U.S. DEPARTMENT OF THE INTERIOR

U.S. GEOLOGICAL SURVEY

LEVEL II BRIDGE SCOUR ANALYSIS FOR STRUCTURE 124007200200 ON ROUTE SC 72, CROSSING THE SANDY RIVER IN CHESTER COUNTY, SOUTH CAROLINA

By J. Mike Sullivan and Andy W. Caldwell

Prepared in cooperation with the
SOUTH CAROLINA DEPARTMENT
OF TRANSPORTATION

Columbia, South Carolina

1994

UNIT ABBREVIATIONS

cubic foot per second	ft^3/s
feet per second	ft/s
foot	ft
mile	mi
millimeter	mm
square foot	ft^2
square mile	mi^2

OTHER ABBREVIATIONS

downstream	D/S
upstream	U/S
flood plain	f/p
Water-Surface Profile computation model	WSPRO
median diameter of bed material	D_{50}
South Carolina Department of Transportation	SCDOT

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.

Level II bridge scour analysis for structure 124007200200 on Route SC 72, crossing the Sandy River in Chester County, South Carolina

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This report provides the results of the detailed Level II analysis of scour potential at structure 124007200200 on Route SC 72, crossing the Sandy River in Chester County, South Carolina (figure 1 in pocket; figures 4-7). The site is located in the Piedmont physiographic province near the town of Leeds in the southwestern part of Chester County. The drainage area for the site is 105 mi^2, and is a predominantly rural drainage basin with little development in recent years. In the vicinity of the study site, the land is covered by moderate to dense woods consisting of hardwoods and the downstream, right flood plain is a pasture that extends 540 ft downstream of the Route SC 72 crossing.

In the study area, the Sandy River has a meandering channel with a slope of approximately 0.0015 ft/ft (7.9 ft/mi), an average channel top width of 68 ft and an average channel depth of 9.4 ft. The predominant channel bed material is sand (D_{50} is 1.3 mm) and the channel banks consist of a silty sand (D_{50} is 0.88 mm). In general, the banks have moderate to heavy woody vegetative cover and were noted as having some bank failure with exposed tree roots and trees leaning over the channel at the time of the Level I site visit, January 28, 1991, and the Level II site visit, April 20, 1993.

The Route SC 72 crossing of the Sandy River is a 390-ft-long, two-lane bridge consisting of thirteen 30-ft concrete spans, supported by steel and concrete bents with spillthrough abutments. The left and right abutments are protected by riprap. In this report, the words "right" and "left" refer to directions that would be reported by an observer facing downstream. Additional details describing conditions at the site are included in the Scour Report Summary.

Scour depths were computed using engineering judgement and the general guidelines described in Hydraulic Engineering Circular 18 (Richardson and others, 1993) and the Transportation Research Board Draft Paper, "Evaluating scour at bridges using WSPRO" (Arneson and others, 1992). Scour depths were calculated assuming an infinite depth of erosive material and a homogeneous particle-size distribution. The results of the scour analysis are presented in tables 1 through 4 and a graph of the scour depths is shown on figure 2.

Pile penetration depths were obtained from the SCDOT bridge plans. The minimum remaining pile penetration depths for the 100- and 500-year discharges are 12.3 ft and 11.8 ft, respectively. These minimum depths occur at bent 4.

It should be noted that the SCDOT bridge plan borings (file number 12.248) show subsurface rock and gravel deposits that could affect the scour depths shown in this study. For more information, see the SCDOT bridge plans in the pocket at the back of the report.

Table 1. *--Remaining pile/footing penetration at piers/bents for the 100-year discharge at structure 124007200200 on Route SC 72, crossing the Sandy River in Chester County, South Carolina*

Pier/bent [1] number	Station from [2] left end of bridge (feet)	Pile tip/ [3] footing elevation, SCDOT datum (feet)	Pile tip/ footing elevation, USGS datum (feet)	Ground elevation at pier/bent, USGS datum (feet)	Total [4] scour depth (feet)	Elevation of scour, USGS datum (feet)	Remaining pile/footing penetration (feet)
100-year discharge is 14,300 cubic feet per second							
2	30	295.3	295.1	329.5	1.9	327.6	32.5
3	60	296.0	295.8	323.3	3.2	320.1	24.3
4	90	296.9	296.7	314.8	5.8	309.0	12.3
5	120	294.9	294.7	315.4	5.8	309.6	14.9
6	150	292.0	291.8	322.9	3.2	319.7	27.9
7	180	294.4	294.2	323.5	5.9	317.6	23.4
8	210	295.3	295.1	323.8	5.9	317.9	22.8
9	240	297.3	297.1	324.3	5.8	318.5	21.4
10	270	300.8	300.6	323.8	5.9	317.9	17.3
11	300	301.6	301.4	324.5	5.8	318.7	17.3
12	330	300.7	300.5	325.4	5.8	319.6	19.1
13	360	304.3	304.1	331.6	5.3	326.3	22.2

[1] Pier/bent number corresponds to the South Carolina Department of Transportation (SCDOT) bridge plans.

[2] Stations are determined from left to right looking downstream.

[3] Pile tip/footing elevations obtained from the SCDOT bridge plans. The maximum elevation at each pier/bent is used.

[4] Total scour depth is the sum of the contraction and pier/bent scour depths.

NOTE: The SCDOT bridge plan borings (docket number 12.248) show subsurface rock and gravel deposits that could reduce the scour depths shown in the above table. For more information, see the SCDOT plans in report pocket.

Table 2. *--Remaining pile/footing penetration at piers/bents for the 500-year discharge at structure 124007200200 on Route SC 72, crossing the Sandy River in Chester County, South Carolina*

Pier/bent [1] number	Station from[2] left end of bridge (feet)	Pile tip/ [3] footing elevation, SCDOT datum (feet)	Pile tip/ footing elevation, USGS datum (feet)	Ground elevation at pier/bent, USGS datum (feet)	Total [4] scour depth (feet)	Elevation of scour, USGS datum (feet)	Remaining pile/footing penetration (feet)
500-year discharge is 21,000 cubic feet per second							
2	30	295.3	295.1	329.5	2.2	327.3	32.2
3	60	296.0	295.8	323.3	3.4	319.9	24.1
4	90	296.9	296.7	314.8	6.3	308.5	11.8
5	120	294.9	294.7	315.4	6.3	309.1	14.4
6	150	292.0	291.8	322.9	3.4	319.5	27.7
7	180	294.4	294.2	323.5	9.9	313.6	19.4
8	210	295.3	295.1	323.8	9.9	313.9	18.8
9	240	297.3	297.1	324.3	9.9	314.4	17.3
10	270	300.8	300.6	323.8	9.9	313.9	13.3
11	300	301.6	301.4	324.5	9.9	314.6	13.2
12	330	300.7	300.5	325.4	9.8	315.6	15.1
13	360	304.3	304.1	331.6	9.5	322.1	18.0

[1] Pier/bent number corresponds to the South Carolina Department of Transportation (SCDOT) bridge plans.

[2] Stations are determined from left to right looking downstream.

[3] Pile tip/footing elevations obtained from the SCDOT bridge plans. The maximum elevation at each pier/bent is used.

[4] Total scour depth is the sum of the contraction and pier/bent scour depths.

NOTE: The SCDOT bridge plan borings (docket number 12.248) show subsurface rock and gravel deposits that could reduce the scour depths shown in the above table. For more information, see the SCDOT plans in report pocket.

Table 3. --*Cumulative scour depths at piers/bents for the 100-year discharge at structure 124007200200 on Route SC 72, crossing the Sandy River in Chester County, South Carolina*

Pier/bent [1] number	Station from [2] left end of bridge (feet)	Contraction scour depth (feet)	Pier/bent scour depth **without** debris (feet)	Total [3] scour depth **without** debris (feet)
100-year discharge is 14,300 cubic feet per second				
2	30	0.0	1.9	1.9
3	60	0.0[4]	3.2	3.2
4	90	0.0[4]	5.8	5.8
5	120	0.0[4]	5.8	5.8
6	150	0.0[4]	3.2	3.2
7	180	3.3	2.6	5.9
8	210	3.3	2.6	5.9
9	240	3.3	2.5	5.8
10	270	3.3	2.6	5.9
11	300	3.3	2.5	5.8
12	330	3.3	2.5	5.8
13	360	3.3	2.0	5.3

[1] Pier/bent number corresponds to the South Carolina Department of Transportation (SCDOT) bridge plans.

[2] Stations are determined from left to right looking downstream.

[3] Total scour depth is the sum of the contraction and pier/bent scour depths.

[4] The calculated contraction scour is a negative value, but was set equal to zero to reflect a more reasonable estimate of scour during peak flood conditions.

NOTE: The SCDOT bridge plan borings (docket number 12.248) show subsurface rock and gravel deposits that could reduce the scour depths shown in the above table. For more information, see the SCDOT plans in report pocket.

NOTE: The pier and contraction scour equations used in this scour analysis were those recommended in Hydraulic Engineering Circular 18 (Richardson and others, 1993). Scour depths were calculated assuming an infinite depth of erosive material and a homogeneous particle-size distribution.

Table 4. --*Cumulative scour depths at piers/bents for the 500-year discharge at structure 124007200200 on Route SC 72, crossing the Sandy River in Chester County, South Carolina*

Pier/bent [1] number	Station from [2] left end of bridge (feet)	Contraction scour depth (feet)	Pier/bent scour depth **without** debris (feet)	Total [3] scour depth **without** debris (feet)
500-year discharge is 21,000 cubic feet per second				
2	30	0.0	2.2	2.2
3	60	0.0[4]	3.4	3.4
4	90	0.0[4]	6.3	6.3
5	120	0.0[4]	6.3	6.3
6	150	0.0[4]	3.4	3.4
7	180	7.0	2.9	9.9
8	210	7.0	2.9	9.9
9	240	7.0	2.9	9.9
10	270	7.0	2.9	9.9
11	300	7.0	2.9	9.9
12	330	7.0	2.8	9.8
13	360	7.0	2.5	9.5

[1] Pier/bent number corresponds to the South Carolina Department of Transportation (SCDOT) bridge plans.

[2] Stations are determined from left to right looking downstream.

[3] Total scour depth is the sum of the contraction and pier/bent scour depths.

[4] The calculated contraction scour is a negative value, but was set equal to zero to reflect a more reasonable estimate of scour during peak flood conditions.

NOTE: The SCDOT bridge plan borings (docket number 12.248) show subsurface rock and gravel deposits that could reduce the scour depths shown in the above table. For more information, see the SCDOT plans in report pocket.

NOTE: The pier and contraction scour equations used in this scour analysis were those recommended in Hydraulic Engineering Circular 18 (Richardson and others, 1993). Scour depths were calculated assuming an infinite depth of erosive material and a homogeneous particle-size distribution.

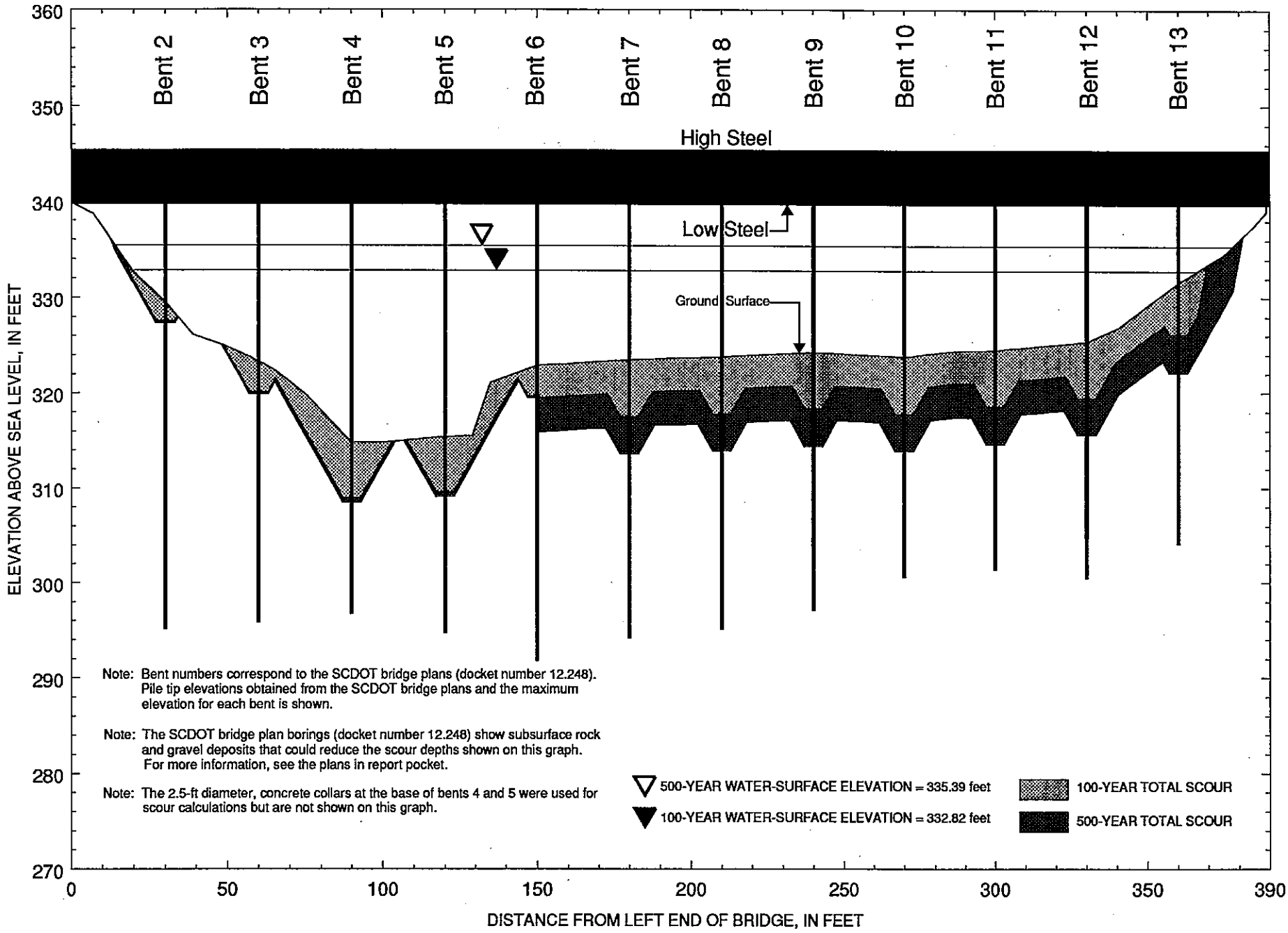

Figure 2.--Total scour depths for the 100- and 500-year discharges at the downstream face of structure 124007200200 on Route SC 72, crossing the Sandy River in Chester County, South Carolina.

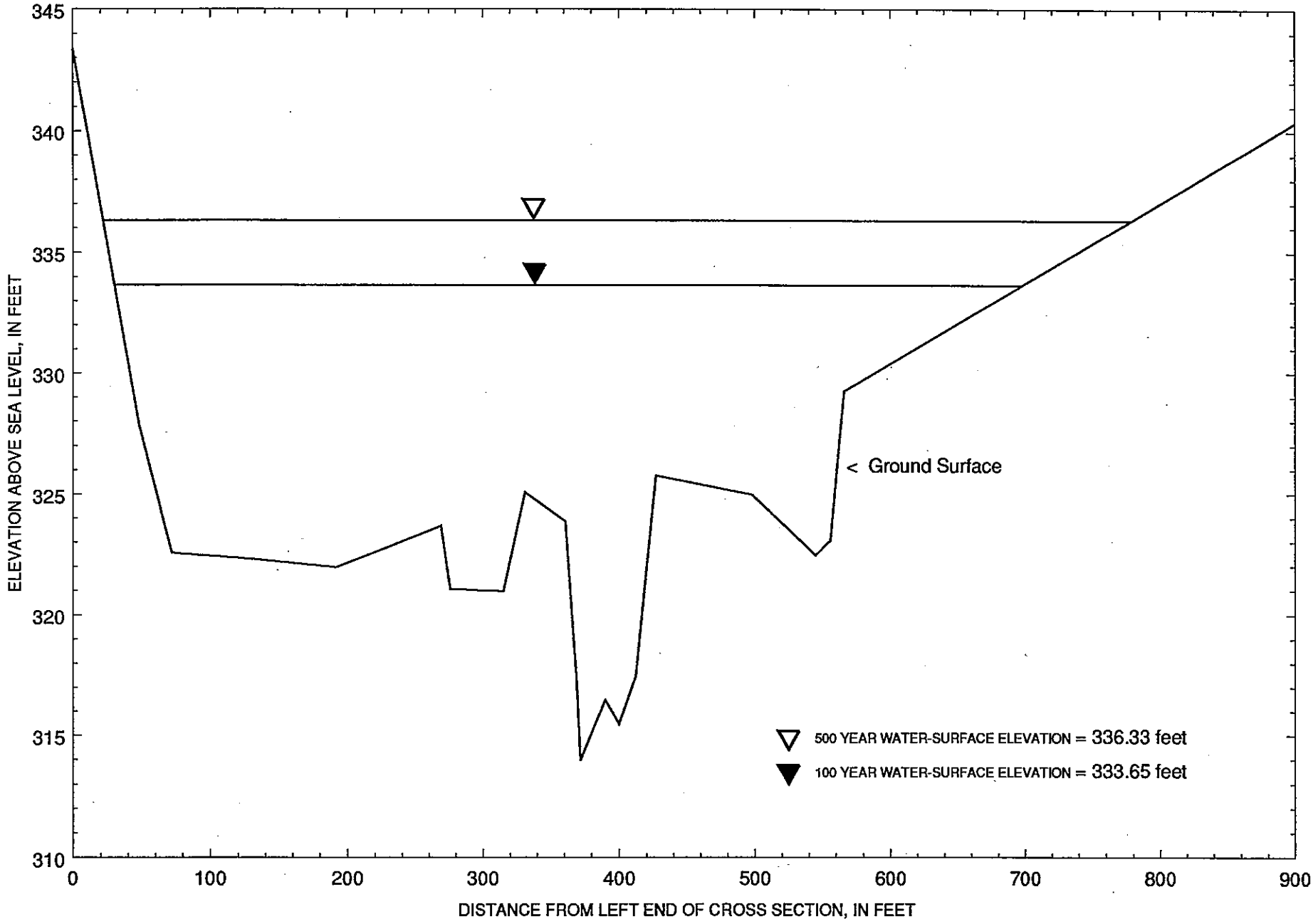

Figure 3.--Approach cross section at structure 124007200200 on Route SC 72, crossing the Sandy River in Chester County, South Carolina.

Figure 4.--Structure 124007200200 on Route SC 72, crossing the Sandy River in Chester County, South Carolina as viewed from 145 ft upstream (April 20, 1993).

Figure 5.--Upstream channel as viewed from structure 124007200200 on Route SC 72, crossing the Sandy River in Chester County, South Carolina (January 28, 1991).

Figure 6.--Downstream channel as viewed from structure 124007200200 on Route SC 72, crossing the Sandy River in Chester County, South Carolina (January 28, 1991).

Figure 7.--Structure 124007200200 on Route SC 72, crossing the Sandy River in Chester County, South Carolina as viewed from the upstream, left abutment (January 28, 1991).

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SCOUR REPORT SUMMARY

Structure Number 124007200200 *Stream* Sandy River

County Chester *Road* SC 72 *District* 4

Description of Bridge

Bridge length 390 *ft* *Bridge width* 33 *ft* *Max span length* 30 *ft*

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

Abutment type spillthrough *Embankment type* sloping

Riprap on abutment? yes *Date of inspection* 04-08-1993

Description of riprap Both abutments are protected with 6- to 18-inch rock and asphalt chunks.

Brief description of piers/pile bents The bridge is supported by 12 interior bents, each consisting of four 0.80-ft by 0.85-ft steel H-piles. Additionally, bents 4 and 5 have 2.5-ft-diameter concrete collars at the base of their piles.

Is bridge skewed to flood plain according to USGS topo map? no *Angle* 0

Is bridge located on a bend in channel? no *If so, describe (mild, moderate, severe)*

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	1-28-1991	45	2
Level II	04-08-1993	0	0

Potential for debris Moderate: high velocities could transport brush and debris that are lying in the upstream flood plain.

Describe any features near or at the bridge that may affect flow (include observation date).
None observed.

Description of Flood Plain

General topography In the vicinity of the study area, the left flood plain is approximately 400 ft wide and the right flood plain rises quickly.

Flood-plain conditions at bridge site: downstream (D/S), upstream (U/S)

Date of inspection 04-08-1993

D/S left: Moderate hardwood cover with some underbrush

D/S right: Moderate hardwood cover with some underbrush

U/S left: Moderate hardwood cover with some underbrush

U/S right: Moderate hardwood cover with some underbrush

Description of Channel

Average top width 68 *ft* *Average depth* 9.4 *ft*

Predominant bed material sand *Bank material* silty sand

Stream type (straight, meandering, braided, swampy, channelized) meandering

Vegetative cover on channel banks near bridge: *Date of inspection* 04-08-1993

D/S left: Moderate hardwood cover with trees leaning over channel

D/S right: Moderate hardwood cover with trees leaning over channel

U/S left: Moderate hardwood cover with trees leaning over channel

U/S right: Moderate hardwood cover with trees leaning over channel

Do banks appear stable? no *If not, describe location and type of instability and date of observation.* There are many points of bank failure and moderate to heavy fluvial erosion causing roots to be exposed and trees to lean over the channel.

Describe any obstructions in channel and date of observation. None observed.

Hydrology

Drainage area 105 mi^2

Percentage of drainage area in physiographic provinces:

Physiographic province	*Percent of drainage area*
Piedmont (high flow)	100

Is drainage area considered rural or urban? rural *Describe any significant urbanization and potential for development.* The site encompasses a predominately rural drainage basin with little development in recent years.

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

USGS gage description _____

USGS gage number _____

Gage drainage area _____ mi^2

Is there a lake/pond that will significantly affect hydrology/hydraulics? no

If so, describe _____

Calculated Discharges

Q100 14,300 ft^3/s *Q500* 21,000 ft^3/s

Method used to determine discharges The drainage basin is located within the "high-flow" area of South Carolina; therefore, the method described by C.L. Sanders (written commun., 11-1993) was used to compute flood discharges. In general, this method uses North Carolina USGS flood discharge equations (WRIR 87-4096) to compute the 100-year discharge, and extrapolates the 500-year discharge using the 2-, 10-, and 100-year discharges (USGS Bulletin 17B, p.5-2).

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

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

Datum tie between USGS survey and SCDOT plans Add 0.2 ft to USGS survey to obtain SCDOT plans' datum (docket number 12.248).

Description of reference marks used to determine USGS datum. USGS Benchmark C 27 1933 434 (elevation=434.18 ft above sea level) is located approximately 3,200 ft northeast of the Route SC 72 crossing of the Sandy River. RM1 is a chiseled square on the upstream, left headwall and has a surveyed elevation of 342.69 ft. RM2 is a chiseled square on the downstream, right headwall and has a surveyed elevation of 342.65 ft.

Cross Sections Used in WSPRO Analysis

*Cross section ID	*Section Reference Distance (SRD) in feet*	**How cross section was developed*	*Comments*
SYNTA	-550	2 & 3	Starting cross section
SYNTB	-540	2 & 3	Transition from wooded area to pasture area
EXIT	-390	3	Exit cross section
FULV	0	3	Full valley cross section
BRIDG	0	1	D/S bridge face
APPRO	423	2 & 3	Approach cross section

* For location of cross sections see topographic map included with report (figure 1). For more detail on how cross sections were developed see WSPRO input file.

** Cross section development: 1) survey at SRD 2) shift of survey data to SRD 3) modification of survey data based on topographic map 4) synthesized by combining channel survey data and topographic contours 5) other

Description of data and assumptions used in developing WSPRO model.

The Sandy River has a relatively uniform flood plain width in the study area, with no downstream natural or man-made contractions of flow that cause significant backwater at the Route SC 72 crossing. Therefore, it was assumed that slope-conveyance methodology would be adequate for estimating the starting water-surface elevation for the water-surface profile computations.

For this study, the WSPRO model requires, as a minimum, an exit section one bridge width downstream of the bridge, a full-valley section at the downstream face of the bridge, the bridge section, and an approach section one bridge width upstream of the bridge. Cross sections at the upstream and downstream faces of the bridge were directly surveyed and the more constricted (downstream) bridge face was used in the WSPRO model. The section reference distance (SRD) at the downstream face of the bridge was set to zero. An exit cross section was surveyed 382 ft downstream of the downstream bridge face, and an approach cross section was surveyed 145 ft upstream of the upstream bridge face. These cross sections were shifted by the channel slope to the appropriate SRD to represent the exit, full-valley, and approach cross sections required by the WSPRO model. These cross sections were extended using the slope of the contour lines from the USGS topographic map. In addition, section SYNTB was added 540 ft downstream to model the pasture on the right flood plain. Section SYNTA was added 550 ft downstream to simulate the transition from pasture to forest on the right flood plain.

Bridge Hydraulics

Average embankment elevation 342.3 *ft*

Average low steel elevation 339.7 *ft*

100-year discharge 14,300 ft^3/s

Water-surface elevation at D/S bridge face 332.82 *ft*

Area of flow at D/S bridge face 3,297 ft^2

Average velocity in bridge opening 4.34 *ft/s*

Maximum WSPRO tube velocity at bridge 6.19 *ft/s*

Water-surface elevation at Approach section with bridge 333.65 *ft*

Water-surface elevation at Approach section without bridge 333.12 *ft*

Amount of backwater caused by bridge 0.53 *ft*

500-year discharge 21,000 ft^3/s

Water-surface elevation at D/S bridge face 335.39 *ft*

Area of flow at D/S bridge face 4,212 ft^2

Average velocity in bridge opening 4.99 *ft/s*

Maximum WSPRO tube velocity at bridge 6.95 *ft/s*

Water-surface elevation at Approach section with bridge 336.33 *ft*

Water-surface elevation at Approach section without bridge 335.69 *ft*

Amount of backwater caused by bridge 0.64 *ft*

Scour

Describe any special assumptions or considerations made in bridge scour analysis.

Scour depths were computed using engineering judgement and the general guidelines described in Hydraulic Engineering Circular 18 (Richardson and others, 1993) and the Transportation Research Board Draft Paper, "Evaluating scour at bridges using WSPRO" (Arneson and others, 1992). Scour depths were calculated assuming an infinite depth of erosive material and a homogeneous particle-size distribution. The results of the scour analysis are presented in tables 1 through 4 and a graph of the scour depths is shown on figure 2.

The local pier scour was determined using the Colorado State University pier scour equation (Richardson and others, 1993). Bent 2 is located on the left overbank and was analyzed using the maximum left overbank WSPRO tube velocity and the depth of flow at that bent. Bents 7 through 13 are located on the right overbank and were analyzed using the maximum right overbank WSPRO tube velocity and the depth of flow at each bent. Bents 3 and 6 are located near the top of the banks and were analyzed as if they were in the channel to account for the possibility of a shift in the channel during a flood. Bents 4 and 5 are located in the channel and have 2.5-ft-diameter concrete collars at the base of the piles. The 2.5-ft collar width was used as the pile width and a pier length of 10 ft, using the cumulative collar widths, was used for bents 4 and 5 as recommended in Hydraulic Engineering Circular 18 (Richardson and others, 1993). Bents 3, 4, 5, and 6 were analyzed using 90 percent of the maximum WSPRO tube velocity and the maximum depth within the channel at the bridge. The maximum depth within the channel was used to account for possible changes in the thalweg during a flood.

The right overbank at the bridge was analyzed for contraction scour using Laursen's clear-water contraction scour equation (Richardson and others, 1993). The channel contraction scour was analyzed using Laursen's modified live-bed contraction scour equation (Richardson and others, 1993). There is no left overbank at the bridge, so contraction scour was not computed.

The live-bed contraction scour equation indicates the deposition of sediment in the channel at the bridge during the 100- and 500-year floods. (See negative scour values determined in scour calculations included at the end of the report). However, it seems unreasonable to expect sediment deposition at the bridge during peak flood conditions. Therefore, the negative scour values were set equal to zero as reflected in tables 1 through 4 and figure 2.

No abutment scour computations were made because the abutments are protected by riprap.

It should be noted that the SCDOT bridge plan borings (file number 12.248) show subsurface rock and gravel deposits that could affect the scour depths shown in this study. For more information, see the SCDOT bridge plans in the pocket at the back of the report.

WSPRO INPUT FILE

```
T1        Sandy River at SC 72 in Chester County     Structure 124007200200
T2        JMS   2 September 1994
*
*
*         Q100    Q500
Q         14300  21000
SK        0.0015  0.0015
*
*
*         Section TEMP1 was surveyed 382 ft downstream of the downstream
*         bridge face.  The right end of the cross section was extended by
*         drawing the cross section on the USGS topographic map and adding
*         station 990 that corresponds to the 340 ft contour.  The distance
*         was determined from the USGS field survey notes.
*
XT   TEMP1  -382 0.0015
GR          0  336.5   41  332.8   100  329.1   139  324.3   167  324.6
GR        216  322.8  274  323.4   318  324.3   373  325.0   454  325.0
GR        509  324.8  521  319.9   530  316.4   539  314.4   551  315.0
GR        564  314.7  572  316.4   579  322.1   618  322.2   658  324.3
GR        687  325.2  727  324.6   765  326.6   852  329.9   916  332.9
GR        938  334.2  990  340.0
*
*         Section SYNTA is used to model the wooded area on the right
*         flood plain 550 ft downstream of the bridge.
*
XS   SYNTA  -550
GT
N          0.17    0.045    0.17
SA             509       579
*
*         Section SYNTB is used to model the change from wooded area to
*         pasture 540 ft downstream of the bridge.
*
XS   SYNTB  -540
GT
N          0.17    0.045    0.05
SA             509       579
*
XS   EXIT   -390
GT
*
XS   FULV   0
GT
*
*          Downstream Bridge Face
*
BR   BRIDG  0   339.7
GR          0  339.7     1  339.7   1.1  339.7     7  338.7    20  332.6
GR         30  329.5    39  326.1    49  325.0    60  323.3    65  322.4
GR         70  321.2    75  319.9    81  317.8    90  314.8   100  314.8
GR        110  315.1   120  315.4   129  315.5   135  321.1   150  322.9
GR        180  323.5   210  323.8   240  324.3   270  323.8   285  324.4
GR        300  324.5   330  325.4   340  326.8   360  331.6   375  334.5
GR        385  337.6 388.9  339.0   389  339.7   390  339.7     0  339.7
N         0.045    0.045   0.045
SA              57       150
CD        3  33  2  342.3.
```

```
KD          *  *  *  280  670
PW 1        314.8  2.5   315.4  2.5   315.4  5.0  318.3  5.0   318.3  3.35
PW 1        318.9  3.35  318.9  1.7   322.9  1.7  322.9  2.55  323.4  2.55
PW 1        323.4  4.25  323.8  4.25  323.8  5.95 324.3  5.95  324.3  6.8
PW 1        324.5  6.8   324.5  7.65  325.4  7.65 325.4  8.5   329.5  8.5
PW 1        329.5  9.35  331.6  9.35  331.6 10.2  339.7 10.2   339.7  0.0
*
*           Section TEMP2 was surveyed 145 ft upstream of the upstream bridge
*           face.  The distance was determined from the USGS field survey notes.
*           The right end of the cross section was extended by drawing the cross
*           section on the USGS topographic map and adding station 900 that
*           corresponds to the 340 ft contour.
*
XT    TEMP2  178  0.0015
GR           0  343.0   48  327.5   72  322.2   139  321.9   192  321.6
GR         269  323.3  276  320.7  315  320.6   331  324.7   361  323.5
GR         369  317.1  372  313.6  390  316.1   400  315.1   412  317.1
GR         427  325.4  498  324.6  545  322.1   556  322.7   566  328.9
GR         900  340.0
*
AS    APPRO  423
GT
N            0.15   0.045   0.14
SA               361     427
BP           301
*
HP 1 BRIDG  332.82, ,332.82,14300
HP 2 BRIDG  332.86, ,332.86,14300
HP 1 APPRO  333.65, ,333.65,14300
HP 2 APPRO  333.65, ,333.65,14300
HP 1 BRIDG  335.39, ,335.39,21000
HP 2 BRIDG  335.43, ,335.43,21000
HP 1 APPRO  336.33, ,336.33,21000
HP 2 APPRO  336.33, ,336.33,21000
*
EX
ER
```

WSPRO OUTPUT

```
WSPRO          FEDERAL HIGHWAY ADMINISTRATION - U. S. GEOLOGICAL SURVEY
V060188            MODEL  FOR  WATER-SURFACE  PROFILE  COMPUTATIONS

        Sandy River at SC 72 in Chester County      Structure 124007200200
        JMS   2 September 1994
           *** RUN DATE & TIME: 09-07-94  13:42
    CROSS-SECTION PROPERTIES:  ISEQ =  5;  SECID = BRIDG;  SRD =        0.

     WSEL  SA#      AREA         K    TOPW    WETP  ALPH     LEW     REW      QCR
             1      203.    20293.    37.     39.                             2684.
             2     1367.   264830.    93.     97.                            29740.
             3     1726.   227583.   216.    217.                            27661.
   332.32          3296.   512706.   347.    352.  1.14     20.    366.     54087.
```

```
WSPRO          FEDERAL HIGHWAY ADMINISTRATION - U. S. GEOLOGICAL SURVEY
V060188            MODEL  FOR  WATER-SURFACE  PROFILE  COMPUTATIONS

        Sandy River at SC 72 in Chester County      Structure 124007200200
        JMS   2 September 1994
           *** RUN DATE & TIME: 09-07-94  13:42


    VELOCITY DISTRIBUTION:  ISEQ =  5;  SECID = BRIDG;  SRD =        0.

         WSEL      LEW      REW     AREA         K         Q     VEL
       332.86     19.4    366.5   3309.8.   515881.   14300.    4.32

X STA.        19.4       61.2       75.8       85.0       91.8       98.2
  A(I)           244.2      166.0      136.3      118.1      116.8
  V(I)            2.93       4.31       5.25       6.05       6.12

X STA.        98.2      104.7      111.3      118.0      125.1      133.2
  A(I)           115.5      119.1      117.2      124.1      132.0
  V(I)            6.19       6.00       6.10       5.76       5.42

X STA.       133.2      147.9      165.7      183.9      203.0      223.0
  A(I)           164.8      174.9      172.7      176.2      180.1
  V(I)            4.34       4.09       4.14       4.06       3.97

X STA.       223.0      244.3      265.5      285.7      309.1      366.5
  A(I)           184.6      186.6      178.5      194.8      307.5
  V(I)            3.87       3.83       4.01       3.67       2.33
```

WSPRO OUTPUT --Continued

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WSPRO          FEDERAL HIGHWAY ADMINISTRATION - U. S. GEOLOGICAL SURVEY
V060188            MODEL  FOR  WATER-SURFACE  PROFILE  COMPUTATIONS

        Sandy River at SC 72 in Chester County      Structure 124007200200
        JMS   2 September 1994
           *** RUN DATE & TIME: 09-07-94  13:42
    CROSS-SECTION PROPERTIES:  ISEQ =  6;  SECID = APPRO;  SRD =      423.

     WSEL  SA#      AREA         K    TOPW   WETP  ALPH     LEW     REW      QCR
           1     3469.   164247.    331.   333.                            63744.
           2     1053.   207752.     66.    72.                            23865.
           3     1538.    51873.    271.   273.                            20804.
   333.65        6061.   423872.    668.   679.  4.11     30.    698.     51125.
```


```
WSPRO          FEDERAL HIGHWAY ADMINISTRATION - U. S. GEOLOGICAL SURVEY
V060188            MODEL  FOR  WATER-SURFACE  PROFILE  COMPUTATIONS

        Sandy River at SC 72 in Chester County      Structure 124007200200
        JMS   2 September 1994
           *** RUN DATE & TIME: 09-07-94  13:42
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```
    VELOCITY DISTRIBUTION:  ISEQ =  6;  SECID = APPRO;  SRD =      423.

        WSEL      LEW      REW     AREA         K         Q     VEL
      333.65     30.1    697.9   6060.6   423872.    14300.    2.36

X STA.        30.1      100.6      137.4      174.9      211.3      251.5
  A(I)           573.5      415.1      430.5      420.2      435.0
  V(I)            1.25       1.72       1.66       1.70       1.64

X STA.       251.5      288.9      322.1      365.1      372.8      377.4
  A(I)           419.3      413.7      408.9      126.6       88.9
  V(I)            1.71       1.73       1.75       5.65       8.04

X STA.       377.4      382.5      387.9      393.6      399.0      404.2
  A(I)            94.2       96.4       98.5       95.9       93.5
  V(I)            7.59       7.42       7.26       7.46       7.65

X STA.       404.2      410.1      417.6      454.1      510.1      697.9
  A(I)            99.6      113.5      316.8      479.1      841.2
  V(I)            7.18       6.30       2.26       1.49       0.85
```

WSPRO OUTPUT --Continued

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WSPRO          FEDERAL HIGHWAY ADMINISTRATION - U. S. GEOLOGICAL SURVEY
V060188            MODEL  FOR  WATER-SURFACE  PROFILE  COMPUTATIONS

        Sandy River at SC 72 in Chester County     Structure 124007200200
        JMS   2 September 1994
           *** RUN DATE & TIME: 09-07-94  13:42
    CROSS-SECTION PROPERTIES:  ISEQ =  5;  SECID = BRIDG;  SRD =       0.

     WSEL  SA#      AREA         K    TOPW   WETP  ALPH     LEW     REW      QCR
             1      306.    36561.    43.    45.                             4646.
             2     1606.   346417.    93.    97.                            37872.
             3     2298.   354015.   228.   229.                            41411.
   335.39          4211.   736993.   364.   370.  1.11     14.    378.     77186.
```

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WSPRO          FEDERAL HIGHWAY ADMINISTRATION - U. S. GEOLOGICAL SURVEY
V060188            MODEL  FOR  WATER-SURFACE  PROFILE  COMPUTATIONS

        Sandy River at SC 72 in Chester County     Structure 124007200200
        JMS   2 September 1994
           *** RUN DATE & TIME: 09-07-94  13:42


    VELOCITY DISTRIBUTION:  ISEQ =  5;  SECID = BRIDG;  SRD =       0.

         WSEL      LEW      REW     AREA         K         Q      VEL
       335.43     14.0    378.0   4225.1   740824.    21000.    4.97

X STA.        14.0       57.1       73.3       83.8       91.8       99.1
  A(I)           309.1      214.8      175.6      158.0      151.0
  V(I)            3.40       4.89       5.98       6.64       6.95

X STA.        99.1      106.6      114.2      121.9      130.1      143.8
  A(I)           154.3      153.6      155.9      163.3      202.5
  V(I)            6.80       6.84       6.73       6.43       5.19

X STA.       143.8      160.3      177.9      195.8      214.6      234.0
  A(I)           208.3      213.7      212.0      219.6      220.7
  V(I)            5.04       4.91       4.95       4.78       4.76

X STA.       234.0      253.8      272.9      292.7      314.0      378.0
  A(I)           221.8      220.5      220.8      229.7      419.7
  V(I)            4.73       4.76       4.76       4.57       2.50
```

WSPRO OUTPUT --Continued

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WSPRO          FEDERAL HIGHWAY ADMINISTRATION - U. S. GEOLOGICAL SURVEY
V060188            MODEL  FOR  WATER-SURFACE  PROFILE  COMPUTATIONS

        Sandy River at SC 72 in Chester County      Structure 124007200200
        JMS   2 September 1994
           *** RUN DATE & TIME: 09-07-94  13:42
    CROSS-SECTION PROPERTIES:  ISEQ =  6;  SECID = APPRO;  SRD =      423.

     WSEL  SA#      AREA         K    TOPW    WETP  ALPH     LEW     REW      QCR
           1     4367.   236937.    339.    342.                             88922.
           2     1230.   269118.     66.     72.                             30125.
           3     2372.    89836.    352.    353.                             34973.
   336.33        7969.   595891.    757.    768.  4.12     22.    779.     72337.
```


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WSPRO          FEDERAL HIGHWAY ADMINISTRATION - U. S. GEOLOGICAL SURVEY
V060188            MODEL  FOR  WATER-SURFACE  PROFILE  COMPUTATIONS

        Sandy River at SC 72 in Chester County      Structure 124007200200
        JMS   2 September 1994
           *** RUN DATE & TIME: 09-07-94  13:42
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```
    VELOCITY DISTRIBUTION:  ISEQ =  6;  SECID = APPRO;  SRD =      423.

        WSEL      LEW      REW     AREA         K         Q     VEL
      336.33     21.8    778.5   7969.4   595891.   21000.    2.64

X STA.        21.8       98.2      135.3      171.2      206.6      245.3
  A(I)           739.4      517.7      508.2      505.3      526.5
  V(I)            1.42       2.03       2.07       2.08       1.99

X STA.       245.3      284.5      316.4      362.1      372.1      377.3
  A(I)           533.8      488.8      561.7      175.1      115.1
  V(I)            1.97       2.15       1.87       6.00       9.12

X STA.       377.3      383.0      389.1      395.2      401.2      407.2
  A(I)           120.5      123.4      123.4      122.9      122.4
  V(I)            8.71       8.51       8.51       8.54       8.58

X STA.       407.2      414.1      428.5      479.7      526.2      778.5
  A(I)           130.7      197.9      556.2      547.9     1252.3
  V(I)            8.03       5.30       1.89       1.92       0.84
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WSPRO OUTPUT --Continued

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WSPRO          FEDERAL HIGHWAY ADMINISTRATION - U. S. GEOLOGICAL SURVEY
V060188            MODEL  FOR  WATER-SURFACE  PROFILE  COMPUTATIONS

        Sandy River at SC 72 in Chester County     Structure 124007200200
        JMS   2 September 1994
           *** RUN DATE & TIME: 09-07-94  13:42

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

SYNTA:XS    ******     49.     6267.  0.51  *****  332.55  327.53  14300.  332.04
     -550.  ******    903.   369140.  6.31  *****  *******    0.37    2.28

 ===135 CONVEYANCE RATIO OUTSIDE OF RECOMMENDED LIMITS.
                              "SYNTB"     KRATIO =  1.43

SYNTB:XS       10.     45.     6506.  0.23  0.01  332.56  *******  14300.  332.34
     -540.     10.    909.   529163.  3.01  0.00    0.00     0.24    2.20

EXIT :XS      150.     46.     6408.  0.23  0.11  332.68  *******  14300.  332.45
     -390.    150.    907.   518803.  3.02  0.00    0.00     0.25    2.23

FULV :FV      390.     51.     6166.  0.25  0.31  333.00  *******  14300.  332.75
        0.    390.    901.   493231.  3.04  0.01    0.00     0.26    2.32
         <<<<<THE ABOVE RESULTS REFLECT "NORMAL" (UNCONSTRICTED) FLOW>>>>>

APPRO:AS      423.     32.     5712.  0.40  0.45  333.52  *******  14300.  333.12
      423.    423.    682.   393730.  4.10  0.07    0.00     0.30    2.50
         <<<<<THE ABOVE RESULTS REFLECT "NORMAL" (UNCONSTRICTED) FLOW>>>>>

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

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

BRIDG:BR      390.     20.     3297.  0.43  0.50  333.26  327.14  14300.  332.82
        0.    390.    366.   512984.  1.48  0.07    0.01     0.30    4.34

     TYPE PPCD FLOW      C     P/A     LSEL    BLEN    XLAB    XRAB
       3.   1.   1.  0.822   0.032  339.70  ******  ******  ******

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

APPRO:AS      390.     30.     6062.  0.36  0.71  334.01  327.25  14300.  333.65
      423.    451.    698.   424022.  4.11  0.04    0.02     0.28    2.36

       M(G)    M(K)        KQ    XLKQ    XRKQ     OTEL
      0.467   0.278   305390.    280.    670.   333.21

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

WSPRO OUTPUT --Continued

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WSPRO          FEDERAL HIGHWAY ADMINISTRATION - U. S. GEOLOGICAL SURVEY
V060188             MODEL  FOR  WATER-SURFACE  PROFILE  COMPUTATIONS

         Sandy River at SC 72 in Chester County      Structure 124007200200
         JMS   2 September 1994
            *** RUN DATE & TIME: 09-07-94  13:42

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

SYNTA:XS    ******     18.      8605.   0.57  *****   335.22   329.05   21000.   334.66
     -550. ******    944.    541824.   6.12  *****  *******     0.35     2.44

 ===135 CONVEYANCE RATIO OUTSIDE OF RECOMMENDED LIMITS.
                              "SYNTB"      KRATIO =  1.51

SYNTB:XS       10.     14.      8905.   0.24   0.01   335.23  *******   21000.   334.99
     -540.     10.    947.    816852.   2.74   0.00     0.00     0.22     2.36

EXIT :XS      150.     15.      8790.   0.24   0.10   335.34  *******   21000.   335.10
     -390.    150.    946.    801688.   2.75   0.00     0.00     0.23     2.39

FULV :FV      390.     19.      8498.   0.26   0.28   335.63  *******   21000.   335.37
        0.    390.    943.    763854.   2.78   0.01     0.00     0.24     2.47
          <<<<<THE ABOVE RESULTS REFLECT "NORMAL" (UNCONSTRICTED) FLOW>>>>>

APPRO:AS      423.     24.      7491.   0.50   0.44   336.19  *******   21000.   335.69
      423.    423.    759.    551785.   4.11   0.12     0.00     0.31     2.80
          <<<<<THE ABOVE RESULTS REFLECT "NORMAL" (UNCONSTRICTED) FLOW>>>>>

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

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

BRIDG:BR      390.     14.      4212.   0.58   0.50   335.97   328.46   21000.   335.39
        0.    390.    378.    737300.   1.50   0.14     0.00     0.32     4.99

     TYPE PPCD FLOW       C     P/A     LSEL    BLEN    XLAB    XRAB
       3.   1.   1.   0.816   0.031   339.70 ******  ******  ******

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

APPRO:AS      390.     22.      7968.   0.44   0.76   336.77   328.71   21000.   336.33
      423.    444.    778.    595766.   4.12   0.04     0.00     0.29     2.64

      M(G)    M(K)        KQ    XLKQ    XRKQ     OTEL
     0.505   0.277   430757.    280.    670.    335.84

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

 NORMAL  END  OF  WSPRO  EXECUTION.
```

PIER SCOUR COMPUTATIONS
FOR
Sandy River at SC 72 in Chester County, SC Structure 124007200200
Q100 scour computations including bents 2 through 9 JMS 8 Sept. 1994

	HYDRAULIC VARIABLES USED IN CSU EQUATION							
PIER NUMBER	2	3	4	5	6	7	8	9
PIER STATION (FT)	30	60	90	120	150	180	210	240
LOCATION OF PIER	lfp	ltb	mcl	mcr	rtb	rfp	rfp	rfp
Y1: DEPTH (FT)	3.4	18.1	18.1	18.1	18.1	9.4	9.1	8.6
V1: VEL. (FPS)	2.9	5.6	5.6	5.6	5.6	4.1	4.1	4.1
a: PIER WIDTH (FT)	0.9	0.9	2.5	2.5	0.9	0.9	0.9	0.9
L: PIER LENGTH (FT)	3.4	3.4	10.0	10.0	3.4	3.4	3.4	3.4
PIER SHAPE	1	1	2	2	1	1	1	1
ATTACK ANGLE	0	0	0	0	0	0	0	0
K1 (SHAPE COEF.)	1.10	1.10	1.00	1.00	1.10	1.10	1.10	1.10
K2 (ANGLE COEF.)	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
FROUDE NO.	0.28	0.23	0.23	0.23	0.23	0.24	0.24	0.25
	COMPUTED SCOUR DEPTHS USING CSU EQUATION							
SCOUR DEPTH (FT)	1.76	2.90	5.32	5.32	2.90	2.34	2.33	2.31
MAX SCOUR DEPTH (FT)	1.93	3.19	5.85	5.85	3.19	2.57	2.56	2.54

Q100 scour computations including bents 10 through 13 JMS 8 Sept. 1994

	HYDRAULIC VARIABLES USED IN CSU EQUATION			
PIER NUMBER	10	11	12	13
PIER STATION (FT)	270	300	330	360
LOCATION OF PIER	rfp	rfp	rfp	rfp
Y1: DEPTH (FT)	9.1	8.4	7.5	1.3
V1: VEL. (FPS)	4.1	4.1	4.1	4.1
a: PIER WIDTH (FT)	0.9	0.9	0.9	0.9
L: PIER LENGTH (FT)	3.4	3.4	3.4	3.4
PIER SHAPE	1	1	1	1
ATTACK ANGLE	0	0	0	0
K1 (SHAPE COEF.)	1.10	1.10	1.10	1.10
K2 (ANGLE COEF.)	1.00	1.00	1.00	1.00
FROUDE NO.	0.24	0.25	0.27	0.64
	COMPUTED SCOUR DEPTHS USING CSU EQUATION			
SCOUR DEPTH (FT)	2.33	2.30	2.27	1.79
MAX SCOUR DEPTH (FT)	2.56	2.53	2.50	1.97

"MAX SCOUR DEPTH" includes an additional 10 percent of the computed CSU scour depth as recommended in HEC 18

CONTRACTION SCOUR COMPUTATIONS
FOR
Sandy River at SC 72 in Chester County, SC Structure 124007200200
Q100 scour computations JMS 8 Sept. 1994

LIVE-BED SCOUR COMPUTATIONS

	MAIN CHANNEL	CONTRACTED SECTION
DISCHARGE (CFS)	7010.	7390.
BOTTOM WIDTH (FT)	66.0	86.3
MANNINGS n	0.045	0.045
AVERAGE DEPTH (FT)	19.0	

ENERGY SLOPE	0.00170
D50 (FT)	0.0043
FALL VELOCITY (FPS)	0.59
K1 COEF.	0.64
K2 COEF.	0.21

COMPUTED DEPTH AT CONTRACTED SECTION (FT)	=	16.7
DEPTH AT MAIN CHANNEL (FT)	=	19.0
DEPTH OF CONTRACTION SCOUR (FT)	=	-2.3

RIGHT OVERBANK IN BRIDGE OPENING
CLEAR-WATER CONTRACTION SCOUR COMPUTATIONS

DISCHARGE IN CONTRACTED SECTION (CFS)	=	6350.
WIDTH OF CONTRACTED SECTION (FT)	=	190.0
MEDIAN GRAIN SIZE (FT)	=	0.0036
COMPUTED DEPTH OF CONTRACTED SECTION (FT)	=	13.0
AVERAGE FLOOD PLAIN DEPTH (FT)	=	9.6
DEPTH OF CONTRACTION SCOUR (FT)	=	3.3

PIER SCOUR COMPUTATIONS
FOR
Sandy River at SC 72 in Chester County, SC Structure 124007200200
Q500 scour computations including bents 2 through 9 JMS 8 Sept. 1994

	HYDRAULIC VARIABLES USED IN CSU EQUATION							
PIER NUMBER	2	3	4	5	6	7	8	9
PIER STATION (FT)	30	60	90	120	150	180	210	240
LOCATION OF PIER	lfp	ltb	mcl	mcr	rtb	rfp	rfp	rfp
Y1: DEPTH (FT)	5.9	20.6	20.6	20.6	20.6	11.9	11.6	11.1
V1: VEL. (FPS)	3.4	6.3	6.3	6.3	6.3	5.0	5.0	5.0
a: PIER WIDTH (FT)	0.9	0.9	2.5	2.5	0.9	0.9	0.9	0.9
L: PIER LENGTH (FT)	3.4	3.4	10.0	10.0	3.4	3.4	3.4	3.4
PIER SHAPE	1	1	2	2	1	1	1	1
ATTACK ANGLE	0	0	0	0	0	0	0	0
K1 (SHAPE COEF.)	1.10	1.10	1.00	1.00	1.10	1.10	1.10	1.10
K2 (ANGLE COEF.)	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
FROUDE NO.	0.25	0.24	0.24	0.24	0.24	0.26	0.26	0.27
	COMPUTED SCOUR DEPTHS USING CSU EQUATION							
SCOUR DEPTH (FT)	2.02	3.11	5.69	5.69	3.11	2.63	2.62	2.60
MAX SCOUR DEPTH (FT)	2.22	3.42	6.26	6.26	3.42	2.89	2.88	2.86

Q500 scour computations including bents 10 through 13 JMS 8 Sept. 1994

	HYDRAULIC VARIABLES USED IN CSU EQUATION			
PIER NUMBER	10	11	12	13
PIER STATION (FT)	270	300	330	360
LOCATION OF PIER	rfp	rfp	rfp	rfp
Y1: DEPTH (FT)	11.6	10.9	10.0	3.8
V1: VEL. (FPS)	5.0	5.0	5.0	5.0
a: PIER WIDTH (FT)	0.9	0.9	0.9	0.9
L: PIER LENGTH (FT)	3.4	3.4	3.4	3.4
PIER SHAPE	1	1	1	1
ATTACK ANGLE	0	0	0	0
K1 (SHAPE COEF.)	1.10	1.10	1.10	1.10
K2 (ANGLE COEF.)	1.00	1.00	1.00	1.00
FROUDE NO.	0.26	0.27	0.28	0.46
	COMPUTED SCOUR DEPTHS USING CSU EQUATION			
SCOUR DEPTH (FT)	2.62	2.60	2.57	2.25
MAX SCOUR DEPTH (FT)	2.88	2.86	2.82	2.48

"MAX SCOUR DEPTH" includes an additional 10 percent of the computed CSU scour depth as recommended in HEC 18

CONTRACTION SCOUR COMPUTATIONS
FOR
Sandy River at SC 72 in Chester County, SC Structure 124007200200
Q500 scour computations JMS 8 Sept. 1994

LIVE-BED SCOUR COMPUTATIONS

	MAIN CHANNEL	CONTRACTED SECTION
DISCHARGE (CFS)	9480.	9870.
BOTTOM WIDTH (FT)	66.0	86.3
MANNINGS n	0.045	0.045
AVERAGE DEPTH (FT)	21.6	

ENERGY SLOPE	0.00180
D50 (FT)	0.0043
FALL VELOCITY (FPS)	0.59
K1 COEF.	0.64
K2 COEF.	0.21

COMPUTED DEPTH AT CONTRACTED SECTION (FT)	=	18.8
DEPTH AT MAIN CHANNEL (FT)	=	21.6
DEPTH OF CONTRACTION SCOUR (FT)	=	-2.8

RIGHT OVERBANK IN BRIDGE OPENING
CLEAR-WATER CONTRACTION SCOUR COMPUTATIONS

DISCHARGE IN CONTRACTED SECTION (CFS)	=	10090.
WIDTH OF CONTRACTED SECTION (FT)	=	190.0
MEDIAN GRAIN SIZE (FT)	=	0.0036
COMPUTED DEPTH OF CONTRACTED SECTION (FT)	=	19.3
AVERAGE FLOOD PLAIN DEPTH (FT)	=	12.3
DEPTH OF CONTRACTION SCOUR (FT)	=	7.0

United States Department of the Interior

GEOLOGICAL SURVEY
Water Resources Division
Stephenson Center, Suite 129
720 Gracern Road
Columbia, SC 29210-7651

September 22, 1994

William H. Hulbert, P.E.
Hydraulic Engineer
South Carolina Department of Transportation
955 Park Street
Columbia, South Carolina 29202

Dear Mr. Hulbert:

We are pleased to transmit to you another report of the Level II Bridge Scour Program titled, "Level II bridge scour analysis for structure 124007200200 on Route SC 72, crossing the Sandy River in Chester County, South Carolina," by J. Mike Sullivan and Andy W. Caldwell. The technical aspects of the report have been reviewed by the South Carolina District Surface-Water Specialist and the report has been approved by the South Carolina District Report Specialist.

If you have any questions concerning this report please contact me (750-6165) or Andy Caldwell (750-6101) and we will be glad to assist you in any way possible.

Sincerely,

J. Mike Sullivan

J. Mike Sullivan, E.I.T.
Civil Engineer

Enclosure

SEP 1994
RECEIVED
HYDRAULICS

	STATE						
	S.C.						

INDEX OF SHEETS

STATE OF SOUTH CAROLINA

STATE HIGHWAY DEPARTMENT

PLAN AND PROFILE OF PROPOSED STATE HIGHWAY

RT. 72, DOCKET NO. 12.248

BRIDGE, APPROACHES AND DETOUR OVER

SANDY RIVER, CHESTER COUNTY

SCALES: PLAN AND PROFILE, 1 INCH = [illegible] HORIZONTAL, 1 IN = [illegible] VERTICAL

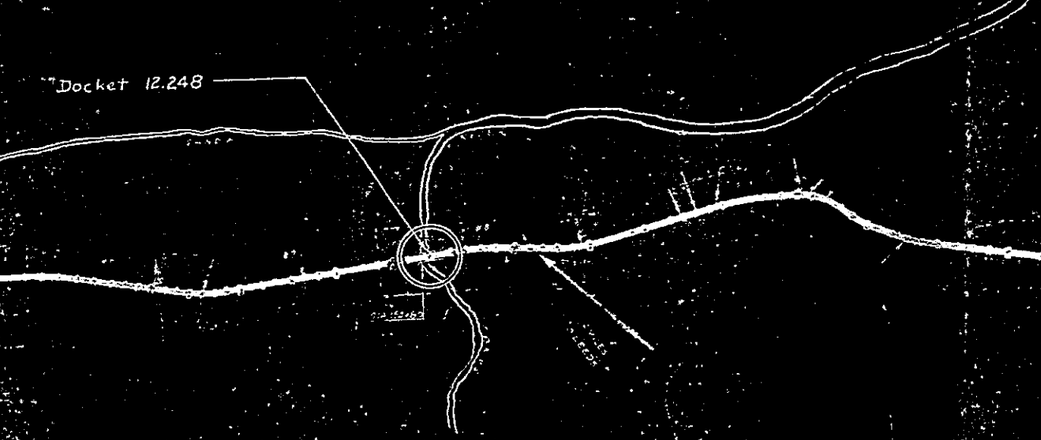
F.A. Project F-235(7)

SUMMARY OF ESTIMATED BRIDGE QUANTITIES

ITEM	QUANTITY	UNIT
Class "A" Concrete	59.75	C.Y.
Reinforcing Steel	2,593	LBS.
10"@ 42# H-Section Steel Piling	570	L.F.
Pre-cast Concrete Slope Drains	50	L.F.
Structural Steel	5147	LBS.
Removal & Disposal of Existing Bridge	Lump Sum	L.S.
Detour Bridge	Lump Sum	L.S.
Pipe Hand-Railing	50	L.F.

SUMMARY OF ESTIMATED ROAD QUANTITIES

ITEM	QUANTITY	UNIT
Clearing & Grubbing of Borrow & Material Pits	1.0	Acre.
Unclassified Excavation	6757	C.Y.
Overhaul	8078	C.Y.H.M.
Selected Material for Shoulders	262	C.Y.
Earth Type Base Course (Ground Surface Material)	1,024	C.Y.
Scarifying, Mixing, Remixing, Shaping & Reshaping	4918	M.S.Y.
Additional Scarifying, Mixing Remixing Shaping & Reshaping	600	M.S.Y.
Clearing & Grubbing within R/W & for Detour	Lump Sum	L.S.



CONVENTIONAL SIGNS

State Lines
County Lines
Civil or Town Limits
Property Lines
Fences
Retaining Walls
Existing Roads
Graded Roads
Railroads
Railroad Right of Way
Railroad Crossing (P.T.)
Trolley Poles
Power Poles
Telephone or Telegraph Poles
Marshes
Trees
Brush
Stumps
Buildings
Bridges
Concrete Box Culverts
Pipe Culverts
Drop Inlet and Culvert
Hub or Center Line

LEGEND

PROPOSED PROJECT
ROAD OTHER THAN THIS PROJECT

LAYOUT

Scale: 1 inch = [illegible]

Net Length of Roadway	=	0.142 Miles
Net Length of Bridges	=	0.014
Net Length of Project	=	0.216
Length of Exceptions	=	0.000
Gross Length of Project	=	0.216

Equations in Stationing

NONE

Note: All workmanship and material on this project to conform with South Carolina State Highway Department Standard Specifications for Highway Construction dated March 15th, 1939, as approved by the Administrator of Federal Works Agency, [illegible]

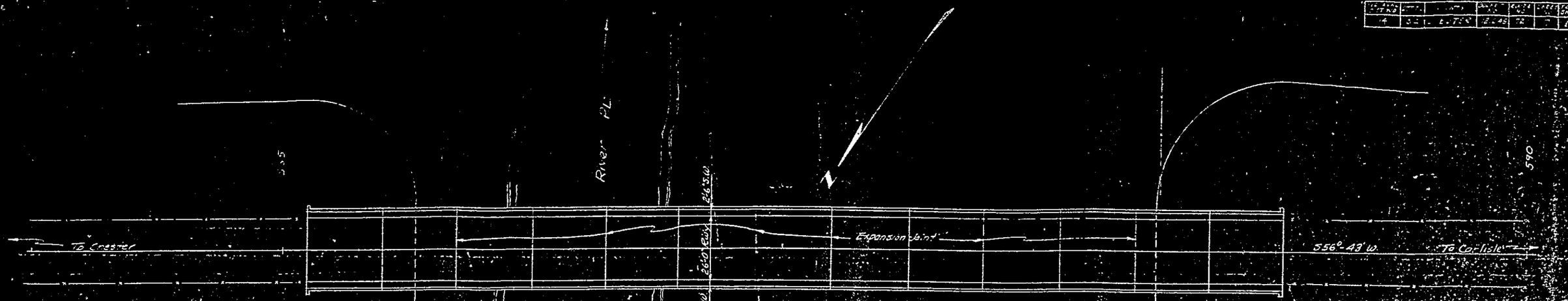
APPROVED

[illegible]
STATE HIGHWAY ENGINEER

RECOMMENDED FOR APPROVAL

[illegible]
DISTRICT ENGINEER

4	3-C.I.	2-7/8"	27.48	12	1	14



NOTES:

Construct flared curb and gutter and concrete rip rap slope drains on both sides of roadway on both ends of bridge.

All cost of necessary excavation for End Bents and at Excavation to one foot below bottom of beams to be included in Unit Price bid for class "A" concrete.

X indicates expansion end of span.

D.A. 10.1 Sq. Mi.
Effective Opening 2566 Sq. Ft.
Area Submerged 5528 Sq. Ft.

13 @ 20'-0" = 260'-0"

Pier No. 1 2 3 4 5 6 7 8 9 10 11 12 13 14

10 @ 42' Piles

Silty Clay
Sand & Gravel
Loose Disintegrated Granite
Soft Disintegrating Granite
Rock Bot. Boring

Silty Sand
Packed Mud
Sand & Gravel
Soft Disintegrating Granite
Rock Bot. Boring

HW El. 312.2 (1928)

Timber Pile Bents in Place

Silty Clay
Silty Sand
Sand, Gravel & Hard Gravel
Loose Disintegrated Granite

Silty Clay
Silty Sand
Loose Disintegrated Granite
Soft Disintegrating Granite
Rock Bot. Boring

584 590

S. C. STATE HIGHWAY DEPARTMENT
COLUMBIA, S. C.

PLAN & PROFILE
OF
FOR BRIDGE OVER
SANDY RIVER

S. C. DOCKET NO. 12,249 CHESTER COUNTY
ROUTE NO. 7 DATE: 8-47

PILE RECORD ON DOCKET NO.

WEIGHT OF HAMMER 2990# FALL 15 FEET TYPE DROP

BENT NO.	FOOTING	PILE NO.	DATE DRIVEN	DIAMETER BUTT	DIAMETER TIP	PENETRATION	PEN. PER BLOW	BEARING	ELEVATION PILE TIP	ELEVATION CUT-OFF	LENGTH IN PLACE	ORIGINAL LENGTH	LENGTH CUT-OFF	PAY LENGTH	C.O. AT 0.40 OF UNIT PRICE	C.O. AT 0.25 OF UNIT PRICE
				STEEL H PILES 10" @ 42#												
14		1	5-7-48			25.09	.350	33.22	305.31	338.17	32.86	40.00	7.14	33.86		
14		2	5-6-48			26.06	.100	40.77	304.34	"	33.83	45.00	11.17	34.83		
14		3	5-7-48			24.77	.250	35.88	305.63	"	32.54	45.00	12.46	33.54		
14		4	5-7-48			22.29	.175	38.17	308.11	338.17	30.06	40.00	9.94	31.06		
										Total Bt 14	129.29	170.00	40.71	133.29		
13		2	5-8-48			24.30	.300	34.50	301.41	338.17	36.76	45.00	8.24	37.76		
13		1	"			23.72	.275	35.18	301.99	"	36.18	"	8.82	37.18		
13		3	"			21.42	.300	34.50	304.29	"	33.88	"	11.12	34.88		
13		4	5-8-48			22.28	.250	35.88	303.43	338.17	34.74	45.00	10.26	35.74		
										Total Bt 13	141.56	180.00	38.44	145.56		
12		1	5-10-48			24.42	.150	39.17	300.69	338.17	37.48	45.00	7.52	38.48		
12		2	"			27.11	.300	34.50	298.00	"	40.17	"	4.83	41.17		
12		3	"			27.76	.250	35.88	297.35	"	40.82	"	4.18	41.82		
12		4	5-10-48			25.27	.150	39.17	299.84	338.17	38.33	45.00	6.67	39.33		
										Total Bt 12	156.80	180.00	23.20	160.80		
11		1	5-10-48			22.71	.300	34.50	301.61	338.17	36.56	45.00	8.44	37.56		
11		2	"			22.92	.200	37.38	299.98	"	38.19	50.00	11.81	39.19		
11		3	"			26.00	.275	35.18	296.94	"	41.23	47.00	5.77	42.23		
11		4	5-10-48			25.80	.275	35.18	298.25	338.17	39.92	50.00	10.08	40.92		
										Total Bt 11	155.90	192.00	36.10	159.90		
10		1	5-11-48			25.92	.300	34.50	298.62	338.17	39.55	50.00	10.45	40.55		
10		2	"			23.71	.275	35.18	298.72	"	39.45	"	10.55	40.45		
10		3	"			22.97	.275	35.18	300.84	"	37.33	"	12.67	38.33		
10		4	5-11-48			26.94	.275	35.18	297.25	338.17	40.92	50.00	9.08	41.92		
										Total Bt 10	157.25	200.00	42.75	161.25		
9		1	5-11-48			29.77	.275	35.18	296.32	338.17	41.85	50.00	8.15	42.85		
9		2	"			24.32	.300	34.50	296.84	"	41.33	"	8.67	42.33		
9		3	"			26.90	.300	34.50	296.25	"	41.92	"	8.08	42.92		
9		4	5-11-48			26.32	.250	35.88	297.27	338.17	40.90	50.00	9.10	41.90		
										Total Bt 9	166.00	200.00	34.00	170.00		
8		1	5-12-48			29.23	.250	35.88	294.36	338.17	43.81	50.00	6.19	44.81		
8		2	"			24.94	.275	35.18	295.11	"	43.06	"	6.94	44.06		
8		3	"			27.02	.275	35.18	295.31	"	42.86	"	7.14	43.86		
8		4	5-12-48			29.47	.200	37.38	294.01	338.17	44.16	50.00	5.84	45.16		
										Total Bt 8	173.89	200.00	26.11	177.89		
7		1	5-13-48			31.39	.275	35.18	292.02	338.17	46.15	50.00	3.85	47.15		
7		2	5-12-48			27.12	.275	35.18	292.17	"	46.00	"	4.00	47.00		
7		3	"			27.51	.275	35.18	292.90	"	45.27	"	4.73	46.27		
7		4	5-12-48			28.68	.275	35.18	294.35	338.17	43.82	50.00	6.18	44.82		
										Total Bt 7	181.24	200.00	18.76	185.24		
6		1	5-13-48			30.54	.300	34.50	291.50	338.17	46.67	50.00	3.33	47.67		
6		2	"			25.77	.250	35.88	291.95	"	46.22	"	3.78	47.22		
6		3	"			27.88	.250	35.88	291.78	"	46.39	"	3.61	47.39		
6		4	5-13-48			31.74	.300	34.50	291.96	338.17	46.21	50.00	3.79	47.21		
										Total Bt 6	185.49	200.00	14.51	189.49		
5		1	5-13-48			20.96	.300	34.50	294.88	338.17	43.29	50.00	6.71	44.29		
5		2	"			21.16	.300	34.50	294.68	"	43.49	"	6.51	44.49		
5		3	"			22.07	.325	33.88	293.77	"	44.40	"	5.60	45.40		
5		4	5-13-48			22.90	.300	34.50	292.94	338.17	45.23	50.00	4.77	46.23		
										Total Bt 5	176.41	200.00	23.59	180.41		
4		1	5-14-48			18.19	.275	35.18	296.90	338.17	41.27	50.00	8.73	42.27		
4		2	"			21.50	.175	38.17	293.59	"	44.58	48.58	4.00	45.58		
4		3	"			21.95	.300	34.50	293.14	"	45.03	50.00	4.97	46.03		
4		4	5-14-48			22.56	.250	35.88	292.53	338.17	45.64	50.00	4.36	46.64		
										Total Bt 4	176.52	198.58	22.06	180.52		
3		1	5-14-48			25.61	.275	36.61	295.98	338.17	42.19	50.00	7.81	43.19		
3		2	"			25.96	.250	35.88	294.83	"	43.34	"	6.66	44.34		
3		3	"			25.79	.300	34.50	293.59	"	44.58	"	5.42	45.58		
3		4	5-14-48			26.68	.260	35.88	292.14	338.17	46.03	50.00	3.97	47.03		
										Total Bt 3	176.14	200.00	23.86	180.14		
2		1	5-15-48			31.33	.300	34.50	293.93	338.17	44.24	50.00	5.76	45.24		
2		2	"			29.92	.275	35.18	295.34	"	42.83	"	7.17	43.83		
2		3	"			31.30	.250	35.88	293.96	"	44.21	48.67	4.46	45.21		
2		4	5-15-48			32.33	.300	34.50	292.93	338.17	45.24	50.00	4.76	46.24		
										Total Bt 2	176.52	198.67	22.15	180.52		
1		1	5-17-48			26.78	.275	35.18	298.37	338.17	39.80	50.00	10.20	40.80		
1		2	"			29.20	.225	36.61	295.95	"	42.22	"	7.78	43.22		
1		3	"			27.81	.300	34.50	297.34	"	40.83	"	9.17	41.83		
1		4	5-17-48			29.66	.300	34.50	299.49	338.17	42.68	50.00	7.32	43.68		
										Total Bt 1	165.53	200.00	34.47	169.53		
									Total Docket	12.248	2318.54	2719.25	400.71	2374.54		
TOTAL																

BENT NO.	FOOTING	PILE NO.	DATE DRIVEN	DIAMETER BUTT	DIAMETER TIP	PENETRATION	PEN. PER BLOW	BEARING	ELEVATION PILE TIP	ELEVATION CUT-OFF	LENGTH IN PLACE	ORIGINAL LENGTH	LENGTH CUT-OFF	PAY LENGTH	C.O. AT 0.40 OF UNIT PRICE	C.O. AT
			P =	$\frac{2WH}{S+1.0}$	$\frac{2 \times 2990 \times 15}{(\ldots) \times \ldots}$	$= \frac{44.85}{S+1.0}$										
TOTAL																
GRAND TOTAL																

NOTES CONCERNING ANY UNUSUAL FOUNDATION CONDITION

BENT NO.	FOOTING	PILE NO.	REMARKS

CONSTRUCTION RECORD DATA

UNITED STATES
DEPARTMENT OF THE INTERIOR
GEOLOGICAL SURVEY

CARLISLE SE QUADRANGLE
SOUTH CAROLINA
7.5 MINUTE SERIES (TOPOGRAPHIC)

4753 III NW (LEEDS)
4753 III NE (BATON ROUGE)
4753 II NW (CHESTER)
4753 III SW (CARLISLE)
4753 II SW (BLACKSTOCK)
4752 IV NW (BLAIR)
4752 IV NE (SALEM CROSSROADS)
4752 I NW (LEBANON)

81° 22′ 30″ — 81° 15′ — 34° 37′ 30″ — 34° 30′

STUDY AREA

APPRO
EXIT
SYNTA

WHITMIRE 17 MI.
CARLISLE 5 MI.

ROCK HILL 29 MI.
CHESTER 7 MI.

CHESTER CO
FAIRFIELD CO

CARLISLE 9 MI.
COOL BRANCH 1.2 MI.

SALEM CROSSROADS 7 MI.
COLUMBIA 41 MI.

1 920 000 FEET
590 000 FEET
550 000 FEET
1 890 000 FEET

Mapped, edited, and published by the Geological Survey

Control by USGS, USC&GS, and South Carolina Geodetic Survey

Topography by photogrammetric methods from aerial photographs taken 1968. Field checked 1969

Polyconic projection. 1927 North American datum
10,000-foot grid based on South Carolina coordinate system, north zone
1000-meter Universal Transverse Mercator grid ticks,
zone 17, shown in blue

UTM GRID AND 1969 MAGNETIC NORTH DECLINATION AT CENTER OF SHEET

SCALE 1:24 000

CONTOUR INTERVAL 10 FEET
DATUM IS MEAN SEA LEVEL

EXPLANATION

EXIT cross section

QUADRANGLE LOCATION

ROAD CLASSIFICATION

Primary highway, hard surface
Secondary highway, hard surface
Light-duty road, hard or improved surface
Unimproved road
Interstate Route
U. S. Route
State Route

CARLISLE SE, S. C.
N3430—W8115/7.5

1969

AMS 4753 III SE—SERIES V846

☆U.S. GOVERNMENT PRINTING OFFICE: 1973—516—080/6

Figure 1.–Topography of study area and location of cross sections used in WSPRO analysis for structure 124007200200 on Route SC 72, crossing the Sandy River in Chester County, South Carolina.