LEVEL II SCOUR ANALYSIS FOR BRIDGE 8 (HANCTH00020008) on TOWN HIGHWAY 2, crossing HANCOCK BRANCH WHITE RIVER, HANCOCK, VERMONT

U.S. Geological Survey
Open-File Report 96-235

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

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By ERICK M. BOEHMLER

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Pembroke, New Hampshire

1996

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

U.S. GEOLOGICAL SURVEY
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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 8 (HANCTH00020008) ON TOWN HIGHWAY 2, CROSSING HANCOCK BRANCH WHITE RIVER, HANCOCK, VERMONT

***By* Erick M. Boehmler**

INTRODUCTION

This report provides the results of a detailed Level II analysis of scour potential at structure HANCTH00020008 on town highway 2 crossing the Hancock Branch White River, Hancock, 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). A Level I study is included in Appendix E of this report. A Level I study provides a qualitative geomorphic characterization of the study site. Information on the bridge, gleaned from VTAOT files, was compiled prior to conducting Level I and Level II analyses and can be found in Appendix D.

The site is in the Green Mountain physiographic province of central Vermont in the town of Hancock. The 8.4-mi^2 drainage area is predominantly rural and forested. In the vicinity of this site, the banks have dense woody vegetation coverage.

In the study area, the Hancock Branch White River is an incised, sinuous channel with a slope of approximately 0.038 ft/ft, an average channel top width of 47.0 ft and an average channel depth of 3.0 ft. The predominant channel bed material is cobble (D_{50} is 102 mm or 0.336 ft). The geomorphic assessment at the time of the Level I and Level II site visit on November 16, 1994, indicated that the reach was stable.

The town highway 2 crossing of the Hancock Branch White River is a 33-ft-long, two-lane bridge consisting of one 30-foot steel-beam span with a concrete deck (Vermont Agency of Transportation, written commun., August 26, 1994). The bridge is supported by steep sloping, cement-grouted, cobble-stone abutments with wingwalls. The channel is skewed approximately ten degrees to the opening while the opening-skew-to-roadway is zero degrees.

A scour hole 1.5 ft deeper than the mean thalweg depth was observed along the upstream left wingwall and left abutment during the Level I assessment. The only scour protection measure at the site was type-2 stone fill (less than 36 inches diameter) at the upstream end of the upstream left wingwall. Additional details describing conditions at the site are included in the Level II Summary and Appendices D and E.

Scour depths and rock rip-rap sizes were computed using the general guidelines described in Hydraulic Engineering Circular 18 (Richardson and others, 1993).
Total scour at a highway crossing is comprised of three components: 1) long-term aggradation or degradation; 2) contraction scour (due to reduction in flow area caused by 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 scour depths for contraction and local scour and a summary of the results follows.

Contraction scour for all modelled flows ranged from 0.6 ft to 1.3 ft and the worst-case contraction scour occurred at the 500-year discharge. Abutment scour ranged from 9.4 ft to 15.2 ft and the worst-case abutment scour occurred at the 500-year discharge. Scour depths and depths to armoring are summarized on p. 14 in the section titled “Scour Results”. Scour elevations, based on the calculated depths are presented in tables 1 and 2; a graph of the scour elevations is presented in figure 8 Scour depths were calculated assuming an infinite depth of erosive material and a homogeneous particle-size distribution.

For all scour presented in this report, “the scour depths adopted [by VTAOT] may differ from the equation values based on engineering judgement” (Richardson and others, 1993, p. 21, 27). It is generally accepted that the Froehlich equation (abutment scour) gives “excessively conservative estimates of scour depths” (Richardson and others, 1993, p. 48). Many factors, including historical performance during flood events, the geomorphic assessment, and the results of the hydraulic analyses, must be considered to properly assess the validity of abutment scour results.

Bread Loaf, VT 1:24000; Contour Interval 20 feet
Aerial Photographs, 1962; Field checked, 1970.

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 HANCTH00020008 ***Stream*** Hancock Branch White River

County Windsor ***Road*** TH002 ***District*** 04

Description of Bridge

Bridge length 33 ***ft*** ***Bridge width*** 15.0 ***ft*** ***Max span length*** 30 ***ft***

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

Abutment type Nearly vertical ***Embankment type*** Sloping

Stone fill on abutment? No ***Date of inspection*** 11/16/94

Description of stone fill Type-2 at the upstream end of the upstream left wingwall in good condition.

Brief description of piers/abutments Abutments and wingwalls are steeply sloped, cement-grouted, cobble-stone walls. There is a one and a half foot scour hole at the upstream end of the left abutment and the upstream left wingwall.

Is bridge skewed to flood flow according to Y ***survey?*** Y ***Angle*** 10

Is bridge located on a bend in channel? If so, describe (mild, moderate, severe) There is a mild channel bend in the upstream reach. The scour hole has developed in the location where the bend impacts the upstream left wingwall and left abutment.

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	11/16/94	0	0
Level II	11/16/94	--	--

Potential for debris Moderate. There is some scattered debris caught on boulders and trees leaning over the channel upstream.

Describe any features near or at the bridge that may affect flow (include observation date) The left abutment significantly protrudes into the channel at the upstream face, which has resulted in a significant scour hole as of 11/16/94.

Description of the Geomorphic Setting

General topography The channel is located within a 150 foot-wide, steep, V-shaped valley with steep valley walls on both sides and little or no flood plains.

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

Date of inspection 11/16/94

DS left: Steep channel bank to steep valley wall

DS right: Moderately sloped bank to narrow, irregular terrace to steep valley wall.

US left: Steep bank to narrow, irregular terrace, to steep valley wall.

US right: Moderately sloped bank to narrow, irregular terrace to steep valley wall.

Description of the Channel

Average top width 47.0 *ft* ***Average depth*** 3.0 *ft*

Predominant bed material Cobbles ***Bank material*** Cobbles/Boulders

Sinuous but stable with non-alluvial channel boundaries and little or no flood plain.

11/08/95

Vegetative co[ver] Trees.

DS left: Trees.

DS right: Trees.

US left: Trees.

US right:

Do banks appear stable? Y ***If not, describe location and type of instability and date of observation.***

The assessment of 11/16/94 noted flow is significantly redirected by the protrusion of the left abutment into the channel and has resulted in a scour hole localized at the upstream end of the left abutment and around its corner with the upstream left wingwall.

Describe any obstructions in channel and date of observation.

Hydrology

Drainage area 8.4 ***mi²***

Percentage of drainage area in physiographic provinces: (approximate)

Physiographic province	***Percent of drainage area***
Green Mountain	100

Is drainage area considered rural or urban? Rural ***Describe any significant urbanization***: None.

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

USGS gage description

USGS gage number

Gage drainage area ***mi²***

Is there a lake/ No

Calculated Discharges

Q100 1,850 ***ft³/s*** ***Q500*** 2,800 ***ft³/s***

The 100- and 500-year discharges were selected based on a range of results from several empirical methods applicable to a watershed of this size in this region (Potter, 1957a&b; Johnson and Tasker, 1974; FHWA, 1983; Talbot, 1887; FEMA, 1980).

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 None

Description of reference marks used to determine USGS datum. RM1 is a chiseled square on top of the concrete US end of the left abutment (elev. 101.18 ft, arbitrary datum). RM2 is a chiseled square on top of the concrete at DS end of the right abutment (elev. 101.14 ft, arbitrary datum).

Cross-Sections Used in WSPRO Analysis

[1]Cross-section	*Section Reference Distance (SRD) in feet*	*[2]Cross-section development*	*Comments*
EXIT1	-32	1	Exit section
FULLV	0	2	Downstream Full-valley section (Templated from EXITX)
BRIDG	0	1	Bridge section
RDWAY	11	3	Road Grade section
APPRO	45	2,3	Modelled Approach section (Templated from APTEM)
APTEM	114	1	Approach section as surveyed (Used as a template)

[1] For location of cross-sections see plan-view plot 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). 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, Jr. and Schneider (1989). Final adjustments to the values were made during the modelling of the reach. Channel "n" values for the reach ranged from 0.05 to 0.065, and overbank "n" values ranged from 0.055 to 0.093.

Normal depth at the exit section (EXIT1) 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 0.0377 ft/ft which was determined from surveyed channel points just downstream of the exit section.

The surveyed approach section (APTEM) was moved along the approach channel slope (0.029 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 approach also provides a consistent method for determining scour variables.

At this bridge site, when the water surface overtops the upstream right bank, a portion of the flow is diverted away from the bridge, down a relief channel, and returns to the main channel 300 ft downstream of the surveyed exit section. Thus, the exit section never conveys the entire 100- and 500-year discharges as assumed by the model. The incipient overtopping model, however, does reflect actual conditions at this site and may be the only reliable model.

For all of the modelled discharges, WSPRO assumes critical depth at the bridge section. Further analysis, in which the water surface is shown to pass through critical depth in the bridge, suggests the critical depth assumtions at the bridge section are satisfactory solutions.

Bridge Hydraulics Summary

Average bridge embankment elevation 100.5 *ft*
Average low steel elevation 97.4 *ft*

100-year discharge 1850 *ft³/s*
Water-surface elevation in bridge opening 92.1 *ft*
Road overtopping? Y *Discharge over road* 110 *ft³/s*
Area of flow in bridge opening 135.0 *ft²*
Average velocity in bridge opening 12.9 *ft/s*
Maximum WSPRO tube velocity at bridge 15.4 *ft/s*

Water-surface elevation at Approach section with bridge 95.9
Water-surface elevation at Approach section without bridge 93.5
Amount of backwater caused by bridge 2.4 *ft*

500-year discharge 2800 *ft³/s*
Water-surface elevation in bridge opening 93.0 *ft*
Road overtopping? Y *Discharge over road* 586 *ft³/s*
Area of flow in bridge opening 159 *ft²*
Average velocity in bridge opening 13.9 *ft/s*
Maximum WSPRO tube velocity at bridge 17.0 *ft/s*

Water-surface elevation at Approach section with bridge 97.3
Water-surface elevation at Approach section without bridge 94.8
Amount of backwater caused by bridge 2.5

Incipient overtopping discharge 1450 *ft³/s*
Water-surface elevation in bridge opening 91.5 *ft*
Area of flow in bridge opening 119 *ft²*
Average velocity in bridge opening 12.2 *ft/s*
Maximum WSPRO tube velocity at bridge 14.4 *ft/s*

Water-surface elevation at Approach section with bridge 94.8
Water-surface elevation at Approach section without bridge 92.8
Amount of backwater caused by bridge 2.0 *ft*

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, 1993). 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, 1993, p. 35, equation 18) for the 100-year, 500-year, and incipient road-overflow discharges. 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 Q500 model resulted in the worst case contraction scour with a scour depth of 1.3 ft. Examining the computed armoring depths suggests that streambed armoring will not limit the depth of contraction scour.

Abutment scour was computed by use of the Froehlich equation (Richardson and others, 1993, p. 49, equation 24). The Froehlich equation gives "excessively conservative estimates of scour depths" (Richardson and others, 1993, p. 48). 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	0.9	1.3	0.6
Depth to armoring	27.1	37.1	21.8
Left overbank	--	--	--
Right overbank	--	--	--
Local scour:			
Abutment scour			
Left abutment	11.7	15.2	9.6
Right abutment	11.3	14.1	9.4
Pier scour			
Pier 1	--	--	--
Pier 2	--	--	--
Pier 3	--	--	--

Rock Riprap Sizing

	100-yr discharge	500-yr discharge	Incipient overtopping discharge
		(D_{50} in feet)	
Abutments:			
Left abutment	2.2	2.5	1.9
Right abutment	2.2	2.5	1.9
Piers:			
Pier 1	--	--	--
Pier 2	--	--	--

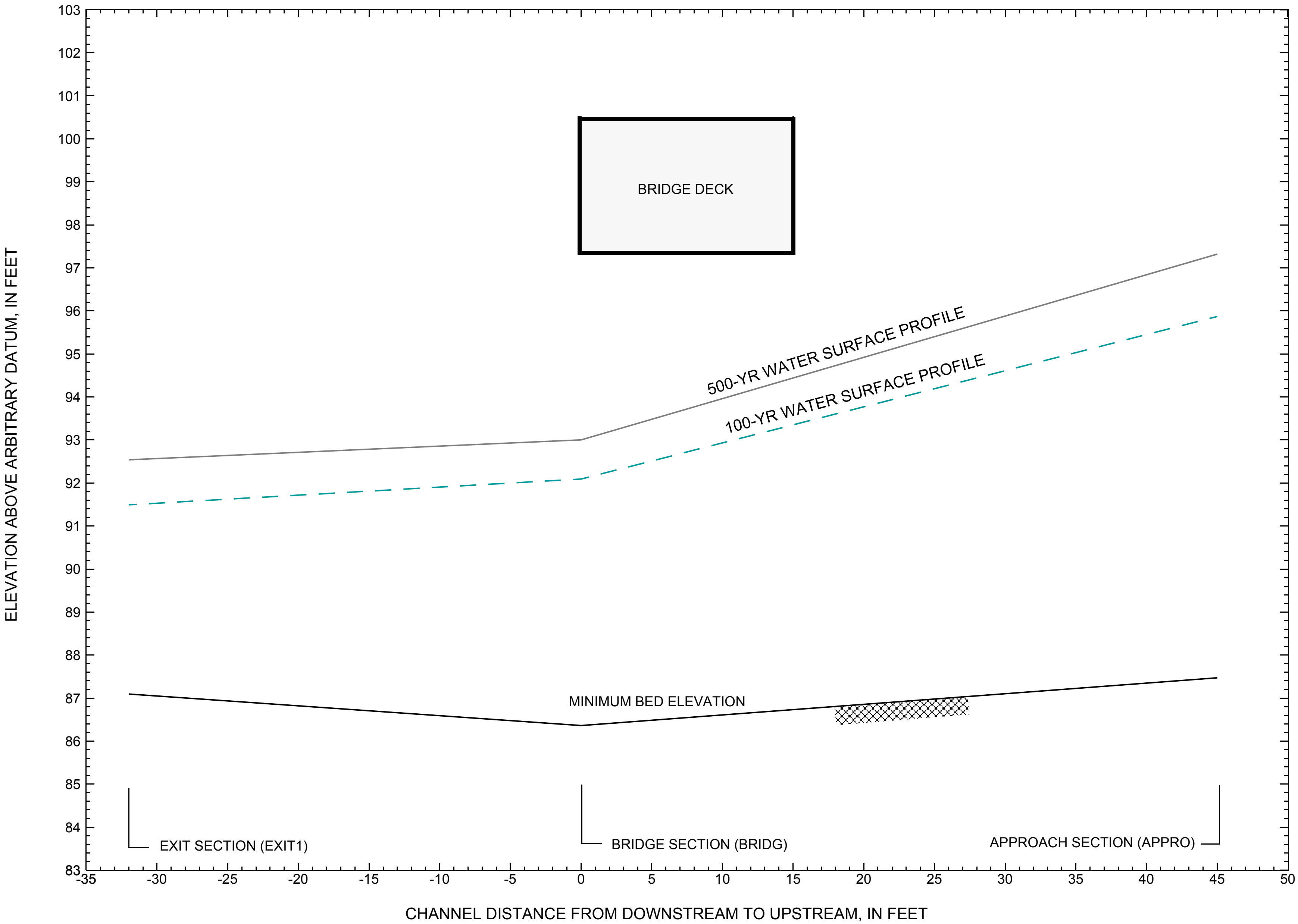

Figure 7. Water-surface profiles for the 100- and 500-yr discharges at structure HANCTH00020008 on town highway 2, crossing Hancock Branch White River, Hancock, Vermont.

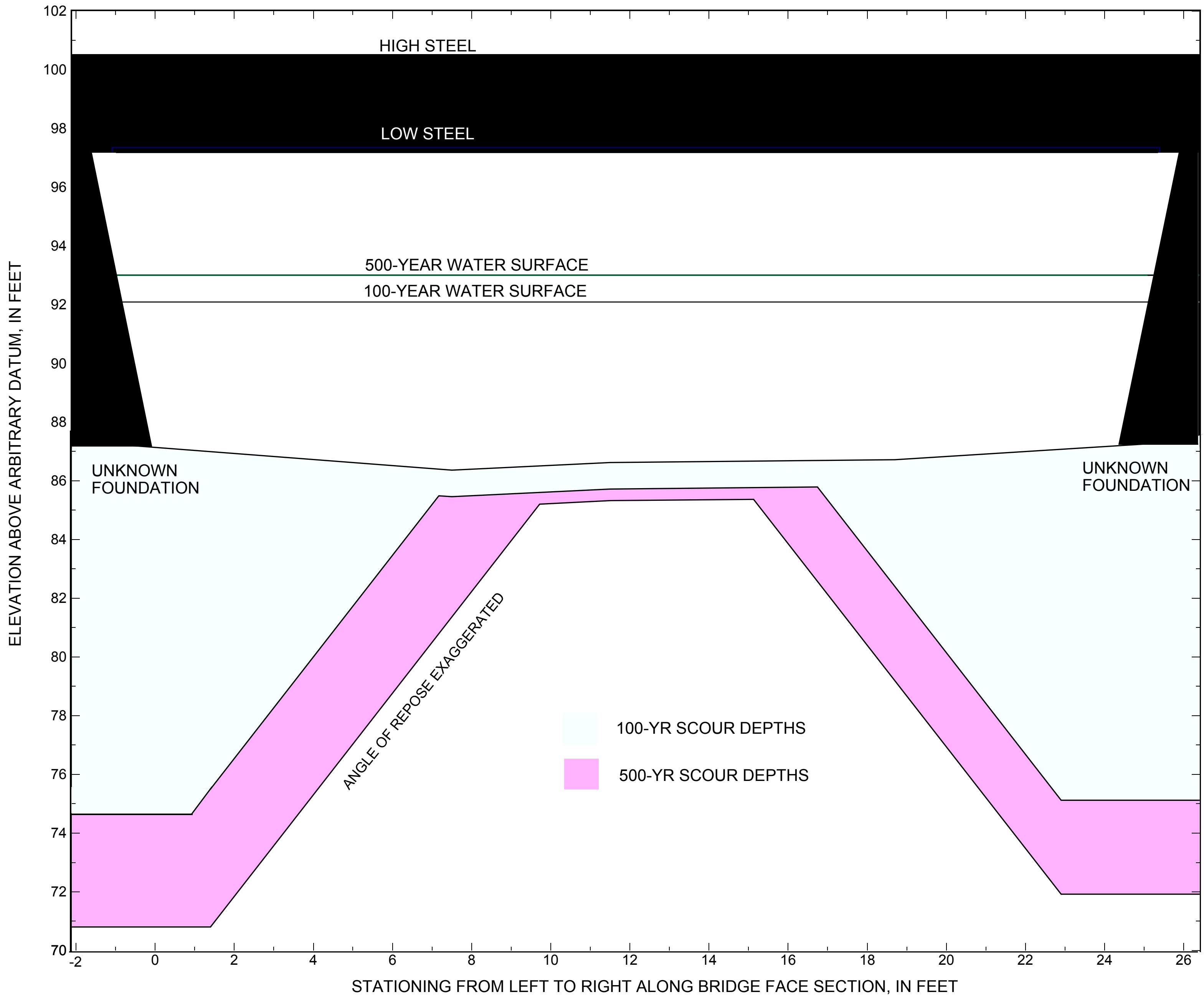

Figure 8. Scour elevations for the 100-yr and 500-yr discharges at structure HANCTH00020008 on town highway 2, crossing Hancock Branch White River, Hancock, Vermont.

Table 1. Remaining footing/pile depth at abutments for the 100-year discharge at structure HANCTH00020008 on Town Highway 2, crossing Hancock Branch White River, Hancock, Vermont.

[VTAOT, Vermont Agency of Transportation; --,no data]

Description	Station[1]	VTAOT minimum low-chord 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 1,850 cubic-feet per second											
Left abutment	-1.6	--	97.4	--	87.3	0.9	11.7	--	12.6	74.7	--
Right abutment	25.9	--	97.4	--	87.3	0.9	11.3	--	12.2	75.1	--

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 HANCTH00020008 on Town Highway 2, crossing Hancock Branch White River, Hancock, Vermont.

[VTAOT, Vermont Agency of Transportation; --, no data]

Description	Station[1]	VTAOT minimum low-chord 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 2,800 cubic-feet per second											
Left abutment	-1.6	--	97.4	--	87.3	1.3	15.2	--	16.5	70.8	--
Right abutment	25.9	--	97.4	--	87.3	1.3	14.1	--	15.4	71.9	--

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, 1962, Bread Loaf, Vermont 7.5 Minute Series quadrangle map: U.S. Geological Survey Topographic Maps, Field checked, 1970, Scale 1:24,000, Contour interval, 20 feet.

APPENDIX A:

WSPRO INPUT FILE

WSPRO INPUT FILE

```
T1        U.S. GEOLOGICAL SURVEY WSPRO INPUT FILE hanc008.wsp
T2        CREATED ON 12-MAY-95 FOR BRIDGE hancth00020008 USING FILE hanc008.dca
T3        Town Highway 2 crossing the Hancock Branch of White River       JDA
*
J3         6 29 30 552 553 551 5 16 17 13 3 * 15 14 23 21 11 12 4 7 3
*
Q          1850   2800   1450
SK         0.0377 0.0377 0.0377
*
XS   EXIT1   -32
GR          -35.6, 103.79    -21.6,  97.28    -15.8,  93.03     -7.6,  90.53
GR           -4.9,  88.66      0.0,  87.85      6.6,  87.42     16.9,  87.30
GR           25.4,  87.14     31.0,  87.09     35.9,  87.97     42.6,  90.76
GR           47.3,  92.64     67.1,  94.73     96.9,  98.99
N            0.065        0.075
SA                  43.
*
XS   FULLV      0
*
BR   BRIDG   0      97.35
GR           -1.6,  97.35     -0.3,  88.09      0.0,  87.30      7.5,  86.36
GR           11.5,  86.62     18.7,  86.72     24.6,  87.32     24.8,  88.24
GR           25.9,  97.35      -1.6,  97.35
N            0.050
CD           4 21.5 1.7 100.5 42.5
*
XR   RDWAY     11      19.5   1
GR         -194.3, 103.73    -86.4, 101.21      0.0, 100.51     29.4, 100.46
GR           70.2,  99.82     77.6,  99.68     98.2,  96.79    124.2,  95.18
GR          139.7,  94.73    154.6,  95.54    164.8,  95.76    178.8, 102.39
GR          183.8, 104.03
*
*           The rdway section crosses the bridge and then 40 feet right of the
*           bridge the section bends and crosses the control on the right upstream
*           bank.
*
XT   APTEM    114
GR         -182.7, 102.92    -81.9,  99.69    -69.1,  96.97    -11.8,  95.35
GR            0.0,  90.61      4.9,  90.54     12.6,  89.47     22.3,  90.23
GR           33.0,  90.86     36.5,  90.78     40.2,  93.89     42.9,  95.36
GR           56.1,  95.18    107.0,  97.18    122.4,  96.73    137.4,  97.54
GR          147.6,  97.76    160.8, 104.21    176.7, 105.04
*
AS   APPRO    45
GT            -2.0
N             0.055        0.064        0.093
SA                  -11.8         40.2
*
HP 1 BRIDG   92.09 1  92.09
HP 2 BRIDG   92.09 * * 1740
HP 2 RDWAY   95.81 * *  110
HP 1 APPRO   95.87 1  95.87
HP 2 APPRO   95.87 * * 1850
*
HP 1 BRIDG   93.00 1  93.00
HP 2 BRIDG   93.00 * * 2214
HP 2 RDWAY   97.02 * *  586
HP 1 APPRO   97.32 1  97.32
HP 2 APPRO   97.32 * * 2800
*
HP 1 BRIDG   91.49 1  91.49
HP 2 BRIDG   91.49 * * 1450
HP 1 APPRO   94.85 1  94.85
HP 2 APPRO   94.85 * * 1450
EX
ER
```

APPENDIX B:

WSPRO OUTPUT FILE

```
1
 WSPRO         FEDERAL HIGHWAY ADMINISTRATION - U. S. GEOLOGICAL SURVEY
 V042094           MODEL  FOR  WATER-SURFACE  PROFILE  COMPUTATIONS

           *** RUN DATE & TIME: 02-08-96  15:34

   T1        U.S. GEOLOGICAL SURVEY WSPRO INPUT FILE hanc008.wsp
   T2        CREATED ON 12-MAY-95 FOR BRIDGE hancth00020008 USING FILE hanc008.dca
   T3        Town Highway 2 crossing the Hancock Branch of White River       JDA
   *
   J3         6 29 30 552 553 551 5 16 17 13 3 * 15 14 23 21 11 12 4 7 3
   *
   Q          1850   2800   1450
 *** Q-DATA FOR SEC-ID, ISEQ =           1
   SK         0.0377 0.0377 0.0377
   *
   HP 1 BRIDG   92.09 1  92.09
     CROSS-SECTION PROPERTIES:  ISEQ =  3;  SECID = BRIDG;  SRD =       0.

      WSEL  SA#     AREA         K   TOPW   WETP  ALPH    LEW    REW      QCR
              1      135     10007     26     34                         1741
     92.09           135     10007     26     34  1.00      0     25     1741
1
   HP 2 BRIDG   92.09 * * 1740
     VELOCITY DISTRIBUTION:  ISEQ =  3;  SECID = BRIDG;  SRD =       0.

          WSEL     LEW     REW    AREA        K        Q    VEL
         92.09    -0.9    25.3   135.0   10007.    1740.  12.89

 X STA.        -0.9        2.0        3.4        4.7        5.8        6.9
   A(I)            12.1        7.5        6.8        6.2        6.1
   V(I)            7.22      11.66      12.85      13.93      14.31

 X STA.         6.9        7.9        8.9       10.0       11.0       12.0
   A(I)             5.8        5.7        5.7        5.7        5.7
   V(I)           15.01      15.27      15.37      15.19      15.36

 X STA.        12.0       13.1       14.1       15.2       16.2       17.4
   A(I)             5.7        5.7        5.8        5.7        6.1
   V(I)           15.19      15.23      15.09      15.25      14.31

 X STA.        17.4       18.5       19.7       21.0       22.5       25.3
   A(I)             6.0        6.4        6.7        7.6       12.1
   V(I)           14.58      13.66      12.94      11.38       7.17
1
   HP 2 RDWAY   95.81 * *  110

     VELOCITY DISTRIBUTION:  ISEQ =  4;  SECID = RDWAY;  SRD =      11.

          WSEL     LEW     REW    AREA        K        Q    VEL
         95.81   114.0   164.9    28.1     377.     110.   3.91

 X STA.       114.0      122.8      125.3      127.4      129.1      130.6
   A(I)             2.4        1.5        1.4        1.3        1.3
   V(I)            2.33       3.55       3.83       4.33       4.38

 X STA.       130.6      132.1      133.4      134.6      135.7      136.8
   A(I)             1.2        1.1        1.1        1.1        1.1
   V(I)            4.68       4.79       5.03       4.93       5.07

 X STA.       136.8      137.9      139.0      140.0      141.1      142.3
   A(I)             1.1        1.1        1.1        1.1        1.2
   V(I)            5.05       5.05       4.97       4.86       4.55

 X STA.       142.3      143.8      145.5      147.8      151.1      164.9
   A(I)             1.3        1.4        1.6        1.8        2.9
   V(I)            4.27       3.93       3.46       2.99       1.89
1
   HP 1 APPRO   95.87 1  95.87

     CROSS-SECTION PROPERTIES:  ISEQ =  5;  SECID = APPRO;  SRD =      45.
      WSEL  SA#     AREA         K   TOPW   WETP  ALPH    LEW    REW      QCR
              1      100      3733     62     62                          722
              2      355     28987     52     54                         5271
              3      156      3208    108    108                         1071
     95.87           612     35928    221    224  1.61    -72    148     4550
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1
   HP 2 APPRO   95.87 * * 1850

     VELOCITY DISTRIBUTION:  ISEQ =  5;  SECID = APPRO;  SRD =      45.

          WSEL     LEW     REW    AREA        K        Q    VEL
         95.87   -73.3   147.8   611.7   35928.    1850.   3.02

 X STA.       -73.3      -31.6      -13.2       -4.2       -0.2        2.8
   A(I)             55.5       41.0       34.4       25.2       21.6
   V(I)             1.67       2.26       2.69       3.67       4.28

 X STA.         2.8        5.7        8.4       11.0       13.3       15.6
   A(I)             21.4       20.8       20.4       19.5       19.4
   V(I)             4.32       4.45       4.55       4.74       4.77

 X STA.        15.6       18.1       20.6       23.2       26.0       28.8
   A(I)             19.7       19.8       20.0       20.5       20.7
   V(I)             4.69       4.66       4.63       4.50       4.47

 X STA.        28.8       31.7       34.8       38.5       60.1      147.8
   A(I)             21.2       21.6       24.8       61.2      103.1
   V(I)             4.37       4.29       3.72       1.51       0.90

   HP 1 BRIDG   93.00 1  93.00
     CROSS-SECTION PROPERTIES:  ISEQ =  3;  SECID = BRIDG;  SRD =       0.

      WSEL  SA#     AREA         K   TOPW   WETP  ALPH    LEW    REW      QCR
              1      159     12682     26     36                         2213
     93.00           159     12682     26     36  1.00      0     25     2213
1
   HP 2 BRIDG   93.00 * * 2214

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

          WSEL     LEW     REW    AREA        K        Q    VEL
         93.00    -1.0    25.4   158.9   12682.    2214.  13.94

 X STA.        -1.0        2.0        3.5        4.7        5.9        6.9
   A(I)             14.7        9.0        7.7        7.5        6.9
   V(I)             7.53      12.25      14.37      14.80      16.07

 X STA.         6.9        8.0        9.0       10.0       11.0       12.0
   A(I)              6.9        6.7        6.5        6.6        6.5
   V(I)            16.14      16.55      16.98      16.76      16.91

 X STA.        12.0       13.1       14.1       15.2       16.2       17.3
   A(I)              6.6        6.6        6.7        6.7        6.9
   V(I)            16.70      16.73      16.58      16.40      15.99

 X STA.        17.3       18.5       19.7       21.0       22.5       25.4
   A(I)              7.1        7.4        7.9        9.0       14.8
   V(I)            15.56      14.89      14.05      12.30       7.47
1
   HP 2 RDWAY   97.02 * *  586

     VELOCITY DISTRIBUTION:  ISEQ =  4;  SECID = RDWAY;  SRD =      11.

          WSEL     LEW     REW    AREA        K        Q    VEL
         97.02    96.6   167.5   102.8    2609.     586.   5.70

 X STA.        96.6      112.3      117.7      121.5      124.4      127.0
   A(I)              9.6        6.8        5.8        5.2        5.0
   V(I)             3.05       4.30       5.01       5.68       5.84

 X STA.       127.0      129.5      131.7      133.8      135.8      137.8
   A(I)              4.8        4.6        4.3        4.4        4.2
   V(I)             6.17       6.39       6.78       6.70       6.94

 X STA.       137.8      139.6      141.4      143.4      145.5      147.9
   A(I)              4.1        4.1        4.2        4.3        4.5
   V(I)             7.11       7.15       6.91       6.81       6.47

 X STA.       147.9      150.4      153.5      157.0      161.0      167.5
   A(I)              4.6        5.0        5.1        5.5        6.7
   V(I)             6.40       5.87       5.77       5.30       4.39
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```
1
   HP 1 APPRO   97.32 1  97.32
     CROSS-SECTION PROPERTIES:  ISEQ =  5;  SECID = APPRO;  SRD =      45.

      WSEL  SA#     AREA         K   TOPW   WETP  ALPH    LEW    REW      QCR
              1      194     10513     68     69                         1855
              2      431     39948     52     54                         7035
              3      315     10075    111    111                         3012
     97.32           939     60536    231    234  1.53    -79    151     8690
1
   HP 2 APPRO   97.32 * * 2800

     VELOCITY DISTRIBUTION:  ISEQ =  5;  SECID = APPRO;  SRD =      45.

          WSEL     LEW     REW    AREA        K        Q    VEL
         97.32   -80.2   150.8   939.5   60536.    2800.   2.98

 X STA.       -80.2      -48.0      -31.1      -17.6       -6.5       -1.3
   A(I)            68.8       53.8       48.7       49.4       37.5
   V(I)            2.03       2.60       2.87       2.83       3.73

 X STA.        -1.3        2.5        6.1        9.5       12.5       15.5
   A(I)            32.8       31.2       31.1       29.1       29.4
   V(I)            4.26       4.48       4.50       4.81       4.76

 X STA.        15.5       18.6       21.9       25.2       28.7       32.3
   A(I)            29.3       30.3       30.0       30.9       31.1
   V(I)            4.78       4.61       4.66       4.53       4.51

 X STA.        32.3       36.2       46.5       66.3       95.8      150.8
   A(I)            32.9       55.3       79.5       93.1      115.0
   V(I)            4.25       2.53       1.76       1.50       1.22
1
   *
   HP 1 BRIDG   91.49 1  91.49
     CROSS-SECTION PROPERTIES:  ISEQ =  3;  SECID = BRIDG;  SRD =       0.

      WSEL  SA#     AREA         K   TOPW   WETP  ALPH    LEW    REW      QCR
              1      119      8348     26     33                         1452
     91.49           119      8348     26     33  1.00      0     25     1452
1
   HP 2 BRIDG   91.49 * * 1450

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

          WSEL     LEW     REW    AREA        K        Q    VEL
         91.49    -0.8    25.2   119.4    8348.    1450.  12.15

 X STA.        -0.8        2.0        3.4        4.7        5.8        6.9
   A(I)            10.4        6.6        6.0        5.5        5.3
   V(I)            6.94      11.04      12.11      13.09      13.71

 X STA.         6.9        7.9        8.9        9.9       11.0       12.0
   A(I)             5.2        5.0        5.1        5.1        5.1
   V(I)           13.96      14.43      14.24      14.10      14.27

 X STA.        12.0       13.1       14.1       15.2       16.3       17.4
   A(I)             5.1        5.1        5.1        5.3        5.2
   V(I)           14.22      14.26      14.14      13.72      13.92

 X STA.        17.4       18.5       19.7       21.0       22.5       25.2
   A(I)             5.5        5.7        6.0        6.6       10.5
   V(I)           13.30      12.76      12.13      11.05       6.89
1
   HP 1 APPRO   94.85 1  94.85
     CROSS-SECTION PROPERTIES:  ISEQ =  5;  SECID = APPRO;  SRD =      45.

      WSEL  SA#     AREA         K   TOPW   WETP  ALPH    LEW    REW      QCR
              1       40       890     53     53                          196
              2      302     22141     52     54                         4136
              3       63       980     65     65                          350
     94.85           405     24011    170    172  1.41    -64    125     2983
1
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```
   HP 2 APPRO   94.85 * * 1450

     VELOCITY DISTRIBUTION:  ISEQ =  5;  SECID = APPRO;  SRD =      45.

          WSEL     LEW     REW    AREA        K        Q    VEL
         94.85   -64.9   124.6   404.8   24011.    1450.   3.58

 X STA.       -64.9       -8.1       -2.5        0.6        3.3        5.9
   A(I)            48.1       23.2       18.0       16.9       16.1
   V(I)            1.51       3.13       4.02       4.28       4.51

 X STA.         5.9        8.2       10.4       12.4       14.3       16.3
   A(I)            15.4       15.0       14.5       14.5       14.2
   V(I)            4.71       4.85       5.01       4.99       5.10

 X STA.        16.3       18.4       20.5       22.7       25.0       27.4
   A(I)            14.5       14.6       14.7       15.1       15.2
   V(I)            5.01       4.97       4.94       4.80       4.76

 X STA.        27.4       29.9       32.5       35.2       38.7      124.6
   A(I)            15.6       15.8       16.4       19.1       67.9
   V(I)            4.65       4.59       4.41       3.79       1.07
1
   EX

 +++ BEGINNING PROFILE CALCULATIONS --   3
1
 WSPRO         FEDERAL HIGHWAY ADMINISTRATION - U. S. GEOLOGICAL SURVEY
 V042094           MODEL  FOR  WATER-SURFACE  PROFILE  COMPUTATIONS

         U.S. GEOLOGICAL SURVEY WSPRO INPUT FILE hanc008.wsp
         CREATED ON 12-MAY-95 FOR BRIDGE hancth00020008 USING FILE hanc008.dca
         Town Highway 2 crossing the Hancock Branch of White River       JDA
            *** RUN DATE & TIME: 02-08-96  15:34

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

 EXIT1:XS   ******    -10      186  1.55 *****   93.04   91.37    1850   91.49
        -31 ******     44     9520  1.00 ***** *******    0.96    9.96

  ===135 CONVEYANCE RATIO OUTSIDE OF RECOMMENDED LIMITS.
                              "FULLV"     KRATIO =  1.77

 FULLV:FV       32    -15      275  0.72  0.68   93.71 *******    1850   92.99
          0     32     51    16850  1.03  0.00   -0.01    0.59    6.72
          <<<<<THE ABOVE RESULTS REFLECT "NORMAL" (UNCONSTRICTED) FLOW>>>>>

  ===125 FR# EXCEEDS FNTEST AT SECID "APPRO":  TRIALS CONTINUED.
              FNTEST,FR#,WSEL,CRWS =  0.80    0.82      93.49      92.37

  ===110 WSEL NOT FOUND AT SECID "APPRO":  REDUCED DELTAY.
                   WSLIM1,WSLIM2,DELTAY =    92.49     103.04    0.50

  ===115 WSEL NOT FOUND AT SECID "APPRO":  USED WSMIN = CRWS.
                   WSLIM1,WSLIM2,CRWS =    92.49     103.04      92.37

 APPRO:AS       45    -16      239  0.98  0.64   94.48   92.37    1850   93.50
         45     45     64    14316  1.05  0.13    0.00    0.82    7.73
          <<<<<THE ABOVE RESULTS REFLECT "NORMAL" (UNCONSTRICTED) FLOW>>>>>

  ===215 FLOW CLASS 1 SOLUTION INDICATES POSSIBLE ROAD OVERFLOW.
             WS1,WSSD,WS3,RGMIN =    96.25       0.00      92.30      94.73

  ===260 ATTEMPTING FLOW CLASS 4 SOLUTION.

  ===285 CRITICAL WATER-SURFACE ELEVATION  A _ S _ S _ U _ M _ E _ D !!!!!
                   SECID "BRIDG"     Q,CRWS =    1740.      92.09

             <<<<<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       32      0      135  2.89 *****   94.98   92.09    1740   92.09
          0     32     25    10000  1.12 ***** *******    1.06   12.90
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```
     TYPE PPCD FLOW      C    P/A    LSEL   BLEN   XLAB   XRAB
       4. ****   4.  0.946 ******   97.35 ****** ****** ******

    XSID:CODE    SRD   FLEN    HF   VHD     EGL     ERR      Q    WSEL
   RDWAY:RG      11.    26.  0.07  0.23   96.03    0.00    110.   95.81

            Q   WLEN    LEW    REW  DMAX  DAVG  VMAX  VAVG  HAVG  CAVG
   LT:      0. ****** ****** ****** ***** ***** ***** ***** ***** *****
   RT:    110.    51.   114.   165.   1.1   0.6   4.2   3.9   0.8   3.2

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

 APPRO:AS       24    -72      611  0.23  0.23   96.10   92.37    1850   95.87
         45     25    148    35872  1.61  0.89    0.00    0.41    3.03

       M(G)   M(K)       KQ   XLKQ   XRKQ    OTEL
      0.677  0.485   18447.     4.    30. ********

                      <<<<<END OF BRIDGE COMPUTATIONS>>>>>
   FIRST USER DEFINED TABLE.

    XSID:CODE    SRD    LEW    REW       Q        K     AREA     VEL    WSEL
   EXIT1:XS     -32.   -11.    44.   1850.    9520.     186.    9.96   91.49
   FULLV:FV       0.   -16.    51.   1850.   16850.     275.    6.72   92.99
   BRIDG:BR       0.    -1.    25.   1740.   10000.     135.   12.90   92.09
   RDWAY:RG      11.*******     0.    110.       0.*********    1.00   95.81
   APPRO:AS      45.   -73.   148.   1850.   35872.     611.    3.03   95.87

    XSID:CODE   XLKQ   XRKQ       KQ
   APPRO:AS       4.    30.   18447.
1
  SECOND USER DEFINED TABLE.

    XSID:CODE    CRWS     FR#    YMIN    YMAX    HF    HO  VHD      EGL    WSEL
   EXIT1:XS     91.37    0.96   87.09  103.79************  1.55   93.04   91.49
   FULLV:FV  ********    0.59   87.09  103.79  0.68  0.00  0.72   93.71   92.99
   BRIDG:BR     92.09    1.06   86.36   97.35************  2.89   94.98   92.09
   RDWAY:RG  ****************   94.73  104.03  0.07******  0.23   96.03   95.81
   APPRO:AS     92.37    0.41   87.47  103.04  0.23  0.89  0.23   96.10   95.87

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

 EXIT1:XS   ******    -13      246  2.04 *****   94.58   92.52    2800   92.54
        -31 ******     47    14413  1.02 ***** *******    1.01   11.36

  ===135 CONVEYANCE RATIO OUTSIDE OF RECOMMENDED LIMITS.
                               "FULLV"     KRATIO =  1.77

 FULLV:FV       32    -17      371  0.95  0.68   95.25 *******    2800   94.30
          0     32     63    25495  1.07  0.00   -0.01    0.64    7.54
          <<<<<THE ABOVE RESULTS REFLECT "NORMAL" (UNCONSTRICTED) FLOW>>>>>

  ===125 FR# EXCEEDS FNTEST AT SECID "APPRO":  TRIALS CONTINUED.
              FNTEST,FR#,WSEL,CRWS =  0.80    0.94      94.83      93.85

  ===110 WSEL NOT FOUND AT SECID "APPRO":  REDUCED DELTAY.
                   WSLIM1,WSLIM2,DELTAY =    93.80     103.04    0.50

  ===115 WSEL NOT FOUND AT SECID "APPRO":  USED WSMIN = CRWS.
                   WSLIM1,WSLIM2,CRWS =    93.80     103.04      93.85

 APPRO:AS       45    -63      400  1.07  0.58   95.89   93.85    2800   94.82
         45     45    124    23761  1.40  0.06    0.00    0.94    7.00
          <<<<<THE ABOVE RESULTS REFLECT "NORMAL" (UNCONSTRICTED) FLOW>>>>>

  ===215 FLOW CLASS 1 SOLUTION INDICATES POSSIBLE ROAD OVERFLOW.
           WS1,WSSD,WS3,RGMIN =    99.04       0.00      94.05      94.73

  ===260 ATTEMPTING FLOW CLASS 4 SOLUTION.

  ===285 CRITICAL WATER-SURFACE ELEVATION  A _ S _ S _ U _ M _ E _ D !!!!!
                   SECID "BRIDG"     Q,CRWS =    2214.      93.00

             <<<<<RESULTS REFLECTING THE CONSTRICTED FLOW FOLLOW>>>>>
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  XSID:CODE   SRDL    LEW     AREA   VHD    HF     EGL    CRWS       Q    WSEL
        SRD   FLEN    REW        K  ALPH    HO     ERR     FR#     VEL

 BRIDG:BR       32      0      159  3.50 *****   96.49   93.00    2214   93.00
          0     32     25    12673  1.16 ***** *******    1.08   13.94

      TYPE PPCD FLOW      C    P/A    LSEL   BLEN   XLAB   XRAB
        4. ****   4.  0.930 ******   97.35 ****** ****** ******

     XSID:CODE    SRD   FLEN    HF   VHD     EGL     ERR       Q    WSEL
    RDWAY:RG      11.    26.  0.05  0.21   97.48    0.00    586.   97.02

              Q   WLEN    LEW    REW  DMAX  DAVG  VMAX  VAVG  HAVG  CAVG
    LT:      0. ****** ****** ****** ***** ***** ***** ***** ***** *****
    RT:    586.    71.    97.   167.   2.3   1.5   6.5   5.7   1.9   3.1

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

 APPRO:AS       24    -79      940  0.21  0.22   97.53   93.85    2800   97.32
         45     27    151    60599  1.53  0.82    0.02    0.32    2.98

        M(G)   M(K)       KQ   XLKQ   XRKQ    OTEL
       0.858  0.590   24724.     3.    30. ********

                       <<<<<END OF BRIDGE COMPUTATIONS>>>>>
   FIRST USER DEFINED TABLE.

     XSID:CODE    SRD    LEW    REW       Q        K     AREA     VEL    WSEL
    EXIT1:XS     -32.   -14.    47.   2800.   14413.     246.   11.36   92.54
    FULLV:FV       0.   -18.    63.   2800.   25495.     371.    7.54   94.30
    BRIDG:BR       0.    -1.    25.   2214.   12673.     159.   13.94   93.00
    RDWAY:RG      11.*******     0.    586.       0.*********    1.00   97.02
    APPRO:AS      45.   -80.   151.   2800.   60599.     940.    2.98   97.32

     XSID:CODE   XLKQ   XRKQ       KQ
    APPRO:AS       3.    30.   24724.
1
  SECOND USER DEFINED TABLE.

     XSID:CODE    CRWS     FR#    YMIN    YMAX     HF    HO   VHD      EGL    WSEL
    EXIT1:XS     92.52    1.01   87.09  103.79************  2.04    94.58   92.54
    FULLV:FV  ********    0.64   87.09  103.79  0.68  0.00  0.95    95.25   94.30
    BRIDG:BR     93.00    1.08   86.36   97.35************  3.50    96.49   93.00
    RDWAY:RG  ****************   94.73  104.03  0.05******  0.21    97.48   97.02
    APPRO:AS     93.85    0.32   87.47  103.04  0.22  0.82  0.21    97.53   97.32
1
  XSID:CODE   SRDL    LEW     AREA   VHD    HF     EGL    CRWS       Q    WSEL
        SRD   FLEN    REW        K  ALPH    HO     ERR     FR#     VEL

 EXIT1:XS   ******     -8      158  1.31 *****   92.29   90.82    1450   90.98
        -31 ******     43     7462  1.00 ***** *******    0.93    9.17

  ===135 CONVEYANCE RATIO OUTSIDE OF RECOMMENDED LIMITS.
                            "FULLV"     KRATIO =  1.81

 FULLV:FV       32    -13      235  0.60  0.67   92.95 *******    1450   92.35
          0     32     47    13482  1.01  0.00    0.00    0.55    6.16
          <<<<<THE ABOVE RESULTS REFLECT "NORMAL" (UNCONSTRICTED) FLOW>>>>>

 APPRO:AS       45    -10      200  0.83  0.63   93.68 *******    1450   92.85
         45     45     42    11197  1.01  0.11   -0.01    0.66    7.27
          <<<<<THE ABOVE RESULTS REFLECT "NORMAL" (UNCONSTRICTED) FLOW>>>>>

  ===215 FLOW CLASS 1 SOLUTION INDICATES POSSIBLE ROAD OVERFLOW.
           WS1,WSSD,WS3,RGMIN =    94.85       0.00      91.49      94.73

  ===260 ATTEMPTING FLOW CLASS 4 SOLUTION.

  ===240 NO DISCHARGE BALANCE IN 15 ITERATIONS.
                   WS,QBO,QRD =    98.99         0.       1450.

  ===280 REJECTED FLOW CLASS 4 SOLUTION.

  ===245 ATTEMPTING FLOW CLASS 2 (5) SOLUTION.
```

```
 ===250 INSUFFICIENT HEAD FOR PRESSURE FLOW.
                       YU/Z,WSIU,WS = 1.02      97.52      97.55

 ===270 REJECTED FLOW CLASS 2 (5) SOLUTION.

           <<<<<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       32      0      119  2.44  1.08   93.92   86.56    1450   91.49
        0      32     25     8339  1.06  0.17    0.00    1.03   12.16

     TYPE PPCD FLOW      C    P/A    LSEL   BLEN   XLAB   XRAB
       4. ****   1.  0.972 ******   97.35 ****** ****** ******

    XSID:CODE    SRD   FLEN    HF   VHD     EGL     ERR       Q    WSEL
   RDWAY:RG      11.        <<<<<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       24    -64      404  0.28  0.27   95.13   91.80    1450   94.85
       45      26    125    23993  1.41  0.94    0.00    0.49    3.58

       M(G)   M(K)       KQ   XLKQ   XRKQ    OTEL
      0.501  0.394   14527.     4.    30.    94.75

                    <<<<<END OF BRIDGE COMPUTATIONS>>>>>
  FIRST USER DEFINED TABLE.

    XSID:CODE    SRD    LEW    REW       Q        K     AREA     VEL    WSEL
   EXIT1:XS     -32.    -9.    43.   1450.    7462.     158.    9.17   90.98
   FULLV:FV       0.   -14.    47.   1450.   13482.     235.    6.16   92.35
   BRIDG:BR       0.    -1.    25.   1450.    8339.     119.   12.16   91.49
   RDWAY:RG      11.**************      0.       0.*********    1.00********
   APPRO:AS      45.   -65.   125.   1450.   23993.     404.    3.58   94.85

    XSID:CODE   XLKQ   XRKQ       KQ
   APPRO:AS       4.    30.   14527.

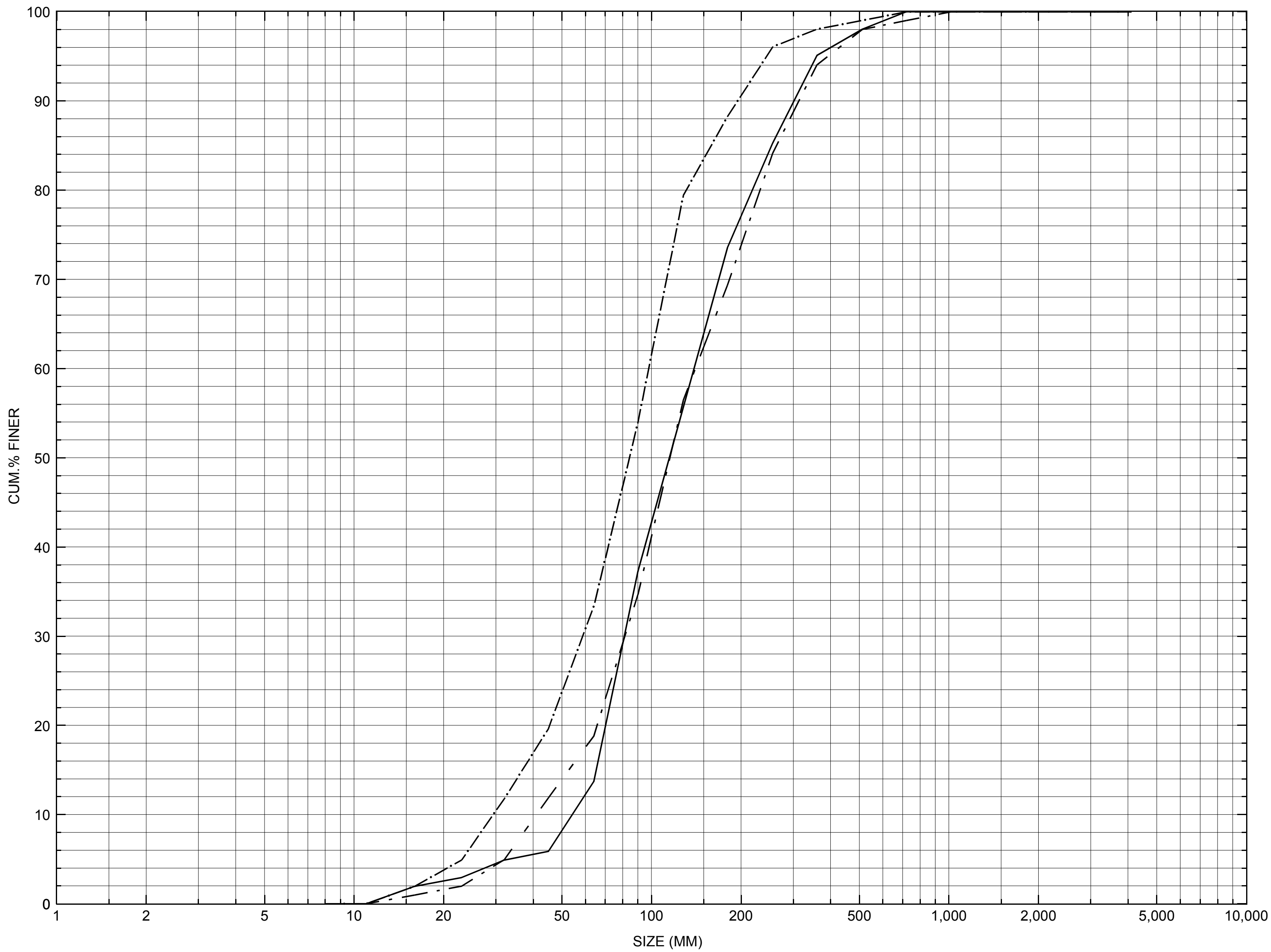
 SECOND USER DEFINED TABLE.

    XSID:CODE    CRWS     FR#    YMIN    YMAX    HF    HO  VHD     EGL    WSEL
   EXIT1:XS     90.82    0.93   87.09  103.79************  1.31   92.29   90.98
   FULLV:FV  ********    0.55   87.09  103.79  0.67  0.00  0.60   92.95   92.35
   BRIDG:BR     86.56    1.03   86.36   97.35  1.08  0.17  2.44   93.92   91.49
   RDWAY:RG  ****************   94.73  104.03************  0.05   97.59********
   APPRO:AS     91.80    0.49   87.47  103.04  0.27  0.94  0.28   95.13   94.85
  ER

1  NORMAL  END  OF  WSPRO  EXECUTION.
```

APPENDIX C:

BED-MATERIAL PARTICAL-SIZE DISTRIBUTION



Appendix C. Bed material particle-size distributions for three pebble count transects at the approach cross-section for structure HANCTH00020008, in Hancock, Vermont.

APPENDIX D:

HISTORICAL DATA FORM