SCOUR EVALUATION

FOR

SOUTH CAROLINA DEPARTMENT OF HIGHWAYS AND PUBLIC TRANSPORTATION

ON

STRUCTURE # 132000100800
US-1 OVER THOMPSON CREEK
CHESTERFIELD COUNTY, SC

Prepared by:

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Charlotte, NC 28204

October 1994

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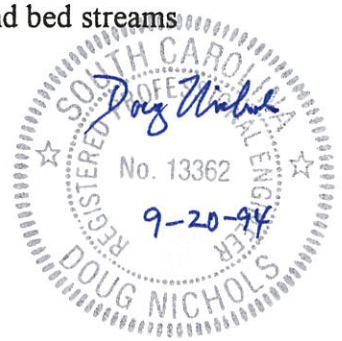


SCOUR EVALUATION FOR US-1 OVER THOMPSON CREEK

1.0 STREAM STABILITY

1.1 Stream Characteristics

The stream characteristics were investigated in the field and recorded on Figure 1 and on forms contained in Appendix 1.

A portion of the USGS Quad map is presented as Figure 2 for location purposes.

1.2 Land Use Changes

The bridge site is approximately 2.3 miles south of the town of Cheraw, South Carolina. The land use in the basin is of a rural character. No future land use changes are expected for the life of the structure.

1.3 Overall Stream Stability

The overall stream stability appears to be generally stable. The 2-Year discharge and the stream slope have been plotted in the transitional zone on Figure 3 (Figure 8 in HEC-20). This shows that a sand bed stream at this site would be in transition between a meandering and braided pattern. The actual stream conditions include dense vegetation which will influence the behavior of the stream.

1.4 Lateral Stability

The stream alignment is skewed about 15° to the bridge opening. Photographs of the site are presented in Appendix 2. Photographs show that the stream banks are vegetated and generally stable during average flow conditions. A cut bank was observed on the southern channel bank which may have a tendency to shift toward the south in the future.

1.5 Vertical Stability

The stream bed profile is relatively stable. This is evidenced by similar channel depths shown on the 1930 construction plans and the soundings performed for this report.

1.6 Channel Response to Change

The channel may still be responding to the change resulting from the construction of the bridge. No site changes are anticipated at this time which would further influence the stream behavior.

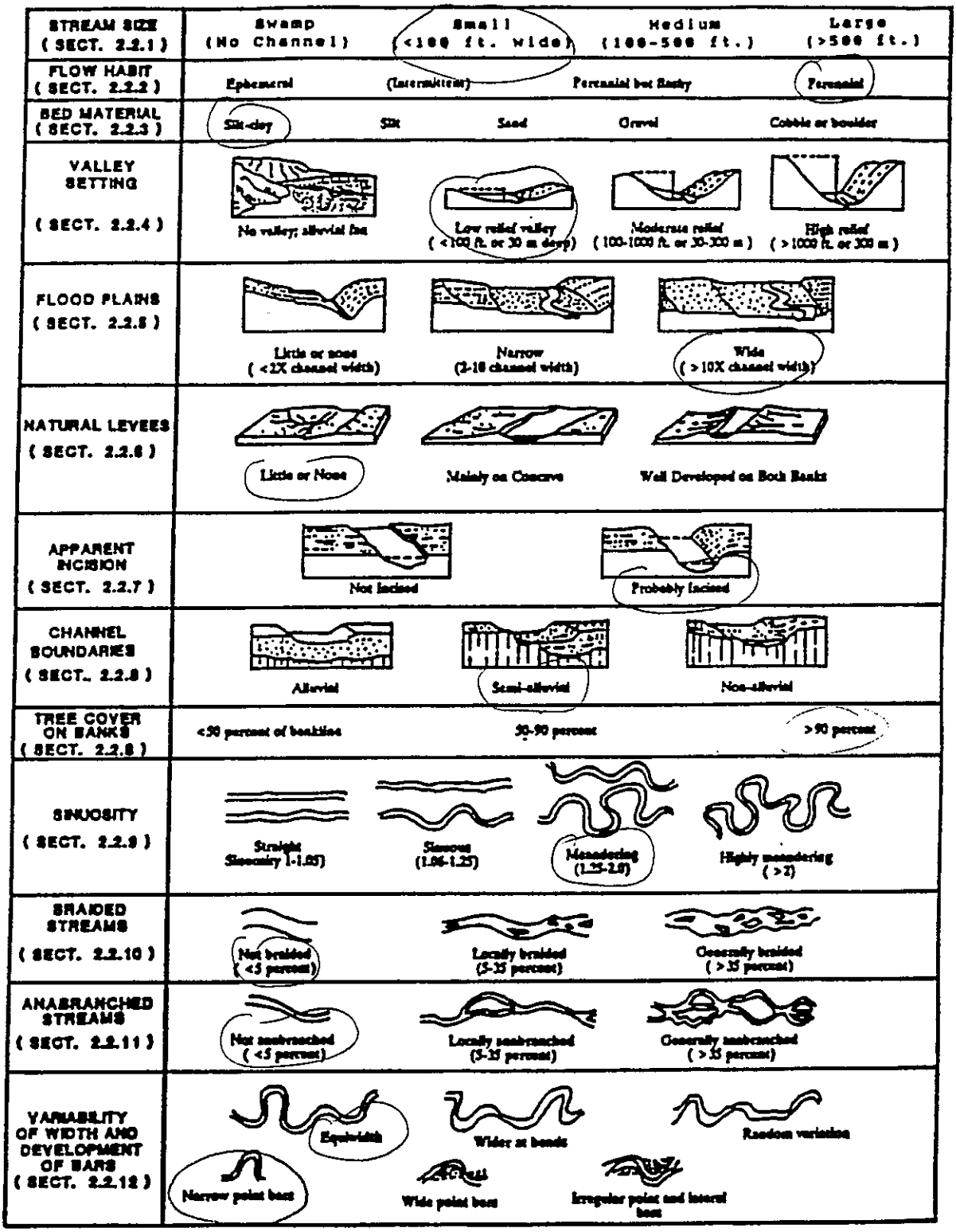
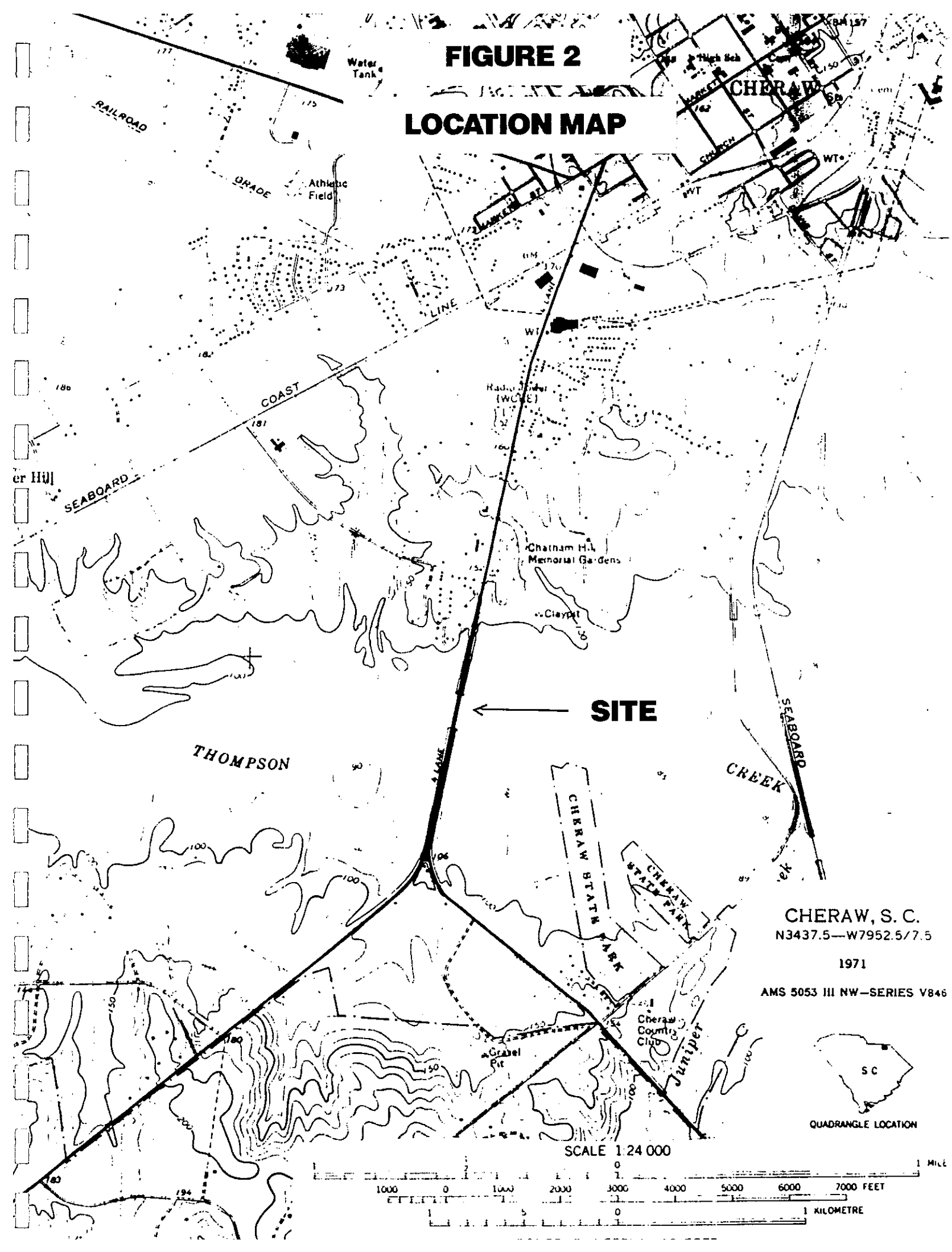


Figure 1. Geomorphic factors that affect stream stability (From HEC-20)

FIGURE 2

LOCATION MAP



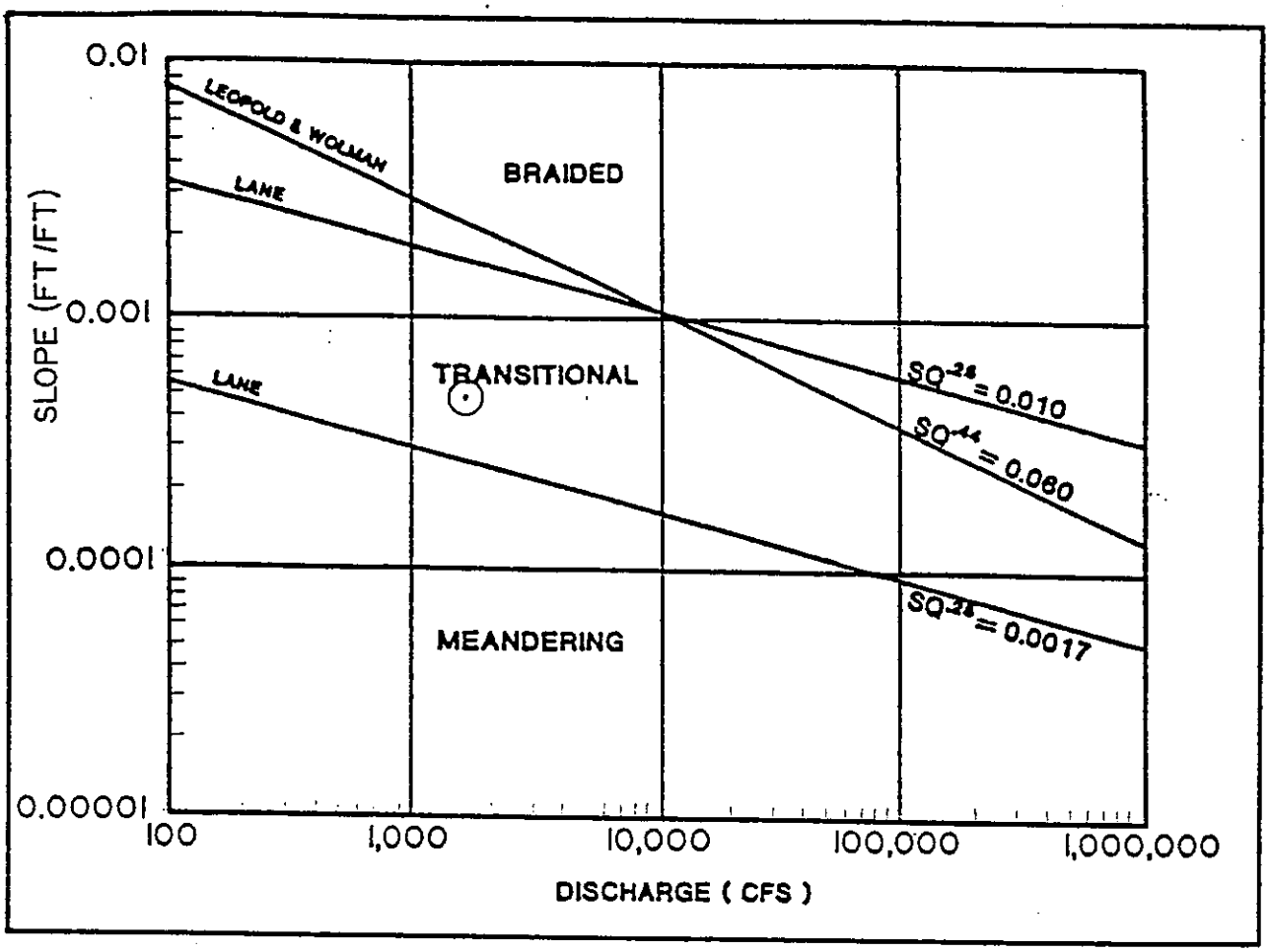


Figure 3. Slope-discharge relationship for braiding or meandering in sand bed streams (Figure 8 in HEC-20)

2.0 SCOUR ANALYSES

2.1 Flood History and Rainfall-Runoff Relations

The 1930 bridge construction plans show a 1928 H.W. El. = 431.1 FT MSL. This water surface elevation is significantly different from the elevation that was calculated for the 100-year storm by the WSPRO computer program. The reason for this difference is likely the result of backwater from the Pee Dee River.

The rainfall-runoff relations were obtained using the USGS Report 91-4157 titled "Techniques for Estimating Magnitude and Frequency of Floods in South Carolina, 1988". The results of the regression equations for the Lower Coastal Plain are listed below:

Frequency (years)	Regression Equation Flowrate (cfs)
2	1592
10	3174
25	4069
50	4934
100	5578
500	7274

2.2 Hydraulic Conditions

The hydraulic conditions were investigated using the WSPRO computer program and the bridge geometry measured in the field. The approach and exit cross sections were developed by combining the channel geometry from the bridge soundings and the flood plain geometry from the 1930 centerline profile. The soundings were taken from the upstream face of the bridge which is also representative of the downstream face of the bridge.

The results of the computer analysis show that the bridge opening is within the limits that would be allowed for a new bridge at this site. The existing bridge creates 0.30 feet of backwater and has a velocity of 2.0 fps in the bridge opening. Standard design practice for South Carolina is 1.0' backwater and 5 fps maximum for the 100-year event.

2.3 Bed and Bank Material Analysis

The field investigation visually identified the bed and bank materials as clayey silt.

2.4 Watershed Sediment Yield Evaluation

The sediment yield for the watershed appears to be relatively stable as evidenced by the consistent stream bed geometry. A rural well vegetated drainage basin such as this one is generally characterized by relatively low sediment yields and discharge rates.

2.5 Rating Curve Shifts

Rating curve shifts have not been investigated at this time at the direction of SCDHPT.

2.6 Scour Condition Evaluation

The scour conditions were evaluated using the WSPRO computer program and the scour equations presented in HEC-18. The WSPRO computer output and the scour calculations are presented in Appendix 3. The results of the scour calculations have been summarized in Table 1.

The scour calculations for the bridge show severe scour depths. This is mostly due to the 20 degree skew of the bents relative to the flow direction and the large amount of flood plain that is blocked by the abutments.

The thalweg for this stream could shift to Bents 15 thru 19 during the life of the structure. For this reason, the ground elevation for these bents was assumed to be the thalweg elevation.

The results of the scour calculations show that scour could undermine the piles if they are driven in erodible material. The elevation datum for the 1930 and 1959 construction plans are different. The datum for the 1930 plans was used for this report since these plans had a good profile of the flood plain. Pile length data for the 1930 construction plans was called out as "El. Bottom of Footing". The 1959 construction plans called out "Avg. Elevs. existing pile tips" but they were deeper than those shown on the 1930 plans. A discrepancy exists between these two sources of pile tip information and this discrepancy will need to be resolved by SCDOT. The 1930 plans had the shallowest pile tip elevations and these elevations were used in Table 1. The in-place pile lengths for each pile were also available from the pile record summary sheet for the 1959 construction. These pile tips were considerably deeper than the 1930 pile tips. Pile length data was not available for the widening which occurred after 1959. A geotechnical and structural review of the information will be needed to determine if the foundations are stable.

2.7 Recommendations

We recommend a structural engineer and a geotechnical engineer review the scour conditions at this site to determine if the stability of the bridge can be determined with the currently available information. The geotechnical engineer will need to determine if the calculated scour depths can be reduced due to erosion resistant material. The recommendations of the geotechnical engineer should then be given to a structural engineer for a structural stability analysis. The structural engineer should review the pile length data to determine the individual pile lengths. Particular attention should be given to confirming the 1930 pile tip elevations and determining the post 1959 widening pile tip elevations.

The abutments are protected with 12-inch stone. The quantity and size of stone appears to meet the current SCDOT standards for new construction.

Table 1 - Remaining pile/footing penetration at piers/bents for structure 132000100800 on Route US-1, crossing Thompson Creek in Chesterfield County, South Carolina

Pier/bent[1] number	Station[1]	Pile tip[2] elevation (feet)	Ground elevation at pier/bent (feet)	Total[3] scour depth (feet)	Elevation of scour (feet)	Remaining[4] pile penetration (feet)
100-year discharge is 5578 cfs - 500-year discharge is 7274 cfs						
Scour Information for 100-Year Storm:						
1	9400	407.1	434.4	0	434.4	27.2
2	9425	407.1	424.3	10.1 1.3+2.4+6.4	414.2	7.0
3	9450	407.1	415.6	10.1	405.5	-1.7
4	9475	407.1	416.3	3.7 1.3+2.4	412.6	5.4
5	9500	407.1	416.5	3.7	412.8	5.6
6	9525	407.1	416.7	3.7	413.0	5.8
7	9550	407.1	416.4	3.7	412.7	5.5
8	9575	407.1	415.1	3.7	411.4	4.2
9	9600	407.1	415.2	3.7	411.5	4.3
10	9625	407.1	415.5	3.7	411.8	4.6
11	9650	407.1	415.6	3.7	411.9	4.7
12	9675	407.1	415.3	3.7	411.6	4.4
13	9700	407.1	415.0	3.7	411.3	4.1
14	9725	405.1	415.4	3.7	411.7	6.5
15	9750	402.1	404.7	11	393.7	-8.4
16	9775	398.1	404.7	11	393.7	-4.5
17	9800	398.1	404.7	11	393.7	-4.5
18	9825	400.1	404.7	11	393.7	-6.5
19	9850	402.1	404.7	11	393.7	-8.5
20	9875	405.1	415.7	3.7	412.0	6.8
21	9900	407.1	415.8	3.7	412.1	4.9
22	9925	407.1	414.6	3.7	410.9	3.7
23	9950	407.1	413.8	3.7	410.1	2.9
24	9975	407.1	412.9	3.7	409.2	2.0
25	10000	407.1	416.5	10.1	406.4	-0.8
26	10025	407.1	424.9	10.1	414.8	7.6
27	10050	407.1	432.2	0	432.2	25.0
Scour Information for 500-Year Storm:						
1	9400	407.1	434.4	0	434.4	27.2
2	9425	407.1	424.3	13.2	411.1	3.9
3	9450	407.1	415.6	13.2	402.4	-4.8
4	9475	407.1	416.3	5.3	411.0	3.8
5	9500	407.1	416.5	5.3	411.2	4.0
6	9525	407.1	416.7	5.3	411.4	4.2
7	9550	407.1	416.4	5.3	411.1	3.9
8	9575	407.1	415.1	5.3	409.8	2.6
9	9600	407.1	415.2	5.3	409.9	2.7
10	9625	407.1	415.5	5.3	410.2	3.0
11	9650	407.1	415.6	5.3	410.3	3.1
12	9675	407.1	415.3	5.3	410.0	2.8
13	9700	407.1	415.0	5.3	409.7	2.5
14	9725	405.1	415.4	5.3	410.1	4.9
15	9750	402.1	404.7	12.9	391.8	-10.0

Pier/bent[1] number	Station[1]	Pile tip[2] elevation (feet)	Ground elevation at pier/bent (feet)	Total[3] scour depth (feet)	Elevation of scour (feet)	Remaining[4] pile penetration (feet)
100-year discharge is 5578 cfs - 500-year discharge is 7274 cfs						
Scour Information for 500-Year Storm: (contd.)						
16	9775	398.1	404.7	12.9	391.8	-6.4
17	9800	398.1	404.7	12.9	391.8	-6.4
18	9825	400.1	404.7	12.9	391.8	-8.4
19	9850	402.1	404.7	12.9	391.8	-10.4
20	9875	405.1	415.7	5.3	410.4	5.2
21	9900	407.1	415.8	5.3	410.5	3.3
22	9925	407.1	414.6	5.3	409.3	2.1
23	9950	407.1	413.8	5.3	408.5	1.3
24	9975	407.1	412.9	5.3	407.6	0.4
25	10000	407.1	416.5	13.2	403.3	-3.9
26	10025	407.1	424.9	13.2	411.7	4.5
27	10050	407.1	432.2	0	432.2	25.0

[1]Pier/bent number and stations correspond to South Carolina Department of Transportation bridge plans.
[2]Pile tip elevations obtained from SCDOT bridge plans. Shortest pile length listed.
[3]Total scour depth is the sum of the contraction, pier/bent and abutment scour depths.
[4]A negative number signifies undermining of pile tip/footing.

APPENDIX 1

FIELD INFORMATION

HYDRAULIC DESIGN
AND
RISK ASSESSMENT FOR
BRIDGE/BRIDGE REPLACEMENT OVER
stream name THOMPSON CREEK
ROUTE/ROAD NUMBER US. No. 1
FILE NO._____ PROJECT NO. 291-A
CHESTERFIELD COUNTY, SOUTH CAROLINA

STRUCTURE # 13200010008OO

DATE

9-1-94

Prepared By DOUG N/STEPHEN F
Checked By _____

Signed and Sealed

PROJECT DESCRIPTION

County CHESTERFIELD Rt./Rd. No. US-1
Stream THOMPSON CREEK File No. N/A Project No. 291-A
PIN _____ Charge Code _____
Project Engineer Doug Nichols Road Squad _____

COMPARATIVE DATA

By S.F Date 9/6/94 Checked DYN Date 9-26-94

ROUTE/ROAD NO.	S-22	US 1	S-148	
DIST. FROM NEW BR. (MI.)	4.5 mi	-	2.3 mi	
DRAINAGE AREA (SQ. MI.)	260	274	277	
ZONE	UPPER COASTAL PLAIN			
Q_{10}	3058	3174	3199	
Q_{25}	3923	4069	4100	
Q_{50}	4756	4934	4972	
Q_{100}	5380	5578	5620	
Q_{500}	7026	7274	7326	
BRIDGE LENGTH (FT.)	479.7	650.0	120.0	
AVG. F. G. (FT.)	NA	10%	NA	
OPENING FURN.(SQ.FT.)	6859	11940	1736	
VELOCITY (FT./SEC.)	0.78	0.47	3.2	
HIGH-WATER ELEV. (FT.)	N/A	431.1	N/A	
HIGH-WATER DATE	7/30/94	1928	7/30/94	
HIGH-WATER DEPTH	14.2	27.0	14.6	
NORMAL-WATER ELEV. (FT.)	N/A	NA	N/A	
NORMAL-WATER DATE	8/30/94	8/30/94	8/30/94	
NORMAL-WATER DEPTH	6.8	4.8	7.0	
FILE/DOCKET/PROJ. NO.	N/A	13,362	F-291(8)	
LOCATION OF PLANS	SCDOT	SCDOT	SCDOT	
DATUM/DATUM TIE	N/A	MSL	N/A	
FLOODWAY MAP				

SITE INSPECTION

County CHESTERFIELD Rt/Rd No. US. Alt. 1 Date 8/30/94
Stream THOMPSON CREEK PIN _____
By DOUG NICHOLS STEPHEN FRECH

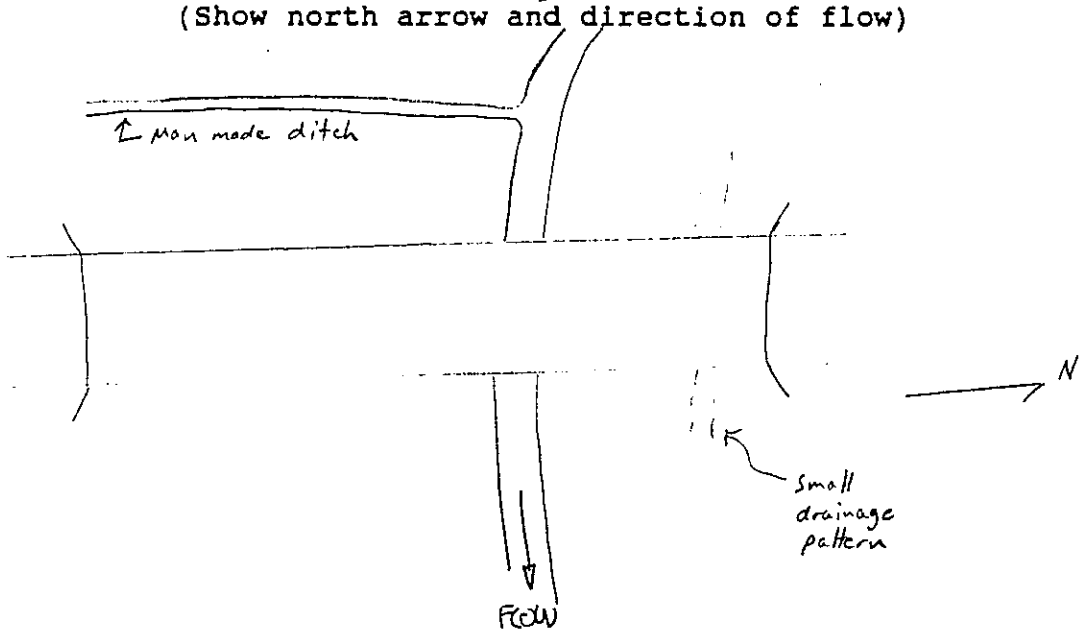
Note: All references to left and right are looking in the direction of flow.

EXISTING BRIDGE

Length 650 Ft. Width 91.8 out to out Ft. Max. Span Length 25 FT.
Alignment (Tangent)/Curved Bridge skewed Yes/(No) Angle _____
End Abutment Type Spill Thru
Riprap on Fills? Yes/No Condition Yes Excellent $D_{50} = 1.0$ ft
Superstructure Type Reinforced Concrete Girders
Substructure Type Concrete Piles 18" □
Utilities Present Yes/No Describe Overhead power along downstream RW. Telephone is hung along upstream face of bridge

Debris accumulations on bridge, percent channel blocked horizontal 1 Percent channel blocked vertical 1
Hydraulic Problems? (Yes)/No Describe The southern channel bank is a cut bank likely caused by the slight curve in the channel alignment. The channel may have a tendency to shift toward the south with time.

Draw Sketch of Bridge and Stream Below
(Show north arrow and direction of flow)



Site Characteristics

General Topography small hills and gentle slopes
Stream Type (circle one) Straight, Braided, or (Meandering)
Are Channel banks Stable? Yes (No) If No, Describe
The southern channel bank is a cut bank. Otherwise the banks are well vegetated.
Are there any Hydraulic Controls Upstream or Downstream? (Yes) No
Describe Pee Dee River is relatively close to the site and it's backwater will likely extend to the site.

Soil type clayey silt Exposed Rock Yes (No) If so, give description and location

Describe potential for drift Moderate

Give description and location of any structures or other property that could be damaged by backwater None

Describe any other features that might affect or be affected by the hydraulic performance of the proposed bridge Small ponds exist upstream that may affect the flowrate slightly.

Mannings "n" Values

Channel

$$n = (n_b + n_1 + n_2 + n_3 \; n_4)\, m$$

n_b -- Base n for soil	Earth	.020	
	Rock Cut	.025	
	Fine Gravel	.024	
	Course Gravel	.028	
n_1 -- Degree of Irregularity	Smooth	.000	
	Minor	.001	-.005
	Moderate	.006	-.010
	Severe	.011	-.020
n_2 -- Variations of Channel Cross Sections	Gradual	.000	
	Alternating occasionally	.001	-.005
	Frequently	.010	-.015
n_3 -- Relative Effect of Obstructions	Negligible	.000	-.004
	Minor	.010	-.015
	Appreciable	.020	-.030
	Severe	.040	-.060

n_4 -- Vegetation	Low	.002-.010
	Medium	.010-.025
	High	.025-.050
	Very High	.050-.100
m -- Degree of Meandering	Minor	1.00
	Appreciable	1.15
	Severe	1.30

Field Observations
for Channel

		Channel Depth	n_b	n_1	n_2	n_3	n_4	m	Computed n
22	UPS. FLOOD	PLAIN WIDTH	0.020	0.005	0.0	0.005	0.01	1.00	0.04
		AT BRIDGE	0.020	0.005	0.0	0.005	0.01	1.00	0.04
148	DOWNS. FLOOD	PLAIN WIDTH	0.020	0.005	0.0	0.005	0.01	1.00	0.04

Mannings "n"
For Over Bank Areas

$$n = n_b + n_1 + n_3 + n_4$$

n_b -- Base n for soil	Earth	.020
	Rock Cut	.025
	Fine Gravel	.024
	Course Gravel	.028
n_1 -- Degree of Irregularity	Smooth	.000
	Minor	.001-.005
	Moderate	.006-.010
	Severe	.011-.020
n_3 -- Effect of Obstructions	Negligible	.000-.004
	Minor	.005-.019
	Appreciable	.020-.030
n_4 -- Amount of Vegetation	Small	.001-.010
	Medium	.011-.025
	Large	.025-.Very Large

Field Observations
For Over Bank Areas

	Location	Depth	n_b	n_1	n_3	n_4	Computed n
U.S.1	FLOOD PLAIN WIDTH		0.020	0.01	0.0	0.15	0.18
	AT BRIDGE		0.020	0.01	0.02	0.01	0.06
D.S.1	FLOOD PLAIN WIDTH		0.020	0.01	0.0	0.15	0.18

STREAM BED SOUNDINGS

BRIDGE NO. 320001008000 COUNTY CHESTERFIELD DATE 8-30-94 BY Doug N. / Stephen F.

RECORD SOUNDINGS FROM TOP OF RAIL. OTHER LOCATION IF NEEDED: _____

DISTANCE H. W. MARK TO TOP OF RAIL 16.1 LOCATION H. W. MARK Bent 23 Water Stain

Continuation of US [redacted] North End South bound PGL to Top of Rail = 2.2 UPSTREAM 0+00 = FF

STATION	SOUNDING	DESCRIPTION	STATION	SOUNDING	DESCRIPTION
Continuation from right		column	0+01	4.3	North Upstream Lower Chord
2+23.7	23.2	Just Before Bent 9	0+02	5.7	
36.7	23.2		+14	9.9	
48.5	23.1	Just Before Bent 10	+23.6	14.4	Just before Bent 1 (1.2')
63.5	23.2		+31.7	17.8	
73.5	23.4	Just Before Bent 11	41.3	21.2	
88.4	23.7		48.7	23.1	Just before Bent 2
98.5	23.7	Just Before Bent 12	51.4	24.1	Edge H_2O LEW
3+13.5	23.4		53.4	25.1	
23.7	23.3	Just Before Bent 13	62	24.3	Edge H_2O
37	23.4		73.7	22.4	Just Before Bent 3
48.6	23.7	Just Before Bent 14	88.6	22.5	
54.7	24.9		98.7	22.2	Just Before Bent 4
59.3	24.1		1+12.2	22.1	
67.4	24.1		23.7	22.0	Just Before Bent 5
73.4	24.3	Just Before Bent 15	37	22.1	
82	25.4		48.7	22.3	Just Before Bent 6
85.7	28.3		64.4	22.8	
88.5	29.2	Edge H_2O	73.5	23.6	Just Before Bent 7
93.4	31.0		87.8	23.6	
96.5	31.2		98.7	23.5	Just Before Bent 8
98.5	32.8	Just Before Bent 16	2+13.8	23.3	

STREAM BED SOUNDINGS

BRIDGE NO. 132000100800 COUNTY CHESTERFIELD DATE 8-30-94 BY DOUG N./STEPHEN F.

RECORD SOUNDINGS FROM TOP OF RAIL. OTHER LOCATION IF NEEDED: _____

DISTANCE H. W. MARK TO TOP OF RAIL 16.1 LOCATION H. W. MARK BENT 23 WATER SIDE

~~DOWNSTREAM~~ Continuation of us PGL to Top of Rail = 22 UPSTREAM

STATION	SOUNDING	DESCRIPTION	STATION	SOUNDING	DESCRIPTION
Continuation from Right Column			4+04.2	33.0	~~Lower Chord~~
6+07.7	20.4	Fill Toe	4+09.0	33.2	
16.5	16.5		12.4	33.2	
23.7	13.8	Just Before Bent 25	19.1	31.4	
35.7	9.3		23.5	30.9	Just Before Bent 17
48.6	6.5	Just Before EB South	30.5	33.9	
6+50	—	FF U.S. South	35.4	34.0	
			38.7	26.4	
			43.2	24.5	
			48.7	24.5	Just Before Bent 18
			63.3	23.7	
			73.7	23.0	Just Before Bent 19
			87.7	22.2	
			98.6	22.9	Just Before Bent 20
			5+13.2	23.7	
			23.7	24.1	Just Before Bent 21
			38.4	24.4	
			48.8	24.9	Just Before Bent 22
			63.5	24.8	
			73.8	25.8	Just Before Bent 23
			87.3	23.7	
			98.8	22.2	Just Before Bent 24

COMPARATIVE

STREAM BED SOUNDINGS

BRIDGE NO. Upst Down Stream Bridges COUNTY CHESTERFIELD DATE 8-30-94 BY Doug N / Stephen F

RECORD SOUNDINGS FROM TOP OF RAIL. OTHER LOCATION IF NEEDED: S-148 = 14.2

DISTANCE H. W. MARK TO TOP OF RAIL S-22 = 17.0 LOCATION H. W. MARK Mud on leaves near channel Near EB-1 Debris

S-148 S-148 PGL to Top of Rail = 2.2

~~DOWNSTREAM~~ upstream S-22 PGL to Top of Rail = 2.4 UPSTREAM S-22

STATION	SOUNDING	DESCRIPTION	STATION	SOUNDING	DESCRIPTION
0+00		N. FF	0+00.7	4.8	East EB Lower Chord
0+01	3.9	N. Lower Chord	0+03.6	5.1	
12.9	4.3	Top Vert Abut	33	18.2	Toe Fill
19.2	14.2	Bot. Vert Abut	51	19.0	
28.5	17.1	TB	76	18.6	
30.0	17.6	℄ B-1	1+57	19.6	
33.9	21.8	Edge H_2O	2+08.4	20.3	TB
43.2	27.2		14.5	24.3	Edge H_2O
51.8	28.6		38	28.0	
60	26.4	℄ B-2	58	31.2	
72.9	28.8		82	28.9	
81.8	25.8		3+04.3	24.4	Edge H_2O
90	24.6	℄ B-3	9.5	19.0	
96.4	21.8	Edge H_2O	41.0	16.2	
1+00.6	20.5	Bot. Vert Abut	4+09.0	17.1	
1+04.7	4.2	Top. Vert Abut	53.8	15.5	Toe Fill
1+20		FF South	73.0	4.8	
			4+79.7		FF West

SHEET 1 OF 1

COMPARATIVE BRIDGE SITE INSPECTION FORM

County CHESTERFIELD Rt/Rd No. S-148
Stream THOMPSON CREEK Measured bridge length 120 FT

Maximum span length 30 ft Superstructure type C Beams

Substructure type Wooden Piles End Abutment type Vert. Abut.

Rip-rap present? Yes (No) Condition None

Stream type (circle one) Straight, Braided, (Meander), or Anabranched. (Alluvial) or Rock. (circle)

Any visible signs of scour problems (describe) Yes. Southern End Bent has channel migration toward it. Future undermining possible

Are banks stable (describe) Yes well vegetated

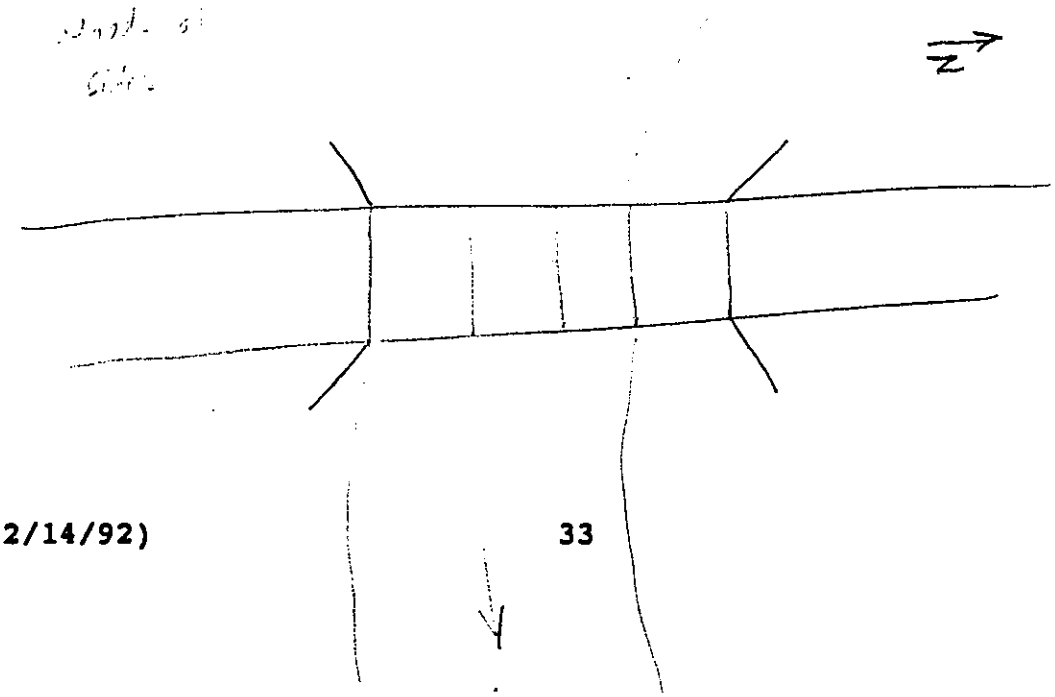
Debris blockage; Percent of channel blocked horizontally 1

vertically 1. Describe other signs of debris

Log jamb downstream

Any other problems None

Draw sketch and indicate problem areas. On sketch indicate location of woods, fields and other land uses in the vicinity of bridge. Show north arrow and direction of flow.



Draft (9/22/92)

COMPARATIVE BRIDGE SITE INSPECTION FORM

County CHESTERFIELD Rt/RdNo. S-22
Stream THOMPSON CREEK Measured Bridge length 479.7 Ft

Maximum Span length NA Superstructure Type RC Girders

Substructure type Concrete Piles End Abutment type Spill Thru

Rip-rap present? Yes/No Condition Yes Good - Only beneath bridge

Stream type (circle one) Straight, Braided, (Meander,) or Anabranched. (Alluvial) or Rock. (circle)

Any visible signs of scour problems (describe) No

Are banks stable (describe) Yes Well Vegetated

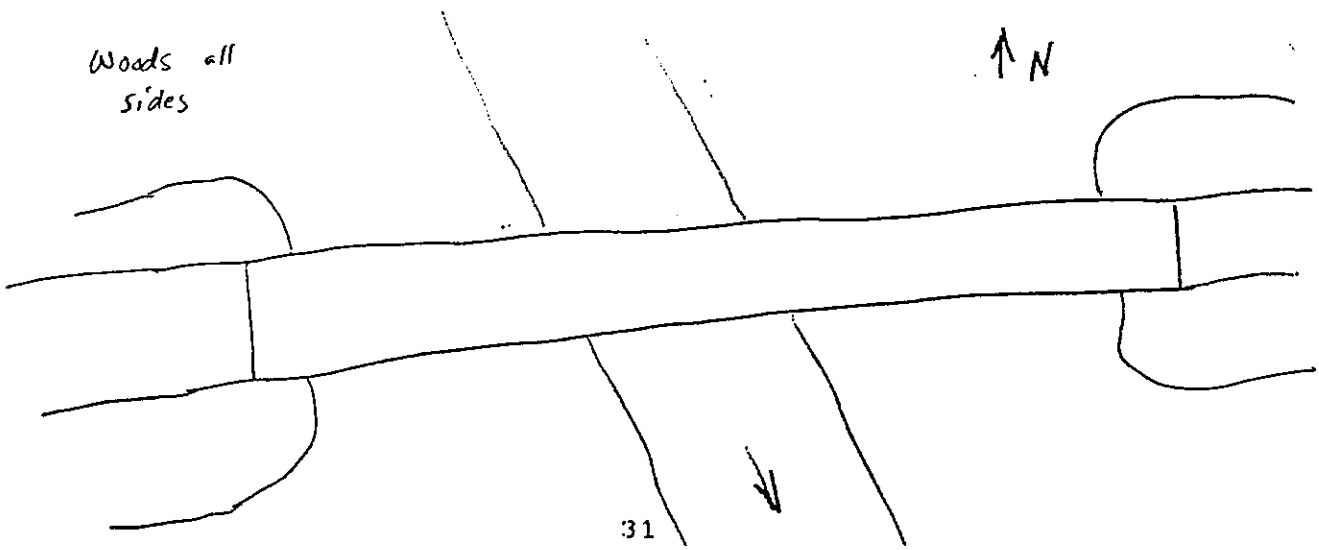
Debris blockage; Percent of channel blocked horizontally 5

vertically 5. Describe other signs of debris

Log jamb upstream

Any other problems No

Draw sketch and indicate problem areas. On sketch indicate location of woods, fields and other land uses in the vicinity of bridge. Show north arrow and direction of flow.



Flood History

Local resident's name : John Gantt
address: 100 English Lane 29520
Phone # : 537-9860
Period of knowledge: 7 Yrs
High water mark location: 3 to 6' deep in floodplain
Date of occurrence : Usually in August
Frequency of flooding : out of banks twice a year

APPENDIX 2

PHOTOGRAPHS

US-1 OVER THOMPSON CREEK
Chesterfield County

(1) Looking north

(2) Upstream side looking north

US-1 OVER THOMPSON CREEK
Chesterfield County

(3) Looking upstream

(4) Upstream side looking south

US-1 OVER THOMPSON CREEK
Chesterfield County

(5) Looking upstream

(6) Underside of original and widened bridge

US-1 OVER THOMPSON CREEK
Chesterfield County

(7) Upstream side of End Bent 2

(8) Scour at Bent 23

US-1 OVER THOMPSON CREEK
Chesterfield County

(9) Upstream side of End Bent 1

(10) Looking downstream

US-1 OVER THOMPSON CREEK
Chesterfield County

(11) Looking downstream

(12) Downstream side looking north

APPENDIX 3

WSPRO COMPUTER DATA
and
SCOUR CALCULATIONS

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SPRO          FEDERAL HIGHWAY ADMINISTRATION - U. S. GEOLOGICAL SURVEY
060188            MODEL  FOR  WATER-SURFACE  PROFILE  COMPUTATIONS
                   (Input modified to free format by GKY&A 01/92)

           *** RUN DATE & TIME: 09-22-94  09:14

  T1       STR. NO. 132000100800 CHESTERFIELD CO.

  T2       US-1 OVER THOMPSON CREEK

  *F

  Q        5578.3       7273.9

** Q-DATA FOR SEC-ID, ISEQ =           1
  SK       0.0005       0.0005
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SPRO          FEDERAL HIGHWAY ADMINISTRATION - U. S. GEOLOGICAL SURVEY
060188            MODEL  FOR  WATER-SURFACE  PROFILE  COMPUTATIONS
                   (Input modified to free format by GKY&A 01/92)

       STR. NO. 132000100800 CHESTERFIELD CO.
       US-1 OVER THOMPSON CREEK
         *** RUN DATE & TIME: 09-22-94  09:14

*** START PROCESSING CROSS SECTION - "1     "
  XT   1        1000

  GR          8365 436.5   8370   436   8400   431   8405   430
  GR          8430 425.5   8470   424   8500   419   8600   417
  GR          8700 417.7   8900 416.7   8966   414   9000 416.3
  GR          9065   416   9100   414   9167   412   9170   411
  GR          9183   411   9190   413   9200 413.8   9360 414.5
  GR          9370 413.8   9390 415.3   9400   415   9425 414.5
  GR          9450   416   9465   417   9474 416.3   9489 416.2
  GR          9499 416.5   9512 416.6   9524 416.7   9537 416.6
  GR          9549 416.4   9564 415.9   9574 415.1   9588 415.1
  GR          9599 415.2   9614 415.4   9624 415.5   9637 415.5
  GR          9649 415.6   9664 415.5   9674 415.3   9688   415
  GR          9699   415   9714 415.3   9724 415.4   9737 415.3
  GR          9749   415   9755 413.8   9759 414.6   9767 414.6
  GR          9773 414.4   9782 413.3   9786 410.4   9789 409.5
  GR          9793 407.7   9797 407.5   9799 405.9   9804 405.7
  GR          9809 405.5   9812 405.5   9819 407.3   9824 407.8
  GR          9831 404.8   9835 404.7   9839 412.3   9843 414.2
  GR          9849 414.2   9863   415   9874 415.7   9888 416.5
  GR          9899 415.8   9913   415   9924 414.6   9938 414.3
  GR          9949 413.8   9964 413.9   9974 412.9   9987   415
  GR          9999 416.5  10008 418.3  10400   417  10500   419
  GR         10600   420  10700   419  10800   419  10900   418
  GR         11500   418  11600 418.5  11700 416.9  11800   417
  GR         11900   418  12100   419  12200   419  12250 419.5
  GR         12300   419  12350 419.6  12400 423.4  12450   434

*** FINISH PROCESSING CROSS SECTION - "1     "
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SPRO          FEDERAL HIGHWAY ADMINISTRATION - U. S. GEOLOGICAL SURVEY
060188           MODEL  FOR  WATER-SURFACE  PROFILE  COMPUTATIONS
                  (Input modified to free format by GKY&A 01/92)

       STR. NO. 132000100800 CHESTERFIELD CO.
       US-1 OVER THOMPSON CREEK
         *** RUN DATE & TIME: 09-22-94  09:14

** START PROCESSING CROSS SECTION - "EXIT "
 XS   EXIT      350      *       *      * 0.0005

 GT

 N             0.18  0.04    0.18

 SA            9782 9843.


** FINISH PROCESSING CROSS SECTION - "EXIT "
*** CROSS SECTION "EXIT " WRITTEN TO DISK, RECORD NO. =  1

-- DATA SUMMARY FOR SECID "EXIT " AT SRD =    350.  ERR-CODE =      0

    SKEW      IHFNO     VSLOPE         EK         CK
      .0         0.      .0005        .50        .00

X-Y COORDINATE PAIRS  (NGP = 100):
       X      Y          X      Y          X      Y          X      Y
  8365.0  436.17    8370.0  435.67    8400.0  430.67    8405.0  429.67
  8430.0  425.17    8470.0  423.67    8500.0  418.67    8600.0  416.67
  8700.0  417.38    8900.0  416.38    8966.0  413.67    9000.0  415.97
  9065.0  415.67    9100.0  413.67    9167.0  411.67    9170.0  410.67
  9183.0  410.67    9190.0  412.67    9200.0  413.47    9360.0  414.17
  9370.0  413.47    9390.0  414.97    9400.0  414.67    9425.0  414.17
  9450.0  415.67    9465.0  416.67    9474.0  415.97    9489.0  415.88
  9499.0  416.17    9512.0  416.27    9524.0  416.38    9537.0  416.27
  9549.0  416.07    9564.0  415.57    9574.0  414.77    9588.0  414.77
  9599.0  414.88    9614.0  415.07    9624.0  415.17    9637.0  415.17
  9649.0  415.27    9664.0  415.17    9674.0  414.97    9688.0  414.67
  9699.0  414.67    9714.0  414.97    9724.0  415.07    9737.0  414.97
  9749.0  414.67    9755.0  413.47    9759.0  414.27    9767.0  414.27
  9773.0  414.07    9782.0  412.97    9786.0  410.07    9789.0  409.17
  9793.0  407.38    9797.0  407.17    9799.0  405.57    9804.0  405.38
  9809.0  405.17    9812.0  405.17    9819.0  406.97    9824.0  407.47
  9831.0  404.47    9835.0  404.38    9839.0  411.97    9843.0  413.88
  9849.0  413.88    9863.0  414.67    9874.0  415.38    9888.0  416.17
  9899.0  415.47    9913.0  414.67    9924.0  414.27    9938.0  413.97
  9949.0  413.47    9964.0  413.57    9974.0  412.57    9987.0  414.67
  9999.0  416.17   10008.0  417.97   10400.0  416.67   10500.0  418.67
 10600.0  419.67   10700.0  418.67   10800.0  418.67   10900.0  417.67
 11500.0  417.67   11600.0  418.17   11700.0  416.57   11800.0  416.67
 11900.0  417.67   12100.0  418.67   12200.0  418.67   12250.0  419.17
 12300.0  418.67   12350.0  419.27   12400.0  423.07   12450.0  433.67

X-Y MAX-MIN POINTS:
    XMIN       Y          X    YMIN       XMAX       Y          X    YMAX
  8365.0  436.17    9835.0  404.38   12450.0  433.67    8365.0  436.17

UBAREA BREAKPOINTS (NSA =  3):
       9782.   9843.

OUGHNESS COEFFICIENTS (NSA =  3):
        .180    .040    .180
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SPRO          FEDERAL HIGHWAY ADMINISTRATION - U. S. GEOLOGICAL SURVEY
060188            MODEL  FOR  WATER-SURFACE  PROFILE  COMPUTATIONS
                   (Input modified to free format by GKY&A 01/92)

       STR. NO. 132000100800 CHESTERFIELD CO.
       US-1 OVER THOMPSON CREEK
          *** RUN DATE & TIME: 09-22-94  09:14

*** START PROCESSING CROSS SECTION - "FULLV"
  XS   FULLV  1000      *       *      * 0.0005

  GT

  N            0.18  0.04   0.18

  SA           9782 9843.


*** FINISH PROCESSING CROSS SECTION - "FULLV"
*** CROSS SECTION "FULLV" WRITTEN TO DISK, RECORD NO. =  2

-- DATA SUMMARY FOR SECID "FULLV" AT SRD =    1000.  ERR-CODE =       0

     SKEW      IHFNO     VSLOPE         EK         CK
       .0         0.      .0005        .50        .00

X-Y COORDINATE PAIRS  (NGP = 100):
       X       Y          X       Y          X       Y          X       Y
  8365.0  436.50     8370.0  436.00     8400.0  431.00     8405.0  430.00
  8430.0  425.50     8470.0  424.00     8500.0  419.00     8600.0  417.00
  8700.0  417.70     8900.0  416.70     8966.0  414.00     9000.0  416.30
  9065.0  416.00     9100.0  414.00     9167.0  412.00     9170.0  411.00
  9183.0  411.00     9190.0  413.00     9200.0  413.80     9360.0  414.50
  9370.0  413.80     9390.0  415.30     9400.0  415.00     9425.0  414.50
  9450.0  416.00     9465.0  417.00     9474.0  416.30     9489.0  416.20
  9499.0  416.50     9512.0  416.60     9524.0  416.70     9537.0  416.60
  9549.0  416.40     9564.0  415.90     9574.0  415.10     9588.0  415.10
  9599.0  415.20     9614.0  415.40     9624.0  415.50     9637.0  415.50
  9649.0  415.60     9664.0  415.50     9674.0  415.30     9688.0  415.00
  9699.0  415.00     9714.0  415.30     9724.0  415.40     9737.0  415.30
  9749.0  415.00     9755.0  413.80     9759.0  414.60     9767.0  414.60
  9773.0  414.40     9782.0  413.30     9786.0  410.40     9789.0  409.50
  9793.0  407.70     9797.0  407.50     9799.0  405.90     9804.0  405.70
  9809.0  405.50     9812.0  405.50     9819.0  407.30     9824.0  407.80
  9831.0  404.80     9835.0  404.70     9839.0  412.30     9843.0  414.20
  9849.0  414.20     9863.0  415.00     9874.0  415.70     9888.0  416.50
  9899.0  415.80     9913.0  415.00     9924.0  414.60     9938.0  414.30
  9949.0  413.80     9964.0  413.90     9974.0  412.90     9987.0  415.00
  9999.0  416.50    10008.0  418.30    10400.0  417.00    10500.0  419.00
 10600.0  420.00    10700.0  419.00    10800.0  419.00    10900.0  418.00
 11500.0  418.00    11600.0  418.50    11700.0  416.90    11800.0  417.00
 11900.0  418.00    12100.0  419.00    12200.0  419.00    12250.0  419.50
 12300.0  419.00    12350.0  419.60    12400.0  423.40    12450.0  434.00

X-Y MAX-MIN POINTS:
    XMIN       Y          X    YMIN       XMAX       Y          X    YMAX
  8365.0  436.50     9835.0  404.70    12450.0  434.00     8365.0  436.50

UBAREA BREAKPOINTS (NSA =  3):
       9782.   9843.

OUGHNESS COEFFICIENTS (NSA =  3):
        .180    .040    .180
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SPRO          FEDERAL HIGHWAY ADMINISTRATION - U. S. GEOLOGICAL SURVEY
060188            MODEL  FOR  WATER-SURFACE  PROFILE  COMPUTATIONS
                   (Input modified to free format by GKY&A 01/92)

       STR. NO. 132000100800 CHESTERFIELD CO.
       US-1 OVER THOMPSON CREEK
          *** RUN DATE & TIME: 09-22-94  09:14

*** START PROCESSING CROSS SECTION - "BRID "
 BR   BRID    1000 434.4      0

 GR         9400.0 434.4 9401.0 434.4 9402.0 433.0 9414.0 428.8

 GR         9423.6 424.3 9431.7 420.9 9441.3 417.5 9448.7 415.6

 GR         9451.4 414.6 9453.4 413.6 9462.0 414.4 9473.7 416.3

 GR         9488.6 416.2 9498.7 416.5 9512.2 416.6 9523.7 416.7

 GR         9537.0 416.6 9548.7 416.4 9564.4 415.9 9573.5 415.1

 GR         9587.8 415.1 9598.7 415.2 9613.8 415.4 9623.7 415.5

 GR         9636.7 415.5 9648.5 415.6 9663.5 415.5 9673.5 415.3

 GR         9688.4 415.0 9698.5 415.0 9713.5 415.3 9723.7 415.4

 GR         9737.0 415.3 9748.6 415.0 9754.7 413.8 9759.3 414.6

 GR         9767.4 414.6 9773.4 414.4 9782.0 413.3 9785.7 410.4

 GR         9788.5 409.5 9793.4 407.7 9796.5 407.5 9798.5 405.9

 GR         9804.2 405.7 9809.0 405.5 9812.4 405.5 9819.1 407.3

 GR         9823.5 407.8 9830.5 404.8 9835.4 404.7 9838.7 412.3

 GR         9843.2 414.2 9848.7 414.2 9863.3 415.0 9873.7 415.7

 GR         9887.7 416.5 9898.6 415.8 9913.2 415.0 9923.7 414.6

 GR         9938.4 414.3 9948.8 413.8 9963.5 413.9 9973.8 412.9

 GR          9987 415.0   9999 416.5  10008 418.3  10017 422.2

 GR         10024 424.9  10036 429.4  10049 432.2  10050 432.2

 GR          9400 434.4

 N           0.06  0.04   0.06

 SA          9782 9843.

 CD             3  91.8  2.000 436.5      0     0      0

 PW 1       404.7   1.5    405   1.5    405     3    411     3   411   4.5

             412   4.5    412   7.5    413   7.5    413    15   414    15

             414  34.5    422  34.5    422  37.5    432  37.5

 HP            1 BRID  419.44     * 419.44
```

*** FINISH PROCESSING CROSS SECTION - "BRID "
*** CROSS SECTION "BRID " WRITTEN TO DISK, RECORD NO. = 3

-- DATA SUMMARY FOR SECID "BRID " AT SRD = 1000. ERR-CODE = 0

SKEW	IHFNO	VSLOPE	EK	CK
.0	0.	.0005	.50	.00

X-Y COORDINATE PAIRS (NGP = 73):

X	Y	X	Y	X	Y	X	Y
9400.0	434.40	9401.0	434.40	9402.0	433.00	9414.0	428.80
9423.6	424.30	9431.7	420.90	9441.3	417.50	9448.7	415.60
9451.4	414.60	9453.4	413.60	9462.0	414.40	9473.7	416.30
9488.6	416.20	9498.7	416.50	9512.2	416.60	9523.7	416.70
9537.0	416.60	9548.7	416.40	9564.4	415.90	9573.5	415.10
9587.8	415.10	9598.7	415.20	9613.8	415.40	9623.7	415.50
9636.7	415.50	9648.5	415.60	9663.5	415.50	9673.5	415.30
9688.4	415.00	9698.5	415.00	9713.5	415.30	9723.7	415.40
9737.0	415.30	9748.6	415.00	9754.7	413.80	9759.3	414.60
9767.4	414.60	9773.4	414.40	9782.0	413.30	9785.7	410.40
9788.5	409.50	9793.4	407.70	9796.5	407.50	9798.5	405.90
9804.2	405.70	9809.0	405.50	9812.4	405.50	9819.1	407.30
9823.5	407.80	9830.5	404.80	9835.4	404.70	9838.7	412.30
9843.2	414.20	9848.7	414.20	9863.3	415.00	9873.7	415.70
9887.7	416.50	9898.6	415.80	9913.2	415.00	9923.7	414.60
9938.4	414.30	9948.8	413.80	9963.5	413.90	9973.8	412.90
9987.0	415.00	9999.0	416.50	10008.0	418.30	10017.0	422.20
10024.0	424.90	10036.0	429.40	10049.0	432.20	10050.0	432.20
9400.0	434.40						

X-Y MAX-MIN POINTS:

XMIN	Y	X	YMIN	XMAX	Y	X	YMAX
9400.0	434.40	9835.4	404.70	10050.0	432.20	9400.0	434.40

SUBAREA BREAKPOINTS (NSA = 3):

9782. 9843.

ROUGHNESS COEFFICIENTS (NSA = 3):

.060 .040 .060

BRIDGE PARAMETERS:

BRTYPE	BRWDTH	LSEL	USERCD	EMBSS	EMBELV	ABSLPL	ABSLPR
3	91.8	434.40	*******	2.00	436.50	*******	*******

PIER DATA: NPW = 14 PPCD = 1.

PELV	PWDTH	PELV	PWDTH	PELV	PWDTH	PELV	PWDTH
404.70	1.5	405.00	1.5	405.00	3.0	411.00	3.0
411.00	4.5	412.00	4.5	412.00	7.5	413.00	7.5
413.00	15.0	414.00	15.0	414.00	34.5	422.00	34.5
422.00	37.5	432.00	37.5				

SPRO
060188

FEDERAL HIGHWAY ADMINISTRATION - U. S. GEOLOGICAL SURVEY
MODEL FOR WATER-SURFACE PROFILE COMPUTATIONS
(Input modified to free format by GKY&A 01/92)

STR. NO. 132000100800 CHESTERFIELD CO.
US-1 OVER THOMPSON CREEK
*** RUN DATE & TIME: 09-22-94 09:14
CROSS-SECTION PROPERTIES: ISEQ = 3; SECID = BRID ; SRD = 1000.

WSEL	SA#	AREA	K	TOPW	WETP	ALPH	LEW	REW	QCR
	1	1350.	82826.	346.	348.				15129.
	2	728.	130130.	61.	69.				14273.
	3	744.	49704.	168.	169.				8891.
419.44		2822.	262660.	575.	585.	2.06	9436.	10011.	24712.

HP	1	BRID	420.16	* 420.16

SPRO
P060188

FEDERAL HIGHWAY ADMINISTRATION - U. S. GEOLOGICAL SURVEY
MODEL FOR WATER-SURFACE PROFILE COMPUTATIONS
(Input modified to free format by GKY&A 01/92)

STR. NO. 132000100800 CHESTERFIELD CO.
US-1 OVER THOMPSON CREEK
*** RUN DATE & TIME: 09-22-94 09:14
CROSS-SECTION PROPERTIES: ISEQ = 3; SECID = BRID ; SRD = 1000.

WSEL	SA#	AREA	K	TOPW	WETP	ALPH	LEW	REW	QCR
	1	1600.	109481.	348.	350.				19463.
	2	772.	143475.	61.	69.				15584.
	3	865.	63480.	169.	170.				11097.
420.16		3237.	316436.	579.	589.	1.92	9434.	10012.	31347.

HP 2 BRID 419.44 * 419.44 5578.

WSPRO
P060188

FEDERAL HIGHWAY ADMINISTRATION - U. S. GEOLOGICAL SURVEY
MODEL FOR WATER-SURFACE PROFILE COMPUTATIONS
(Input modified to free format by GKY&A 01/92)

STR. NO. 132000100800 CHESTERFIELD CO.
US-1 OVER THOMPSON CREEK
*** RUN DATE & TIME: 09-22-94 09:14

VELOCITY DISTRIBUTION: ISEQ = 3; SECID = BRID ; SRD = 1000.

WSEL	LEW	REW	AREA	K	Q	VEL
419.44	9435.8	10010.6	2821.9	262660.	5578.	1.98

STA.	9435.8	9502.3	9581.8	9630.8	9684.2	9731.8
A(I)		233.1	255.5	202.9	213.2	202.2
V(I)		1.20	1.09	1.37	1.31	1.38
STA.	9731.8	9772.3	9789.9	9796.2	9801.4	9806.0
A(I)		189.7	122.7	71.5	68.3	62.8
V(I)		1.47	2.27	3.90	4.08	4.44
STA.	9806.0	9810.5	9815.1	9820.5	9826.3	9830.9
A(I)		63.8	63.0	66.7	69.5	64.7
V(I)		4.37	4.43	4.18	4.01	4.31
STA.	9830.9	9835.0	9875.5	9929.6	9962.7	10010.6
A(I)		60.1	218.2	212.6	178.0	203.5
V(I)		4.64	1.28	1.31	1.57	1.37

HP 2 BRID 420.16 * 420.16 7273.

SPRO
P060188

FEDERAL HIGHWAY ADMINISTRATION - U. S. GEOLOGICAL SURVEY
MODEL FOR WATER-SURFACE PROFILE COMPUTATIONS
(Input modified to free format by GKY&A 01/92)

STR. NO. 132000100800 CHESTERFIELD CO.
US-1 OVER THOMPSON CREEK
*** RUN DATE & TIME: 09-22-94 09:14

VELOCITY DISTRIBUTION: ISEQ = 3; SECID = BRID ; SRD = 1000.

WSEL	LEW	REW	AREA	K	Q	VEL
420.16	9433.8	10012.3	3237.1	316436.	7273.	2.25

X STA.	9433.8	9494.6	9569.6	9613.6	9662.8	9706.0
A(I)		253.2	280.3	218.6	228.3	215.5
V(I)		1.44	1.30	1.66	1.59	1.69
STA.	9706.0	9751.3	9784.1	9793.0	9799.2	9804.4
A(I)		223.2	197.0	94.7	81.4	74.4
V(I)		1.63	1.85	3.84	4.47	4.89
STA.	9804.4	9809.4	9814.5	9820.3	9826.5	9831.6
A(I)		73.3	73.2	77.9	79.4	75.0
V(I)		4.96	4.97	4.67	4.58	4.85
STA.	9831.6	9843.3	9888.9	9933.1	9964.4	10012.3
A(I)		128.7	224.4	218.5	192.4	227.8
V(I)		2.83	1.62	1.66	1.89	1.60

```
SPRO          FEDERAL HIGHWAY ADMINISTRATION - U. S. GEOLOGICAL SURVEY
P060188           MODEL  FOR  WATER-SURFACE  PROFILE  COMPUTATIONS
                   (Input modified to free format by GKY&A 01/92)

        STR. NO. 132000100800 CHESTERFIELD CO.
        US-1 OVER THOMPSON CREEK
           *** RUN DATE & TIME: 09-22-94  09:14

*** START PROCESSING CROSS SECTION - "APPR "
  AS   APPR  1741.8     *       *      * 0.0005

  GT

  N            0.18  0.04   0.18

  SA           9782 9843.

  HP              1 APPR  419.96      * 419.96


** FINISH PROCESSING CROSS SECTION - "APPR "
*** CROSS SECTION "APPR " WRITTEN TO DISK, RECORD NO. =  4

-- DATA SUMMARY FOR SECID "APPR " AT SRD =    1742.  ERR-CODE =       0

     SKEW      IHFNO     VSLOPE         EK         CK
       .0         0.      .0005        .50        .00

X-Y COORDINATE PAIRS  (NGP = 100):
       X       Y          X       Y          X       Y          X       Y
  8365.0  436.87     8370.0  436.37     8400.0  431.37     8405.0  430.37
  8430.0  425.87     8470.0  424.37     8500.0  419.37     8600.0  417.37
  8700.0  418.07     8900.0  417.07     8966.0  414.37     9000.0  416.67
  9065.0  416.37     9100.0  414.37     9167.0  412.37     9170.0  411.37
  9183.0  411.37     9190.0  413.37     9200.0  414.17     9360.0  414.87
  9370.0  414.17     9390.0  415.67     9400.0  415.37     9425.0  414.87
  9450.0  416.37     9465.0  417.37     9474.0  416.67     9489.0  416.57
  9499.0  416.87     9512.0  416.97     9524.0  417.07     9537.0  416.97
  9549.0  416.77     9564.0  416.27     9574.0  415.47     9588.0  415.47
  9599.0  415.57     9614.0  415.77     9624.0  415.87     9637.0  415.87
  9649.0  415.97     9664.0  415.87     9674.0  415.67     9688.0  415.37
  9699.0  415.37     9714.0  415.67     9724.0  415.77     9737.0  415.67
  9749.0  415.37     9755.0  414.17     9759.0  414.97     9767.0  414.97
  9773.0  414.77     9782.0  413.67     9786.0  410.77     9789.0  409.87
  9793.0  408.07     9797.0  407.87     9799.0  406.27     9804.0  406.07
  9809.0  405.87     9812.0  405.87     9819.0  407.67     9824.0  408.17
  9831.0  405.17     9835.0  405.07     9839.0  412.67     9843.0  414.57
  9849.0  414.57     9863.0  415.37     9874.0  416.07     9888.0  416.87
  9899.0  416.17     9913.0  415.37     9924.0  414.97     9938.0  414.67
  9949.0  414.17     9964.0  414.27     9974.0  413.27     9987.0  415.37
  9999.0  416.87    10008.0  418.67    10400.0  417.37    10500.0  419.37
 10600.0  420.37    10700.0  419.37    10800.0  419.37    10900.0  418.37
 11500.0  418.37    11600.0  418.87    11700.0  417.27    11800.0  417.37
 11900.0  418.37    12100.0  419.37    12200.0  419.37    12250.0  419.87
 12300.0  419.37    12350.0  419.97    12400.0  423.77    12450.0  434.37

X-Y MAX-MIN POINTS:
    XMIN       Y          X     YMIN       XMAX       Y          X     YMAX
  8365.0  436.87     9835.0  405.07    12450.0  434.37     8365.0  436.87

UBAREA BREAKPOINTS (NSA =  3):
       9782.    9843.
```

.100 .040 .100

RIDGE PROJECTION DATA: XREFLT XREFRT FDSTLT FDSTRT
******* ******* ******* *******

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FEDERAL HIGHWAY ADMINISTRATION - U. S. GEOLOGICAL SURVEY
MODEL FOR WATER-SURFACE PROFILE COMPUTATIONS
(Input modified to free format by GKY&A 01/92)

STR. NO. 132000100800 CHESTERFIELD CO.
US-1 OVER THOMPSON CREEK
*** RUN DATE & TIME: 09-22-94 09:14
CROSS-SECTION PROPERTIES: ISEQ = 4; SECID = APPR ; SRD = 1742.

WSEL	SA#	AREA	K	TOPW	WETP	ALPH	LEW	REW	QCR
	1	4992.	102031.	1286.	1287.				55826.
	2	733.	132150.	61.	69.				14428.
	3	3962.	45509.	2424.	2425.				28749.
419.96		9688.	279690.	3770.	3780.	18.62	8496.	12349.	20423.

HP	1	APPR	420.78	* 420.78

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WSEL	SA#	AREA	K	TOPW	WETP	ALPH	LEW	REW	QCR
	1	6048.	140126.	1290.	1292.				74306.
	2	783.	147512.	61.	69.				15929.
	3	6006.	88736.	2518.	2518.				52634.
420.78		12837.	376375.	3869.	3879.	16.46	8492.	12361.	32705.

HP	2 APPR	419.96	*	419.96	5578.

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STR. NO. 132000100800 CHESTERFIELD CO.
US-1 OVER THOMPSON CREEK
*** RUN DATE & TIME: 09-22-94 09:14

VELOCITY DISTRIBUTION: ISEQ = 4; SECID = APPR ; SRD = 1742.

WSEL	LEW	REW	AREA	K	Q	VEL
419.96	8496.5	12349.1	9688.1	279690.	5578.	.58

X STA.	8496.5	8975.9	9127.6	9193.4	9293.3	9404.6
A(I)		1193.3	648.6	487.3	560.8	570.1
V(I)		.23	.43	.57	.50	.49
STA.	9404.6	9600.2	9751.6	9790.3	9796.7	9802.1
A(I)		723.1	647.1	235.0	75.5	71.5
V(I)		.39	.43	1.19	3.69	3.90
STA.	9802.1	9806.9	9811.7	9816.7	9822.5	9828.3
A(I)		66.5	67.3	67.8	71.6	73.0
V(I)		4.19	4.14	4.11	3.90	3.82
STA.	9828.3	9832.9	9874.4	10132.9	11314.4	12349.1
A(I)		66.2	251.6	803.1	1593.1	1415.7
V(I)		4.22	1.11	.35	.18	.20

HP 2 APPR 420.78 * 420.78 7273.

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P060188

FEDERAL HIGHWAY ADMINISTRATION - U. S. GEOLOGICAL SURVEY
MODEL FOR WATER-SURFACE PROFILE COMPUTATIONS
(Input modified to free format by GKY&A 01/92)

STR. NO. 132000100800 CHESTERFIELD CO.
US-1 OVER THOMPSON CREEK
*** RUN DATE & TIME: 09-22-94 09:14

VELOCITY DISTRIBUTION: ISEQ = 4; SECID = APPR ; SRD = 1742.

WSEL	LEW	REW	AREA	K	Q	VEL
420.78	8491.5	12360.6	12837.5	376375.	7273.	.57

X STA.	8491.5	8937.5	9096.5	9178.0	9273.4	9389.4
A(I)		1362.4	789.2	620.6	648.7	705.0
V(I)		.27	.46	.59	.56	.52
STA.	9389.4	9577.2	9725.9	9789.8	9797.7	9803.8
A(I)		842.4	758.8	395.6	98.4	88.6
V(I)		.43	.48	.92	3.69	4.11
STA.	9803.8	9809.6	9815.6	9822.5	9829.4	9834.8
A(I)		86.3	87.9	90.8	93.2	84.8
V(I)		4.22	4.14	4.00	3.90	4.29
STA.	9834.8	9943.8	10301.7	11131.6	11671.5	12360.6
A(I)		612.0	1131.6	1631.5	1280.8	1428.8
V(I)		.59	.32	.22	.28	.25

==========

S-1 OVER THOMPSON CREEK CHESTERFIELD CO. #132000100800

00 YEAR CHANNEL CONTRACTION SCOUR

Y1=	14.9	ft
Wc1=	61	ft
Wc2=	61	ft
Qmc1=	2636	cfs
Qmc2=	2764	cfs
K1=	0.59	

Y2= Y1*(Qmc2/Qmc1)^(6/7)*(Wc1/Wc2)^K1)

Y2=	15.5	ft
Ys=Y2-Y1=	0.6	ft

00 YEAR CHANNEL CONTRACTION SCOUR

Y1=	15.7	ft
Wc1=	61	ft
Wc2=	61	ft
Qmc1=	2851	cfs
Qmc2=	3298	cfs
K1=	0.59	

Y2= Y1*(Qmc2/Qmc1)^(6/7)*(Wc1/Wc2)^K1)

Y2=	17.8	ft
Ys=Y2-Y1=	2.1	ft

00 YEAR CHANNEL PIER SCOUR

Y1=	14.74	
K1=	1.1	
K2=	2.5	
K3=	1.1	
a=	1.5	ft
V1=	4.6	
Fr1=	0.213	

Ys= Y1*2*K1*K2*K3*(a/Y1)^0.65*Fr1^0.43

Ys=	10.4	

00 YEAR CHANNEL PIER SCOUR

Y1=	15.5	
K1=	1.1	
K2=	2.5	
K3=	1.1	
a=	1.5	ft
V1=	4.97	
Fr1=	0.223	

Ys= Y1*2*K1*K2*K3*(a/Y1)^0.65*Fr1^0.43

Ys=	10.8	

US-1 OVER THOMPSON CREEK CHESTERFIELD CO. #132000100800

00 YEAR FLOODPLAIN CLEAR WATER CONTRACTION SCOUR

Y1=	5.36
Q=	279.46
Dm=	0.000820
W2=	30.1
Ys=	Y1*.13*[(Q/(Dm^.333*Y1^1.167*W)^.857
Ys=	1.3

00 YEAR FLOODPLAIN CLEAR WATER CONTRACTION SCOUR

Y1=	6.18
Q=	363.636
Dm=	0.000820
W2=	28.3
Ys=	Y1*.13*[(Q/(Dm^.333*Y1^1.167*W)^.857
Ys=	2.7

00 YEAR FLOODPLAIN PIER SCOUR

GROUND=	412
Y1=	7.96
K1=	1.1
K2=	1.0
K3=	1.1
a=	1.5 ft
V1=	1.6
Fr1=	0.098
Ys=	Y1*2*K1*K2*K3*(a/Y1)^0.65*Fr1^0.43
Ys=	2.4

00 YEAR FLOODPLAIN PIER SCOUR

GROUND=	412
Y1=	8.8
K1=	1.1
K2=	1.0
K3=	1.1
a=	1.5 ft
V1=	1.89
Fr1=	0.112
Ys=	Y1*2*K1*K2*K3*(a/Y1)^0.65*Fr1^0.43
Ys=	2.6

S-1 OVER THOMPSON CREEK CHESTERFIELD CO. #132000100800
00 YR NORTHERN ABUTMENT SCOUR

' LENGTH OF ABUT.
ROJ. NORMAL TO FLOW= 945.0
OBSTRUCTED FLOW AREA= 3644
a= 3.9

VERT. WALL 1
VERT. WALL W/ WINGS 0.82
PILL THROUGH 0.55
1= 0.55

MB. ANGLE= 70
2= 0.968

OBSTRUCTED FLOW (cfs) 1456
e= 0.40
re=Ve/(gYa)^0.5= 0.0358

Ys/Ya=2.27 K1 K2 (a'/Ya)^0.43 Fre^0.61 + 1
s= 7.5

500 YR ABUTMENT SCOUR

a' LENGTH OF ABUT.
PROJ. NORMAL TO FLOW= 950.0
BSTRUCTED FLOW AREA= 4442
a= 4.7

ERT. WALL 1
ERT. WALL W/ WINGS 0.82
SPILL THROUGH 0.55
K1= 0.55

MB. ANGLE= 70
K2= 0.968

BSTRUCTED FLOW (cfs) 2330
e= 0.52
Fre=Ve/(gYa)^0.5= 0.0427

s/Ya=2.27 K1 K2 (a'/Ya)^0.43 Fre^0.61 + 1
s= 9.1

S-1 OVER THOMPSON CREEK CHESTERFIELD CO. #132000100800
00 YR SOUTHERN ABUTMENT SCOUR

' LENGTH OF ABUT.
ROJ. NORMAL TO FLOW= 2376.0
OBSTRUCTED FLOW AREA= 3502
a= 1.5

VERT. WALL 1
VERT. WALL W/ WINGS 0.82
PILL THROUGH 0.55
1= 0.55

MB. ANGLE= 110
2= 1.026

OBSTRUCTED FLOW (cfs) 742
Ve= 0.21
re=Ve/(gYa)^0.5= 0.0308

Ys/Ya=2.27 K1 K2 (a'/Ya)^0.43 Fre^0.61 + 1
s= 6.4

500 YR ABUTMENT SCOUR

a' LENGTH OF ABUT.
PROJ. NORMAL TO FLOW= 2387.0
BSTRUCTED FLOW AREA= 5470
a= 2.3

ERT. WALL 1
ERT. WALL W/ WINGS 0.82
SPILL THROUGH 0.55
K1= 0.55

EMB. ANGLE= 110
K2= 1.026

BSTRUCTED FLOW (cfs) 1437
e= 0.26
Fre=Ve/(gYa)^0.5= 0.0306

s/Ya=2.27 K1 K2 (a'/Ya)^0.43 Fre^0.61 + 1
s= 7.9