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**U.S. DEPARTMENT OF THE INTERIOR
U.S. GEOLOGICAL SURVEY**

**LEVEL II BRIDGE SCOUR ANALYSIS FOR STRUCTURE 124021500200
ON ROUTE SC 215, CROSSING THE SANDY RIVER IN CHESTER
COUNTY, SOUTH CAROLINA**

By J. Mike Sullivan and Michael G. Zalants

**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 124021500200 on Route SC 215,
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 124021500200 on Route SC 215, crossing the Sandy River in Chester County, South Carolina (figure 1 in pocket; figures 4-8). 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 150 mi², 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.

In the study area, the Sandy River has a meandering channel with a slope of 0.00054 ft/ft (2.8 ft/mi), an average channel top width of 87 ft and an average channel depth of 15 ft. The predominant channel bed material is sand (D_{50} is 1.1 mm) and the channel banks consist of a silty sand (D_{50} is 0.30 mm). In general, the banks have moderate to heavy woody vegetative cover and were noted as having heavy fluvial erosion and some bank failure with exposed tree roots and trees leaning over the channel at the time of the Level I site visit, July 16, 1990, and the Level II site visit, April 20, 1993.

The Route SC 215 crossing of the Sandy River is a 450-ft-long, two-lane bridge consisting of fifteen 30-ft concrete spans, supported by steel and concrete bents with spillthrough abutments. The left abutment is protected by riprap but the right abutment has no riprap protection. 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 5 and a graph of the scour depths is shown on figure 2.

Pile penetration depths were obtained from SCDOT bridge plans. The minimum remaining pile penetration depth for the 100-year discharge is 5.0 ft and occurs at bent 12. The minimum remaining pile penetration depth for the 500-year discharge is 3.7 ft and occurs at bent 3.

It should be noted that the SCDOT bridge plan borings (docket number 12.245) 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 124021500200 on Route SC 215, 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 18,000 cubic feet per second							
2	30	293.0	293.1	319.5	6.2	313.3	20.2
3	60	294.9	295.0	308.5	6.4	302.1	7.1
4	90	292.2	292.3	313.9	6.3	307.6	15.3
5	120	292.7	292.8	315.4	6.3	309.1	16.3
6	150	295.3	295.4	315.1	6.3	308.8	13.4
7	180	296.0	296.1	314.6	6.3	308.3	12.2
8	210	293.0	293.1	315.4	6.3	309.1	16.0
9	240	289.4	289.5	318.3	6.2	312.1	22.6
10	270	290.5	290.6	314.0	3.2	310.8	20.2
11	300	286.6	286.7	300.3	6.4	293.9	7.2
12	330	289.7	289.8	301.2	6.4	294.8	5.0
13	360	287.0	287.1	304.0	6.4	297.6	10.5
14	390	290.5	290.6	311.2	10.2	301.0	10.4
15	420	293.1	293.2	317.7	10.0	307.7	14.5

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 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 12.245) 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 124021500200 on Route SC 215, 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 26,400 cubic feet per second							
2	30	293.0	293.1	319.5	9.6	309.9	16.8
3	60	294.9	295.0	308.5	9.8	298.7	3.7
4	90	292.2	292.3	313.9	9.7	304.2	11.9
5	120	292.7	292.8	315.4	9.7	305.7	12.9
6	150	295.3	295.4	315.1	9.7	305.4	10.0
7	180	296.0	296.1	314.6	9.7	304.9	8.8
8	210	293.0	293.1	315.4	9.6	305.8	12.7
9	240	289.4	289.5	318.3	9.7	308.6	19.1
10	270	290.5	290.6	314.0	3.6	310.4	19.8
11	300	286.6	286.7	300.3	7.3	293.0	6.3
12	330	289.7	289.8	301.2	7.3	293.9	4.1
13	360	287.0	287.1	304.0	7.3	296.7	9.6
14	390	290.5	290.6	311.2	16.8	294.4	3.8
15	420	293.1	293.2	317.7	16.7	301.0	7.8

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 12.245) 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 124021500200 on Route SC 215, 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 18,000 cubic feet per second				
2	30	3.4	2.8	6.2
3	60	3.4	3.0	6.4
4	90	3.4	2.9	6.3
5	120	3.4	2.9	6.3
6	150	3.4	2.9	6.3
7	180	3.4	2.9	6.3
8	210	3.4	2.9	6.3
9	240	3.4	2.8	6.2
10	270	0.0 ⁴	3.2	3.2
11	300	0.0 ⁴	6.4	6.4
12	330	0.0 ⁴	6.4	6.4
13	360	0.0 ⁴	6.4	6.4
14	390	7.2	3.0	10.2
15	420	7.2	2.8	10.0

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 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 12.245) 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 124021500200 on Route SC 215, 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 26,400 cubic feet per second				
2	30	6.3	3.3	9.6
3	60	6.3	3.5	9.8
4	90	6.3	3.4	9.7
5	120	6.3	3.4	9.7
6	150	6.3	3.4	9.7
7	180	6.3	3.4	9.7
8	210	6.3	3.3	9.6
9	240	6.3	3.4	9.7
10	270	0.0 ⁴	3.6	3.6
11	300	0.0 ⁴	7.3	7.3
12	330	0.0 ⁴	7.3	7.3
13	360	0.0 ⁴	7.3	7.3
14	390	13.4	3.4	16.8
15	420	13.4	3.3	16.7

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 12.245) 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 5. --Abutment scour depths for the 100- and 500-year discharges at structure 124021500200 on Route SC 215, crossing the Sandy River in Chester County, South Carolina

Recurrence interval for discharge	Discharge (cubic feet per second)	Depth of scour ^{1, 2} at left abutment (feet)	Depth of scour ^{1, 2} at right abutment (feet)
100-year	18,000	0 ³	25.2
500-year	26,400	0 ³	30.7

¹ Abutment scour depths were calculated using the Froehlich (1989) live-bed abutment scour equation, assuming no abutment protection.

² The words "right" and "left" refer to directions that would be reported by an observer facing downstream.

³ Scour was not computed for the left abutment because of adequate riprap protection.



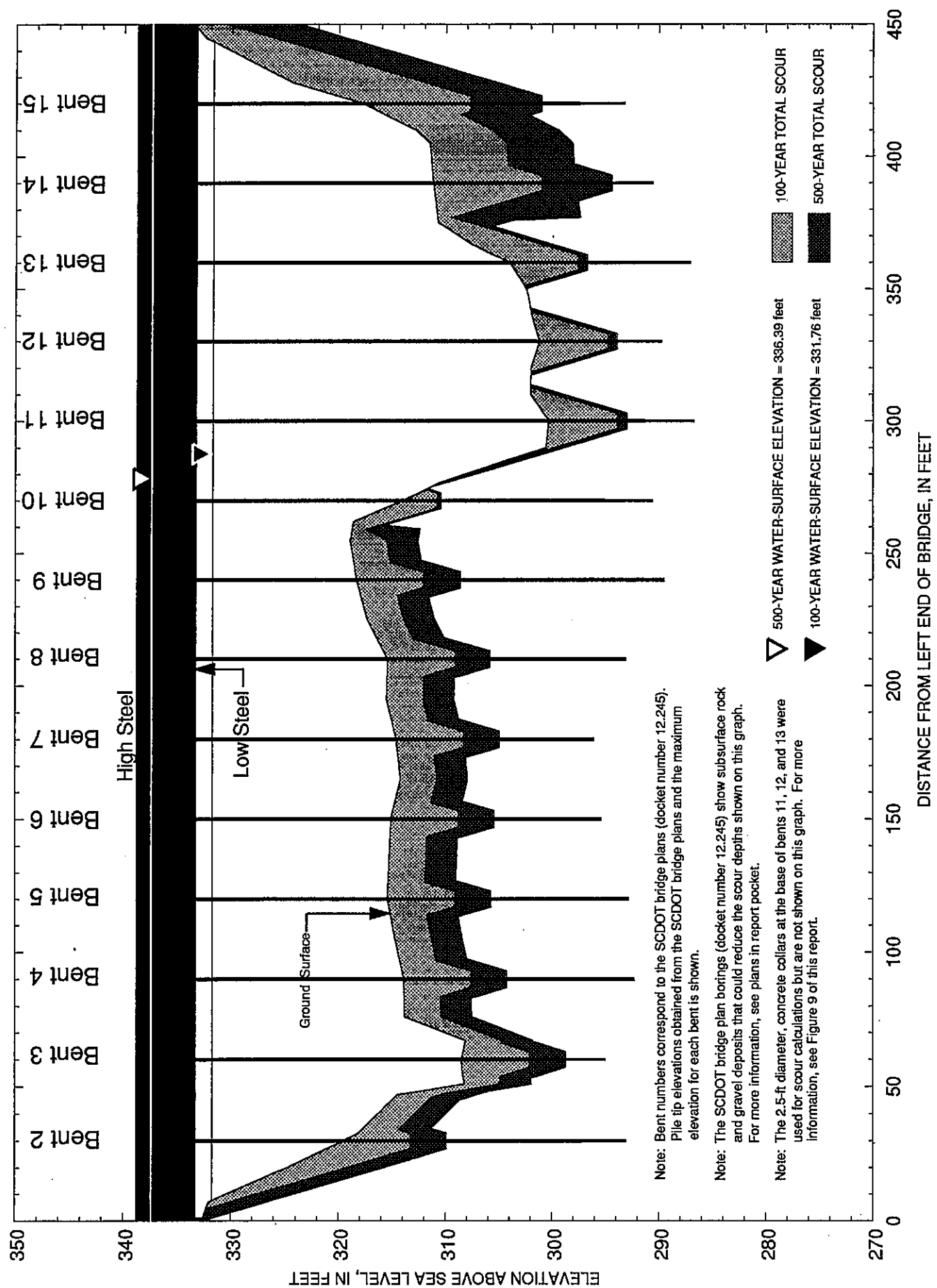


Figure 2.--Total scour depths for the 100- and 500-year discharges at the upstream face of structure 124021500200 on Route SC 215, crossing the Sandy River in Chester County, South Carolina.

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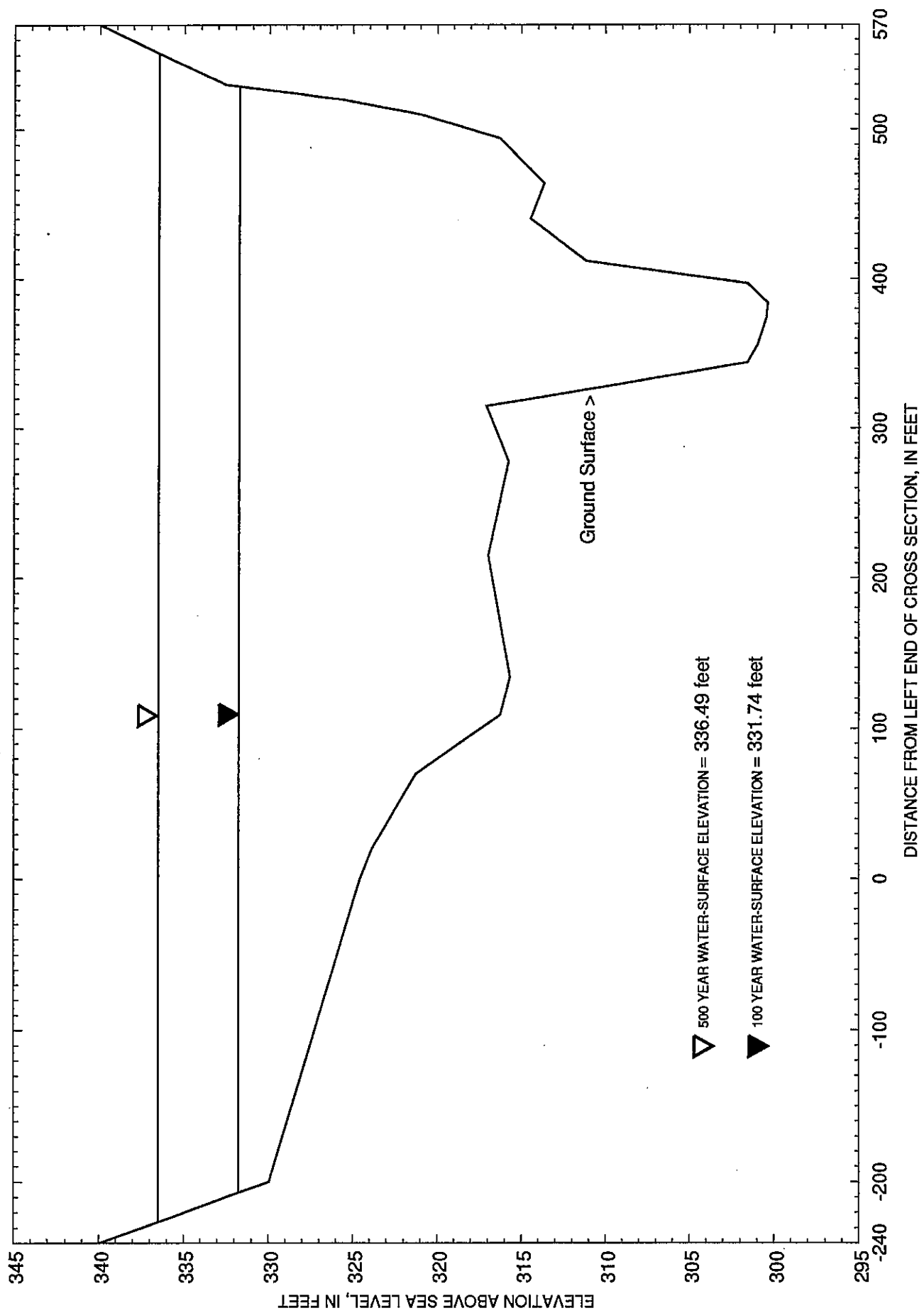


Figure 3.--Approach cross section at structure 124021500200 on Route SC 215, crossing the Sandy River in Chester County, South Carolina.





Figure 4.--Approximately 500 ft upstream of structure 124021500200 on Route SC 215, crossing the Sandy River in Chester County, South Carolina facing downstream (April 20, 1993).



Figure 5.--Approximately 650 ft downstream of structure 124021500200 on Route SC 215, crossing the Sandy River in Chester County, South Carolina facing upstream (April 20, 1993).





Figure 6.--Upstream channel as viewed from structure 124021500200 on Route SC 215, crossing the Sandy River in Chester County, South Carolina (July 16, 1990).



Figure 7.--Structure 124021500200 on Route SC 215, crossing the Sandy River in Chester County, South Carolina as viewed from the upstream channel (July 16, 1990).





Figure 8.--Bents 11 and 12 of structure 124021500200 on Route SC 215, crossing the Sandy River in Chester County, South Carolina, showing the 2.5-ft diameter, concrete collars at the pile bases (April 20, 1993).



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SCOUR REPORT SUMMARY

Structure Number 124021500200 Stream Sandy River
County Chester Road SC 215 District 4

Description of Bridge

Bridge length 450 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/no Date of inspection 04-20-1993

Description of riprap The left abutment is protected with 6- to 12-inch granite riprap.
The right abutment is not protected with riprap.

Brief description of piers/pile bents The bridge is supported with 14 sets of interior bents. Each bent consists of four 0.8-ft by 0.85-ft steel H-piles. In addition, bents 11, 12, and 13 have 2.5-ft diameter, concrete collars at the base of their piles.

Is bridge skewed to flood plain according to USGS topo map? yes Angle 14

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	<u>07-16-1990</u>	<u>15</u>	<u>15</u>
Level II	<u>04-20-1993</u>	<u>---</u>	<u>---</u>

Potential for debris Moderate because of many trees leaning over the upstream channel.

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

Description of Flood Plain

General topography Relatively narrow valley sections that rise quickly in elevation

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

Date of inspection 04-20-1993

D/S left: Moderate to heavy coverage of hardwoods and moderate undergrowth

D/S right: Moderate to heavy coverage of hardwoods and moderate undergrowth

U/S left: Moderate to heavy coverage of hardwoods and moderate undergrowth

U/S right: Light to moderate coverage of hardwoods and moderate undergrowth

Description of Channel

Average top width 87 *ft* *Average depth* 15 *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 04-20-1993

D/S left: Moderate to heavy coverage of hardwoods and moderate undergrowth

D/S right: Moderate to heavy coverage of hardwoods and moderate undergrowth

U/S left: Moderate to heavy coverage of hardwoods and moderate undergrowth

U/S right: Light to moderate coverage of hardwoods and moderate undergrowth

Do banks appear stable? no *If not, describe location and type of instability and date of observation.* The banks were noted as having heavy fluvial erosion and some failure. Many tree roots are exposed and the trees are leaning over the upstream and downstream channel. This was observed during the Level I site visit on July 16, 1990, and during the Level II site visit on April 20, 1993.

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

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 Subtract 0.1 ft from USGS
survey datum to obtain SCDOT plans' datum (docket number 12.245).

<i>Description of reference marks used to determine USGS datum.</i>	<i>USGS Benchmark</i>
J185 (elevation=372.38 ft above sea level) is located on Route SC 215 approximately 850 ft northwest of the Route SC 215 crossing of the Sandy River. RM1 is a chiseled square on the upstream, left abutment headwall of the Route SC 215 crossing and has a surveyed elevation of 336.01 ft. RM2 is a chiseled square on the downstream, right abutment headwall of the Route SC 215 crossing and has an elevation of 336.04 ft.	

Cross Sections Used in WSPRO Analysis

[illegible]

* 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 US 215 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 (upstream) bridge face was used in the WSPRO model. A 12 degree bridge skew was determined by averaging the 10 degree skew noted on the Level I Inspection Form, dated July 16, 1990, and the 14 degree skew measured from the USGS topographic map. The section reference distance (SRD) at the downstream face of the bridge was set to zero. An exit cross section was surveyed 670 ft downstream of the downstream bridge face, an approach cross section was surveyed 560 ft upstream of the upstream bridge face, and a full-valley cross section was surveyed at the toe of the downstream road embankment. 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. The cross sections were extended using the slope of the contour lines from the USGS topographic map. In addition, the centerline of Route SC 215 was surveyed and included in the analysis to model flow over the road.

Bridge Hydraulics

Average embankment elevation 335.6 ft

Average low steel elevation 333.3 ft

100-year discharge 18,000 ft³/s

Water-surface elevation at D/S bridge face 331.76 ft

Area of flow at D/S bridge face 7,952 ft²

Average velocity in bridge opening 2.26 ft/s

Maximum WSPRO tube velocity at bridge 2.91 ft/s

Water-surface elevation at Approach section with bridge 331.74 ft

Water-surface elevation at Approach section without bridge 331.72 ft

Amount of backwater caused by bridge 0.02 ft

500-year discharge 26,400 ft³/s

Water-surface elevation at D/S bridge face 336.39⁺ ft

Area of flow at D/S bridge face 8,364 ft²

Average velocity in bridge opening 3.14 ft/s

Maximum WSPRO tube velocity at bridge 3.86 ft/s

Water-surface elevation at Approach section with bridge 336.49 ft

Water-surface elevation at Approach section without bridge 336.55 ft

Amount of backwater caused by bridge 0* ft

⁺The water-surface elevation at the downstream bridge face is determined from the full-valley section because the bridge is in pressure flow.

*Backwater for the 500-year discharge is -0.06 ft. Since negative backwater is unlikely, it was set to zero.

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 5 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). Bents 2 through 9 are located on the left overbank and were analyzed using the maximum left overbank WSPRO tube velocity and the depth of flow at each bent. Bents 14 and 15 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 10, 11, 12, and 13 are located in the channel and 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 width of the concrete collars (2.5 ft) was used as the pile width and a pier length of 10 ft, using the cumulative collar widths, was used on bents 11, 12, and 13 as recommended in Hydraulic Engineering Circular 18 (Richardson and others, 1993) because of the round, concrete collars at the base of each of the piles in those bents.

The left and right overbanks at the bridge were 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).

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 3 through 4 and figure 2.

The right abutment is not protected by riprap, therefore abutment scour was calculated using the Froehlich (1989) live-bed abutment scour equation. The left abutment is protected by 6- to 12-inch granite riprap; therefore, no abutment scour computations were made.

It should be noted that the SCDOT bridge plan borings (docket number 12.245) 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

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T1      Sandy River at SC 215 in Chester County   Structure 124021500200
T2      JMS      6 September 1994
*
*      Q100      Q500
Q      18000      26400
SK      0.00054  0.00054
J1      * * 0.0025
*
*      Section TEMP1 was surveyed 670 ft downstream of the downstream
*      bridge face. The distance was determined from the USGS field
*      survey notes in conjunction with the USGS topographic map.
*      The right end of the cross section was extended by drawing
*      the section on the USGS topographic map and scaling the stations
*      for the 320 ft, 330 ft, and 340 ft contour lines.
*
XT      TEMP1 -670 0.00054
GR      0 338.8 9 338.3 16 336.7 30 328.8 41 326.2
GR      60 323.0 65 322.0 78 310.1 85 304.4 88 300.5
GR      100 299.8 109 299.8 117 299.3 131 300.8 136 303.4
GR      142 310.3 161 314.1 181 316.0 200 311.9 212 312.8
GR      246 315.0 273 316.9 366 320.0 666 330.0 866 340.0
*
XS      EXIT -450
GT
N      0.17 0.045 0.17
SA      65 142
*
*      Section FULLV is the full valley cross section surveyed at the
*      downstream road embankment toe. The left end of the cross section
*      was extended by drawing the section on the USGS topographic map and
*      scaling the stations for the 330 ft and 340 ft contour lines on the
*      left end and scaling the stations for the 340 ft contour line on the
*      right end.
*
XS      FULLV 0
GR      -300 340.0 -20 330.0
GR      0 326.8 26 324.4 42 321.7 63 315.8 114 309.5
GR      118 305.3 125 310.7 149 311.2 222 316.1 276 316.2
GR      297 314.5 312 311.4 328 305.0 337 302.0 344 300.4
GR      349 300.9 357 300.9 365 302.0 372 305.4 379 302.0
GR      389 301.2 398 302.0 411 308.4 429 309.2 465 313.6
GR      545 326.4 586 333.8 613 341.8 628 345.9
N      0.17 0.045 0.17
SA      312 411
FL      350 312 450 411 550
*
*      Upstream bridge face
*      A 12 degree bridge skew was determined from averaging a 10 degree
*      skew from the Level I Inspection Form and a 14 degree skew
*      from the USGS topographic map.
*
BR      BRIDG 0 333.3 12
GR      0 333.3 1 333.3 1.1 332.6 7 332.1 20 324.8 30 319.5
GR      33 318.1 47 314.5 51 308.2 56 308.4 60 308.5 67 308.1
GR      76 313.8 90 313.9 105 314.7 120 315.4 150 315.1 165 314.2
GR      180 314.6 195 315.5 210 315.4 225 317.3 240 318.3 255 318.9
GR      262 318.6 270 314.0 277 310.4 285 304.5 290 300.6 300 300.3
GR      310 302.0 320 302.0 330 301.2 340 301.9 350 302.4 360 304.0

```

WSPRO INPUT FILE --Continued

GR	367	307.6	375	310.7	390	311.2	405	311.5	410	312.8	420	317.7
GR	428	324.4	445	332.5	448.9	333.3	449	333.3	450	333.3	0	333.3
N	0.04	0.045	0.04									
SA		262	375									
CD	3	33	1.5	335.6								
PW 1	300.3	0.85		301.2	0.85	301.2	1.7	304.0	1.7	304.0	2.55	
PW 1	308.5	2.55		308.5	3.40	311.2	3.40	311.2	4.25	313.9	4.25	
PW 1	313.9	5.95		314.8	5.95	314.8	7.65	315.4	7.65	315.4	9.35	
PW 1	317.7	9.35		317.7	10.2	318.3	10.2	318.3	11.05	319.5	11.05	
PW 1	319.5	11.9		333.3	11.9	333.3	0.0					

*

*

Centerline of SC 215 to model flow over the road.

*

The same 12 degree skew used on the bridge section was used on the road section.

*

XR	ROAD	16	33	*	*	12						
GR		0	340.8	48	338.6	88	337.4	116	336.8	148	336.2	
GR		176	335.9	202	335.6	202.1	338.8	651.9	338.8	652	335.6	
GR		677	335.9	705	336.4	770	338.8	808	340.6			
BP		202										

*

*

Section TEMP2 was surveyed 560 ft upstream of the upstream bridge face. The distance was determined from the USGS field survey notes. Both ends of the cross section were extended by drawing the section and scaling the stations for the 330 ft and 340 ft contour lines on the left end and the 340 ft contour line on the right end

*

XT	TEMP2	560	0.00054									
GR				-240	340.0	-200	330.0					
GR		0	324.6	20	323.9	70	321.3	109	316.3	134	315.7	
GR		215	317.0	278	315.8	315	317.1	344	301.6	356	301.0	
GR		374	300.5	384	300.4	397	301.6	412	311.2	440	314.5	
GR		464	313.7	494	316.3	510	321.0	520	325.6	530	332.6	
GR		570	340.0									

*

AS APPRO 483

GT

N 0.17 0.045 0.11

SA 315 412

BP 53

*

HP 1	BRIDG	331.76,	,331.76,18000
HP 2	BRIDG	331.76,	,331.76,18000
HP 1	APPRO	331.74,	,331.74,18000
HP 2	APPRO	331.74,	,331.74,18000
HP 1	BRIDG	333.30,	,333.30,26253
HP 2	BRIDG	333.30,	,333.30,26253
HP 1	APPRO	336.49,	,336.49,26400
HP 2	APPRO	336.49,	,336.49,26400

*

EX

ER

WSPRO OUTPUT

WSPRO
V060188

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

Sandy River at SC 215 in Chester County Structure 124021500200
JMS 6 September 1994

*** RUN DATE & TIME: 09-14-94 12:50

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

WSEL	SA#	AREA	K	TOPW	WETP	ALPH	LEW	REW	QCR
	1	3950.	906498.	249.	258.				89302.
	2	2999.	859111.	111.	118.				88641.
	3	1002.	214881.	67.	72.				21983.
331.76		7950.	1980489.	426.	449.	1.04	8.	443.	190800.

WSPRO
V060188

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

Sandy River at SC 215 in Chester County Structure 124021500200
JMS 6 September 1994

*** RUN DATE & TIME: 09-14-94 12:50

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

	WSEL	LEW	REW	AREA	K	Q	VEL
	331.76	7.6	443.4	7950.5	1980489.	18000.	2.26
X STA.		7.6	57.3	73.3		95.5	120.6
A(I)		610.6	354.8	391.2		415.1	402.2
V(I)		1.47	2.54	2.30		2.17	2.24
X STA.		145.5	169.9	194.0		221.5	255.8
A(I)		407.9	400.4	430.9		458.3	504.2
V(I)		2.21	2.25	2.09		1.96	1.78
X STA.		284.3	295.5	306.0		317.1	328.0
A(I)		330.1	321.3	322.0		320.7	314.5
V(I)		2.73	2.80	2.80		2.81	2.86
X STA.		338.6	349.3	361.3		378.2	395.6
A(I)		309.4	335.4	385.0		351.7	584.6
V(I)		2.91	2.68	2.34		2.56	1.54

WSPRO OUTPUT --Continued

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

Sandy River at SC 215 in Chester County Structure 124021500200
JMS 6 September 1994

*** RUN DATE & TIME: 09-14-94 12:50

CROSS-SECTION PROPERTIES: ISEQ = 5; SECID = APPRO; SRD = 483.

WSEL	SA#	AREA	K	TOPW	WETP	ALPH	LEW	REW	QCR
	1	5199.	210736.	522.	523.				93106.
	2	2669.	770062.	97.	104.				79447.
	3	1780.	144944.	117.	121.				39429.
331.74		9649.	1125742.	736.	747.	4.27	-207.	529.	95957.

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

Sandy River at SC 215 in Chester County Structure 124021500200
JMS 6 September 1994

*** RUN DATE & TIME: 09-14-94 12:50

VELOCITY DISTRIBUTION: ISEQ = 5; SECID = APPRO; SRD = 483.

	WSEL	LEW	REW	AREA	K	Q	VEL
	331.74	-207.1	528.8	9648.6	1125742.	18000.	1.87
X STA.	-207.1		130.1	196.1	264.6	321.6	333.7
A(I)		2351.2	1029.6	1038.5	889.6	259.6	
V(I)		0.38	0.87	0.87	1.01	3.47	
X STA.	333.7		341.7	347.8	353.5	359.1	364.7
A(I)		213.8	182.9	172.7	174.8	170.4	
V(I)		4.21	4.92	5.21	5.15	5.28	
X STA.	364.7		370.2	375.8	381.4	387.0	392.7
A(I)		173.0	173.9	176.4	174.9	175.7	
V(I)		5.20	5.18	5.10	5.15	5.12	
X STA.	392.7		398.7	406.9	428.7	463.4	528.8
A(I)		180.5	218.6	439.8	616.7	836.2	
V(I)		4.99	4.12	2.05	1.46	1.08	

WSPRO OUTPUT --Continued

WSPRO
V060188

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

Sandy River at SC 215 in Chester County Structure 124021500200
JMS 6 September 1994

*** RUN DATE & TIME: 09-14-94 12:50

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

WSEL	SA#	AREA	K	TOPW	WETP	ALPH	LEW	REW	QCR
	1	4339.	658749.	-7.	527.				0.
	2	3169.	601636.	-2.	231.				0.
	3	1108.	154455.	-3.	153.				0.
333.30		8617.	1414839.	-12.	911.	1.05	1.	449.	0.

WSPRO
V060188

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

Sandy River at SC 215 in Chester County Structure 124021500200
JMS 6 September 1994

*** RUN DATE & TIME: 09-14-94 12:50

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

	WSEL	LEW	REW	AREA	K	Q	VEL
	333.30	1.0	448.9	8616.6	1414839.	26253.	3.05
X STA.	1.0	57.3	73.0	95.7	119.6	144.7	
A(I)	690.7	373.8	434.1	431.3	443.9		
V(I)	1.90	3.51	3.02	3.04	2.96		
X STA.	144.7	168.6	192.3	218.5	251.1	280.7	
A(I)	435.0	429.7	454.4	491.4	520.9		
V(I)	3.02	3.05	2.89	2.67	2.52		
X STA.	280.7	293.0	303.9	315.2	326.7	337.6	
A(I)	361.7	348.9	349.8	354.0	339.7		
V(I)	3.63	3.76	3.75	3.71	3.86		
X STA.	337.6	349.1	361.1	377.7	395.7	448.9	
A(I)	351.1	350.7	407.5	390.5	657.5		
V(I)	3.74	3.74	3.22	3.36	2.00		

WSPRO OUTPUT --Continued

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

Sandy River at SC 215 in Chester County Structure 124021500200
JMS 6 September 1994

*** RUN DATE & TIME: 09-14-94 12:50

CROSS-SECTION PROPERTIES: ISEQ = 5; SECID = APPRO; SRD = 483.

WSEL	SA#	AREA	K	TOPW	WETP	ALPH	LEW	REW	QCR
	1	7725.	397768.	541.	542.				165615.
	2	3130.	1004134.	97.	104.				100883.
	3	2382.	209628.	139.	144.				55900.
336.49		13236.	1611530.	777.	790.	4.44	-226.	551.	147106.

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

Sandy River at SC 215 in Chester County Structure 124021500200
JMS 6 September 1994

*** RUN DATE & TIME: 09-14-94 12:50

VELOCITY DISTRIBUTION: ISEQ = 5; SECID = APPRO; SRD = 483.

	WSEL	LEW	REW	AREA	K	Q	VEL
	336.49	-226.1	551.3	13236.4	1611530.	26400.	1.99
X STA.	-226.1		62.4	134.4		194.4	257.8
A(I)		2758.9		1328.9		1218.8	1195.8
V(I)		0.48		0.99		1.08	1.10
X STA.	316.9		331.4	340.3		347.4	353.7
A(I)		352.1		273.5		243.8	224.2
V(I)		3.75		4.83		5.41	5.89
X STA.	360.0		366.4	372.7		378.9	385.2
A(I)		227.3		228.4		223.9	229.9
V(I)		5.81		5.78		5.89	5.74
X STA.	391.7		398.2	407.1		429.3	463.1
A(I)		230.5		276.4		552.3	1201.2
V(I)		5.73		4.78		2.39	1.10

WSPRO OUTPUT --Continued

+++ BEGINNING PROFILE CALCULATIONS -- 2

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

Sandy River at SC 215 in Chester County Structure 124021500200
JMS 6 September 1994

*** RUN DATE & TIME: 09-14-94 12:50

XSID:CODE	SRDL	LEW	AREA	VHD	HF	EGL	CRWS	Q	WSEL
SRD	FLEN	REW	K	ALPH	HO	ERR	FR#	VEL	
EXIT :XS	*****	26.	7538.	0.45	*****	331.67	316.22	18000.	331.23
-450.	*****	688.	774030.	5.04	*****	*****	0.28	2.39	

===135 CONVEYANCE RATIO OUTSIDE OF RECOMMENDED LIMITS.
"FULLV" KRATIO = 1.53

FULLV:FV	SRDL	LEW	AREA	VHD	HF	EGL	CRWS	Q	WSEL
	FLEN	REW	K	ALPH	HO	ERR	FR#	VEL	
450.	-65.	10082.	0.22	0.15	331.83	*****	18000.	331.61	
0.	437.	574.	1184661.	4.48	0.00	0.00	0.17	1.79	

<<<<THE ABOVE RESULTS REFLECT "NORMAL" (UNCONSTRICTED) FLOW>>>>

APPRO:AS	SRDL	LEW	AREA	VHD	HF	EGL	CRWS	Q	WSEL
	FLEN	REW	K	ALPH	HO	ERR	FR#	VEL	
483.	-207.	9633.	0.23	0.12	331.95	*****	18000.	331.72	
483.	483.	529.	1123731.	4.27	0.00	0.00	0.19	1.87	

<<<<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	450.	8.	7952.	0.08	0.17	331.84	313.79	18000.	331.76
0.	450.	443.	1981080.	1.00	0.00	0.00	0.09	2.26	

TYPE	PPCD	FLOW	C	P/A	LSEL	BLEN	XLAB	XRAB
3.	1.	1.	1.000	0.029	333.30	*****	*****	*****

XSID:CODE	SRD	FLEN	HF	VHD	EGL	ERR	Q	WSEL
ROAD :RG	16.							

<<<<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	450.	-207.	9647.	0.23	0.12	331.97	314.59	18000.	331.74
483.	468.	529.	1125480.	4.27	0.00	0.00	0.19	1.87	

M(G)	M(K)	KQ	XLKQ	XRKQ	OTEL
0.409	0.016	1106990.	88.	523.	331.62

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

WSPRO OUTPUT --Continued

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

Sandy River at SC 215 in Chester County Structure 124021500200
JMS 6 September 1994

*** RUN DATE & TIME: 09-14-94 12:50

XSID:CODE	SRDL	LEW	AREA	VHD	HF	EGL	CRWS	Q	WSEL
SRD	FLEN	REW	K	ALPH	HO	ERR	FR#	VEL	
EXIT :XS	*****	17.	10967.	0.50	*****	336.52	320.07	26400.	336.02
-450.	*****	784.	1135804.	5.54	*****	*****	0.26	2.41	

===135 CONVEYANCE RATIO OUTSIDE OF RECOMMENDED LIMITS.

"FULLV" KRATIO = 1.42

FULLV:FV	450.	-199.	13511.	0.31	0.17	336.69	*****	26400.	336.39
0.	437.	595.	1609194.	5.14	0.00	0.00	0.19	1.95	

<<<<<THE ABOVE RESULTS REFLECT "NORMAL" (UNCONSTRICTED) FLOW>>>>>

APPRO:AS	483.	-226.	13281.	0.27	0.13	336.82	*****	26400.	336.55
483.	483.	552.	1617869.	4.44	0.00	0.00	0.18	1.99	

<<<<<THE ABOVE RESULTS REFLECT "NORMAL" (UNCONSTRICTED) FLOW>>>>>

===255 ATTEMPTING FLOW CLASS 3 (6) SOLUTION.

WS3N,LSEL = 336.39 333.30

<<<<<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	450.	1.	8364.	0.16	*****	333.46	317.18	26253.	333.30
0.	*****	449.	1414839.	1.05	*****	*****	0.13	3.14	

TYPE	PPCD	FLOW	C	P/A	LSEL	BLEN	XLAB	XRAB
3.	1.	6.	0.800	0.029	333.30	*****	*****	*****

XSID:CODE	SRD	FLEN	HF	VHD	EGL	ERR	Q	WSEL
ROAD :RG	16.	450.	0.12	0.27	336.64	0.00	202.	336.47

	Q	WLEN	LEW	REW	DMAX	DAVG	VMAX	VAVG	HAVG	CAVG
LT:	110.	67.	134.	202.	0.9	0.5	3.8	3.5	0.6	3.2
RT:	91.	52.	652.	705.	0.9	0.5	3.9	3.5	0.7	3.1

XSID:CODE	SRDL	LEW	AREA	VHD	HF	EGL	CRWS	Q	WSEL
SRD	FLEN	REW	K	ALPH	HO	ERR	FR#	VEL	
APPRO:AS	450.	-226.	13236.	0.27	0.14	336.76	318.53	26400.	336.49
483.	462.	551.	1611544.	4.44	0.00	0.00	0.18	1.99	

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

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

ER

NORMAL END OF WSPRO EXECUTION.

PIER SCOUR COMPUTATIONS

FOR

Sandy River at SC 215 in Chester County, SC Structure 124021500200
Q100 scour computations including bents 2 through 9 JMS 14 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	lfp	lfp	lfp	lfp	lfp	lfp	lfp
Y1: DEPTH (FT)	12.3	23.3	17.9	16.4	16.7	17.2	16.4	13.5
V1: VEL. (FPS)	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5
a: PIER WIDTH (FT)	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9
L: PIER LENGTH (FT)	3.4	3.4	3.4	3.4	3.4	3.4	3.4	3.4
PIER SHAPE	1	1	1	1	1	1	1	1
ATTACK ANGLE	12	12	12	12	12	12	12	12
K1 (SHAPE COEF.)	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
K2 (ANGLE COEF.)	1.40	1.40	1.40	1.40	1.40	1.40	1.40	1.40
FROUDE NO.	0.13	0.09	0.11	0.11	0.11	0.11	0.11	0.12

COMPUTED SCOUR DEPTHS USING CSU EQUATION

SCOUR DEPTH (FT)	2.50	2.73	2.63	2.60	2.61	2.62	2.60	2.53
MAX SCOUR DEPTH (FT)	2.75	3.00	2.90	2.86	2.87	2.88	2.86	2.79

Q100 scour computations including bents 10 through 15 JMS 14 Sept. 1994

HYDRAULIC VARIABLES USED IN CSU EQUATION

PIER NUMBER	10	11	12	13	14	15
PIER STATION (FT)	270	300	330	360	390	420
LOCATION OF PIER	ltb	mcl	mcm	mcr	rfp	rfp
Y1: DEPTH (FT)	31.5	31.5	31.5	31.5	20.6	14.1
V1: VEL. (FPS)	2.6	2.6	2.6	2.6	2.6	2.6
a: PIER WIDTH (FT)	0.9	2.5	2.5	2.5	0.9	0.9
L: PIER LENGTH (FT)	3.4	10.0	10.0	10.0	3.4	3.4
PIER SHAPE	1	2	2	2	1	1
ATTACK ANGLE	12	12	12	12	12	12
K1 (SHAPE COEF.)	1.00	1.00	1.00	1.00	1.00	1.00
K2 (ANGLE COEF.)	1.40	1.40	1.40	1.40	1.40	1.40
FROUDE NO.	0.08	0.08	0.08	0.08	0.10	0.12

COMPUTED SCOUR DEPTHS USING CSU EQUATION

SCOUR DEPTH (FT)	2.88	5.80	5.80	5.80	2.69	2.56
MAX SCOUR DEPTH (FT)	3.17	6.39	6.39	6.39	2.96	2.81

"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 215 in Chester County, SC Structure 124021500200

LIVE-BED SCOUR COMPUTATIONS

	MAIN CHANNEL	CONTRACTED SECTION
DISCHARGE (CFS)	12300.	7810.
BOTTOM WIDTH (FT)	97.0	102.1
MANNINGS n	0.045	0.045
AVERAGE DEPTH (FT)	30.7	

ENERGY SLOPE	0.00028
D50 (FT)	0.0036
FALL VELOCITY (FPS)	0.54
K1 COEF.	0.64
K2 COEF.	0.21

COMPUTED DEPTH AT CONTRACTED SECTION (FT)	=	20.1
DEPTH AT MAIN CHANNEL (FT)	=	30.7
DEPTH OF CONTRACTION SCOUR (FT)	=	-10.6

LEFT OVERBANK IN BRIDGE OPENING
CLEAR-WATER CONTRACTION SCOUR COMPUTATIONS

DISCHARGE IN CONTRACTED SECTION (CFS)	=	8240.
WIDTH OF CONTRACTED SECTION (FT)	=	224.0
MEDIAN GRAIN SIZE (FT)	=	0.0012

COMPUTED DEPTH OF CONTRACTED SECTION (FT)	=	19.1
AVERAGE FLOOD PLAIN DEPTH (FT)	=	15.7
DEPTH OF CONTRACTION SCOUR (FT)	=	3.4

RIGHT OVERBANK IN BRIDGE OPENING
CLEAR-WATER CONTRACTION SCOUR COMPUTATIONS

DISCHARGE IN CONTRACTED SECTION (CFS)	=	1950.
WIDTH OF CONTRACTED SECTION (FT)	=	34.0
MEDIAN GRAIN SIZE (FT)	=	0.0012

COMPUTED DEPTH OF CONTRACTED SECTION (FT)	=	27.9
AVERAGE FLOOD PLAIN DEPTH (FT)	=	20.7
DEPTH OF CONTRACTION SCOUR (FT)	=	7.2

ABUTMENT SCOUR COMPUTATIONS

FOR

Sandy River at SC 215 in Chester County, SC Structure 124021500200

RIGHT ABUTMENT SCOUR COMPUTATIONS

ABUTMENT TYPE	3 -SPILL THROUGH
DISCHARGE BLOCKED BY ABUTMENT (CFS)	1350.
AREA BLOCKED BY ABUTMENT (SQ FT)	1140.0
DEPTH OF FLOW AT ABUTMENT (FT)	19.0
LENGTH OF ABUT. 90 DEG. TO FLOW (FT)	83.0
ABUTMENT SKEW (DEG)	12
AJUSTED ABUTMENT LENGTH (FT)	60.0
AVERAGE F/P VELOCITY U/S OF ABUT. (FPS)	1.2
FROUDE NUMBER	0.048
K1 COEF.	0.6
K2 COEF.	1.0
DESIGN DEPTH OF SCOUR (FROELICH EQUATION, 1989) (FT)	= 25.2

PIER SCOUR COMPUTATIONS

FOR

Sandy River at SC 215 in Chester County, SC Structure 124021500200
Q500 scour computations including bents 2 through 9 JMS 14 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	lfp	lfp	lfp	lfp	lfp	lfp	lfp
Y1: DEPTH (FT)	16.8	27.8	22.4	21.0	21.8	21.0	18.0	22.4
V1: VEL. (FPS)	3.5	3.5	3.5	3.5	3.5	3.5	3.5	3.5
a: PIER WIDTH (FT)	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9
L: PIER LENGTH (FT)	3.4	3.4	3.4	3.4	3.4	3.4	3.4	3.4
PIER SHAPE	1	1	1	1	1	1	1	1
ATTACK ANGLE	12	12	12	12	12	12	12	12
K1 (SHAPE COEF.)	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
K2 (ANGLE COEF.)	1.40	1.40	1.40	1.40	1.40	1.40	1.40	1.40
FROUDE NO.	0.15	0.12	0.13	0.13	0.13	0.13	0.15	0.13

COMPUTED SCOUR DEPTHS USING CSU EQUATION

SCOUR DEPTH (FT)	3.00	3.21	3.12	3.09	3.11	3.09	3.03	3.12
MAX SCOUR DEPTH (FT)	3.30	3.53	3.43	3.40	3.42	3.40	3.33	3.43

Q500 scour computations including bents 10 through 15 JMS 14 Sept. 1994

HYDRAULIC VARIABLES USED IN CSU EQUATION

PIER NUMBER	10	11	12	13	14	15
PIER STATION (FT)	270	300	330	360	390	420
LOCATION OF PIER	ltb	mcl	mcm	mcr	rfp	rfp
Y1: DEPTH (FT)	36.0	36.0	36.0	36.0	25.2	18.6
V1: VEL. (FPS)	3.5	3.5	3.5	3.5	3.4	3.4
a: PIER WIDTH (FT)	0.9	2.5	2.5	2.5	0.9	0.9
L: PIER LENGTH (FT)	3.4	10.0	10.0	10.0	3.4	3.4
PIER SHAPE	1	2	2	2	1	1
ATTACK ANGLE	12	12	12	12	12	12
K1 (SHAPE COEF.)	1.00	1.00	1.00	1.00	1.00	1.00
K2 (ANGLE COEF.)	1.40	1.40	1.40	1.40	1.40	1.40
FROUDE NO.	0.10	0.10	0.10	0.10	0.12	0.14

COMPUTED SCOUR DEPTHS USING CSU EQUATION

SCOUR DEPTH (FT)	3.31	6.67	6.67	6.67	3.11	2.98
MAX SCOUR DEPTH (FT)	3.64	7.34	7.34	7.34	3.42	3.28

"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 215 in Chester County, SC Structure 124021500200

LIVE-BED SCOUR COMPUTATIONS

	MAIN CHANNEL	CONTRACTED SECTION
DISCHARGE (CFS)	16450.	11160.
BOTTOM WIDTH (FT)	97.0	102.1
MANNINGS n	0.045	0.045
AVERAGE DEPTH (FT)	35.5	

ENERGY SLOPE	0.00026
D50 (FT)	0.0036
FALL VELOCITY (FPS)	0.54
K1 COEF.	0.64
K2 COEF.	0.21

COMPUTED DEPTH AT CONTRACTED SECTION (FT)	=	24.6
DEPTH AT MAIN CHANNEL (FT)	=	35.5
DEPTH OF CONTRACTION SCOUR (FT)	=	-10.9

LEFT OVERBANK IN BRIDGE OPENING
CLEAR-WATER CONTRACTION SCOUR COMPUTATIONS

DISCHARGE IN CONTRACTED SECTION (CFS)	=	12220.
WIDTH OF CONTRACTED SECTION (FT)	=	224.0
MEDIAN GRAIN SIZE (FT)	=	0.0012

COMPUTED DEPTH OF CONTRACTED SECTION (FT)	=	26.8
AVERAGE FLOOD PLAIN DEPTH (FT)	=	20.5
DEPTH OF CONTRACTION SCOUR (FT)	=	6.3

RIGHT OVERBANK IN BRIDGE OPENING
CLEAR-WATER CONTRACTION SCOUR COMPUTATIONS

DISCHARGE IN CONTRACTED SECTION (CFS)	=	2870.
WIDTH OF CONTRACTED SECTION (FT)	=	34.0
MEDIAN GRAIN SIZE (FT)	=	0.0012

COMPUTED DEPTH OF CONTRACTED SECTION (FT)	=	38.9
AVERAGE FLOOD PLAIN DEPTH (FT)	=	25.5
DEPTH OF CONTRACTION SCOUR (FT)	=	13.4

ABUTMENT SCOUR COMPUTATIONS

FOR

Sandy River at SC 215 in Chester County, SC Structure 124021500200

RIGHT ABUTMENT SCOUR COMPUTATIONS

ABUTMENT TYPE	3 -SPILL THROUGH
DISCHARGE BLOCKED BY ABUTMENT (CFS)	1990.
AREA BLOCKED BY ABUTMENT (SQ FT)	1590.0
DEPTH OF FLOW AT ABUTMENT (FT)	23.6
LENGTH OF ABUT. 90 DEG. TO FLOW (FT)	105.0
ABUTMENT SKEW (DEG)	12
AJUSTED ABUTMENT LENGTH (FT)	67.4
AVERAGE F/P VELOCITY U/S OF ABUT. (FPS)	1.3
FROUDE NUMBER	0.045
K1 COEF.	0.6
K2 COEF.	1.0
DESIGN DEPTH OF SCOUR (FROELICH EQUATION, 1989) (FT)	= 30.7

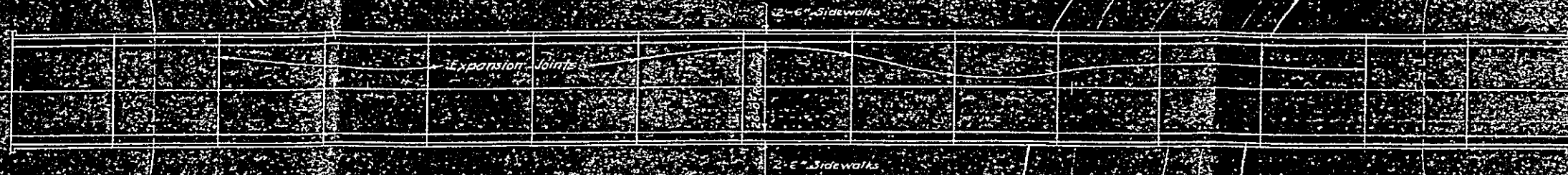


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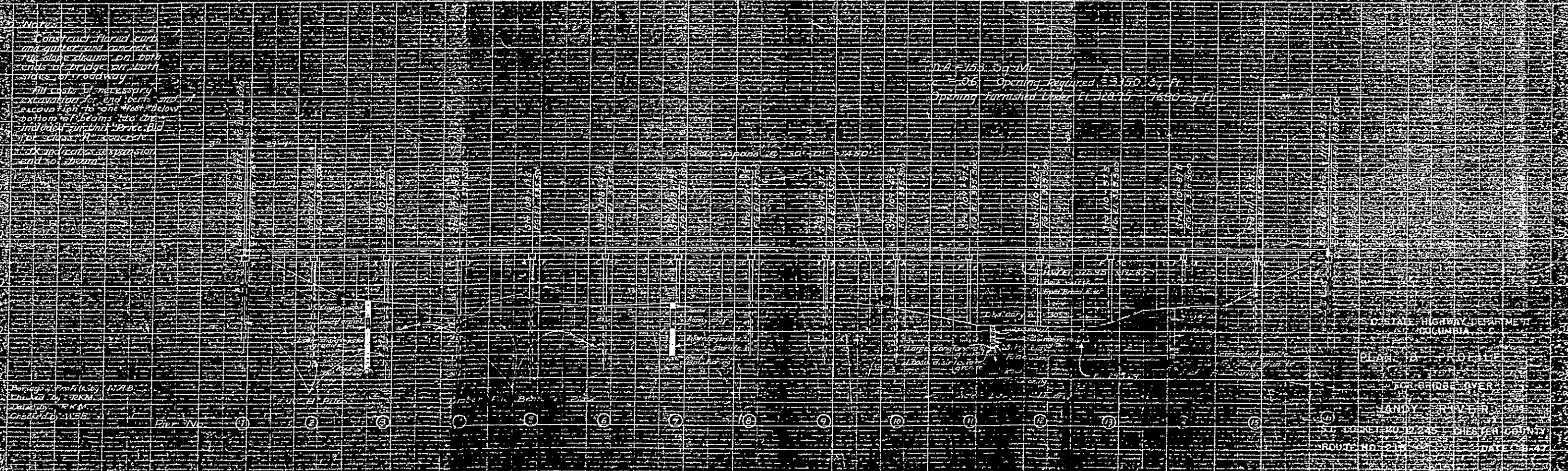
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450' Timber Bridge 20' wide
in place to be removed

SANDY RIVER



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

PLAN - 15 - PROPOSED

FOR BRIDGE OVER

SANDY RIVER

ST. DUNSTON 2235 DIST. 1000

ROUTE NO. 215

