# LEVEL II SCOUR ANALYSIS FOR BRIDGE 46 (BRNETH00610046) on TOWN HIGHWAY 61, crossing EAST PEACHAM BROOK, BARNET, VERMONT

Open-File Report 97-766

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 MICHAEL A. IVANOFF

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**Pembroke, New Hampshire**

**1997**

U.S. DEPARTMENT OF THE INTERIOR
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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 46 (BRNETH00610046) ON TOWN HIGHWAY 61, CROSSING EAST PEACHAM BROOK, BARNET, VERMONT

*By* **Michael A. Ivanoff**

## INTRODUCTION AND SUMMARY OF RESULTS

This report provides the results of a detailed Level II analysis of scour potential at structure BRNETH00610046 on Town Highway 61 crossing East 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 east-central Vermont. The 15.8-$mi^2$ drainage area is in a predominantly rural and forested basin. In the vicinity of the study site, the surface cover is forest.

In the study area, East Peacham Brook has an incised, sinuous channel with a slope of approximately 0.02 ft/ft, an average channel top width of 59 ft and an average bank height of 5 ft. The channel bed material ranges from gravel to boulder with a median grain size ($D_{50}$) of 121 mm (0.397 ft). The geomorphic assessment at the time of the Level I and Level II site visit on August 23, 1995, indicated that the reach was laterally unstable with cut banks both upstream and downstream of the bridge.

The Town Highway 61 crossing of East Peacham Brook is a 28-ft-long, one-lane bridge consisting of one 26-foot steel-beam span (Vermont Agency of Transportation, written communication, March 24, 1995). The opening length of the structure parallel to the bridge face is 24.5 ft. The bridge is supported by vertical, concrete abutments with wingwalls. The channel is skewed approximately 5 degrees to the opening while the opening-skew-to-roadway is zero degrees.

A scour hole 0.7 ft deeper than the mean thalweg depth was observed along the upstream left wingwall extending along the left abutment during the Level I assessment. The only scour protection measure at the site was type-2 stone fill (less than 36 inches diameter) at the upstream end of the upstream left wingwall extending along the upstream left bank and along the entire base of the downstream left 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 is 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 0 to 1.2 ft. The worst-case contraction scour occurred at the 500-year discharge. Abutment scour ranged from 10.4 to 13.9 ft. The worst-case abutment scour occurred at the 500-year discharge. Additional information on scour depths and depths to armoring are included in the section titled “Scour Results”. Scoured-streambed elevations, based on the calculated scour depths, are presented in tables 1 and 2. A cross-section of the scour computed at the bridge is presented in figure 8. Scour depths were calculated assuming an infinite depth of erosive material and a homogeneous particle-size distribution.

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

Barnet, VT. Quadrangle, 1:25,000, 1983

NORTH

Figure 1. Location of study area on USGS 1:25,000 scale map.

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

## LEVEL II SUMMARY

***Structure Number*** BRNETH00610046 ***Stream*** East Peacham Brook

***County*** Caledonia ***Road*** TH 61 ***District*** 7

## Description of Bridge

***Bridge length*** 28 ***ft*** ***Bridge width*** 14.3 ***ft*** ***Max span length*** 26 ***ft***

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

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

***Stone fill on abutment?*** No ***Date of inspection*** 08/23/95

***Description of stone fill*** Type-2, around the upstream end of the upstream left wingwall, extending along the upstream left bank and along the entire base of the downstream left wingwall.

Abutments and wingwalls are concrete. There is a 0.7 foot deep scour hole in front of the upstream left wingwall. The left and right abutment footings are exposed.

Yes

***Is bridge skewed to flood flow according to*** There ***survey?*** 5 ***Angle*** Yes

is a moderate channel bend in the upstream reach. The scour hole has developed in the location where the bend impacts the upstream left wingwall.

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

| | ***Date of inspection*** | ***Percent of channel blocked horizontally*** | ***Percent of channel blocked vertically*** |
|---|---|---|---|
| ***Level I*** | 08/23/95 | 0 | 0 |
| ***Level II*** | 08/23/95 | 0 | 0 |

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

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

A point bar is located along the upstream right bank. The stream flow is impacting the upstream left wingwall resulting in a scour hole. There was a shallow stone pile across the downstream channel, 08/23/95.

## Description of the Geomorphic Setting

***General topography*** The channel is located within a moderate relief valley with steep valley walls on both sides.

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

***Date of inspection*** 08/23/95

***DS left:*** Moderately sloped overbank.

***DS right:*** Moderately sloped overbank.

***US left:*** Steep channel bank to a moderately sloped overbank.

***US right:*** Steep valley wall.

## Description of the Channel

***Average top width*** 59 ***ft***

***Average depth*** 5 ***ft***

***Predominant bed material*** Gravel / Cobbles

***Bank material*** Gravel/Cobbles

Sinuous and laterally unstable stream with non-alluvial channel boundaries and no flood plain.

08/23/95

***Vegetative co***

***DS left:*** Trees and brush.

***DS right:*** Trees and brush.

***US left:*** Trees and brush.

***US right:*** Trees and brush.

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

The channel is sinuous with cutbanks upstream and downstream of the bridge.

***Describe any obstructions in channel and date of observation.*** None, 08/23/95.

## Hydrology

***Drainage area*** 15.8 ***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***: -

***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*** 2,340 ***ft³/s*** ***Q500*** 3,000 ***ft³/s***

The 100- and 500-year discharges are the median values based on a range of computed flood frequency curves 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)*** USGS survey

***Datum tie between USGS survey and VTAOT plans*** None

***Description of reference marks used to determine USGS datum.*** RM1 is a chiseled X on top of the downstream end of the left abutment (elev. 898.21 ft, arbitrary survey datum). RM2 is on top of the steel bridge rail above the upstream end of the right abutment (elev. 900.98 ft, arbitrary survey datum).

### Cross-Sections Used in WSPRO Analysis

| [1]*Cross-section* | *Section Reference Distance (SRD) in feet* | [2]*Cross-section development* | *Comments* |
|---|---|---|---|
| EXITX | -23 | 1 | Exit section |
| FULLV | 0 | 2 | Downstream Full-valley section (Templated from EXITX) |
| BRIDG | 0 | 1 | Bridge section |
| RDWAY | 8 | 1 | Road Grade section |
| APPRO | 40 | 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 0.040 to 0.065, and overbank "n" values ranged from 0.070 to 0.075.

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 0.0174 ft/ft, which was estimated from surveyed points downstream of the bridge.

The approach section (APPRO) 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*** 898.3 ***ft***
***Average low steel elevation*** 896.4 ***ft***

***100-year discharge*** 2,340 ***ft³/s***
***Water-surface elevation in bridge opening*** 896.4 ***ft***
***Road overtopping?*** Yes ***Discharge over road*** 501 ***ft³/s***
***Area of flow in bridge opening*** 174 ***ft²***
***Average velocity in bridge opening*** 10.7 ***ft/s***
***Maximum WSPRO tube velocity at bridge*** 12.8 ***ft/s***

***Water-surface elevation at Approach section with bridge*** 900.1
***Water-surface elevation at Approach section without bridge*** 896.5
***Amount of backwater caused by bridge*** 3.6 ***ft***

***500-year discharge*** 3,000 ***ft³/s***
***Water-surface elevation in bridge opening*** 896.4 ***ft***
***Road overtopping?*** Yes ***Discharge over road*** 803 ***ft³/s***
***Area of flow in bridge opening*** 174 ***ft²***
***Average velocity in bridge opening*** 12.6 ***ft/s***
***Maximum WSPRO tube velocity at bridge*** 15.0 ***ft/s***

***Water-surface elevation at Approach section with bridge*** 900.5
***Water-surface elevation at Approach section without bridge*** 897.2
***Amount of backwater caused by bridge*** 3.3 ***ft***

***Incipient overtopping discharge*** 1,490 ***ft³/s***
***Water-surface elevation in bridge opening*** 896.4 ***ft***
***Area of flow in bridge opening*** 174 ***ft²***
***Average velocity in bridge opening*** 8.4 ***ft/s***
***Maximum WSPRO tube velocity at bridge*** 10.2 ***ft/s***

***Water-surface elevation at Approach section with bridge*** 898.2
***Water-surface elevation at Approach section without bridge*** 895.3
***Amount of backwater caused by bridge*** 2.9 ***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.

At this site, the 100-year and incipient roadway-overtopping discharges resulted in unsubmerged orifice flow. The 500-year discharge resulted in submerged 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). The results of the 100-year and 500-year scour analysis are

presented in tables 1 and 2 and a graph of the scour depths is presented in figure 8. The computed streambed armoring depths suggest that armoring will not limit the depth of contraction scour.

For comparison, contraction scour for the discharges resulting in orifice flow was also computed 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) and 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 are provided in Appendix F.

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

## Scour Results

| *Contraction scour:* | *100-yr discharge* | *500-yr discharge* | *Incipient overtopping discharge* |
|---|---|---|---|
| | | *(Scour depths in feet)* | |
| *Main channel* | | | |
| *Live-bed scour* | -- | -- | -- |
| *Clear-water scour* | 0.0 | 1.2 | 0.0 |
| *Depth to armoring* | 6.2 | 13.0 | 6.7 |
| *Left overbank* | -- | -- | -- |
| *Right overbank* | -- | -- | -- |

| *Local scour:* | | | |
|---|---|---|---|
| *Abutment scour* | | | |
| *Left abutment* | 10.5 | 11.0 | 10.4 |
| *Right abutment* | 12.9 | 13.9 | 11.0 |
| *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* | 2.4 | 2.8 | 2.2 |
| *Right abutment* | 2.4 | 2.8 | 2.2 |
| *Piers:* | | | |
| *Pier 1* | -- | -- | -- |
| *Pier 2* | -- | -- | -- |

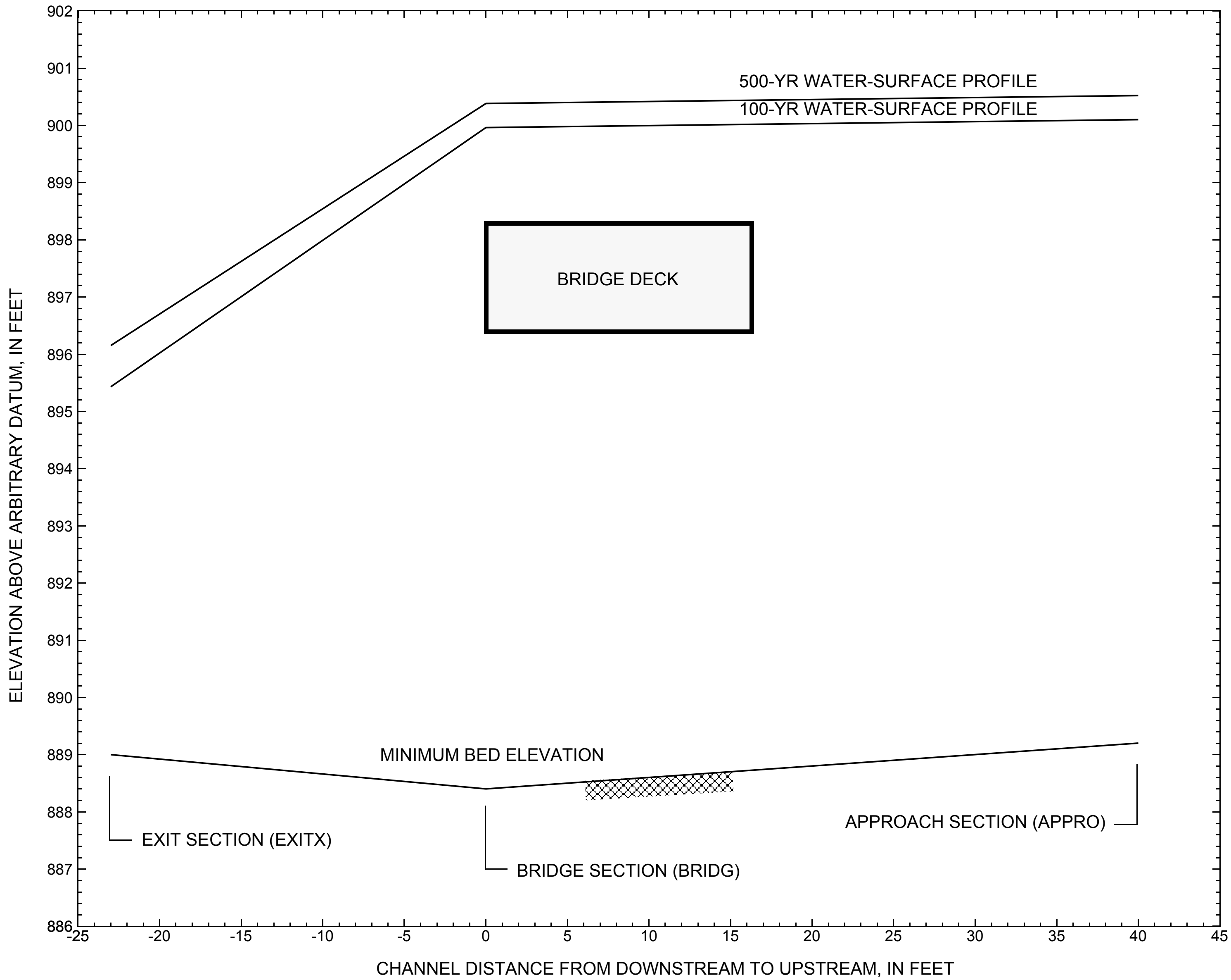


Figure 7. Water-surface profiles for the 100- and 500-yr discharges at structure BRNETH00610046 on Town Highway 61, crossing East Peacham Brook, Barnet, Vermont.

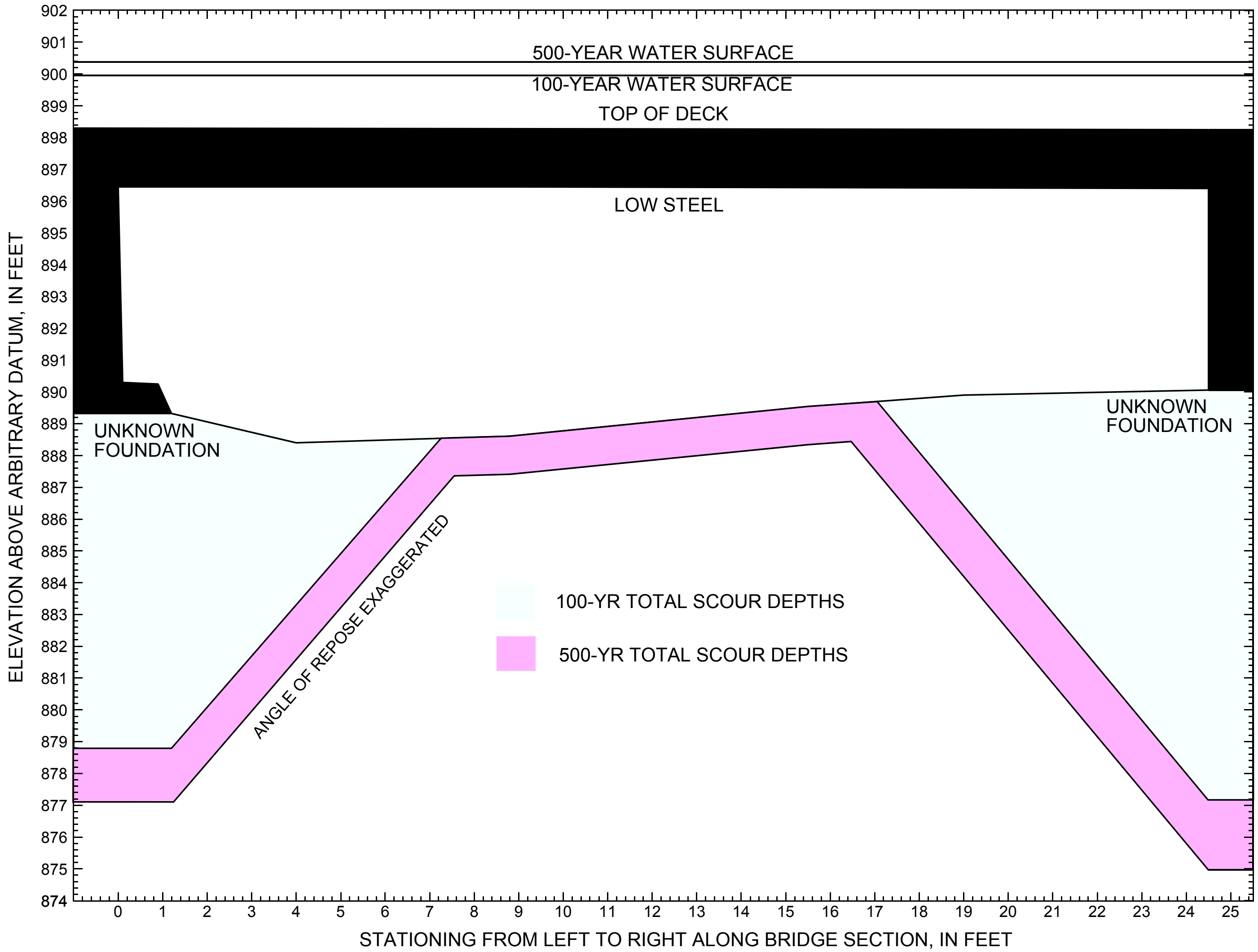


Figure 8. Scour elevations for the 100-yr and 500-yr discharges at structure BRNETH00610046 on Town Highway 61, crossing East Peacham Brook, Barnet, Vermont.

**Table 1.** Remaining footing/pile depth at abutments for the 100-year discharge at structure BRNETH00610046 on Town Highway 61, crossing East 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/pile elevation[2] (feet) | Channel elevation at abutment/ pier[2] (feet) | Contraction scour depth (feet) | Abutment scour depth (feet) | Pier scour depth (feet) | Depth of total scour (feet) | Elevation of scour[2] (feet) | Remaining footing/pile depth (feet) |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 100-yr. discharge is 2,340 cubic-feet per second | | | | | | | | | | | |
| Left abutment | 0.0 | -- | 896.4 | -- | 889.3 | 0.0 | 10.5 | -- | 10.5 | 878.8 | -- |
| Right abutment | 24.5 | -- | 896.4 | -- | 890.1 | 0.0 | 12.9 | -- | 12.9 | 877.2 | -- |

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 BRNETH00610046 on Town Highway 61, crossing East 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/pile 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 3,000 cubic-feet per second | | | | | | | | | | | |
| Left abutment | 0.0 | -- | 896.4 | -- | 889.3 | 1.2 | 11.0 | -- | 12.2 | 877.1 | -- |
| Right abutment | 24.5 | -- | 896.4 | -- | 890.1 | 1.2 | 13.9 | -- | 15.1 | 875.0 | -- |

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

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U.S. Geological Survey, 1983, Barnet, Vermont 7.5 X 15 Minute Series quadrangle map: U.S. Geological Survey Topographic Maps, Scale 1:25,000.

APPENDIX A:

# WSPRO INPUT FILE

# WSPRO INPUT FILE

```
T1        U.S. Geological Survey WSPRO Input File brne046.wsp
T2        Hydraulic analysis for structure BRNETH00610046   Date: 12-AUG-97
T3        Bridge 46 on Town Highway 61 over East Peacham Brook Barnet, VT by MAI
*
J3         6 29 30 552 553 551 5 16 17 13 3 * 15 14 23 21 11 12 4 7 3
*
Q           2340.0   3000.0   1490.0
SK          0.0174   0.0174   0.0174
*
XS   EXITX    -23
GR         -163.3, 918.27   -142.0, 909.67   -126.3, 910.82   -104.5, 908.26
GR          -58.7, 903.19    -33.8, 898.99    -25.0, 896.22     -7.5, 892.10
GR           -3.5, 890.15      0.0, 889.56      5.0, 889.05     10.4, 889.00
GR           16.0, 889.18     21.9, 889.65     25.4, 890.46     31.7, 892.67
GR           56.9, 893.85     66.6, 896.04     89.3, 898.77    223.5, 902.32
GR          353.0, 909.10    389.7, 913.33
N           0.070        0.060        0.075
SA                 -33.8         31.7
*
XS   FULLV      0  * * *   0.0
*
*              SRD     LSEL    XSSKEW
BR   BRIDG      0    896.41       0.0
GR            0.0, 896.45      0.1, 890.30      0.9, 890.25      1.2, 889.32
GR            4.0, 888.40      8.8, 888.61     15.5, 889.54     19.0, 889.90
GR           24.5, 890.06     24.5, 896.37      0.0, 896.45
*
*         BRTYPE  BRWDTH    EMBSS   EMBELV   WWANGL
CD           4      16.4      2.5    898.3     47.7
N           0.040
*
*              SRD    EMBWID   IPAVE
XR   RDWAY      8      14.3     2
GR         -360.9, 930.64   -300.1, 926.33   -193.4, 914.68   -134.2, 910.43
GR         -121.3, 910.56   -107.0, 909.08    -78.4, 904.27    -48.6, 900.78
GR            0.0, 898.30     26.3, 898.25    107.7, 901.53    143.7, 902.91
GR          310.9, 911.94
*
AS   APPRO     40
GR         -178.5, 921.28   -132.9, 910.35   -115.7, 910.69    -95.9, 908.60
GR          -37.8, 900.26    -14.3, 897.30     -9.3, 894.54     -5.4, 891.65
GR            0.0, 890.26      3.6, 889.57      8.9, 889.20     13.3, 889.72
GR           16.7, 890.15     20.6, 890.69     30.9, 892.27     37.7, 893.12
GR           47.0, 896.85     60.8, 896.76     76.3, 905.83     91.9, 907.78
N           0.070        0.065
SA                  -14.3
*
HP 1 BRIDG   896.45 1 896.45
HP 2 BRIDG   896.45 * * 1870
HP 1 BRIDG   896.06 1 896.06
HP 2 RDWAY   899.96 * * 501
HP 1 APPRO   900.10 1 900.10
HP 2 APPRO   900.10 * * 2340
*
HP 1 BRIDG   896.45 1 896.45
HP 2 BRIDG   896.45 * * 2194
HP 2 RDWAY   900.38 * * 803
HP 1 APPRO   900.52 1 900.52
```

# APPENDIX B:

# WSPRO OUTPUT FILE

```
        U.S. Geological Survey WSPRO Input File brne046.wsp
        Hydraulic analysis for structure BRNETH00610046   Date: 12-AUG-97
        Bridge 46 on Town Highway 61 over East Peacham Brook Barnet, VT by MAI
           *** RUN DATE & TIME: 09-18-97  15:33
    CROSS-SECTION PROPERTIES:  ISEQ =  3;  SECID = BRIDG;  SRD =       0.

     WSEL  SA#     AREA        K   TOPW   WETP  ALPH    LEW    REW     QCR
             1     174.   12883.     0.    62.                           0.
   896.45          174.   12883.     0.    62.  1.00     0.    25.      0.

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

         WSEL     LEW     REW    AREA        K        Q    VEL
       896.45     0.0    24.5   174.2   12883.    1870.  10.73

X STA.         0.0         2.2         3.5         4.5         5.5         6.4
  A(I)             14.8         9.4         8.2         8.0         7.5
  V(I)             6.30        9.91       11.34       11.69       12.50

X STA.         6.4         7.4         8.3         9.3        10.3        11.2
  A(I)              7.6         7.3         7.5         7.4         7.5
  V(I)            12.38       12.79       12.55       12.65       12.49

X STA.        11.2        12.2        13.3        14.4        15.5        16.7
  A(I)              7.4         7.7         7.7         7.9         8.0
  V(I)            12.59       12.07       12.14       11.80       11.69

X STA.        16.7        18.0        19.3        20.7        22.2        24.5
  A(I)              8.2         8.6         9.0         9.6        14.8
  V(I)            11.38       10.87       10.34        9.77        6.32

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

     WSEL  SA#     AREA        K   TOPW   WETP  ALPH    LEW    REW     QCR
             1     166.   16736.    24.    37.                        2444.
   896.06          166.   16736.    24.    37.  1.00     0.    25.   2444.

    VELOCITY DISTRIBUTION:  ISEQ =  4;  SECID = RDWAY;  SRD =       8.

         WSEL     LEW     REW    AREA        K        Q    VEL
       899.96   -32.5    68.7   107.6    2748.     501.   4.66

X STA.       -32.5       -13.2        -7.4        -3.5        -0.2         2.6
  A(I)              9.5         6.6         5.4         5.1         4.7
  V(I)             2.64        3.80        4.62        4.92        5.36

X STA.         2.6         5.3         7.9        10.4        13.0        15.4
  A(I)              4.5         4.4         4.2         4.3         4.1
  V(I)             5.54        5.73        5.91        5.87        6.04

X STA.        15.4        17.8        20.3        22.6        24.9        27.3
  A(I)              4.1         4.1         4.0         3.9         4.0
  V(I)             6.14        6.12        6.25        6.40        6.25

X STA.        27.3        29.7        32.9        37.8        45.0        68.7
  A(I)              4.0         4.8         6.6         7.9        11.4
  V(I)             6.29        5.17        3.80        3.18        2.21

    CROSS-SECTION PROPERTIES:  ISEQ =  5;  SECID = APPRO;  SRD =      40.

     WSEL  SA#     AREA        K   TOPW   WETP  ALPH    LEW    REW     QCR
             1      31.     825.    22.    22.                         209.
             2     552.   44162.    81.    85.                        8184.
   900.10          583.   44987.   103.   107.  1.06    -37.    67.   7651.

    VELOCITY DISTRIBUTION:  ISEQ =  5;  SECID = APPRO;  SRD =      40.

         WSEL     LEW     REW    AREA        K        Q    VEL
       900.10   -36.5    66.5   583.0   44987.    2340.   4.01

X STA.       -36.5        -8.4        -4.5        -1.7         0.8         3.1
  A(I)             57.2        29.9        25.3        24.1        23.2
  V(I)             2.05        3.91        4.62        4.85        5.04

X STA.         3.1         5.2         7.2         9.2        11.3        13.4
  A(I)             22.2        21.4        22.3        21.9        22.8
  V(I)             5.26        5.46        5.25        5.34        5.14

X STA.        13.4        15.7        18.1        20.6        23.4        26.5
  A(I)             23.1        23.9        24.3        25.9        26.8
  V(I)             5.06        4.90        4.82        4.52        4.37

X STA.        26.5        30.0        33.9        38.7        47.4        66.5
  A(I)             28.8        30.2        33.7        42.4        53.6
  V(I)             4.06        3.87        3.47        2.76        2.18
```

```
        U.S. Geological Survey WSPRO Input File brne046.wsp
        Hydraulic analysis for structure BRNETH00610046   Date: 12-AUG-97
        Bridge 46 on Town Highway 61 over East Peacham Brook Barnet, VT by MAI
           *** RUN DATE & TIME: 09-18-97  15:33

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

     WSEL  SA#     AREA        K   TOPW   WETP  ALPH    LEW    REW     QCR
             1     174.   12883.     0.    62.                          0.
   896.45          174.   12883.     0.    62.  1.00     0.    25.      0.

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

         WSEL     LEW     REW    AREA        K        Q    VEL
       896.45     0.0    24.5   174.2   12883.    2194.  12.59

 X STA.        0.0         2.2         3.5         4.5         5.5         6.4
  A(I)            14.8         9.4         8.2         8.0         7.5
  V(I)            7.40       11.63       13.30       13.72       14.66

 X STA.        6.4         7.4         8.3         9.3        10.3        11.2
  A(I)             7.6         7.3         7.5         7.4         7.5
  V(I)           14.53       15.01       14.72       14.85       14.65

 X STA.       11.2        12.2        13.3        14.4        15.5        16.7
  A(I)             7.4         7.7         7.7         7.9         8.0
  V(I)           14.77       14.16       14.24       13.84       13.72

 X STA.       16.7        18.0        19.3        20.7        22.2        24.5
  A(I)             8.2         8.6         9.0         9.6        14.8
  V(I)           13.36       12.75       12.14       11.46        7.42

    VELOCITY DISTRIBUTION:  ISEQ =  4;  SECID = RDWAY;  SRD =       8.

         WSEL     LEW     REW    AREA        K        Q    VEL
       900.38   -40.8    79.2   154.1    4592.     803.   5.21

 X STA.      -40.8       -18.7       -11.8        -7.0        -3.1         0.2
  A(I)            12.4         9.0         7.8         7.1         6.5
  V(I)            3.23        4.47        5.17        5.68        6.17

 X STA.        0.2         3.2         6.1         9.0        11.8        14.6
  A(I)             6.2         6.2         6.0         6.0         5.8
  V(I)            6.45        6.51        6.72        6.67        6.87

 X STA.       14.6        17.4        20.1        22.8        25.5        28.2
  A(I)             5.8         5.8         5.7         5.7         5.7
  V(I)            6.92        6.90        7.05        7.07        7.07

 X STA.       28.2        31.1        35.7        41.5        50.2        79.2
  A(I)             5.9         8.3         9.6        11.6        16.9
  V(I)            6.78        4.81        4.17        3.47        2.37

    CROSS-SECTION PROPERTIES:  ISEQ =  5;  SECID = APPRO;  SRD =      40.

     WSEL  SA#     AREA        K   TOPW   WETP  ALPH    LEW    REW     QCR
             1      41.    1203.    25.    26.                        297.
             2     586.   48485.    82.    85.                       8915.
   900.52          627.   49688.   107.   111.  1.07   -40.    67.   8345.

    VELOCITY DISTRIBUTION:  ISEQ =  5;  SECID = APPRO;  SRD =      40.

         WSEL     LEW     REW    AREA        K        Q    VEL
       900.52   -39.6    67.2   627.1   49688.    3000.   4.78

 X STA.      -39.6        -9.5        -5.0        -2.1         0.5         2.9
  A(I)            63.1        33.9        27.1        25.8        24.9
  V(I)            2.38        4.43        5.53        5.80        6.02

 X STA.        2.9         5.0         7.1         9.2        11.3        13.6
  A(I)            23.9        23.4        23.3        23.7        24.6
  V(I)            6.27        6.40        6.44        6.33        6.09

 X STA.       13.6        15.9        18.4        21.0        23.9        27.1
  A(I)            24.7        25.5        25.9        27.7        28.7
  V(I)            6.07        5.87        5.78        5.42        5.23

 X STA.       27.1        30.7        34.8        39.7        48.8        67.2
  A(I)            30.8        33.2        35.9        43.9        56.8
  V(I)            4.86        4.51        4.17        3.41        2.64
```

```
      U.S. Geological Survey WSPRO Input File brne046.wsp
      Hydraulic analysis for structure BRNETH00610046   Date: 12-AUG-97
      Bridge 46 on Town Highway 61 over East Peacham Brook Barnet, VT by MAI
         *** RUN DATE & TIME: 09-18-97  15:33

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

   WSEL  SA#     AREA        K   TOPW   WETP  ALPH    LEW    REW     QCR
           1     174.   12883.     0.    62.                          0.
 896.45          174.   12883.     0.    62.  1.00     0.    25.      0.


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

       WSEL     LEW     REW    AREA        K        Q    VEL
     896.45     0.0    24.5   174.2   12883.    1490.   8.55

X STA.         0.0        2.2        3.5        4.5        5.5        6.4
  A(I)            14.8        9.4        8.2        8.0        7.5
  V(I)            5.02       7.90       9.03       9.32       9.96

X STA.         6.4        7.4        8.3        9.3       10.3       11.2
  A(I)             7.6        7.3        7.5        7.4        7.5
  V(I)            9.87      10.19      10.00      10.08       9.95

X STA.        11.2       12.2       13.3       14.4       15.5       16.7
  A(I)             7.4        7.7        7.7        7.9        8.0
  V(I)           10.03       9.62       9.67       9.40       9.32

X STA.        16.7       18.0       19.3       20.7       22.2       24.5
  A(I)             8.2        8.6        9.0        9.6       14.8
  V(I)            9.07       8.66       8.24       7.78       5.04


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

   WSEL  SA#     AREA        K   TOPW   WETP  ALPH    LEW    REW     QCR
           1     137.   12803.    24.    35.                       1849.
 894.91          137.   12803.    24.    35.  1.00     0.    25.   1849.

  CROSS-SECTION PROPERTIES:  ISEQ =  5;  SECID = APPRO;  SRD =      40.

   WSEL  SA#     AREA        K   TOPW   WETP  ALPH    LEW    REW     QCR
           1       3.      35.     7.     7.                         11.
           2     398.   26455.    77.    81.                       5125.
 898.16          401.   26490.    84.    88.  1.01   -21.    63.   4941.


  VELOCITY DISTRIBUTION:  ISEQ =  5;  SECID = APPRO;  SRD =      40.

       WSEL     LEW     REW    AREA        K        Q    VEL
     898.16   -21.1    63.2   401.3   26490.    1490.   3.71

X STA.       -21.1       -5.8       -2.8       -0.5        1.6        3.5
  A(I)            31.5       20.0       17.5       16.6       15.6
  V(I)            2.36       3.73       4.25       4.48       4.78

X STA.         3.5        5.2        7.0        8.7       10.4       12.2
  A(I)            15.3       15.2       15.2       15.1       15.7
  V(I)            4.86       4.89       4.90       4.94       4.75

X STA.        12.2       14.1       16.1       18.2       20.5       23.1
  A(I)            16.0       16.5       16.8       18.0       18.6
  V(I)            4.66       4.51       4.43       4.15       4.00

X STA.        23.1       26.0       29.5       33.5       38.9       63.2
  A(I)            20.0       22.0       23.2       28.2       44.2
  V(I)            3.72       3.39       3.20       2.64       1.68
```

# WSPRO OUTPUT FILE (continued)

```
        U.S. Geological Survey WSPRO Input File brne046.wsp
        Hydraulic analysis for structure BRNETH00610046   Date: 12-AUG-97
        Bridge 46 on Town Highway 61 over East Peacham Brook Barnet, VT by MAI
           *** RUN DATE & TIME: 09-18-97  15:33

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

EXITX:XS   ******   -22.     300.  1.10 *****  896.53  894.82   2340.  895.43
      -23. ******    64.   17731.  1.16 ***** *******    0.79    7.80

FULLV:FV      23.   -24.     355.  0.78  0.32  896.84 *******   2340.  896.06
        0.    23.    67.   22098.  1.16  0.00   -0.01    0.63    6.58
          <<<<<THE ABOVE RESULTS REFLECT “NORMAL” (UNCONSTRICTED) FLOW>>>>>

APPRO:AS      40.   -13.     275.  1.13  0.58  897.59 *******   2340.  896.46
       40.    40.    46.   17092.  1.00  0.17    0.00    0.69    8.52
          <<<<<THE ABOVE RESULTS REFLECT “NORMAL” (UNCONSTRICTED) FLOW>>>>>

 ===215 FLOW CLASS 1 SOLUTION INDICATES POSSIBLE ROAD OVERFLOW.
           WS1,WSSD,WS3,RGMIN =   899.75       0.00     895.88     898.25
 ===260 ATTEMPTING FLOW CLASS 4 SOLUTION.
 ===220 FLOW CLASS 1 (4) SOLUTION INDICATES POSSIBLE PRESSURE FLOW.
           WS3,WSIU,WS1,LSEL =   895.57     898.95     899.19     896.41
 ===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      23.     0.     174.  1.79 *****  898.24  894.96   1870.  896.45
        0. ******    25.   12883.  1.00 ***** *******    0.71   10.74

     TYPE PPCD FLOW      C     P/A    LSEL   BLEN   XLAB   XRAB
       4. ****   5.  0.495  0.000  896.41 ****** ****** ******

    XSID:CODE    SRD   FLEN    HF    VHD      EGL     ERR       Q    WSEL
   RDWAY:RG       8.    26.  0.07  0.26  900.30    0.01    501.  899.96

             Q   WLEN    LEW    REW  DMAX  DAVG  VMAX  VAVG  HAVG  CAVG
   LT:    213.    44.   -32.    11.   1.7   1.0   5.3   4.7   1.4   3.0
   RT:    288.    57.    11.    69.   1.7   1.1   5.3   4.7   1.4   3.0

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

APPRO:AS      24.   -37.     583.  0.26  0.19  900.37  895.31   2340.  900.10
       40.    25.    67.   45004.  1.06  0.35    0.01    0.31    4.01

  FIRST USER DEFINED TABLE.

    XSID:CODE    SRD    LEW    REW       Q        K     AREA     VEL    WSEL
   EXITX:XS     -23.   -22.    64.   2340.   17731.     300.    7.80  895.43
   FULLV:FV       0.   -24.    67.   2340.   22098.     355.    6.58  896.06
   BRIDG:BR       0.     0.    25.   1870.   12883.     174.   10.74  896.45
   RDWAY:RG       8.*******   213.    501.******************    2.00  899.96
   APPRO:AS      40.   -37.    67.   2340.   45004.     583.    4.01  900.10

 SECOND USER DEFINED TABLE.

    XSID:CODE    CRWS     FR#    YMIN    YMAX    HF    HO  VHD      EGL    WSEL
   EXITX:XS    894.82    0.79  889.00  918.27************  1.10  896.53  895.43
   FULLV:FV  ********    0.63  889.00  918.27  0.32  0.00  0.78  896.84  896.06
   BRIDG:BR    894.96    0.71  888.40  896.45************  1.79  898.24  896.45
   RDWAY:RG  ****************  898.25  930.64  0.07******  0.26  900.30  899.96
   APPRO:AS    895.31    0.31  889.20  921.28  0.19  0.35  0.26  900.37  900.10
```

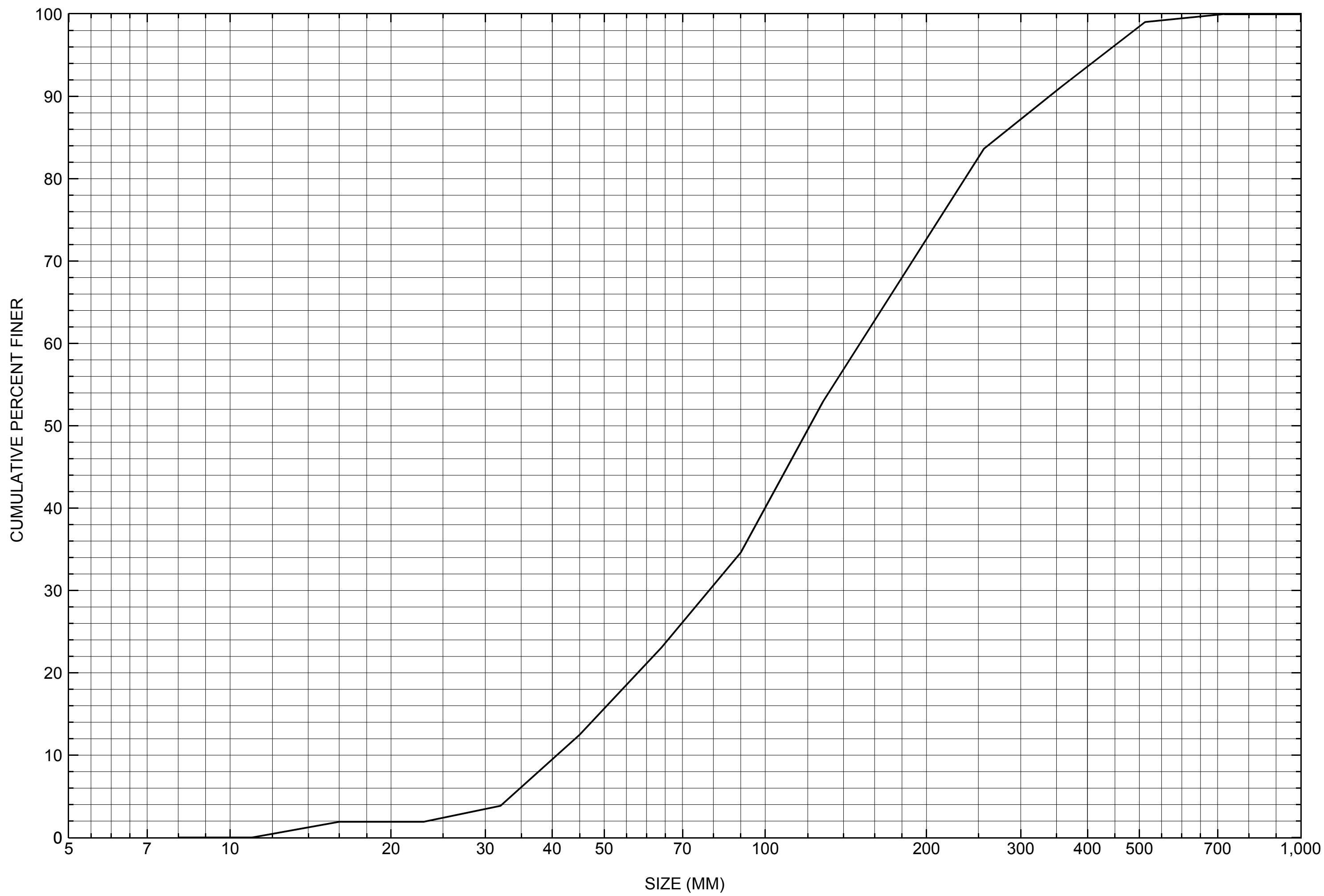
# WSPRO OUTPUT FILE (continued)

```
        U.S. Geological Survey WSPRO Input File brne046.wsp
        Hydraulic analysis for structure BRNETH00610046   Date: 12-AUG-97
        Bridge 46 on Town Highway 61 over East Peacham Brook Barnet, VT by MAI
           *** RUN DATE & TIME: 09-18-97  15:33

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

EXITX:XS   ******   -25.     364.  1.23 *****  897.37  895.48   3000.  896.15
      -23. ******    67.   22737.  1.16 ***** *******    0.79    8.25

FULLV:FV      23.   -27.     425.  0.91  0.33  897.69 *******   3000.  896.79
        0.    23.    73.   27825.  1.17  0.00   -0.01    0.65    7.06
         <<<<<THE ABOVE RESULTS REFLECT "NORMAL" (UNCONSTRICTED) FLOW>>>>>

APPRO:AS      40.   -14.     328.  1.30  0.66  898.55 *******   3000.  897.25
       40.    40.    62.   19482.  1.00  0.20   -0.01    0.77    9.14
         <<<<<THE ABOVE RESULTS REFLECT "NORMAL" (UNCONSTRICTED) FLOW>>>>>

 ===255 ATTEMPTING FLOW CLASS 3 (6) SOLUTION.
                        WS3N,LSEL =   896.79     896.41

            <<<<<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      23.     0.     174.  2.47 *****  898.92  895.59   2194.  896.45
        0. ******    25.   12883.  1.00 ***** *******    0.83   12.60

     TYPE PPCD FLOW      C     P/A    LSEL   BLEN   XLAB   XRAB
       4. ****   6.  0.800  0.000  896.41 ****** ****** ******

    XSID:CODE    SRD   FLEN    HF   VHD     EGL     ERR       Q    WSEL
   RDWAY:RG       8.    26.  0.09  0.38  900.80    0.00    803.  900.38

            Q   WLEN    LEW    REW  DMAX  DAVG  VMAX  VAVG  HAVG  CAVG
   LT:    343.    52.   -41.    11.   2.1   1.3   5.8   5.2   1.7   3.0
   RT:    460.    68.    11.    79.   2.1   1.3   5.9   5.2   1.7   3.0

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

APPRO:AS      24.   -40.     627.  0.38  0.26  900.90  896.07   3000.  900.52
       40.    25.    67.   49657.  1.07  0.35    0.00    0.36    4.79

  FIRST USER DEFINED TABLE.

    XSID:CODE    SRD    LEW    REW       Q        K      AREA     VEL    WSEL
   EXITX:XS     -23.   -25.    67.   3000.   22737.     364.    8.25  896.15
   FULLV:FV       0.   -27.    73.   3000.   27825.     425.    7.06  896.79
   BRIDG:BR       0.     0.    25.   2194.   12883.     174.   12.60  896.45
   RDWAY:RG       8.*******   343.    803.******************    2.00  900.38
   APPRO:AS      40.   -40.    67.   3000.   49657.     627.    4.79  900.52

 SECOND USER DEFINED TABLE.

    XSID:CODE    CRWS     FR#    YMIN    YMAX    HF    HO   VHD      EGL    WSEL
   EXITX:XS    895.48    0.79  889.00  918.27************  1.23  897.37  896.15
   FULLV:FV  ********    0.65  889.00  918.27  0.33  0.00  0.91  897.69  896.79
   BRIDG:BR    895.59    0.83  888.40  896.45************  2.47  898.92  896.45
   RDWAY:RG  ****************  898.25  930.64  0.09******  0.38  900.80  900.38
   APPRO:AS    896.07    0.36  889.20  921.28  0.26  0.35  0.38  900.90  900.52
```

```
        U.S. Geological Survey WSPRO Input File brne046.wsp
        Hydraulic analysis for structure BRNETH00610046   Date: 12-AUG-97
        Bridge 46 on Town Highway 61 over East Peacham Brook Barnet, VT by MAI
           *** RUN DATE & TIME: 09-18-97  15:33

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

EXITX:XS   ******   -17.     209.  0.90 *****  895.21  893.68   1490.  894.31
      -23. ******    59.   11294.  1.15 ***** *******    0.81    7.12

FULLV:FV      23.   -19.     256.  0.61  0.31  895.52 *******   1490.  894.91
        0.    23.    62.   14506.  1.16  0.00   -0.01    0.62    5.82
         <<<<<THE ABOVE RESULTS REFLECT "NORMAL" (UNCONSTRICTED) FLOW>>>>>

APPRO:AS      40.   -11.     212.  0.77  0.52  896.11 *******   1490.  895.34
       40.    40.    43.   11757.  1.00  0.08    0.00    0.63    7.04
         <<<<<THE ABOVE RESULTS REFLECT "NORMAL" (UNCONSTRICTED) FLOW>>>>>

 ===220 FLOW CLASS 1 (4) SOLUTION INDICATES POSSIBLE PRESSURE FLOW.
           WS3,WSIU,WS1,LSEL =   894.16     896.63     896.93     896.41

 ===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      23.     0.     174.  1.10 *****  897.55  894.12   1467.  896.45
        0. ******    25.   12883.  1.00 ***** *******    0.56    8.42

     TYPE PPCD FLOW      C    P/A    LSEL   BLEN   XLAB   XRAB
       4. ****   2.  0.453  0.000  896.41 ****** ****** ******

    XSID:CODE    SRD   FLEN    HF   VHD     EGL     ERR       Q    WSEL
   RDWAY:RG       8.        <<<<<EMBANKMENT IS NOT OVERTOPPED>>>>>

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

APPRO:AS      24.   -21.     401.  0.22  0.16  898.38  894.16   1490.  898.16
       40.    25.    63.   26479.  1.01  0.41   -0.02    0.30    3.71

  FIRST USER DEFINED TABLE.

    XSID:CODE    SRD    LEW    REW       Q        K     AREA     VEL    WSEL
   EXITX:XS     -23.   -17.    59.   1490.   11294.     209.    7.12  894.31
   FULLV:FV       0.   -19.    62.   1490.   14506.     256.    5.82  894.91
   BRIDG:BR       0.     0.    25.   1467.   12883.     174.    8.42  896.45
   RDWAY:RG       8.**************       0.       0.*********    2.00********
   APPRO:AS      40.   -21.    63.   1490.   26479.     401.    3.71  898.16

 SECOND USER DEFINED TABLE.

    XSID:CODE    CRWS     FR#    YMIN    YMAX    HF    HO  VHD      EGL    WSEL
   EXITX:XS    893.68    0.81  889.00  918.27************  0.90  895.21  894.31
   FULLV:FV  ********    0.62  889.00  918.27  0.31  0.00  0.61  895.52  894.91
   BRIDG:BR    894.12    0.56  888.40  896.45************  1.10  897.55  896.45
   RDWAY:RG  ****************  898.25  930.64************  0.20  898.48********
   APPRO:AS    894.16    0.30  889.20  921.28  0.16  0.41  0.22  898.38  898.16
```

# APPENDIX C:

# BED-MATERIAL PARTICLE-SIZE DISTRIBUTION




Appendix C. Bed material particle-size distribution for a pebble count in the channel approach of structure BRNETH00610046, in Barnet, Vermont.

APPENDIX D:

# HISTORICAL DATA FORM

United States Geological Survey
Bridge Historical Data Collection and Processing Form

Structure Number **BRNETH00610046**

## General Location Descriptive

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

Date *(MM/DD/YY)* **03 / 24 / 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)* **EAST PEACHAM BROOK**

Road Name *(I - 7):* **-**

Route Number **TH061**

Vicinity *(I - 9)* **0.03 MI TO JCT W CL2 TH2**

Topographic Map **Barnet**

Hydrologic Unit Code: **01080103**

Latitude *(I - 16; nnnn.n)* **44192**

Longitude *(i - 17; nnnnn.n)* **72071**

## Select Federal Inventory Codes

FHWA Structure Number *(I - 8)* **10030100460301**

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

Maximum span length *(I - 48; nnnn)* **0026**

Year built *(I - 27; YYYY)* **1928**

Structure length *(I - 49; nnnnnn)* **000028**

Average daily traffic, ADT *(I - 29; nnnnnn)* **000100**

Deck Width *(I - 52; nn.n)* **143**

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)* **5**

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

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

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

Year Reconstructed *(I - 106)* **1949**

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

Clear span (*nnn.n ft*) **025.2**

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

Vertical clearance from streambed (*nnn.n ft*) **006.9**

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

Waterway of full opening (*nnn.n* $ft^2$) **174.2**

Comments:

**The structural inspection report of 9/7/94 indicates the structure is a steel stringer type bridge with a concrete deck. The abutment walls and wingwalls are concrete. The right abutment wall has some small spalls reported along the base of the wall; its wingwalls have some random map cracking and areas of leaking reported. On the left abutment, there is a full-height crack with a little leaking noted near the centerline of the roadway and some other random fine cracks. Its wingwalls have some map cracking and spalling reported. The left abutment footing is exposed, and its concrete has areas of heavy spalling. The stream makes a moderate bend into the crossing with most of the flow directed into the left abutment. The channel bed is composed of mostly silt, cobbles, and some boulders.** **(Continued, page 33)**

## Bridge Hydrologic Data

Is there hydrologic data available? N *if No, type ctrl-n h* VTAOT Drainage area *($mi^2$)*: -

Terrain character: -

Stream character & type: -

Streambed material: -

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

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

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

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

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

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

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

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

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

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

Water Surface Elevation Estimates for Existing Structure:

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

Long term stream bed changes: -

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

Relief Elevation (*ft*): - Discharge over roadway at $Q_{100}$ (*$ft^3$/ 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 (*$ft^2$*): -

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

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

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

Comments:

**There is a gravel point bar reported just upstream from the right abutment. Some debris is noted in the channel, both upstream and downstream from the bridge. A shallow stone dam is reported across the channel just downstream of the bridge. While the left abutment footing is exposed, the report indicates there has been no undermining or settling. The banks are noted as slightly eroded upstream. There is very little reported on stone fill protection at this site.**

## USGS Watershed Data

Watershed Hydrographic Data

Drainage area *(DA)* **12.6** $mi^2$ Lake/pond/swamp area **0.02** $mi^2$

Watershed storage *(ST)* **0.2** %

Bridge site elevation **807** ft Headwater elevation **2513** ft

Main channel length **7.02** mi

10% channel length elevation **860** ft 85% channel length elevation **1585** ft

Main channel slope *(S)* **137.71** 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? N *If no, type ctrl-n pl* Date issued for construction *(MM / YYYY)*: - / -

Project Number -

Minimum channel bed elevation: -

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

Benchmark location description:
**NO BENCHMARK INFORMATION**

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

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

If 1: Footing Thickness - Footing bottom elevation: -

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 FOUNDATION MATERIAL INFORMATION**

Comments:
**NO PLANS.**

## Cross-sectional Data

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

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

Comments: **This cross section is the upstream face. The low cord elevations are from the survey log done for this report on 8/23/95. The low cord to bed length data is from the sketch attached to a bridge inspection report dated 9/7/94. The sketch was done on 6/25/92.**

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Station | 0 | 3.9 | 8.9 | 16.9 | 24.3 | 25.2 | - | - | - | - | - |
| Feature | LAB | | | | | RAB | - | - | - | - | - |
| Low chord elevation | 896.4 | 896.4 | 896.4 | 896.4 | 896.4 | 896.4 | - | - | - | - | - |
| Bed elevation | 890.4 | 890.2 | 889.5 | 888.6 | 889.1 | 890.3 | - | - | - | - | - |
| Low chord-bed | 6.0 | 6.2 | 6.9 | 7.8 | 7.3 | 6.1 | - | - | - | - | - |

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

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

Comments: -

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

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

APPENDIX E:

# LEVEL I DATA FORM

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

Qa/Qc Check by: **RB** Date: **2/26/96**

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

Reviewd by: **MAI** Date: **9/24/97**

Structure Number **BRNETH00610046**

## A. General Location Descriptive

1. Data collected by *(First Initial, Full last name)* **M. IVANOFF** Date *(MM/DD/YY)* **8** / **23** / 19**95**

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

County **Caledonia (005)** Town **Barnet (02875)**

Waterway *(I - 6)* **East Peacham Brook** Road Name **-**

Route Number **TH 61** Hydrologic Unit Code: **01080103**

3. Descriptive comments:

**The site is located 0.03 miles to junction with Town Highway 2.**

## B. Bridge Deck Observations

4. Surface cover... LBUS **6** RBUS **6** LBDS **6** RBDS **6** Overall **6**
*(2b us,ds,lb,rb: **1**- Urban; **2**- Suburban; **3**- Row crops; **4**- Pasture; **5**- Shrub- and brushland; **6**- Forest; **7**- Wetland)*

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

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

7. Bridge length **28** *(feet)* Span length **26** *(feet)* Bridge width **14.3** *(feet)*

### Road approach to bridge:

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

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

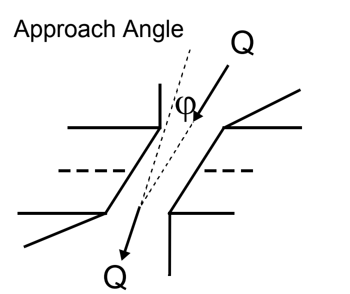
10. Embankment slope (*run / rise in feet / foot*):
US left **3.6:1** US right **1.4:1**

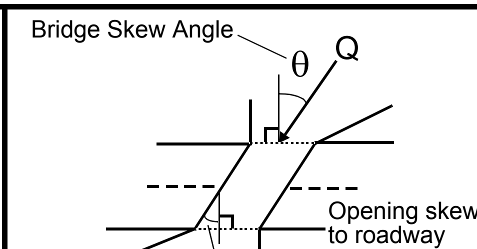
| | Protection | | 13.Erosion | 14.Severity |
|---|---|---|---|---|
| | 11.Type | 12.Cond. | | |
| LBUS | 2 | 1 | 3 | 1 |
| RBUS | 3 | 1 | 2 | 1 |
| RBDS | 0 | - | 0 | 0 |
| LBDS | 0 | - | 0 | 0 |

*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: **0** 16. Bridge skew: **5**




α= **0.0**

17. Channel impact zone 1: Exist? **Y** *(Y or N)*
Where? **LB** *(LB, RB)* Severity **1**
Range? **13** feet **US** *(US, UB, DS)* to **0** feet **US**

Channel impact zone 2: Exist? **Y** *(Y or N)*
Where? **RB** *(LB, RB)* Severity **1**
Range? **0** feet **DS** *(US, UB, DS)* to **5** feet **UB**

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

18. Bridge Type: **4**

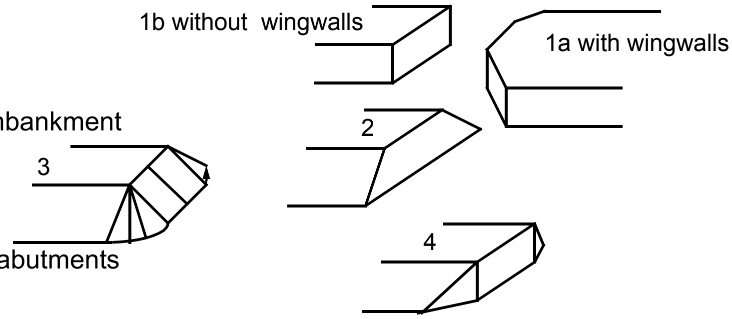
1a- Vertical abutments with wingwalls

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. The bridge dimension values are from VTAOT files. The measured bridge length is 28 feet, bridge span is 25.5 feet, and bridge width is 14.3 feet.**

## 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 |
|---|---|---|---|---|---|---|---|---|---|---|
| **23.5** | **5.5** | | | **2.5** | **4** | **4** | **325** | **325** | **1** | **1** |

23. Bank width **30.0** 24. Channel width **10.0** 25. Thalweg depth **52.0** 29. Bed Material **435**

30 .Bank protection type: LB **2** RB **0** 31. Bank protection condition: LB **1** 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*

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

**30. The left bank protection extends 35 feet from the bridge. The protection is comprised of large stones up to the geometric break of the bank.**
**27. The bank material consists of gravels, sand, and some boulders.**
**29. The bed material consists of cobbles, sand, and boulders.**

33. Point/Side bar present? **Y** (Y or N. if N type ctrl-n pb) 34. Mid-bar distance: **30** 35. Mid-bar width: **25**

36. Point bar extent: **75** feet **US** (US, UB) to **0** feet **US** (US, UB, DS) positioned **50** %LB to **100** %RB

37. Material: **435**

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

**The point bar consists of cobble and gravel with few boulders. The vegetation consists of ferns. Another bar begins at 102 feet and extends to 160 feet upstream on the left bank.**

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

41. Mid-bank distance: **50** 42. Cut bank extent: **38** feet **US** (US, UB) to **102** feet **US** (US, UB, DS)

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

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

**At the cut bank tree roots and larger stones are exposed. There was another cut bank on the right bank from 75 feet to 160 feet upstream.**

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

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

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

**NO CHANNEL SCOUR**

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

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

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

54. Confluence comments (eg. confluence name):

**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 |
|---|---|---|---|---|---|---|---|
| 26.0 | | 1.0 | | 2 | 7 | 7 | 0 |

58. Bank width (BF) **-** 59. Channel width **-** 60. Thalweg depth **90.0** 63. Bed Material **0**

*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.):

**342**

**The bed material consists of gravel, cobble, and sand.**

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

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

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

70. Debris and Ice Comments:

**1**

**There are many trees along the banks with most leaning in due to light fluvial erosion at the cut banks.**

| 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 | | 0 | 90 | 2 | 2 | 0.3 | 1.3 | 90.0 |
| RABUT | 1 | 5 | 90 | | | 2 | 2 | 24.5 |

*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.):

**0**

**0.5**

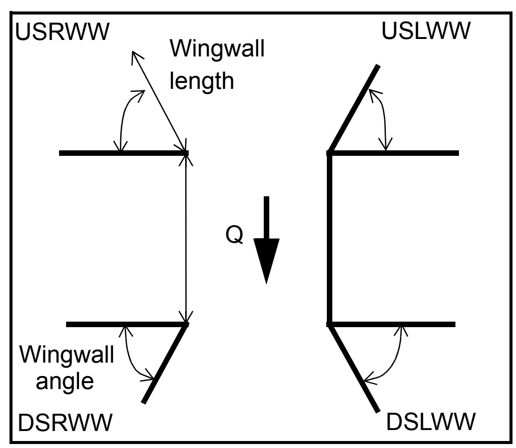
**1**

**The average thalweg depth of the reach is 0.5 feet. The maximum scour was observed at the upstream junction of the left abutment with the upstream left wingwall. The right abutment scour was at the downstream junction with the right wingwall.**

80. **Wingwalls**:

| | Exist? | Material? | Scour Condition? | Scour depth? | Exposure depth? | 81. Angle? | Length? |
|---|---|---|---|---|---|---|---|
| USLWW: | | | | | | 24.5 | |
| USRWW: | Y | | 1 | | 2 | 1.5 | |
| DSLWW: | 0.7 | | 1.7 | | Y | 17.0 | |
| DSRWW: | 1 | | 0 | | 0 | 16.0 | |

*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 | 0 | Y | 0 | 1 | - | - | - |
| Condition | Y | 0 | 1 | 0.5 | 2 | - | - | - |
| Extent | 1 | 0 | 2 | 2 | 0 | 0 | 0 | - |

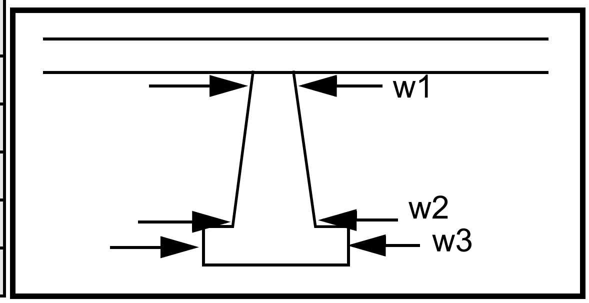
*Bank / Bridge protection types: 0- absent; 1- < 12 inches; 2- < 36 inches; 3- < 48 inches; 4- < 60 inches; 5- wall / artificial levee*
*Bank / Bridge protection conditions: 1- good; 2- slumped; 3- eroded; 4- failed*
*Protection extent: 1- entire base length; 2- US end; 3- DS end; 4- other*

83. Wingwall and protection comments (eg. undermined penetration, unusual scour processes, etc.):
-
-
-
-
-
**2**
**1**
**1**
**0**
-
-

## Piers:

84. Are there piers? **Th** *(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 | | | | **35.0** | **11.5** | **60.0** |
| Pier 2 | | | | **13.0** | **50.0** | **11.5** |
| Pier 3 | | | - | **50.0** | **12.5** | - |
| Pier 4 | - | - | - | - | - | - |




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

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 |
|---|---|---|---|---|---|---|---|---|---|---|
| - | - | | | - | - | - | - | - | - | - |

Bank width (BF) - Channel width - Thalweg depth - 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.):
-
-
-
-
-
-
-
-
-

**NO PIERS**

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

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

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

**4**
**4**
**345**
**345**

106. Point/Side bar present? 2 (Y or N. if N type ctrl-n pb) Mid-bar distance: 1 Mid-bar width: 435

Point bar extent: 0 feet 0 (US, UB, DS) to - feet - (US, UB, DS) positioned Th %LB to e %RB

Material: ba

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

**nk material consists of gravel, cobble, and some boulders.**
**The bed material consists of cobble, gravel, and some boulders.**

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

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.):

**N**

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

Scour dimensions: Length DRO Width P Depth: STR Positioned UC %LB to TU %RB

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

**RE**

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

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

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

Confluence comments (eg. confluence name):

-
-

## 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)*:

**-**

**NO POINT BARS**

**Y**

**LB**

**80**

**60**

**DS**

**200**

**DS**

**1**

## 109. G. Plan View Sketch

- Bo

| | | | |
|---|---|---|---|
| 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: BRNETH00610046 Town: Barnet
Road Number: TH 61 County: Caledonia
Stream: East Pea

Initials MAI Date: 09/18/97 Checked: ECW

I. 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 | 2340 | 3000 | 1490 |
| Main Channel Area, ft2 | 552 | 586 | 398 |
| Left overbank area, ft2 | 31 | 41 | 3 |
| Right overbank area, ft2 | 0 | 0 | 0 |
| Top width main channel, ft | 81 | 82 | 77 |
| Top width L overbank, ft | 22 | 25 | 7 |
| Top width R overbank, ft | 0 | 0 | 0 |
| D50 of channel, ft | 0.3972 | 0.3972 | 0.3972 |
| D50 left overbank, ft | -- | -- | -- |
| D50 right overbank, ft | -- | -- | -- |
| y1, average depth, MC, ft | 6.8 | 7.1 | 5.2 |
| y1, average depth, LOB, ft | 1.4 | 1.6 | 0.4 |
| y1, average depth, ROB, ft | ERR | ERR | ERR |
| Total conveyance, approach | 44987 | 49688 | 26490 |
| Conveyance, main channel | 44162 | 48485 | 26455 |
| Conveyance, LOB | 825 | 1203 | 35 |
| Conveyance, ROB | 0 | 0 | 0 |
| Percent discrepancy, conveyance | 0.0000 | 0.0000 | 0.0000 |
| Qm, discharge, MC, cfs | 2297.1 | 2927.4 | 1488.0 |
| Ql, discharge, LOB, cfs | 42.9 | 72.6 | 2.0 |
| Qr, discharge, ROB, cfs | 0.0 | 0.0 | 0.0 |
| Vm, mean velocity MC, ft/s | 4.2 | 5.0 | 3.7 |
| Vl, mean velocity, LOB, ft/s | 1.4 | 1.8 | 0.7 |
| Vr, mean velocity, ROB, ft/s | ERR | ERR | ERR |
| Vc-m, crit. velocity, MC, ft/s | 11.3 | 11.4 | 10.8 |
| 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 | 2340 | 3000 | 1490 |
| (Q) discharge thru bridge, cfs | 1870 | 2194 | 1490 |
| Main channel conveyance | 12883 | 12883 | 12883 |
| Total conveyance | 12883 | 12883 | 12883 |
| Q2, bridge MC discharge,cfs | 1870 | 2194 | 1490 |
| Main channel area, ft2 | 174 | 174 | 174 |
| Main channel width (normal), ft | 24.5 | 24.5 | 24.5 |
| Cum. width of piers in MC, ft | 0.0 | 0.0 | 0.0 |
| W, adjusted width, ft | 24.5 | 24.5 | 24.5 |
| y_bridge (avg. depth at br.), ft | 7.11 | 7.11 | 7.11 |
| Dm, median (1.25*D50), ft | 0.4965 | 0.4965 | 0.4965 |
| y2, depth in contraction,ft | 6.21 | 7.12 | 5.11 |
| ys, scour depth (y2-ybridge), ft | -0.90 | 0.01 | -2.00 |

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 | 2340 | 3000 | 1490 |
| Q, thru bridge MC, cfs | 1870 | 2194 | 1490 |
| Vc, critical velocity, ft/s | 11.35 | 11.44 | 10.84 |
| Va, velocity MC approach, ft/s | 4.16 | 5.00 | 3.74 |
| Main channel width (normal), ft | 24.5 | 24.5 | 24.5 |
| Cum. width of piers in MC, ft | 0.0 | 0.0 | 0.0 |
| W, adjusted width, ft | 24.5 | 24.5 | 24.5 |
| qbr, unit discharge, ft2/s | 76.3 | 89.6 | 60.8 |
| Area of full opening, ft2 | 174.2 | 174.2 | 174.2 |
| Hb, depth of full opening, ft | 7.11 | 7.11 | 7.11 |
| Fr, Froude number, bridge MC | 0.71 | 0.83 | 0.56 |
| Cf, Fr correction factor (<=1.0) | 1.00 | 1.00 | 1.00 |
| **Area at downstream face, ft2 | 166 | N/A | 137 |
| **Hb, depth at downstream face, ft | 6.78 | N/A | 5.59 |
| **Fr, Froude number at DS face | 0.76 | ERR | 0.81 |
| **Cf, for downstream face (<=1.0) | 1.00 | N/A | 1.00 |

| | | | |
|---|---|---|---|
| Elevation of Low Steel, ft | 896.41 | 896.41 | 896.41 |
| Elevation of Bed, ft | 889.30 | 889.30 | 889.30 |
| Elevation of Approach, ft | 900.1 | 900.52 | 898.16 |
| Friction loss, approach, ft | 0.19 | 0.26 | 0.16 |
| Elevation of WS immediately US, ft | 899.91 | 900.26 | 898.00 |
| ya, depth immediately US, ft | 10.61 | 10.96 | 8.70 |
| Mean elevation of deck, ft | 898.28 | 898.28 | 898.28 |
| w, depth of overflow, ft (>=0) | 1.63 | 1.98 | 0.00 |
| Cc, vert contrac correction (<=1.0) | 0.94 | 0.94 | 0.95 |
| **Cc, for downstream face (<=1.0) | 0.929461 | ERR | 0.880953 |
| | | | |
| Ys, scour w/Chang equation, ft | **0.03** | **1.20** | **-1.20** |
| Ys, scour w/Umbrell equation, ft | -1.34 | -0.61 | -2.06 |

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

| | | | |
|---|---|---|---|
| **Ys, scour w/Chang equation, ft | 0.46 | N/A | 0.78 |
| **Ys, scour w/Umbrell equation, ft | -1.00 | N/A | -0.54 |

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 | 6.21 | 7.12 | 5.11 |
| WSEL at downstream face, ft | 896.06 | -- | 894.91 |
| Depth at downstream face, ft | 6.78 | N/A | 5.59 |
| Ys, depth of scour (Laursen), ft | -0.56 | N/A | -0.48 |

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 | 1870 | 2194 | 1490 |
| Main channel area (DS), ft2 | 166 | 174.2 | 137 |
| Main channel width (normal), ft | 24.5 | 24.5 | 24.5 |
| Cum. width of piers, ft | 0.0 | 0.0 | 0.0 |
| Adj. main channel width, ft | 24.5 | 24.5 | 24.5 |
| D90, ft | 1.1127 | 1.1127 | 1.1127 |
| D95, ft | 1.3962 | 1.3962 | 1.3962 |
| Dc, critical grain size, ft | 0.6893 | 0.8427 | 0.7037 |
| Pc, Decimal percent coarser than Dc | 0.250 | 0.163 | 0.241 |
| | | | |
| Depth to armoring, ft | **6.21** | **13.01** | **6.66** |

Abutment Scour

Froehlich's Abutment Scour

Ys/Y1 = 2.27*K1*K2*(a'/Y1)^0.43*Fr1^0.61+1

(Richardson and others, 1995, p. 48, eq. 28)

| Characteristic | Left Abutment 100 yr Q | 500 yr Q | Other Q | Right Abutment 100 yr Q | 500 yr Q | Other Q |
|---|---|---|---|---|---|---|
| (Qt), total discharge, cfs | 2340 | 3000 | 1490 | 2340 | 3000 | 1490 |
| a', abut.length blocking flow, ft | 36.5 | 39.6 | 21.1 | 42 | 42.7 | 38.7 |
| Ae, area of blocked flow ft2 | 101.85 | 103.2 | 72.95 | 167.67 | 170.8 | 127.94 |
| Qe, discharge blocked abut.,cfs | -- | -- | 241.24 | -- | -- | 336.53 |
| (If using Qtotal_overbank to obtain Ve, leave Qe blank and enter Ve and Fr manually) | | | | | | |
| Ve, (Qe/Ae), ft/s | 3.34 | 3.94 | 3.31 | 3.21 | 3.89 | 2.63 |
| ya, depth of f/p flow, ft | 2.79 | 2.61 | 3.46 | 3.99 | 4.00 | 3.31 |
| --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 | 90 | 90 | 90 | 90 | 90 | 90 |
| K2 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| Fr, froude number f/p flow | 0.314 | 0.363 | 0.313 | 0.255 | 0.300 | 0.255 |
| ys, scour depth, ft | **10.53** | **11.03** | **10.36** | **12.87** | **13.89** | **11.01** |

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) | 36.5 | 39.6 | 21.1 | 42 | 42.7 | 38.7 |
| y1 (depth f/p flow, ft) | 2.79 | 2.61 | 3.46 | 3.99 | 4.00 | 3.31 |
| a'/y1 | 13.08 | 15.20 | 6.10 | 10.52 | 10.68 | 11.71 |
| Skew correction (p. 49, fig. 16) | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| Froude no. f/p flow | 0.31 | 0.36 | 0.31 | 0.26 | 0.30 | 0.25 |
| Ys w/ corr. factor K1/0.55: | | | | | | |
| vertical | ERR | ERR | ERR | ERR | ERR | ERR |
| vertical w/ ww's | ERR | ERR | ERR | ERR | ERR | ERR |
| spill-through | ERR | ERR | ERR | ERR | ERR | ERR |

Abutment riprap Sizing

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

| Characteristic | Q100 | Q500 | Other Q | Q100 | Q500 | Other Q |
|---|---|---|---|---|---|---|
| Fr, Froude Number | 0.76 | 0.83 | 0.81 | 0.76 | 0.83 | 0.81 |
| y, depth of flow in bridge, ft | 6.78 | 7.11 | 5.59 | 6.78 | 7.11 | 5.59 |
| Median Stone Diameter for riprap at: | left abutment | | | right abutment, ft | | |
| Fr<=0.8 (vertical abut.) | **2.42** | ERR | ERR | **2.42** | ERR | ERR |
| Fr>0.8 (vertical abut.) | ERR | **2.82** | **2.20** | ERR | **2.82** | **2.20** |