LEVEL II SCOUR ANALYSIS FOR BRIDGE 13 (NEWFVT00300013) on STATE ROUTE 30, crossing SMITH BROOK, NEWFANE, VERMONT

U.S. Geological Survey
Open-File Report 97-218

Prepared in cooperation with
VERMONT AGENCY OF TRANSPORTATION
and
FEDERAL HIGHWAY ADMINISTRATION

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By MICHAEL A. IVANOFF & LAURA MEDALIE

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Pembroke, New Hampshire

1997

U.S. DEPARTMENT OF THE INTERIOR
BRUCE BABBITT, Secretary

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CONVERSION FACTORS, ABBREVIATIONS, AND VERTICAL DATUM

Multiply	By	To obtain
	Length	
inch (in.)	25.4	millimeter (mm)
foot (ft)	0.3048	meter (m)
mile (mi)	1.609	kilometer (km)
	Slope	
foot per mile (ft/mi)	0.1894	meter per kilometer (m/km)
	Area	
square mile (mi^2)	2.590	square kilometer (km^2)
	Volume	
cubic foot (ft^3)	0.02832	cubic meter (m^3)
	Velocity and Flow	
foot per second (ft/s)	0.3048	meter per second (m/s)
cubic foot per second (ft^3/s)	0.02832	cubic meter per second (m^3/s)
cubic foot per second per square mile [(ft^3/s)/mi^2]	0.01093	cubic meter per second per square kilometer [(m^3/s)/km^2]

OTHER ABBREVIATIONS

BF	bank full	LWW	left wingwall
cfs	cubic feet per second	MC	main channel
D_{50}	median diameter of bed material	RAB	right abutment
DS	downstream	RABUT	face of right abutment
elev.	elevation	RB	right bank
f/p	flood plain	ROB	right overbank
ft^2	square feet	RWW	right wingwall
ft/ft	feet per foot	TH	town highway
JCT	junction	UB	under bridge
LAB	left abutment	US	upstream
LABUT	face of left abutment	USGS	United States Geological Survey
LB	left bank	VTAOT	Vermont Agency of Transportation
LOB	left overbank	WSPRO	water-surface profile model

In this report, the words “right” and “left” refer to directions that would be reported by an observer facing downstream.

Sea level: In this report, “sea level” refers to the National Geodetic Vertical Datum of 1929-- a geodetic datum derived from a general adjustment of the first-order level nets of the United States and Canada, formerly called Sea Level Datum of 1929.

In the appendices, the above abbreviations may be combined. For example, USLB would represent upstream left bank.

LEVEL II SCOUR ANALYSIS FOR BRIDGE 13 (NEWFVT00300013) ON STATE ROUTE 30, CROSSING SMITH BROOK, NEWFANE, VERMONT

By **Michael A. Ivanoff and Laura Medalie**

INTRODUCTION AND SUMMARY OF RESULTS

This report provides the results of a detailed Level II analysis of scour potential at structure NEWFVT00300013 on State Route 30 crossing Smith Brook, Newfane, Vermont (figures 1–8). A Level II study is a basic engineering analysis of the site, including a quantitative analysis of stream stability and scour (U.S. Department of Transportation, 1993). Results of a Level I scour investigation also are included in Appendix E of this report. A Level I investigation provides a qualitative geomorphic characterization of the study site. Information on the bridge, gleaned from Vermont Agency of Transportation (VTAOT) files, was compiled prior to conducting Level I and Level II analyses and is found in Appendix D.

The site is in the New England Upland section of the New England physiographic province in southeastern Vermont. The 9.38-mi^2 drainage area is in a predominantly rural and forested basin. In the vicinity of the study site, the surface cover is grass and shrubs except for the upstream right bank which is forested.

In the study area, Smith Brook has an incised, sinuous channel with a slope of approximately 0.01 ft/ft, an average channel top width of 53 ft and an average bank height of 5 ft. The channel bed material is predominantly cobbles with a median grain size (D_{50}) of 79.5 mm (0.261 ft). The geomorphic assessment at the time of the Level I and Level II site visit on August 20, 1996, indicated that the reach was stable.

The State Route 30 crossing of Smith Brook is a 69-ft-long, two-lane bridge consisting of one 66-foot steel-beam span (Vermont Agency of Transportation, written communication, March 30, 1995). The bridge is supported by vertical, concrete abutments with wingwalls. The channel is skewed approximately 45 degrees to the opening while the opening-skew-to-roadway is 55 degrees.

The scour protection measures at the site were type-1 stone fill (less than 12 inches diameter) along the upstream right bank. There was also type-2 stone fill (less than 36 inches diameter) along the upstream left bank. A stone wall extends to 72 feet upstream from the end of the upstream left wingwall. There is another stone wall along the upstream right bank. Additional details describing conditions at the site are included in the Level II Summary and Appendices D and E.

Scour depths and recommended rock rip-rap sizes were computed using the general guidelines described in Hydraulic Engineering Circular 18 (Richardson and others, 1995). Total scour at a highway crossing is comprised of three components: 1) long-term streambed degradation; 2) contraction scour (due to accelerated flow caused by a reduction in flow area at a bridge) and; 3) local scour (caused by accelerated flow around piers and abutments). Total scour is the sum of the three components. Equations are available to compute depths for contraction and local scour and a summary of the results of these computations follows.

Contraction scour for all modelled flows ranged from 0.0 to 0.8 ft. The worst-case contraction scour occurred at the 500-year discharge. Abutment scour ranged from 14.4 to 18.2 ft. The worst-case abutment scour occurred at the 500-year discharge. Additional information on scour depths and depths to armoring are included in the section titled “Scour Results”. Scoured-streambed elevations, based on the calculated scour depths, are presented in tables 1 and 2. A cross-section of the scour computed at the bridge is presented in figure 8. Scour depths were calculated assuming an infinite depth of erosive material and a homogeneous particle-size distribution.

It is generally accepted that the Froehlich equation (abutment scour) gives “excessively conservative estimates of scour depths” (Richardson and others, 1995, p. 47). Usually, computed scour depths are evaluated in combination with other information including (but not limited to) historical performance during flood events, the geomorphic stability assessment, existing scour protection measures, and the results of the hydraulic analyses. Therefore, scour depths adopted by VTAOT may differ from the computed values documented herein.

Newfane, VT. Quadrangle, 1:25,000, 1984

NORTH

Figure 1. Location of study area on USGS 1:24,000 scale map.

Figure 2. Location of study area on Vermont Agency of Transportation town highway map.

LEVEL II SUMMARY

Structure Number NEWFVT00300013 ***Stream*** Smith Brook

County Windham ***Road*** VT 30 ***District*** 2

Description of Bridge

Bridge length 69 ***ft*** ***Bridge width*** 32.5 ***ft*** ***Max span length*** 66 ***ft***

Alignment of bridge to road (on curve or straight) Slight curve

Abutment type Vertical, concrete ***Embankment type*** Vertical

Stone fill on abutment? No ***Date of inspection*** 08/20/96

Description of stone fill Type-1, along the upstream right bank. Type-2, along the upstream left bank. A stone wall extends 72 feet upstream of the upstream left wingwall. Another stone wall is along the right bank from 44 to 88 feet upstream.

Abutments and wingwalls are concrete.

Yes 45

Is bridge skewed to flood flow according to Yes ***survey?*** ***Angle***

There is a mild channel bend immediately upstream of the bridge.

Debris accumulation on bridge at time of Level I or Level II site visit:

	Date of inspection	***Percent of channel blocked horizontally***	***Percent of channel blocked vertically***
Level I	08/20/96	0	0
Level II	08/20/96	0	0

Potential for debris Moderate. There is a downed tree and some trees leaning over the channel upstream.

Describe any features near or at the bridge that may affect flow (include observation date) There is a side bar noted on the assessment of 08/20/96 along the left bank upstream extending through the bridge.

Description of the Geomorphic Setting

General topography The channel is located in a moderate relief valley with a narrow flood plain and steep valley walls on both sides.

Geomorphic conditions at bridge site: downstream (DS), upstream (US)

Date of inspection 08/20/96

DS left: Steep channel bank to a narrow overbank.

DS right: Moderately sloping channel bank to a narrow flood plain.

US left: Steep channel bank to a narrow flood plain.

US right: Moderately sloping channel bank to a narrow flood plain.

Description of the Channel

Average top width 53 ft ***Average depth*** 5 ft

Predominant bed material Gravel to Boulders ***Bank material*** Sand to Cobbles

Sinuous but stable with semi-alluvial channel boundaries.

08/20/96

Vegetative co Trees and brush.

DS left: Trees and brush.

DS right: Trees and brush.

US left: Trees and brush.

US right:

Do banks appear stable? Yes

date of observation.

None noted on the assessment of 08/20/96.

Describe any obstructions in channel and date of observation.

Hydrology

Drainage area 9.38 ***mi***^{2}

Percentage of drainage area in physiographic provinces: (approximate)

Physiographic province/section	***Percent of drainage area***
New England/ New England Upland	100

Is drainage area considered rural or urban? Rural ***Describe any significant urbanization***:

Is there a USGS gage on the stream of interest? No

USGS gage description --

USGS gage number --

Gage drainage area -- ***mi***^{2}

Is there a lake/p No

Calculated Discharges

Q100 2,460 ***ft***^{3}***/s*** ***Q500*** 3,500 ***ft***^{3}***/s***

The 100- and 500- year discharges are based on the flood frequency results of the Johnson and Tasker empirical equation. This included a drainage area relationship [(9.38/12.6)exp 0.7] with the 100 year flood discharge at the mouth of Smith Brook. The mouth of Smith Brook has a flood frequency estimate based on the Johnson and Tasker equation available in the Flood Insurance Study for Newfane, VT (Federal Emergency Management Agency, June 5, 1989). The drainage area at the mouth of Smith Brook is 12.6 square miles. These values are within a range defined by several empirical flood frequency curves (Benson, 1962; Johnson and Tasker, 1974; FHWA, 1983; Potter, 1957a&b; Talbot, 1887).

Description of the Water-Surface Profile Model (WSPRO) Analysis

Datum for WSPRO analysis (USGS survey, sea level, VTAOT plans) USGS survey

Datum tie between USGS survey and VTAOT plans Subtract 250.1 feet from the USGS arbitrary survey datum to obtain VTAOT plans' datum.

Description of reference marks used to determine USGS datum. RM1 is a chiseled X on top of the upstream end of the left abutment (elev. 501.25 ft, arbitrary survey datum). RM2 is a chiseled X on top of the downstream end of the right abutment (elev. 500.84 ft, arbitrary survey datum).

Cross-Sections Used in WSPRO Analysis

[1]*Cross-section*	*Section Reference Distance (SRD) in feet*	[2]*Cross-section development*	*Comments*
EXITX	-54	1	Exit section
FULLV	0	2	Downstream Full-valley section (Templated from EXITX)
BRIDG	0	1	Bridge section
RDWAY	30	1	Road Grade section
APPRO	95	2	Modelled Approach section (Templated from APTEM)
APTEM	120	1	Approach section as surveyed (Used as a template)

[1] For location of cross-sections see plan-view sketch included with Level I field form, Appendix E.
For more detail on how cross-sections were developed see WSPRO input file.

Data and Assumptions Used in WSPRO Model

Hydraulic analyses of the reach were done by use of the Federal Highway Administration's WSPRO step-backwater computer program (Shearman and others, 1986, and Shearman, 1990). The analyses reported herein reflect conditions existing at the site at the time of the study. Furthermore, in the development of the model it was necessary to assume no accumulation of debris or ice at the site. Results of the hydraulic model are presented in the Bridge Hydraulic Summary, Appendix B, and figure 7.

Channel roughness factors (Manning's "n") used in the hydraulic model were estimated using field inspections at each cross section following the general guidelines described by Arcement and Schneider (1989). Final adjustments to the values were made during the modelling of the reach. Channel "n" values for the reach ranged from 0.040 to 0.055, and overbank "n" values ranged from 0.035 to 0.045.

Normal depth at the exit section (EXITX) was assumed as the starting water surface. This depth was computed by use of the slope-conveyance method outlined in the user's manual for WSPRO (Shearman, 1990). The slope used was 0.0132 ft/ft. This slope was estimated from the 100-year discharge water surface profile slope downstream of the site presented in the Flood Insurance Study for the town of Newfane, VT (Federal Emergency Management Agency, June 5, 1989).

The surveyed approach section (APTEM) was moved along the approach channel slope (0.0106 ft/ft) to establish the modelled approach section (APPRO), one bridge length upstream of the upstream face as recommended by Shearman and others (1986). This location also provides a consistent method for determining scour variables.

Bridge Hydraulics Summary

Average bridge embankment elevation 500.3 *ft*
Average low steel elevation 496.0 *ft*

100-year discharge 2,460 *ft³/s*
Water-surface elevation in bridge opening 491.4 *ft*
Road overtopping? No *Discharge over road* -- *³/s*
Area of flow in bridge opening 245 *ft²*
Average velocity in bridge opening 10.0 *ft/s*
Maximum WSPRO tube velocity at bridge 12.1 *ft/s*

Water-surface elevation at Approach section with bridge 493.2
Water-surface elevation at Approach section without bridge 493.4
Amount of backwater caused by bridge N/A *t*

500-year discharge 3,500 *ft³/s*
Water-surface elevation in bridge opening 492.4 *ft*
Road overtopping? No *Discharge over road* -- */s*
Area of flow in bridge opening 282 *ft²*
Average velocity in bridge opening 12.4 *ft/s*
Maximum WSPRO tube velocity at bridge 15.2 */s*

Water-surface elevation at Approach section with bridge 495.2
Water-surface elevation at Approach section without bridge 495.1
Amount of backwater caused by bridge 0.1

Incipient overtopping discharge -- *ft³/s*
Water-surface elevation in bridge opening -- *ft*
Area of flow in bridge opening -- *ft²*
Average velocity in bridge opening -- *ft/s*
Maximum WSPRO tube velocity at bridge -- *ft/s*

Water-surface elevation at Approach section with bridge --
Water-surface elevation at Approach section without bridge --
Amount of backwater caused by bridge -- *t*

Scour Analysis Summary

Special Conditions or Assumptions Made in Scour Analysis

Scour depths were computed using the general guidelines described in Hydraulic Engineering Circular 18 (Richardson and others, 1995). Scour depths were calculated assuming an infinite depth of erosive material and a homogeneous particle-size distribution. The results of the scour analysis are presented in tables 1 and 2 and a graph of the scour depths is presented in figure 8.

Contraction scour was computed by use of the clear-water contraction scour equation (Richardson and others, 1995, p. 32, equation 20). For contraction scour computations, the average depth in the contracted section (AREA/TOPWIDTH) is subtracted from the depth of flow computed by the scour equation (Y2) to determine the actual amount of scour. In this case, the 500-year model resulted in the worst case contraction scour with a scour depth of 0.8 ft. The streambed armoring depths computed suggest that armoring will not limit the depth of contraction scour.

Abutment scour was computed by use of the Froehlich equation (Richardson and others, 1995, p. 48, equation 28). Variables for the Froehlich equation include the Froude number of the flow approaching the embankments, the length of the embankment blocking flow, and the depth of flow approaching the embankment less any roadway overtopping.

Scour Results

Contraction scour:	*100-yr discharge*	*500-yr discharge*	*Incipient overtopping discharge*
		(Scour depths in feet)	
Main channel			
Live-bed scour	--	--	--
Clear-water scour	0.0 0.8	--	5.7
Depth to armoring	13.5	--	--
Left overbank	--	--	--
Right overbank	--	--	16.3

Local scour:			
Abutment scour	18.2	--	14.4
Left abutment	18.0–	---	---
Right abutment			
Pier scour	--	--	--
Pier 1	--	--	--
Pier 2	--	--	1.9
Pier 3			

Riprap Sizing

	100-yr discharge	*500-yr discharge*	*Incipient overtopping discharge*
		(D_{50} in feet)	
Abutments:	3.0	--	1.9
Left abutment	3.0	--	--
Right abutment	--	--	--
Piers:	--	--	--
Pier 1	--	--	
Pier 2			

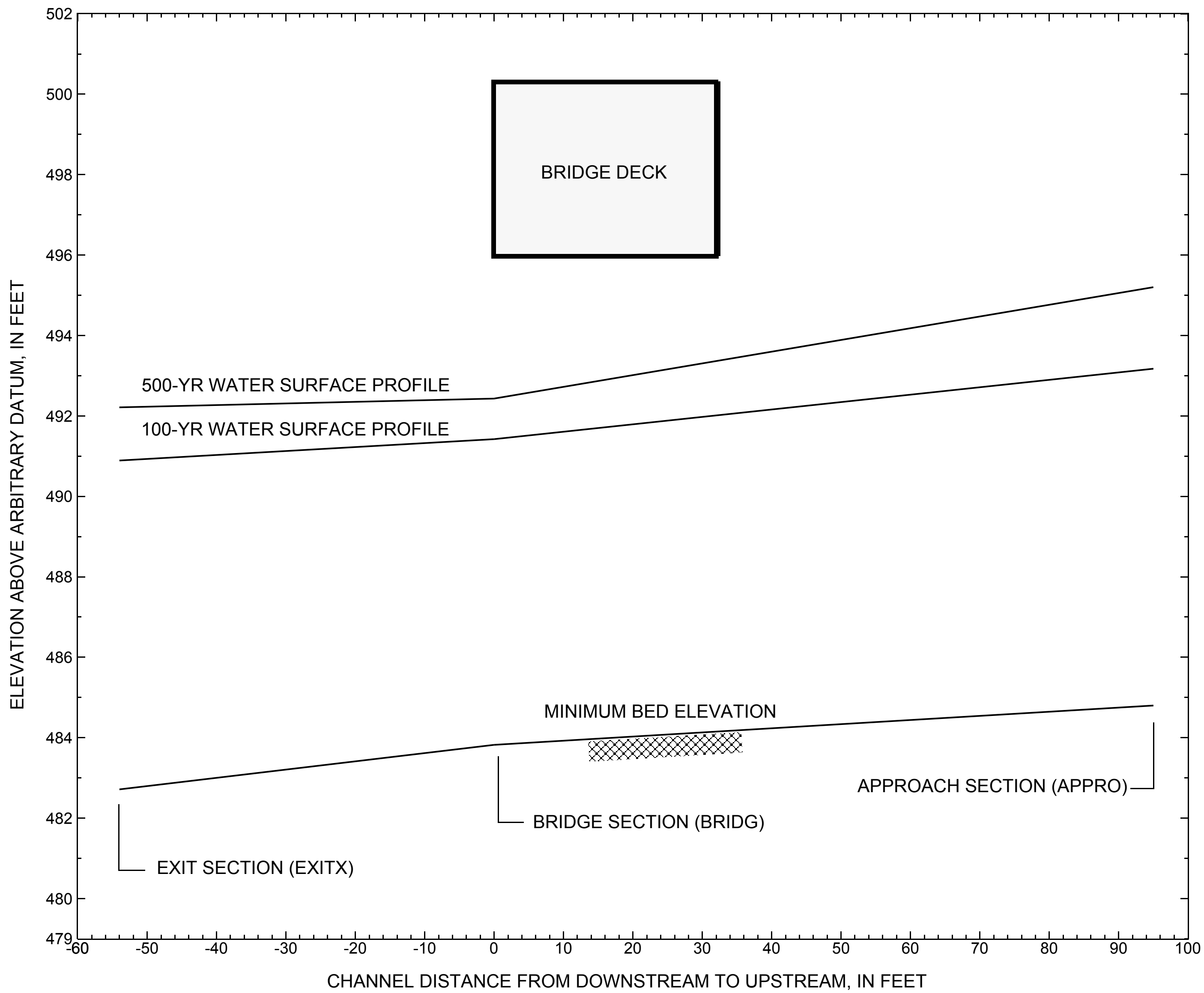

Figure 7. Water-surface profiles for the 100- and 500-yr discharges at structure NEWFVT00300013 on State Route 30, crossing Smith Brook, Newfane, Vermont.

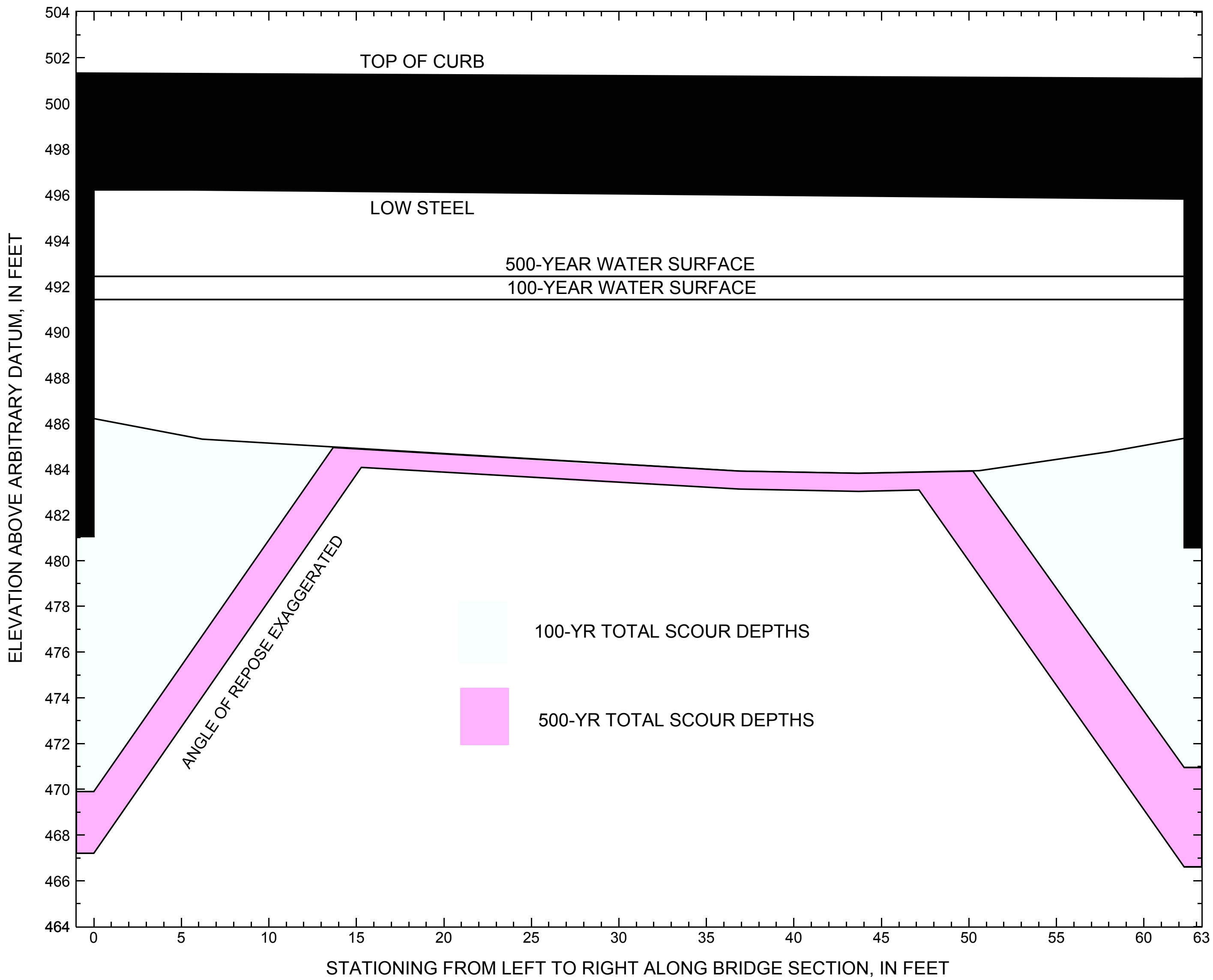

Figure 8. Scour elevations for the 100-yr and 500-yr discharges at structure NEWFVT00300013 on State Route 30, crossing Smith Brook, Newfane, Vermont.

Table 1. Remaining footing/pile depth at abutments for the 100-year discharge at structure NEWFVT00300013 on State Route 30, crossing Smith Brook, Newfane, Vermont.
[VTAOT, Vermont Agency of Transportation; --,no data]

Description	Station[1]	VTAOT bridge seat elevation (feet)	Surveyed minimum low-chord elevation[2] (feet)	Bottom of footing elevation[2] (feet)	Channel elevation at abutment/ pier[2] (feet)	Contraction scour depth (feet)	Abutment scour depth (feet)	Pier scour depth (feet)	Depth of total scour (feet)	Elevation of scour[2] (feet)	Remaining footing/pile depth (feet)
100-yr. discharge is 2,460 cubic-feet per second											
Left abutment	0.0	246.4	496.2	481.1	486.2	0.0	16.3	--	16.3	469.9	-11.2
Right abutment	62.3	246.1	495.8	480.6	485.4	0.0	14.4	--	14.4	471.0	-9.6

1.Measured along the face of the most constricting side of the bridge.
2.Arbitrary datum for this study.

Table 2. Remaining footing/pile depth at abutments for the 500-year discharge at structure NEWFVT00300013 on State Route 30, crossing Smith Brook, Newfane, Vermont.
[VTAOT, Vermont Agency of Transportation; --, no data]

Description	Station[1]	VTAOT bridge seat elevation (feet)	Surveyed minimum low-chord elevation[2] (feet)	Bottom of footing elevation[2] (feet)	Channel elevation at abutment/ pier[2] (feet)	Contraction scour depth (feet)	Abutment scour depth (feet)	Pier scour depth (feet)	Depth of total scour (feet)	Elevation of scour[2] (feet)	Remaining footing/pile depth (feet)
500-yr. discharge is 3,500 cubic-feet per second											
Left abutment	0.0	246.4	496.2	481.1	486.2	0.8	18.2	--	19.0	467.2	-13.9
Right abutment	62.3	246.1	495.8	480.6	485.4	0.8	18.0	--	18.8	466.6	-14.0

1.Measured along the face of the most constricting side of the bridge.
2.Arbitrary datum for this study.

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U.S. Geological Survey, 1984, Newfane, Vermont 7.5 X 15 Minute Series quadrangle map: U.S. Geological Survey Topographic Maps, Scale 1:25,000.

APPENDIX A:

WSPRO INPUT FILE

WSPRO INPUT FILE

```
T1        U.S. Geological Survey WSPRO Input File newf013.wsp
T2        Hydraulic analysis for structure NEWFVT00300013   Date: 29-JAN-97
T3        Bridge # 13 on VT 30 over Smith Brook in Newfane, VT  by MAI
*
J3         6 29 30 552 553 551 5 16 17 13 3 * 15 14 23 21 11 12 4 7 3
*
Q           2460.0   3500.0
SK          0.0132   0.0132
*
XS   EXITX    -54
GR         -232.8, 502.75    -93.5, 498.68     -8.5, 490.88      0.0, 484.58
GR            5.5, 483.31      9.8, 482.71     13.7, 482.84     17.8, 482.77
GR           19.6, 483.27     29.4, 486.80     50.6, 498.88     93.1, 500.37
GR          210.7, 504.34
N           0.045        0.055        0.035
SA                   -8.5         29.4
*
XS   FULLV      0  * * *   0.0184
*
*             SRD     LSEL    XSSKEW
BR   BRIDG     0    496.00      55.0
GR            0.0, 496.22      0.0, 486.21      6.2, 485.31     28.1, 484.25
GR           36.9, 483.92     43.7, 483.82     50.6, 483.93     58.0, 484.76
GR           62.3, 485.35     62.3, 495.78      0.0, 496.22
*
*         BRTYPE  BRWDTH
CD           1      69.8
N           0.040
*
*             SRD    EMBWID   IPAVE
XR   RDWAY     30      32.5     1
GR         -134.2, 502.75    -62.1, 501.50     -1.6, 500.33     -1.6, 501.25
GR            0.0, 501.33     63.3, 501.09     65.6, 501.06     65.9, 500.21
GR          180.2, 500.37    464.2, 504.34
*
XT   APTEM    120
GR         -124.8, 502.75    -52.7, 501.50    -17.4, 500.88      0.0, 494.14
GR            5.0, 486.73     12.6, 485.62     13.6, 485.07     19.2, 485.11
GR           22.3, 485.14     28.3, 485.47     47.5, 488.25     67.1, 489.25
GR           89.6, 497.82    132.7, 502.90    211.5, 504.95
*
AS   APPRO    95  * * *  0.0106
GT
N           0.045        0.045        0.044
SA                    0.0         67.1
*
HP 1 BRIDG   491.42 1 491.42
HP 2 BRIDG   491.42 * * 2460
HP 1 APPRO   493.17 1 493.17
HP 2 APPRO   493.17 * * 2460
*
HP 1 BRIDG   492.43 1 492.43
HP 2 BRIDG   492.43 * * 3500
HP 1 APPRO   495.20 1 495.20
HP 2 APPRO   495.20 * * 3500
*
EX
```

APPENDIX B:

WSPRO OUTPUT FILE

WSPRO OUTPUT FILE

```
        U.S. Geological Survey WSPRO Input File newf013.wsp
        Hydraulic analysis for structure NEWFVT00300013   Date: 29-JAN-97
        Bridge # 13 on VT 30 over Smith Brook in Newfane, VT  by MAI
           *** RUN DATE & TIME: 02-28-97  11:05

    CROSS-SECTION PROPERTIES:  ISEQ =  3;  SECID = BRIDG;  SRD =       0.

     WSEL  SA#     AREA         K  TOPW   WETP  ALPH    LEW    REW      QCR
             1      246     27418    36     47                         3654
   491.42           246     27418    36     47  1.00      0     62     3654


    VELOCITY DISTRIBUTION:  ISEQ =  3;  SECID = BRIDG;  SRD =       0.

         WSEL     LEW     REW    AREA         K        Q    VEL
       491.42     0.0    62.3   245.6   27418.    2460.  10.02

X STA.         0.0         6.6        10.5        13.9        17.0        20.0
  A(I)            21.5        14.0        12.3        11.8        11.6
  V(I)            5.73        8.77       10.02       10.39       10.64

X STA.        20.0        22.8        25.5        28.1        30.6        33.0
  A(I)            11.0        10.9        10.5        10.2        10.3
  V(I)           11.19       11.31       11.68       12.05       11.90

X STA.        33.0        35.5        37.8        40.2        42.6        45.0
  A(I)            10.4        10.2        10.1        10.4        10.6
  V(I)           11.86       12.10       12.12       11.88       11.61

X STA.        45.0        47.5        50.1        53.0        56.4        62.3
  A(I)            10.8        11.2        12.2        13.6        22.1
  V(I)           11.41       10.97       10.08        9.05        5.57


    CROSS-SECTION PROPERTIES:  ISEQ =  5;  SECID = APPRO;  SRD =      95.

     WSEL  SA#     AREA         K  TOPW   WETP  ALPH    LEW    REW      QCR
             2      418     45236    67     71                         5936
             3       23      1218    11     12                          189
   493.17           441     46454    78     82  1.03      0     78     5860


    VELOCITY DISTRIBUTION:  ISEQ =  5;  SECID = APPRO;  SRD =      95.

         WSEL     LEW     REW    AREA         K        Q    VEL
       493.17     0.5    78.1   440.8   46454.    2460.   5.58

X STA.         0.5         7.7        10.7        13.4        15.7        17.9
  A(I)            33.9        21.9        21.1        18.8        18.7
  V(I)            3.63        5.62        5.83        6.55        6.59

X STA.        17.9        20.1        22.3        24.5        26.7        29.0
  A(I)            18.0        18.2        18.2        18.0        18.3
  V(I)            6.83        6.75        6.77        6.82        6.72

X STA.        29.0        31.4        34.1        37.0        40.2        43.8
  A(I)            18.8        19.6        19.9        21.0        21.5
  V(I)            6.55        6.27        6.19        5.84        5.72

X STA.        43.8        48.2        53.0        58.3        64.1        78.1
  A(I)            23.5        24.6        25.1        25.8        35.9
  V(I)            5.23        5.00        4.89        4.76        3.43
```

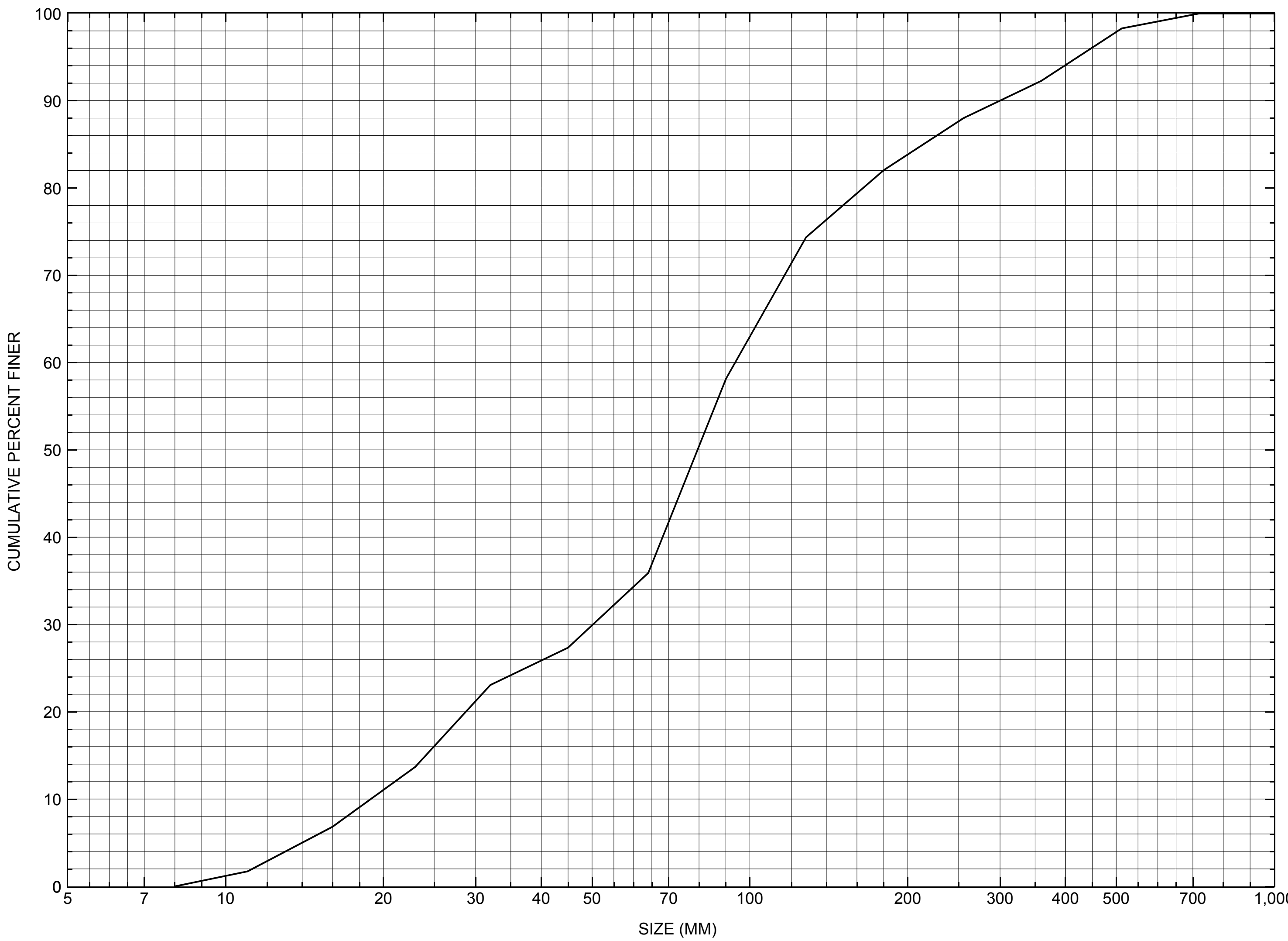
```
        U.S. Geological Survey WSPRO Input File newf013.wsp
        Hydraulic analysis for structure NEWFVT00300013   Date: 29-JAN-97
        Bridge # 13 on VT 30 over Smith Brook in Newfane, VT  by MAI
           *** RUN DATE & TIME: 02-28-97  11:05

    CROSS-SECTION PROPERTIES:  ISEQ =  3;  SECID = BRIDG;  SRD =       0.

     WSEL  SA#     AREA         K   TOPW   WETP  ALPH    LEW    REW      QCR
             1      282     33511     36     49                         4488
   492.43           282     33511     36     49  1.00      0     62     4488


    VELOCITY DISTRIBUTION:  ISEQ =  3;  SECID = BRIDG;  SRD =       0.

         WSEL     LEW     REW    AREA        K        Q    VEL
       492.43     0.0    62.3   281.7   33511.    3500.  12.43

X STA.         0.0        6.7       10.5       13.8       17.0       19.8
  A(I)            25.6       16.1       14.0       13.5       12.6
  V(I)            6.83      10.87      12.47      12.97      13.90

X STA.        19.8       22.6       25.3       27.8       30.3       32.8
  A(I)            12.6       12.2       12.0       11.6       11.8
  V(I)           13.93      14.32      14.54      15.02      14.86

X STA.        32.8       35.2       37.6       40.0       42.4       44.8
  A(I)            11.5       11.6       11.8       11.8       12.0
  V(I)           15.23      15.07      14.81      14.86      14.53

X STA.        44.8       47.3       49.9       52.8       56.2       62.3
  A(I)            12.3       12.8       13.9       15.6       26.3
  V(I)           14.27      13.71      12.55      11.19       6.67

    CROSS-SECTION PROPERTIES:  ISEQ =  5;  SECID = APPRO;  SRD =      95.

     WSEL  SA#     AREA         K   TOPW   WETP  ALPH    LEW    REW      QCR
             1        2        54      3      4                           10
             2      554     71791     67     71                         9029
             3       51      3495     16     17                          507
   495.20           607     75340     87     93  1.05     -2     83     8870


    VELOCITY DISTRIBUTION:  ISEQ =  5;  SECID = APPRO;  SRD =      95.

         WSEL     LEW     REW    AREA        K        Q    VEL
       495.20    -3.4    83.4   606.8   75340.    3500.   5.77

X STA.        -3.4        7.3       10.6       13.5       16.0       18.5
  A(I)            48.1       30.1       29.0       26.2       25.4
  V(I)            3.64       5.82       6.04       6.68       6.89

X STA.        18.5       20.9       23.4       25.9       28.3       31.0
  A(I)            25.2       25.1       25.5       24.9       25.8
  V(I)            6.93       6.97       6.87       7.02       6.77

X STA.        31.0       33.8       36.8       40.0       43.5       47.5
  A(I)            26.4       26.8       27.7       28.4       30.1
  V(I)            6.64       6.53       6.32       6.16       5.81

X STA.        47.5       52.0       56.6       61.5       66.6       83.4
  A(I)            31.5       31.6       32.4       32.8       53.7
  V(I)            5.56       5.54       5.41       5.33       3.26
```

```
        U.S. Geological Survey WSPRO Input File newf013.wsp
        Hydraulic analysis for structure NEWFVT00300013   Date: 29-JAN-97
        Bridge # 13 on VT 30 over Smith Brook in Newfane, VT  by MAI
           *** RUN DATE & TIME: 02-28-97  11:05

 XSID:CODE   SRDL    LEW     AREA   VHD    HF     EGL    CRWS       Q    WSEL
       SRD   FLEN    REW        K  ALPH    HO     ERR     FR#     VEL

EXITX:XS   ******     -8      250  1.52 *****  492.42  489.73    2460  490.89
       -53 ******     37    21405  1.01 ***** *******    0.74    9.84

FULLV:FV       54     -7      237  1.70  0.77  493.29 *******    2460  491.59
         0     54     36    19820  1.01  0.09    0.02    0.80   10.38
         <<<<<THE ABOVE RESULTS REFLECT "NORMAL" (UNCONSTRICTED) FLOW>>>>>

 ===135 CONVEYANCE RATIO OUTSIDE OF RECOMMENDED LIMITS.
                           "APPRO"     KRATIO =  2.50

APPRO:AS       95      0      460  0.46  0.59  493.88 *******    2460  493.41
        95     95     79    49492  1.04  0.00    0.00    0.40    5.35
         <<<<<THE ABOVE RESULTS REFLECT "NORMAL" (UNCONSTRICTED) FLOW>>>>>

            <<<<<RESULTS REFLECTING THE CONSTRICTED FLOW FOLLOW>>>>>

 XSID:CODE   SRDL    LEW     AREA   VHD    HF     EGL    CRWS       Q    WSEL
       SRD   FLEN    REW        K  ALPH    HO     ERR     FR#     VEL

BRIDG:BR       54      0      245  1.56  0.56  492.98  489.82    2460  491.42
         0     54     62    27389  1.00  0.00   -0.01    0.67   10.02

     TYPE PPCD FLOW      C    P/A    LSEL   BLEN   XLAB   XRAB
       1. ****   1.  1.000 ******  496.00 ****** ****** ******

    XSID:CODE     SRD   FLEN    HF   VHD     EGL     ERR       Q    WSEL
   RDWAY:RG      30.        <<<<<EMBANKMENT IS NOT OVERTOPPED>>>>>

 XSID:CODE   SRDL    LEW     AREA   VHD    HF     EGL    CRWS       Q    WSEL
       SRD   FLEN    REW        K  ALPH    HO     ERR     FR#     VEL

APPRO:AS       25      0      441  0.50  0.14  493.67  490.34    2460  493.17
        95     30     78    46473  1.03  0.56    0.02    0.42    5.58

       M(G)   M(K)       KQ   XLKQ   XRKQ    OTEL
      0.206  0.093   41983.    -4.    59.   492.99


  FIRST USER DEFINED TABLE.

    XSID:CODE     SRD     LEW     REW       Q        K     AREA     VEL    WSEL
   EXITX:XS      -54.     -9.     37.   2460.   21405.     250.    9.84  490.89
   FULLV:FV        0.     -8.     36.   2460.   19820.     237.   10.38  491.59
   BRIDG:BR        0.      0.     62.   2460.   27389.     245.   10.02  491.42
   RDWAY:RG       30.**************      0.******************     1.00********
   APPRO:AS       95.      0.     78.   2460.   46473.     441.    5.58  493.17

    XSID:CODE   XLKQ   XRKQ       KQ
   APPRO:AS      -4.    59.   41983.


 SECOND USER DEFINED TABLE.

    XSID:CODE     CRWS     FR#    YMIN    YMAX    HF    HO   VHD      EGL    WSEL
   EXITX:XS     489.73    0.74  482.71  504.34************  1.52  492.42  490.89
   FULLV:FV   ********    0.80  483.70  505.33  0.77  0.09  1.70  493.29  491.59
   BRIDG:BR     489.82    0.67  483.82  496.22  0.56  0.00  1.56  492.98  491.42
   RDWAY:RG   ****************  500.21  504.34**********************************
   APPRO:AS     490.34    0.42  484.80  504.68  0.14  0.56  0.50  493.67  493.17
```

```
        U.S. Geological Survey WSPRO Input File newf013.wsp
        Hydraulic analysis for structure NEWFVT00300013   Date: 29-JAN-97
        Bridge # 13 on VT 30 over Smith Brook in Newfane, VT  by MAI
           *** RUN DATE & TIME: 02-28-97  11:05

 XSID:CODE   SRDL    LEW     AREA   VHD    HF     EGL    CRWS       Q    WSEL
       SRD   FLEN    REW        K  ALPH    HO     ERR     FR#     VEL

EXITX:XS   ******    -22      321  1.95 *****  494.16  491.14    3500  492.21
       -53 ******     39    30433  1.05 ***** *******    0.87   10.91

 ===125 FR# EXCEEDS FNTEST AT SECID “FULLV”:  TRIALS CONTINUED.
             FNTEST,FR#,WSEL,CRWS =  0.80    0.92     492.87     492.13

 ===110 WSEL NOT FOUND AT SECID “FULLV”:  REDUCED DELTAY.
                  WSLIM1,WSLIM2,DELTAY =   491.71     505.33    0.50

 ===115 WSEL NOT FOUND AT SECID “FULLV”:  USED WSMIN = CRWS.
                  WSLIM1,WSLIM2,CRWS =   491.71     505.33     492.13

FULLV:FV       54    -18      301  2.19  0.78  495.06  492.13    3500  492.87
         0     54     38    27917  1.04  0.12    0.00    0.92   11.64
         <<<<<THE ABOVE RESULTS REFLECT “NORMAL” (UNCONSTRICTED) FLOW>>>>>

 ===135 CONVEYANCE RATIO OUTSIDE OF RECOMMENDED LIMITS.
                             “APPRO”     KRATIO =  2.62

APPRO:AS       95     -2      595  0.57  0.57  495.62 *******    3500  495.06
        95     95     83    73070  1.05  0.00    0.00    0.40    5.89
         <<<<<THE ABOVE RESULTS REFLECT “NORMAL” (UNCONSTRICTED) FLOW>>>>>

            <<<<<RESULTS REFLECTING THE CONSTRICTED FLOW FOLLOW>>>>>

 XSID:CODE   SRDL    LEW     AREA   VHD    HF     EGL    CRWS       Q    WSEL
       SRD   FLEN    REW        K  ALPH    HO     ERR     FR#     VEL

BRIDG:BR       54      0      282  2.40  0.65  494.83  491.23    3500  492.43
         0     54     62    33503  1.00  0.02   -0.01    0.78   12.43

     TYPE PPCD FLOW      C    P/A    LSEL   BLEN   XLAB   XRAB
       1. ****   1.  1.000 ******  496.00 ****** ****** ******

    XSID:CODE    SRD   FLEN    HF   VHD     EGL     ERR       Q    WSEL
   RDWAY:RG      30.        <<<<<EMBANKMENT IS NOT OVERTOPPED>>>>>

 XSID:CODE   SRDL    LEW     AREA   VHD    HF     EGL    CRWS       Q    WSEL
       SRD   FLEN    REW        K  ALPH    HO     ERR     FR#     VEL

APPRO:AS       25     -2      607  0.54  0.16  495.75  491.28    3500  495.20
        95     34     83    75413  1.05  0.76    0.01    0.39    5.76

       M(G)   M(K)       KQ   XLKQ   XRKQ    OTEL
      0.276  0.109   67047.    -2.    60.   495.07


  FIRST USER DEFINED TABLE.

    XSID:CODE    SRD    LEW    REW       Q        K     AREA     VEL    WSEL
   EXITX:XS     -54.   -23.    39.   3500.   30433.     321.   10.91  492.21
   FULLV:FV       0.   -19.    38.   3500.   27917.     301.   11.64  492.87
   BRIDG:BR       0.     0.    62.   3500.   33503.     282.   12.43  492.43
   RDWAY:RG      30.**************      0.*****************     1.00********
   APPRO:AS      95.    -3.    83.   3500.   75413.     607.    5.76  495.20

    XSID:CODE   XLKQ   XRKQ       KQ
   APPRO:AS      -2.    60.   67047.


 SECOND USER DEFINED TABLE.

    XSID:CODE    CRWS     FR#    YMIN    YMAX    HF    HO   VHD     EGL    WSEL
   EXITX:XS    491.14    0.87  482.71  504.34************  1.95  494.16  492.21
   FULLV:FV    492.13    0.92  483.70  505.33  0.78  0.12  2.19  495.06  492.87
   BRIDG:BR    491.23    0.78  483.82  496.22  0.65  0.02  2.40  494.83  492.43
   RDWAY:RG  ****************  500.21  504.34**********************************
   APPRO:AS    491.28    0.39  484.80  504.68  0.16  0.76  0.54  495.75  495.20
```

APPENDIX C:

BED-MATERIAL PARTICAL-SIZE DISTRIBUTION



Appendix C. Bed material particle-size distribution for a pebble count in the channel approach of structure NEWFVT00300013, in Newfane, Vermont.

APPENDIX D:

HISTORICAL DATA FORM

United States Geological Survey
Bridge Historical Data Collection and Processing Form

Structure Number NEWFVT00300013

General Location Descriptive

Data collected by *(First Initial, Full last name)* E. BOEHMLER

Date *(MM/DD/YY)* 03 / 30 / 95

Highway District Number *(I - 2; nn)* 02

County *(FIPS county code; I - 3; nnn)* 025

Town *(FIPS place code; I - 4; nnnnn)* 48400

Mile marker *(I - 11; nnn.nnn)* 002610

Waterway *(I - 6)* SMITH BROOK

Road Name *(I - 7):* -

Route Number VT030

Vicinity *(I - 9)* 5.2 MI S JCT. VT.35

Topographic Map Newfane

Hydrologic Unit Code: 01080107

Latitude *(I - 16; nnnn.n)* 42589

Longitude *(i - 17; nnnnn.n)* 72394

Select Federal Inventory Codes

FHWA Structure Number *(I - 8)* 20001500131312

Maintenance responsibility *(I - 21; nn)* 01

Maximum span length *(I - 48; nnnn)* 0066

Year built *(I - 27; YYYY)* 1945

Structure length *(I - 49; nnnnnn)* 000069

Average daily traffic, ADT *(I - 29; nnnnnn)* 005050

Deck Width *(I - 52; nn.n)* 325

Year of ADT *(I - 30; YY)* 92

Channel & Protection *(I - 61; n)* 8

Opening skew to Roadway *(I - 34; nn)* 53

Waterway adequacy *(I - 71; n)* 7

Operational status *(I - 41; X)* A

Underwater Inspection Frequency *(I - 92B; XYY)* N

Structure type *(I - 43; nnn)* 302

Year Reconstructed *(I - 106)* 0000

Approach span structure type *(I - 44; nnn)* 000

Clear span (*nnn.n ft*) 65.8

Number of spans *(I - 45; nnn)* 001

Vertical clearance from streambed (*nnn.n ft*) 011.0

Number of approach spans *(I - 46; nnnn)* 0000

Waterway of full opening (*nnn.n ft^2*) 390

Comments:

The structural inspection report of 10/28/93 indicates the structure is a steel stringer type bridge with a concrete deck and an asphalt roadway surface. The abutment walls and wingwalls are concrete. The tops of the concrete wingwalls and abutments reportedly have been patched with newer concrete, but still have some minor hairline cracks. There is a "laid-up" stone retaining wall reported extending upstream from the end of the upstream left wingwall. The abutment footings are reported as "not in view". The waterway proceeds nearly straight through the crossing. The streambed consists of coarse gravel, stones, and some boulders. The report notes that channel scour, bank erosion, point bar and debris accumulation problems are not evident at this site.

Bridge Hydrologic Data

Is there hydrologic data available? N *if No, type ctrl-n h* VTAOT Drainage area *(mi²)*: -

Terrain character: -

Stream character & type: -

Streambed material: -

Discharge Data *(cfs)*: $Q_{2.33}$ - Q_{10} - Q_{25} -

Q_{50} - Q_{100} - Q_{500} -

Record flood date *(MM / DD / YY)*: - / / Water surface elevation *(ft)*: -

Estimated Discharge *(cfs)*: - Velocity at Q - *(ft/s)*: -

Ice conditions *(Heavy, Moderate, Light)* : - Debris *(Heavy, Moderate, Light)*: -

The stage increases to maximum highwater elevation (*Rapidly, Not rapidly*): -

The stream response is (*Flashy, Not flashy*): -

Describe any significant site conditions upstream or downstream that may influence the stream's stage: -

Watershed storage area (*in percent*): - %

The watershed storage area is: - (*1-mainly at the headwaters; 2- uniformly distributed; 3-immediatly upstream oi the site*)

Water Surface Elevation Estimates for Existing Structure:

Peak discharge frequency	$Q_{2.33}$	Q_{10}	Q_{25}	Q_{50}	Q_{100}
Water surface elevation (*ft*)	-	-	-	-	-
Velocity (*ft / sec*)	-	-	-	-	-

Long term stream bed changes: -

Is the roadway overtopped below the Q_{100}? (*Yes, No, Unknown*): U Frequency: -

Relief Elevation (*ft*): - Discharge over roadway at Q_{100} (*ft³/ sec*): -

Are there other structures nearby? (*Yes, No, Unknown*): U *If No or Unknown, type ctrl-n os*

Upstream distance (*miles*): - Town: - Year Built: -

Highway No. : - Structure No. : - Structure Type: -

Clear span (*ft*): - Clear Height (*ft*): - Full Waterway (*ft²*): -

Downstream distance (*miles*): - Town: - Year Built: -
Highway No. : - Structure No. : - Structure Type: -
Clear span (*ft*): - Clear Height (*ft*): - Full Waterway (ft^2): -

Comments:

USGS Watershed Data

Watershed Hydrographic Data

Drainage area *(DA)* 9.38 mi^2 Lake and pond area 0 mi^2
Watershed storage *(ST)* 0 %
Bridge site elevation 532 ft Headwater elevation 1476 ft
Main channel length 3.23 mi
10% channel length elevation 551.2 ft 85% channel length elevation 1063 ft
Main channel slope *(S)* 211.16 ft / mi

Watershed Precipitation Data

Average site precipitation ______ in Average headwater precipitation ______ in

Maximum 2yr-24hr precipitation event *(I24,2)* ______ in

Average seasonal snowfall *(Sn)* ______ ft

Bridge Plan Data

Are plans available? Y *If no, type ctrl-n pl* Date issued for construction *(MM / YYYY)*: 04 / 1945

Project Number ST 39 M Minimum channel bed elevation: 235.3

Low superstructure elevation: USLAB 246.55 DSLAB 246.38 USRAB 246.23 DSRAB 246.06

Benchmark location description:

BM#19, [spike in root or trunk of] an 18 inch locust tree, located about 30 feet left-bankward from the left abutment on the downstream side of the roadway, no elevation.

Reference Point (*MSL, Arbitrary, Other*): Arbitrary Datum (*NAD27, NAD83, Other*): Arbitrary

Foundation Type: 1 (*1-Spreadfooting; 2-Pile; 3- Gravity; 4-Unknown*)

If 1: Footing Thickness 2.5 Footing bottom elevation: 230.*

If 2: Pile Type: ____ (*1-Wood; 2-Steel or metal; 3-Concrete*) Approximate pile driven length: _______

If 3: Footing bottom elevation: ______

Is boring information available? N *If no, type ctrl-n bi* Number of borings taken: -

Foundation Material Type: 3 (*1-regolith, 2-bedrock, 3-unknown*)

Briefly describe material at foundation bottom elevation or around piles:

-

Comments:

***Footing bottom elevation left: 230.96 and right: 230.47. Other points shown on the plans with elevations are: 1) the point on the top streamward edge of the concrete upstream left wingwall where the concrete slope of the wingwall changes from horizontal to downward, elevation 250.96; and 2) the point at the same location as in (1) but on the upstream right wingwall, elevation 250.64.**

Cross-sectional Data

Is cross-sectional data available? **Y** *If no, type ctrl-n xs*

Source (*FEMA, VTAOT, Other*)? **VTAOT**

Comments: **There are several cross sections that are printed and kept with the plans, and may be retrieved when needed. There are no reproducible bridge face cross sections.**

Station											
Feature											
Low cord elevation											
Bed elevation											
Low cord to bed length											

Station											
Feature											
Low cord elevation											
Bed elevation											
Low cord to bed length											

Source (*FEMA, VTAOT, Other*)? __________

Comments:

Station											
Feature											
Low cord elevation											
Bed elevation											
Low cord to bed length											

Station											
Feature											
Low cord elevation											
Bed elevation											
Low cord to bed length											

APPENDIX E:

LEVEL I DATA FORM

U. S. Geological Survey
Bridge Field Data Collection and Processing Form

Qa/Qc Check by: EW Date: 11/1/96
Computerized by: EW Date: 11/4/96
Reviewd by: MAI Date: 03/12/97

Structure Number NEWFVT00300013

A. General Location Descriptive

1. Data collected by *(First Initial, Full last name)* L. MEDALIE Date *(MM/DD/YY)* 08 / 20 / 1996
2. Highway District Number 02 Mile marker 002610
County WINDHAM (025) Town NEWFANE (48400)
Waterway *(I - 6)* SMITH BROOK Road Name -
Route Number VT 30 Hydrologic Unit Code: 01080107
3. Descriptive comments:

Located 5.2 miles south of the junction with VT 35.
COMMENT: A nearby resident informed a crew member there used to be a covered bridge at this site just upstream of the current bridge. It was replaced, not washed out. The resident has lived near the site since 1940.

B. Bridge Deck Observations

4. Surface cover... LBUS 4 RBUS 6 LBDS 4 RBDS 4 Overall 4
*(2b us,ds,lb,rb: **1**- Urban; **2**- Suburban; **3**- Row crops; **4**- Pasture; **5**- Shrub- and brushland; **6**- Forest; **7**- Wetland)*
5. Ambient water surface... US 2 UB 2 DS 2 *(**1**- pool; **2**- riffle)*
6. Bridge structure type 1 *(**1**- single span; **2**- multiple span; **3**- single arch; **4**- multiple arch; **5**- cylindrical culvert; **6**- box culvert; or **7**- other)*
7. Bridge length 69 *(feet)* Span length 66 *(feet)* Bridge width 32.5 *(feet)*

Road approach to bridge:

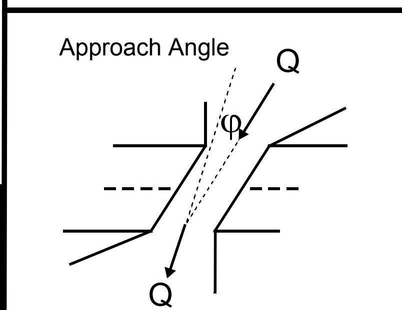
8. LB 0 RB 2 *(**0** even, **1**- lower, **2**- higher)*
9. LB 1 RB 1 *(**1**- Paved, **2**- Not paved)*
10. Embankment slope (*run / rise in feet / foot*):
US left 0.0:1 US right 0.0:1

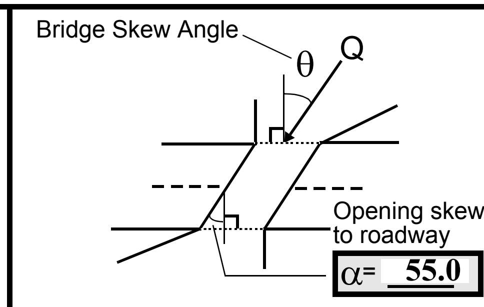
	Protection		13.Erosion	14.Severity
	11.Type	12.Cond.		
LBUS	0	-	2	1
RBUS	0	-	2	1
RBDS	0	-	2	1
LBDS	1	1	0	-

*Bank protection types: **0**- none; **1**- < 12 inches; **2**- < 36 inches; **3**- < 48 inches; **4**- < 60 inches; **5**- wall / artificial levee*
*Bank protection conditions: **1**- good; **2**- slumped; **3**- eroded; **4**- failed*
*Erosion: **0** - none; **1**- channel erosion; **2**- road wash; **3**- both; **4**- other*
*Erosion Severity: **0** - none; **1**- slight; **2**- moderate; **3**- severe*

Channel approach to bridge (BF):

15. Angle of approach: 0 16. Bridge skew: 45





17. Channel impact zone 1: Exist? Y *(Y or N)*
Where? LB *(LB, RB)* Severity 3
Range? 140 feet US *(US, UB, DS)* to 120 feet US
Channel impact zone 2: Exist? Y *(Y or N)*
Where? RB *(LB, RB)* Severity 1
Range? 50 feet US *(US, UB, DS)* to 5 feet UB

*Impact Severity: **0**- none to very slight; **1**- Slight; **2**- Moderate; **3**- Severe*

18. Bridge Type: **1a**

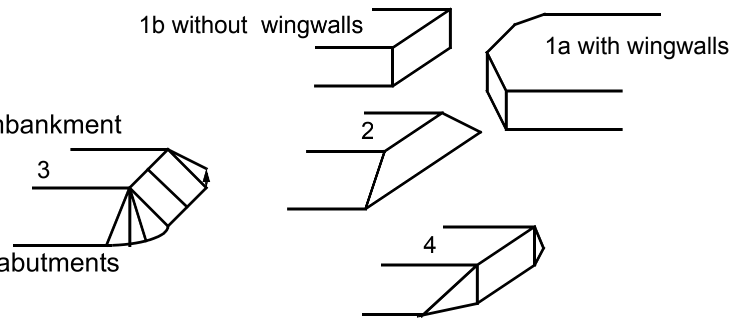
1a- Vertical abutments with wingwalls

1b- Vertical abutments without wingwalls

2- Vertical abutments and wingwalls, sloping embankment
Wingwalls perpendicular to abut. face

3- Spill through abutments

4- Sloping embankment, vertical wingwalls and abutments
Wingwall angle less than 90°.



19. Bridge Deck Comments (surface cover variations, measured bridge and span lengths, bridge type variations, approach overflow width, etc.)

4: The left bank US has a few houses with lawns, shrubs, and trees. The right bank US also has houses with lawns, though the surface cover is predominately forest. The right bank DS surface cover is trees, house, some shrubs, with VT 30 on the flood plain. The left bank DS has shrubs, trees, lawn and a house.
7: The measured bridge length = 66 feet; span = 64 feet; deck width = 29 feet (measured between the inside of the curbs and perpendicular to traffic flow); and the deck width = 31.6 feet including each side curb.
8: The left bank road approach is even for about 60 feet to the left, then it is lower.
11: The protection on the left bank DS is 2.2 feet of asphalt which has been placed from along the bankward edge of the wingwall to 12 feet down the VT 30 road embankment.
17: The impact zone on the right bank upstream extends to 5 feet UB measured from the upstream bridge face.
18: The bridge type is 1a, but the USRWW, DSLWW and DSRWW ends drop below the low steel of the bridge.

C. Upstream Channel Assessment

20. SRD	21. Bank height (BF) LB	21. Bank height (BF) RB	22. Bank angle (BF) LB	22. Bank angle (BF) RB	26. % Veg. cover (BF) LB	26. % Veg. cover (BF) RB	27. Bank material (BF) LB	27. Bank material (BF) RB	28. Bank erosion (BF) LB	28. Bank erosion (BF) RB
58.0	**7.5**			**3.0**	**2**	**3**	**7**	**2**	**2**	**0**

23. Bank width **55.0** 24. Channel width **10.0** 25. Thalweg depth **47.5** 29. Bed Material **543**

30 .Bank protection type: LB **5, 2** RB **1** 31. Bank protection condition: LB **1, 2** RB **1**

SRD - Section ref. dist. to US face *% Vegetation (Veg) cover: **1**- 0 to 25%; **2**- 26 to 50%; **3**- 51 to 75%; **4**- 76 to 100%*
*Bed and bank Material: **0**- organics; **1**- silt / clay, < 1/16mm; **2**- sand, 1/16 - 2mm; **3**- gravel, 2 - 64mm; **4**- cobble, 64 - 256mm; **5**- boulder, > 256mm; **6**- bedrock; **7**- manmade*
*Bank Erosion: **0**- not evident; **1**- light fluvial; **2**- moderate fluvial; **3**- heavy fluvial / mass wasting*
*Bank protection types: **0**- absent; **1**- < 12 inches; **2**- < 36 inches; **3**- < 48 inches; **4**- < 60 inches; **5**- wall / artificial levee*
*Bank protection conditions: **1**- good; **2**- slumped; **3**- eroded; **4**- failed*

32. Comments (bank material variation, minor inflows, protection extent, etc.):

26: The right bank tree cover is shrubs from bridge face to 60 feet upstream and then type 3 upstream. The left bank surface cover is type 2 from the bridge face to 95 feet upstream. There is no surface cover from 95 feet to 130 feet upstream, but for 100 feet beyond there are shrubs are along the left bank.

There is a stone wall which is parallel to the right bank, about 60 feet away from the top of the right bank. It extends from 44 feet upstream to 88 feet upstream, refer to the plan view sketch. The right bank protection extends from bridge face to 50 feet upstream. It is mostly type 1 protection with some type 2 protection. Along the left bank, a stone wall extends from the end of the wingwall at 40 feet upstream to 72 feet upstream. This is probably the abutment of the covered bridge that was at this site. From 72 feet upstream to 116 feet upstream, there are some boulders that are in the channel. From 116 feet upstream to 140 feet upstream, protection is mostly type 1, though there are some slightly larger stones. A local resident said this protection has slumped on the bank.

33. Point/Side bar present? **Y** (Y or N. if N type ctrl-n pb) 34. Mid-bar distance: **134** 35. Mid-bar width: **24**

36. Point bar extent: **250** feet **US** (US, UB) to **54** feet **US** (US, UB, DS) positioned **25** %LB to **100** %RB

37. Material: **34**

38. Point or side bar comments (Circle Point or Side; Note additional bars, material variation, status, etc.):

Some areas of grass exist on the point bar. The grass is mostly upstream and towards the right bank. A side bar extends from 50 feet upstream to 5 feet downstream. The mid-bar distance is measured at the upstream bridge face where it is 16 feet wide. The bar is positioned 0% LB to 45% RB.

39. Is a cut-bank present? **Y** (Y or if N type ctrl-n cb) 40. Where? **LB** (LB or RB)

41. Mid-bank distance: **118** 42. Cut bank extent: **170** feet **US** (US, UB) to **70** feet **US** (US, UB, DS)

43. Bank damage: **2** (**1**- eroded and/or creep; **2**- slip failure; **3**- block failure)

44. Cut bank comments (eg. additional cut banks, protection condition, etc.):

45. Is channel scour present? **N** (Y or if N type ctrl-n cs) 46. Mid-scour distance: **-**

47. Scour dimensions: Length **-** Width **-** Depth : **-** Position **-** %LB to **-** %RB

48. Scour comments (eg. additional scour areas, local scouring process, etc.):

NO CHANNEL SCOUR

49. Are there major confluences? **N** (Y or if N type ctrl-n mc) 50. How many? **-**

51. Confluence 1: Distance **-** 52. Enters on **-** (LB or RB) 53. Type **-** (**1**- perennial; **2**- ephemeral)

Confluence 2: Distance **-** Enters on **-** (LB or RB) Type **-** (**1**- perennial; **2**- ephemeral)

54. Confluence comments (eg. confluence name):

A minor ephemeral confluence enters on the left bank 140 feet upstream.

D. Under Bridge Channel Assessment

55. Channel restraint (BF)? LB **2** RB ____ (**1**- natural bank; **2**- abutment; **3**- artificial levee)

56. Height (BF) LB	56. Height (BF) RB	57 Angle (BF) LB	57 Angle (BF) RB	61. Material (BF) LB	61. Material (BF) RB	62. Erosion (BF) LB	62. Erosion (BF) RB
23.5		**0.5**		**2**	**7**	**7**	**-**

58. Bank width (BF) **-** 59. Channel width (Amb) **-** 60. Thalweg depth (Amb) **90.0** 63. Bed Material **-**

*Bed and bank Material: **0**- organics; **1**- silt / clay, < 1/16mm; **2**- sand, 1/16 - 2mm; **3**- gravel, 2 - 64mm; **4**- cobble, 64 - 256mm; **5**- boulder, > 256mm; **6**- bedrock; **7**- manmade*

*Bank Erosion: **0**- not evident; **1**- light fluvial; **2**- moderate fluvial; **3**- heavy fluvial / mass wasting*

64. Comments (bank material variation, minor inflows, protection extent, etc.):

345

65. <u>Debris and Ice</u> Is there debris accumulation? ____ *(Y or N)* 66. Where? **Y** ____ *(1- Upstream; 2- At bridge; 3- Both)*

67. Debris Potential **1** ____ *(1- Low; 2- Moderate; 3- High)* 68. Capture Efficiency **1** ____ *(1- Low; 2- Moderate; 3- High)*

69. Is there evidence of ice build-up? **1** ___ *(Y or N)* Ice Blockage Potential **N** ____ *(1- Low; 2- Moderate; 3- High)*

70. Debris and Ice Comments:

1

A tree has fallen from the left bank down across the channel 255 feet upstream. There are also some trees leaning into the channel and minor debris along the banks (small branches).

<u>Abutments</u>	71. Attack ∠(BF)	72. Slope ∠ (Qmax)	73. Toe loc. (BF)	74. Scour Condition	75. Scour depth	76. Exposure depth	77. Material	78. Length
LABUT		**0**	**90**	**2**	**0**	**-**	**-**	**90.0**
RABUT	**1**	**0**	**90**			**2**	**0**	**35.5**

Pushed: LB or RB *Toe Location (Loc.): 0- even, 1- set back, 2- protrudes*
Scour cond.: 0- not evident; 1- evident (comment); 2- footing exposed; 3-undermined footing; 4- piling exposed; 5- settled; 6- failed
Materials: *1*- Concrete; *2*- Stone masonry or drywall; *3*- steel or metal; *4*- wood

79. Abutment comments (eg. undermined penetration, unusual scour processes, debris, etc.):

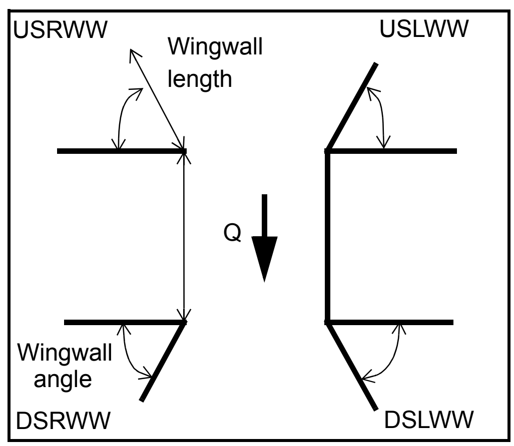
-

-

1

80. <u>Wingwalls</u>:

	Exist?	Material?	Scour Condition?	Scour depth?	Exposure depth?	81. Angle?	Length?
USLWW:						**35.5**	
USRWW:	**Y**		**1**		**0**	**0.5**	
DSLWW:	**-**		**-**		**Y**	**59.5**	
DSRWW:	**1**		**0**		**-**	**59.5**	



Wingwall materials: 1- Concrete; 2- Stone masonry or drywall; 3- steel or metal; 4- wood

82. <u>Bank / Bridge Protection</u>:

Location	USLWW	USRWW	LABUT	RABUT	LB	RB	DSLWW	DSRWW
Type	**-**	**0**	**Y**	**-**	**1**	**1**	**-**	**-**
Condition	**Y**	**-**	**1**	**-**	**2**	**4**	**-**	**-**
Extent	**1**	**-**	**0**	**5**	**1**	**0**	**0**	**-**

Bank / Bridge protection types: 0- absent; 1- < 12 inches; 2- < 36 inches; 3- < 48 inches; 4- < 60 inches; 5- wall / artificial levee

Bank / Bridge protection conditions: 1- good; 2- slumped; 3- eroded; 4- failed

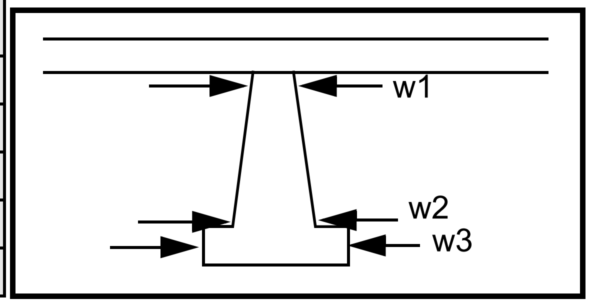
Protection extent: 1- entire base length; 2- US end; 3- DS end; 4- other

83. Wingwall and protection comments (eg. undermined penetration, unusual scour processes, etc.):
-
-
-
-
-
0
-
-
0
-
-

Piers:

84. Are there piers? **82:** (Y or if N type ctrl-n pr)

85. Pier no.	width (w) feet			elevation (e) feet		
	w1	w2	w3	e@w1	e@w2	e@w3
Pier 1		9.5		35.0	130.0	20.0
Pier 2				130.0	13.0	20.0
Pier 3		-	-	23.5	-	-
Pier 4	-	-	-	-	-	-



Level 1 Pier Descr.	1	2	3	4	
86. Location (BF)	A	WW,	begi	nds	LFP, LTB, LB, MCL, MCM, MCR, RB, RTB, RFP
87. Type	stone	as	ns at	as	**1**- Solid pier, **2**- column, **3**- bent
88. Material	wall	desc	4	desc	**1**- Wood; **2**- concrete; **3**- metal; **4**- stone
89. Shape	exte	ribe	feet	ribe	**1**- Round; **2**- Square; **3**- Pointed
90. Inclined?	nds	d in	upst	d in	Y- yes; N- no
91. Attack ∠ (BF)	from	#32.	ream	#32.	
92. Pushed	the	The	of	In	LB or RB
93. Length (feet)	-	-	-	-	
94. # of piles	upst	USR	brid	addi-	
95. Cross-members	ream	WW	ge	tion,	**0**- none; **1**- laterals; **2**- diagonals; **3**- both
96. Scour Condition	end	pro-	face	there	**0**- not evident; **1**- evident (comment); **2**- footing exposed; **3**- piling exposed; **4**- undermined footing; **5**- settled; **6**- failed
97. Scour depth	of	tec-	and	are a	
98. Exposure depth	USL	tion	exte	few	

99. Pier comments (eg. undermined penetration, protection and protection extent, unusual scour processes, etc.):

"laid-up" stones at the end of the wingwall.

The DSRWW has no protection except for a large boulder (48 inches) approximately in the center of wing-wall base.

N

E. Downstream Channel Assessment

100.

SRD	Bank height (BF) LB	Bank height (BF) RB	Bank angle (BF) LB	Bank angle (BF) RB	% Veg. cover (BF) LB	% Veg. cover (BF) RB	Bank material (BF) LB	Bank material (BF) RB	Bank erosion (BF) LB	Bank erosion (BF) RB
-	-			-	-	-	-	-	-	-

Bank width (BF) -_____ Channel width (Amb) -_____ Thalweg depth (Amb) -_____ Bed Material -_____

Bank protection type (Qmax): LB -_____ RB -_____ Bank protection condition: LB -_____ RB -_____

*SRD - Section ref. dist. to US face % Vegetation (Veg) cover: **1**- 0 to 25%; **2**- 26 to 50%; **3**- 51 to 75%; **4**- 76 to 100%*
*Bed and bank Material: **0**- organics; **1**- silt / clay, < 1/16mm; **2**- sand, 1/16 - 2mm; **3**- gravel, 2 - 64mm; **4**- cobble, 64 - 256mm; **5**- boulder, > 256mm; **6**- bedrock; **7**- manmade*
*Bank Erosion: **0**- not evident; **1**- light fluvial; **2**- moderate fluvial; **3**- heavy fluvial / mass wasting*
*Bank protection types: **0**- absent; **1**- < 12 inches; **2**- < 36 inches; **3**- < 48 inches; **4**- < 60 inches; **5**- wall / artificial levee*
*Bank protection conditions: **1**- good; **2**- slumped; **3**- eroded; **4**- failed*

Comments (eg. bank material variation, minor inflows, protection extent, etc.):
-
-
-
-
-
-
-
-
-
-
-
-
-
-
-

101. Is a drop structure present? -___ *(Y or N, if N type ctrl-n ds)* 102. Distance: -_____ feet

103. Drop: -_____ feet 104. Structure material: -____ *(**1**- steel sheet pile; **2**- wood pile; **3**- concrete; **4**- other)*

105. Drop structure comments (eg. downstream scour depth):
-
-
-
-
-
-

106. Point/Side bar present? - (Y or N. if N type ctrl-n pb) Mid-bar distance: - Mid-bar width: -

Point bar extent: - feet - (US, UB, DS) to - feet - (US, UB, DS) positioned - %LB to - %RB

Material: -

Point or side bar comments (Circle Point or Side; note additional bars, material variation, status, etc.):

-
-
-
-

Is a cut-bank present? N (Y or if N type ctrl-n cb) Where? O (LB or RB) Mid-bank distance: PIE

Cut bank extent: RS feet ____ (US, UB, DS) to ____ feet ____ (US, UB, DS)

Bank damage: ____ (*1*- eroded and/or creep; *2*- slip failure; *3*- block failure)

Cut bank comments (eg. additional cut banks, protection condition, etc.):

Is channel scour present? ____ (Y or if N type ctrl-n cs) Mid-scour distance: 4

Scour dimensions: Length 3 Width 45 Depth: 34 Positioned 1 %LB to 2 %RB

Scour comments (eg. additional scour areas, local scouring process, etc.):

43
0
0
-

Are there major confluences? - (Y or if N type ctrl-n mc) How many? Left

Confluence 1: Distance bank Enters on has (LB or RB) Type dens (*1*- perennial; *2*- ephemeral)

Confluence 2: Distance e Enters on veg- (LB or RB) Type eta- (*1*- perennial; *2*- ephemeral)

Confluence comments (eg. confluence name):

tion coverage from bridge face to 54 feet downstream and less than 25% vegetation coverage beyond.

F. Geomorphic Channel Assessment

107. Stage of reach evolution Th

1- Constructed
2- Stable
3- Aggraded
4- Degraded
5- Laterally unstable
6- Vertically and laterally unstable

108. Evolution comments *(Channel evolution not considering bridge effects; See HEC-20, Figure 1 for geomorphic descriptors)*:

ere is left bank protection from 68 feet downstream to 136 feet downstream. The nearly vertical left bank downstream of the protection contains remnants of a stone wall for 220 feet.

N

109. G. Plan View Sketch

- -

point bar (pb)	debris	flow (Q)	stone wall
cut-bank (cb)	rip rap or stone fill	cross-section	other wall
scour hole		ambient channel	

APPENDIX F:

SCOUR COMPUTATIONS

SCOUR COMPUTATIONS

Structure Number: NEWFVT00300013 Town: Newfane
Road Number: VT 30 County: Windham
Stream: Smith Brook

Initials MAI Date: 02/24/97 Checked:

Analysis of contraction scour, live-bed or clear water?

Critical Velocity of Bed Material (converted to English units)
Vc=11.21*y1^0.1667*D50^0.33 with Ss=2.65
(Richardson and others, 1995, p. 28, eq. 16)

Approach Section

Characteristic	100 yr	500 yr	other Q
Total discharge, cfs	2460	3500	0
Main Channel Area, ft2	418	554	0
Left overbank area, ft2	0	2	0
Right overbank area, ft2	23	51	0
Top width main channel, ft	67	67	0
Top width L overbank, ft	0	3	0
Top width R overbank, ft	11	16	0
D50 of channel, ft	0.261	0.261	0
D50 left overbank, ft	--	--	--
D50 right overbank, ft	--	--	--
y1, average depth, MC, ft	6.2	8.3	ERR
y1, average depth, LOB, ft	ERR	0.7	ERR
y1, average depth, ROB, ft	2.1	3.2	ERR
Total conveyance, approach	46454	75340	0
Conveyance, main channel	45236	71791	0
Conveyance, LOB	0	54	0
Conveyance, ROB	1218	3495	0
Percent discrepancy, conveyance	0.0000	0.0000	ERR
Qm, discharge, MC, cfs	2395.5	3335.1	ERR
Ql, discharge, LOB, cfs	0.0	2.5	ERR
Qr, discharge, ROB, cfs	64.5	162.4	ERR
Vm, mean velocity MC, ft/s	5.7	6.0	ERR
Vl, mean velocity, LOB, ft/s	ERR	1.3	ERR
Vr, mean velocity, ROB, ft/s	2.8	3.2	ERR
Vc-m, crit. velocity, MC, ft/s	9.7	10.2	N/A
Vc-l, crit. velocity, LOB, ft/s	ERR	ERR	ERR
Vc-r, crit. velocity, ROB, ft/s	ERR	ERR	ERR

Results

Live-bed(1) or Clear-Water(0) Contraction Scour?

	100 yr	500 yr	other Q
Main Channel	0	0	N/A

Clear Water Contraction Scour in MAIN CHANNEL

y2 = (Q2^2/(131*Dm^(2/3)*W2^2))^(3/7)   Converted to English Units
ys=y2-y_bridge
(Richardson and others, 1995, p. 32, eq. 20, 20a)

Approach Section	Q100	Q500	Qother
Main channel Area, ft2	418	554	0
Main channel width, ft	67	67	0
y1, main channel depth, ft	6.24	8.27	ERR

Bridge Section			
(Q) total discharge, cfs	2460	3500	0
(Q) discharge thru bridge, cfs	2460	3500	0
Main channel conveyance	27418	33511	0
Total conveyance	27418	33511	0
Q2, bridge MC discharge,cfs	2460	3500	ERR
Main channel area, ft2	246	282	0
Main channel width (skewed), ft	35.7	35.7	0.0
Cum. width of piers in MC, ft	0.0	0.0	0.0
W, adjusted width, ft	35.7	35.7	0
y_bridge (avg. depth at br.), ft	6.88	7.89	ERR
Dm, median (1.25*D50), ft	0.32625	0.32625	0
y2, depth in contraction,ft	6.42	8.68	ERR
ys, scour depth (y2-ybridge), ft	-0.46	0.79	N/A

ARMORING			
D90	0.982	0.982	0
D95	1.384	1.384	0
Critical grain size,Dc, ft	0.5112	0.7402	ERR
Decimal-percent coarser than Dc	0.212	0.1411	0
Depth to armoring,ft	5.70	13.52	ERR

Abutment Scour

Froehlich's Abutment Scour
Ys/Y1 = 2.27*K1*K2*(a'/Y1)^0.43*Fr1^0.61+1
(Richardson and others, 1995, p. 48, eq. 28)

Characteristic	Left Abutment 100 yr Q	500 yr Q	Other Q	Right Abutment 100 yr Q	500 yr Q	Other Q
(Qt), total discharge, cfs	2460	3500	0	2460	3500	0
a', abut.length blocking flow, ft	12.8	16.7	0	29.1	34.4	0
Ae, area of blocked flow ft2	76.1	105.2	0	107.3	171.5	0
Qe, discharge blocked abut.,cfs	364.4	512.9	0	471.5	816.7	0
(If using Qtotal_overbank to obtain Ve, leave Qe blank and enter Ve and Fr manually)						
Ve, (Qe/Ae), ft/s	4.79	4.88	ERR	4.39	4.76	ERR
ya, depth of f/p flow, ft	5.95	6.30	ERR	3.69	4.99	ERR
--Coeff., K1, for abut. type (1.0, verti.; 0.82, verti. w/ wingwall; 0.55, spillthru)						
K1	1	1	1	1	1	1
--Angle (theta) of embankment (<90 if abut. points DS; >90 if abut. points US)						
theta	135	135	135	45	45	45
K2	1.05	1.05	1.05	0.91	0.91	0.91
Fr, froude number f/p flow	0.346	0.342	ERR	0.403	0.376	ERR
ys, scour depth, ft	16.30	18.22	N/A	14.37	18.05	N/A

HIRE equation (a'/ya > 25)
ys = 4*Fr^0.33*y1*K/0.55
(Richardson and others, 1995, p. 49, eq. 29)

a'(abut length blocked, ft)	12.8	16.7	0	29.1	34.4	0
y1 (depth f/p flow, ft)	5.95	6.30	ERR	3.69	4.99	ERR
a'/y1	2.15	2.65	ERR	7.89	6.90	ERR
Skew correction (p. 49, fig. 16)	1.10	1.10	1.10	0.80	0.80	0.80
Froude no. f/p flow	0.35	0.34	N/A	0.40	0.38	N/A
Ys w/ corr. factor K1/0.55:						
vertical	ERR	ERR	ERR	ERR	ERR	ERR
vertical w/ ww's	ERR	ERR	ERR	ERR	ERR	ERR
spill-through	ERR	ERR	ERR	ERR	ERR	ERR

Abutment riprap Sizing

Isbash Relationship
D50=y*K*Fr^2/(Ss-1) and D50=y*K*(Fr^2)^0.14/(Ss-1)
(Richardson and others, 1995, p112, eq. 81,82)

Characteristic	Q100	Q500	Qother			
Fr, Froude Number	0.67	0.78	0	0.67	0.78	0
(Fr from the characteristic V and y in contracted section--mc, bridge section)						
y, depth of flow in bridge, ft	6.88	7.89	0.00	6.88	7.89	0.00
Median Stone Diameter for riprap at: left abutment				right abutment, ft		
Fr<=0.8 (vertical abut.)	1.91	2.97	0.00	1.91	2.97	0.00