recurrence intervals along each flooding source studied in detail.

Field surveys were conducted at all bridges and road cossings on all rivers studied in detail. The locations of intermediate valley and channel cross sections were taken from photogrammetric maps (Reference 6).

Locations of selected cross sections used in the hydraulic analyses are shown on the Flood Profiles (Exhibit 1). For stream segments for which a floodway was computed (Section 4.2), selected cross section locations are also shown on the Flood Boundary and Floodway Map (Exhibit 2).

Manning's roughness coefficients used in the backwater computations were selected based on engineering experience and judgment. A value of 0.035 was used for all stream channels and 0.080 was used for overbank areas. Energy losses due to gradual changes in the cross sectional flow area were computed using coefficients of 0.1 and 0.3 for contraction and expansion, respectively, whereas 0.3 and 0.5 were used for abrupt changes.

Starting water-surface elevations were determined for the Stroudwater River and the Presumpscot River using previously published elevation-discharge relationships (References 4 and 5). Starting water-surface elevations for Minnow Brook and Mill Brook were determined at their respective mouths at the Presumpscot River. Starting water-surface elevations for Clark Brook were determined at its confluence with the Stroudwater River. Starting water-surface elevations for Tributary to Clark Brook were determined at its confluence with Clark Brook. Flood profiles were computed for all the streams using the U.S. Army Corps of Engineers (COE) HEC-2 computer program (Reference 7). Flood profiles were drawn showing computed water-suface elevations to an accuracy of 0.5 foot for floods of the selected recurrence intervals (Exhibit 1).

It is noted that profiles developed by backwater computations do not allow for debris, ice, excessive turbulence, or river bends which might affect flood levels experienced during a major flood. It is therefore concluded that the computed profiles represent minimum levels that might be expected under the various magnitudes of flow.

FIGURE 2 - Flood of March 1936. Huge ice cakes left by floodwaters near intersection of Bridge Street and Route 302 in Westbrook (Kennebec Journal photo).

FIGURE 3 - Downstream of Portland Terminal railroad bridge - Westbrook. Note building in foreground - waters would approach top of basement window.

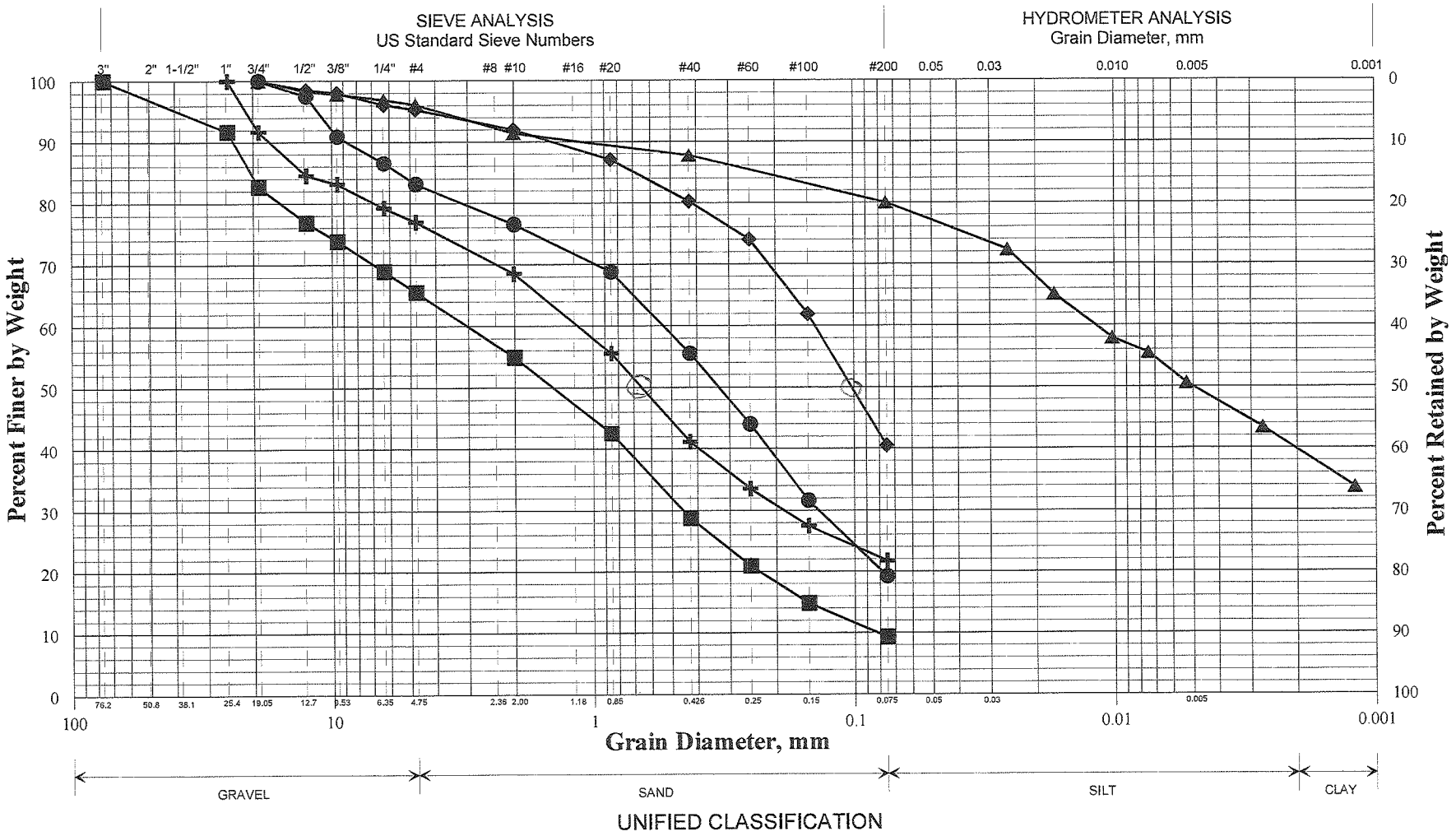
TABLE 1 - SUMMARY OF DISCHARGES

FLOODING SOURCE AND LOCATION	DRAINAGE AREA SQ MILES	PEAK DISCHARGES (CFS) 10-YEAR	50-YEAR	100-YEAR	500-YEAR
STROUDWATER RIVER					
At Spring Street Bridge	25.1	2,760	3,310	3,510	4,860
At Mouth	27.7	2,960	3,540	3,760	5,200
PRESUMPSCOT RIVER					
At Cumberland Mills Dam	134	8,500	11,800	13,300	17,000
At Westbrook-Falmouth Boundary	154	9,300	12,900	14,500	18,600
CLARK BROOK					
At Mouth	1.02	295	350	375	515
TRIBUTARY TO CLARK BROOK					
At Mouth	0.45	165	200	210	290
MILL BROOK					
At Mouth	4.5	480	630	700	860
MINNOW BROOK					
At Mouth	1.3	340	460	520	660

D50= 0.7 → 0.1

State of Maine Department of Transportation

GRAIN SIZE DISTRIBUTION CURVE



UNIFIED CLASSIFICATION

	Boring/Sample No.	Station	Offset, ft	Depth, ft	Description	W, %	LL	PL	PI
✚	BB-WMB-101/2D			5.0-7.0	SAND, some gravel, some silt.	6.7			
◆	BB-WMB-101/3D			10.0-12.0	Silty SAND, trace gravel.	13.1			
■	BB-WMB-101/4D			15.0-17.0	SAND, some gravel, trace silt.	5.1			
●	BB-WMB-101/5D			20.5-21.0	SAND, little silt, little gravel.	10.2			
▲	BB-WMB-101/6D			25.0-27.0	Clayey SILT, little sand, trace gravel.	42.5			
✕									

PIN
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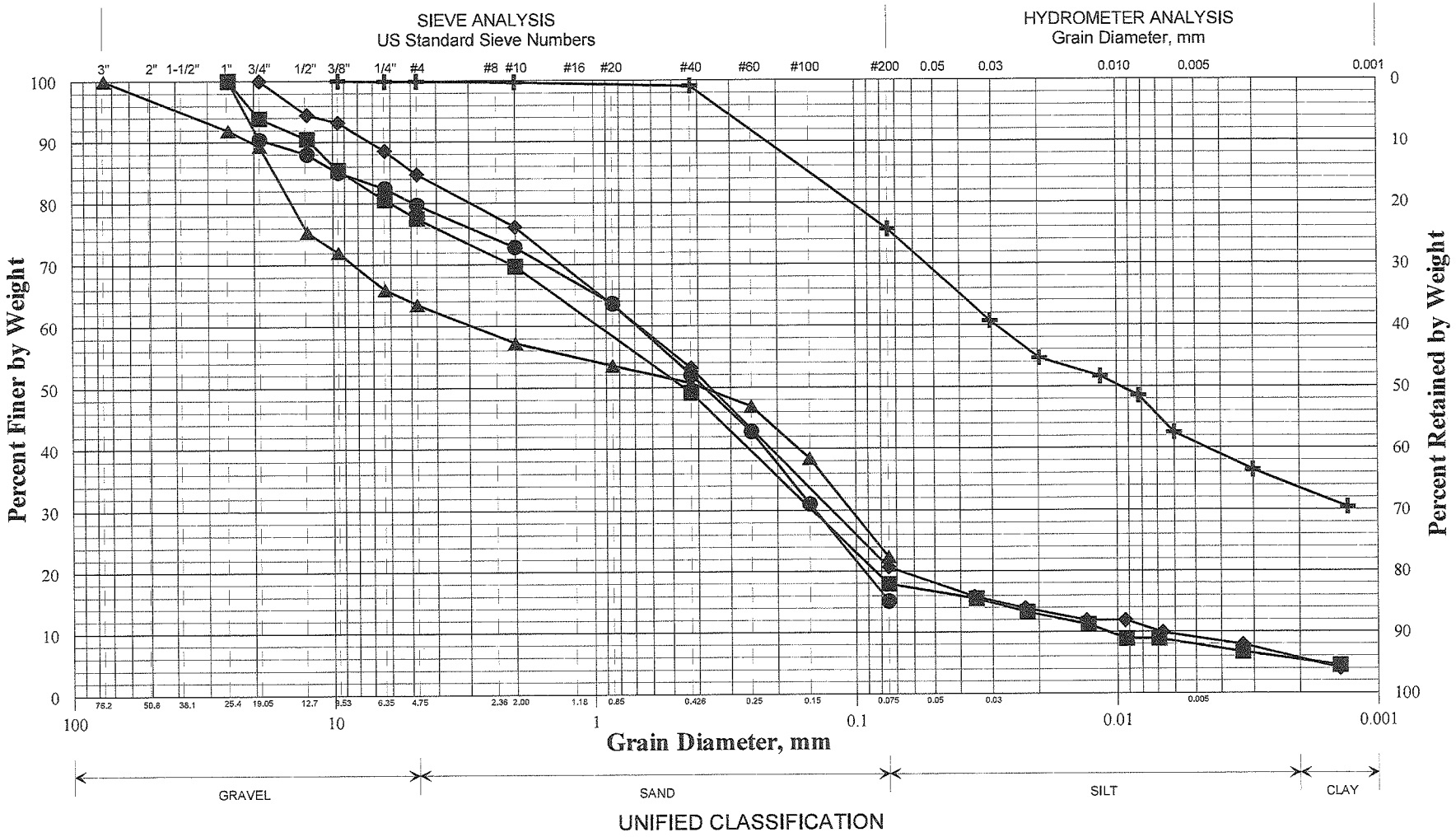
Town
Westbrook
Reported by/Date
WHITE, TERRY A 2/1/2010

State of Maine Department of Transportation

GRAIN SIZE DISTRIBUTION CURVE



	Boring/Sample No.	Station	Offset, ft	Depth, ft	Description	W, %	LL	PL	PI
✚	BB-WMB-101/1U			30.0-32.0	SILT, some clay, some sand, trace gravel.	29.2	22	17	5
◆	BB-WMB-101/7D			39.0-41.0	SAND, little gravel, little silt, trace clay.	11.3			
■	BB-WMB-101/8D			44.0-46.0	SAND, some gravel, little silt, trace clay.	9.3			
●	BB-WMB-101/9D			49.0-51.0	SAND, little gravel, little silt.	11.1			
▲	BB-WMB-101/10D			54.0-55.3	Gravelly SAND, some silt.	9.4			
✕									

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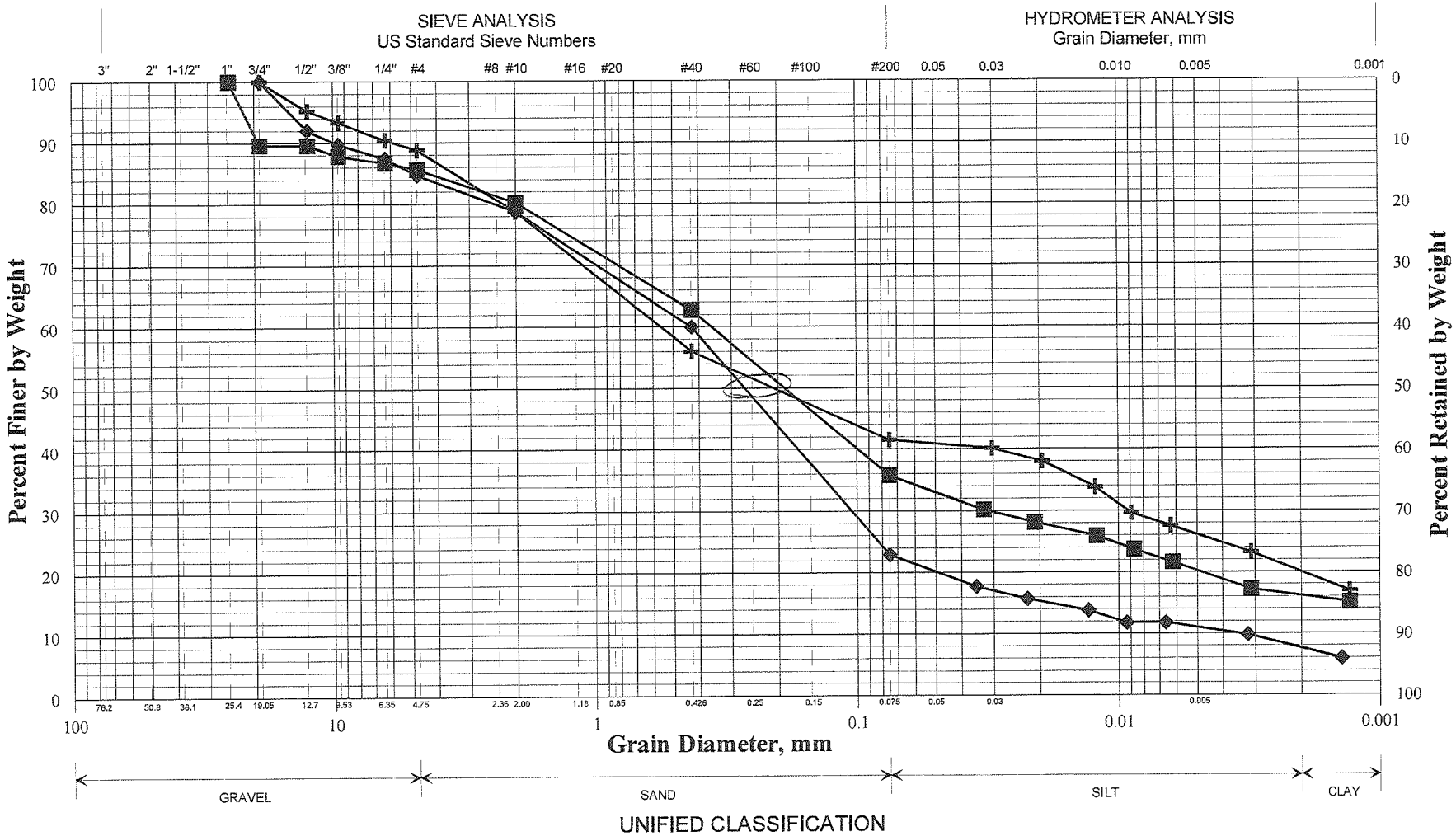
D50=.27→.2

State of Maine Department of Transportation

GRAIN SIZE DISTRIBUTION CURVE



	Boring/Sample No.	Station	Offset, ft	Depth, ft	Description	W, %	LL	PL	PI
✚	BB-WMB-102/2D			5.0-7.0	SAND, some silt, little clay, little gravel.	10.6			
◆	BB-WMB-102/3D			10.0-12.0	SAND, little silt, little gravel, trace clay.	7.8			
■	BB-WMB-102/4D			15.0-15.5	SAND, little silt, little clay. little gravel.	11.8			
●									
▲									
✕									

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Town
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Reported by/Date
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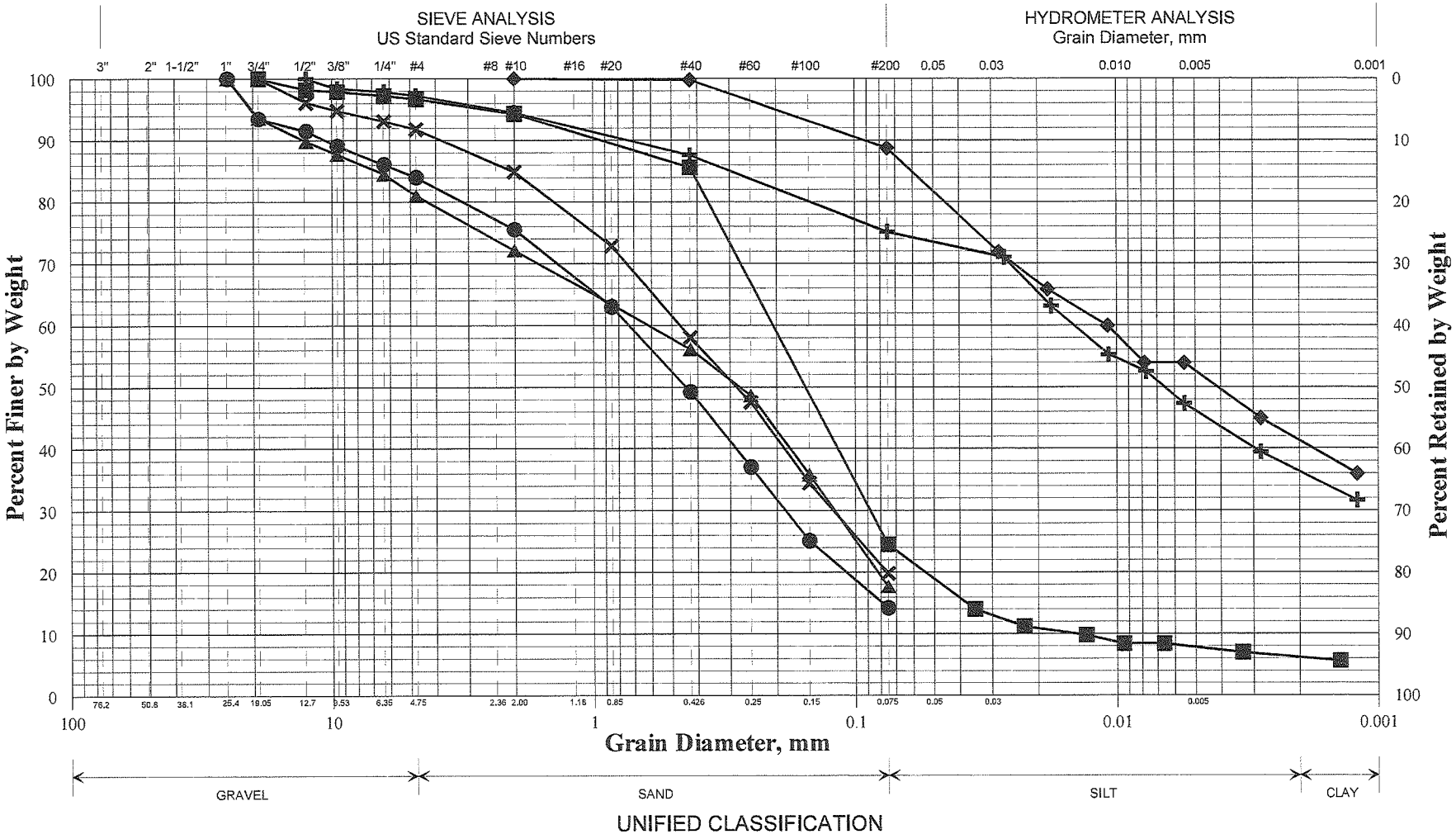
State of Maine Department of Transportation

GRAIN SIZE DISTRIBUTION CURVE



	Boring/Sample No.	Station	Offset, ft	Depth, ft	Description	W, %	LL	PL	PI
✚	BB-WMB-102A/1D			20.0-22.0	Clayey SILT, some sand, trace gravel.	26.2			
◆	BB-WMB-102A/2D			25.5-27.5	CLAY, some silt, little sand.	33.7	28	18	10
■	BB-WMB-102A/3D			30.0-32.0	SAND, little silt, trace clay, trace gravel.	18.7			
●	BB-WMB-102A/4D			35.0-37.0	SAND, little gravel, little silt.	10.1			
▲	BB-WMB-102A/5D			41.0-43.0	SAND, little gravel, little silt.	12.8			
✕	BB-WMB-102A/6D			50.0-52.0	SAND, little silt, trace gravel.	10.4			

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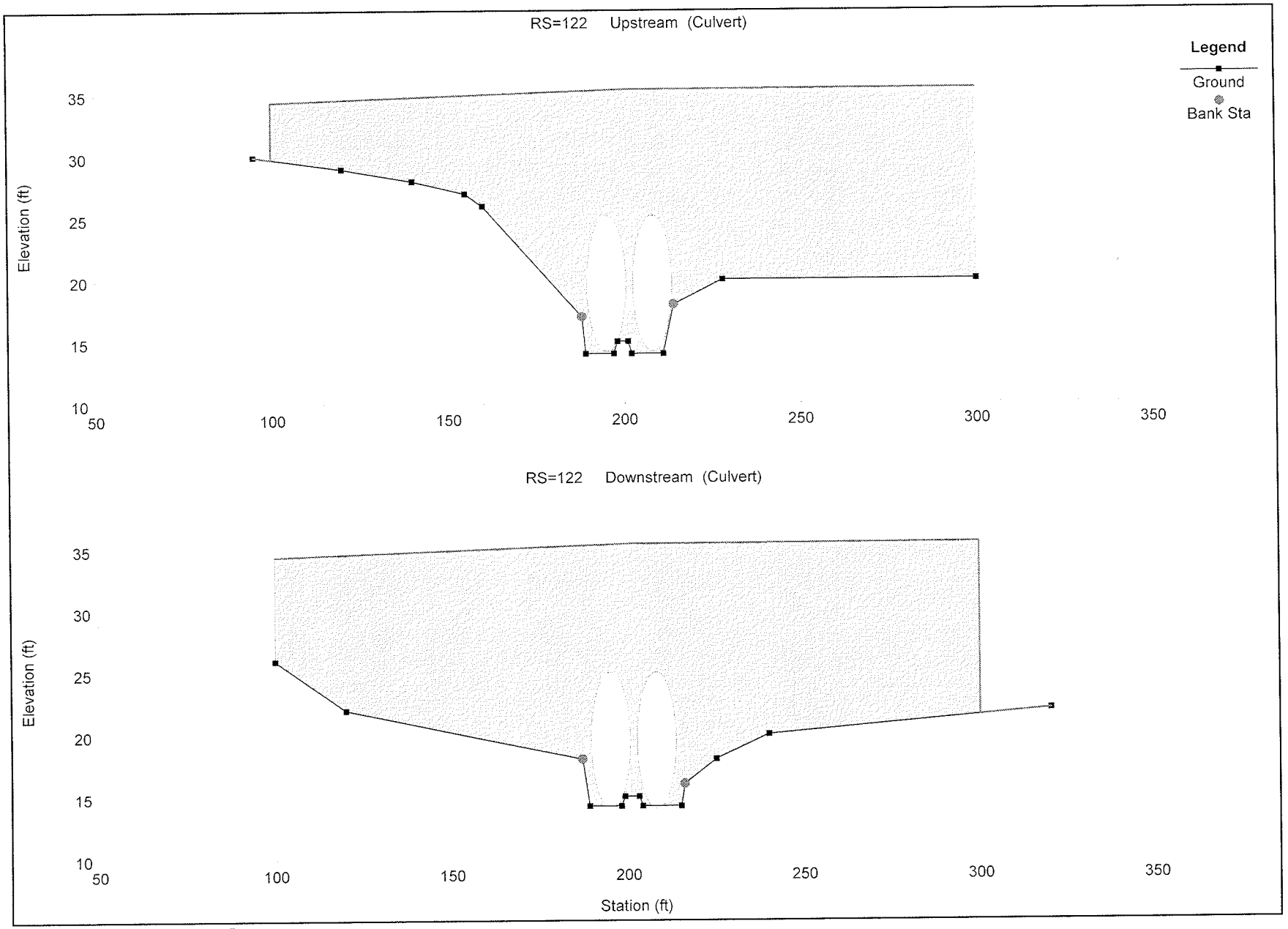
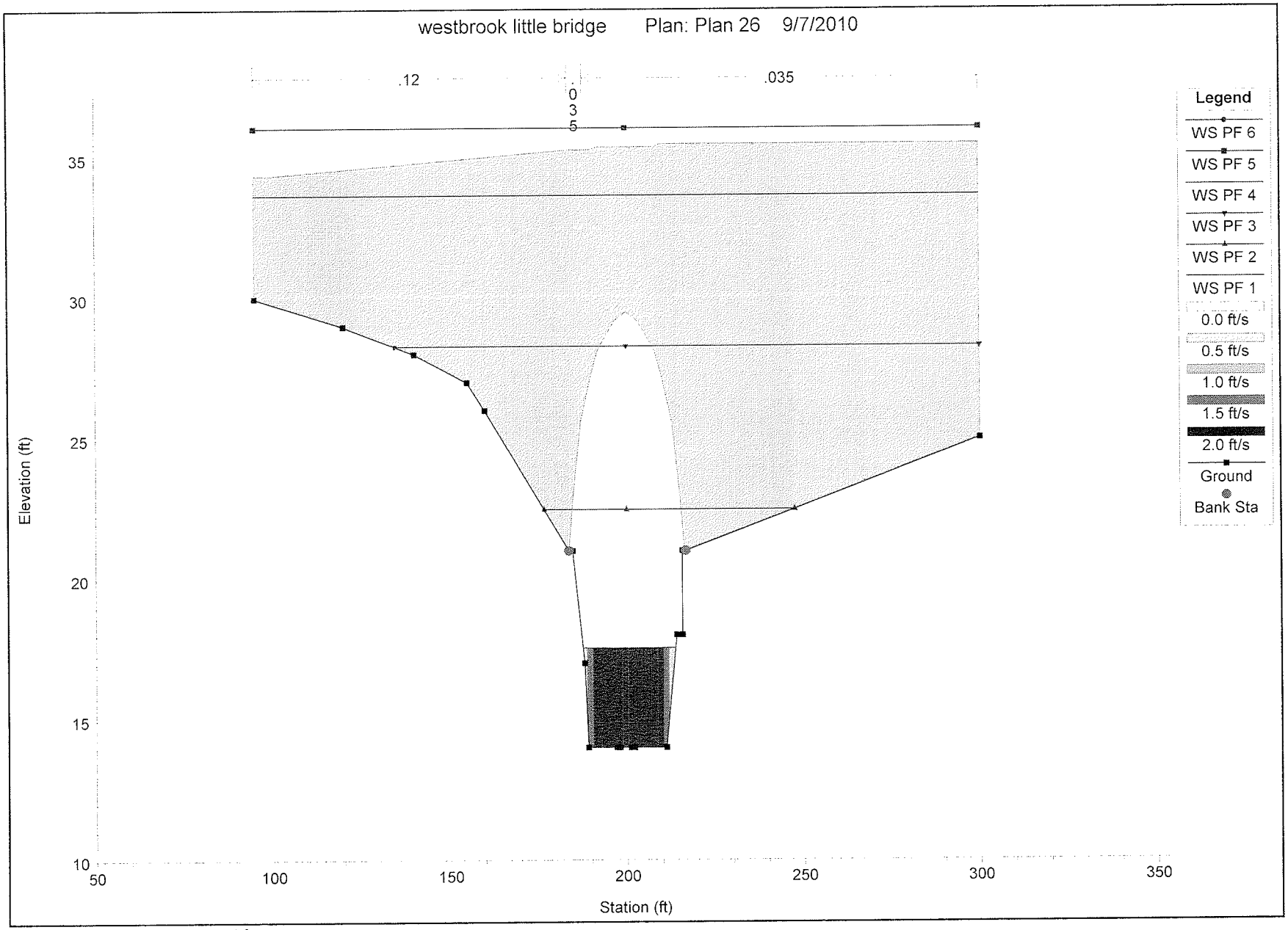
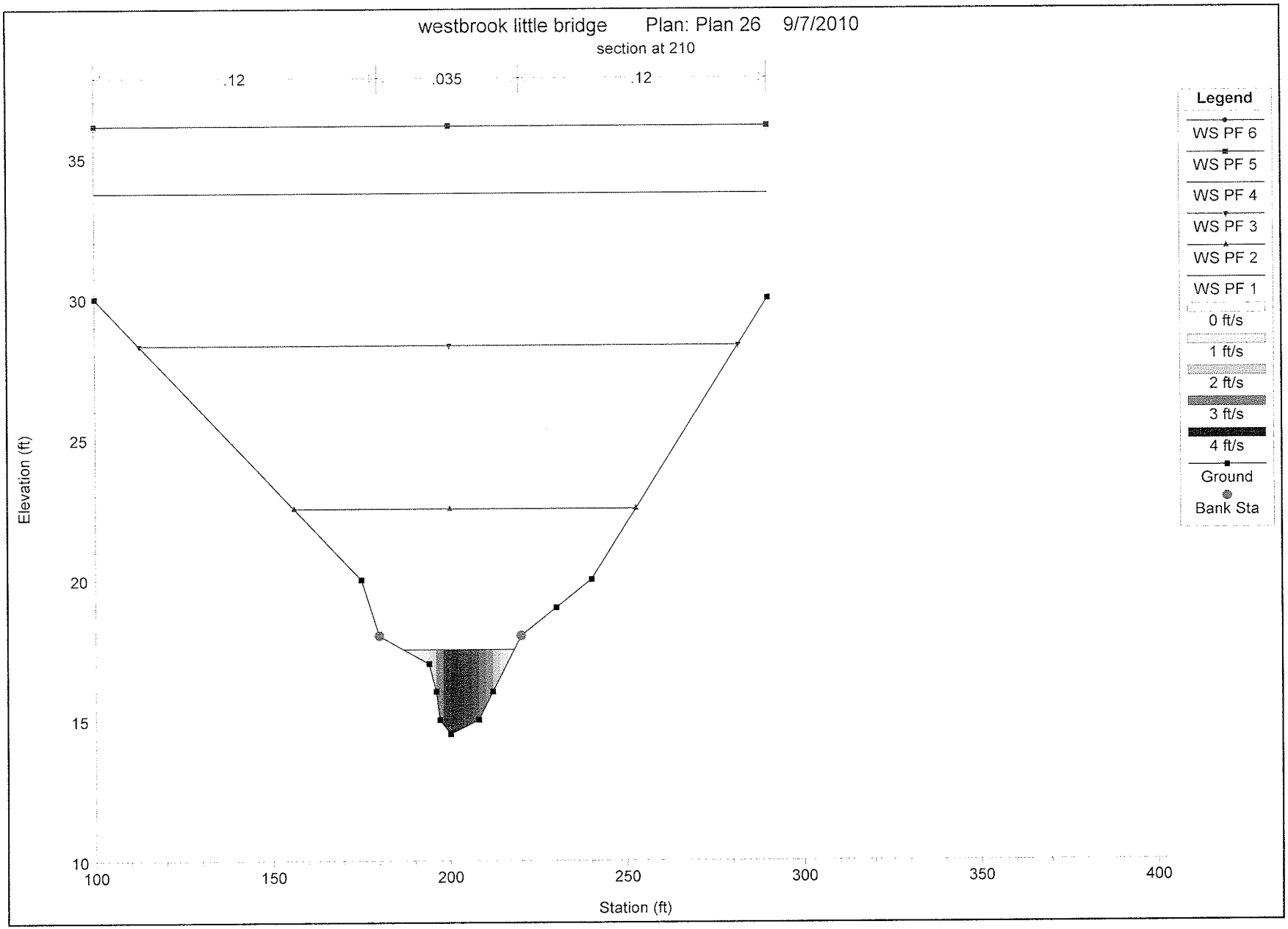


1 in Horiz. = 40 1 in Vert. = 5

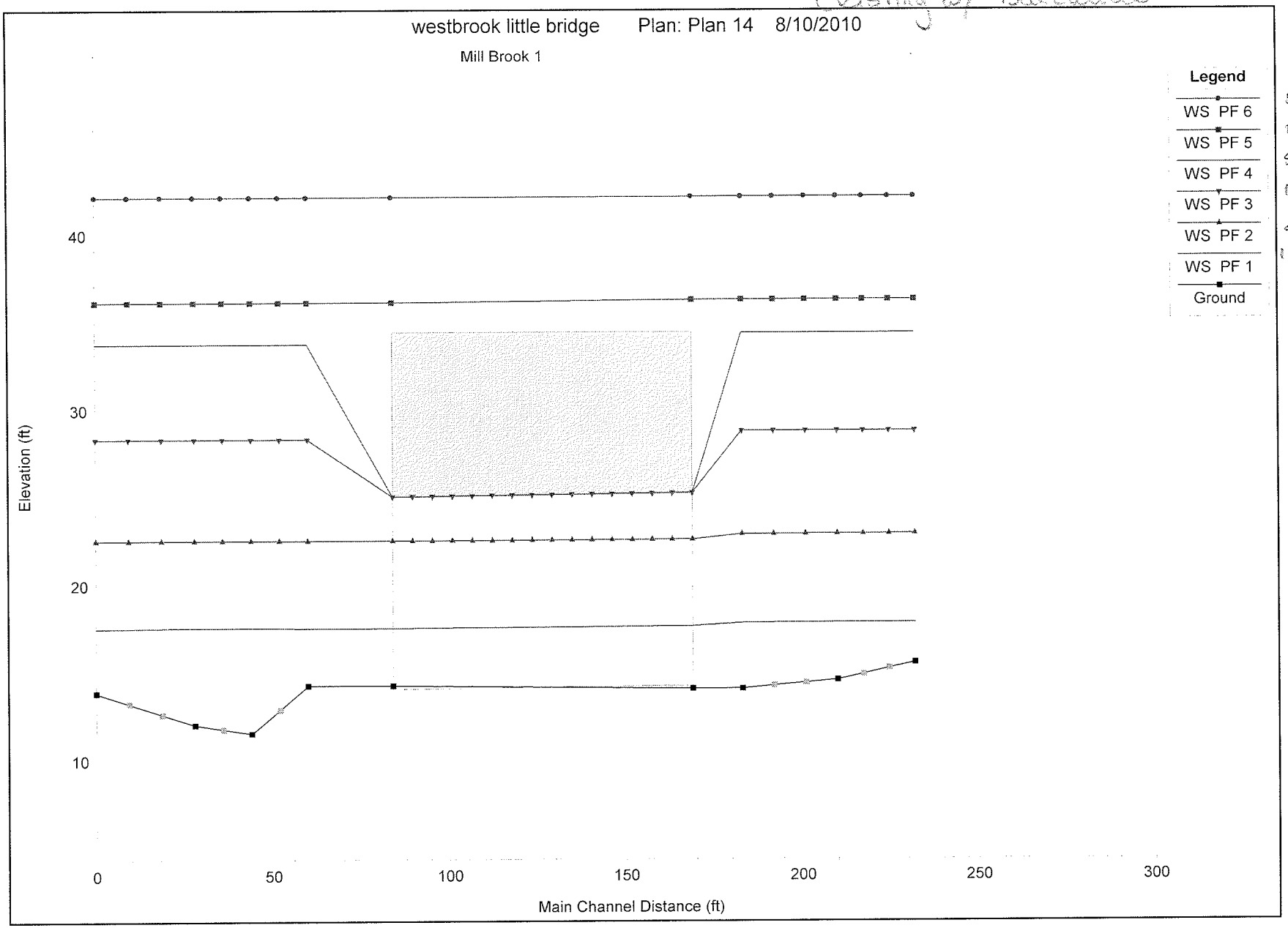


1 in Horiz. = 40 ft 1 in Vert. = 5 ft



1 in Horiz. = 40 ft 1 in Vert. = 5 ft

Crushing w/ backwater



500
100
50
10
2
1.1

1 in Horiz. = 40 ft 1 in Vert. = 8 ft

HEC-RAS Plan: Plan 05 River: Mill Brook Reach: 1

EXISTING W/ BACKWATER

Reach	River Sta	Profile	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl
			(cfs)	(ft)	(ft)	(ft)	(ft)	(ft/ft)	(ft/s)	(sq ft)	(ft)	
1	232	PF 1	153.00	15.50	17.78		17.98	0.004552	3.58	48.08	44.96	0.53
1	232	PF 2	564.00	15.50	22.86		22.91	0.000185	1.96	603.96	141.51	0.14
1	232	PF 3	713.00	15.50	28.76		28.77	0.000024	1.09	1628.44	206.31	0.06
1	232	PF 4	829.00	15.50	34.33		34.33	0.000007	0.77	2845.45	220.00	0.03
1	232	PF 5	954.00	15.50	36.23		36.23	0.000006	0.78	3263.77	220.00	0.03
1	232	PF 6	1255.00	15.50	42.11		42.11	0.000004	0.75	4557.10	220.00	0.03
1	210	PF 1	153.00	14.50	17.77		17.88	0.002173	2.66	57.54	35.87	0.37
1	210	PF 2	564.00	14.50	22.84		22.90	0.000189	1.99	406.72	100.56	0.14
1	210	PF 3	713.00	14.50	28.75		28.77	0.000027	1.15	1218.37	174.36	0.06
1	210	PF 4	829.00	14.50	34.32		34.33	0.000008	0.81	2267.68	190.00	0.03
1	210	PF 5	954.00	14.50	36.22		36.23	0.000007	0.82	2628.97	190.00	0.03
1	210	PF 6	1255.00	14.50	42.10		42.11	0.000005	0.78	3746.03	190.00	0.03
1	183	PF 1	153.00	14.00	17.76	15.34	17.84	0.000857	2.14	72.49	23.20	0.20
1	183	PF 2	564.00	14.00	22.83	17.12	22.89	0.000289	2.22	510.58	130.14	0.14
1	183	PF 3	713.00	14.00	28.75	17.63	28.76	0.000042	1.23	1359.08	174.99	0.06
1	183	PF 4	829.00	14.00	34.32	18.15	34.33	0.000013	0.85	2482.44	205.00	0.03
1	183	PF 5	954.00	14.00	36.23	18.52	36.23	0.000011	0.85	2872.27	205.00	0.03
1	183	PF 6	1255.00	14.00	42.11	19.29	42.11	0.000007	0.80	4077.54	205.00	0.03
1	122		Culvert									
1	60	PF 1	153.00	14.20	17.50		17.55	0.000450	1.74	92.21	35.50	0.18
1	60	PF 2	564.00	14.20	22.48		22.53	0.000163	1.99	617.74	202.39	0.12
1	60	PF 3	713.00	14.20	28.30		28.31	0.000020	1.01	1866.93	220.00	0.05
1	60	PF 4	829.00	14.20	33.70		33.70	0.000007	0.73	3055.33	220.00	0.03
1	60	PF 5	954.00	14.20	36.10		36.10	0.000006	0.72	3583.36	220.00	0.03
1	60	PF 6	1255.00	14.20	42.10		42.10	0.000004	0.71	4903.42	220.00	0.02
1	44	PF 1	153.00	11.50	17.53		17.53	0.000049	0.71	218.72	66.17	0.06
1	44	PF 2	564.00	11.50	22.50		22.52	0.000031	0.99	931.43	187.51	0.06
1	44	PF 3	713.00	11.50	28.30		28.31	0.000007	0.66	2089.27	205.00	0.03
1	44	PF 4	829.00	11.50	33.70		33.70	0.000003	0.52	3196.25	205.00	0.02
1	44	PF 5	954.00	11.50	36.10		36.10	0.000003	0.53	3688.25	205.00	0.02
1	44	PF 6	1255.00	11.50	42.10		42.10	0.000002	0.53	4918.24	205.00	0.02
1	28	PF 1	153.00	12.00	17.52		17.53	0.000083	0.93	182.68	69.32	0.08

HEC-RAS Plan: Plan 05 River: Mill Brook Reach: 1 (Continued)

Reach	River Sta	Profile	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl
			(cfs)	(ft)	(ft)	(ft)	(ft)	(ft/ft)	(ft/s)	(sq ft)	(ft)	
1	28	PF 2	564.00	12.00	22.50		22.52	0.000043	1.16	1014.24	200.83	0.07
1	28	PF 3	713.00	12.00	28.30		28.31	0.000009	0.74	2198.04	205.00	0.03
1	28	PF 4	829.00	12.00	33.70		33.70	0.000004	0.59	3305.08	205.00	0.02
1	28	PF 5	954.00	12.00	36.10		36.10	0.000003	0.60	3797.08	205.00	0.02
1	28	PF 6	1255.00	12.00	42.10		42.10	0.000002	0.60	5027.07	205.00	0.02
1	0	PF 1	153.00	13.80	17.50	15.28	17.53	0.000435	1.33	115.45	62.00	0.17
1	0	PF 2	564.00	13.80	22.50	16.88	22.51	0.000047	1.02	932.91	200.83	0.07
1	0	PF 3	713.00	13.80	28.30	17.17	28.30	0.000008	0.62	2116.70	205.00	0.03
1	0	PF 4	829.00	13.80	33.70	17.38	33.70	0.000003	0.49	3223.70	205.00	0.02
1	0	PF 5	954.00	13.80	36.10	17.58	36.10	0.000003	0.49	3715.70	205.00	0.02
1	0	PF 6	1255.00	13.80	42.10	18.02	42.10	0.000002	0.50	4945.70	205.00	0.02

Existing w/ Backwater

Plan: Plan 05 Mill Brook 1 RS: 60 Profile: PF 1

	Pos	Left Sta	Right Sta	Flow	Area	W.P.	Percent	Hydr	Velocity
		(ft)	(ft)	(cfs)	(sq ft)	(ft)	Conv	Depth(ft)	(ft/s)
1	Chan	187.00	188.45	0.74	1.34	2.55	0.49	1.13	0.55
2	Chan	188.45	189.90	6.41	4.50	2.08	4.19	3.10	1.42
3	Chan	189.90	191.35	9.04	4.79	1.45	5.91	3.30	1.89
4	Chan	191.35	192.80	9.04	4.79	1.45	5.91	3.30	1.89
5	Chan	192.80	194.25	9.04	4.79	1.45	5.91	3.30	1.89
6	Chan	194.25	195.70	9.04	4.79	1.45	5.91	3.30	1.89
7	Chan	195.70	197.15	9.04	4.79	1.45	5.91	3.30	1.89
8	Chan	197.15	198.60	7.99	4.64	1.62	5.22	3.20	1.72
9	Chan	198.60	200.05	5.58	3.69	1.56	3.65	2.55	1.51
10	Chan	200.05	201.50	5.70	3.63	1.45	3.72	2.50	1.57
11	Chan	201.50	202.95	5.70	3.63	1.45	3.72	2.50	1.57
12	Chan	202.95	204.40	6.84	4.35	1.73	4.47	3.00	1.57
13	Chan	204.40	205.85	9.04	4.79	1.45	5.91	3.30	1.89
14	Chan	205.85	207.30	9.04	4.79	1.45	5.91	3.30	1.89
15	Chan	207.30	208.75	9.04	4.79	1.45	5.91	3.30	1.89
16	Chan	208.75	210.20	9.04	4.79	1.45	5.91	3.30	1.89
17	Chan	210.20	211.65	9.04	4.79	1.45	5.91	3.30	1.89
18	Chan	211.65	213.10	9.04	4.79	1.45	5.91	3.30	1.89
19	Chan	213.10	214.55	9.04	4.79	1.45	5.91	3.30	1.89
20	Chan	214.55	216.00	4.43	3.89	2.51	2.90	2.68	1.14
21	ROB	216.00	320.00	1.08	5.08	6.92	0.71	0.75	0.21

Plan: Plan 05 Mill Brook 1 RS: 60 Profile: PF 2

	Pos	Left Sta	Right Sta	Flow	Area	W.P.	Percent	Hydr	Velocity
		(ft)	(ft)	(cfs)	(sq ft)	(ft)	Conv	Depth(ft)	(ft/s)
1	LOB	100.00	187.00	47.14	166.62	69.56	8.36	2.40	0.28
2	Chan	187.00	188.45	8.65	8.49	3.11	1.53	5.86	1.02
3	Chan	188.45	189.90	19.35	11.72	2.08	3.43	8.08	1.65
4	Chan	189.90	191.35	25.63	12.00	1.45	4.54	8.28	2.14
5	Chan	191.35	192.80	25.63	12.00	1.45	4.54	8.28	2.14
6	Chan	192.80	194.25	25.63	12.00	1.45	4.54	8.28	2.14
7	Chan	194.25	195.70	25.63	12.00	1.45	4.54	8.28	2.14
8	Chan	195.70	197.15	25.63	12.00	1.45	4.54	8.28	2.14
9	Chan	197.15	198.60	23.35	11.86	1.62	4.14	8.18	1.97
10	Chan	198.60	200.05	20.79	10.91	1.56	3.69	7.52	1.91
11	Chan	200.05	201.50	21.64	10.84	1.45	3.84	7.48	2.00
12	Chan	201.50	202.95	21.64	10.84	1.45	3.84	7.48	2.00
13	Chan	202.95	204.40	21.40	11.56	1.73	3.80	7.97	1.85
14	Chan	204.40	205.85	25.63	12.00	1.45	4.54	8.28	2.14
15	Chan	205.85	207.30	25.63	12.00	1.45	4.54	8.28	2.14
16	Chan	207.30	208.75	25.63	12.00	1.45	4.54	8.28	2.14
17	Chan	208.75	210.20	25.63	12.00	1.45	4.54	8.28	2.14
18	Chan	210.20	211.65	25.63	12.00	1.45	4.54	8.28	2.14
19	Chan	211.65	213.10	25.63	12.00	1.45	4.54	8.28	2.14
20	Chan	213.10	214.55	25.63	12.00	1.45	4.54	8.28	2.14
21	Chan	214.55	216.00	15.62	11.10	2.51	2.77	7.66	1.41
22	ROB	216.00	320.00	56.87	219.75	104.86	10.08	2.11	0.26

Plan: Plan 05 Mill Brook 1 RS: 60 Profile: PF 3

	Pos	Left Sta	Right Sta	Flow	Area	W.P.	Percent	Hydr	Velocity
		(ft)	(ft)	(cfs)	(sq ft)	(ft)	Conv	Depth(ft)	(ft/s)
1	LOB	100.00	187.00	132.84	641.87	89.81	18.63	7.38	0.21
2	Chan	187.00	188.45	9.70	16.93	3.11	1.36	11.67	0.57
3	Chan	188.45	189.90	16.96	20.15	2.08	2.38	13.90	0.84
4	Chan	189.90	191.35	22.10	20.44	1.45	3.10	14.10	1.08
5	Chan	191.35	192.80	22.10	20.44	1.45	3.10	14.10	1.08
6	Chan	192.80	194.25	22.10	20.44	1.45	3.10	14.10	1.08
7	Chan	194.25	195.70	22.10	20.44	1.45	3.10	14.10	1.08
8	Chan	195.70	197.15	22.10	20.44	1.45	3.10	14.10	1.08
9	Chan	197.15	198.60	20.30	20.30	1.62	2.85	14.00	1.00
10	Chan	198.60	200.05	19.18	19.35	1.56	2.69	13.34	0.99
11	Chan	200.05	201.50	20.05	19.28	1.45	2.81	13.30	1.04
12	Chan	201.50	202.95	20.05	19.28	1.45	2.81	13.30	1.04
13	Chan	202.95	204.40	18.94	20.00	1.73	2.66	13.79	0.95
14	Chan	204.40	205.85	22.10	20.44	1.45	3.10	14.10	1.08
15	Chan	205.85	207.30	22.10	20.44	1.45	3.10	14.10	1.08
16	Chan	207.30	208.75	22.10	20.44	1.45	3.10	14.10	1.08
17	Chan	208.75	210.20	22.10	20.44	1.45	3.10	14.10	1.08
18	Chan	210.20	211.65	22.10	20.44	1.45	3.10	14.10	1.08
19	Chan	211.65	213.10	22.10	20.44	1.45	3.10	14.10	1.08
20	Chan	213.10	214.55	22.10	20.44	1.45	3.10	14.10	1.08
21	Chan	214.55	216.00	14.22	19.54	2.51	1.99	13.48	0.73
22	ROB	216.00	320.00	175.58	824.93	110.67	24.63	7.93	0.21

Plan: Plan 05 Mill Brook 1 RS: 60 Profile: PF 4

	Pos	Left Sta	Right Sta	Flow	Area	W.P.	Percent	Hydr	Velocity
		(ft)	(ft)	(cfs)	(sq ft)	(ft)	Conv	Depth(ft)	(ft/s)
1	LOB	100.00	187.00	185.69	1111.83	95.21	22.40	12.78	0.17
2	Chan	187.00	188.45	10.65	24.76	3.11	1.29	17.08	0.43
3	Chan	188.45	189.90	17.09	27.99	2.08	2.06	19.30	0.61
4	Chan	189.90	191.35	22.12	28.27	1.45	2.67	19.50	0.78
5	Chan	191.35	192.80	22.12	28.27	1.45	2.67	19.50	0.78
6	Chan	192.80	194.25	22.12	28.27	1.45	2.67	19.50	0.78
7	Chan	194.25	195.70	22.12	28.27	1.45	2.67	19.50	0.78
8	Chan	195.70	197.15	22.12	28.27	1.45	2.67	19.50	0.78
9	Chan	197.15	198.60	20.38	28.13	1.62	2.46	19.40	0.72
10	Chan	198.60	200.05	19.70	27.18	1.56	2.38	18.74	0.72
11	Chan	200.05	201.50	20.63	27.11	1.45	2.49	18.70	0.76
12	Chan	201.50	202.95	20.63	27.11	1.45	2.49	18.70	0.76
13	Chan	202.95	204.40	19.15	27.83	1.73	2.31	19.20	0.69
14	Chan	204.40	205.85	22.12	28.27	1.45	2.67	19.50	0.78
15	Chan	205.85	207.30	22.12	28.27	1.45	2.67	19.50	0.78
16	Chan	207.30	208.75	22.12	28.27	1.45	2.67	19.50	0.78
17	Chan	208.75	210.20	22.12	28.27	1.45	2.67	19.50	0.78
18	Chan	210.20	211.65	22.12	28.27	1.45	2.67	19.50	0.78
19	Chan	211.65	213.10	22.12	28.27	1.45	2.67	19.50	0.78
20	Chan	213.10	214.55	22.12	28.27	1.45	2.67	19.50	0.78
21	Chan	214.55	216.00	14.54	27.37	2.51	1.75	18.88	0.53
22	ROB	216.00	320.00	235.14	1386.72	116.08	28.36	13.33	0.17

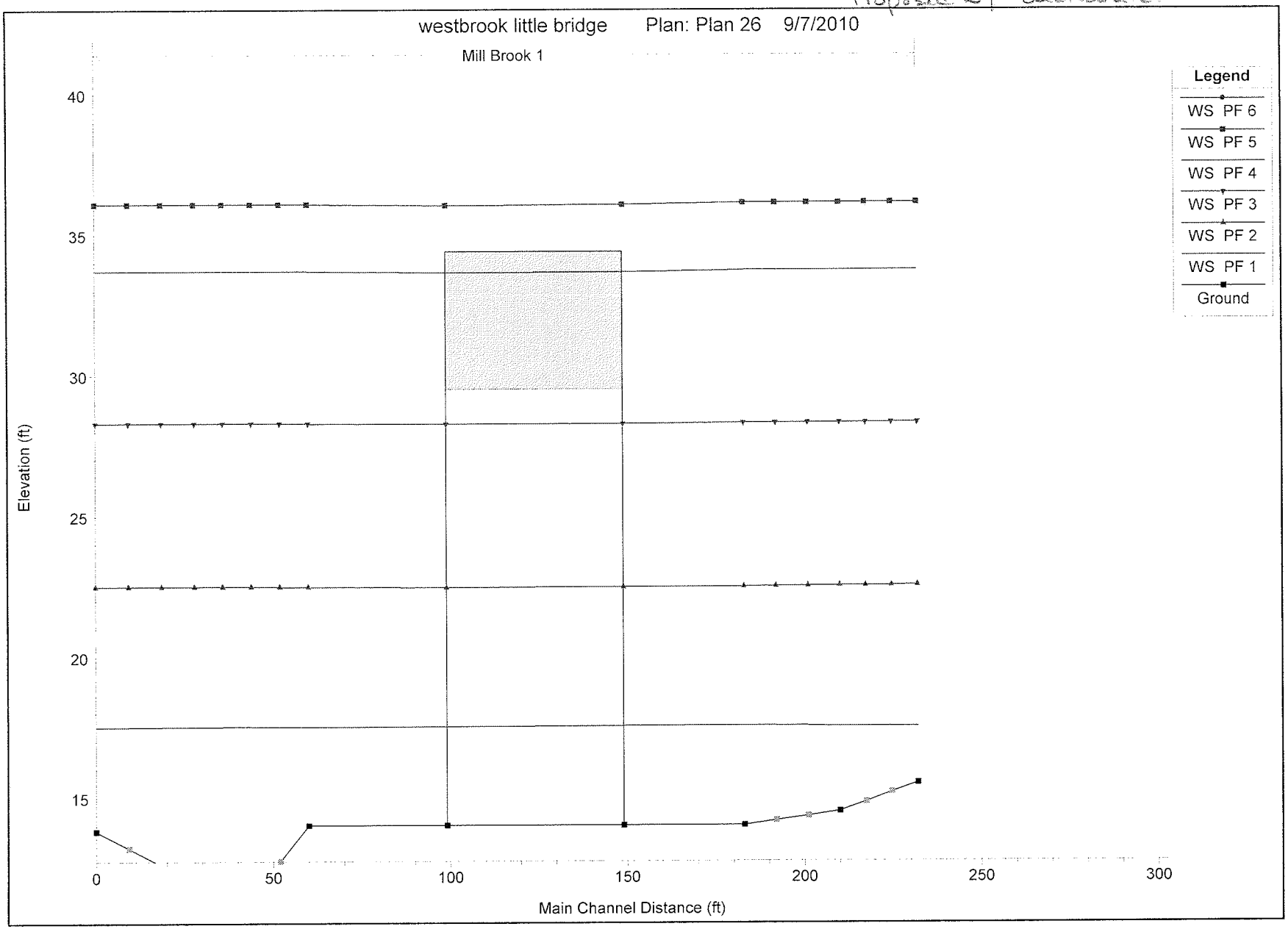
Plan: Plan 05 Mill Brook 1 RS: 60 Profile: PF 5

	Pos	Left Sta	Right Sta	Flow	Area	W.P.	Percent	Hydr	Velocity
		(ft)	(ft)	(cfs)	(sq ft)	(ft)	Conv	Depth(ft)	(ft/s)
1	LOB	100.00	187.00	221.98	1320.65	97.61	23.27	15.18	0.17
2	Chan	187.00	188.45	12.11	28.24	3.11	1.27	19.48	0.43
3	Chan	188.45	189.90	18.97	31.47	2.08	1.99	21.70	0.60
4	Chan	189.90	191.35	24.50	31.75	1.45	2.57	21.90	0.77
5	Chan	191.35	192.80	24.50	31.75	1.45	2.57	21.90	0.77
6	Chan	192.80	194.25	24.50	31.75	1.45	2.57	21.90	0.77
7	Chan	194.25	195.70	24.50	31.75	1.45	2.57	21.90	0.77
8	Chan	195.70	197.15	24.50	31.75	1.45	2.57	21.90	0.77
9	Chan	197.15	198.60	22.60	31.61	1.62	2.37	21.80	0.71
10	Chan	198.60	200.05	21.99	30.66	1.56	2.30	21.14	0.72
11	Chan	200.05	201.50	23.03	30.59	1.45	2.41	21.10	0.75
12	Chan	201.50	202.95	23.03	30.59	1.45	2.41	21.10	0.75
13	Chan	202.95	204.40	21.27	31.31	1.73	2.23	21.60	0.68
14	Chan	204.40	205.85	24.50	31.75	1.45	2.57	21.90	0.77
15	Chan	205.85	207.30	24.50	31.75	1.45	2.57	21.90	0.77
16	Chan	207.30	208.75	24.50	31.75	1.45	2.57	21.90	0.77
17	Chan	208.75	210.20	24.50	31.75	1.45	2.57	21.90	0.77
18	Chan	210.20	211.65	24.50	31.75	1.45	2.57	21.90	0.77
19	Chan	211.65	213.10	24.50	31.75	1.45	2.57	21.90	0.77
20	Chan	213.10	214.55	24.50	31.75	1.45	2.57	21.90	0.77
21	Chan	214.55	216.00	16.20	30.85	2.51	1.70	21.28	0.53
22	ROB	216.00	320.00	278.85	1636.34	118.48	29.23	15.73	0.17

Plan: Plan 05 Mill Brook 1 RS: 60 Profile: PF 6

	Pos	Left Sta	Right Sta	Flow	Area	W.P.	Percent	Hydr	Velocity
		(ft)	(ft)	(cfs)	(sq ft)	(ft)	Conv	Depth(ft)	(ft/s)
1	LOB	100.00	187.00	307.71	1842.67	103.62	24.52	21.18	0.17
2	Chan	187.00	188.45	15.70	36.94	3.11	1.25	25.48	0.42
3	Chan	188.45	189.90	23.61	40.17	2.08	1.88	27.70	0.59
4	Chan	189.90	191.35	30.40	40.45	1.45	2.42	27.90	0.75
5	Chan	191.35	192.80	30.40	40.45	1.45	2.42	27.90	0.75
6	Chan	192.80	194.25	30.40	40.45	1.45	2.42	27.90	0.75
7	Chan	194.25	195.70	30.40	40.45	1.45	2.42	27.90	0.75
8	Chan	195.70	197.15	30.40	40.45	1.45	2.42	27.90	0.75
9	Chan	197.15	198.60	28.08	40.31	1.62	2.24	27.80	0.70
10	Chan	198.60	200.05	27.63	39.36	1.56	2.20	27.14	0.70
11	Chan	200.05	201.50	28.96	39.29	1.45	2.31	27.10	0.74
12	Chan	201.50	202.95	28.96	39.29	1.45	2.31	27.10	0.74
13	Chan	202.95	204.40	26.53	40.01	1.73	2.11	27.60	0.66
14	Chan	204.40	205.85	30.40	40.45	1.45	2.42	27.90	0.75
15	Chan	205.85	207.30	30.40	40.45	1.45	2.42	27.90	0.75
16	Chan	207.30	208.75	30.40	40.45	1.45	2.42	27.90	0.75
17	Chan	208.75	210.20	30.40	40.45	1.45	2.42	27.90	0.75
18	Chan	210.20	211.65	30.40	40.45	1.45	2.42	27.90	0.75
19	Chan	211.65	213.10	30.40	40.45	1.45	2.42	27.90	0.75
20	Chan	213.10	214.55	30.40	40.45	1.45	2.42	27.90	0.75
21	Chan	214.55	216.00	20.31	39.55	2.51	1.62	27.28	0.51
22	ROB	216.00	320.00	382.75	2260.36	124.48	30.50	21.73	0.17

Proposed w/ backwater



1 in Horiz. = 40 ft 1 in Vert. = 5 ft

HEC-RAS Plan: Plan 24 River: Mill Brook Reach: 1 With Backwater

Reach	River Sta	Profile	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl
			(cfs)	(ft)	(ft)	(ft)	(ft)	(ft/ft)	(ft/s)	(sq ft)	(ft)	
1	232	PF 1	153.00	15.50	17.52		17.82	0.007463	4.35	37.63	36.78	0.67
1	232	PF 2	564.00	15.50	22.54		22.59	0.000225	2.09	559.32	137.99	0.15
1	232	PF 3	713.00	15.50	28.33		28.34	0.000028	1.14	1541.31	201.61	0.06
1	232	PF 4	829.00	15.50	33.74		33.75	0.000008	0.80	2717.16	220.00	0.03
1	232	PF 5	954.00	15.50	36.15		36.16	0.000007	0.78	3246.88	220.00	0.03
1	232	PF 6	1255.00	15.50	42.11		42.11	0.000004	0.75	4557.00	220.00	0.03
1	210	PF 1	153.00	14.50	17.52		17.67	0.003105	3.12	49.01	31.30	0.44
1	210	PF 2	564.00	14.50	22.52		22.59	0.000227	2.11	375.01	96.54	0.15
1	210	PF 3	713.00	14.50	28.32		28.34	0.000030	1.20	1144.91	169.02	0.06
1	210	PF 4	829.00	14.50	33.74		33.75	0.000009	0.85	2156.84	190.00	0.04
1	210	PF 5	954.00	14.50	36.15		36.16	0.000007	0.82	2614.38	190.00	0.03
1	210	PF 6	1255.00	14.50	42.10		42.11	0.000005	0.78	3745.94	190.00	0.03
1	183	PF 1	153.00	14.00	17.55	15.14	17.61	0.000484	1.87	82.22	25.60	0.18
1	183	PF 2	564.00	14.00	22.49	16.70	22.58	0.000275	2.54	350.87	84.80	0.15
1	183	PF 3	713.00	14.00	28.31	17.14	28.34	0.000053	1.58	976.05	144.27	0.07
1	183	PF 4	829.00	14.00	33.74	17.47	33.75	0.000016	1.10	1991.89	203.98	0.04
1	183	PF 5	954.00	14.00	36.14	17.81	36.15	0.000013	1.04	2485.72	205.00	0.04
1	183	PF 6	1255.00	14.00	42.10	18.59	42.11	0.000008	0.94	3706.98	205.00	0.03
1	122		Bridge									
1	60	PF 1	153.00	14.00	17.50		17.55	0.000385	1.68	95.45	34.64	0.16
1	60	PF 2	564.00	14.00	22.48		22.53	0.000147	1.81	619.61	207.25	0.12
1	60	PF 3	713.00	14.00	28.30		28.31	0.000017	0.90	2010.81	250.00	0.04
1	60	PF 4	829.00	14.00	33.70		33.70	0.000005	0.64	3361.15	250.00	0.03
1	60	PF 5	954.00	14.00	36.10		36.10	0.000004	0.63	3961.19	250.00	0.02
1	60	PF 6	1255.00	14.00	42.10		42.10	0.000003	0.61	5461.26	250.00	0.02
1	44	PF 1	153.00	11.50	17.53		17.53	0.000049	0.71	218.72	66.17	0.06
1	44	PF 2	564.00	11.50	22.50		22.52	0.000031	0.99	931.43	187.51	0.06
1	44	PF 3	713.00	11.50	28.30		28.31	0.000007	0.66	2089.27	205.00	0.03
1	44	PF 4	829.00	11.50	33.70		33.70	0.000003	0.52	3196.25	205.00	0.02
1	44	PF 5	954.00	11.50	36.10		36.10	0.000003	0.53	3688.25	205.00	0.02
1	44	PF 6	1255.00	11.50	42.10		42.10	0.000002	0.53	4918.24	205.00	0.02
1	28	PF 1	153.00	12.00	17.52		17.53	0.000083	0.93	182.68	69.32	0.08
1	28	PF 2	564.00	12.00	22.50		22.52	0.000043	1.16	1014.24	200.83	0.07
1	28	PF 3	713.00	12.00	28.30		28.31	0.000009	0.74	2198.04	205.00	0.03
1	28	PF 4	829.00	12.00	33.70		33.70	0.000004	0.59	3305.08	205.00	0.02
1	28	PF 5	954.00	12.00	36.10		36.10	0.000003	0.60	3797.08	205.00	0.02
1	28	PF 6	1255.00	12.00	42.10		42.10	0.000002	0.60	5027.07	205.00	0.02
1	0	PF 1	153.00	13.80	17.50	15.28	17.53	0.000435	1.33	115.45	62.00	0.17
1	0	PF 2	564.00	13.80	22.50	16.88	22.51	0.000047	1.02	932.91	200.83	0.07
1	0	PF 3	713.00	13.80	28.30	17.19	28.30	0.000008	0.62	2116.70	205.00	0.03
1	0	PF 4	829.00	13.80	33.70	17.37	33.70	0.000003	0.49	3223.70	205.00	0.02
1	0	PF 5	954.00	13.80	36.10	17.58	36.10	0.000003	0.49	3715.70	205.00	0.02
1	0	PF 6	1255.00	13.80	42.10	18.01	42.10	0.000002	0.50	4945.70	205.00	0.02

HEC-RAS Plan: Plan 24 River: Mill Brook Reach: 1 Westbrook Backwater

Reach	River Sta	Profile	E.G. Elev	W.S. Elev	Crit W.S.	Frctn Loss	C & E Loss	Top Width	Q Left	Q Channel	Q Right	Vel Chnl
			(ft)	(ft)	(ft)	(ft)	(ft)	(ft)	(cfs)	(cfs)	(cfs)	(ft/s)
1	183	PF 1	17.61	17.55	15.14	0.02	0.00	25.60	0.05	152.95		1.87
1	183	PF 2	22.58	22.49	16.70	0.01	0.00	84.80	18.26	507.98	37.76	2.54
1	183	PF 3	28.34	28.31	17.14	0.00	0.00	144.27	46.68	536.57	129.75	1.58
1	183	PF 4	33.75	33.74	17.47	0.00	0.01	203.98	124.94	515.59	188.47	1.10
1	183	PF 5	36.15	36.14	17.81	0.00	0.01	205.00	172.55	547.12	234.33	1.04
1	183	PF 6	42.11	42.10	18.59	0.00	0.00	205.00	283.99	630.18	340.83	0.94
1	122 BR U	PF 1	17.59	17.54	15.14	0.02	0.00	26.09		153.00		1.81
1	122 BR U	PF 2	22.57	22.48	16.68	0.02	0.00	30.65		564.00		2.42
1	122 BR U	PF 3	28.33	28.28	17.11	0.01	0.00	14.49		713.00		1.90
1	122 BR U	PF 4	33.74	33.67	17.44	0.02	0.00			829.00		2.14
1	122 BR U	PF 5	36.15	36.08	17.76	0.02	0.00	205.00	34.41	888.82	30.77	2.17
1	122 BR U	PF 6	42.11	42.10	18.54	0.00	0.00	205.00	192.08	535.02	527.90	0.88
1	122 BR D	PF 1	17.56	17.52	15.20	0.02	0.00	27.48		153.00		1.71
1	122 BR D	PF 2	22.55	22.46	16.61	0.01	0.01	30.67		564.00		2.38
1	122 BR D	PF 3	28.32	28.27	17.01	0.00	0.01	14.57		713.00		1.87
1	122 BR D	PF 4	33.72	33.65	17.31	0.00	0.02			829.00		2.12
1	122 BR D	PF 5	36.12	36.05	17.61	0.00	0.02	250.00	30.55	903.02	20.42	2.19
1	122 BR D	PF 6	42.11	42.10	18.30	0.00	0.00	250.00	204.58	612.24	438.18	1.00
1	60	PF 1	17.55	17.50		0.00	0.01	34.64		151.99	1.01	1.68
1	60	PF 2	22.53	22.48		0.00	0.01	207.25	29.62	477.03	57.36	1.81
1	60	PF 3	28.31	28.30		0.00	0.00	250.00	101.46	427.63	183.91	0.90
1	60	PF 4	33.70	33.70		0.00	0.00	250.00	143.20	430.26	255.54	0.64
1	60	PF 5	36.10	36.10		0.00	0.00	250.00	171.16	477.40	305.43	0.63
1	60	PF 6	42.10	42.10		0.00	0.00	250.00	236.53	594.01	424.46	0.61

Plan: Plan 24 Mill Brook 1 RS: 210 Profile: PF 2 10 YR Westbrook Mill Brook

	Pos	Left Sta	Right Sta	Flow	Area	W.P.	Percent	Hydr	Velocity
		(ft)	(ft)	(cfs)	(sq ft)	(ft)	Conv	Depth(ft)	(ft/s)
1	LOB	100.00	180.00	10.99	41.48	24.47	1.95	1.73	0.27
2	Chan	180.00	182.00	15.88	9.19	2.01	2.82	4.59	1.73
3	Chan	182.00	184.00	16.71	9.47	2.01	2.96	4.74	1.76
4	Chan	184.00	186.00	17.56	9.76	2.01	3.11	4.88	1.80
5	Chan	186.00	188.00	18.42	10.05	2.01	3.27	5.02	1.83
6	Chan	188.00	190.00	19.30	10.33	2.01	3.42	5.17	1.87
7	Chan	190.00	192.00	20.20	10.62	2.01	3.58	5.31	1.90
8	Chan	192.00	194.00	21.12	10.90	2.01	3.74	5.45	1.94
9	Chan	194.00	196.00	23.18	12.05	2.24	4.11	6.02	1.92
10	Chan	196.00	198.00	30.34	14.63	2.43	5.38	7.31	2.07
11	Chan	198.00	200.00	38.54	15.71	2.03	6.83	7.86	2.45
12	Chan	200.00	202.00	39.70	15.92	2.00	7.04	7.96	2.49
13	Chan	202.00	204.00	38.67	15.67	2.00	6.86	7.84	2.47
14	Chan	204.00	206.00	37.65	15.42	2.00	6.67	7.71	2.44
15	Chan	206.00	208.00	36.64	15.17	2.00	6.50	7.59	2.41
16	Chan	208.00	210.00	33.51	14.55	2.06	5.94	7.27	2.30
17	Chan	210.00	212.00	29.76	13.55	2.06	5.28	6.77	2.20
18	Chan	212.00	214.00	26.19	12.55	2.06	4.64	6.27	2.09
19	Chan	214.00	216.00	22.81	11.55	2.06	4.04	5.77	1.98
20	Chan	216.00	218.00	19.61	10.55	2.06	3.48	5.27	1.86
21	Chan	218.00	220.00	16.61	9.55	2.06	2.94	4.77	1.74
22	ROB	220.00	290.00	30.61	86.37	32.96	5.43	2.65	0.35

Plan: Plan 24 Mill Brook 1 RS: 210 Profile: PF 5 100 YR

	Pos	Left Sta	Right Sta	Flow	Area	W.P.	Percent	Hydr	Velocity
		(ft)	(ft)	(cfs)	(sq ft)	(ft)	Conv	Depth(ft)	(ft/s)
1	LOB	100.00	180.00	148.17	921.85	87.20	15.53	11.52	0.16
2	Chan	180.00	182.00	28.74	36.44	2.01	3.01	18.22	0.79
3	Chan	182.00	184.00	29.11	36.72	2.01	3.05	18.36	0.79
4	Chan	184.00	186.00	29.49	37.01	2.01	3.09	18.51	0.80
5	Chan	186.00	188.00	29.87	37.30	2.01	3.13	18.65	0.80
6	Chan	188.00	190.00	30.26	37.58	2.01	3.17	18.79	0.81
7	Chan	190.00	192.00	30.64	37.87	2.01	3.21	18.93	0.81
8	Chan	192.00	194.00	31.03	38.15	2.01	3.25	19.08	0.81
9	Chan	194.00	196.00	30.31	39.30	2.24	3.18	19.65	0.77
10	Chan	196.00	198.00	31.90	41.88	2.43	3.34	20.94	0.76
11	Chan	198.00	200.00	37.53	42.96	2.03	3.93	21.48	0.87
12	Chan	200.00	202.00	38.14	43.17	2.00	4.00	21.59	0.88
13	Chan	202.00	204.00	37.77	42.92	2.00	3.96	21.46	0.88
14	Chan	204.00	206.00	37.40	42.67	2.00	3.92	21.34	0.88
15	Chan	206.00	208.00	37.04	42.42	2.00	3.88	21.21	0.87
16	Chan	208.00	210.00	35.46	41.80	2.06	3.72	20.90	0.85
17	Chan	210.00	212.00	34.05	40.80	2.06	3.57	20.40	0.83
18	Chan	212.00	214.00	32.67	39.80	2.06	3.42	19.90	0.82
19	Chan	214.00	216.00	31.32	38.80	2.06	3.28	19.40	0.81
20	Chan	216.00	218.00	29.98	37.80	2.06	3.14	18.90	0.79
21	Chan	218.00	220.00	28.67	36.80	2.06	3.01	18.40	0.78
22	ROB	220.00	290.00	154.46	900.36	77.24	16.19	12.86	0.17

Plan: Plan 24 Mill Brook 1 RS: 210 Profile: PF 6 500 yr Westbrook Mill Brook

	Pos	Left Sta	Right Sta	Flow	Area	W.P.	Percent	Hydr	Velocity
		(ft)	(ft)	(cfs)	(sq ft)	(ft)	Conv	Depth(ft)	(ft/s)
1	LOB	100.00	180.00	226.86	1398.29	93.15	18.08	17.48	0.16
2	Chan	180.00	182.00	36.82	48.35	2.01	2.93	24.18	0.76
3	Chan	182.00	184.00	37.18	48.64	2.01	2.96	24.32	0.76
4	Chan	184.00	186.00	37.54	48.92	2.01	2.99	24.46	0.77
5	Chan	186.00	188.00	37.91	49.21	2.01	3.02	24.60	0.77
6	Chan	188.00	190.00	38.28	49.49	2.01	3.05	24.75	0.77
7	Chan	190.00	192.00	38.65	49.78	2.01	3.08	24.89	0.78
8	Chan	192.00	194.00	39.02	50.06	2.01	3.11	25.03	0.78
9	Chan	194.00	196.00	37.67	51.21	2.24	3.00	25.60	0.74
10	Chan	196.00	198.00	38.71	53.79	2.43	3.08	26.90	0.72
11	Chan	198.00	200.00	45.13	54.87	2.03	3.60	27.44	0.82
12	Chan	200.00	202.00	45.77	55.08	2.00	3.65	27.54	0.83
13	Chan	202.00	204.00	45.42	54.83	2.00	3.62	27.42	0.83
14	Chan	204.00	206.00	45.08	54.58	2.00	3.59	27.29	0.83
15	Chan	206.00	208.00	44.74	54.33	2.00	3.56	27.17	0.82
16	Chan	208.00	210.00	43.06	53.71	2.06	3.43	26.85	0.80
17	Chan	210.00	212.00	41.73	52.71	2.06	3.33	26.35	0.79
18	Chan	212.00	214.00	40.42	51.71	2.06	3.22	25.85	0.78
19	Chan	214.00	216.00	39.13	50.71	2.06	3.12	25.35	0.77
20	Chan	216.00	218.00	37.85	49.71	2.06	3.02	24.85	0.76
21	Chan	218.00	220.00	36.59	48.71	2.06	2.92	24.35	0.75
22	ROB	220.00	290.00	221.46	1317.25	83.19	17.65	18.82	0.17

Plan: Plan 24 Mill Brook 1 RS: 122 BR U Profile: PF 2 10 yr

	Pos	Left Sta	Right Sta	Flow	Area	W.P.	Percent	Hydr	Velocity
		(ft)	(ft)	(cfs)	(sq ft)	(ft)	Conv	Depth(ft)	(ft/s)
1	Chan	183.75	185.40	0.87	2.01	3.77	0.15	1.22	0.43
2	Chan	185.40	187.05	5.76	5.42	2.61	1.02	3.29	1.06
3	Chan	187.05	188.69	11.01	9.18	3.70	1.95	5.57	1.20
4	Chan	188.69	190.34	29.81	13.82	2.31	5.29	8.39	2.16
5	Chan	190.34	191.99	38.01	13.96	1.65	6.74	8.48	2.72
6	Chan	191.99	193.64	38.01	13.96	1.65	6.74	8.48	2.72
7	Chan	193.64	195.28	38.01	13.96	1.65	6.74	8.48	2.72
8	Chan	195.28	196.93	38.01	13.96	1.65	6.74	8.48	2.72
9	Chan	196.93	198.58	38.01	13.96	1.65	6.74	8.48	2.72
10	Chan	198.58	200.23	38.01	13.96	1.65	6.74	8.48	2.72
11	Chan	200.23	201.87	38.01	13.96	1.65	6.74	8.48	2.72
12	Chan	201.87	203.52	38.01	13.96	1.65	6.74	8.48	2.72
13	Chan	203.52	205.17	38.01	13.96	1.65	6.74	8.48	2.72
14	Chan	205.17	206.82	38.01	13.96	1.65	6.74	8.48	2.72
15	Chan	206.82	208.46	38.01	13.96	1.65	6.74	8.48	2.72
16	Chan	208.46	210.11	38.01	13.96	1.65	6.74	8.48	2.72
17	Chan	210.11	211.76	30.37	13.58	2.15	5.38	8.24	2.24
18	Chan	211.76	213.41	16.79	10.49	2.75	2.98	6.37	1.60
19	Chan	213.41	215.05	11.97	7.61	2.04	2.12	4.62	1.57
20	Chan	215.05	216.70	1.27	3.03	5.94	0.22	2.53	0.42

Plan: Plan 24 Mill Brook 1 RS: 122 BR U Profile: PF 5 100yr Westbrook Mill Brook

	Pos	Left Sta	Right Sta	Flow	Area	W.P.	Percent	Hydr	Velocity
		(ft)	(ft)	(cfs)	(sq ft)	(ft)	Conv	Depth(ft)	(ft/s)
1	LOB	95.00	183.75	34.41	111.34	90.43	3.61	1.25	0.31
2	Chan	183.75	185.40	2.01	3.68	6.65	0.21	2.23	0.55
3	Chan	185.40	187.05	10.37	9.94	6.81	1.09	6.03	1.04
4	Chan	187.05	188.69	22.40	16.23	7.31	2.35	9.85	1.38
5	Chan	188.69	190.34	44.58	22.42	5.84	4.67	13.61	1.99
6	Chan	190.34	191.99	53.84	23.80	5.10	5.64	14.44	2.26
7	Chan	191.99	193.64	58.02	24.66	4.99	6.08	14.97	2.35
8	Chan	193.64	195.28	60.54	25.29	4.98	6.35	15.35	2.39
9	Chan	195.28	196.93	62.93	25.87	4.98	6.60	15.70	2.43
10	Chan	196.93	198.58	64.84	26.28	4.95	6.80	15.95	2.47
11	Chan	198.58	200.23	65.95	26.55	4.95	6.91	16.12	2.48
12	Chan	200.23	201.87	65.66	26.48	4.95	6.88	16.07	2.48
13	Chan	201.87	203.52	64.42	26.20	4.96	6.75	15.90	2.46
14	Chan	203.52	205.17	62.32	25.72	4.98	6.53	15.61	2.42
15	Chan	205.17	206.82	59.84	25.12	4.99	6.27	15.25	2.38
16	Chan	206.82	208.46	56.99	24.46	5.02	5.97	14.85	2.33
17	Chan	208.46	210.11	51.90	23.29	5.11	5.44	14.14	2.23
18	Chan	210.11	211.76	42.05	21.44	5.70	4.41	13.01	1.96
19	Chan	211.76	213.41	25.28	16.69	6.53	2.65	10.13	1.52
20	Chan	213.41	215.05	12.84	10.93	6.26	1.35	6.63	1.18
21	Chan	215.05	216.70	2.06	4.04	8.10	0.22	2.45	0.51
22	ROB	216.70	300.00	30.77	48.24	83.88	3.23	0.58	0.64

Plan: Plan 24 Mill Brook 1 RS: 122 BR U Profile: PF 6 500yr

	Pos	Left Sta	Right Sta	Flow	Area	W.P.	Percent	Hydr	Velocity
		(ft)	(ft)	(cfs)	(sq ft)	(ft)	Conv	Depth(ft)	(ft/s)
1	LOB	95.00	183.75	192.08	645.44	96.45	15.31	7.27	0.30
2	Chan	183.75	185.40	5.82	13.59	6.65	0.46	8.25	0.43
3	Chan	185.40	187.05	10.77	19.85	6.81	0.86	12.05	0.54
4	Chan	187.05	188.69	16.26	26.15	7.31	1.30	15.87	0.62
5	Chan	188.69	190.34	26.91	32.34	5.84	2.14	19.63	0.83
6	Chan	190.34	191.99	31.55	33.71	5.10	2.51	20.46	0.94
7	Chan	191.99	193.64	33.42	34.58	4.99	2.66	20.99	0.97
8	Chan	193.64	195.28	34.46	35.21	4.98	2.75	21.37	0.98
9	Chan	195.28	196.93	35.44	35.78	4.98	2.82	21.72	0.99
10	Chan	196.93	198.58	36.25	36.20	4.95	2.89	21.97	1.00
11	Chan	198.58	200.23	36.70	36.47	4.95	2.92	22.13	1.01
12	Chan	200.23	201.87	36.59	36.40	4.95	2.92	22.09	1.01
13	Chan	201.87	203.52	36.07	36.11	4.96	2.87	21.92	1.00
14	Chan	203.52	205.17	35.19	35.63	4.98	2.80	21.63	0.99
15	Chan	205.17	206.82	34.17	35.04	4.99	2.72	21.27	0.98
16	Chan	206.82	208.46	32.95	34.37	5.02	2.63	20.86	0.96
17	Chan	208.46	210.11	30.74	33.20	5.11	2.45	20.15	0.93
18	Chan	210.11	211.76	25.98	31.35	5.70	2.07	19.03	0.83
19	Chan	211.76	213.41	18.04	26.60	6.53	1.44	16.15	0.68
20	Chan	213.41	215.05	12.36	20.84	6.26	0.98	12.65	0.59
21	Chan	215.05	216.70	5.33	13.96	8.10	0.42	8.47	0.38
22	ROB	216.70	300.00	527.90	549.55	89.90	42.06	6.60	0.96

Plan: Plan 24 Mill Brook 1 RS: 122 BR D Profile: PF 2 10 YR Westbrook Mill Brook

	Pos	Left Sta	Right Sta	Flow	Area	W.P.	Percent	Hydr	Velocity
		(ft)	(ft)	(cfs)	(sq ft)	(ft)	Conv	Depth(ft)	(ft/s)
1	Chan	183.75	185.40	0.80	1.93	3.60	0.14	1.17	0.41
2	Chan	185.40	187.05	4.74	4.64	2.24	0.84	2.82	1.02
3	Chan	187.05	188.69	7.69	7.84	4.02	1.36	4.76	0.98
4	Chan	188.69	190.34	25.56	13.43	2.55	4.53	8.15	1.90
5	Chan	190.34	191.99	34.95	13.61	1.65	6.20	8.26	2.57
6	Chan	191.99	193.64	34.95	13.61	1.65	6.20	8.26	2.57
7	Chan	193.64	195.28	34.95	13.61	1.65	6.20	8.26	2.57
8	Chan	195.28	196.93	34.95	13.61	1.65	6.20	8.26	2.57
9	Chan	196.93	198.58	34.98	13.63	1.65	6.20	8.27	2.57
10	Chan	198.58	200.23	35.82	13.84	1.65	6.35	8.40	2.59
11	Chan	200.23	201.87	35.97	13.85	1.65	6.38	8.41	2.60
12	Chan	201.87	203.52	35.38	13.72	1.65	6.27	8.33	2.58
13	Chan	203.52	205.17	34.97	13.61	1.65	6.20	8.26	2.57
14	Chan	205.17	206.82	34.95	13.61	1.65	6.20	8.26	2.57
15	Chan	206.82	208.46	34.95	13.61	1.65	6.20	8.26	2.57
16	Chan	208.46	210.11	34.95	13.61	1.65	6.20	8.26	2.57
17	Chan	210.11	211.76	34.95	13.61	1.65	6.20	8.26	2.57
18	Chan	211.76	213.41	34.95	13.61	1.65	6.20	8.26	2.57
19	Chan	213.41	215.05	31.92	13.60	1.88	5.66	8.26	2.35
20	Chan	215.05	216.70	1.58	4.16	8.85	0.28	3.48	0.38

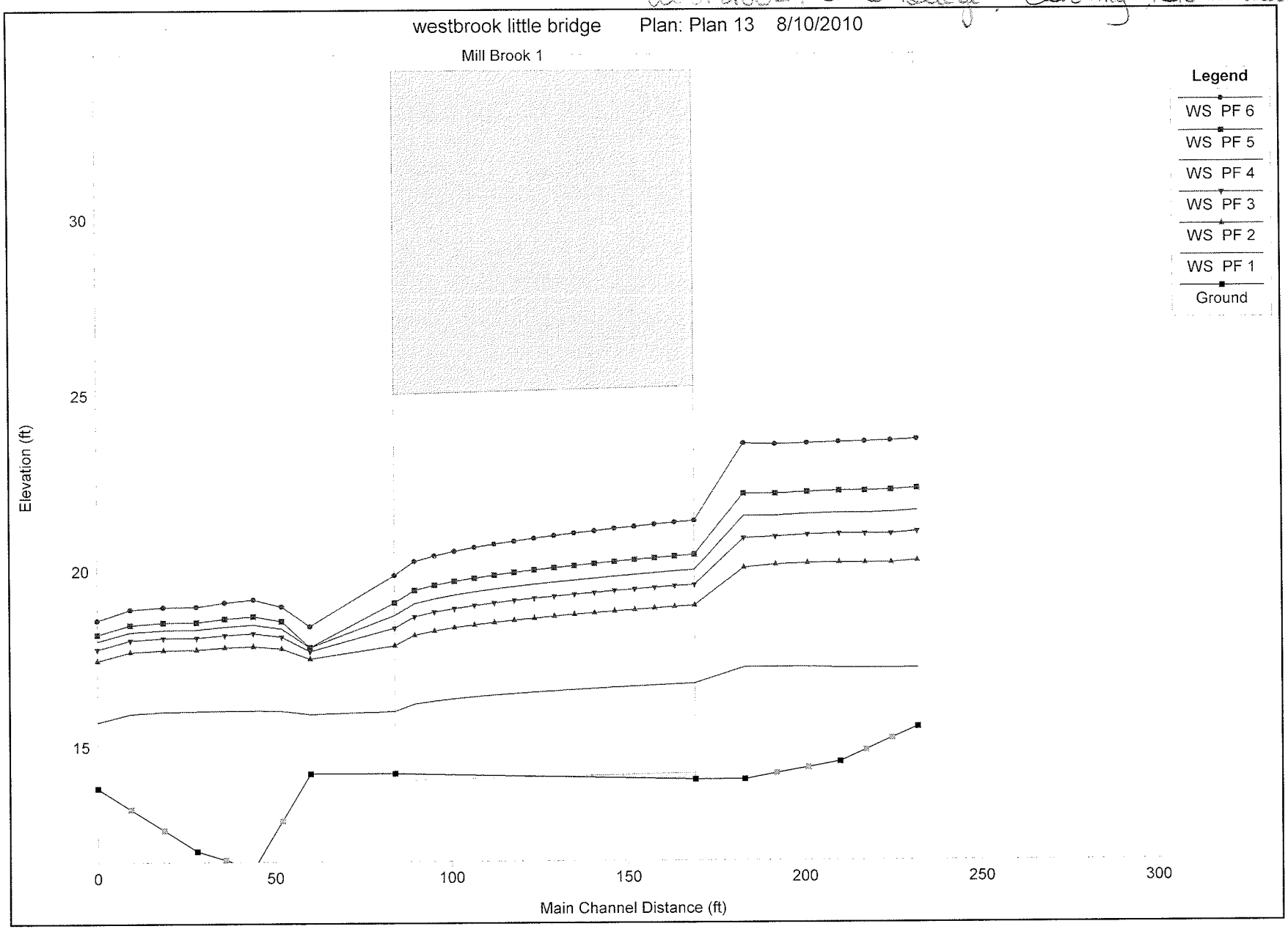
Plan: Plan 24 Mill Brook 1 RS: 122 BR D Profile: PF 5 100YR Westbrook Mill Brook

	Pos	Left Sta	Right Sta	Flow	Area	W.P.	Percent	Hydr	Velocity
		(ft)	(ft)	(cfs)	(sq ft)	(ft)	Conv	Depth(ft)	(ft/s)
1	LOB	100.00	183.75	30.55	100.79	85.41	3.20	1.20	0.30
2	Chan	183.75	185.40	1.96	3.57	6.49	0.21	2.17	0.55
3	Chan	185.40	187.05	9.35	9.06	6.38	0.98	5.50	1.03
4	Chan	187.05	188.69	18.67	14.75	7.65	1.96	8.95	1.27
5	Chan	188.69	190.34	42.23	21.98	6.10	4.43	13.34	1.92
6	Chan	190.34	191.99	52.87	23.43	5.10	5.54	14.22	2.26
7	Chan	191.99	193.64	57.02	24.29	4.99	5.98	14.74	2.35
8	Chan	193.64	195.28	59.54	24.92	4.98	6.24	15.13	2.39
9	Chan	195.28	196.93	61.92	25.49	4.98	6.49	15.47	2.43
10	Chan	196.93	198.58	63.87	25.93	4.95	6.70	15.74	2.46
11	Chan	198.58	200.23	65.81	26.41	4.96	6.90	16.03	2.49
12	Chan	200.23	201.87	65.64	26.35	4.95	6.88	16.00	2.49
13	Chan	201.87	203.52	63.84	25.93	4.96	6.69	15.74	2.46
14	Chan	203.52	205.17	61.33	25.35	4.98	6.43	15.39	2.42
15	Chan	205.17	206.82	58.84	24.75	4.99	6.17	15.02	2.38
16	Chan	206.82	208.46	56.00	24.09	5.02	5.87	14.62	2.32
17	Chan	208.46	210.11	50.93	22.92	5.11	5.34	13.91	2.22
18	Chan	210.11	211.76	45.13	21.45	5.19	4.73	13.02	2.10
19	Chan	211.76	213.41	38.28	19.79	5.43	4.01	12.01	1.93
20	Chan	213.41	215.05	27.25	16.90	6.10	2.86	10.26	1.61
21	Chan	215.05	216.70	2.52	5.14	11.03	0.26	3.12	0.49
22	ROB	216.70	350.00	20.42	73.78	133.85	2.14	0.55	0.28

Plan: Plan 24 Mill Brook 1 RS: 122 BR D Profile: PF 6 500YR Westbrook Mill Brook

	Pos	Left Sta	Right Sta	Flow	Area	W.P.	Percent	Hydr	Velocity
		(ft)	(ft)	(cfs)	(sq ft)	(ft)	Conv	Depth(ft)	(ft/s)
1	LOB	100.00	183.75	204.58	606.87	91.45	16.30	7.25	0.34
2	Chan	183.75	185.40	6.64	13.53	6.49	0.53	8.21	0.49
3	Chan	185.40	187.05	11.85	19.02	6.38	0.94	11.54	0.62
4	Chan	187.05	188.69	16.25	24.71	7.65	1.29	15.00	0.66
5	Chan	188.69	190.34	28.99	31.94	6.10	2.31	19.39	0.91
6	Chan	190.34	191.99	35.14	33.38	5.10	2.80	20.26	1.05
7	Chan	191.99	193.64	37.24	34.24	4.99	2.97	20.79	1.09
8	Chan	193.64	195.28	38.41	34.88	4.98	3.06	21.17	1.10
9	Chan	195.28	196.93	39.51	35.45	4.98	3.15	21.52	1.11
10	Chan	196.93	198.58	40.44	35.89	4.95	3.22	21.78	1.13
11	Chan	198.58	200.23	41.32	36.36	4.96	3.29	22.07	1.14
12	Chan	200.23	201.87	41.25	36.31	4.95	3.29	22.04	1.14
13	Chan	201.87	203.52	40.41	35.89	4.96	3.22	21.78	1.13
14	Chan	203.52	205.17	39.24	35.31	4.98	3.13	21.43	1.11
15	Chan	205.17	206.82	38.08	34.70	4.99	3.03	21.06	1.10
16	Chan	206.82	208.46	36.72	34.04	5.02	2.93	20.66	1.08
17	Chan	208.46	210.11	34.23	32.87	5.11	2.73	19.95	1.04
18	Chan	210.11	211.76	31.38	31.41	5.19	2.50	19.06	1.00
19	Chan	211.76	213.41	27.81	29.74	5.43	2.22	18.05	0.94
20	Chan	213.41	215.05	21.72	26.86	6.10	1.73	16.30	0.81
21	Chan	215.05	216.70	5.60	15.09	11.03	0.45	9.16	0.37
22	ROB	216.70	350.00	438.18	879.27	139.90	34.91	6.60	0.50

Westbrook, Little Bridge, Existing, No backwater



1 in Horiz. = 40 ft 1 in Vert. = 4 ft

Westbrook, Little Bridge — Existing / No backwater

HEC-RAS Plan: Plan 05 River: Mill Brook Reach: 1

Reach	River Sta	Profile	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl
			(cfs)	(ft)	(ft)	(ft)	(ft)	(ft/ft)	(ft/s)	(sq ft)	(ft)	
1	232	PF 1	153.00	15.50	17.17	17.10	17.69	0.015284	5.79	26.70	25.55	0.93
1	232	PF 2	564.00	15.50	20.22		20.41	0.001434	3.82	268.44	112.44	0.35
1	232	PF 3	713.00	15.50	21.05		21.22	0.001066	3.76	364.76	121.50	0.31
1	232	PF 4	829.00	15.50	21.65		21.81	0.000896	3.74	440.02	128.13	0.29
1	232	PF 5	954.00	15.50	22.28		22.44	0.000766	3.74	522.65	135.04	0.27
1	232	PF 6	1255.00	15.50	23.68		23.83	0.000580	3.76	722.99	150.48	0.25
1	210	PF 1	153.00	14.50	17.18		17.41	0.004841	3.88	39.41	25.18	0.55
1	210	PF 2	564.00	14.50	20.17		20.36	0.001248	3.60	182.26	67.08	0.32
1	210	PF 3	713.00	14.50	20.98		21.18	0.001013	3.69	240.99	77.26	0.30
1	210	PF 4	829.00	14.50	21.58		21.78	0.000890	3.75	289.33	84.72	0.29
1	210	PF 5	954.00	14.50	22.20		22.41	0.000787	3.80	344.61	92.52	0.28
1	210	PF 6	1255.00	14.50	23.60		23.81	0.000625	3.90	486.22	110.00	0.26
1	183	PF 1	153.00	14.00	17.20	15.34	17.30	0.001442	2.55	59.98	21.02	0.26
1	183	PF 2	564.00	14.00	20.02	17.12	20.32	0.002009	4.40	157.26	121.40	0.34
1	183	PF 3	713.00	14.00	20.86	17.63	21.14	0.001688	4.46	260.34	124.02	0.32
1	183	PF 4	829.00	14.00	21.49	18.15	21.75	0.001453	4.42	338.72	125.97	0.30
1	183	PF 5	954.00	14.00	22.13	18.52	22.37	0.001258	4.37	420.21	127.97	0.28
1	183	PF 6	1255.00	14.00	23.56	19.29	23.77	0.000960	4.30	606.73	132.42	0.26
1	122		Culvert									
1	60	PF 1	153.00	14.20	15.89		16.10	0.004947	3.68	41.59	27.83	0.53
1	60	PF 2	564.00	14.20	17.48		18.13	0.006273	6.48	91.37	35.38	0.66
1	60	PF 3	713.00	14.20	17.69		18.59	0.008063	7.64	98.86	36.43	0.75
1	60	PF 4	829.00	14.20	17.80	17.43	18.93	0.009766	8.58	102.91	36.98	0.83
1	60	PF 5	954.00	14.20	17.80	17.73	19.30	0.012883	9.86	103.05	37.00	0.96
1	60	PF 6	1255.00	14.20	18.40	18.40	20.22	0.012761	10.92	127.62	47.69	0.97
1	44	PF 1	153.00	11.50	16.01		16.03	0.000185	1.14	134.07	47.13	0.12
1	44	PF 2	564.00	11.50	17.84		17.93	0.000512	2.40	240.18	71.02	0.21
1	44	PF 3	713.00	11.50	18.20		18.32	0.000614	2.78	267.22	80.82	0.23
1	44	PF 4	829.00	11.50	18.45		18.60	0.000687	3.05	288.70	90.00	0.25
1	44	PF 5	954.00	11.50	18.68		18.85	0.000772	3.34	310.23	98.34	0.27
1	44	PF 6	1255.00	11.50	19.16		19.40	0.000969	3.98	361.58	122.89	0.30
1	28	PF 1	153.00	12.00	15.99		16.03	0.000357	1.52	100.84	37.62	0.16
1	28	PF 2	564.00	12.00	17.75		17.91	0.000942	3.23	198.98	71.10	0.28
1	28	PF 3	713.00	12.00	18.08		18.30	0.001162	3.75	224.43	105.45	0.32
1	28	PF 4	829.00	12.00	18.32		18.57	0.001303	4.11	256.58	151.95	0.34
1	28	PF 5	954.00	12.00	18.52		18.82	0.001460	4.48	288.64	156.53	0.36
1	28	PF 6	1255.00	12.00	18.96		19.36	0.001804	5.28	358.19	166.01	0.41
1	0	PF 1	153.00	13.80	15.69	15.28	15.96	0.006501	4.19	36.54	26.41	0.63
1	0	PF 2	564.00	13.80	17.44	16.88	17.83	0.006505	5.06	111.56	61.12	0.66
1	0	PF 3	713.00	13.80	17.76	17.17	18.21	0.006511	5.40	132.08	65.65	0.67
1	0	PF 4	829.00	13.80	17.99	17.38	18.48	0.006506	5.63	147.37	68.83	0.68
1	0	PF 5	954.00	13.80	18.18	17.58	18.73	0.006503	5.94	163.18	99.73	0.69
1	0	PF 6	1255.00	13.80	18.58	18.01	19.25	0.006501	6.60	216.36	156.50	0.70

Westbrook Little Bridge, Existing, No backwater

Plan: Plan 05 Mill Brook 1 RS: 60 Profile: PF 1

	Pos	Left Sta (ft)	Right Sta (ft)	Flow (cfs)	Area (sq ft)	W.P. (ft)	Percent Conv	Hydr Depth(ft)	Velocity (ft/s)
1	Chan	187.00	188.45	0.09	0.11	0.73	0.06	0.32	0.80
2	Chan	188.45	189.90	6.30	2.17	2.08	4.12	1.50	2.91
3	Chan	189.90	191.35	9.87	2.46	1.45	6.45	1.69	4.02
4	Chan	191.35	192.80	9.87	2.46	1.45	6.45	1.69	4.02
5	Chan	192.80	194.25	9.87	2.46	1.45	6.45	1.69	4.02
6	Chan	194.25	195.70	9.87	2.46	1.45	6.45	1.69	4.02
7	Chan	195.70	197.15	9.87	2.46	1.45	6.45	1.69	4.02
8	Chan	197.15	198.60	8.29	2.31	1.62	5.42	1.59	3.59
9	Chan	198.60	200.05	3.51	1.36	1.56	2.29	0.94	2.58
10	Chan	200.05	201.50	3.40	1.30	1.45	2.22	0.89	2.62
11	Chan	201.50	202.95	3.40	1.30	1.45	2.22	0.89	2.62
12	Chan	202.95	204.40	6.31	2.02	1.73	4.12	1.39	3.13
13	Chan	204.40	205.85	9.87	2.46	1.45	6.45	1.69	4.02
14	Chan	205.85	207.30	9.87	2.46	1.45	6.45	1.69	4.02
15	Chan	207.30	208.75	9.87	2.46	1.45	6.45	1.69	4.02
16	Chan	208.75	210.20	9.87	2.46	1.45	6.45	1.69	4.02
17	Chan	210.20	211.65	9.87	2.46	1.45	6.45	1.69	4.02
18	Chan	211.65	213.10	9.87	2.46	1.45	6.45	1.69	4.02
19	Chan	213.10	214.55	9.87	2.46	1.45	6.45	1.69	4.02
20	Chan	214.55	216.00	3.32	1.56	2.39	2.17	1.12	2.13

Plan: Plan 05 Mill Brook 1 RS: 60 Profile: PF 2

	Pos	Left Sta (ft)	Right Sta (ft)	Flow (cfs)	Area (sq ft)	W.P. (ft)	Percent Conv	Hydr Depth(ft)	Velocity (ft/s)
1	Chan	187.00	188.45	2.70	1.31	2.52	0.48	1.12	2.06
2	Chan	188.45	189.90	23.64	4.47	2.08	4.19	3.08	5.29
3	Chan	189.90	191.35	33.37	4.75	1.45	5.92	3.28	7.02
4	Chan	191.35	192.80	33.37	4.75	1.45	5.92	3.28	7.02
5	Chan	192.80	194.25	33.37	4.75	1.45	5.92	3.28	7.02
6	Chan	194.25	195.70	33.37	4.75	1.45	5.92	3.28	7.02
7	Chan	195.70	197.15	33.37	4.75	1.45	5.92	3.28	7.02
8	Chan	197.15	198.60	29.46	4.61	1.62	5.22	3.18	6.39
9	Chan	198.60	200.05	20.51	3.66	1.56	3.64	2.52	5.61
10	Chan	200.05	201.50	20.93	3.59	1.45	3.71	2.48	5.82
11	Chan	201.50	202.95	20.93	3.59	1.45	3.71	2.48	5.82
12	Chan	202.95	204.40	25.22	4.31	1.73	4.47	2.98	5.85
13	Chan	204.40	205.85	33.37	4.75	1.45	5.92	3.28	7.02
14	Chan	205.85	207.30	33.37	4.75	1.45	5.92	3.28	7.02
15	Chan	207.30	208.75	33.37	4.75	1.45	5.92	3.28	7.02
16	Chan	208.75	210.20	33.37	4.75	1.45	5.92	3.28	7.02
17	Chan	210.20	211.65	33.37	4.75	1.45	5.92	3.28	7.02
18	Chan	211.65	213.10	33.37	4.75	1.45	5.92	3.28	7.02
19	Chan	213.10	214.55	33.37	4.75	1.45	5.92	3.28	7.02
20	Chan	214.55	216.00	16.32	3.85	2.51	2.89	2.66	4.23
21	ROB	216.00	320.00	3.88	4.92	6.82	0.69	0.74	0.79

Plan: Plan 05 Mill Brook 1 RS: 60 Profile: PF 3

	Pos	Left Sta (ft)	Right Sta (ft)	Flow (cfs)	Area (sq ft)	W.P. (ft)	Percent Conv	Hydr Depth(ft)	Velocity (ft/s)
1	Chan	187.00	188.45	3.88	1.57	2.76	0.54	1.22	2.47
2	Chan	188.45	189.90	29.84	4.77	2.08	4.19	3.29	6.26

Plan: Plan 05 Mill Brook 1 RS: 60 Profile: PF 3 (Continued)

	Pos	Left Sta	Right Sta	Flow	Area	W.P.	Percent	Hydr	Velocity
		(ft)	(ft)	(cfs)	(sq ft)	(ft)	Conv	Depth(ft)	(ft/s)
3	Chan	189.90	191.35	41.86	5.06	1.45	5.87	3.49	8.28
4	Chan	191.35	192.80	41.86	5.06	1.45	5.87	3.49	8.28
5	Chan	192.80	194.25	41.86	5.06	1.45	5.87	3.49	8.28
6	Chan	194.25	195.70	41.86	5.06	1.45	5.87	3.49	8.28
7	Chan	195.70	197.15	41.86	5.06	1.45	5.87	3.49	8.28
8	Chan	197.15	198.60	37.07	4.91	1.62	5.20	3.39	7.55
9	Chan	198.60	200.05	26.51	3.96	1.56	3.72	2.73	6.69
10	Chan	200.05	201.50	27.11	3.90	1.45	3.80	2.69	6.96
11	Chan	201.50	202.95	27.11	3.90	1.45	3.80	2.69	6.96
12	Chan	202.95	204.40	31.96	4.62	1.73	4.48	3.18	6.92
13	Chan	204.40	205.85	41.86	5.06	1.45	5.87	3.49	8.28
14	Chan	205.85	207.30	41.86	5.06	1.45	5.87	3.49	8.28
15	Chan	207.30	208.75	41.86	5.06	1.45	5.87	3.49	8.28
16	Chan	208.75	210.20	41.86	5.06	1.45	5.87	3.49	8.28
17	Chan	210.20	211.65	41.86	5.06	1.45	5.87	3.49	8.28
18	Chan	211.65	213.10	41.86	5.06	1.45	5.87	3.49	8.28
19	Chan	213.10	214.55	41.86	5.06	1.45	5.87	3.49	8.28
20	Chan	214.55	216.00	20.95	4.16	2.51	2.94	2.87	5.04
21	ROB	216.00	320.00	6.26	6.41	7.78	0.88	0.84	0.98

Plan: Plan 05 Mill Brook 1 RS: 60 Profile: PF 4

	Pos	Left Sta	Right Sta	Flow	Area	W.P.	Percent	Hydr	Velocity
		(ft)	(ft)	(cfs)	(sq ft)	(ft)	Conv	Depth(ft)	(ft/s)
1	Chan	187.00	188.45	4.80	1.71	2.88	0.58	1.28	2.80
2	Chan	188.45	189.90	34.67	4.93	2.08	4.18	3.40	7.03
3	Chan	189.90	191.35	48.48	5.22	1.45	5.85	3.60	9.29
4	Chan	191.35	192.80	48.48	5.22	1.45	5.85	3.60	9.29
5	Chan	192.80	194.25	48.48	5.22	1.45	5.85	3.60	9.29
6	Chan	194.25	195.70	48.48	5.22	1.45	5.85	3.60	9.29
7	Chan	195.70	197.15	48.48	5.22	1.45	5.85	3.60	9.29
8	Chan	197.15	198.60	43.00	5.07	1.62	5.19	3.50	8.48
9	Chan	198.60	200.05	31.13	4.12	1.56	3.76	2.84	7.56
10	Chan	200.05	201.50	31.88	4.06	1.45	3.85	2.80	7.86
11	Chan	201.50	202.95	31.88	4.06	1.45	3.85	2.80	7.86
12	Chan	202.95	204.40	37.20	4.78	1.73	4.49	3.29	7.79
13	Chan	204.40	205.85	48.48	5.22	1.45	5.85	3.60	9.29
14	Chan	205.85	207.30	48.48	5.22	1.45	5.85	3.60	9.29
15	Chan	207.30	208.75	48.48	5.22	1.45	5.85	3.60	9.29
16	Chan	208.75	210.20	48.48	5.22	1.45	5.85	3.60	9.29
17	Chan	210.20	211.65	48.48	5.22	1.45	5.85	3.60	9.29
18	Chan	211.65	213.10	48.48	5.22	1.45	5.85	3.60	9.29
19	Chan	213.10	214.55	48.48	5.22	1.45	5.85	3.60	9.29
20	Chan	214.55	216.00	24.53	4.32	2.51	2.96	2.98	5.68
21	ROB	216.00	320.00	8.15	7.27	8.29	0.98	0.90	1.12

Plan: Plan 05 Mill Brook 1 RS: 60 Profile: PF 5

	Pos	Left Sta	Right Sta	Flow	Area	W.P.	Percent	Hydr	Velocity
		(ft)	(ft)	(cfs)	(sq ft)	(ft)	Conv	Depth(ft)	(ft/s)
1	Chan	187.00	188.45	5.53	1.72	2.89	0.58	1.28	3.22
2	Chan	188.45	189.90	39.90	4.93	2.08	4.18	3.40	8.08
3	Chan	189.90	191.35	55.78	5.22	1.45	5.85	3.60	10.68

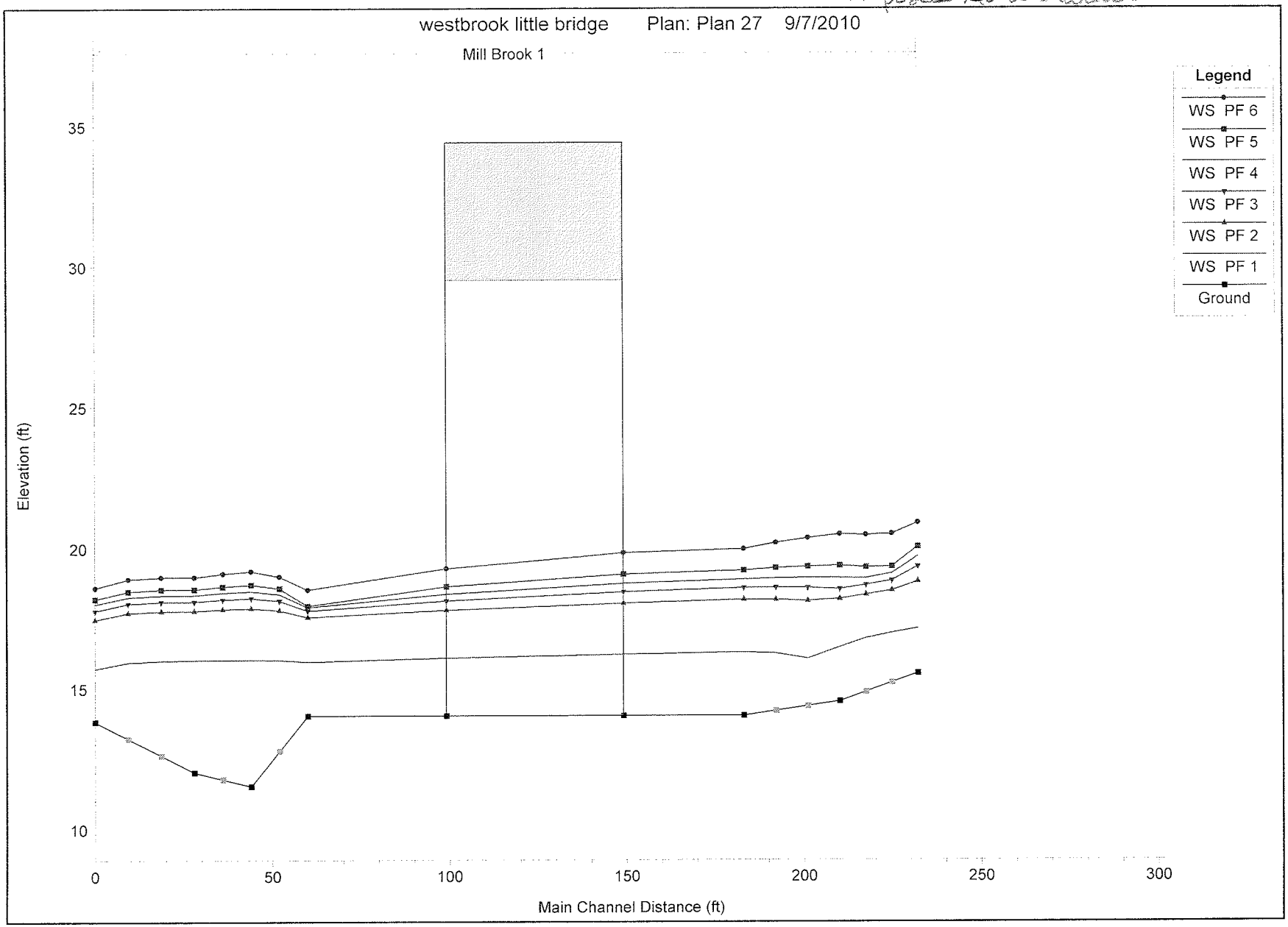
Plan: Plan 05 Mill Brook 1 RS: 60 Profile: PF 5 (Continued)

	Pos	Left Sta	Right Sta	Flow	Area	W.P.	Percent	Hydr	Velocity
		(ft)	(ft)	(cfs)	(sq ft)	(ft)	Conv	Depth(ft)	(ft/s)
4	Chan	191.35	192.80	55.78	5.22	1.45	5.85	3.60	10.68
5	Chan	192.80	194.25	55.78	5.22	1.45	5.85	3.60	10.68
6	Chan	194.25	195.70	55.78	5.22	1.45	5.85	3.60	10.68
7	Chan	195.70	197.15	55.78	5.22	1.45	5.85	3.60	10.68
8	Chan	197.15	198.60	49.48	5.08	1.62	5.19	3.50	9.74
9	Chan	198.60	200.05	35.84	4.13	1.56	3.76	2.85	8.69
10	Chan	200.05	201.50	36.70	4.06	1.45	3.85	2.80	9.03
11	Chan	201.50	202.95	36.70	4.06	1.45	3.85	2.80	9.03
12	Chan	202.95	204.40	42.81	4.78	1.73	4.49	3.30	8.95
13	Chan	204.40	205.85	55.78	5.22	1.45	5.85	3.60	10.68
14	Chan	205.85	207.30	55.78	5.22	1.45	5.85	3.60	10.68
15	Chan	207.30	208.75	55.78	5.22	1.45	5.85	3.60	10.68
16	Chan	208.75	210.20	55.78	5.22	1.45	5.85	3.60	10.68
17	Chan	210.20	211.65	55.78	5.22	1.45	5.85	3.60	10.68
18	Chan	211.65	213.10	55.78	5.22	1.45	5.85	3.60	10.68
19	Chan	213.10	214.55	55.78	5.22	1.45	5.85	3.60	10.68
20	Chan	214.55	216.00	28.24	4.32	2.51	2.96	2.98	6.53
21	ROB	216.00	320.00	9.42	7.30	8.30	0.99	0.90	1.29

Plan: Plan 05 Mill Brook 1 RS: 60 Profile: PF 6

	Pos	Left Sta	Right Sta	Flow	Area	W.P.	Percent	Hydr	Velocity
		(ft)	(ft)	(cfs)	(sq ft)	(ft)	Conv	Depth(ft)	(ft/s)
1	LOB	100.00	187.00	0.64	1.34	6.71	0.05	0.20	0.48
2	Chan	187.00	188.45	10.31	2.58	3.11	0.82	1.78	4.00
3	Chan	188.45	189.90	52.16	5.80	2.08	4.16	4.00	8.99
4	Chan	189.90	191.35	71.94	6.09	1.45	5.73	4.20	11.81
5	Chan	191.35	192.80	71.94	6.09	1.45	5.73	4.20	11.81
6	Chan	192.80	194.25	71.94	6.09	1.45	5.73	4.20	11.81
7	Chan	194.25	195.70	71.94	6.09	1.45	5.73	4.20	11.81
8	Chan	195.70	197.15	71.94	6.09	1.45	5.73	4.20	11.81
9	Chan	197.15	198.60	64.24	5.95	1.62	5.12	4.10	10.81
10	Chan	198.60	200.05	49.17	4.99	1.56	3.92	3.44	9.85
11	Chan	200.05	201.50	50.58	4.93	1.45	4.03	3.40	10.26
12	Chan	201.50	202.95	50.58	4.93	1.45	4.03	3.40	10.26
13	Chan	202.95	204.40	56.42	5.65	1.73	4.50	3.90	9.99
14	Chan	204.40	205.85	71.94	6.09	1.45	5.73	4.20	11.81
15	Chan	205.85	207.30	71.94	6.09	1.45	5.73	4.20	11.81
16	Chan	207.30	208.75	71.94	6.09	1.45	5.73	4.20	11.81
17	Chan	208.75	210.20	71.94	6.09	1.45	5.73	4.20	11.81
18	Chan	210.20	211.65	71.94	6.09	1.45	5.73	4.20	11.81
19	Chan	211.65	213.10	71.94	6.09	1.45	5.73	4.20	11.81
20	Chan	213.10	214.55	71.94	6.09	1.45	5.73	4.20	11.81
21	Chan	214.55	216.00	38.23	5.19	2.51	3.05	3.58	7.37
22	ROB	216.00	320.00	19.40	13.20	12.24	1.55	1.10	1.47

Proposed xs backwater



1 in Horiz. = 40 ft 1 in Vert. = 5 ft

HEC-RAS Plan: Plan 24 River: Mill Brook Reach: 1

Westbrook Backwater

Reach	River Sta	Profile	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl
			(cfs)	(ft)	(ft)	(ft)	(ft)	(ft/ft)	(ft/s)	(sq ft)	(ft)	
1	232	PF 1	153.00	15.50	17.10	17.10	17.69	0.017734	6.15	24.98	23.30	1.00
1	232	PF 2	564.00	15.50	18.78		19.51	0.009582	7.13	114.80	92.38	0.83
1	232	PF 3	713.00	15.50	19.31		19.97	0.006815	6.92	169.66	105.88	0.72
1	232	PF 4	829.00	15.50	19.68		20.31	0.005678	6.85	209.26	108.10	0.67
1	232	PF 5	954.00	15.50	20.02		20.64	0.005085	6.93	245.95	110.22	0.65
1	232	PF 6	1255.00	15.50	20.87		21.46	0.003852	6.96	343.12	119.52	0.59
1	210	PF 1	153.00	14.50	16.43	16.43	17.08	0.017632	6.46	23.70	18.58	1.01
1	210	PF 2	564.00	14.50	18.16	18.16	19.10	0.015723	7.77	72.70	41.97	1.02
1	210	PF 3	713.00	14.50	18.51	18.50	19.56	0.013920	8.23	88.16	46.34	0.99
1	210	PF 4	829.00	14.50	18.91	18.71	19.91	0.010641	8.05	107.62	51.32	0.89
1	210	PF 5	954.00	14.50	19.35		20.30	0.008169	7.85	131.70	56.89	0.80
1	210	PF 6	1255.00	14.50	20.45		21.28	0.004793	7.41	202.11	70.69	0.64
1	183	PF 1	153.00	14.00	16.26	15.14	16.40	0.002073	2.98	51.26	23.32	0.35
1	183	PF 2	564.00	14.00	18.15	16.70	18.68	0.003919	5.86	98.11	28.73	0.52
1	183	PF 3	713.00	14.00	18.56	17.14	19.25	0.004499	6.71	110.86	33.29	0.56
1	183	PF 4	829.00	14.00	18.86	17.47	19.68	0.004851	7.28	121.42	36.65	0.59
1	183	PF 5	954.00	14.00	19.18	17.81	20.12	0.005114	7.81	133.82	40.23	0.61
1	183	PF 6	1255.00	14.00	19.94	18.59	21.12	0.005407	8.82	167.55	48.66	0.65
1	122		Bridge									
1	60	PF 1	153.00	14.00	15.92		16.09	0.003298	3.29	46.57	27.41	0.44
1	60	PF 2	564.00	14.00	17.52		18.11	0.005153	6.17	95.98	34.71	0.60
1	60	PF 3	713.00	14.00	17.75		18.56	0.006601	7.27	104.07	35.81	0.69
1	60	PF 4	829.00	14.00	17.87		18.90	0.007953	8.15	108.60	36.40	0.76
1	60	PF 5	954.00	14.00	17.92	17.59	19.24	0.010081	9.25	110.38	36.64	0.85
1	60	PF 6	1255.00	14.00	18.50	18.50	20.11	0.013503	10.27	134.76	49.90	0.99
1	44	PF 1	153.00	11.50	16.01		16.03	0.000185	1.14	134.07	47.13	0.12
1	44	PF 2	564.00	11.50	17.84		17.93	0.000512	2.40	240.18	71.02	0.21
1	44	PF 3	713.00	11.50	18.20		18.32	0.000614	2.78	267.19	80.81	0.23
1	44	PF 4	829.00	11.50	18.45		18.60	0.000687	3.05	288.68	89.99	0.25
1	44	PF 5	954.00	11.50	18.68		18.85	0.000772	3.34	310.21	98.33	0.27
1	44	PF 6	1255.00	11.50	19.15		19.40	0.000970	3.98	361.47	122.81	0.30
1	28	PF 1	153.00	12.00	15.99		16.03	0.000357	1.52	100.84	37.62	0.16
1	28	PF 2	564.00	12.00	17.75		17.91	0.000942	3.23	198.97	71.10	0.28
1	28	PF 3	713.00	12.00	18.08		18.30	0.001162	3.75	224.39	105.32	0.32
1	28	PF 4	829.00	12.00	18.32		18.57	0.001303	4.11	256.54	151.95	0.34
1	28	PF 5	954.00	12.00	18.52		18.82	0.001460	4.48	288.59	156.52	0.36
1	28	PF 6	1255.00	12.00	18.95		19.36	0.001805	5.28	358.01	165.99	0.41
1	0	PF 1	153.00	13.80	15.69	15.28	15.96	0.006501	4.19	36.54	26.41	0.63
1	0	PF 2	564.00	13.80	17.44	16.88	17.83	0.006505	5.06	111.56	61.12	0.66
1	0	PF 3	713.00	13.80	17.76	17.19	18.21	0.006512	5.40	132.07	65.65	0.67
1	0	PF 4	829.00	13.80	17.99	17.38	18.48	0.006506	5.63	147.37	68.83	0.68
1	0	PF 5	954.00	13.80	18.18	17.58	18.73	0.006503	5.94	163.18	99.73	0.69
1	0	PF 6	1255.00	13.80	18.58	18.01	19.25	0.006501	6.60	216.36	156.50	0.70

HEC-RAS Plan: Plan 24 River: Mill Brook Reach: 1 Westbrook No Backwater

Reach	River Sta	Profile	E.G. Elev	W.S. Elev	Crit W.S.	Frctn Loss	C & E Loss	Top Width	Q Left	Q Channel	Q Right	Vel Chnl
			(ft)	(ft)	(ft)	(ft)	(ft)	(ft)	(cfs)	(cfs)	(cfs)	(ft/s)
1	183	PF 1	16.40	16.26	15.14	0.07	0.00	23.32		153.00		2.98
1	183	PF 2	18.68	18.15	16.70	0.14	0.00	28.73	1.06	562.93	0.01	5.86
1	183	PF 3	19.25	18.56	17.14	0.16	0.01	33.29	2.56	710.00	0.44	6.71
1	183	PF 4	19.68	18.86	17.47	0.17	0.01	36.65	4.27	823.29	1.44	7.28
1	183	PF 5	20.12	19.18	17.81	0.18	0.02	40.23	6.72	943.82	3.46	7.81
1	183	PF 6	21.12	19.94	18.59	0.20	0.03	48.66	15.31	1226.33	13.36	8.82
1	122 BR U	PF 1	16.33	16.19	15.14	0.12	0.00	24.37		153.00		3.02
1	122 BR U	PF 2	18.53	18.01	16.68	0.23	0.00	28.52		564.00		5.80
1	122 BR U	PF 3	19.08	18.41	17.11	0.27	0.00	28.85		713.00		6.55
1	122 BR U	PF 4	19.49	18.71	17.44	0.29	0.01	29.09		829.00		7.06
1	122 BR U	PF 5	19.92	19.04	17.76	0.31	0.01	29.36		954.00		7.51
1	122 BR U	PF 6	20.90	19.81	18.54	0.35	0.02	29.98		1255.00		8.38
1	122 BR D	PF 1	16.21	16.06	15.20	0.12	0.00	26.83		153.00		3.08
1	122 BR D	PF 2	18.30	17.77	16.61	0.19	0.01	27.60		564.00		5.86
1	122 BR D	PF 3	18.81	18.10	17.01	0.24	0.01	27.81		713.00		6.76
1	122 BR D	PF 4	19.19	18.34	17.31	0.28	0.02	28.07		829.00		7.39
1	122 BR D	PF 5	19.59	18.60	17.61	0.32	0.03	28.36		954.00		7.98
1	122 BR D	PF 6	20.53	19.25	18.30	0.39	0.03	29.06		1255.00		9.08
1	60	PF 1	16.09	15.92		0.01	0.04	27.41		153.00		3.29
1	60	PF 2	18.11	17.52		0.02	0.12	34.71		560.22	3.78	6.17
1	60	PF 3	18.56	17.75		0.03	0.16	35.81		706.77	6.23	7.27
1	60	PF 4	18.90	17.87		0.03	0.21	36.40		820.77	8.23	8.15
1	60	PF 5	19.24	17.92	17.59	0.03	0.28	36.64		944.08	9.92	9.25
1	60	PF 6	20.11	18.50	18.50	0.04	0.33	49.90		1233.37	21.63	10.27

Plan: Plan 24 Mill Brook 1 RS: 122 BR U Profile: PF 2 10YR Westbrook Mill Brook No Backwater

	Pos	Left Sta	Right Sta	Flow	Area	W.P.	Percent	Hydr	Velocity
		(ft)	(ft)	(cfs)	(sq ft)	(ft)	Conv	Depth(ft)	(ft/s)
1	Chan	187.05	188.69	2.92	1.83	3.49	0.52	1.21	1.59
2	Chan	188.69	190.34	31.43	6.46	2.31	5.57	3.92	4.86
3	Chan	190.34	191.99	40.85	6.61	1.65	7.24	4.01	6.18
4	Chan	191.99	193.64	40.85	6.61	1.65	7.24	4.01	6.18
5	Chan	193.64	195.28	40.85	6.61	1.65	7.24	4.01	6.18
6	Chan	195.28	196.93	40.85	6.61	1.65	7.24	4.01	6.18
7	Chan	196.93	198.58	40.85	6.61	1.65	7.24	4.01	6.18
8	Chan	198.58	200.23	40.85	6.61	1.65	7.24	4.01	6.18
9	Chan	200.23	201.87	40.85	6.61	1.65	7.24	4.01	6.18
10	Chan	201.87	203.52	40.85	6.61	1.65	7.24	4.01	6.18
11	Chan	203.52	205.17	40.85	6.61	1.65	7.24	4.01	6.18
12	Chan	205.17	206.82	40.85	6.61	1.65	7.24	4.01	6.18
13	Chan	206.82	208.46	40.85	6.61	1.65	7.24	4.01	6.18
14	Chan	208.46	210.11	40.85	6.61	1.65	7.24	4.01	6.18
15	Chan	210.11	211.76	30.94	6.22	2.15	5.49	3.78	4.97
16	Chan	211.76	213.41	8.38	3.13	2.75	1.49	1.90	2.67
17	Chan	213.41	215.05	0.15	0.25	2.04	0.03	0.15	0.61
18	Chan	215.05	216.70	0.00	0.01	0.66	0.00	0.01	0.11

Plan: Plan 24 Mill Brook 1 RS: 122 BR U Profile: PF 5 100YR

	Pos	Left Sta	Right Sta	Flow	Area	W.P.	Percent	Hydr	Velocity
		(ft)	(ft)	(cfs)	(sq ft)	(ft)	Conv	Depth(ft)	(ft/s)
1	Chan	185.40	187.05	0.35	0.30	1.11	0.04	0.43	1.17
2	Chan	187.05	188.69	9.44	3.52	3.70	0.99	2.14	2.68
3	Chan	188.69	190.34	52.54	8.16	2.31	5.51	4.95	6.44
4	Chan	190.34	191.99	67.79	8.30	1.65	7.11	5.04	8.16
5	Chan	191.99	193.64	67.79	8.30	1.65	7.11	5.04	8.16
6	Chan	193.64	195.28	67.79	8.30	1.65	7.11	5.04	8.16
7	Chan	195.28	196.93	67.79	8.30	1.65	7.11	5.04	8.16
8	Chan	196.93	198.58	67.79	8.30	1.65	7.11	5.04	8.16
9	Chan	198.58	200.23	67.79	8.30	1.65	7.11	5.04	8.16
10	Chan	200.23	201.87	67.79	8.30	1.65	7.11	5.04	8.16
11	Chan	201.87	203.52	67.79	8.30	1.65	7.11	5.04	8.16
12	Chan	203.52	205.17	67.79	8.30	1.65	7.11	5.04	8.16
13	Chan	205.17	206.82	67.79	8.30	1.65	7.11	5.04	8.16
14	Chan	206.82	208.46	67.79	8.30	1.65	7.11	5.04	8.16
15	Chan	208.46	210.11	67.79	8.30	1.65	7.11	5.04	8.16
16	Chan	210.11	211.76	52.43	7.92	2.15	5.50	4.81	6.62
17	Chan	211.76	213.41	19.54	4.83	2.75	2.05	2.93	4.05
18	Chan	213.41	215.05	5.24	1.95	2.04	0.55	1.18	2.69
19	Chan	215.05	216.70	1.01	0.67	1.69	0.11	1.04	1.51

Plan: Plan 24 Mill Brook 1 RS: 122 BR U Profile: PF 6 500YR

	Pos	Left Sta	Right Sta	Flow	Area	W.P.	Percent	Hydr	Velocity
		(ft)	(ft)	(cfs)	(sq ft)	(ft)	Conv	Depth(ft)	(ft/s)
1	Chan	185.40	187.05	1.98	1.08	2.10	0.16	0.82	1.83
2	Chan	187.05	188.69	16.14	4.78	3.70	1.29	2.90	3.37
3	Chan	188.69	190.34	68.45	9.43	2.31	5.45	5.72	7.26
4	Chan	190.34	191.99	87.98	9.57	1.65	7.01	5.81	9.20
5	Chan	191.99	193.64	87.98	9.57	1.65	7.01	5.81	9.20
6	Chan	193.64	195.28	87.98	9.57	1.65	7.01	5.81	9.20

Plan: Plan 24 Mill Brook 1 RS: 122 BR U Profile: PF 6 (Continued) 500YR Westbrook Mill Brk

	Pos	Left Sta	Right Sta	Flow	Area	W.P.	Percent	Hydr	Velocity
		(ft)	(ft)	(cfs)	(sq ft)	(ft)	Conv	Depth(ft)	(ft/s)
7	Chan	195.28	196.93	87.98	9.57	1.65	7.01	5.81	9.20
8	Chan	196.93	198.58	87.98	9.57	1.65	7.01	5.81	9.20
9	Chan	198.58	200.23	87.98	9.57	1.65	7.01	5.81	9.20
10	Chan	200.23	201.87	87.98	9.57	1.65	7.01	5.81	9.20
11	Chan	201.87	203.52	87.98	9.57	1.65	7.01	5.81	9.20
12	Chan	203.52	205.17	87.98	9.57	1.65	7.01	5.81	9.20
13	Chan	205.17	206.82	87.98	9.57	1.65	7.01	5.81	9.20
14	Chan	206.82	208.46	87.98	9.57	1.65	7.01	5.81	9.20
15	Chan	208.46	210.11	87.98	9.57	1.65	7.01	5.81	9.20
16	Chan	210.11	211.76	68.77	9.19	2.15	5.48	5.58	7.49
17	Chan	211.76	213.41	29.51	6.09	2.75	2.35	3.70	4.84
18	Chan	213.41	215.05	12.37	3.21	2.04	0.99	1.95	3.85
19	Chan	215.05	216.70	2.03	1.17	2.46	0.16	1.81	1.74

Plan: Plan 24 Mill Brook 1 RS: 122 BR D Profile: PF 2 10YR

	Pos	Left Sta	Right Sta	Flow	Area	W.P.	Percent	Hydr	Velocity
		(ft)	(ft)	(cfs)	(sq ft)	(ft)	Conv	Depth(ft)	(ft/s)
1	Chan	187.05	188.69	0.89	0.76	2.48	0.16	1.20	1.18
2	Chan	188.69	190.34	25.27	5.70	2.55	4.48	3.46	4.43
3	Chan	190.34	191.99	35.59	5.88	1.65	6.31	3.57	6.05
4	Chan	191.99	193.64	35.59	5.88	1.65	6.31	3.57	6.05
5	Chan	193.64	195.28	35.59	5.88	1.65	6.31	3.57	6.05
6	Chan	195.28	196.93	35.59	5.88	1.65	6.31	3.57	6.05
7	Chan	196.93	198.58	35.72	5.90	1.65	6.33	3.58	6.06
8	Chan	198.58	200.23	37.80	6.11	1.65	6.70	3.71	6.19
9	Chan	200.23	201.87	38.05	6.13	1.65	6.75	3.72	6.21
10	Chan	201.87	203.52	36.65	5.99	1.65	6.50	3.64	6.12
11	Chan	203.52	205.17	35.64	5.89	1.65	6.32	3.57	6.05
12	Chan	205.17	206.82	35.59	5.88	1.65	6.31	3.57	6.05
13	Chan	206.82	208.46	35.59	5.88	1.65	6.31	3.57	6.05
14	Chan	208.46	210.11	35.59	5.88	1.65	6.31	3.57	6.05
15	Chan	210.11	211.76	35.59	5.88	1.65	6.31	3.57	6.05
16	Chan	211.76	213.41	35.59	5.88	1.65	6.31	3.57	6.05
17	Chan	213.41	215.05	32.47	5.87	1.88	5.76	3.57	5.53
18	Chan	215.05	216.70	1.15	0.99	3.34	0.20	1.64	1.15

Plan: Plan 24 Mill Brook 1 RS: 122 BR D Profile: PF 5 100YR

	Pos	Left Sta	Right Sta	Flow	Area	W.P.	Percent	Hydr	Velocity
		(ft)	(ft)	(cfs)	(sq ft)	(ft)	Conv	Depth(ft)	(ft/s)
1	Chan	187.05	188.69	2.66	1.53	3.61	0.28	1.13	1.74
2	Chan	188.69	190.34	43.17	7.08	2.55	4.53	4.30	6.10
3	Chan	190.34	191.99	60.20	7.26	1.65	6.31	4.40	8.30
4	Chan	191.99	193.64	60.20	7.26	1.65	6.31	4.40	8.30
5	Chan	193.64	195.28	60.20	7.26	1.65	6.31	4.40	8.30
6	Chan	195.28	196.93	60.20	7.26	1.65	6.31	4.40	8.30
7	Chan	196.93	198.58	60.36	7.27	1.65	6.33	4.41	8.30
8	Chan	198.58	200.23	63.19	7.48	1.65	6.62	4.54	8.44
9	Chan	200.23	201.87	63.55	7.50	1.65	6.66	4.55	8.47
10	Chan	201.87	203.52	61.64	7.36	1.65	6.46	4.47	8.37
11	Chan	203.52	205.17	60.27	7.26	1.65	6.32	4.41	8.30
12	Chan	205.17	206.82	60.20	7.26	1.65	6.31	4.40	8.30

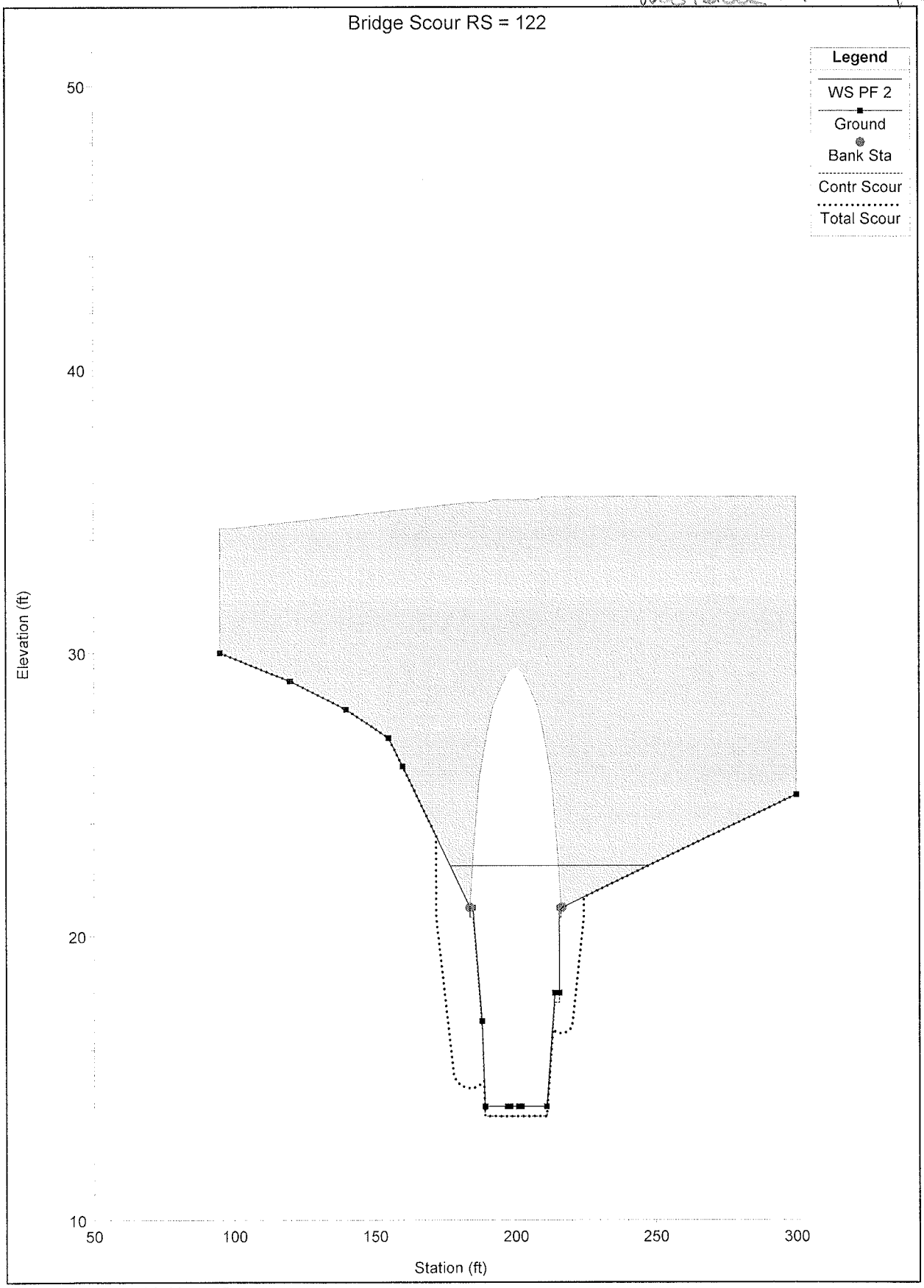
Plan: Plan 24 Mill Brook 1 RS: 122 BR D Profile: PF 5 (Continued) Westbrook Mill Brk

	Pos	Left Sta	Right Sta	Flow	Area	W.P.	Percent	Hydr	Velocity
		(ft)	(ft)	(cfs)	(sq ft)	(ft)	Conv	Depth(ft)	(ft/s)
13	Chan	206.82	208.46	60.20	7.26	1.65	6.31	4.40	8.30
14	Chan	208.46	210.11	60.20	7.26	1.65	6.31	4.40	8.30
15	Chan	210.11	211.76	60.20	7.26	1.65	6.31	4.40	8.30
16	Chan	211.76	213.41	60.20	7.26	1.65	6.31	4.40	8.30
17	Chan	213.41	215.05	54.94	7.25	1.88	5.76	4.40	7.58
18	Chan	215.05	216.70	2.42	1.53	4.18	0.25	2.36	1.58

Plan: Plan 24 Mill Brook 1 RS: 122 BR D Profile: PF 6 500YR

	Pos	Left Sta	Right Sta	Flow	Area	W.P.	Percent	Hydr	Velocity
		(ft)	(ft)	(cfs)	(sq ft)	(ft)	Conv	Depth(ft)	(ft/s)
1	Chan	185.40	187.05	0.06	0.07	0.55	0.01	0.19	0.85
2	Chan	187.05	188.69	6.09	2.55	4.02	0.49	1.55	2.38
3	Chan	188.69	190.34	57.02	8.14	2.55	4.54	4.94	7.00
4	Chan	190.34	191.99	79.08	8.32	1.65	6.30	5.05	9.50
5	Chan	191.99	193.64	79.08	8.32	1.65	6.30	5.05	9.50
6	Chan	193.64	195.28	79.08	8.32	1.65	6.30	5.05	9.50
7	Chan	195.28	196.93	79.08	8.32	1.65	6.30	5.05	9.50
8	Chan	196.93	198.58	79.25	8.34	1.65	6.31	5.06	9.50
9	Chan	198.58	200.23	82.46	8.55	1.65	6.57	5.19	9.64
10	Chan	200.23	201.87	82.90	8.57	1.65	6.61	5.20	9.68
11	Chan	201.87	203.52	80.72	8.43	1.65	6.43	5.12	9.57
12	Chan	203.52	205.17	79.15	8.33	1.65	6.31	5.06	9.50
13	Chan	205.17	206.82	79.08	8.32	1.65	6.30	5.05	9.50
14	Chan	206.82	208.46	79.08	8.32	1.65	6.30	5.05	9.50
15	Chan	208.46	210.11	79.08	8.32	1.65	6.30	5.05	9.50
16	Chan	210.11	211.76	79.08	8.32	1.65	6.30	5.05	9.50
17	Chan	211.76	213.41	79.08	8.32	1.65	6.30	5.05	9.50
18	Chan	213.41	215.05	72.19	8.32	1.88	5.75	5.05	8.68
19	Chan	215.05	216.70	3.44	1.95	4.83	0.27	3.01	1.76

Westbrook Mill 104R



Contraction Scour

Westbrook 104R

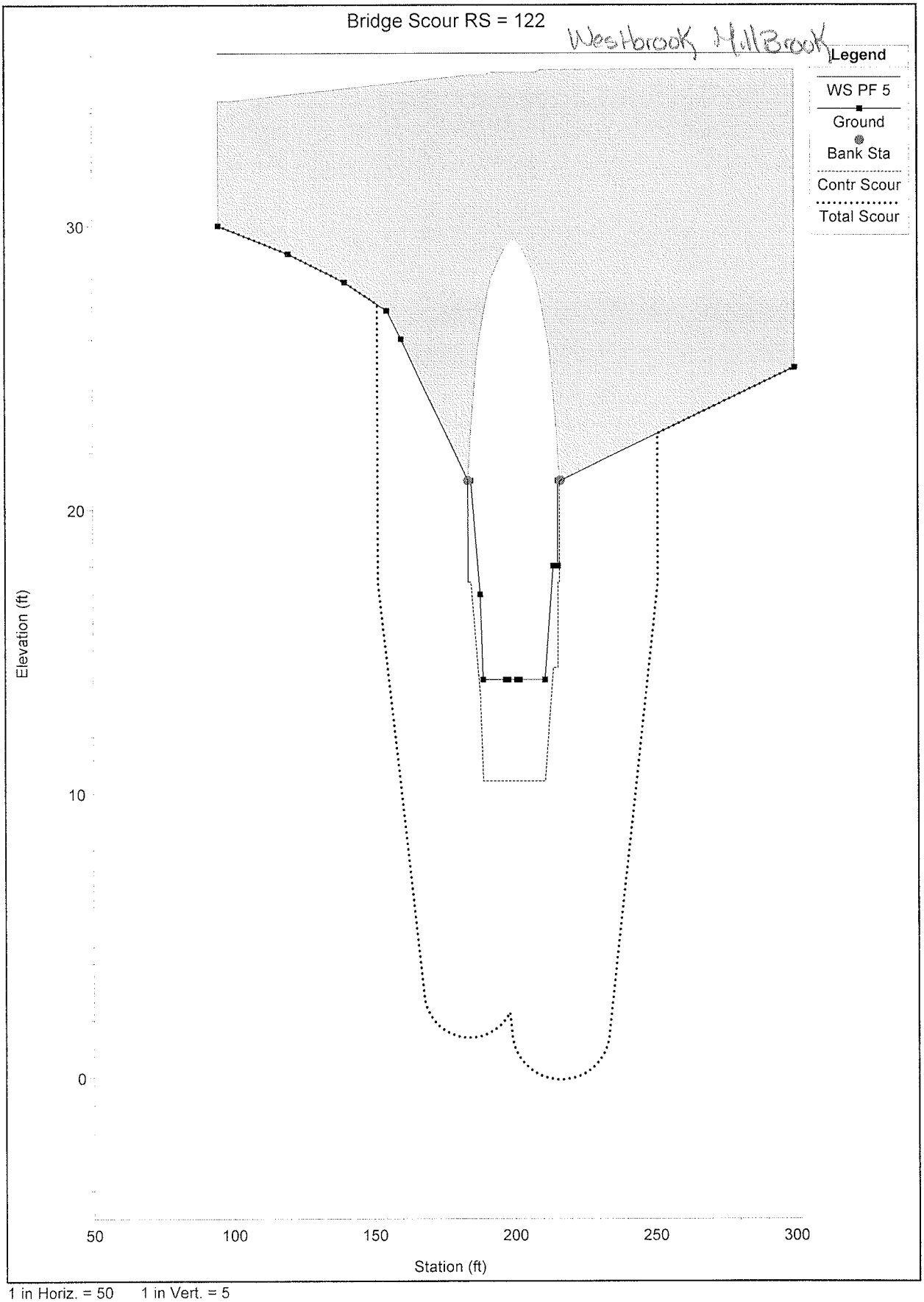
		Left	Channel	Right
Input Data				
	Average Depth (ft):	1.73	6.18	2.65
	Approach Velocity (ft/s):	0.27	2.11	0.35
	Br Average Depth (ft):		7.59	
	BR Opening Flow (cfs):		564.00	
	BR Top WD (ft):		30.65	
	Grain Size D50 (mm):	0.20	0.20	0.20
	Approach Flow (cfs):	10.99	522.40	30.61
	Approach Top WD (ft):	23.92	40.00	32.61
	K1 Coefficient:	0.640	0.690	0.640
Results				
	Scour Depth Ys (ft):		0.34	
	Critical Velocity (ft/s):		1.32	
	Equation:		Live	

Abutment Scour

		Left	Right
Input Data			
	Station at Toe (ft):	183.75	216.25
	Toe Sta at appr (ft):	185.33	214.22
	Abutment Length (ft):	29.25	38.39
	Depth at Toe (ft):	1.49	1.49
	K1 Shape Coef:	1.00 - Vertical abutment	
	Degree of Skew (degrees):	90.00	90.00
	K2 Skew Coef:	1.00	1.00
	Projected Length L' (ft):	29.25	38.39
	Avg Depth Obstructed Ya (ft):	2.28	3.04
	Flow Obstructed Qe (cfs):	55.26	87.12
	Area Obstructed Ae (sq ft):	66.63	116.73
Results			
	Scour Depth Ys (ft):	6.01	4.08
	Qe/Ae = Ve:	0.83	0.83
	Froude #:	0.10	0.05
	Equation:	Froehlich	HIRE

Combined Scour Depths

Left abutment scour + contraction scour (ft):	6.35
Right abutment scour + contraction scour (ft):	4.42



1 in Horiz. = 50 1 in Vert. = 5

Contraction Scour

Westbrook Mill Bridge

		Left	Channel	Right
Input Data				
	Average Depth (ft):	11.52	19.80	12.86
	Approach Velocity (ft/s):	0.16	0.82	0.17
	Br Average Depth (ft):	1.25	12.42	0.58
	BR Opening Flow (cfs):	34.41	888.82	30.77
	BR Top WD (ft):	88.75	32.95	83.30
	Grain Size D50 (mm):	0.20	0.20	0.20
	Approach Flow (cfs):	148.17	651.37	154.46
	Approach Top WD (ft):	80.00	40.00	70.00
	K1 Coefficient:	0.640	0.640	0.640
Results				
	Scour Depth Ys (ft):	0.00	3.57	0.00
	Critical Velocity (ft/s):	1.46	1.60	1.49
	Equation:	Clear	Clear	Clear

100YR

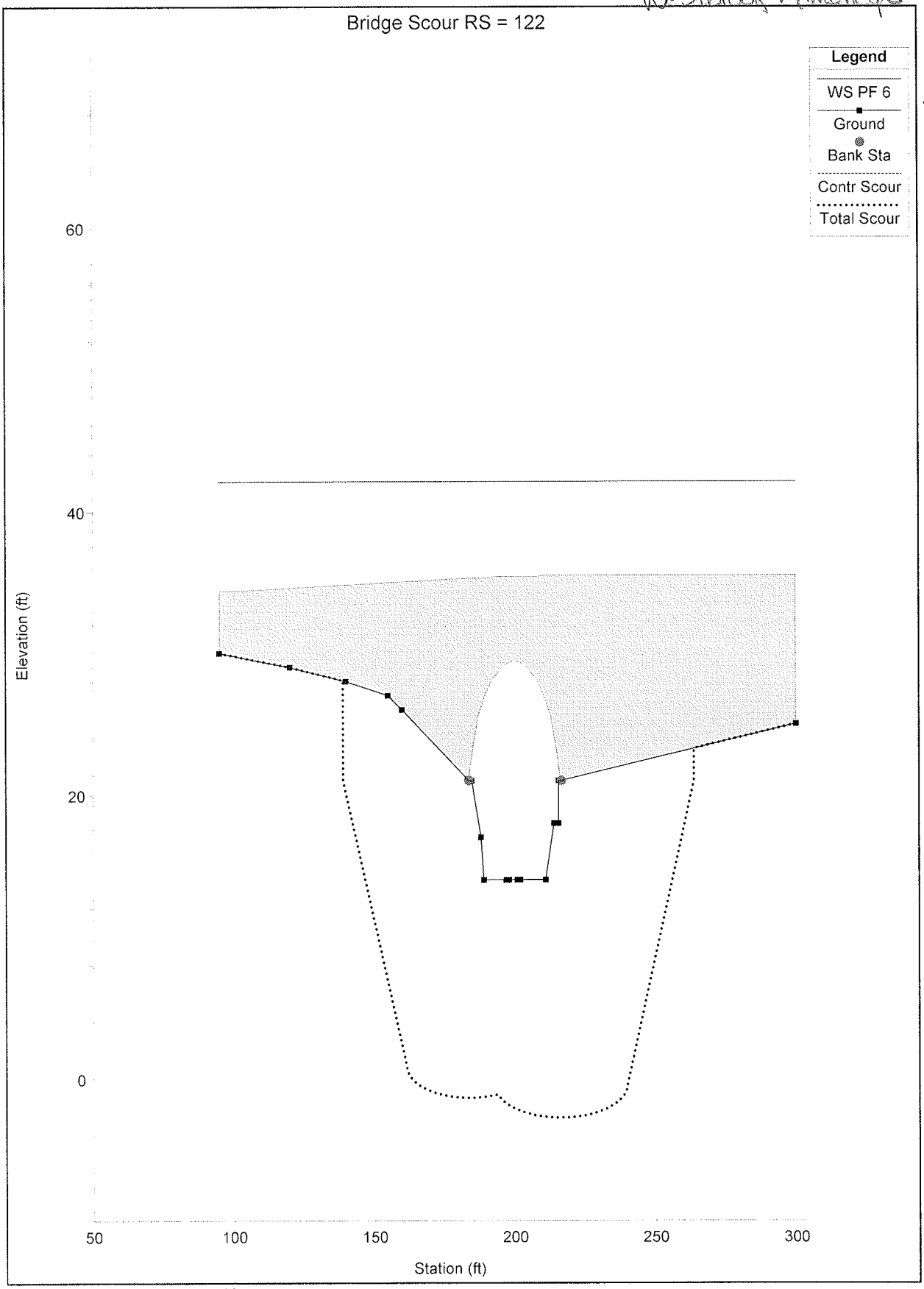
Abutment Scour

		Left	Right
Input Data			
	Station at Toe (ft):	183.75	216.25
	Toe Sta at appr (ft):	185.33	214.22
	Abutment Length (ft):	85.33	75.78
	Depth at Toe (ft):	15.14	15.14
	K1 Shape Coef:	1.00 - Vertical abutment	
	Degree of Skew (degrees):	90.00	90.00
	K2 Skew Coef:	1.00	1.00
	Projected Length L' (ft):	85.33	75.78
	Avg Depth Obstructed Ya (ft):	11.95	13.32
	Flow Obstructed Qe (cfs):	225.63	240.98
	Area Obstructed Ae (sq ft):	1019.62	1009.49
Results			
	Scour Depth Ys (ft):	16.05	17.52
	Qe/Ae = Ve:	0.22	0.24
	Froude #:	0.01	0.01
	Equation:	Froehlich	Froehlich

Combined Scour Depths

Left abutment scour + contraction scour (ft):	19.62
Right abutment scour + contraction scour (ft):	21.09

Westbrook Mill Bridge



5004R

1 in Horiz. = 50 1 in Vert. = 10

Contraction Scour

Westbrook Mill Bridge 5004R

		Left	Channel	Right
Input Data				
	Average Depth (ft):	17.48	25.76	18.82
	Approach Velocity (ft/s):	0.16	0.78	0.17
	Br Average Depth (ft):	7.27	18.43	6.60
	BR Opening Flow (cfs):	192.08	535.02	527.90
	BR Top WD (ft):	88.75	32.95	83.30
	Grain Size D50 (mm):	0.20	0.20	0.20
	Approach Flow (cfs):	226.86	806.68	221.46
	Approach Top WD (ft):	80.00	40.00	70.00
	K1 Coefficient:	0.690	0.690	0.690
Results				
	Scour Depth Ys (ft):	0.00	0.00	0.00
	Critical Velocity (ft/s):	1.57	1.67	1.59
	Equation:	Clear	Clear	Clear

Abutment Scour

		Left	Right
Input Data			
	Station at Toe (ft):	183.75	216.25
	Toe Sta at appr (ft):	185.33	214.22
	Abutment Length (ft):	85.33	75.78
	Depth at Toe (ft):	21.10	21.10
	K1 Shape Coef:	1.00 - Vertical abutment	
	Degree of Skew (degrees):	90.00	90.00
	K2 Skew Coef:	1.00	1.00
	Projected Length L' (ft):	85.33	75.78
	Avg Depth Obstructed Ya (ft):	17.90	19.28
	Flow Obstructed Qe (cfs):	325.83	330.71
	Area Obstructed Ae (sq ft):	1527.81	1460.80
Results			
	Scour Depth Ys (ft):	22.36	23.76
	Qe/Ae = Ve:	0.21	0.23
	Froude #:	0.01	0.01
	Equation:	Froehlich	Froehlich

HYDROLOGY, HYDRAULICS, AND SCOUR REPORT

General Information

Mill Brook Bridge carries Route 302 over Mill Brook in Westbrook, Maine. The existing buried structure consists of twin concrete box culverts with concrete wingwalls at each end skewed at approximately 45 degrees. The culverts kink near the center with a maximum skew of approximately 20 degrees. The stream flow is controlled by a dam at the south end of Highland Lake located approximately 0.25 miles upstream of the bridge. Mill Brook flows approximately 5 miles from the dam to the Presumpscot River.

Backwater from the Presumpscot River is improbable due to an approximate 150 foot drop in streambed elevation between Mill Brook Bridge and the Presumpscot River. There is approximately 20 feet of fill above the existing box culvert openings so overtopping the roadway is unlikely.

The streambed at the bridge location has a gravely bottom. Recent borings indicate that approximately 25 feet of sand and clay is deposited between the streambed and bedrock beneath. A small sandbag fish weir has been constructed at the inlet of one of the culverts to direct all flow through the other culvert during low flow periods. The riverbanks upstream of the bridge are heavily wooded so there is a risk of debris piling up at the inlet. However, the risk is somewhat limited since the dam is located only 0.25 miles upstream.

Hydrology

The following information was obtained from MDOT hydrologists:

Drainage Area:	9.1 mi^2
Wetlands Percentage:	21.7%

Peak flows were calculated by MDOT hydrologists and are listed below:

Q1.1	77.3 cfs
Q25	337 cfs
Q50	389 cfs
Q100	445 cfs
Q500	579 cfs

Hydraulics

The hydraulic openings of the existing structures were determined based on maintenance records and survey information. Each box culvert has a 9 foot wide by 6 foot tall hydraulic opening. This results in an overall area of 108 SF.

The existing culverts are oriented such that Mill Brook makes a sharp bend entering the inlet and a milder bend exiting the outlet. There is also a kink approximately halfway through each of the structures. To improve hydraulics, the proposed structure will shift west and provide a straight alignment from the inlet to the outlet. This leads to a skew of the proposed culverts to the

roadway of 16 degrees. This modification provides a smoother path for the water traveling in and out of the structure while causing relatively minor alterations to the existing streambed and banks. This orientation also allows the contractor to maintain flows through a combination of the existing and proposed culverts throughout construction without needing to pump water from one end to the other. However, pumping water is still a viable option if the contractor chooses to cofferdam the water on each end. Any method will require the contractor to maintain a reasonable amount of downstream flow to provide a suitable habitat for fish during construction.

Wingwalls

The existing culverts contain concrete wingwalls at each end. However, the proposed culverts will have beveled ends which eliminate the need for wingwalls. This will reduce construction costs and preclude future maintenance that would otherwise be required to preserve the wings.

Fish Passage and Sediment Control

Mill Brook is a significant waterway for fish because it provides connectivity between the Presumpscot River and Highland Lake. Most notably it provides passage for substantial alewife runs in the spring and fall. The proposed bridge will contain design features to help facilitate fish passage. Because water depths are relatively low during dry periods, the elevations of the culverts will be offset to direct the majority or all of the flow through just one side. This will consequently increase the depth of water. In addition, the lower box will contain a stony fill material atop the bottom slab to mimic the natural stream bottom. Sediment retention sills will be strategically designed and spaced to contain the fill within the culvert and prevent washout.

Hydraulic Model

Because of the significant drop in streambed elevation between Mill Brook Bridge and the Presumpscot River, backwater is not a concern. Therefore, the hydraulic analysis only considers a headwater condition.

HY-8 software was used to model the existing and proposed conditions. The existing bridge was modeled as twin rectangular box culverts set at the same elevation with inside dimensions of 9 feet wide by 6 feet tall. The proposed bridge was modeled as 2 rectangular box culverts with a 1-foot offset in their respective elevations. Each box culvert was modeled with a 12 foot width. However, because of the offset, the inside vertical dimension of the lower box is 6 feet and the upper box is 5 feet. This results in a total hydraulic opening that is 22% greater than the existing bridge.

The following is a summary of the headwater elevations and outlet velocities of the 2 models for Q1.1, Q25, Q50, and Q100. Note for reference that the streambed elevation in the models at the inlet is approximately 165.0 feet.

	Existing Box Culverts	Proposed Lower Box Culvert	Proposed Upper Box Culvert
Hydraulic Opening	108 ft^2	72 ft^2	60 ft^2
Headwater EL. @ $Q_{1.1}$	167.4 ft	166.5 ft	166.5 ft
Headwater EL. @ Q_{25}	169.7 ft	168.3 ft	168.3 ft
Headwater EL. @ Q_{50}	170.1 ft	168.6 ft	168.6 ft
Headwater EL. @ Q_{100}	170.5 ft	168.9 ft	168.9 ft
Outlet Velocity @ $Q_{1.1}$	8.22 ft/s	6.02 ft/s	8.09 ft/s
Outlet Velocity @ Q_{25}	12.0 ft/s	9.07 ft/s	12.3 ft/s
Outlet Velocity @ Q_{50}	12.4 ft/s	9.50 ft/s	12.3 ft/s
Outlet Velocity @ Q_{100}	12.9 ft/s	9.89 ft/s	12.8 ft/s
Clearance @ Q50	1.9 ft	2.4 ft	2.4 ft

Scour

The streambed beneath the proposed structure consists primarily of dense sand. The standard detail for stone scour protection 610(02), will be used at the inlet and outlet to minimize the risk of scour. Also, all steam bank alterations will require riprap slopes.

The lower box culvert will contain 12 inches of stone fill to mimic the natural stream bottom. Sediment retention sills will be constructed along the bottom of the box to contain the fill and prevent washout.

Reported by Craig Weaver