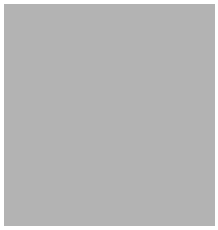
LEVEL II SCOUR ANALYSIS FOR BRIDGE 10 (NORWTH00120010) on TOWN HIGHWAY 12, crossing BLOODY BROOK, NORWICH, VERMONT

U.S. Geological Survey
Open-File Report 96-161



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

LEVEL II SCOUR ANALYSIS FOR BRIDGE 10 (NORWTH00120010) on TOWN HIGHWAY 12, crossing BLOODY BROOK, NORWICH, VERMONT

By JOSEPH D. AYOTTE

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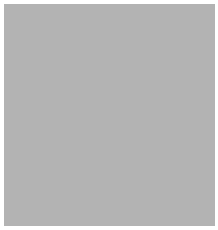

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VERMONT AGENCY OF TRANSPORTATION
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Pembroke, New Hampshire

1996

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

U.S. GEOLOGICAL SURVEY
Gordon P. Eaton, Director

For additional information
write to:

District Chief
U.S. Geological Survey
361 Commerce Way
Pembroke, NH 03275-3718

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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 10 (NORWTH00120010) ON TOWN HIGHWAY 12, CROSSING BLOODY BROOK, NORWICH, VERMONT

By **Joseph D. Ayotte**

INTRODUCTION

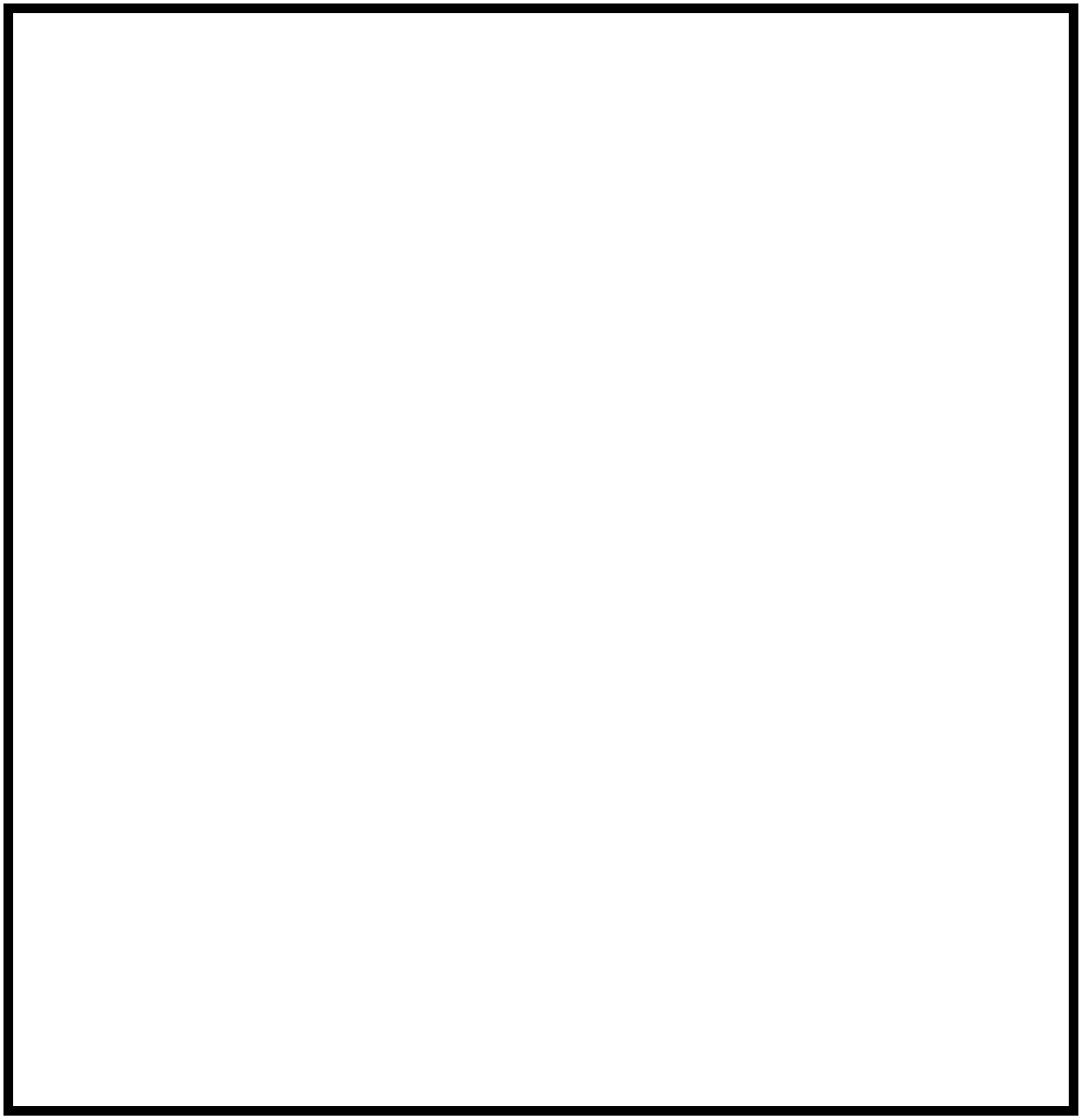
This report provides the results of a detailed Level II analysis of scour potential at structure NORWTH00120010 on town highway 12 crossing Bloody Brook, Norwich, Vermont (figures 1–8). A Level II study is a basic engineering analysis of the site, including a quantitative analysis of stream stability 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, available from VTAOT files, was compiled prior to conducting the Level I and Level II analyses and can be found in Appendix D.

The site is in the New England Upland physiographic province in east-central Vermont. The 8.98-mi^2 drainage area is in a predominantly rural and forested basin. In the vicinity of the study site, the left bank upstream and the left and right banks downstream are forested. The immediate right bank upstream is covered by shrub and brush with pasture on the overbank. Town Highway 12 runs along the valley of Bloody Brook; however, at structure NORWTH00120010 the road crosses Bloody Brook at a 90-degree angle.

In the study area, Bloody Brook has a sinuous channel with a slope of approximately 0.014 ft/ft, an average channel top width of 41 ft and an average channel depth of 3 ft. The predominant channel bed materials are gravel and cobble (D_{50} is 51.0 mm or 0.167 ft). The geomorphic assessment at the time of the Level I site visit on October 31, 1994, indicated that the reach was unstable.

The town highway 12 crossing of Bloody Brook is a 34-ft-long, two-lane bridge consisting of one 30-foot clear span (Vermont Agency of Transportation, written commun., July 29, 1994). The bridge is supported by vertical, concrete abutments with wingwalls. The right abutment is protected by sparse type-2 stone fill (less than 24 inches diameter). The channel is skewed 0 degrees to the opening and the opening-skew-to-roadway is 0 degrees. 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). Scour depths were calculated assuming an infinite depth of erosive material and a homogeneous particle-size distribution. The scour analysis results are presented in tables 1 and 2 and a graph of the scour depths is presented in figure 8.

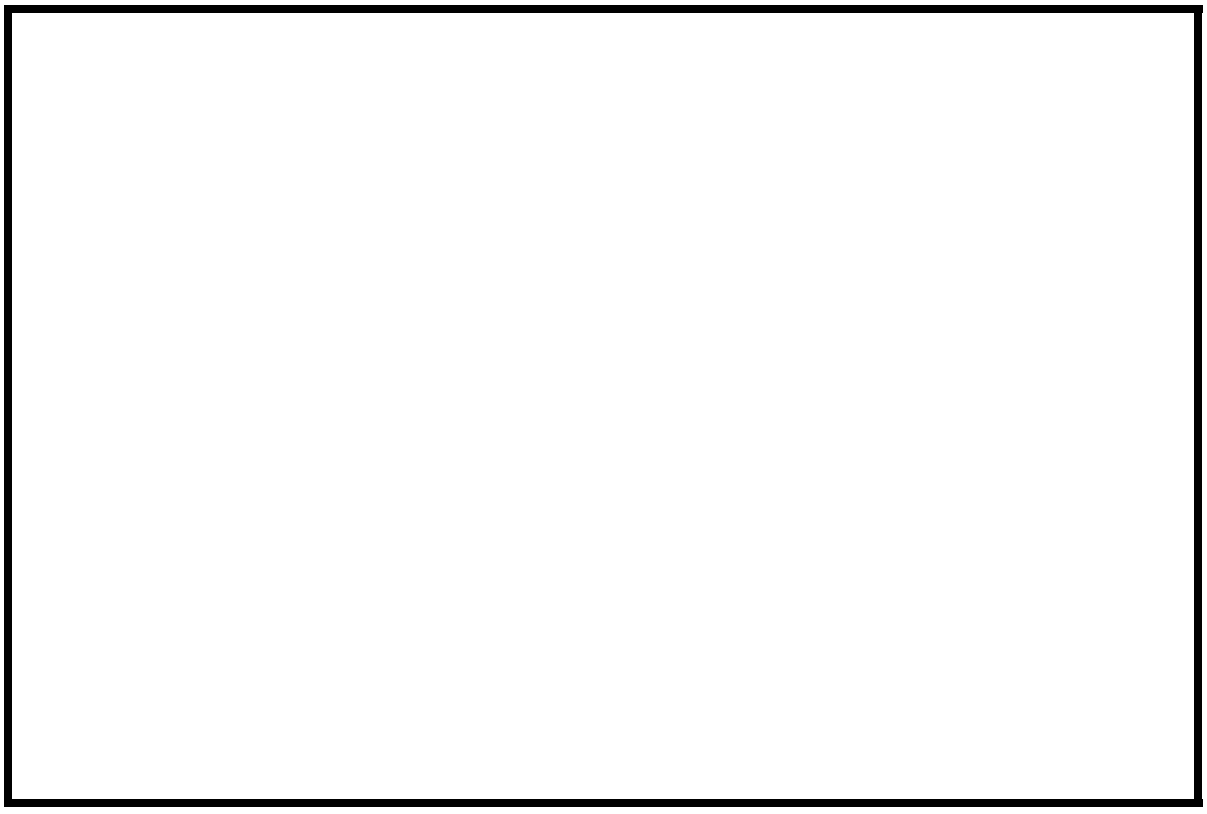


Hanover, NH-VT. Quadrangle, 1:24,000, 1959

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 NORWTH00120010 ***Stream*** Bloody Brook

County Windsor ***Road*** TH012 ***District*** 04

Description of Bridge

Bridge length 34 ***ft*** ***Bridge width*** 23.3 ***ft*** ***Max span length*** 30 ***ft***

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

Abutment type Concrete, vertical ***Embankment type*** sloping

Stone fill on abutment? Right only ***Date of inspection*** 10/31/94

Description of stone fill Type-II stone fill exists on the right abutment while left abutment is unprotected; Type I on the US left wingwall; Type II on the US and DS right wingwalls.

No Piers; Abutments are vertical concrete with wingwalls. Footings of the right abutment are exposed.

Is bridge skewed to flood flow according to No ***survey?*** No ***Angle*** --

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	10/31/94	0	0
Level II	07/19/94	0	0

Potential for debris Moderate: this is a high-gradient stream with localized areas of bank instability.

Describe any features near or at the bridge that may affect flow (include observation date) The roadway at the left road approach may convey a considerable amount of discharge in an extreme event.

Description of the Geomorphic Setting

General topography The reach is in a moderate-relief valley with wide a flood plain compared to the channel width.

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

Date of inspection 10/31/94

DS left: Relatively wide flood plain.

DS right: Relatively wide flood plain.

US left: Relatively wide flood plain.

US right: Relatively wide flood plain.

Description of the Channel

Average top width 41 ***ft***

Average depth 3 ***ft***

Predominant bed material Gravel and cobbles

Bank material Gravel

sinuous, equi-width with no anabranching or braiding.

Vegetative co ... 10/31/94

forested

DS left: forested

DS right: forested

US left: thin woods with pasture beyond

US right: N

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

On 10/31/94, the banks were described as laterally unstable in places upstream and downstream of the bridge, but are stable in the immediate vicinity of the bridge. The channel has shifted toward the right abutment in the bridge opening.

Describe any obstructions in channel and date of observation.

On 10/31/94, a point bar exists under the bridge on the left half of the channel. This feature blocks a small amount of the flow in the vicinity of the bridge opening.

Hydrology

Drainage area 8.98 ***mi²***

Percentage of drainage area in physiographic provinces: (approximate)

Physiographic province	***Percent of drainage area***
New England Upland	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/p -- No

Calculated Discharges

Q100 1790 ***ft³/s*** ***Q500*** 3040 ***ft³/s***

The Q100 was determined by a drainage area relationship to a site on the same stream with a drainage area of 5.7 mi². This site had a Q100 of 1300 cfs according to VTAOT files (Vermont Agency of Transportation, written commun., March 8, 1995). The Q500 was determined by multiplying the Q100 by 1.7 (Richardson and others, 1993).

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 VTAOT datum not available.

Description of reference marks used to determine USGS datum. RM1 is a chiseled square on top of the downstream left abutment corner with an arbitrary survey elevation of 597.05 feet.

Cross-Sections Used in WSPRO Analysis

[1]*Cross-section*	*Section Reference Distance (SRD) in feet*	[2]*Cross-section development*	*Comments*
EXIT	0	1	Exit section
FV	44	2	Downstream Full-valley section (Templated from EXITX)
BRO	44	1	Bridge section
RD	56	1	Road Grade section
APPR	96	2	Modelled Approach section (Templated from SURVA)
SURVA	110	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). 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 0.035 to 0.050, and overbank "n" values ranged from 0.040 to 0.090.

Normal depth at the exit section (EXIT) 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 0.014 ft/ft which was determined from surveyed water surface points downstream of the bridge.

The surveyed approach section (SURVA) was moved along the approach channel slope (0.017 ft/ft) to establish the modelled approach section (APPR), 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.

The modeled 100- and 500-year discharges overtop the roadway embankments. The incipient overtopping discharge was determined to be 1250 cfs. At this discharge about 3 percent of the total flow crosses the roadway; however, this was within acceptible tolerances.

Bridge Hydraulics Summary

Average bridge embankment elevation 597.7 *ft*
Average low steel elevation 594.5 *ft*

100-year discharge 1790 *ft³/s*
Water-surface elevation in bridge opening 594.5 *ft*
Road overtopping? Yes *Discharge over road* 260 *ft³/s*
Area of flow in bridge opening 182 *ft²*
Average velocity in bridge opening 8.4 *ft/s*
Maximum WSPRO tube velocity at bridge 11.1 *ft/s*

Water-surface elevation at Approach section with bridge 596.4
Water-surface elevation at Approach section without bridge 593.3
Amount of backwater caused by bridge 3.1 *ft*

500-year discharge 3040 *ft³/s*
Water-surface elevation in bridge opening 594.5 *ft*
Road overtopping? Yes *Discharge over road* 1190 *ft³/s*
Area of flow in bridge opening 182 *ft²*
Average velocity in bridge opening 10.2 *ft/s*
Maximum WSPRO tube velocity at bridge 11.9 *ft/s*

Water-surface elevation at Approach section with bridge 598.0
Water-surface elevation at Approach section without bridge 594.3
Amount of backwater caused by bridge 3.7

Incipient overtopping discharge 1250 *ft³/s*
Water-surface elevation in bridge opening 594.5 *ft*
Area of flow in bridge opening 182 *ft²*
Average velocity in bridge opening 6.6 *ft/s*
Maximum WSPRO tube velocity at bridge -- *ft/s*

Water-surface elevation at Approach section with bridge 595.4
Water-surface elevation at Approach section without bridge 592.6
Amount of backwater caused by bridge 2.8 *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.

The 100-year, 500-year and the incipient road-overflow discharges resulted in unsubmerged orifice flow. Contraction scour at bridges with orifice flow is best estimated by use of the Chang pressure-flow scour equation (oral communication, J. Sterling Jones, October 4, 1996). Therefore, contraction scour for all three discharges was computed by use of the Chang equation (Richardson and others, 1995, p. 145-146). The results of Laursen's clear-water contraction scour (Richardson and others, 1993, p. 35, equation 18) for the three events were also computed and can be found in appendix F.

Abutment scour was computed by use of the HIRE equation (Richardson and others, 1993, p. 50, equation 25) because the HIRE equation is recommended when the length to depth ratio of the embankment blocking flow exceeds 25. Variables for the HIRE 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	0.3	1.9	0.0
Depth to armoring	2.2	7.0	0.6
Left overbank	--	--	--
Right overbank	--	--	--
Local scour:			
Abutment scour	6.5	9.3	4.7
Left abutment	11.5	15.4	9.0
Right abutment			
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:	1.4	2.0	0.9
Left abutment	1.4	2.0	0.9
Right abutment	--	--	--
Piers:	--	--	--
Pier 1	--	--	--
Pier 2	--	--	--

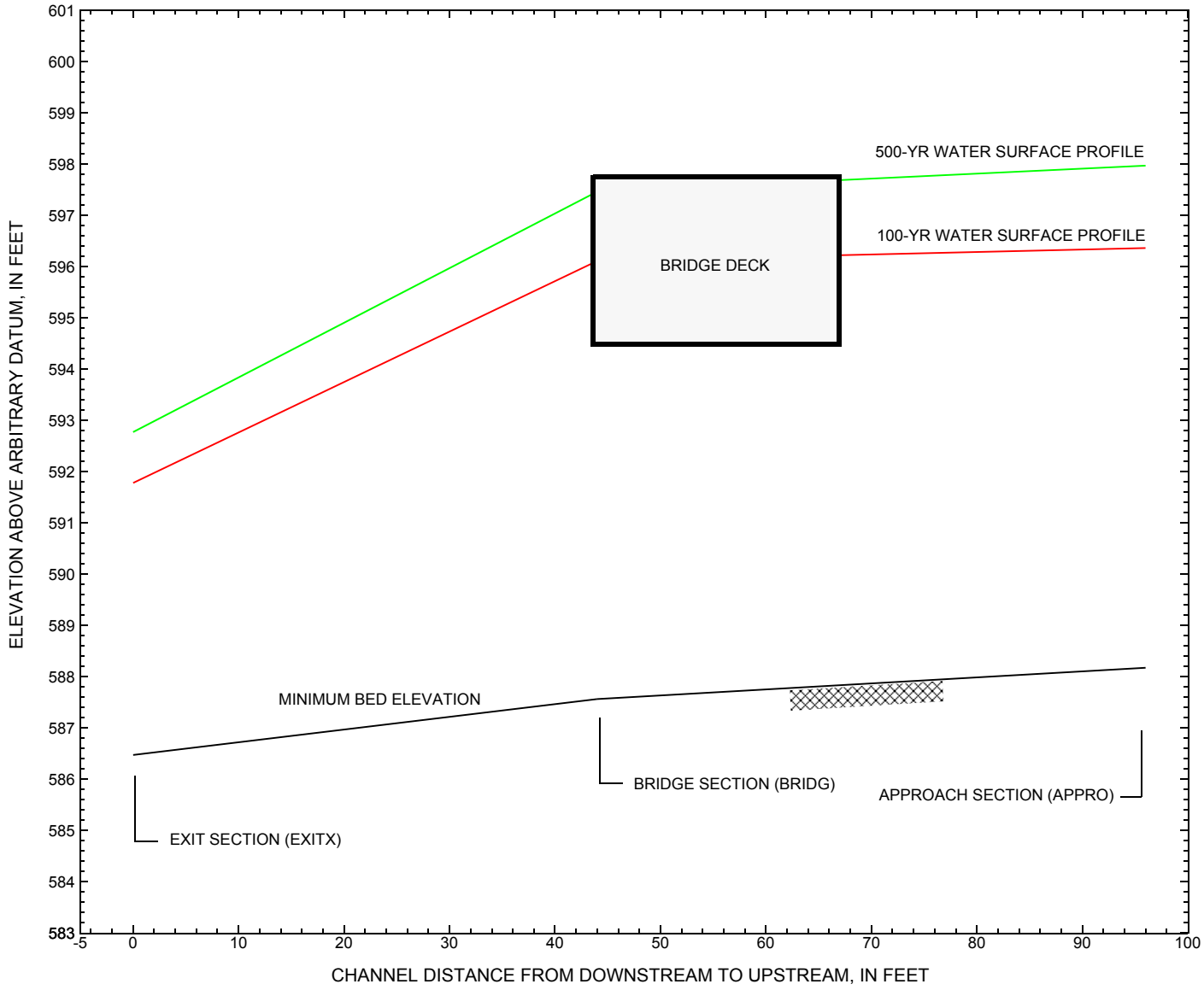


Figure 7. Water-surface profiles for the 100- and 500-yr discharges at structure NORWTH00120010 on town highway 12, crossing Bloody Brook, Norwich, Vermont.

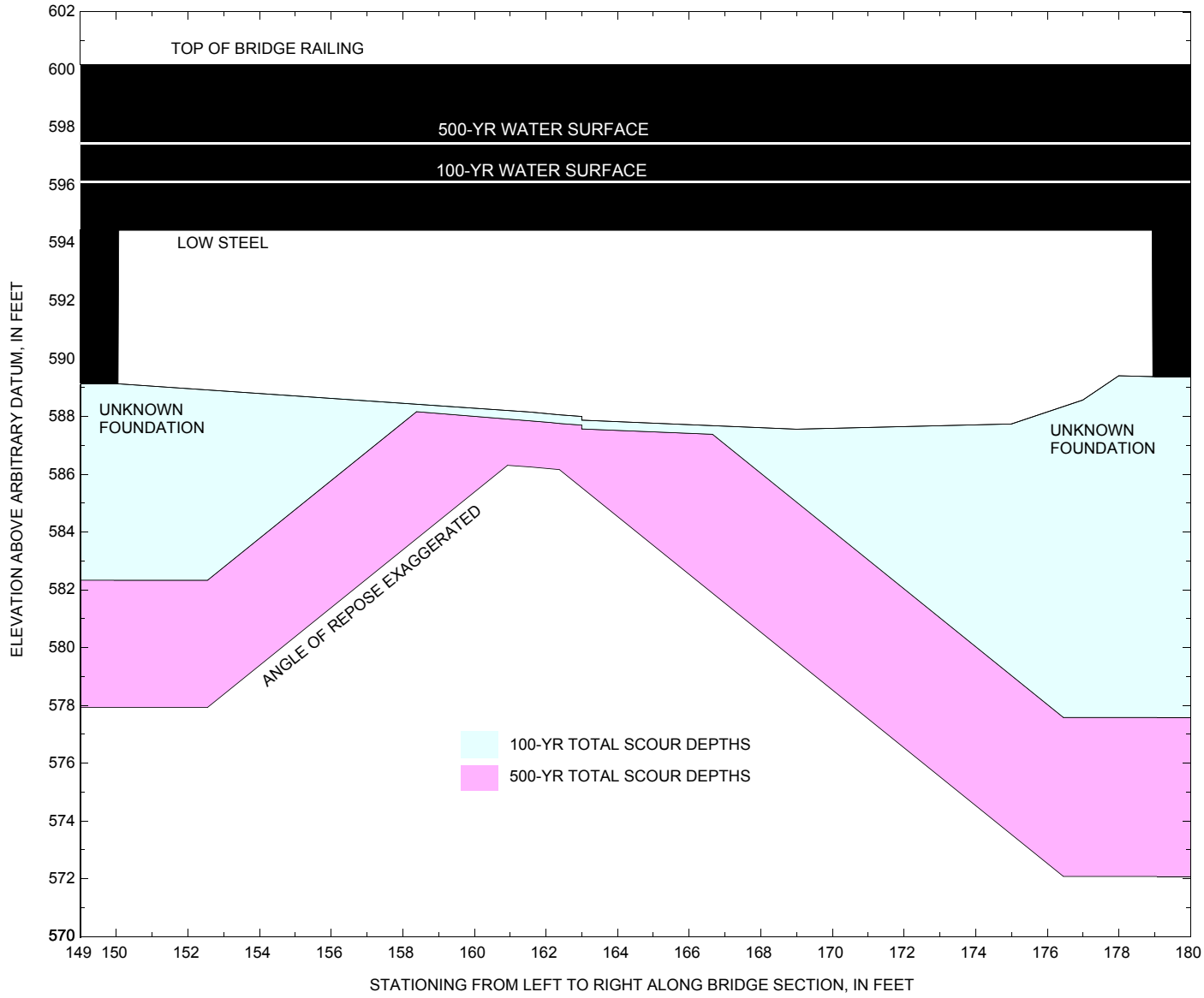


Figure 8. Scour elevations for the 100-yr and 500-yr discharges at structure NORWTH00120010 on town highway 12, crossing Bloody Brook, Norwich, Vermont.

Table 1. Remaining footing/pile depth at abutments for the 100-year discharge at structure NORWTH00120010 on Town Highway 12, crossing Bloody Brook, Norwich, 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 1,790 cubic-feet per second											
Left abutment	150	--	594.5	--	589.1	0.3	6.5	--	6.8	582.3	--
Right abutment	179	--	594.5	--	589.4	0.3	11.5	--	11.8	577.6	--

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 NORWTH00120010 on Town Highway 12, crossing Bloody Brook, Norwich, 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 3,040 cubic-feet per second											
Left abutment	150	--	594.5	--	589.1	1.9	9.3	--	11.2	577.9	--
Right abutment	179	--	594.5	--	589.4	1.9	15.4	--	17.3	572.1	--

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

SELECTED REFERENCES

Arcement, G.J., Jr., and Schneider, V.R., 1989, Guide for selecting Manning's roughness coefficients for natural channels and flood plains: U.S. Geological Survey Water-Supply Paper 2339, 38 p.

Barnes, H.H., Jr., 1967, Roughness characteristics of natural channels: U.S. Geological Survey Water-Supply Paper 1849, 213 p.

Brown, S.A. and Clyde, E.S., 1989, Design of riprap revetment: Federal Highway Administration Hydraulic Engineering Circular No. 11, Publication FHWA-IP-89-016, 156 p.

Federal Emergency Management Agency, 1988, Flood Insurance Study, Town of Norwich, Windsor County, Vermont: Washington, D.C., June 15, 1988.

Froehlich, D.C., 1989, Local scour at bridge abutments *in* Ports, M.A., ed., Hydraulic Engineering--Proceedings of the 1989 National Conference on Hydraulic Engineering: New York, American Society of Civil Engineers, p. 13-18.

Hayes, D.C.,1993, Site selection and collection of bridge-scour data in Delaware, Maryland, and Virginia: U.S. Geological Survey Water-Resources Investigation Report 93-4017, 23 p.

Laursen, E.M., 1960, Scour at bridge crossings: Journal of the Hydraulics Division, American Society of Civil Engineers, v. 86, no. HY2, p. 39-53.

Richardson, E.V. and Davis, S.R., 1995, Evaluating scour at bridges: Federal Highway Administration Hydraulic Engineering Circular No. 18, Publication FHWA-IP-90-017, 204 p.

Richardson, E.V., Harrison, L.J., Richardson, J.R., and Davis, S.R., 1993, Evaluating scour at bridges: Federal Highway Administration Hydraulic Engineering Circular No. 18, Publication FHWA-IP-90-017, 131 p.

Richardson, E.V., Simons, D.B., and Julien, P.Y., 1990, Highways in the river environment: Federal Highway Administration Publication FHWA-HI-90-016.

Ritter, D.F., 1984, Process Geomorphology: W.C. Brown Co., Debuque, Iowa, 603 p.

Shearman, J.O., 1990, User's manual for WSPRO--a computer model for water surface profile computations: Federal Highway Administration Publication FHWA-IP-89-027, 187 p.

Shearman, J.O., Kirby, W.H., Schneider, V.R., and Flippo, H.N., 1986, Bridge waterways analysis model; research report: Federal Highway Administration Publication FHWA-RD-86-108, 112 p.

U.S. Department of Transportation, 1993, Stream stability and scour at highway bridges, Participant Workbook: Federal Highway Administration Publication FHWA HI-91-011.

U.S. Geological Survey, 1959, Hanover, NH-VT 7.5 Minute Series quadrangle map: U.S. Geological Survey Topographic Maps, Scale 1:24,000.

APPENDIX A:

WSPRO INPUT FILE

WSPRO INPUT FILE

```
T1            HYDRAULIC ANALYSIS
T2            Norwich, VT BRIDGE #010
T3            USGS  BOW,NH   04/03/95
*
J1            * * 0.005
J3            6 29 30 28 17 13 23 3 * 5 15 14 7 4 11 12 3
*
Q             1246 1790 3040
SK            0.014 0.014 0.014
*
XS   EXIT      0
GR            22., 593.77      40., 591.38      56., 592.20      66., 591.72
GR            73., 590.75      97., 590.29     102., 589.85     120., 589.73
GR           132., 589.53     146., 590.22     150., 589.50     154., 588.25
GR           156., 587.07     158., 588.29     165., 586.99     169., 586.47
GR           174., 587.10     182., 587.52     189., 590.11     201., 591.24
GR           237., 591.43     248., 592.16     272., 592.67     283., 593.39
GR           298., 593.52     312., 594.15     316., 595.78
N             0.090        0.050        0.090
SA                 146.         189.
*
XS   FV       44 * * * 0.014
*
BR   BRO      44 594.5
GR           150., 594.53     150., 589.13     158., 588.51     163., 588.00
GR           163., 587.87     169., 587.56     175., 587.74     177., 588.57
GR           178., 589.41     179., 589.38     179., 594.48     150., 594.53
CD           4 23 1.9 597.7 50
N             0.035
*
XR   RD       56 23
GR            28., 594.66      51., 594.95      99., 596.11     150., 597.58
GR           150., 600.19     184., 600.19     184., 597.80     192., 597.84
GR           275., 597.43     417., 603.54     533., 613.72
BP           160
*
*             road overflow will begin way to the left. note bridge
*             railings are concrete and will block flow
*
XT   SURVA    110
GR           -33., 598.60     -24., 595.63     -13., 595.78     -10., 594.15
GR            -9., 595.07      18., 594.82      31., 594.31      32., 594.30
GR            44., 593.07      66., 593.33      75., 594.11     118., 593.74
GR           125., 593.07     129., 592.07     135., 594.93     135., 594.92
GR           147., 590.88     150., 589.04     154., 588.41     159., 588.49
GR           161., 588.49     165., 588.73     166., 589.08     166., 589.66
GR           181., 589.61     185., 590.98     197., 591.78     207., 593.40
GR           218., 592.65     248., 592.30     288., 594.53     304., 595.30
GR           337., 599.39     369., 600.18     411., 606.67
*
AS   APPR     96
GT            -0.24
```

WSPRO INPUT FILE (continued)

```
N              0.080     0.050       0.040
SA                 135.         197.
BP            150
*



HP 1 BRO   594.50 1 594.50
HP 2 RD    595.31 * * 43
HP 1 APPR  595.41 1 595.41
HP 2 APPR  595.41 * * 1246
*
HP 1 BRO   594.50 1 594.50
HP 2 BRO   594.50 * * 1535
HP 2 RD    596.11 * * 260
HP 1 APPR  596.36 1 596.36
HP 2 APPR  596.36 * * 1790
*
HP 1 BRO   594.53 1 594.53
HP 2 BRO   594.53 * * 1855
HP 2 RD    597.46 * * 1177
HP 1 APPR  597.97 1 597.97
HP 2 APPR  597.97 * * 3040
*
EX
ER
```

APPENDIX B:

WSPRO OUTPUT FILE

WSPRO OUTPUT FILE

```
           HYDRAULIC ANALYSIS
           Norwich, VT BRIDGE #010
           USGS  BOW,NH   04/03/95
          *** RUN DATE & TIME: 04-19-95  10:55
    CROSS-SECTION PROPERTIES:  ISEQ =  3;  SECID = BRO  ;  SRD =      44.
     WSEL  SA#     AREA        K   TOPW   WETP  ALPH    LEW    REW     QCR
             1     182.   17867.    17.    52.                       3331.
   594.50          182.   17867.    17.    52.  1.00   150.   179.   3331.

    CROSS-SECTION PROPERTIES:  ISEQ =  5;  SECID = APPR ;  SRD =      96.
     WSEL  SA#     AREA        K   TOPW   WETP  ALPH    LEW    REW     QCR
             1     248.    6413.   149.   151.                      1809.
             2     326.   28700.    62.    64.                      4239.
             3     256.   16779.   110.   110.                      2223.
   595.41          830.   51891.   321.   325.  1.47   -24.   307.   6238.

    VELOCITY DISTRIBUTION:  ISEQ =  5;  SECID = APPR ;  SRD =      96.
        WSEL     LEW     REW    AREA        K        Q    VEL
      595.41   -24.1   306.8   829.8   51891.    1246.   1.50
X STA.       -24.1       64.7      118.3      145.9      151.5      155.3
  A(I)           112.1       95.1       68.4       32.4       27.1
  V(I)            0.56       0.66       0.91       1.92       2.30

X STA.       155.3      158.9      162.4      166.4      170.9      175.3
  A(I)            25.8       24.7       27.6       26.7       26.7
  V(I)            2.42       2.52       2.26       2.34       2.33

X STA.       175.3      179.7      185.0      192.3      201.2      215.5
  A(I)            26.5       29.3       32.3       33.8       37.3
  V(I)            2.35       2.13       1.93       1.85       1.67

X STA.       215.5      227.0      237.8      248.7      262.6      306.8
  A(I)            34.8       34.0       35.8       40.9       58.6
  V(I)            1.79       1.83       1.74       1.52       1.06

           HYDRAULIC ANALYSIS
           Norwich, VT BRIDGE #010
           USGS  BOW,NH   04/03/95
          *** RUN DATE & TIME: 04-19-95  10:55
    VELOCITY DISTRIBUTION:  ISEQ =  3;  SECID = BRO  ;  SRD =      44.
        WSEL     LEW     REW    AREA        K        Q    VEL
      594.50   150.0   179.0   181.7   17867.    1535.   8.45
X STA.       150.0      152.7      154.2      155.6      156.9      158.1
  A(I)            14.7        8.7        8.1        7.4        7.3
  V(I)            5.24       8.78       9.48      10.39      10.54

X STA.       158.1      159.3      160.4      161.5      162.6      163.7
  A(I)             7.1        7.0        6.9        7.0        7.2
  V(I)           10.74      10.93      11.09      11.03      10.72

X STA.       163.7      164.8      165.8      166.9      168.2      169.6
  A(I)             7.0        7.1        7.2        8.8       10.1
  V(I)           10.89      10.81      10.59       8.68       7.62

X STA.       169.6      171.1      172.6      174.2      175.9      179.0
  A(I)            10.1       10.2       10.8       11.4       17.4
  V(I)            7.57       7.52       7.08       6.73       4.42

    VELOCITY DISTRIBUTION:  ISEQ =  4;  SECID = RD   ;  SRD =      56.
        WSEL     LEW     REW    AREA        K        Q    VEL
      596.11    28.0    99.0    57.9     824.     260.   4.49
X STA.        28.0       30.0       31.5       33.0       34.5       36.1
  A(I)             2.9        2.1        2.1        2.1        2.1
  V(I)            4.54       6.27       6.07       6.10       6.17

X STA.        36.1       37.7       39.4       41.2       43.0       45.0
  A(I)             2.2        2.2        2.3        2.3        2.4
  V(I)            5.95       5.80       5.63       5.58       5.34

X STA.        45.0       47.0       49.2       51.5       54.0       56.8
  A(I)             2.5        2.6        2.7        2.8        3.0
  V(I)            5.23       5.02       4.89       4.59       4.38

X STA.        56.8       60.1       64.0       68.8       75.8       99.0
  A(I)             3.2        3.4        3.8        4.5        6.5
  V(I)            4.01       3.77       3.41       2.89       2.00
```

WSPRO OUTPUT FILE (continued)

```
    CROSS-SECTION PROPERTIES:  ISEQ =  5;  SECID = APPR ;  SRD =      96.
     WSEL  SA#     AREA        K   TOPW   WETP  ALPH    LEW    REW     QCR
             1     399.   13478.   162.   164.                        3559.
             2     385.   37856.    62.    64.                        5439.
             3     364.   28810.   117.   118.                        3641.
   596.36         1149.   80143.   341.   346.  1.44   -27.   314.   9961.

    VELOCITY DISTRIBUTION:  ISEQ =  5;  SECID = APPR ;  SRD =      96.
        WSEL     LEW     REW    AREA        K        Q    VEL
      596.36   -26.9   314.5  1148.5   80143.    1790.   1.56
X STA.       -26.9       48.6       84.6      124.2      146.4      152.4
  A(I)           142.8      108.9      110.2       78.3       42.1
  V(I)            0.63       0.82       0.81       1.14       2.12

X STA.       152.4      157.0      161.3      165.7      171.3      176.7
  A(I)            37.0       35.1       35.4       38.9       37.6
  V(I)            2.42       2.55       2.53       2.30       2.38

X STA.       176.7      182.2      189.7      198.5      211.2      222.7
  A(I)            38.0       42.8       44.3       46.9       44.0
  V(I)            2.36       2.09       2.02       1.91       2.04

X STA.       222.7      233.9      244.4      255.9      271.4      314.5
  A(I)            45.4       44.4       47.4       53.3       75.7
  V(I)            1.97       2.01       1.89       1.68       1.18

          HYDRAULIC ANALYSIS
          Norwich, VT BRIDGE #010
          USGS  BOW,NH   04/03/95
         *** RUN DATE & TIME: 04-19-95  10:55
    CROSS-SECTION PROPERTIES:  ISEQ =  3;  SECID = BRO  ;  SRD =      44.
     WSEL  SA#     AREA        K   TOPW   WETP  ALPH    LEW    REW     QCR
             1     182.   14758.     0.    69.                         0.
   594.53          182.   14758.     0.    69.  1.00   150.   179.      0.

    VELOCITY DISTRIBUTION:  ISEQ =  3;  SECID = BRO  ;  SRD =      44.
        WSEL     LEW     REW    AREA        K        Q    VEL
      594.53   150.0   179.0   181.9   14758.    1855.  10.20
X STA.       150.0      152.6      154.4      156.0      157.6      159.0
  A(I)            14.5       10.2        9.2        9.1        8.5
  V(I)            6.38       9.14      10.12      10.21      10.93

X STA.       159.0      160.4      161.7      163.0      164.2      165.4
  A(I)             8.7        8.4        8.2        8.2        8.0
  V(I)           10.70      11.03      11.37      11.34      11.59

X STA.       165.4      166.5      167.7      168.8      170.0      171.1
  A(I)             7.8        7.9        7.8        7.9        8.1
  V(I)           11.82      11.72      11.90      11.67      11.51

X STA.       171.1      172.3      173.5      174.8      176.3      179.0
  A(I)             8.2        8.3        8.8        9.7       14.6
  V(I)           11.32      11.23      10.59       9.52       6.36

    VELOCITY DISTRIBUTION:  ISEQ =  4;  SECID = RD   ;  SRD =      56.
        WSEL     LEW     REW    AREA        K        Q    VEL
      597.46    28.0   275.7   185.4    4084.    1177.   6.35
X STA.        28.0       31.4       33.9       36.4       38.9       41.5
  A(I)            9.4        6.8        6.8        6.7        6.9
  V(I)            6.27       8.63       8.71       8.73       8.58

X STA.        41.5       44.2       46.9       49.7       52.7       55.9
  A(I)            7.1        7.1        7.1        7.5        7.7
  V(I)            8.33       8.31       8.26       7.88       7.62

X STA.        55.9       59.3       63.0       67.0       71.4       76.4
  A(I)            8.0        8.4        8.7        9.2        9.7
  V(I)            7.38       6.98       6.79       6.42       6.06

X STA.        76.4       82.0       88.6       96.8      108.3      275.7
  A(I)           10.3       11.2       12.2       14.3       20.5
  V(I)            5.74       5.26       4.81       4.12       2.88
```

WSPRO OUTPUT FILE (continued)

```
    CROSS-SECTION PROPERTIES:  ISEQ =  5;  SECID = APPR ;  SRD =      96.
     WSEL  SA#     AREA        K   TOPW   WETP  ALPH    LEW    REW     QCR
             1     664.   30807.   167.   169.                       7518.
             2     485.   55602.    62.    64.                       7688.
             3     564.   55623.   130.   131.                       6653.
   597.97         1713.  142031.   359.   364.  1.37   -32.   327.  18120.

    VELOCITY DISTRIBUTION:  ISEQ =  5;  SECID = APPR ;  SRD =      96.
        WSEL     LEW     REW    AREA        K        Q    VEL
      597.97   -31.8   327.5  1712.6  142031.    3040.   1.78
X STA.       -31.8       30.5       61.1       94.0      125.6      146.1
  A(I)            184.7      146.2      144.0      141.4      105.2
  V(I)             0.82       1.04       1.06       1.08       1.44

X STA.       146.1      153.4      159.0      164.6      171.5      178.2
  A(I)             63.0       54.8       53.5       60.4       57.6
  V(I)             2.41       2.77       2.84       2.52       2.64

X STA.       178.2      185.5      195.3      205.9      218.5      229.6
  A(I)             59.8       67.1       61.9       65.3       62.2
  V(I)             2.54       2.27       2.45       2.33       2.45

X STA.       229.6      240.8      251.7      265.0      282.0      327.5
  A(I)             64.8       63.8       70.5       76.5      110.0
  V(I)             2.34       2.38       2.16       1.99       1.38

           HYDRAULIC ANALYSIS
           Norwich, VT BRIDGE #010
           USGS  BOW,NH   04/03/95
          *** RUN DATE & TIME: 04-19-95  10:55

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

EXIT :XS   ******    70.     230.  0.77 *****  591.95  591.00   1246.  591.17
        0. ******   200.   10521.  1.69 ***** *******    0.94    5.42

 ===125 FR# EXCEEDS FNTEST AT SECID "FV   ":  TRIALS CONTINUED.
              FNTEST,FR#,WSEL,CRWS =  0.80    0.92     591.82     591.62

 ===110 WSEL NOT FOUND AT SECID "FV   ":  REDUCED DELTAY.
                   WSLIM1,WSLIM2,DELTAY =   590.67     596.40    0.50

 ===115 WSEL NOT FOUND AT SECID "FV   ":  USED WSMIN = CRWS.
                   WSLIM1,WSLIM2,CRWS =   590.67     596.40     591.62

FV   :FV      44.    70.     232.  0.76  0.61  592.57  591.62   1246.  591.80
       44.    44.   200.   10619.  1.69  0.00    0.01    0.93    5.38
         <<<<<THE ABOVE RESULTS REFLECT "NORMAL" (UNCONSTRICTED) FLOW>>>>>
 ===125 FR# EXCEEDS FNTEST AT SECID "APPR ":  TRIALS CONTINUED.
              FNTEST,FR#,WSEL,CRWS =  0.80    1.07     592.55     592.52

 ===110 WSEL NOT FOUND AT SECID "APPR ":  REDUCED DELTAY.
                   WSLIM1,WSLIM2,DELTAY =   591.30     606.43    0.50

 ===115 WSEL NOT FOUND AT SECID "APPR ":  USED WSMIN = CRWS.
                   WSLIM1,WSLIM2,CRWS =   591.30     606.43     592.52

APPR :AS      52.   126.     172.  0.91  0.82  593.47  592.52   1246.  592.55
       96.    52.   257.    9275.  1.12  0.08    0.01    1.07    7.24
         <<<<<THE ABOVE RESULTS REFLECT "NORMAL" (UNCONSTRICTED) FLOW>>>>>

 ===220 FLOW CLASS 1 (4) SOLUTION INDICATES POSSIBLE PRESSURE FLOW.
           WS3,WSIU,WS1,LSEL =   592.09     594.50     594.64     594.50

 ===245 ATTEMPTING 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

BRO  :BR      44.   150.     182.  0.68 *****  595.18  592.01   1203.  594.50
```

WSPRO OUTPUT FILE (continued)

```
       44. ******   179.   17851.  1.00 ***** *******    0.47    6.62

     TYPE PPCD FLOW      C    P/A    LSEL   BLEN   XLAB   XRAB
       4. ****   5.  0.411  0.000  594.50 ****** ****** ******


    XSID:CODE    SRD   FLEN    HF   VHD     EGL     ERR       Q    WSEL
   RD   :RG      56.    29.  0.02  0.05  595.44    0.00     43.  595.31

            Q   WLEN    LEW    REW  DMAX  DAVG  VMAX  VAVG  HAVG  CAVG
   LT:     43.    38.    28.    66.   0.7   0.4   3.4   3.0   0.5   3.1
   RT:      0.   139.   184.   323.   2.1   1.6   7.3   7.9   2.5   3.1

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

APPR :AS      29.   -24.     829.  0.05  0.05  595.46  592.52   1246.  595.41
       96.    31.   307.   51860.  1.47  0.43    0.00    0.20    1.50

                          <<<<<END OF BRIDGE COMPUTATIONS>>>>>

  FIRST USER DEFINED TABLE.

    XSID:CODE    SRD    LEW    REW   XSTW     AREA     VEL    YMIN    WSEL
   EXIT :XS       0.    70.   200.   130.     230.    5.42  586.47  591.17
   FV   :FV      44.    70.   200.   131.     232.    5.38  587.09  591.80
   BRO  :BR      44.   150.   179.    17.     182.    6.62  587.56  594.50
   RD   :RG      56.*******    43.*******       0.    1.00  594.66  595.31
   APPR :AS      96.   -24.   307.   321.     829.    1.50  588.17  595.41   SECOND USER DEFINED TABLE.

    XSID:CODE       Q    CRWS     FR#     EGL  VHD     HF    HO    WSEL
   EXIT :XS     1246.  591.00    0.94  591.95  0.77************  591.17
   FV   :FV     1246.  591.62    0.93  592.57  0.76  0.61  0.00  591.80
   BRO  :BR     1203.  592.01    0.47  595.18  0.68************  594.50
   RD   :RG       43.****************  595.44  0.05  0.02******  595.31
   APPR :AS     1246.  592.52    0.20  595.46  0.05  0.05  0.43  595.41

           HYDRAULIC ANALYSIS
           Norwich, VT BRIDGE #010
           USGS  BOW,NH   04/03/95
          *** RUN DATE & TIME: 04-19-95  10:55

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

EXIT :XS   ******    37.     330.  0.91 *****  592.69  591.60   1790.  591.78
        0. ******   242.   15116.  1.98 ***** *******    1.02    5.42

 ===125 FR# EXCEEDS FNTEST AT SECID "FV   ":  TRIALS CONTINUED.
             FNTEST,FR#,WSEL,CRWS =  0.80    1.00     592.43     592.21

 ===110 WSEL NOT FOUND AT SECID "FV   ":  REDUCED DELTAY.
                  WSLIM1,WSLIM2,DELTAY =   591.28     596.40    0.50

 ===115 WSEL NOT FOUND AT SECID "FV   ":  USED WSMIN = CRWS.
                  WSLIM1,WSLIM2,CRWS =   591.28     596.40     592.21

FV   :FV      44.    37.     334.  0.89  0.61  593.31  592.21   1790.  592.42
       44.    44.   243.   15269.  1.99  0.00    0.01    1.01    5.36
         <<<<<THE ABOVE RESULTS REFLECT "NORMAL" (UNCONSTRICTED) FLOW>>>>>

 ===125 FR# EXCEEDS FNTEST AT SECID "APPR ":  TRIALS CONTINUED.
             FNTEST,FR#,WSEL,CRWS =  0.80    1.14     593.16     593.26

 ===110 WSEL NOT FOUND AT SECID "APPR ":  REDUCED DELTAY.
                  WSLIM1,WSLIM2,DELTAY =   591.92     606.43    0.50

 ===115 WSEL NOT FOUND AT SECID "APPR ":  USED WSMIN = CRWS.
                  WSLIM1,WSLIM2,CRWS =   591.92     606.43     593.26



 ===130 CRITICAL WATER-SURFACE ELEVATION  A _ S _ S _ U _ M _ E _ D  !!!!!
              ENERGY EQUATION  N_O_T  B_A_L_A_N_C_E_D  AT SECID "APPR "
                   WSBEG,WSEND,CRWS =   593.26     606.43     593.26
```

WSPRO OUTPUT FILE (continued)

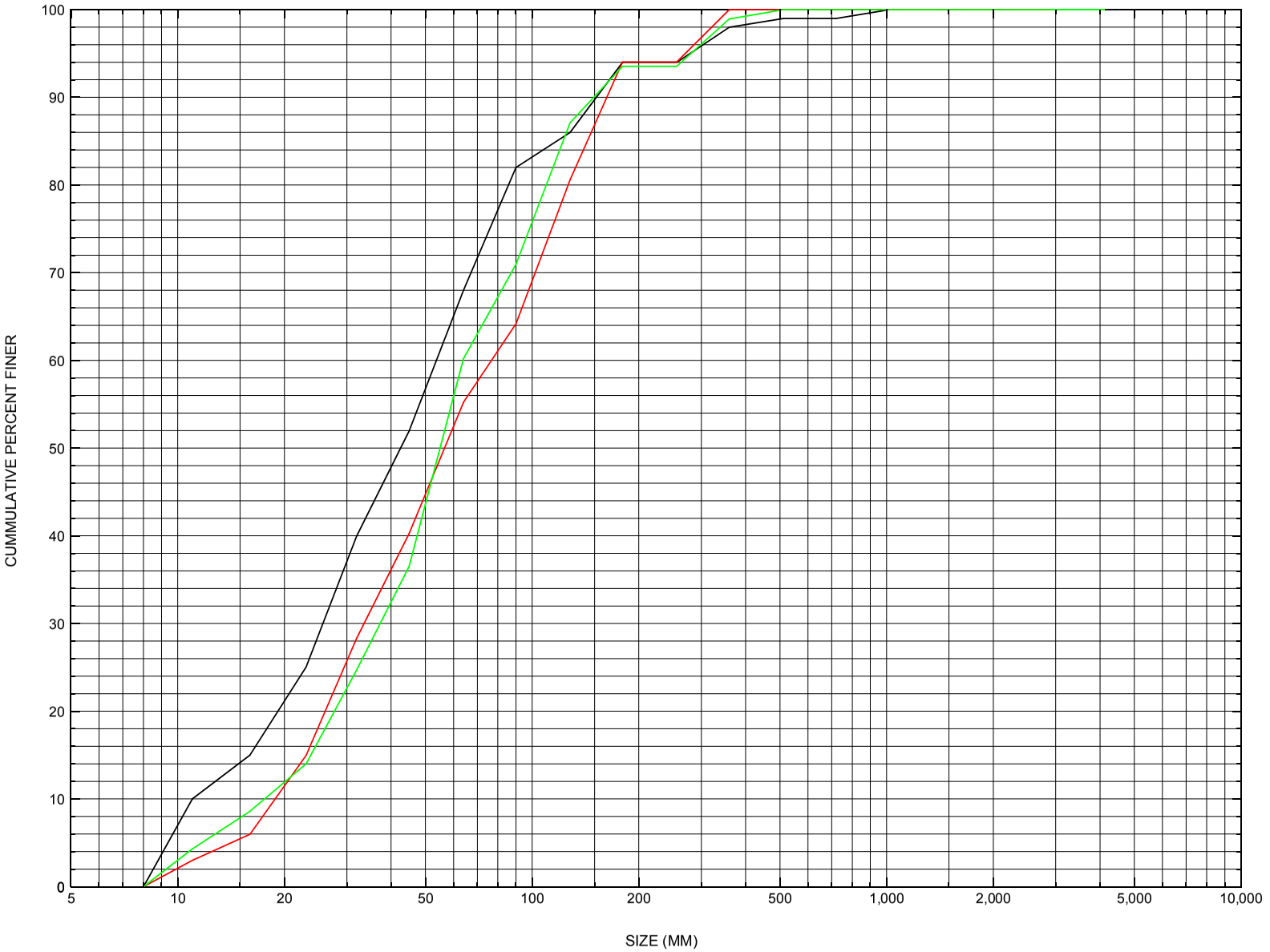
```
APPR :AS      52.    40.     269.  0.87 *****  594.13  593.26   1790.  593.26
       96.    52.   270.   14880.  1.26 ***** *******    1.05    6.67
         <<<<<THE ABOVE RESULTS REFLECT "NORMAL" (UNCONSTRICTED) FLOW>>>>>

 ===215 FLOW CLASS 1 SOLUTION INDICATES POSSIBLE ROAD OVERFLOW.
           WS1,WSSD,WS3,RGMIN =   596.36       0.00     593.14     594.66

 ===260 ATTEMPTING FLOW CLASS 4 SOLUTION.

 ===240 NO DISCHARGE BALANCE IN 15 ITERATIONS.
                   WS,QBO,QRD =   598.46         0.      1790.

 ===280 REJECTED FLOW CLASS 4 SOLUTION.

 ===245 ATTEMPTING 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
BRO  :BR      44.   150.      182.  1.11 *****  595.61  592.67   1535.  594.50
       44. ******   179.   17867.  1.00 ***** *******    0.60    8.45

     TYPE PPCD FLOW      C    P/A    LSEL   BLEN   XLAB   XRAB
       4. ****   5.  0.472  0.000  594.50 ****** ****** ******

    XSID:CODE    SRD   FLEN    HF   VHD     EGL     ERR       Q    WSEL
   RD   :RG      56.    29.  0.01  0.05  596.40    0.00    260.  596.11

            Q   WLEN    LEW    REW  DMAX  DAVG  VMAX  VAVG  HAVG  CAVG
   LT:    260.    71.    28.    99.   1.5   0.8   5.0   4.5   1.1   3.1
   RT:      0.   139.   184.   323.   2.1   1.6   7.3   7.9   2.5   3.1

 XSID:CODE   SRDL    LEW     AREA   VHD    HF     EGL    CRWS       Q    WSEL
       SRD   FLEN    REW        K  ALPH    HO     ERR     FR#     VEL
APPR :AS      29.   -27.    1150.  0.05  0.07  596.42  593.26   1790.  596.36
       96.    34.   315.   80277.  1.44  0.00    0.00    0.18    1.56

  FIRST USER DEFINED TABLE.
    XSID:CODE    SRD    LEW    REW   XSTW     AREA     VEL    YMIN    WSEL
   EXIT :XS       0.    37.   242.   189.     330.    5.42  586.47  591.78
   FV   :FV      44.    37.   243.   190.     334.    5.36  587.09  592.42
   BRO  :BR      44.   150.   179.    17.     182.    8.45  587.56  594.50
   RD   :RG      56.*******   260.*******       0.    1.00  594.66  596.11
   APPR :AS      96.   -27.   315.   341.    1150.    1.56  588.17  596.36
 SECOND USER DEFINED TABLE.
    XSID:CODE       Q    CRWS     FR#     EGL  VHD     HF    HO    WSEL
   EXIT :XS     1790.  591.60    1.02  592.69  0.91************  591.78
   FV   :FV     1790.  592.21    1.01  593.31  0.89  0.61  0.00  592.42
   BRO  :BR     1535.  592.67    0.60  595.61  1.11************  594.50
   RD   :RG      260.****************  596.40  0.05  0.01******  596.11
   APPR :AS     1790.  593.26    0.18  596.42  0.05  0.07  0.00  596.36

           HYDRAULIC ANALYSIS
           Norwich, VT BRIDGE #010
           USGS  BOW,NH   04/03/95
          *** RUN DATE & TIME: 04-19-95  10:55
 XSID:CODE   SRDL    LEW     AREA   VHD    HF     EGL    CRWS       Q    WSEL
       SRD   FLEN    REW        K  ALPH    HO     ERR     FR#     VEL
EXIT :XS   ******    30.      547.  1.08 *****  593.85  592.75   3040.  592.77
       0. ******   274.   25675.  2.24 ***** *******    0.98    5.56

 ===125 FR# EXCEEDS FNTEST AT SECID "FV   ":  TRIALS CONTINUED.
             FNTEST,FR#,WSEL,CRWS =  0.80    0.96     593.42     593.37

 ===110 WSEL NOT FOUND AT SECID "FV   ":  REDUCED DELTAY.
                   WSLIM1,WSLIM2,DELTAY =   592.27     596.40    0.50

 ===115 WSEL NOT FOUND AT SECID "FV   ":  USED WSMIN = CRWS.
                   WSLIM1,WSLIM2,CRWS =   592.27     596.40     593.37


FV   :FV      44.    30.      542.  1.10  0.62  594.46  593.37   3040.  593.37
       44.    44.   273.   25414.  2.24  0.01   -0.02    0.99    5.61
         <<<<<THE ABOVE RESULTS REFLECT "NORMAL" (UNCONSTRICTED) FLOW>>>>>
```

WSPRO OUTPUT FILE (continued)

```
 ===125 FR# EXCEEDS FNTEST AT SECID "APPR ":  TRIALS CONTINUED.
              FNTEST,FR#,WSEL,CRWS =  0.80    0.94     594.29     594.15

 ===110 WSEL NOT FOUND AT SECID "APPR ":  REDUCED DELTAY.
                   WSLIM1,WSLIM2,DELTAY =   592.87     606.43    0.50

 ===115 WSEL NOT FOUND AT SECID "APPR ":  USED WSMIN = CRWS.
                   WSLIM1,WSLIM2,CRWS =   592.87     606.43     594.15

APPR :AS      52.   -11.     491.  0.85  0.68  595.12  594.15   3040.  594.27
       96.    52.   288.   28012.  1.42  0.00   -0.02    0.95    6.20
         <<<<<THE ABOVE RESULTS REFLECT "NORMAL" (UNCONSTRICTED) FLOW>>>>>
 XSID:CODE   SRDL    LEW     AREA   VHD    HF     EGL    CRWS       Q    WSEL
       SRD   FLEN    REW        K  ALPH    HO     ERR     FR#     VEL
BRO  :BR      44.   150.     182.  1.62 *****  596.15  593.26   1855.  594.53
       44. ******   179.   14758.  1.00 ***** *******    0.72   10.19

     TYPE PPCD FLOW      C    P/A    LSEL   BLEN   XLAB   XRAB
       4. ****   5.  0.496  0.000  594.50 ****** ****** ******

    XSID:CODE    SRD   FLEN    HF   VHD     EGL     ERR       Q    WSEL
   RD   :RG      56.    29.  0.01  0.07  598.03    0.00   1188.  597.46

            Q   WLEN    LEW    REW  DMAX  DAVG  VMAX  VAVG  HAVG  CAVG
   LT:   1177.   118.    28.   146.   2.8   1.6   7.0   6.3   2.1   3.2
   RT:     10.     8.   268.   276.   0.0   0.0   3.4  76.7   0.6   3.0

 XSID:CODE   SRDL    LEW     AREA   VHD    HF     EGL    CRWS       Q    WSEL
       SRD   FLEN    REW        K  ALPH    HO     ERR     FR#     VEL
APPR :AS      29.   -32.    1713.  0.07  0.11  598.04  594.15   3040.  597.97
       96.    37.   327.  142111.  1.37  0.34    0.00    0.17    1.77

  FIRST USER DEFINED TABLE.

    XSID:CODE    SRD    LEW    REW   XSTW     AREA     VEL    YMIN    WSEL
   EXIT :XS       0.    30.   274.   244.     547.    5.56  586.47  592.77
   FV   :FV      44.    30.   273.   244.     542.    5.61  587.09  593.37
   BRO  :BR      44.   150.   179.     0.     182.   10.19  587.56  594.53
   RD   :RG      56.******* 1177.*******       0.    1.00  594.66  597.46
   APPR :AS      96.   -32.   327.   359.    1713.    1.77  588.17  597.97
 SECOND USER DEFINED TABLE.

    XSID:CODE       Q    CRWS     FR#     EGL  VHD     HF    HO    WSEL
   EXIT :XS     3040.  592.75    0.98  593.85  1.08************  592.77
   FV   :FV     3040.  593.37    0.99  594.46  1.10  0.62  0.01  593.37
   BRO  :BR     1855.  593.26    0.72  596.15  1.62************  594.53
   RD   :RG     1188.**************** 598.03  0.07  0.01******  597.46
   APPR :AS     3040.  594.15    0.17  598.04  0.07  0.11  0.34  597.97
```

APPENDIX C:

BED-MATERIAL PARTICAL-SIZE DISTRIBUTION



Appendix C. Bed material particle-size distribution at the approach cross-section for structure NORWTH00120010, in Norwich, Vermont.

APPENDIX D:

HISTORICAL DATA FORM