LEVEL II SCOUR ANALYSIS FOR BRIDGE 37 (BRNETH00740037) on TOWN HIGHWAY 74, crossing SOUTH PEACHAM BROOK, BARNET, VERMONT

Open-File Report 97-815

Prepared in cooperation with

VERMONT AGENCY OF TRANSPORTATION

and

FEDERAL HIGHWAY ADMINISTRATION

U.S. Department of the Interior
U.S. Geological Survey

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By RONDA L. BURNS and TIM SEVERANCE

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Pembroke, New Hampshire

1997

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

U.S. GEOLOGICAL SURVEY
Mark Schaefer, Acting Director

For additional information
write to:

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

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CONTENTS

FIGURES

TABLES

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 37 (BRNETH00740037) ON TOWN HIGHWAY 74, CROSSING SOUTH PEACHAM BROOK, BARNET, VERMONT

By **Ronda L. Burns and Tim Severance**

INTRODUCTION AND SUMMARY OF RESULTS

This report provides the results of a detailed Level II analysis of scour potential at structure BRNETH00740037 on Town Highway 74 crossing South Peacham Brook, Barnet, Vermont (figures 1–8). A Level II study is a basic engineering analysis of the site, including a quantitative analysis of stream stability and scour (U.S. Department of Transportation, 1993). Results of a Level I scour investigation also are included in Appendix E of this report. A Level I investigation provides a qualitative geomorphic characterization of the study site. Information on the bridge, gleaned from Vermont Agency of Transportation (VTAOT) files, was compiled prior to conducting Level I and Level II analyses and is found in Appendix D.

The site is in the New England Upland section of the New England physiographic province in northeastern Vermont. The 12.1-mi^2 drainage area is in a predominantly rural and forested basin. In the vicinity of the study site, the surface cover is pasture upstream of the bridge and on the downstream left bank while the immediate banks have sparse shrubs and trees. Downstream of the bridge, the surface cover is shrub and brushland.

In the study area, South Peacham Brook has an incised, sinuous channel with a slope of approximately 0.004 ft/ft, an average channel top width of 33 ft and an average bank height of 3 ft. The channel bed material ranges from sand to cobble with a median grain size (D_{50}) of 0.914 mm (0.003 ft). The geomorphic assessment at the time of the Level I and Level II site visit on August 24, 1995, indicated that the reach was laterally unstable. There are cut-banks upstream and downstream of the bridge.

The Town Highway 74 crossing of South Peacham Brook is a 30-ft-long, two-lane bridge consisting of one 28-foot concrete slab span (Vermont Agency of Transportation, written communication, March 16, 1995). The opening length of the structure parallel to the bridge face is 25.7 ft. The bridge is supported by vertical, concrete abutments with wingwalls. The channel is skewed approximately 30 degrees to the opening while the computed opening-skew-to-roadway is 5 degrees.

A channel scour hole 2.0 ft deeper than the mean thalweg depth was observed at the upstream bridge face, along the upstream right wingwall protection, during the Level I assessment. The scour protection measures at the site included type-1 stone fill (less than 12 inches diameter) along the downstream left and right wingwalls, downstream banks, and at the downstream end of the left and right abutments. There is also type-2 stone fill (less than 36 inches diameter) along the upstream right bank and upstream right wingwall. Additional details describing conditions at the site are included in the Level II Summary and Appendices D
and E.

Scour depths and recommended rock rip-rap sizes were computed using the general guidelines described in Hydraulic Engineering Circular 18 (Richardson and others, 1995) for the 100- and 500-year discharges. In addition, the incipient roadway-overtopping discharge was determined and analyzed as another potential worst-case scour scenario. Total scour at a highway crossing is comprised of three components: 1) long-term streambed degradation; 2) contraction scour (due to accelerated flow caused by a reduction in flow area at a bridge) and; 3) local scour (caused by accelerated flow around piers and abutments). Total scour is the sum of the three components. Equations are available to compute depths for contraction and local scour and a summary of the results of these computations follows.

Contraction scour for all modelled flows ranged from 15.8 to 22.5 ft. The worst-case contraction scour occurred at the 500-year discharge. Abutment scour ranged from 6.7 to 11.1 ft. The worst-case abutment scour also occurred at the 500-year discharge. Additional information on scour depths and depths to armoring are included in the section titled "Scour Results". Scoured-streambed elevations, based on the calculated scour depths, are presented in Tables 1 and 2. A cross-section of the scour computed at the bridge is presented in Figure 8. Scour depths were calculated assuming an infinite depth of erosive material and a homogeneous particle-size distribution.

Usually, computed scour depths are evaluated in combination with other information including (but not limited to) historical performance during flood events, the geomorphic stability assessment, existing scour protection measures, and the results of the hydraulic analyses. Therefore, scour depths adopted by VTAOT may differ from the computed values documented herein.

Plymouth, VT. Quadrangle, 1:24,000, 1966
Photoinspected 1983

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 BRNETH00740037 ***Stream*** South Peacham Brook

County Caledonia ***Road*** TH 74 ***District*** 7

Description of Bridge

Bridge length 30 ***ft*** ***Bridge width*** 26.2 ***ft*** ***Max span length*** 28 ***ft***

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

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

Stone fill on abutment? Yes ***Date of inspection*** 8/24/95

Description of stone fill Type-1, along the downstream end of the left and right abutment and the downstream left and right wingwalls. Type-2, along the upstream right wingwall.

Abutments and wingwalls are concrete. There is a two foot deep scour hole in front of the protection for the upstream right wingwall.

Brief description of piers/abutments

Yes

Is bridge skewed to flood flow according to There ***survey?*** 30 ***Angle*** Yes

is a mild channel bend through the bridge. Cut-banks have developed in the location where the bend impacts the upstream right bank and downstream left bank.

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	8/24/95	0	0
Level II	8/24/95	0	0

Potential for debris Moderate. Some trees have fallen into the channel upstream and some debris is caught at the downstream bridge face.

Describe any features near or at the bridge that may affect flow (include observation date)

None as of 8/24/95.

Description of the Geomorphic Setting

General topography The channel is located within low relief valley with a wide flood plain.

8/24/95

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

Date of inspection Moderately

DS left: sloped overbank

DS right: Wide flood plain

US left: Moderately sloped overbank

US right: Wide flood plain

Description of the Channel

Average top width 33 ***ft*** ***Average depth*** 3 ***ft***

Predominant bed material Sand/Gravel ***Bank material*** Organics

Sinuous and unstable with alluvial channel boundaries and a wide flood plain.

8/24/95

Vegetative co

Shrubs and brush with grass on the overbank

DS left: Shrubs and brush

DS right: Few trees with lawn on the overbank

US left: Few trees with grass on the overbank

US right:

Do banks appear stable? No ***If not, describe location and type of instability and date of observation.***

The channel is vertically and laterally unstable as observed on 8/24/95. There are cut-banks on the upstream right bank and downstream left bank. There is also a channel scour hole at the upstream bridge face.

None as of 8/24/95.

Describe any obstructions in channel and date of observation.

Hydrology

Drainage area 12.1 ***mi²***

Percentage of drainage area in physiographic provinces: (approximate)

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

Is drainage area considered rural or urban? Rural ***Describe any significant urbanization***: There is a house on the upstream left overbank area.

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 1,800 ***ft³/s*** ***Q500*** 2,500 ***ft³/s***

The 100-year discharge is from flood frequency estimates available from the VTAOT database which were extended graphically to the 500-year discharge. The drainage area above bridge number 37 is reported as 12.5 square miles while the computed drainage area is 12.1 square miles. The values used were within a range defined by flood frequency curves developed from several empirical methods (Benson, 1962; Johnson and Tasker, 1974; FHWA, 1983; Potter, 1957a&b; Talbot, 1887).

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

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

Datum tie between USGS survey and VTAOT plans The VTAOT plans' datum was obtained by adding 1.75 to the USGS arbitrary survey datum.

Description of reference marks used to determine USGS datum. RM1 is a chiseled X on top of the downstream right corner of the bridge deck (elev. 499.88 ft, VTAOT plans' datum). RM2 is a chiseled X on top of the upstream end of the right abutment (elev. 499.84 ft, VTAOT plans' datum).

Cross-Sections Used in WSPRO Analysis

[1]*Cross-section*	*Section Reference Distance (SRD) in feet*	[2]*Cross-section development*	*Comments*
EXITX	-33	1	Exit section
FULLV	0	2	Downstream Full-valley section (Templated from EXITX)
BRIDG	0	1	Bridge section
RDWAY	14	1	Road Grade section
APPR1	54	1	Approach section

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

Data and Assumptions Used in WSPRO Model

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

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

Normal depth at the exit section (EXITX) was assumed as the starting water surface. This depth was computed by use of the slope-conveyance method outlined in the user's manual for WSPRO (Shearman, 1990). The slope used was 0.0042 ft/ft, which was estimated from the topographic map (U.S. Geological Survey, 1983).

The approach section (APPR1) was surveyed one bridge length upstream of the upstream face as recommended by Shearman and others (1986). This location provides a consistent method for determining scour variables.

Bridge Hydraulics Summary

Average bridge embankment elevation 500.3 *ft*
Average low steel elevation 498.2 *ft*

100-year discharge 1,800 *ft^3/s*
Water-surface elevation in bridge opening 498.3 *ft*
Road overtopping? Yes *Discharge over road* 354 *ft^3/s*
Area of flow in bridge opening 171 *ft^2*
Average velocity in bridge opening 8.5 *ft/s*
Maximum WSPRO tube velocity at bridge 10.1 *ft/s*

Water-surface elevation at Approach section with bridge 500.1
Water-surface elevation at Approach section without bridge 496.5
Amount of backwater caused by bridge 3.6 *ft*

500-year discharge 2,500 *ft^3/s*
Water-surface elevation in bridge opening 498.3 *ft*
Road overtopping? Yes *Discharge over road* 963 *ft^3/s*
Area of flow in bridge opening 171 *ft^2*
Average velocity in bridge opening 9.1 *ft/s*
Maximum WSPRO tube velocity at bridge 10.9 *ft/s*

Water-surface elevation at Approach section with bridge 500.6
Water-surface elevation at Approach section without bridge 496.9
Amount of backwater caused by bridge 3.7 *ft*

Incipient overtopping discharge 1,210 *ft^3/s*
Water-surface elevation in bridge opening 498.3 *ft*
Area of flow in bridge opening 171 *ft^2*
Average velocity in bridge opening 7.1 *ft/s*
Maximum WSPRO tube velocity at bridge 8.5 *ft/s*

Water-surface elevation at Approach section with bridge 499.2
Water-surface elevation at Approach section without bridge 496.1
Amount of backwater caused by bridge 3.1 *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, 1995). Scour depths were calculated assuming an infinite depth of erosive material and a homogeneous particle-size distribution. The results of the scour analyses for the 100- and 500-year discharges are presented in Tables 1 and 2 and the scour depths are shown graphically in Figure 8.

The 100-year, 500-year, and incipient roadway-overtopping 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). Thus, contraction scour for these discharges was computed by use of the Chang equation (Richardson and others, 1995, p. 145-146).

For comparison, estimates of contraction scour also were computed, for the discharges resulting in orifice flow, by use of the Laursen clear-water contraction scour equation (Richardson and others, 1995, p. 32, equation 20) and the Umbrell pressure-flow equation (Richardson and others, 1995, p. 144). Results of these computations are presented in Appendix F. Furthermore, for those discharges resulting in unsubmerged orifice flow, contraction scour was computed by substituting estimates for the depth of flow at the downstream bridge face in the contraction scour equations. Results with respect to these substitutions also are provided in Appendix F.

Abutment scour was computed by use of the HIRE equation (Richardson and others, 1995, p. 49, equation 29) 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	20.4	22.5	15.8
Depth to armoring	N/A	N/A	N/A
Left overbank	--	--	--
Right overbank	--	--	--

Local scour:	100-yr discharge	500-yr discharge	Incipient overtopping discharge
Abutment scour			
Left abutment	8.6	9.9	6.7
Right abutment	10.3	11.1	8.8
Pier scour			
Pier 1	--	--	--
Pier 2	--	--	--
Pier 3	--	--	--

Riprap Sizing

	100-yr discharge	500-yr discharge	Incipient overtopping discharge
		(D_{50} in feet)	
Abutments:			
Left abutment	2.0	2.1	1.7
Right abutment	2.0	2.1	1.7
Piers:			
Pier 1	--	--	--
Pier 2	--	--	--

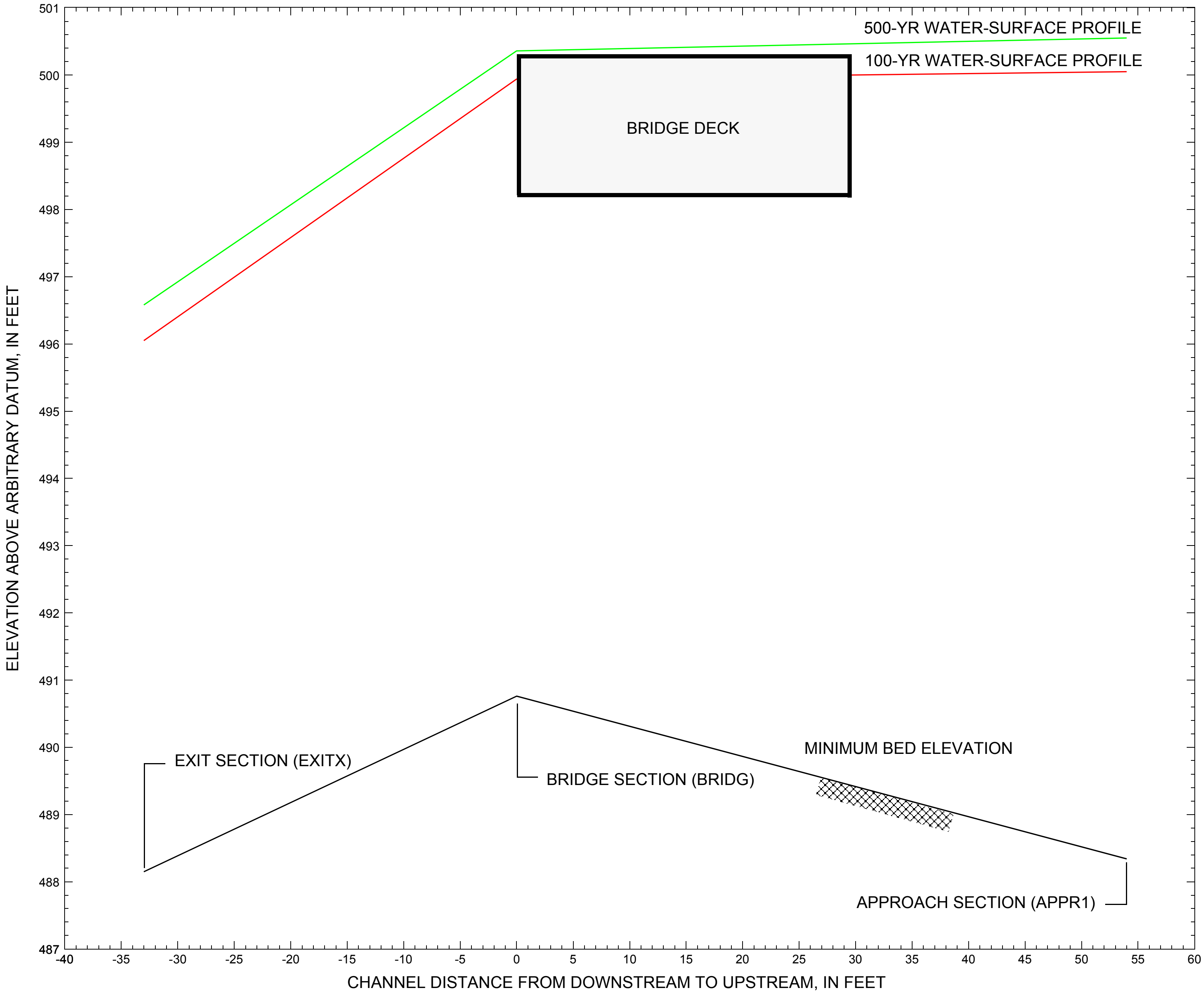

Figure 7. Water-surface profiles for the 100- and 500-yr discharges at structure BRNETH00740037 on Town Highway 74, crossing South Peacham Brook, Barnet, Vermont.

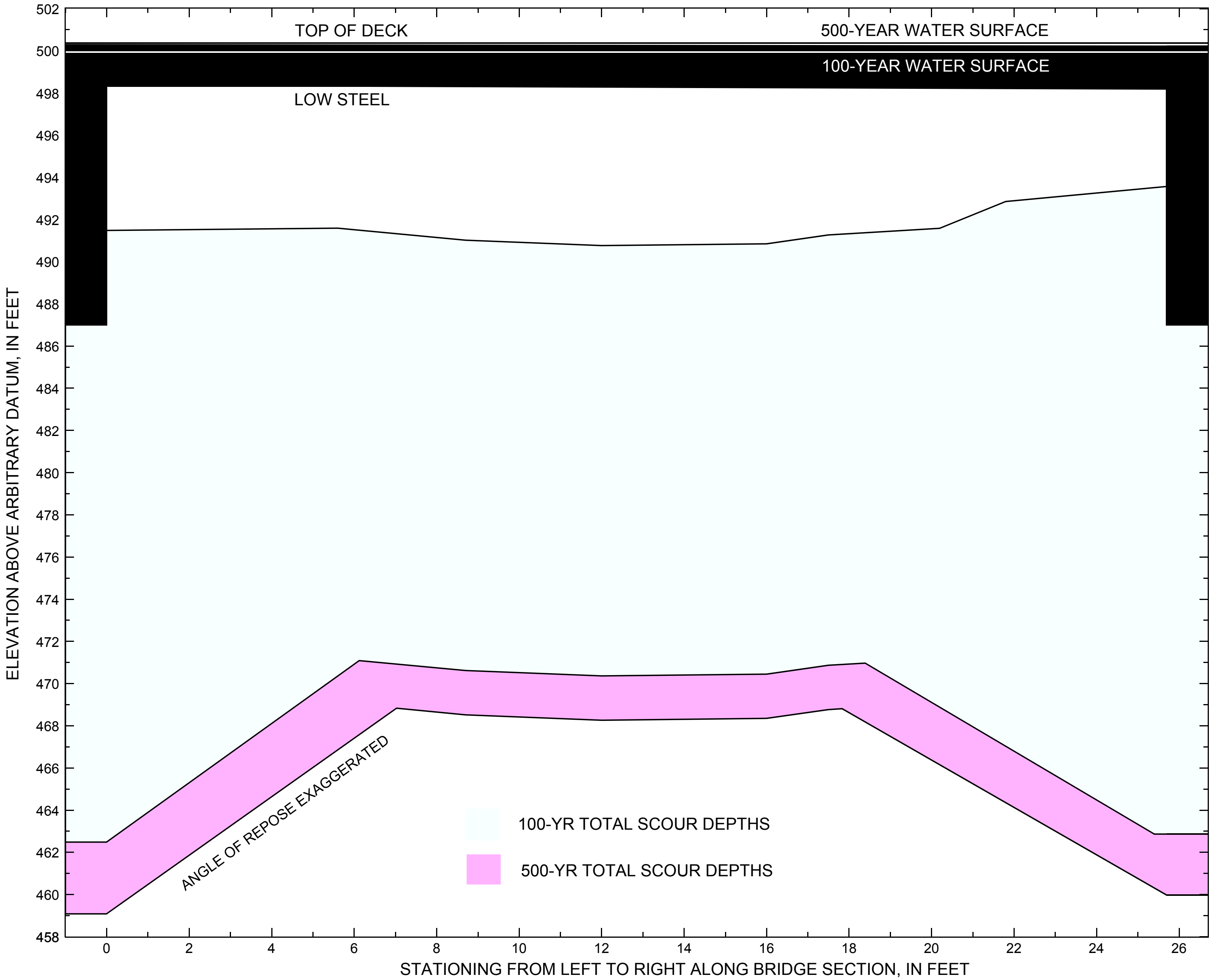

Figure 8. Scour elevations for the 100-yr and 500-yr discharges at structure BRNETH00740037 on Town Highway 74, crossing South Peacham Brook, Barnet, Vermont.

Table 1. Remaining footing/pile depth at abutments for the 100-year discharge at structure BRNETH00740037 on Town Highway 74, crossing South Peacham Brook, Barnet, 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 1,800 cubic-feet per second											
Left abutment	0.0	--	498.3	487.0	491.5	20.4	8.6	--	29.0	462.5	-24.5
Right abutment	25.7	498.2	498.2	487.0	493.6	20.4	10.3	--	30.7	462.9	-24.1

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 BRNETH00740037 on Town Highway 74, crossing South Peacham Brook, Barnet, 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 2,500 cubic-feet per second											
Left abutment	0.0	--	498.3	487.0	491.5	22.5	9.9	--	32.4	459.1	-27.9
Right abutment	25.7	498.2	498.2	487.0	493.6	22.5	11.1	--	33.6	460.0	-27.0

1.Measured along the face of the most constricting side of the bridge.

2.Arbitrary datum for this study.

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APPENDIX A:

WSPRO INPUT FILE

WSPRO INPUT FILE

```
T1        U.S. Geological Survey WSPRO Input File brne037.wsp
T2        Hydraulic analysis for structure BRNETH00740037   Date: 10-SEP-97
T3        TH 74 CROSSING SOUTH PEACHAM BROOK IN BARNET, VT               RLB
*
J3         6 29 30 552 553 551 5 16 17 13 3 * 15 14 23 21 11 12 4 7 3
*
Q           1800.0   2500.0  1210.0
SK          0.0042   0.0042  0.0042
*
XS   EXITX    -33           0.
GR         -195.5, 503.96   -193.5, 501.78   -122.0, 500.54    -78.2, 494.82
GR           -3.7, 495.57      0.0, 494.22      1.2, 491.50      5.7, 490.09
GR           12.9, 488.44     16.8, 488.15     19.3, 488.53     26.4, 491.59
GR           28.0, 494.17     30.5, 495.05     57.5, 495.14    112.6, 494.78
GR          128.4, 494.58    157.9, 494.39    192.4, 495.14    238.1, 498.32
*
N           0.045        0.040        0.055
SA                   0.0         30.5
*
XS   FULLV      0  * * *   0.0023
*
*             SRD     LSEL    XSSKEW
BR   BRIDG     0    498.24       5.0
GR            0.0, 498.33      0.0, 491.48      5.6, 491.59      8.7, 491.02
GR           12.0, 490.76     16.0, 490.85     17.5, 491.27     20.2, 491.58
GR           21.8, 492.86     25.7, 493.57     25.7, 498.15      0.0, 498.33
*
*         BRTYPE  BRWDTH       WWANGL    WWWID
CD           1      37.4 * *     45.4      7.4
N           0.040
*
*             SRD    EMBWID   IPAVE
XR   RDWAY     14      26.2     1
GR         -130.3, 503.90   -129.4, 501.04    -98.2, 500.83      0.0, 500.29
GR           26.9, 500.22    135.8, 499.27    252.3, 499.54    291.5, 499.44
GR          329.1, 499.79    354.0, 506.38
*
AS   APPR1     54           0.
GR         -132.3, 505.06   -117.9, 501.23   -101.8, 500.31    -84.3, 497.43
GR          -17.1, 495.65     -8.7, 495.48      0.0, 494.62      1.5, 493.77
GR            2.3, 491.68      2.4, 491.21      6.8, 490.64     13.4, 488.78
GR           15.9, 488.86     18.6, 488.34     21.9, 490.63     22.3, 491.59
GR           22.9, 494.21     26.4, 495.09     42.6, 495.37    196.2, 495.74
GR          227.4, 495.10    237.4, 495.46    241.6, 496.88    253.0, 497.03
GR          266.3, 497.34    277.0, 496.39    294.0, 500.43    344.0, 512.31
*
N           0.045        0.035        0.040
SA                  -8.7         26.4
*
HP 1 BRIDG  498.33 1 498.33
HP 2 BRIDG  498.33 * * 1449
HP 1 BRIDG  496.24 1 496.24
HP 2 RDWAY  499.94 * * 354
HP 1 APPR1  500.05 1 500.05
HP 2 APPR1  500.05 * * 1800
*
HP 1 BRIDG  498.33 1 498.33
HP 2 BRIDG  498.33 * * 1561
HP 1 BRIDG  496.76 1 496.76
HP 2 RDWAY  500.36 * * 963
HP 1 APPR1  500.55 1 500.55
HP 2 APPR1  500.55 * * 2500
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APPENDIX B:

WSPRO OUTPUT FILE

WSPRO OUTPUT FILE

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        U.S. Geological Survey WSPRO Input File brne037.wsp
        Hydraulic analysis for structure BRNETH00740037   Date: 10-SEP-97
        TH 74 CROSSING SOUTH PEACHAM BROOK IN BARNET, VT               RLB
           *** RUN DATE & TIME: 11-13-97  14:42

    CROSS-SECTION PROPERTIES:  ISEQ =  3;  SECID = BRIDG;  SRD =       0.
     WSEL  SA#     AREA         K   TOPW   WETP  ALPH    LEW    REW      QCR
             1      171     12331      0     63                            0
   498.33           171     12331      0     63  1.00      0     26        0

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

         WSEL     LEW     REW    AREA        K        Q    VEL
       498.33     0.0    25.7   170.8   12331.    1449.   8.48

X STA.        0.0         2.1         3.5         4.8         5.9         7.1
  A(I)             14.2         9.3         8.7         7.9         8.0
  V(I)             5.10        7.79        8.35        9.12        9.08

X STA.        7.1         8.2         9.2        10.2        11.2        12.2
  A(I)              7.5         7.4         7.4         7.2         7.2
  V(I)             9.65        9.77        9.76       10.12       10.03

X STA.       12.2        13.1        14.1        15.1        16.1        17.2
  A(I)              7.3         7.2         7.3         7.5         7.6
  V(I)             9.98       10.02        9.94        9.66        9.57

X STA.       17.2        18.3        19.6        20.9        22.8        25.7
  A(I)              8.0         8.2         8.8        10.4        13.8
  V(I)             9.09        8.88        8.22        6.99        5.26

    CROSS-SECTION PROPERTIES:  ISEQ =  3;  SECID = BRIDG;  SRD =       0.
     WSEL  SA#     AREA         K   TOPW   WETP  ALPH    LEW    REW      QCR
             1      120     10366     26     34                         1467
   496.24           120     10366     26     34  1.00      0     26     1467

    VELOCITY DISTRIBUTION:  ISEQ =  4;  SECID = RDWAY;  SRD =      14.

         WSEL     LEW     REW    AREA        K        Q    VEL
       499.94    59.0   329.7   118.0    1837.     354.   3.00

X STA.       59.0       106.7       120.8       130.7       138.9       146.5
  A(I)              9.9         6.8         5.7         5.4         5.0
  V(I)             1.78        2.62        3.09        3.30        3.55

X STA.      146.5       154.4       162.5       171.0       179.7       188.9
  A(I)              5.1         5.0         5.1         5.0         5.2
  V(I)             3.50        3.55        3.50        3.52        3.43

X STA.      188.9       198.8       209.2       220.6       233.0       247.1
  A(I)              5.3         5.4         5.5         5.7         6.0
  V(I)             3.36        3.30        3.19        3.11        2.93

X STA.      247.1       262.3       275.5       287.9       300.5       329.7
  A(I)              6.2         5.8         5.9         5.9         8.1
  V(I)             2.84        3.03        3.01        2.99        2.18

    CROSS-SECTION PROPERTIES:  ISEQ =  5;  SECID = APPR1;  SRD =      54.
     WSEL  SA#     AREA         K   TOPW   WETP  ALPH    LEW    REW      QCR
             1      294     21205     92     92                         2996
             2      288     44913     35     41                         4682
             3     1113    107397    266    267                        12912
   500.05          1695    173515    393    400  1.21    -99    292    18157

    VELOCITY DISTRIBUTION:  ISEQ =  5;  SECID = APPR1;  SRD =      54.

         WSEL     LEW     REW    AREA        K        Q    VEL
       500.05  -100.2   292.4  1695.0  173515.    1800.   1.06

X STA.     -100.2       -46.2       -18.4        -0.8         6.9        11.8
  A(I)            140.0       111.0        82.8        61.2        48.7
  V(I)             0.64        0.81        1.09        1.47        1.85

X STA.       11.8        15.7        19.8        32.7        50.3        68.5
  A(I)             44.5        45.8        79.4        83.2        84.3
  V(I)             2.02        1.97        1.13        1.08        1.07

X STA.       68.5        86.8       105.7       124.6       144.1       164.3
  A(I)             84.3        86.1        84.9        86.9        89.1
  V(I)             1.07        1.05        1.06        1.04        1.01

X STA.      164.3       184.2       205.0       223.8       245.2       292.4
  A(I)             86.8        90.6        88.1        93.0       124.4
  V(I)             1.04        0.99        1.02        0.97        0.72
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      U.S. Geological Survey WSPRO Input File brne037.wsp
      Hydraulic analysis for structure BRNETH00740037   Date: 10-SEP-97
      TH 74 CROSSING SOUTH PEACHAM BROOK IN BARNET, VT               RLB
         *** RUN DATE & TIME: 11-13-97  14:42

   CROSS-SECTION PROPERTIES:  ISEQ =  3;  SECID = BRIDG;  SRD =       0.
    WSEL  SA#     AREA         K   TOPW   WETP  ALPH    LEW    REW      QCR
            1      171     12331      0     63                            0
  498.33           171     12331      0     63  1.00      0     26        0

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

        WSEL     LEW     REW    AREA        K        Q    VEL
      498.33     0.0    25.7   170.8   12331.    1561.   9.14

X STA.         0.0         2.1         3.5         4.8         5.9         7.1
  A(I)              14.2         9.3         8.7         7.9         8.0
  V(I)              5.49        8.39        9.00        9.83        9.78

X STA.         7.1         8.2         9.2        10.2        11.2        12.2
  A(I)               7.5         7.4         7.4         7.2         7.2
  V(I)             10.40       10.53       10.51       10.91       10.81

X STA.        12.2        13.1        14.1        15.1        16.1        17.2
  A(I)               7.3         7.2         7.3         7.5         7.6
  V(I)             10.75       10.80       10.71       10.40       10.31

X STA.        17.2        18.3        19.6        20.9        22.8        25.7
  A(I)               8.0         8.2         8.8        10.4        13.8
  V(I)              9.79        9.56        8.85        7.53        5.66

   CROSS-SECTION PROPERTIES:  ISEQ =  3;  SECID = BRIDG;  SRD =       0.
    WSEL  SA#     AREA         K   TOPW   WETP  ALPH    LEW    REW      QCR
            1      133     12112     26     35                         1718
  496.76           133     12112     26     35  1.00      0     26     1718

   VELOCITY DISTRIBUTION:  ISEQ =  4;  SECID = RDWAY;  SRD =      14.

        WSEL     LEW     REW    AREA        K        Q    VEL
      500.36   -12.7   331.3   244.2    5639.     963.   3.94

X STA.       -12.7        78.0       100.1       115.7       128.1       138.4
  A(I)              21.8        15.1        13.2        12.0        11.0
  V(I)              2.21        3.20        3.64        4.02        4.38

X STA.       138.4       148.5       158.8       169.1       179.9       191.0
  A(I)              10.8        10.8        10.6        10.8        10.9
  V(I)              4.46        4.46        4.55        4.46        4.44

X STA.       191.0       202.5       214.7       227.1       240.7       254.6
  A(I)              10.9        11.2        11.1        11.7        11.6
  V(I)              4.43        4.28        4.35        4.11        4.16

X STA.       254.6       268.5       281.6       294.1       308.8       331.3
  A(I)              11.7        11.5        11.3        12.2        14.1
  V(I)              4.10        4.19        4.25        3.95        3.41

   CROSS-SECTION PROPERTIES:  ISEQ =  5;  SECID = APPR1;  SRD =      54.
    WSEL  SA#     AREA         K   TOPW   WETP  ALPH    LEW    REW      QCR
            1      341     26035     97     98                         3626
            2      306     49566     35     41                         5116
            3     1246    129030    268    269                        15245
  500.55          1893    204632    401    408  1.19   -105    295    21432

   VELOCITY DISTRIBUTION:  ISEQ =  5;  SECID = APPR1;  SRD =      54.

        WSEL     LEW     REW    AREA        K        Q    VEL
      500.55  -106.0   294.5  1893.0  204632.    2500.   1.32

X STA.      -106.0       -48.9       -21.4        -2.0         6.7        11.8
  A(I)             157.1       121.5        98.9        69.9        54.4
  V(I)              0.80        1.03        1.26        1.79        2.30

X STA.        11.8        16.3        20.9        36.6        54.5        72.4
  A(I)              52.4        53.7        93.7        92.7        91.7
  V(I)              2.39        2.33        1.33        1.35        1.36

X STA.        72.4        90.9       109.5       128.3       147.8       167.5
  A(I)              94.6        93.7        94.0        96.3        96.6
  V(I)              1.32        1.33        1.33        1.30        1.29

X STA.       167.5       187.2       207.3       225.9       249.4       294.5
  A(I)              95.9        97.7        97.2       107.6       133.4
  V(I)              1.30        1.28        1.29        1.16        0.94
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       U.S. Geological Survey WSPRO Input File brne037.wsp
       Hydraulic analysis for structure BRNETH00740037   Date: 10-SEP-97
       TH 74 CROSSING SOUTH PEACHAM BROOK IN BARNET, VT               RLB
          *** RUN DATE & TIME: 11-13-97  14:42

   CROSS-SECTION PROPERTIES:  ISEQ =  3;  SECID = BRIDG;  SRD =       0.
    WSEL  SA#     AREA         K   TOPW   WETP  ALPH    LEW    REW      QCR
            1      171     12331      0     63                            0
  498.33           171     12331      0     63  1.00      0     26        0

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

        WSEL     LEW     REW    AREA        K        Q    VEL
      498.33     0.0    25.7   170.8   12331.    1210.   7.08

X STA.        0.0        2.1        3.5        4.8        5.9        7.1
  A(I)            14.2        9.3        8.7        7.9        8.0
  V(I)            4.26       6.50       6.98       7.62       7.58

X STA.        7.1        8.2        9.2       10.2       11.2       12.2
  A(I)             7.5        7.4        7.4        7.2        7.2
  V(I)            8.06       8.16       8.15       8.45       8.38

X STA.       12.2       13.1       14.1       15.1       16.1       17.2
  A(I)             7.3        7.2        7.3        7.5        7.6
  V(I)            8.34       8.37       8.30       8.06       7.99

X STA.       17.2       18.3       19.6       20.9       22.8       25.7
  A(I)             8.0        8.2        8.8       10.4       13.8
  V(I)            7.59       7.41       6.86       5.84       4.39

   CROSS-SECTION PROPERTIES:  ISEQ =  3;  SECID = BRIDG;  SRD =       0.
    WSEL  SA#     AREA         K   TOPW   WETP  ALPH    LEW    REW      QCR
            1      106      8695     26     33                         1229
  495.72           106      8695     26     33  1.00      0     26     1229

   CROSS-SECTION PROPERTIES:  ISEQ =  5;  SECID = APPR1;  SRD =      54.
    WSEL  SA#     AREA         K   TOPW   WETP  ALPH    LEW    REW      QCR
            1      221     13695     87     87                         2010
            2      259     37685     35     41                         3998
            3      896     75522    263    263                         9391
  499.23          1377    126902    384    391  1.28    -94    289    13046

   VELOCITY DISTRIBUTION:  ISEQ =  5;  SECID = APPR1;  SRD =      54.

        WSEL     LEW     REW    AREA        K        Q    VEL
      499.23   -95.2   289.0  1376.6  126902.    1210.   0.88

X STA.      -95.2      -39.6      -12.4        2.8        7.7       11.7
  A(I)           116.9       90.7       66.9       41.1       37.2
  V(I)            0.52       0.67       0.90       1.47       1.62

X STA.       11.7       15.0       18.4       25.1       41.9       59.7
  A(I)            34.8       35.0       52.5       67.5       68.5
  V(I)            1.74       1.73       1.15       0.90       0.88

X STA.       59.7       78.4       97.2      116.8      136.6      157.2
  A(I)            71.1       70.2       72.7       72.5       74.2
  V(I)            0.85       0.86       0.83       0.83       0.82

X STA.      157.2      177.4      199.2      219.1      237.9      289.0
  A(I)            72.0       76.6       74.8       74.9      106.4
  V(I)            0.84       0.79       0.81       0.81       0.57
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        U.S. Geological Survey WSPRO Input File brne037.wsp
        Hydraulic analysis for structure BRNETH00740037   Date: 10-SEP-97
        TH 74 CROSSING SOUTH PEACHAM BROOK IN BARNET, VT               RLB
           *** RUN DATE & TIME: 11-13-97  14:42

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

EXITX:XS   ******    -87      455  0.57 *****  496.62  495.90    1800  496.05
       -32 ******    205    27767  2.35 ***** *******    0.86    3.96

FULLV:FV       33    -88      490  0.49  0.13  496.73 *******    1800  496.24
         0     33    207    29971  2.31  0.00   -0.02    0.77    3.68
         <<<<<THE ABOVE RESULTS REFLECT "NORMAL" (UNCONSTRICTED) FLOW>>>>>

 ===125 FR# EXCEEDS FNTEST AT SECID "APPR1":  TRIALS CONTINUED.
              FNTEST,FR#,WSEL,CRWS =  0.80    1.14     496.33     496.50
 ===110 WSEL NOT FOUND AT SECID "APPR1":  REDUCED DELTAY.
                   WSLIM1,WSLIM2,DELTAY =   495.74     512.31    0.50
 ===115 WSEL NOT FOUND AT SECID "APPR1":  USED WSMIN = CRWS.
                   WSLIM1,WSLIM2,CRWS =   495.74     512.31     496.50
 ===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 "APPR1"
                   WSBEG,WSEND,CRWS =   496.50     512.31     496.50

APPR1:AS       54    -48      398  0.62 *****  497.12  496.50    1800  496.50
        54     54    277    25796  1.94 ***** *******    0.95    4.52
         <<<<<THE ABOVE RESULTS REFLECT "NORMAL" (UNCONSTRICTED) FLOW>>>>>

 ===215 FLOW CLASS 1 SOLUTION INDICATES POSSIBLE ROAD OVERFLOW.
           WS1,WSSD,WS3,RGMIN =   500.37       0.00     496.94     499.27
 ===260 ATTEMPTING FLOW CLASS 4 SOLUTION.
 ===220 FLOW CLASS 1 (4) SOLUTION INDICATES POSSIBLE PRESSURE FLOW.
           WS3,WSIU,WS1,LSEL =   496.57     499.80     499.85     498.24
 ===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

BRIDG:BR       33      0      171  1.12 *****  499.45  496.20    1449  498.33
         0 ******     26    12331  1.00 ***** *******    0.58    8.48

     TYPE PPCD FLOW      C    P/A    LSEL   BLEN   XLAB   XRAB
       1. ****    5.  0.467  0.000  498.24 ****** ****** ******

    XSID:CODE    SRD   FLEN    HF   VHD     EGL     ERR       Q    WSEL
   RDWAY:RG      14.    28.  0.00  0.02  500.07    0.00    354.  499.94

             Q    WLEN    LEW    REW  DMAX  DAVG  VMAX  VAVG  HAVG  CAVG
   LT:      0.    72.   -60.    12.   0.4   0.2   3.1   4.9   0.5   3.0
   RT:    354.   270.    59.   330.   0.7   0.4   3.5   3.0   0.6   3.1

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

APPR1:AS       17    -99     1696  0.02  0.03  500.07  496.50    1800  500.05
        54     28    292   173742  1.21  0.75    0.00    0.10    1.06

       M(G)   M(K)       KQ   XLKQ   XRKQ    OTEL
     ****** ****** ******** ****** ****** ********

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

  FIRST USER DEFINED TABLE.

    XSID:CODE    SRD    LEW    REW       Q         K      AREA     VEL    WSEL
   EXITX:XS     -33.   -88.   205.   1800.   27767.      455.    3.96  496.05
   FULLV:FV       0.   -89.   207.   1800.   29971.      490.    3.68  496.24
   BRIDG:BR       0.     0.    26.   1449.   12331.      171.    8.48  498.33
   RDWAY:RG      14.*******     0.    354.        0.*********    1.00  499.94
   APPR1:AS      54.  -100.   292.   1800.  173742.     1696.    1.06  500.05

    XSID:CODE   XLKQ   XRKQ       KQ
   APPR1:AS  **********************

 SECOND USER DEFINED TABLE.

    XSID:CODE     CRWS     FR#    YMIN    YMAX     HF    HO  VHD      EGL    WSEL
   EXITX:XS     495.90    0.86  488.15  503.96************  0.57  496.62  496.05
   FULLV:FV   ********    0.77  488.23  504.04  0.13  0.00  0.49  496.73  496.24
   BRIDG:BR     496.20    0.58  490.76  498.33************  1.12  499.45  498.33
   RDWAY:RG  ***************  499.27  506.38  0.00******  0.02  500.07  499.94
   APPR1:AS     496.50    0.10  488.34  512.31  0.03  0.75  0.02  500.07  500.05
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        U.S. Geological Survey WSPRO Input File brne037.wsp
        Hydraulic analysis for structure BRNETH00740037   Date: 10-SEP-97
        TH 74 CROSSING SOUTH PEACHAM BROOK IN BARNET, VT               RLB
           *** RUN DATE & TIME: 11-13-97  14:42

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

EXITX:XS   ******    -91      613  0.56 *****  497.14  496.32    2500  496.58
       -32 ******    213    38550  2.16 ***** *******    0.74    4.08

FULLV:FV       33    -91      646  0.49  0.13  497.25 *******    2500  496.76
         0     33    215    41008  2.11  0.00   -0.01    0.68    3.87
         <<<<<THE ABOVE RESULTS REFLECT "NORMAL" (UNCONSTRICTED) FLOW>>>>>

 ===125 FR# EXCEEDS FNTEST AT SECID "APPR1":  TRIALS CONTINUED.
              FNTEST,FR#,WSEL,CRWS =  0.80    0.88     496.92     496.83
 ===110 WSEL NOT FOUND AT SECID "APPR1":  REDUCED DELTAY.
                   WSLIM1,WSLIM2,DELTAY =   496.26     512.31    0.50
 ===115 WSEL NOT FOUND AT SECID "APPR1":  USED WSMIN = CRWS.
                   WSLIM1,WSLIM2,CRWS =   496.26     512.31     496.83

APPR1:AS       54    -64      527  0.64  0.23  497.56  496.83    2500  496.92
        54     54    279    35264  1.83  0.07    0.00    0.88    4.75
         <<<<<THE ABOVE RESULTS REFLECT "NORMAL" (UNCONSTRICTED) FLOW>>>>>

 ===215 FLOW CLASS 1 SOLUTION INDICATES POSSIBLE ROAD OVERFLOW.
           WS1,WSSD,WS3,RGMIN =   502.41       0.00     498.16     499.27
 ===260 ATTEMPTING FLOW CLASS 4 SOLUTION.
 ===220 FLOW CLASS 1 (4) SOLUTION INDICATES POSSIBLE PRESSURE FLOW.
           WS3,WSIU,WS1,LSEL =   496.98     500.29     500.35     498.24
 ===245 ATTEMPTING FLOW CLASS 2 (5) SOLUTION.
 ===265 ROAD OVERFLOW APPEARS EXCESSIVE.
                   QRD,QRDMAX,RATIO =     963.       923.    1.04

            <<<<<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       33      0      171  1.30 *****  499.63  496.44    1561  498.33
         0 ******     26    12331  1.00 ***** *******    0.63    9.14

     TYPE PPCD FLOW      C    P/A    LSEL   BLEN   XLAB   XRAB
       1. ****   5.  0.481  0.000  498.24 ****** ****** ******

    XSID:CODE    SRD   FLEN    HF   VHD     EGL     ERR       Q    WSEL
   RDWAY:RG      14.    28.  0.00  0.03  500.58    0.01    963.  500.36

             Q   WLEN    LEW    REW  DMAX  DAVG  VMAX  VAVG  HAVG  CAVG
   LT:     11.    25.   -12.    12.   0.1   0.1   2.4   7.4   0.3   3.0
   RT:    952.   319.    12.   331.   1.1   0.8   4.6   3.9   1.0   3.1

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

APPR1:AS       17   -105     1892  0.03  0.05  500.58  496.83    2500  500.55
        54     30    294   204527  1.19  0.73    0.01    0.12    1.32

       M(G)   M(K)       KQ   XLKQ   XRKQ    OTEL
     ****** ****** ******** ****** ****** ********

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

  FIRST USER DEFINED TABLE.

    XSID:CODE    SRD    LEW    REW       Q        K     AREA     VEL    WSEL
   EXITX:XS     -33.   -92.   213.   2500.   38550.     613.    4.08  496.58
   FULLV:FV       0.   -92.   215.   2500.   41008.     646.    3.87  496.76
   BRIDG:BR       0.     0.    26.   1561.   12331.     171.    9.14  498.33
   RDWAY:RG      14.*******    11.    963.       0.*********    1.00  500.36
   APPR1:AS      54.  -106.   294.   2500.  204527.    1892.    1.32  500.55

    XSID:CODE   XLKQ   XRKQ       KQ
   APPR1:AS  **********************

 SECOND USER DEFINED TABLE.

    XSID:CODE    CRWS     FR#    YMIN    YMAX    HF    HO   VHD     EGL    WSEL
   EXITX:XS    496.32    0.74  488.15  503.96************  0.56  497.14  496.58
   FULLV:FV  ********    0.68  488.23  504.04  0.13  0.00  0.49  497.25  496.76
   BRIDG:BR    496.44    0.63  490.76  498.33************  1.30  499.63  498.33
   RDWAY:RG  ***************  499.27  506.38  0.00******  0.03  500.58  500.36
   APPR1:AS    496.83    0.12  488.34  512.31  0.05  0.73  0.03  500.58  500.55
```
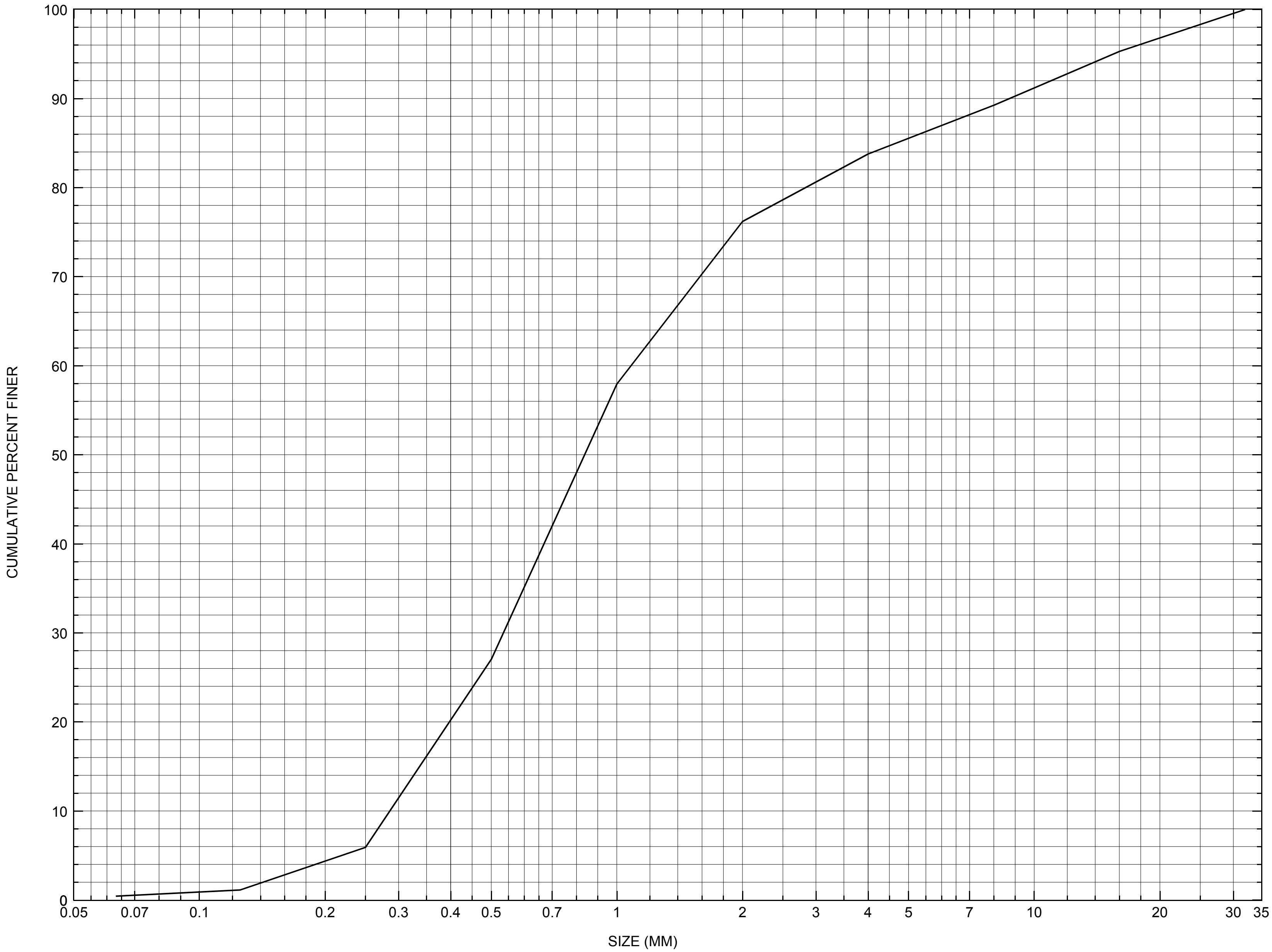

```
        U.S. Geological Survey WSPRO Input File brne037.wsp
        Hydraulic analysis for structure BRNETH00740037   Date: 10-SEP-97
        TH 74 CROSSING SOUTH PEACHAM BROOK IN BARNET, VT              RLB
           *** RUN DATE & TIME: 11-13-97  14:42

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

EXITX:XS   ******    -82      286  0.60 *****  496.06  493.70    1210  495.46
       -32 ******    197    18665  2.15 ***** *******    1.06    4.24

 ===125 FR# EXCEEDS FNTEST AT SECID "FULLV":  TRIALS CONTINUED.
             FNTEST,FR#,WSEL,CRWS =  0.80    0.86     495.74     493.78
 ===110 WSEL NOT FOUND AT SECID "FULLV":  REDUCED DELTAY.
                  WSLIM1,WSLIM2,DELTAY =   494.96     504.04    0.50
 ===115 WSEL NOT FOUND AT SECID "FULLV":  USED WSMIN = CRWS.
                  WSLIM1,WSLIM2,CRWS =   494.96     504.04     493.78

FULLV:FV       33    -84      339  0.46  0.12  496.18  493.78    1210  495.72
         0     33    200    21176  2.31  0.00    0.00    0.88    3.57
         <<<<<THE ABOVE RESULTS REFLECT "NORMAL" (UNCONSTRICTED) FLOW>>>>>

 ===125 FR# EXCEEDS FNTEST AT SECID "APPR1":  TRIALS CONTINUED.
             FNTEST,FR#,WSEL,CRWS =  0.80    1.70     495.70     496.11
 ===110 WSEL NOT FOUND AT SECID "APPR1":  REDUCED DELTAY.
                  WSLIM1,WSLIM2,DELTAY =   495.22     512.31    0.50
 ===115 WSEL NOT FOUND AT SECID "APPR1":  USED WSMIN = CRWS.
                  WSLIM1,WSLIM2,CRWS =   495.22     512.31     496.11
 ===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 "APPR1"
                  WSBEG,WSEND,CRWS =   496.11     512.31     496.11

APPR1:AS       54    -34      289  0.54 *****  496.65  496.11    1210  496.11
        54     54    239    18778  1.98 ***** *******    1.01    4.18
         <<<<<THE ABOVE RESULTS REFLECT "NORMAL" (UNCONSTRICTED) FLOW>>>>>

 ===220 FLOW CLASS 1 (4) SOLUTION INDICATES POSSIBLE PRESSURE FLOW.
           WS3,WSIU,WS1,LSEL =   495.68     498.45     498.50     498.24
 ===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

BRIDG:BR       33      0      171  0.76 *****  499.09  495.65    1193  498.33
         0 ******     26    12331  1.00 ***** *******    0.48    6.99

     TYPE PPCD FLOW      C    P/A    LSEL   BLEN   XLAB   XRAB
       1. ****   2.  0.420  0.000  498.24 ****** ****** ******

    XSID:CODE    SRD   FLEN    HF   VHD     EGL     ERR       Q    WSEL
   RDWAY:RG      14.        <<<<<EMBANKMENT IS NOT OVERTOPPED>>>>>

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

APPR1:AS       17    -94     1376  0.02  0.02  499.24  496.11    1210  499.23
        54     25    289   126864  1.28  0.74   -0.01    0.09    0.88

       M(G)   M(K)       KQ   XLKQ   XRKQ    OTEL
     ****** ****** ******** ****** ******   499.23

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

   FIRST USER DEFINED TABLE.

    XSID:CODE    SRD    LEW    REW      Q        K     AREA     VEL   WSEL
   EXITX:XS     -33.   -83.   197.   1210.   18665.    286.    4.24  495.46
   FULLV:FV       0.   -85.   200.   1210.   21176.    339.    3.57  495.72
   BRIDG:BR       0.     0.    26.   1193.   12331.    171.    6.99  498.33
   RDWAY:RG      14.**************      0.       0.*********    1.00********
   APPR1:AS      54.   -95.   289.   1210.  126864.   1376.    0.88  499.23

    XSID:CODE   XLKQ   XRKQ       KQ
   APPR1:AS  **********************

 SECOND USER DEFINED TABLE.

    XSID:CODE    CRWS     FR#    YMIN    YMAX    HF    HO  VHD      EGL    WSEL
   EXITX:XS    493.70    1.06  488.15  503.96************  0.60  496.06  495.46
   FULLV:FV    493.78    0.88  488.23  504.04  0.12  0.00  0.46  496.18  495.72
   BRIDG:BR    495.65    0.48  490.76  498.33************  0.76  499.09  498.33
   RDWAY:RG  ****************  499.27  506.38************  0.01  499.35********
   APPR1:AS    496.11    0.09  488.34  512.31  0.02  0.74  0.02  499.24  499.23
```

APPENDIX C:

BED-MATERIAL PARTICLE-SIZE DISTRIBUTION



Appendix C. Bed material particle-size distribution for a pebble count in the channel approach of structure BRNETH00740037, in Barnet, Vermont.

APPENDIX D:

HISTORICAL DATA FORM

United States Geological Survey
Bridge Historical Data Collection and Processing Form

Structure Number BRNETH00740037

General Location Descriptive

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

Date *(MM/DD/YY)* 03 / 16 / 95

Highway District Number *(I - 2; nn)* 07

County *(FIPS county code; I - 3; nnn)* 005

Town *(FIPS place code; I - 4; nnnnn)* 02875

Mile marker *(I - 11; nnn.nnn)* 000000

Waterway *(I - 6)* SOUTH PEACHAM BROOK

Road Name *(I - 7):* -

Route Number TH074

Vicinity *(I - 9)* 0.1 MI TO JCT W CL2 TH1

Topographic Map Barnet

Hydrologic Unit Code: 01080103

Latitude *(I - 16; nnnn.n)* 44184

Longitude *(i - 17; nnnnn.n)* 72085

Select Federal Inventory Codes

FHWA Structure Number *(I - 8)* 10030100370301

Maintenance responsibility *(I - 21; nn)* 03

Maximum span length *(I - 48; nnnn)* 0028

Year built *(I - 27; YYYY)* 1948

Structure length *(I - 49; nnnnnn)* 000030

Average daily traffic, ADT *(I - 29; nnnnnn)* 000200

Deck Width *(I - 52; nn.n)* 262

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

Channel & Protection *(I - 61; n)* 5

Opening skew to Roadway *(I - 34; nn)* 00

Waterway adequacy *(I - 71; n)* 6

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

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

Structure type *(I - 43; nnn)* 101

Year Reconstructed *(I - 106)* 1983

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

Clear span (*nnn.n ft*) 026.0

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

Vertical clearance from streambed (*nnn.n ft*) 007.5

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

Waterway of full opening (*nnn.n* ft^2) 195.0

Comments:

The structural inspection report of 9/6/94 indicates the structure is a concrete slab type bridge. The abutment walls and wingwalls are concrete. The upstream 2/3 of the right abutment wall reportedly is of older construction than the downstream 1/3. The upstream portion is noted as battered with randomly distributed fine horizontal cracks and concrete spalling. The right upstream wingwall appears to be of older construction as well and has a full-height crack and break near the corner where it meets the abutment wall. The wingwall is displaced about 2 inches streamward from the abutment. The newer portion of the abutment and the downstream wingwall only have fine cracks noted. The left abutment **(continued, page 33)**

Bridge Hydrologic Data

Is there hydrologic data available? **Y** *if No, type ctrl-n h* VTAOT Drainage area *(mi²)*: **12.5**

Terrain character: -

Stream character & type: -

Streambed material: **Sand and stone with some boulder**

Discharge Data *(cfs)*: $Q_{2.33}$ - Q_{10} **900** Q_{25} **1260**

Q_{50} **1520** Q_{100} **1800** Q_{500} -

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

Estimated Discharge *(cfs)*: - Velocity at Q **25** *(ft/s)*: **8.2**

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

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

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

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

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

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

Water Surface Elevation Estimates for Existing Structure:

Peak discharge frequency	$Q_{2.33}$	Q_{10}	Q_{25}	Q_{50}	Q_{100}
Water surface elevation (*ft*)	-	**495.0**	**496.3**	**497.2**	**498.1**
Velocity (*ft / sec*)	-	-	**8.2**	-	-

Long term stream bed changes: -

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

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

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

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

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

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

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

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

Clear span (*ft*): - Clear Height (*ft*): - Full Waterway (ft^2): -

Comments:

and its wingwalls have some fine cracks reported. The streambed is composed of sand and stones with some boulders. There is some riprap protection placed at the downstream end of the right abutment noted. There is some channel scour reported below the structure. A small dam reportedly is present downstream of the bridge, consisting of stones and brush. The hydraulics section file does not have a full hydraulic report but has some discharge information shown on the previous page.

USGS Watershed Data

Watershed Hydrographic Data

Drainage area *(DA)* **12.05** mi^2

Lake/pond/swamp area **0.39** mi^2

Watershed storage *(ST)* **3.2** %

Bridge site elevation **906** ft

Headwater elevation **2369** ft

Main channel length **5.6** mi

10% channel length elevation **915** ft

85% channel length elevation **1536** ft

Main channel slope *(S)* **147.85** ft / mi

Watershed Precipitation Data

Average site precipitation - in

Average headwater precipitation - in

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

Average seasonal snowfall *(Sn)* - ft

Bridge Plan Data

Are plans available? Y *If no, type ctrl-n pl* Date issued for construction *(MM / YYYY)*: 04 / 1982

Project Number TH 3130 Minimum channel bed elevation: 490.1

Low superstructure elevation: USLAB - DSLAB - USRAB - DSRAB 498.15

Benchmark location description:

No specific benchmark information is provided on the plans. A couple points given with elevations are: 1) The point on top of the concrete slab deck at the extreme downstream right corner, where the end of the deck meets the right bankward edge of the right abutment wall, elevation 499.98, or 2) the same point located on the downstream left corner of the concrete deck, elevation 499.98.

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

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

If 1: Footing Thickness 2.0 Footing bottom elevation: 487.0

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

If 3: Footing bottom elevation: -

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

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

Briefly describe material at foundation bottom elevation or around piles:

NO DRILL BORING INFORMATION

Comments:

The plans available are those for the widening of the bridge. Hence, the elevations provided may only be applicable to the newer portion of the bridge on the downstream end. The streambed elevation is at least 2 feet above the top of the new concrete footings. The plans show that the new footings were set at the same elevation as the older ones. The bridge’s original construction was in 1948. The plans for the original structure were not found.

Cross-sectional Data

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

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

Comments: NO CROSS SECTION INFORMATION

Station	-	-	-	-	-	-	-	-	-	-	-
Feature	-	-	-	-	-	-	-	-	-	-	-
Low chord elevation	-	-	-	-	-	-	-	-	-	-	-
Bed elevation	-	-	-	-	-	-	-	-	-	-	-
Low chord to bed	-	-	-	-	-	-	-	-	-	-	-

Station	-	-	-	-	-	-	-	-	-	-	-
Feature	-	-	-	-	-	-	-	-	-	-	-
Low chord elevation	-	-	-	-	-	-	-	-	-	-	-
Bed elevation	-	-	-	-	-	-	-	-	-	-	-
Low chord to bed	-	-	-	-	-	-	-	-	-	-	-

Source (*FEMA, VTAOT, Other*)? NO

Comments: CROSS SECTION INFORMATION

Station	-	-	-	-	-	-	-	-	-	-	-
Feature	-	-	-	-	-	-	-	-	-	-	-
Low chord elevation	-	-	-	-	-	-	-	-	-	-	-
Bed elevation	-	-	-	-	-	-	-	-	-	-	-
Low chord to bed	-	-	-	-	-	-	-	-	-	-	-

Station	-	-	-	-	-	-	-	-	-	-	-
Feature	-	-	-	-	-	-	-	-	-	-	-
Low chord elevation	-	-	-	-	-	-	-	-	-	-	-
Bed elevation	-	-	-	-	-	-	-	-	-	-	-
Low chord to bed	-	-	-	-	-	-	-	-	-	-	-

APPENDIX E:

LEVEL I DATA FORM

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

Qa/Qc Check by: **RB** Date: **2/23/96**

Computerized by: **RB** Date: **2/26/96**

Reviewd by: **RB** Date: **11/17/97**

Structure Number **BRNETH00740037**

A. General Location Descriptive

1. Data collected by *(First Initial, Full last name)* **T. SEVERANCE** Date *(MM/DD/YY)* **8** / **24** / 19**95**

2. Highway District Number **07** Mile marker **0000**

County **CALENDORIA (005)** Town **BARNET (02875)**

Waterway *(I - 6)* **SOUTH PEACHAM BROOK** Road Name **-**

Route Number **TH074** Hydrologic Unit Code: **01080103**

3. Descriptive comments:

Located 0.1 miles from the junction with Town Highway 1.

B. Bridge Deck Observations

4. Surface cover... LBUS **2** RBUS **4** LBDS **4,5** RBDS **5** Overall **5**

*(2b us,ds,lb,rb: **1**- Urban; **2**- Suburban; **3**- Row crops; **4**- Pasture; **5**- Shrub- and brushland; **6**- Forest; **7**- Wetland)*

5. Ambient water surface... US **1** UB **1** DS **1** *(**1**- pool; **2**- riffle)*

6. Bridge structure type **1** *(**1**- single span; **2**- multiple span; **3**- single arch; **4**- multiple arch; **5**- cylindrical culvert; **6**- box culvert; or **7**- other)*

7. Bridge length **30** *(feet)* Span length **28** *(feet)* Bridge width **26.2** *(feet)*

Road approach to bridge:

8. LB **2** RB **1** *(**0** even, **1**- lower, **2**- higher)*

9. LB **1** RB **1** *(**1**- Paved, **2**- Not paved)*

10. Embankment slope (*run / rise in feet / foot*):
US left **--** US right **--**

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

*Bank protection types: **0**- none; **1**- < 12 inches; **2**- < 36 inches; **3**- < 48 inches; **4**- < 60 inches; **5**- wall / artificial levee*

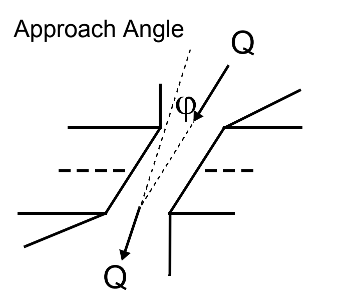
*Bank protection conditions: **1**- good; **2**- slumped; **3**- eroded; **4**- failed*

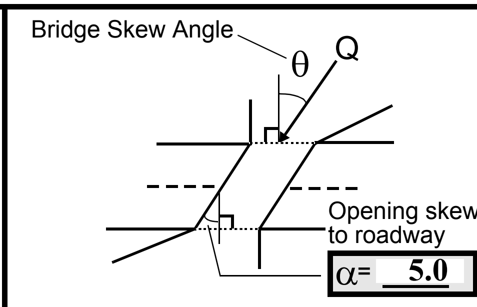
*Erosion: **0** - none; **1**- channel erosion; **2**- road wash; **3**- both; **4**- other*

*Erosion Severity: **0** - none; **1**- slight; **2**- moderate; **3**- severe*

Channel approach to bridge (BF):

15. Angle of approach: **45** 16. Bridge skew: **30**





17. Channel impact zone 1: Exist? **Y** *(Y or N)*

Where? **RB** *(LB, RB)* Severity **1**

Range? **0** feet **US** *(US, UB, DS)* to **45** feet **US**

Channel impact zone 2: Exist? **Y** *(Y or N)*

Where? **LB** *(LB, RB)* Severity **1**

Range? **15** feet **UB** *(US, UB, DS)* to **60** feet **DS**

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

18. Bridge Type: **1a/4**

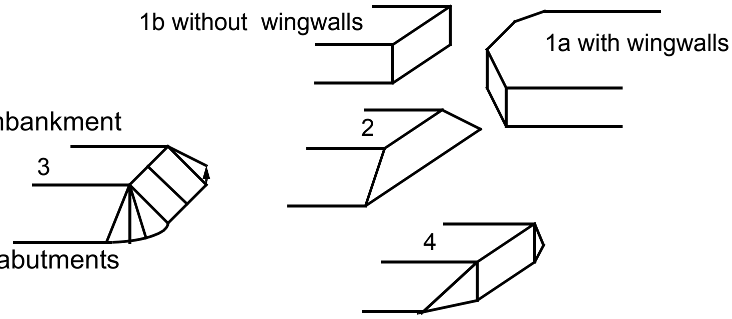
1a- Vertical abutments with wingwalls

1b- Vertical abutments without wingwalls

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

3- Spill through abutments

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



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

7. Values are from the VTAOT files.
Measured bridge length = 30 feet, span length = 28 feet, and bridge width = 26.4 feet.

4. Overall surface cover is brushland verging on a grassy wetland.

C. Upstream Channel Assessment

20. SRD	21. Bank height (BF) LB	21. Bank height (BF) RB	22. Bank angle (BF) LB	22. Bank angle (BF) RB	26. % Veg. cover (BF) LB	26. % Veg. cover (BF) RB	27. Bank material (BF) LB	27. Bank material (BF) RB	28. Bank erosion (BF) LB	28. Bank erosion (BF) RB
29.5	**4.0**			**3.5**	**1**	**1**	**0**	**0**	**2**	**2**

23. Bank width **20.0** 24. Channel width **40.0** 25. Thalweg depth **35.5** 29. Bed Material **2**

30 .Bank protection type: LB **0** RB **2** 31. Bank protection condition: LB **-** RB **2**

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

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

30. Protection extends 30 feet US on the right bank from the end of the US right wingwall.
Thalweg depth = 2 feet.

33. Point/Side bar present? **Y** (Y or N. if N type ctrl-n pb) 34. Mid-bar distance: **27** 35. Mid-bar width: **7**

36. Point bar extent: **18** feet **US** (US, UB) to **50** feet **US** (US, UB, DS) positioned **0** %LB to **20** %RB

37. Material: **2**

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

This point bar is submerged. There is a cutbank above this point bar.

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

41. Mid-bank distance: ***** 42. Cut bank extent: **35** feet **US** (US, UB) to ***** feet **US** (US, UB, DS)

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

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

*** The cutbank extends several hundred feet US. The channel is sinuous.**
The cut bank on the left bank begins at 28 feet US and continues further US.

45. Is channel scour present? **Y** (Y or if N type ctrl-n cs) 46. Mid-scour distance: **20**

47. Scour dimensions: Length **58** Width **6** Depth : **2** Position **30** %LB to **95** %RB

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

Mid scour distance is at the end of the US right wingwall, some protection and stone fill has fallen into the channel and scour hole. Scour starts beneath the US section of the bridge deck. At the US end of the scour hole is a fallen tree on the left bank as well as a smaller tree on the right bank. They are laying across the entire channel and a portion of the bank on the right side.

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

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

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

54. Confluence comments (eg. confluence name):

NO MAJOR CONFLUENCES

D. Under Bridge Channel Assessment

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

56. Height (BF) LB	56. Height (BF) RB	57 Angle (BF) LB	57 Angle (BF) RB	61. Material (BF) LB	61. Material (BF) RB	62. Erosion (BF) LB	62. Erosion (BF) RB
20.0		**3.5**		**2**	**7**	**7**	**-**

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

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

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

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

234

63. US under the bridge is sand and DS under the bridge is gravel and cobbles.
There is a pile of crushed rock strewn across the DS bridge face and just US under the bridge. It extends from the left bank to the right bank and US under the bridge just beyond the DS end of the old right abutment. The bridge was widened recently and the original right abutment was left and the new one was formed around it and DS of it. Both the left and right banks DS and their protection extend into the channel.
Thalweg depth = 2 feet.

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

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

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

70. Debris and Ice Comments:

2

Trees have fallen into the channel 2 bridge lengths US. There is some debris at the DS bridge face and DS under the bridge where there is protection in the channel.

Abutments	71. Attack ∠(BF)	72. Slope ∠ (Qmax)	73. Toe loc. (BF)	74. Scour Condition	75. Scour depth	76. Exposure depth	77. Material	78. Length
LABUT		**30**	**90**	**0**	**0**	**-**	**-**	**90.0**
RABUT	**1**	**0**	**90**			**2**	**0**	**25.5**

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

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

-

-

1

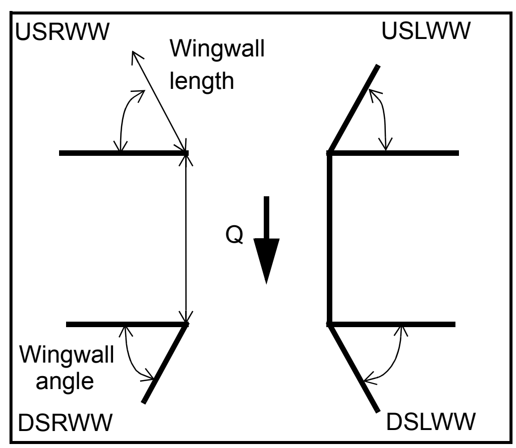
74. Fines have been deposited along the left abutment base, partially due to drain outlets exiting at 3 points along the base. It is possible to penetrate the streambed 1 foot with the range pole through the sand and silt material. At the US half of the left abutment the footing can be reached through the stream bed material.

72. The US portion of the right abutment is old and at 75 degrees. One third of the total DS abutment is new and at 90 degrees. The two parts are even at the top but the US (old) section protrudes 1.3 feet at the base where the angle changes to 90 degrees.

80. **Wingwalls**:

	Exist?	Material?	Scour Condition?	Scour depth?	Exposure depth?	81. Angle?	Length?
USLWW:						**25.5**	
USRWW:	**Y**		**1**		**0**	**1.0**	
DSLWW:	**-**		**-**		**Y**	**29.0**	
DSRWW:	**1**		**0**		**-**	**29.0**	

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



82. **Bank / Bridge Protection**:

Location	USLWW	USRWW	LABUT	RABUT	LB	RB	DSLWW	DSRWW
Type	**-**	**0**	**Y**	**-**	**-**	**1**	**1**	**1**
Condition	**Y**	**-**	**1**	**-**	**-**	**1**	**3**	**3**
Extent	**1**	**-**	**0**	**0**	**2**	**1**	**1**	**-**

Bank / Bridge protection types: 0- absent; 1- < 12 inches; 2- < 36 inches; 3- < 48 inches; 4- < 60 inches; 5- wall / artificial levee
Bank / Bridge protection conditions: 1- good; 2- slumped; 3- eroded; 4- failed
Protection extent: 1- entire base length; 2- US end; 3- DS end; 4- other

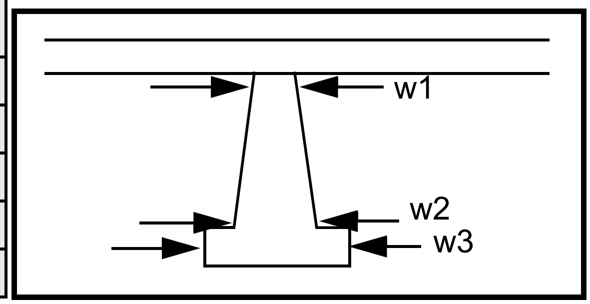
83. Wingwall and protection comments (eg. undermined penetration, unusual scour processes, etc.):

-
-
-
-
-
1
1
1
1
1
1

Piers:

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

85. Pier no.	width (w) feet			elevation (e) feet		
	w1	w2	w3	e@w1	e@w2	e@w3
Pier 1		**7.0**		**35.0**	**55.0**	**15.5**
Pier 2		**6.0**		**45.0**	**40.0**	**14.0**
Pier 3	-	-	-	-	-	-
Pier 4	-	-	-	-	-	-



Level 1 Pier Descr.	1	2	3	4	
86. Location (BF)		-	-	-	*LFP, LTB, LB, MCL, MCM, MCR, RB, RTB, RFP*
87. Type		-	-	-	***1**- Solid pier, **2**- column, **3**- bent*
88. Material		-	-	-	***1**- Wood; **2**- concrete; **3**- metal; **4**- stone*
89. Shape		-	-	-	***1**- Round; **2**- Square; **3**- Pointed*
90. Inclined?		-	-	-	*Y- yes; N- no*
91. Attack ∠ (BF)		-	-	-	
92. Pushed		-	-	-	*LB or RB*
93. Length (feet)	-	-	-	-	
94. # of piles		-	-	-	
95. Cross-members		-	-	-	***0**- none; **1**- laterals; **2**- diagonals; **3**- both*
96. Scour Condition		-	-	-	***0**- not evident; **1**- evident (comment); **2**- footing exposed; **3**- piling exposed; **4**- undermined footing; **5**- settled; **6**- failed*
97. Scour depth	**N**	-	-	-	
98. Exposure depth	-	-	-	-	

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

E. Downstream Channel Assessment

100.

SRD	Bank height (BF) LB	Bank height (BF) RB	Bank angle (BF) LB	Bank angle (BF) RB	% Veg. cover (BF) LB	% Veg. cover (BF) RB	Bank material (BF) LB	Bank material (BF) RB	Bank erosion (BF) LB	Bank erosion (BF) RB
-	-			-	-	NO	PIE	RS		

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

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

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

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

1
1
0
0
2
1
3
1
1
1
1
Approximately 10 feet US under the bridge to 10 feet DS, the channel bed is lined with cobbles. Under the bridge cobbles are above the water surface.

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

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

105. Drop structure comments (eg. downstream scour depth):
weg depth is 0.5 feet at bridge face.

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

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

Material: **NO**

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

DROP STRUCTURE

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

Cut bank extent: **-** feet **-** *(US, UB, DS)* to **-** feet **-** *(US, UB, DS)*

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

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

-
-
-
-

Is channel scour present? **NO** *(Y or if N type ctrl-n cs)* Mid-scour distance: **POIN**

Scour dimensions: Length **T** Width **BAR** Depth: **S** Positioned ____ %LB to ____ %RB

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

Y
LB
33

Are there major confluences? **10** *(Y or if N type ctrl-n mc)* How many? **DS**

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

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

Confluence comments (eg. confluence name):

k continues beyond 120 feet down the left bank.

F. Geomorphic Channel Assessment

107. Stage of reach evolution _____

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

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

N
-
-
-
-
-
-
NO CHANNEL SCOUR

N

109. G. Plan View Sketch

- -

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

APPENDIX F:

SCOUR COMPUTATIONS

SCOUR COMPUTATIONS

Structure Number: BRNETH00740037 Town: BARNET
Road Number: TH 74 County: CALEDONIA
Stream: SOUTH PEACHAM BROOK

Initials RLB Date: 11/13/97 Checked: ECW

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

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

Approach Section

Characteristic	100 yr	500 yr	other Q
Total discharge, cfs	1800	2500	1210
Main Channel Area, ft2	288	306	259
Left overbank area, ft2	294	341	221
Right overbank area, ft2	1113	1246	896
Top width main channel, ft	35	35	35
Top width L overbank, ft	92	97	87
Top width R overbank, ft	266	268	263
D50 of channel, ft	0.0027	0.0027	0.0027
D50 left overbank, ft	--	--	--
D50 right overbank, ft	--	--	--
y1, average depth, MC, ft	8.2	8.7	7.4
y1, average depth, LOB, ft	3.2	3.5	2.5
y1, average depth, ROB, ft	4.2	4.6	3.4
Total conveyance, approach	173515	204632	126902
Conveyance, main channel	44913	49566	37685
Conveyance, LOB	21205	26035	13695
Conveyance, ROB	107397	129030	75522
Percent discrepancy, conveyance	0.0000	0.0005	0.0000
Qm, discharge, MC, cfs	465.9	605.6	359.3
Ql, discharge, LOB, cfs	220.0	318.1	130.6
Qr, discharge, ROB, cfs	1114.1	1576.4	720.1
Vm, mean velocity MC, ft/s	1.6	2.0	1.4
Vl, mean velocity, LOB, ft/s	0.7	0.9	0.6
Vr, mean velocity, ROB, ft/s	1.0	1.3	0.8
Vc-m, crit. velocity, MC, ft/s	2.2	2.2	2.2
Vc-l, crit. velocity, LOB, ft/s	ERR	ERR	ERR
Vc-r, crit. velocity, ROB, ft/s	ERR	ERR	ERR

Results

Live-bed(1) or Clear-Water(0) Contraction Scour?			
Main Channel	0	0	0
Left Overbank	N/A	N/A	N/A
Right Overbank	N/A	N/A	N/A

Clear Water Contraction Scour in MAIN CHANNEL

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

Bridge Section	Q100	Q500	Other Q
(Q) total discharge, cfs	1800	2500	1210
(Q) discharge thru bridge, cfs	1449	1561	1210
Main channel conveyance	12331	12331	12331
Total conveyance	12331	12331	12331
Q2, bridge MC discharge,cfs	1449	1561	1210
Main channel area, ft2	171	171	171
Main channel width (normal), ft	25.6	25.6	25.6
Cum. width of piers in MC, ft	0.0	0.0	0.0
W, adjusted width, ft	25.6	25.6	25.6
y_bridge (avg. depth at br.), ft	6.68	6.68	6.68
Dm, median (1.25*D50), ft	0.003375	0.003375	0.003375
y2, depth in contraction,ft	20.01	21.33	17.14
ys, scour depth (y2-ybridge), ft	13.33	14.65	10.47

Armoring

Dc=[(1.94*V^2)/(5.75*log(12.27*y/D90))^2]/[0.03*(165-62.4)]
Depth to Armoring=3*(1/Pc-1)
(Federal Highway Administration, 1993)

Downstream bridge face property	100-yr	500-yr	Other Q
Q, discharge thru bridge MC, cfs	1449	1561	1210
Main channel area (DS), ft2	120	133	106
Main channel width (normal), ft	25.6	25.6	25.6
Cum. width of piers, ft	0.0	0.0	0.0
Adj. main channel width, ft	25.6	25.6	25.6
D90, ft	0.0286	0.0286	0.0286
D95, ft	0.0507	0.0507	0.0507
Dc, critical grain size, ft	0.2547	0.2343	0.2352
Pc, Decimal percent coarser than Dc	0.000	0.000	0.000
Depth to armoring, ft	N/A	N/A	N/A

Pressure Flow Scour (contraction scour for orifice flow conditions)

Chang pressure flow equation Hb+Ys=Cq*qbr/Vc
Cq=1/Cf*Cc Cf=1.5*Fr^0.43 (<=1) Cc=SQRT[0.10(Hb/(ya-w)-0.56)]+0.79 (<=1)
Umbrell pressure flow equation
(Hb+Ys)/ya=1.1021*[(1-w/ya)*(Va/Vc)]^0.6031
(Richardson and other, 1995, p. 144-146)

	Q100	Q500	OtherQ
Q, total, cfs	1800	2500	1210
Q, thru bridge MC, cfs	1449	1561	1210
Vc, critical velocity, ft/s	2.22	2.24	2.18
Va, velocity MC approach, ft/s	1.62	1.98	1.39
Main channel width (normal), ft	25.6	25.6	25.6
Cum. width of piers in MC, ft	0.0	0.0	0.0
W, adjusted width, ft	25.6	25.6	25.6
qbr, unit discharge, ft2/s	56.6	61.0	47.3
Area of full opening, ft2	171.0	171.0	171.0
Hb, depth of full opening, ft	6.68	6.68	6.68
Fr, Froude number, bridge MC	0.58	0.63	0.48
Cf, Fr correction factor (<=1.0)	1.00	1.00	1.00
**Area at downstream face, ft2	120	133	106
**Hb, depth at downstream face, ft	4.69	5.20	4.14
**Fr, Froude number at DS face	0.98	0.91	0.99
**Cf, for downstream face (<=1.0)	1.00	1.00	1.00
Elevation of Low Steel, ft	498.24	498.24	498.24
Elevation of Bed, ft	491.56	491.56	491.56
Elevation of Approach, ft	500.05	500.55	499.23
Friction loss, approach, ft	0.03	0.05	0.02
Elevation of WS immediately US, ft	500.02	500.50	499.21
ya, depth immediately US, ft	8.46	8.94	7.65
Mean elevation of deck, ft	500.25	500.25	500.25
w, depth of overflow, ft (>=0)	0.00	0.25	0.00
Cc, vert contrac correction (<=1.0)	0.94	0.93	0.97
**Cc, for downstream face (<=1.0)	ERR	0.85	ERR
Ys, scour w/Chang equation, ft	20.43	22.45	15.75
Ys, scour w/Umbrell equation, ft	1.03	2.31	-0.26

**=for UNsubmerged orifice flow using estimated downstream bridge face properties.

**Ys, scour w/Chang equation, ft	ERR	26.77	ERR

**Ys, scour w/Umbrell equation, ft	3.02	3.79	2.28

In UNsubmerged orifice flow, an adjusted scour depth using the Laursen equation results and the estimated downstream bridge face properties can also be computed (ys=y2-ybridgeDS)

y2, from Laursen's equation, ft	20.01	21.33	17.14
WSEL at downstream face, ft	496.24	496.76	495.72
Depth at downstream face, ft	4.69	5.20	4.14
Ys, depth of scour (Laursen), ft	15.32	16.13	13.00

Abutment Scour

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

	Left Abutment			Right Abutment		
Characteristic	100 yr Q	500 yr Q	Other Q	100 yr Q	500 yr Q	Other Q
(Qt), total discharge, cfs	1800	2500	1210	1800	2500	1210
a', abut.length blocking flow, ft	100.3	106.1	95.3	266.7	268.8	263.3
Ae, area of blocked flow ft2	340.95	391.32	262.62	1018.68	1047.35	898.99
Qe, discharge blocked abut.,cfs	280.52	--	170.75	--	--	723.84
(If using Qtotal_overbank to obtain Ve, leave Qe blank and enter Ve and Fr manually)						
Ve, (Qe/Ae), ft/s	0.82	1.03	0.65	1.00	1.26	0.81
ya, depth of f/p flow, ft	3.40	3.69	2.76	3.82	3.90	3.41
--Coeff., K1, for abut. type (1.0, verti.; 0.82, verti. w/ wingwall; 0.55, spillthru)						
K1	0.82	0.82	0.82	0.82	0.82	0.82
--Angle (theta) of embankment (<90 if abut. points DS; >90 if abut. points US)						
theta	85	85	85	95	95	95
K2	0.99	0.99	0.99	1.01	1.01	1.01
Fr, froude number f/p flow	0.079	0.094	0.069	0.086	0.103	0.077
ys, scour depth, ft	9.11	10.52	7.33	13.77	15.17	12.08

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

a'(abut length blocked, ft)	100.3	106.1	95.3	266.7	268.8	263.3
y1 (depth f/p flow, ft)	3.40	3.69	2.76	3.82	3.90	3.41
a'/y1	29.51	28.77	34.58	69.82	68.99	77.12
Skew correction (p. 49, fig. 16)	0.98	0.98	0.98	1.01	1.01	1.01
Froude no. f/p flow	0.08	0.09	0.07	0.09	0.10	0.08
Ys w/ corr. factor K1/0.55:						
vertical	10.50	12.08	8.15	12.50	13.53	10.76
vertical w/ ww's	8.61	9.91	6.69	10.25	11.10	8.83
spill-through	5.78	6.65	4.48	6.87	7.44	5.92

Abutment riprap Sizing

Isbash Relationship

D50=y*K*Fr^2/(Ss-1) and D50=y*K*(Fr^2)^0.14/(Ss-1)

(Richardson and others, 1995, p112, eq. 81,82)

Characteristic	Q100	Q500	Other Q	Q100	Q500	Other Q
Fr, Froude Number	0.98	0.91	0.99	0.98	0.91	0.99
y, depth of flow in bridge, ft	4.69	5.20	4.14	4.69	5.20	4.14
Median Stone Diameter for riprap at:	left abutment			right abutment, ft		
Fr<=0.8 (vertical abut.)	ERR	ERR	ERR	ERR	ERR	ERR
Fr>0.8 (vertical abut.)	1.95	2.12	1.73	1.95	2.12	1.73