SCOUR EVALUATION

FOR

SOUTH CAROLINA DEPARTMENT OF TRANSPORTATION

ON

STRUCTURE # 137002200300
S-22 OVER THOMPSON CREEK
CHESTERFIELD COUNTY, SC

Prepared by:

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May 5, 1995

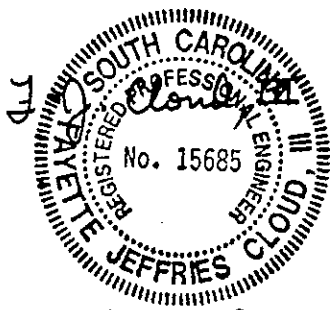

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TABLE OF CONTENTS

Page No.

1.0 STREAM STABILITY 1

1.1 Stream Characteristics 1

1.2 Land Use Changes 1

1.3 Overall Stream Stability 1

1.4 Lateral Stability 1

1.5 Vertical Stability 1

1.6 Channel Response to Change 1

2.0 SCOUR ANALYSES 2

2.1 Flood History and Rainfall-Runoff Relations 2

2.2 Hydraulic Conditions 2

2.3 Bed and Bank Material Analysis 2

2.4 Watershed Sediment Yield Evaluation 2

2.5 Rating Curve Shifts 3

2.6 Scour Condition Evaluation 3

2.7 Recommendations 3-4

LIST OF FIGURES

Figure 1 - Geomorphic factors that affect stream stability

Figure 2 - Location Map

Figure 3 - Slope - discharge relationship for braiding or meandering in sand bed streams

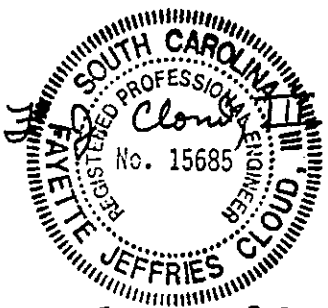
APPENDIX 1 - Field Information

APPENDIX 2 - Photographs

APPENDIX 3 - WSPRO Computer Data and Scour Calculations

APPENDIX 4 - Computer Diskette (WSPRO Input and Output)

APPENDIX 5 - Selected References



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SCOUR EVALUATION FOR S-22 OVER THOMPSON CREEK

1.0 STREAM STABILITY

1.1 Stream Characteristics

A field investigation recorded the stream characteristics on Figure 1 and on forms contained in Appendix 1. The investigation found that the overbank areas are well grassed or forested and the channel area is free from vegetation. The stream is described as perennial. 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 4.5 miles southwest of Cheraw, South Carolina. The land use in the drainage basin is rural. 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 stable. The 2-Year discharge and the stream slope have been plotted in the transitional zone on Figure 3 (Figure 8 in HEC-20[1]). This shows that a sand bed stream at this site would be in transition between a braided and meandering stream. The actual stream conditions include moderate vegetation which will influence the behavior of the stream.

1.4 Lateral Stability

The stream alignment is skewed 30° to the bridge opening. Photographs of the site (Appendix 2) show that the stream banks are vegetated and relatively stable during average flow conditions.

1.5 Vertical Stability

The stream bed profile is relatively stable. This is evidenced by similar channel depths for the 1947 construction plans and the channel depths measured 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.

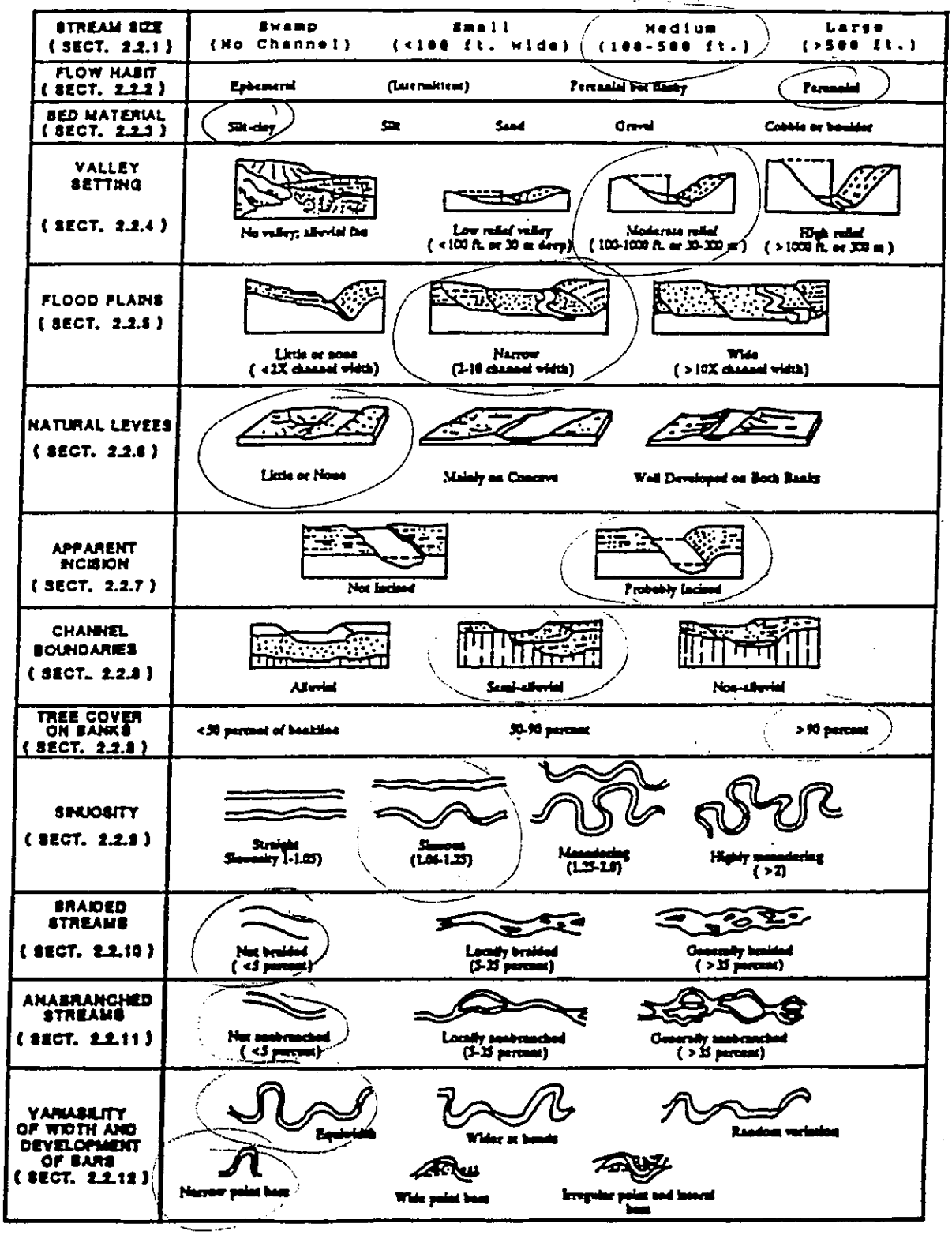
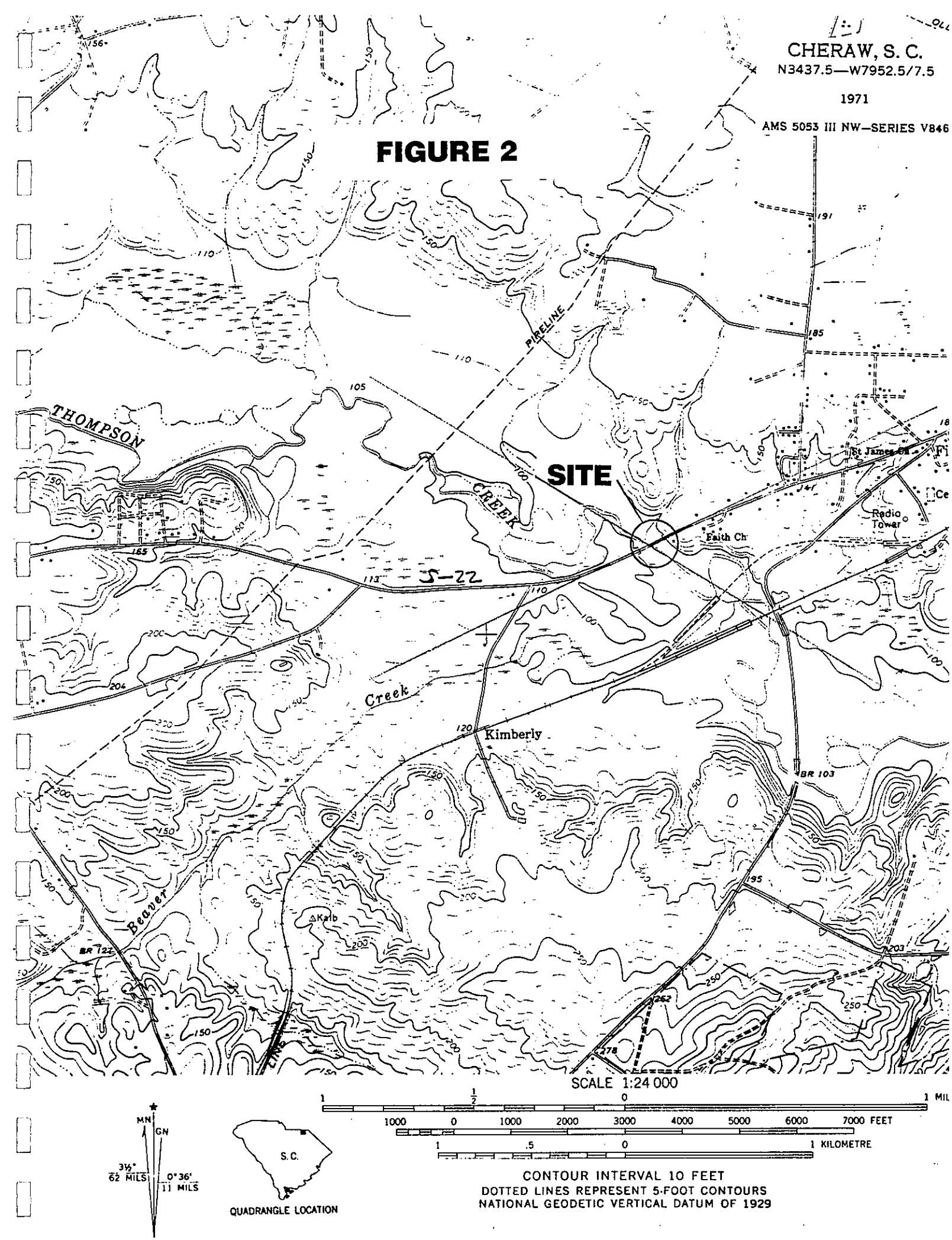


Figure 1. Geomorphic factors that affect stream stability (From HEC-20)


CHERAW, S. C.
N3437.5—W7952.5/7.5
1971
AMS 5053 III NW—SERIES V846
FIGURE 2
SITE
PIPELINE
THOMPSON
CREEK
S-22
Faith Ch
Radio Tower
Kimberly
Creek
Beaver
BR 103
BR 127
Karb
SCALE 1:24 000
1 MIL
1000 0 1000 2000 3000 4000 5000 6000 7000 FEET
1 .5 0 1 KILOMETRE
MN
GN
3½° 62 MILS
0°36' 11 MILS
S.C.
QUADRANGLE LOCATION
CONTOUR INTERVAL 10 FEET
DOTTED LINES REPRESENT 5-FOOT CONTOURS
NATIONAL GEODETIC VERTICAL DATUM OF 1929

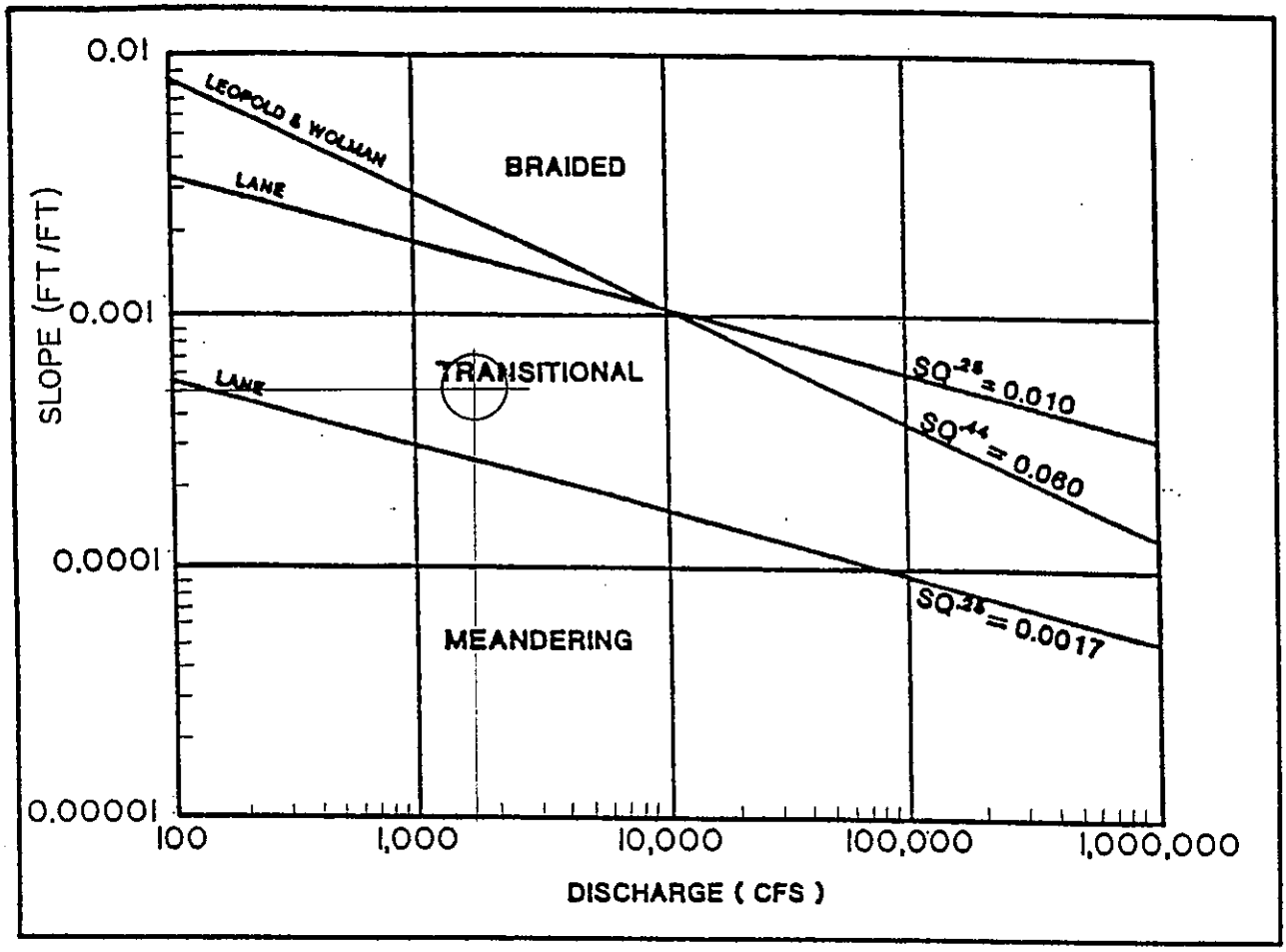


Figure 3. Slope-discharge relationship for braiding or meandering in sand bed streams (Figure 8 in HEC-20)

2.0 SCOUR ANALYSES

2.1 Flood History and Rainfall-Runoff Relations

The 1947 construction plans show a 1929 H.W. El. = 109± FT MSL. The elevations for the 100- and 500-year storms, respectively, at the bridge opening are 101.80 and 103.16 based on the included WSPRO computer program run. These elevations appear to be low in relation to the 1929 highwater mark but appear to be in order when compared to the observed highwater mark from the field visit. The 109.0 elevation was investigated as to the possibility of backwater from the Great Pee Dee. We contacted Mr. Bill Church of USGS who stated that a flood gauge was in place for numerous years on the Great Pee Dee River just east of Cheraw on US 1/SC 9. This gauge provided flood information that in 1945 the Pee Dee flooded with a gauge of 50.42 and a datum of 56.92 MSL which total an elevation of 107.34 MSL. The backwater from the Pee Dee to the bridge location could easily be 109.0 during major flood events for the Pee Dee. This bridge is located approximately 6 miles from the Pee Dee. On the basis of this information, it is determined that a highwater elevation of 109 is from backwater from the Great Pee Dee.

The rainfall-runoff relations for the 259.7 sq. mi. drainage basin were obtained using the USGS Report 91-4157[2] titled "Techniques for Estimating Magnitude and Frequency of Floods in South Carolina, 1988". The results of the regression equations for the Upper Coastal Plain are listed below:

Frequency (years)	Regression Equation Flowrate (cfs)
2	1530
10	3056
25	3919
50	4752
100	5380
500	7026

2.2 Hydraulic Conditions

The hydraulic conditions were investigated using the WSPRO[3] 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 a field survey along the downstream fill toe (upstream toe of fill too heavily vegetated) and the 1947 plan 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 does not exceed the limits that would be allowed for a new bridge at this site. The existing bridge creates 0.0 ft. of backwater and has a velocity of 2.8 fps in the bridge opening. Standard design practice for South Carolina is 1.0 ft. backwater and 5 fps maximum velocity for the 100-year event.

2.3 Bed and Bank Material Analysis

The field investigation visually identified the bed and bank materials as silty clay.

2.4 Watershed Sediment Yield Evaluation

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

2.5 Rating Curve Shifts

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

2.6 Scour Condition Evaluation

The bridge at this site was built in 1947. This current bridge replaced an old bridge that was located just downstream at this site. The current bridge consists of a reinforced concrete deck supported on concrete beams on concrete piles and pile caps with spill-thru abutments.

Scour conditions were evaluated using the WSPRO computer program and the scour equations presented in HEC-18[4]. 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 resulted in 7.2 feet and 7.5 feet for contraction and pier scour, respectively, during the 100- and 500-year storm event.

The abutment scour at this site was calculated to be 4.6 feet during the 100-year storm event and 6.5 feet during the 500-year storm event.

The thalweg for this stream could easily shift to Bents 8, 9, 10 or 11 during the life of the structure. For this reason, the ground elevation at these bents was assumed to be the thalweg elevation.

The results of the scour calculations show that scour could expose a significant length of the piles. The pile tip elevations were from a SCDOT Pile Record Sheet and only the shortest piles were listed in Table 1. A geotechnical and structural review of the information will be needed to determine if the foundations are stable.

2.7 Recommendations

The scour calculations for the bridge show moderate scour depths. We recommend a structural engineer and a geotechnical engineer review the scour conditions at this site and decide 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.

The calculations and recommendations in this report assume that the ground line will stay at nearly the same elevation; however, some minor ground changes in the channel area are expected. SCDOT will need to monitor the ground line beneath the bridge. Lateral shifts of 5 feet or more for the channel area and vertical changes of 2 feet or more for the entire ground line should be immediately reported to the SCDOT Hydraulics Unit. The sounding data presented in Appendix 1 of this report should be used as the reference for determining significant ground line changes. A new scour study will be necessary if significant ground line changes are observed in the future.

The abutments are protected with D_{50}=9" stone under the bridge only. The quantity of stone may not be adequate to protect the bridge from the calculated abutment scour depths of 4.6 to 6.5 feet. We recommend that the abutments be repaired to meet the current SCDOT standards for new construction by adding D_{50}=12" stone to both abutments.

Table 1 - Remaining pile/footing penetration at piers/bents for Structure #137002200300 on Route S-22, crossing Thompson Creek in Chesterfield County, South Carolina

Pier/bent[1] number	Station[1] (feet)	Pile tip[2] elevation (feet)	Ground[3] elevation at pier/bent (feet)	Total[4] scour depth (feet)	Elevation of scour (feet)	Remaining[5] pile penetration (feet)
100-year discharge is 5380 cfs - 500-year discharge is 7026 cfs						
Scour Information for 100-Year Storm:						
1	156+70	80.7	112.7	N/A	N/A	N/A
2	157+00	75.6	101.2	9.9	91.3	15.7
3	157+30	75.5	98.6	5.3	93.3	17.8
4	157+60	75.4	99.1	5.3	93.8	18.4
5	157+90	75.4	98.4	5.3	93.1	17.7
6	158+20	68.3	97.4	5.3	92.1	23.8
7	158+50	68.2	97.4	5.3	92.1	23.9
8	158+80	68.1	86.6	7.2	79.4	11.3
9	159+10	68.1	86.6	7.2	79.4	11.3
10	159+40	68.0	86.6	7.2	79.4	11.4
11	159+70	67.9	86.6	7.2	79.4	11.5
12	160+00	67.8	100.6	5.3	95.3	27.5
13	160+30	67.8	99.8	5.3	94.5	26.7
14	160+60	78.7	99.3	5.3	94.0	15.3
15	160+90	78.6	99.4	5.3	94.1	15.5
16	161+20	78.5	100.1	9.9	90.2	11.7
17	161+50	78.4	111.5	N/A	N/A	N/A
Scour Information for 500-Year Storm:						
1	156+70	80.7	112.7	N/A	N/A	N/A
2	157+00	75.6	101.2	13.8	87.4	11.8
3	157+30	75.5	98.6	7.3	91.3	15.8
4	157+60	75.4	99.1	7.3	91.8	16.4
5	157+90	75.4	98.4	7.3	91.1	15.7
6	158+20	68.3	97.4	7.3	90.1	21.8
7	158+50	68.2	97.4	7.3	90.1	21.9
8	158+80	68.1	86.6	7.5	79.1	11.0
9	159+10	68.1	86.6	7.5	79.1	11.0
10	159+40	68.0	86.6	7.5	79.1	11.1
11	159+70	67.9	86.6	7.5	79.1	11.2
12	160+00	67.8	100.6	7.3	93.3	25.5
13	160+30	67.8	99.8	7.3	92.5	24.7
14	160+60	78.7	99.3	7.3	92.0	13.3
15	160+90	78.6	99.4	7.3	92.1	13.5
16	161+20	78.5	100.1	13.8	86.3	7.8
17	161+50	78.4	111.5	N/A	N/A	N/A

[1]Pier/bent number and station corresponds to South Carolina Department of Transportation bridge plans.
[2]Pile tip elevations obtained from SCDOT bridge plans. Shortest pile length listed.
[3]Thalweg elevation used in some areas since thalweg may shift during life of structure.
[4]Total scour depth is the sum of the contraction, pier/bent and abutment scour depths.
[5]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 S-22
FILE NO._____ PROJECT NO._____
CHESTERFIELD COUNTY, SOUTH CAROLINA
STR.# 137002200300

DATE

Prepared By FJC
Checked By _____

Signed and Sealed

PROJECT DESCRIPTION

County CHESTERFIELD Rt./Rd. No. S-22
Stream THOMPSON CREEK File No. _____ Project No. _____
PIN _____ Charge Code _____
Project Engineer JEFF CLOUD Road Squad _____

COMPARATIVE DATA

By FJC Date 3-6-95 Checked _____ Date _____

	(Upstream)	(SITE)	(Downstream)	
ROUTE/ROAD NO.	S-113	S-22	S-169	
DIST. FROM NEW BR. (MI.)	2.5	—	1.1	
DRAINAGE AREA (SQ. MI.)	180.7	259.7	268.2	
ZONE	UPPER COASTAL	UPPER COASTAL	UPPER COASTAL	
Q_{10}	2362	3056	3126	
Q_{25}	3041	3919	4009	
Q_{50}	3687	4752	4861	
Q_{100}	4186	5376	5497	
Q_{500}	5526	7021	7172	
BRIDGE LENGTH (FT.)	90	480	120'	
AVG. F. G. (FT.)	—	111.5	—	
OPENING FURN.(SQ.FT.)	560	1956	1420	
VELOCITY (FT./SEC.)	7.48	0.77	3.87	
HIGH-WATER ELEV. (FT.)	—	109.0	—	
HIGH-WATER DATE	—	1929	—	
HIGH-WATER DEPTH	—	—	—	
NORMAL-WATER ELEV. (FT.)	—	93.2	—	
NORMAL-WATER DATE	—	12-20-94	—	
NORMAL-WATER DEPTH	—	—	—	
FILE/DOCKET/PROJ. NO.	—	—	—	
LOCATION OF PLANS	S.C.D.O.T.	S.C.D.O.T.	S.C.D.O.T.	
DATUM/DATUM TIE	—	—	—	
FLOODWAY MAP	—	—	—	

FIELD INSPECTION OF SCOUR BRIDGES (USGS)

COUNTY CHESTERFIELD Rt./Rd. No. S-22

STREAM NAME THOMPSON CREEK STRUCTURE # 137002200300

CONSULTANT RALPH WHITEHEAD ASSOCS. INSPECTED BY FJC - RAL

Date 12-20-94

LENGTH 480 Ft. WIDTH 27.3 Ft. MAX.SPAN LENGTH 30 Ft.
Alignment (Tangent)/Curved Bridge Skewed Yes/(No) Angle _____
End Abutment ~~Type~~ Spill thru
RipRap on fills ? (Yes)/No Condition Rod - only under bridge 9" RIP RAP

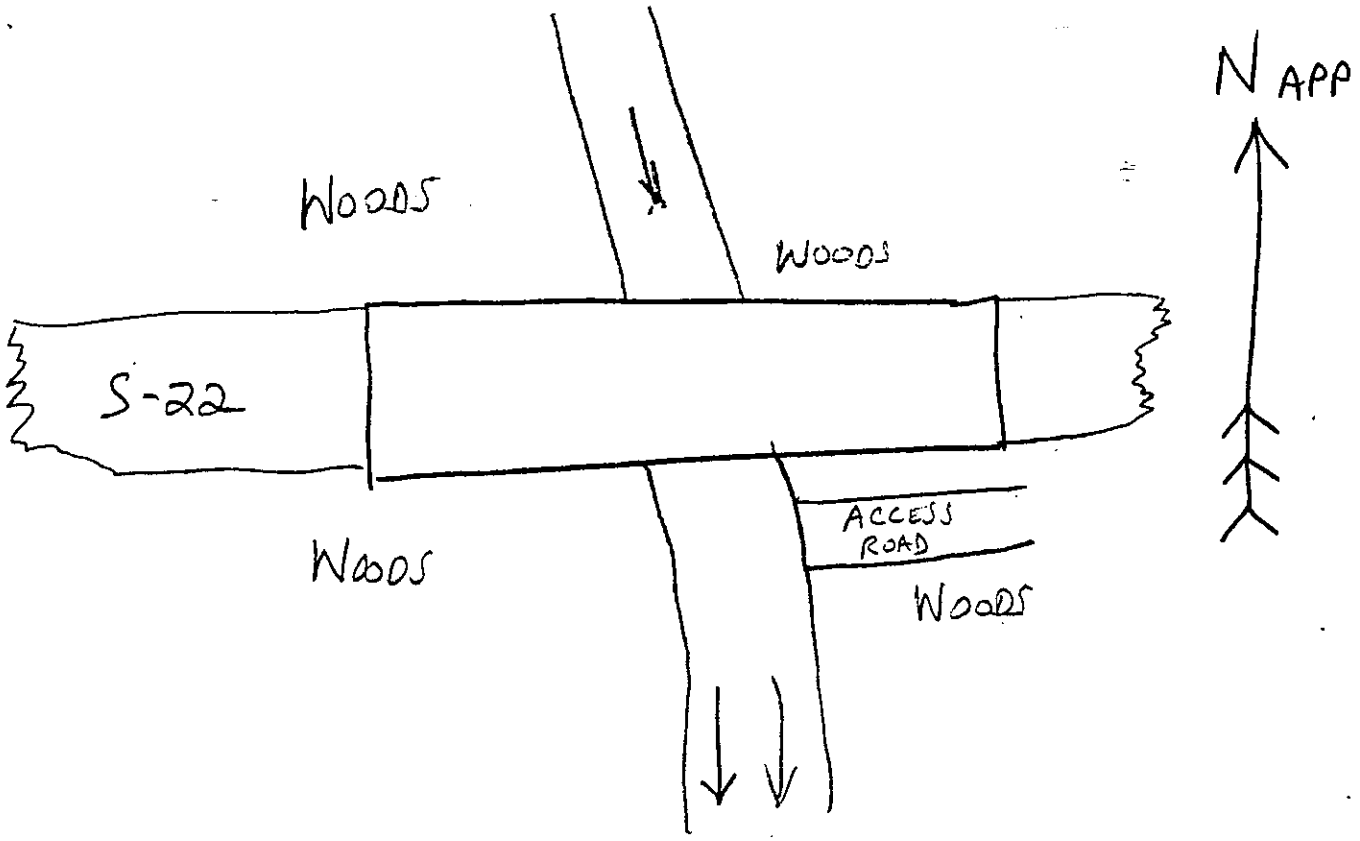
Superstructure Type Concrete Beam & deck composite
Substructure Type Concrete piles & pile caps PILES (1.50 FT SQUARE)
Debris accumulations on bridge. Yes/(NO)
Percent channel blocked horizontal None
Percent channel blocked vertical None
Guide Banks (Spur Dikes) Yes/(No)
Channel Spanned ? Yes/(No)
If No, number of bents in or near channel banks 4
Is the bridge crossing located in or near a channel bend ?
Yes/(No)
Is the bridge located on a tidal stream ? Yes/(No)

Are there any visible scour holes ? Yes/(No)
If Yes, locate scour holes on sketch.

Bank Condition: stable, scalloped

Rock Present ? Yes/(No) Boulders, Bed Rock, Shoals, etc.
If Yes, what type ?

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



Site Characteristics

General Topography Piedmont - Upper Coastal Plain
Stream Type (circle one) (Straight,) Braided, or Meandering
Are Channel banks Stable? (Yes)/~~No~~ If No, Describe _____

Are there any Hydraulic Controls Upstream or Downstream? Yes(No)
Describe _____

Soil type silty clay Exposed Rock Yes(No) If so, give description and location _____

Describe potential for drift little to none

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 None.

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
	0.020	0	0	0.010	0.01	1.00	0.040

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
BANKS	—	.1020	0	0	.1600	.180
BRIDGE BANKS	—	.020	0	0	.030	0.050

SITE

STREAM BED SOUNDINGS

* NOTE STATIONING INCREASING EASTWARD. DOWNSTREAM FACE SIMILIAR TO UPSTREAM.

IDGE NO. S-22 OVER THOMPSON CREEK COUNTY CHESTERFIELD DATE 12-20-94 BY EJC-RAL

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

DISTANCE H. W. MARK TO TOP OF RAIL 19.7 LOCATION H. W. MARK Several bents

~~DOWNSTREAM~~ UPSTREAM PGL to Top of Rail = 2.6 UPSTREAM

STATION	SOUNDING	DESCRIPTION	STATION	SOUNDING	DESCRIPTION
2+66	23.8	Edge of water		4.8	Lower Chord
2+70	20.3	Bent 10 - Top of Bank	0+01	4.2	End Bent #1
2+85	19.6		0+09	5.6	Top of slope
3+00	19.8	Bent 11	0+27	15.9	Toe of slope
3+15	19.9		0+30	16.4	Bent #2
3+30	19.8	Bent 12	0+45	16.9	
3+45	19.6		0+60	17.1	Bent #3
3+60	18.9	Bent 13	0+75	17.0	
3+75	18.7		0+90	17.3	Bent #4
3+90	18.3	Bent 14	1+05	17.0	
4+05	18.6		1+20	16.9	Bent #5
4+20	18.9	Bent #15	1+35	16.4	
4+35	18.9		1+50	16.2	Bent #6
4+47	18.0	Toe of fill	1+65	17.7	
4+50	16.4	Bent 16	1+72	19.2	Top of bank
4+65	9.3		1+76	23.8	Edge of water
4+79	4.0	End Bent #17	1+80	27.7	Bent #7
			1+95	28.3	
			2+10	30.3	Bent #8
			2+25	30.4	
			2+40	28.4	Bent #9
			2+55	27.5	

SHEET ____ OF ____

UPSTREAM

COMPARATIVE BRIDGE SITE INSPECTION FORM

County CHESTERFIELD Rt/Rd No. S-113
Stream THOMPSON CREEK Measured bridge length 90'

Maximum span length 30' Superstructure type Double "T" Concr Beams

Substructure type Steel piles - concrete pile caps End Abutment type Timber Bracketed

Rip-rap present? (Yes)/No Condition fair (6")

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

Any visible signs of scour problems (describe) No

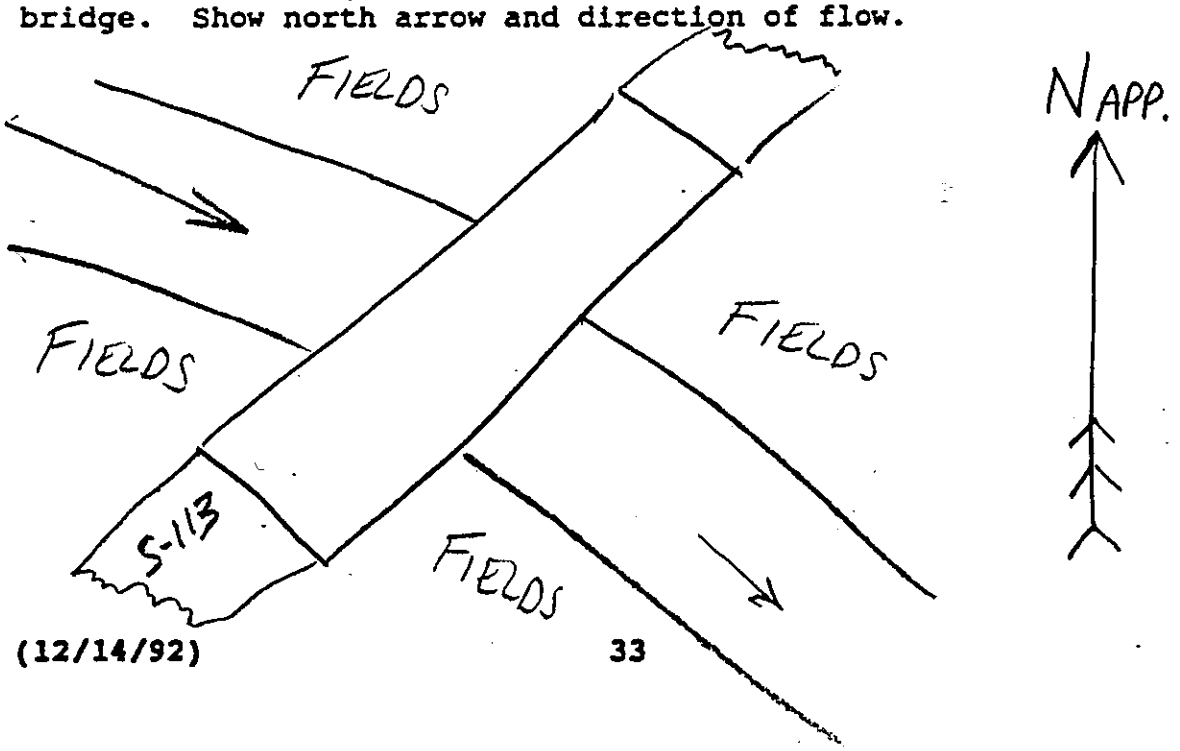
Are banks stable (describe) YES - VEGETATED

Debris blockage; Percent of channel blocked horizontally 0

vertically 0. Describe other signs of debris

Any other problems

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.



* Note Stationing Towards NE

STREAM BED SOUNDINGS

UPSTREAM OVER THOMPSON CREEK

IDGE NO. S-113 COUNTY CHESTERFIELD DATE 12-20-94 BY RAW/FJC

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

DISTANCE H. W. MARK TO TOP OF RAIL 5.6 LOCATION H. W. MARK Banks

PGL to Top of Rail = 0.8

DOWNSTREAM			UPSTREAM		
STATION	SOUNDING	DESCRIPTION	STATION	SOUNDING	DESCRIPTION
				2.4	Lower Chord
			0+01	2.4	NEAR END BENT #1
			0+04	4.7	Top of Riprap
			0+20	10.6	Toe of riprap - water surface
			0+30	12.5	Bent #2
			0+45	13.2	
			0+57	10.6	Edge of water Toe of riprap
			0+60	9.4	Bent #3
			0+75	5.0	Top of riprap
			0+89	2.4	
			0+90	—	END BENT #4

SHEET ___ OF ___

DOWNSTREAM

COMPARATIVE BRIDGE SITE INSPECTION FORM

County CHESTERFIELD Rt/Rd No. S-169
Stream THOMPSON CREEK Measured bridge length 118'

Maximum span length 30' Superstructure type Concrete Slab

Substructure type Timber Piles End Abutment type Timber Wall

Rip-rap present? Yes (No) Condition _____

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

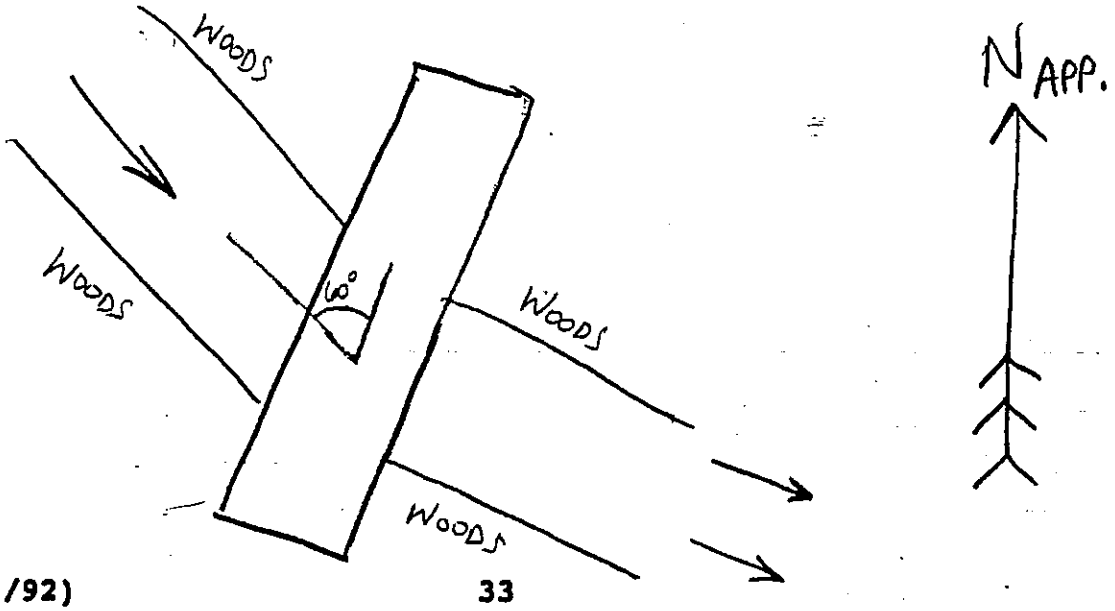
Debris blockage; Percent of channel blocked horizontally None

vertically None. Describe other signs of debris _____

some trash in creek (small appliances, car parts)

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.



DOWNSTREAM

STREAM BED SOUNDINGS

* BRIDGE STATIONED WITH STATIONS INCREASING SOUTHWARD.

BRIDGE NO. S-169 OVER THOMPSON CREEK COUNTY CHESTERFIELD DATE 12-20-94 BY FJC-RAL

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

DISTANCE H. W. MARK TO TOP OF RAIL 12.0 LOCATION H. W. MARK BENT #3

PGL to Top of Rail = 2.7

DOWNSTREAM			UPSTREAM (same as downstream)		
STATION	SOUNDING	DESCRIPTION	STATION	SOUNDING	DESCRIPTION
				3.8	Lower Chord
			0+01	3.5	Top of Abutment
			0+01	7.5	Bottom of Abutment
			0+15.6	12.9	Edge of bank
			0+17.8	16.9	Edge of water
			0+24.5	19.9	
			0+29	20.4	Bent #2
			0+43.5	19.2	
			0+59	19.5	Bent #3
			0+74.2	21.7	
			0+89	18.4	Bent #4
			0+90	16.9	Edge of water
			0+97	11.9	Top of bank
			1+04	9.2	Bent #5
			1+17	4.3	
			1+18	—	End abutment

SHEET ____ OF ____

Flood History

Local resident's name : anonymous MALE
address: CHERAW, S.C.
Phone # : NONE
Period of knowledge: 40 + yr
High water mark location: 1' below lower chord
Date of occurrence : Spring/summer 94
Frequency of flooding : DOESN'T KNOW

* NO EVIDENCE OF A FLOOD UP TO 1' BELOW LOWER CHORD WAS VISIBLE UNDER BRIDGE DURING FIELD INSPECTION.

APPENDIX 2

PHOTOGRAPHS

S-22 OVER THOMPSON CREEK
Chesterfield County

(1) Across Bridge Looking West

(2) Looking West Across Downstream Face

S-22 OVER THOMPSON CREEK
Chesterfield County

(3) Looking West Across Upstream Face

(4) Eastern Abutment

S-22 OVER THOMPSON CREEK
Chesterfield County

(5) Looking West Under Bridge

(6) Looking Upstream

S-22 OVER THOMPSON CREEK
Chesterfield County

(7) Looking Downstream

(8) Upstream Face Looking East

S-22 OVER THOMPSON CREEK
Chesterfield County

(9) Downstream Looking East

(10) Western Abutment

APPENDIX 3

WSPRO COMPUTER DATA
and
SCOUR CALCULATIONS

```
T1           STR. NO. 137002200300  CHESTERFIELD CO.
T2      S-22     OVER       THOMPSON CREEK
*F
Q             5380           7026
SK          0.0005         0.0005
XT         1   1000
GR   15450.0  120.0 15500.0  115.0 15600.0  110.0 15620.0  107.0
GR   15642.0   99.0 15703.0   97.9
GR   15715.0   98.6 15730.0   98.6 15745.0   98.8
GR   15760.0   99.1 15775.0   98.6 15790.0   98.4 15805.0   97.7
GR   15820.0   97.4 15835.0   97.3 15850.0   97.4 15865.0   97.5
GR   15880.0   96.8 15884.0   93.3 15895.0   89.5 15910.0   88.6
GR   15925.0   86.6 15940.0   86.6 15955.0   88.6 15970.0   89.1
GR   15974.0   93.0 15978.0   97.6 15985.0   99.1 16000.0  100.6
GR   16015.0  100.3 16030.0   99.8 16045.0   99.6 16060.0   99.3
GR   16075.0   99.6 16090.0   99.4 16105.0   99.6 16120.0  100.1
GR   16121.0   98.0 16175.0   98.0 16250.0  101.0 16275.0   97.0
GR   16300.0   98.5 16325.0   97.8 16330.0  101.0 16390.0  101.0
GR   16410.0   98.4 16450.0   97.8 16500.0  100.0 16800.0  101.0
GR   17000.0  100.5 17155.0  102.7 17360.0  102.7 17670.0  101.9
GR   17972.0  102.3 18375.0  110.3
XS      EXIT    520       30       *        * 0.0005
GT
N             0.18     0.04    0.18
SA           15884    15974
XS     FULLV   1000       30       *        * 0.0005
GT
N             0.18     0.04    0.18
SA           15884    15974
BR       BRID   1000    110.9      30
GR   15670.0  112.8 15671.0  113.6 15685.0  108.3 15700.0  101.1
GR   15703.0   99.5 15715.0   98.6 15730.0   98.6 15745.0   98.8
GR   15760.0   99.1 15775.0   98.6 15790.0   98.4 15805.0   97.7
GR   15820.0   97.4 15835.0   97.3 15850.0   97.4 15865.0   97.5
GR   15880.0   96.8 15884.0   93.3 15895.0   89.5 15910.0   88.6
GR   15925.0   86.6 15940.0   86.6 15955.0   88.6 15970.0   89.1
GR   15974.0   93.0 15978.0   97.6 15985.0   99.1 16000.0  100.6
GR   16015.0  100.3 16030.0   99.8 16045.0   99.6 16060.0   99.3
GR   16075.0   99.6 16090.0   99.4 16105.0   99.6 16120.0  100.1
GR   16123.0  100.5 16141.0  110.8 16149.0  112.2 16150.0  111.6
GR   15670.0  112.8
N             0.05     0.04    0.05
SA           15884    15974
CD               3     27.3   2.000   113.77       0       0       0
PW 1          86.6      1.5      89      1.5      89     4.5    97.3     4.5
              97.3        9    98.9        9    98.9    13.5    99.7    13.5
              99.7     19.5   100.9     19.5   100.9    22.5   111.5    22.5
             112.8        0
HP               1 BRID     101.8        *  101.8
HP               1 BRID    103.16        * 103.16
HP               2 BRID     101.8        *  101.8    5380
HP               2 BRID    103.16        * 103.16    7026
XR      ROAD 1013.6     27.3       1
GR   15670.0  115.4 17000.0  111.9 17155.0  111.3 17360.0  111.2 18670.0 113.5
GR   18670.0  114.2
AS      APPR 1507.3       30       *        * 0.0005
GT
N             0.18     0.04    0.18
SA           15884    15974
HP               1 APPR    101.95        * 101.95
```

HP	1 APPR	103.36	* 103.36		
HP	2 APPR	101.95	* 101.95	5380	
HP	2 APPR	103.36	* 103.36	7026	
EX					
ER					

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

            *** RUN DATE & TIME: 04-27-95  13:39

  T1             STR. NO. 137002200300  CHESTERFIELD CO.
  T2       S-22      OVER        THOMPSON CREEK
  *F
  Q               5380            7026
*** Q-DATA FOR SEC-ID, ISEQ =              1
  SK             0.0005          0.0005
```

```
WSPRO          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. 137002200300  CHESTERFIELD CO.
        22     OVER       THOMPSON CREEK
           *** RUN DATE & TIME: 04-27-95  13:39

*** START PROCESSING CROSS SECTION - "1    "
  XT   1        1000
  GR   15450.0   120.0 15500.0   115.0 15600.0   110.0 15620.0   107.0
  GR   15642.0    99.0 15703.0    97.9
  GR   15715.0    98.6 15730.0    98.6 15745.0    98.8
  GR   15760.0    99.1 15775.0    98.6 15790.0    98.4 15805.0    97.7
  GR   15820.0    97.4 15835.0    97.3 15850.0    97.4 15865.0    97.5
  GR   15880.0    96.8 15884.0    93.3 15895.0    89.5 15910.0    88.6
  GR   15925.0    86.6 15940.0    86.6 15955.0    88.6 15970.0    89.1
  GR   15974.0    93.0 15978.0    97.6 15985.0    99.1 16000.0   100.6
  GR   16015.0   100.3 16030.0    99.8 16045.0    99.6 16060.0    99.3
  GR   16075.0    99.6 16090.0    99.4 16105.0    99.6 16120.0   100.1
  GR   16121.0    98.0 16175.0    98.0 16250.0   101.0 16275.0    97.0
  GR   16300.0    98.5 16325.0    97.8 16330.0   101.0 16390.0   101.0
  GR   16410.0    98.4 16450.0    97.8 16500.0   100.0 16800.0   101.0
  GR   17000.0   100.5 17155.0   102.7 17360.0   102.7 17670.0   101.9
  GR   17972.0   102.3 18375.0   110.3

*** FINISH PROCESSING CROSS SECTION - "1    "
*** TEMPLATE CROSS SECTION "1    " SAVED INTERNALLY.
```

```
WSPRO          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. 137002200300  CHESTERFIELD CO.
        22     OVER        THOMPSON CREEK
           *** RUN DATE & TIME: 04-27-95  13:39

*** START PROCESSING CROSS SECTION - "EXIT "
  XS   EXIT     520      30       *        * 0.0005
  GT
  N              0.18     0.04    0.18
  SA            15884    15974

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

--- DATA SUMMARY FOR SECID "EXIT " AT SRD =    520.  ERR-CODE =      0

     SKEW      IHFNO     VSLOPE         EK         CK
     30.0        0.      .0005        .50        .00

X-Y COORDINATE PAIRS  (NGP =  55):
       X       Y          X       Y          X       Y          X       Y
  15450.0  119.76   15500.0  114.76   15600.0  109.76   15620.0  106.76
  15642.0   98.76   15703.0   97.66   15715.0   98.36   15730.0   98.36
  15745.0   98.56   15760.0   98.86   15775.0   98.36   15790.0   98.16
  15805.0   97.46   15820.0   97.16   15835.0   97.06   15850.0   97.16
  15865.0   97.26   15880.0   96.56   15884.0   93.06   15895.0   89.26
  15910.0   88.36   15925.0   86.36   15940.0   86.36   15955.0   88.36
  15970.0   88.86   15974.0   92.76   15978.0   97.36   15985.0   98.86
  16000.0  100.36   16015.0  100.06   16030.0   99.56   16045.0   99.36
  16060.0   99.06   16075.0   99.36   16090.0   99.16   16105.0   99.36
  16120.0   99.86   16121.0   97.76   16175.0   97.76   16250.0  100.76
  16275.0   96.76   16300.0   98.26   16325.0   97.56   16330.0  100.76
  16390.0  100.76   16410.0   98.16   16450.0   97.56   16500.0   99.76
  16800.0  100.76   17000.0  100.26   17155.0  102.46   17360.0  102.46
  17670.0  101.66   17972.0  102.06   18375.0  110.06

 X-Y MAX-MIN POINTS:
    XMIN       Y          X     YMIN       XMAX       Y          X     YMAX
  15450.0  119.76   15925.0   86.36   18375.0  110.06   15450.0  119.76

SUBAREA BREAKPOINTS (NSA =  3):
      15884.  15974.

ROUGHNESS COEFFICIENTS (NSA =  3):
         .180    .040    .180
```

```
WSPRO          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. 137002200300  CHESTERFIELD CO.
         22     OVER        THOMPSON CREEK
            *** RUN DATE & TIME: 04-27-95  13:39

*** START PROCESSING CROSS SECTION - "FULLV"
  XS   FULLV   1000      30      *       * 0.0005
  GT
  N              0.18    0.04   0.18
  SA            15884   15974

*** 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
     30.0        0.      .0005        .50        .00

X-Y COORDINATE PAIRS  (NGP =  55):
       X      Y           X      Y           X      Y           X      Y
  15450.0  120.00    15500.0  115.00    15600.0  110.00    15620.0  107.00
  15642.0   99.00    15703.0   97.90    15715.0   98.60    15730.0   98.60
  15745.0   98.80    15760.0   99.10    15775.0   98.60    15790.0   98.40
  15805.0   97.70    15820.0   97.40    15835.0   97.30    15850.0   97.40
  15865.0   97.50    15880.0   96.80    15884.0   93.30    15895.0   89.50
  15910.0   88.60    15925.0   86.60    15940.0   86.60    15955.0   88.60
  15970.0   89.10    15974.0   93.00    15978.0   97.60    15985.0   99.10
  16000.0  100.60    16015.0  100.30    16030.0   99.80    16045.0   99.60
  16060.0   99.30    16075.0   99.60    16090.0   99.40    16105.0   99.60
  16120.0  100.10    16121.0   98.00    16175.0   98.00    16250.0  101.00
  16275.0   97.00    16300.0   98.50    16325.0   97.80    16330.0  101.00
  16390.0  101.00    16410.0   98.40    16450.0   97.80    16500.0  100.00
  16800.0  101.00    17000.0  100.50    17155.0  102.70    17360.0  102.70
  17670.0  101.90    17972.0  102.30    18375.0  110.30

 X-Y MAX-MIN POINTS:
     XMIN       Y         X     YMIN       XMAX       Y         X     YMAX
  15450.0  120.00   15925.0   86.60   18375.0  110.30   15450.0  120.00

SUBAREA BREAKPOINTS (NSA =  3):
      15884.  15974.

ROUGHNESS COEFFICIENTS (NSA =  3):
         .180    .040    .180
```

```
WSPRO          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. 137002200300  CHESTERFIELD CO.
         22     OVER       THOMPSON CREEK
            *** RUN DATE & TIME: 04-27-95  13:39

*** START PROCESSING CROSS SECTION - "BRID "
  BR   BRID    1000   110.9     30
  GR   15670.0  112.8 15671.0  113.6 15685.0  108.3 15700.0  101.1
  GR   15703.0   99.5 15715.0   98.6 15730.0   98.6 15745.0   98.8
  GR   15760.0   99.1 15775.0   98.6 15790.0   98.4 15805.0   97.7
  GR   15820.0   97.4 15835.0   97.3 15850.0   97.4 15865.0   97.5
  GR   15880.0   96.8 15884.0   93.3 15895.0   89.5 15910.0   88.6
  GR   15925.0   86.6 15940.0   86.6 15955.0   88.6 15970.0   89.1
  GR   15974.0   93.0 15978.0   97.6 15985.0   99.1 16000.0  100.6
  GR   16015.0  100.3 16030.0   99.8 16045.0   99.6 16060.0   99.3
  GR   16075.0   99.6 16090.0   99.4 16105.0   99.6 16120.0  100.1
  GR   16123.0  100.5 16141.0  110.8 16149.0  112.2 16150.0  111.6
  GR   15670.0  112.8
  N             0.05    0.04    0.05
  SA           15884   15974
  CD               3    27.3   2.000  113.77       0       0       0
  PW 1          86.6     1.5      89     1.5      89     4.5    97.3     4.5
                97.3       9    98.9       9    98.9    13.5    99.7    13.5
                99.7    19.5   100.9    19.5   100.9    22.5   111.5    22.5
               112.8       0
  HP               1 BRID     101.8       *  101.8

*** 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
     30.0        0.      .0005       .50        .00

X-Y COORDINATE PAIRS  (NGP =  41):
       X      Y          X      Y          X      Y          X      Y
  15670.0  112.80   15671.0  113.60   15685.0  108.30   15700.0  101.10
  15703.0   99.50   15715.0   98.60   15730.0   98.60   15745.0   98.80
  15760.0   99.10   15775.0   98.60   15790.0   98.40   15805.0   97.70
  15820.0   97.40   15835.0   97.30   15850.0   97.40   15865.0   97.50
  15880.0   96.80   15884.0   93.30   15895.0   89.50   15910.0   88.60
  15925.0   86.60   15940.0   86.60   15955.0   88.60   15970.0   89.10
  15974.0   93.00   15978.0   97.60   15985.0   99.10   16000.0  100.60
  16015.0  100.30   16030.0   99.80   16045.0   99.60   16060.0   99.30
  16075.0   99.60   16090.0   99.40   16105.0   99.60   16120.0  100.10
  16123.0  100.50   16141.0  110.80   16149.0  112.20   16150.0  111.60
  15670.0  112.80

X-Y MAX-MIN POINTS:
     XMIN       Y          X    YMIN       XMAX       Y          X    YMAX
  15670.0  112.80   15925.0   86.60   16150.0  111.60   15671.0  113.60

SUBAREA BREAKPOINTS (NSA =  3):
      15884.  15974.
```

ROUGHNESS COEFFICIENTS (NSA = 3):

.050	.040	.050

BRIDGE PARAMETERS:

BRTYPE	BRWDTH	LSEL	USERCD	EMBSS	EMBELV	ABSLPL	ABSLPR
3	27.3	110.90	*******	2.00	113.77	*******	*******

PIER DATA: NPW = 13 PPCD = 1.

PELV	PWDTH	PELV	PWDTH	PELV	PWDTH	PELV	PWDTH
86.60	1.5	89.00	1.5	89.00	4.5	97.30	4.5
97.30	9.0	98.90	9.0	98.90	13.5	99.70	13.5
99.70	19.5	100.90	19.5	100.90	22.5	111.50	22.5
112.80	.0						

WSPRO 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. 137002200300 CHESTERFIELD CO.
22 OVER THOMPSON CREEK
*** RUN DATE & TIME: 04-27-95 13:39
CROSS-SECTION PROPERTIES: ISEQ = 3; SECID = BRID ; SRD = 1000.

WSEL	SA#	AREA	K	TOPW	WETP	ALPH	LEW	REW	QCR
	1	593.	41811.	161.	163.				6463.
	2	1037.	211642.	78.	81.				21450.
	3	288.	14261.	131.	134.				2418.
101.80		1917.	267715.	370.	378.	1.74	15699.	16125.	18801.

HP	1	BRID	103.16	* 103.16

WSPRO 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. 137002200300 CHESTERFIELD CO.
22 OVER THOMPSON CREEK
*** RUN DATE & TIME: 04-27-95 13:39
CROSS-SECTION PROPERTIES: ISEQ = 3; SECID = BRID ; SRD = 1000.

WSEL	SA#	AREA	K	TOPW	WETP	ALPH	LEW	REW	QCR
	1	813.	69967.	163.	166.				10299.
	2	1143.	248931.	78.	81.				24823.
	3	467.	31621.	133.	136.				4968.
103.16		2423.	350519.	374.	383.	1.70	15696.	16128.	26826.

HP	2 BRID	101.8	*	101.8	5380

WSPRO 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. 137002200300 CHESTERFIELD CO.
22 OVER THOMPSON CREEK
*** RUN DATE & TIME: 04-27-95 13:39

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

WSEL	LEW	REW	AREA	K	Q	VEL
101.80	15698.5	16125.3	1917.0	267715.	5380.	2.81

X STA.	15698.5	15790.9	15838.4	15880.8	15892.8	15899.4
A(I)		235.7	172.2	165.3	96.1	70.2
V(I)		1.14	1.56	1.63	2.80	3.83
X STA.	15899.4	15905.4	15911.1	15916.4	15921.3	15926.0
A(I)		66.4	63.7	63.6	61.4	60.2
V(I)		4.05	4.22	4.23	4.38	4.47
X STA.	15926.0	15930.5	15935.0	15939.4	15944.1	15949.1
A(I)		59.5	59.5	58.1	60.5	61.5
V(I)		4.52	4.52	4.63	4.44	4.37
X STA.	15949.1	15954.5	15960.1	15966.1	15975.8	16125.3
A(I)		64.5	63.7	66.6	92.8	275.5
V(I)		4.17	4.22	4.04	2.90	.98

HP	2 BRID	103.16	* 103.16	7026	

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. 137002200300 CHESTERFIELD CO.
22 OVER THOMPSON CREEK
*** RUN DATE & TIME: 04-27-95 13:39

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

WSEL	LEW	REW	AREA	K	Q	VEL
103.16	15695.7	16127.6	2422.6	350519.	7026.	2.90

X STA.	15695.7	15765.5	15814.1	15850.4	15884.2	15894.3
A(I)		245.7	206.6	182.3	179.5	102.9
V(I)		1.43	1.70	1.93	1.96	3.42
X STA.	15894.3	15901.1	15907.6	15913.8	15919.5	15924.9
A(I)		81.3	79.9	78.8	76.2	75.0
V(I)		4.32	4.40	4.46	4.61	4.69
X STA.	15924.9	15930.0	15935.1	15940.1	15945.5	15951.2
A(I)		73.6	73.6	71.9	74.4	77.1
V(I)		4.77	4.77	4.88	4.72	4.55
X STA.	15951.2	15957.5	15963.9	15970.7	16042.1	16127.6
A(I)		79.4	79.6	83.1	245.2	256.2
V(I)		4.42	4.41	4.23	1.43	1.37

```
WSPRO          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. 137002200300  CHESTERFIELD CO.
        22     OVER       THOMPSON CREEK
           *** RUN DATE & TIME: 04-27-95  13:39

*** START PROCESSING CROSS SECTION - "ROAD "
  XR   ROAD  1013.6    27.3      1
  GR   15670.0  115.4 17000.0  111.9 17155.0  111.3 17360.0  111.2 18670.0 113.5
  GR   18670.0  114.2

*** FINISH PROCESSING CROSS SECTION - "ROAD "
*** NO ROUGHNESS DATA INPUT, WILL PROPAGATE FROM PREVIOUS CROSS SECTION.
*** CROSS SECTION "ROAD " WRITTEN TO DISK, RECORD NO. =  4

--- DATA SUMMARY FOR SECID "ROAD " AT SRD =   1014.  ERR-CODE =      0

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

X-Y COORDINATE PAIRS  (NGP =   6):
       X      Y           X      Y           X      Y           X      Y
  15670.0  115.40    17000.0  111.90    17155.0  111.30    17360.0  111.20
  18670.0  113.50    18670.0  114.20

 X-Y MAX-MIN POINTS:
     XMIN       Y          X     YMIN       XMAX       Y          X     YMAX
  15670.0  115.40    17360.0  111.20    18670.0  113.50    15670.0  115.40

SUBAREA BREAKPOINTS (NSA =  3):
      15884.  15974.

ROUGHNESS COEFFICIENTS (NSA =  3):
         .180    .040    .180

ROAD GRADE DATA:  IPAVE  RDWID  USERCF
                     1.   27.3 *******

BRIDGE PROJECTION DATA:  XREFLT  XREFRT  FDSTLT  FDSTRT
                        ******* ******* ******* *******
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WSPRO          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. 137002200300  CHESTERFIELD CO.
         22     OVER        THOMPSON CREEK
            *** RUN DATE & TIME: 04-27-95  13:39

*** START PROCESSING CROSS SECTION - "APPR "
  AS   APPR  1507.3      30       *        * 0.0005
  GT
  N              0.18    0.04   0.18
  SA            15884   15974
  HP                1 APPR    101.95        * 101.95

*** FINISH PROCESSING CROSS SECTION - "APPR "
*** CROSS SECTION "APPR " WRITTEN TO DISK, RECORD NO. =  5

--- DATA SUMMARY FOR SECID "APPR " AT SRD =    1507.  ERR-CODE =       0

     SKEW      IHFNO     VSLOPE         EK         CK
     30.0        0.      .0005        .50        .00

X-Y COORDINATE PAIRS  (NGP =  55):
       X      Y          X      Y          X      Y          X      Y
  15450.0  120.25   15500.0  115.25   15600.0  110.25   15620.0  107.25
  15642.0   99.25   15703.0   98.15   15715.0   98.85   15730.0   98.85
  15745.0   99.05   15760.0   99.35   15775.0   98.85   15790.0   98.65
  15805.0   97.95   15820.0   97.65   15835.0   97.55   15850.0   97.65
  15865.0   97.75   15880.0   97.05   15884.0   93.55   15895.0   89.75
  15910.0   88.85   15925.0   86.85   15940.0   86.85   15955.0   88.85
  15970.0   89.35   15974.0   93.25   15978.0   97.85   15985.0   99.35
  16000.0  100.85   16015.0  100.55   16030.0  100.05   16045.0   99.85
  16060.0   99.55   16075.0   99.85   16090.0   99.65   16105.0   99.85
  16120.0  100.35   16121.0   98.25   16175.0   98.25   16250.0  101.25
  16275.0   97.25   16300.0   98.75   16325.0   98.05   16330.0  101.25
  16390.0  101.25   16410.0   98.65   16450.0   98.05   16500.0  100.25
  16800.0  101.25   17000.0  100.75   17155.0  102.95   17360.0  102.95
  17670.0  102.15   17972.0  102.55   18375.0  110.55

 X-Y MAX-MIN POINTS:
     XMIN       Y          X     YMIN       XMAX       Y          X     YMAX
  15450.0  120.25   15925.0   86.85   18375.0  110.55   15450.0  120.25

SUBAREA BREAKPOINTS (NSA =  3):
      15884.  15974.

ROUGHNESS COEFFICIENTS (NSA =  3):
         .180    .040    .180

BRIDGE PROJECTION DATA:  XREFLT  XREFRT  FDSTLT  FDSTRT
                        ******* ******* ******* *******
```

WSPRO 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. 137002200300 CHESTERFIELD CO.
22 OVER THOMPSON CREEK
*** RUN DATE & TIME: 04-27-95 13:39
CROSS-SECTION PROPERTIES: ISEQ = 5; SECID = APPR ; SRD = 1507.

WSEL	SA#	AREA	K	TOPW	WETP	ALPH	LEW	REW	QCR
	1	761.	14482.	216.	218.				8100.
	2	1028.	208900.	78.	81.				21200.
	3	1653.	19548.	962.	967.				12293.
101.95		3442.	242930.	1255.	1266.	7.13	15635.	17084.	12112.

HP	1	APPR	103.36	* 103.36

WSPRO FEDERAL HIGHWAY ADMINISTRATION - U. S. GEOLOGICAL SURVEY
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STR. NO. 137002200300 CHESTERFIELD CO.
22 OVER THOMPSON CREEK
*** RUN DATE & TIME: 04-27-95 13:39
CROSS-SECTION PROPERTIES: ISEQ = 5; SECID = APPR ; SRD = 1507.

WSEL	SA#	AREA	K	TOPW	WETP	ALPH	LEW	REW	QCR
	1	1068.	25199.	219.	222.				13365.
	2	1138.	247414.	78.	81.				24687.
	3	3630.	48478.	1765.	1771.				29535.
103.36		5836.	321090.	2063.	2074.	12.05	15631.	18013.	16048.

HP	2 APPR	101.95	* 101.95	5380	

WSPRO
P060188

FEDERAL HIGHWAY ADMINISTRATION - U. S. GEOLOGICAL SURVEY
MODEL FOR WATER-SURFACE PROFILE COMPUTATIONS
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STR. NO. 137002200300 CHESTERFIELD CO.
22 OVER THOMPSON CREEK
*** RUN DATE & TIME: 04-27-95 13:39

VELOCITY DISTRIBUTION: ISEQ = 5; SECID = APPR ; SRD = 1507.

WSEL	LEW	REW	AREA	K	Q	VEL
101.95	15634.6	17084.3	3441.7	242930.	5380.	1.56

X STA.	15634.6	15857.2	15892.0	15898.2	15903.6	15909.1
A(I)		650.2	178.4	64.0	59.3	60.6
V(I)		.41	1.51	4.20	4.54	4.44
X STA.	15909.1	15914.1	15918.8	15923.1	15927.3	15931.4
A(I)		58.5	56.4	54.8	54.0	54.2
V(I)		4.60	4.77	4.91	4.98	4.96
X STA.	15931.4	15935.6	15939.8	15944.0	15948.5	15953.5
A(I)		54.3	54.3	54.1	55.9	58.9
V(I)		4.95	4.95	4.97	4.81	4.56
X STA.	15953.5	15958.6	15963.9	15969.4	16183.6	17084.3
A(I)		57.6	59.4	60.3	514.6	1181.7
V(I)		4.67	4.53	4.46	.52	.23

HP	2 APPR	103.36	* 103.36	7026	

WSPRO 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. 137002200300 CHESTERFIELD CO.
22 OVER THOMPSON CREEK
*** RUN DATE & TIME: 04-27-95 13:39

VELOCITY DISTRIBUTION: ISEQ = 5; SECID = APPR ; SRD = 1507.

WSEL	LEW	REW	AREA	K	Q	VEL
103.36	15630.7	18012.6	5835.9	321090.	7026.	1.20

X STA.	15630.7	15815.4	15889.0	15896.5	15902.6	15908.7
A(I)		716.9	396.6	83.4	73.6	75.2
V(I)		.49	.89	4.21	4.77	4.67
X STA.	15908.7	15914.3	15919.5	15924.4	15929.1	15933.8
A(I)		71.3	69.3	68.7	67.2	67.2
V(I)		4.93	5.07	5.11	5.23	5.22
X STA.	15933.8	15938.6	15943.4	15948.4	15953.9	15959.7
A(I)		68.3	67.6	68.2	71.3	73.5
V(I)		5.14	5.19	5.15	4.93	4.78
X STA.	15959.7	15965.7	15975.7	16201.8	16453.5	18012.6
A(I)		73.8	107.4	782.6	814.2	2019.7
V(I)		4.76	3.27	.45	.43	.17

EX

+++ BEGINNING PROFILE CALCULATIONS -- 2

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WSPRO          FEDERAL HIGHWAY ADMINISTRATION - U. S. GEOLOGICAL SURVEY
P060188            MODEL  FOR  WATER-SURFACE  PROFILE  COMPUTATIONS
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            STR. NO. 137002200300  CHESTERFIELD CO.
         22     OVER        THOMPSON CREEK
            *** RUN DATE & TIME: 04-27-95  13:39

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

EXIT :XS   ****** 15635.     3382.   .28 *****  101.68   93.55   5380.  101.41
      520. ****** 17081.   240490.  7.02 ***** *******     .45    1.59

FULLV:FV     480. 15635.     3394.   .28   .24  101.93 *******   5380.  101.66
     1000.   480. 17082.   240982.  7.04   .00     .01     .45    1.59
         <<<<<THE ABOVE RESULTS REFLECT "NORMAL" (UNCONSTRICTED) FLOW>>>>>

APPR :AS     507. 15635.     3404.   .27   .25  102.19 *******   5380.  101.92
     1507.   507. 17082.   241410.  7.06   .00     .01     .45    1.58
         <<<<<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

BRID :BR     480. 15699.     1918.   .14   .26  101.94   94.01   5380.  101.80
     1000.   480. 16125.   267906.  1.13   .00     .01     .23    2.80

     TYPE PPCD FLOW      C     P/A    LSEL   BLEN   XLAB   XRAB
       3.   1.   1.    .941    .057  110.90 ****** ****** ******

   XSID:CODE    SRD   FLEN    HF    VHD     EGL     ERR       Q    WSEL
  ROAD :RG     1014.        <<<<<EMBANKMENT IS NOT OVERTOPPED>>>>>

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

APPR :AS     480. 15635.     3447.   .27   .26  102.22   94.05   5380.  101.95
     1507.   495. 17085.   243164.  7.14   .02     .00     .44    1.56

      M(G)   M(K)       KQ   XLKQ   XRKQ    OTEL
      .706   .076   224698. 15704. 16131.   101.72

                  <<<<<END OF BRIDGE COMPUTATIONS>>>>>
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WSPRO          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. 137002200300  CHESTERFIELD CO.
       22     OVER        THOMPSON CREEK
          *** RUN DATE & TIME: 04-27-95  13:39

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

EXIT :XS   ****** 15631.     5637.    .28 *****  103.05   94.59   7026.  102.77
     520. ****** 18008.   313910. 11.79 ***** *******      .46    1.25

FULLV:FV     480. 15631.     5664.    .28    .24  103.31 *******   7026.  103.02
    1000.    480. 18008.   314880. 11.83    .00     .01      .45    1.24
        <<<<<THE ABOVE RESULTS REFLECT "NORMAL" (UNCONSTRICTED) FLOW>>>>>

APPR :AS     507. 15631.     5687.    .28    .25  103.57 *******   7026.  103.29
    1507.    507. 18009.   315693. 11.86    .00     .01      .45    1.24
        <<<<<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

BRID :BR     480. 15696.     2424.    .16    .27  103.33   95.13   7026.  103.16
    1000.    480. 16128.   350813.   1.25    .00     .00      .22    2.90

     TYPE PPCD FLOW      C     P/A    LSEL   BLEN   XLAB   XRAB
       3.   1.   1.    .896    .058  110.90 ****** ****** ******

   XSID:CODE     SRD    FLEN     HF    VHD      EGL      ERR        Q     WSEL
  ROAD :RG      1014.          <<<<<EMBANKMENT IS NOT OVERTOPPED>>>>>

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

APPR :AS     480. 15631.     5838.    .27    .29  103.63   95.08   7026.  103.36
    1507.    515. 18013.   321167. 12.05    .02     .00      .44    1.20

      M(G)   M(K)       KQ    XLKQ    XRKQ     OTEL
      .819   .138  277016. 15704. 16136.   103.13

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

ER
```

NORMAL END OF WSPRO EXECUTION.

S-22 OVER THOMPSON CREEK CHESTERFIELD COUNTY
100 YEAR FLOODPLAIN CLEAR WATER CONTRACTION SCOUR

Y1=	4.55
Q=	269.4
Dm=	0.000820
W2=	33.2
Ys=	Y1*.13*[(Q/(Dm^.333*Y1^1.167*W)^.857-1]
Ys=	1.4

500 YEAR FLOODPLAIN CLEAR WATER CONTRACTION SCOUR

Y1=	5.96
Q=	351.8
Dm=	0.000820
W2=	27.2
Ys=	Y1*.13*[(Q/(Dm^.333*Y1^1.167*W)^.857-1]
Ys=	2.9

100 YEAR FLOODPLAIN PIER SCOUR

GROUND=	97.4
Y1=	4.55
K1=	1.0
K2=	2.0
K3=	1.1
a=	1.4 ft
V1=	1.6
Fr1=	0.135
Ys=	Y1*2*K1*K2*K3*(a/Y1)^0.65*Fr1^0.43
Ys=	3.9

500 YEAR FLOODPLAIN PIER SCOUR

GROUND=	97.4
Y1=	6.0
K1=	1.0
K2=	2.0
K3=	1.1
a=	1.4 ft
V1=	1.93
Fr1=	0.139
Ys=	Y1*2*K1*K2*K3*(a/Y1)^0.65*Fr1^0.43
Ys=	4.4

S-22 OVER THOMPSON CREEK CHESTERFIELD COUNTY
100 YR ABUTMENT SCOUR

a' LENGTH OF ABUT.		
PROJ. NORMAL TO FLOW=	834.2	
OBSTRUCTED FLOW AREA=	1127	
Ya=	1.4	
VERT. WALL	1	
VERT. WALL W/ WINGS	0.82	
SPILL THROUGH	0.55	
K1=	0.55	
EMB. ANGLE (PERP.=90)	60	SIDE WITH FLOW REVERSAL HAS HIGHER ANGLE
K2=	0.949	
OBSTRUCTED FLOW (cfs)	302	
Ve=	0.27	
Fre=Ve/(gYa)^0.5=	0.0406	

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

Ys= 4.6

500 YR ABUTMENT SCOUR

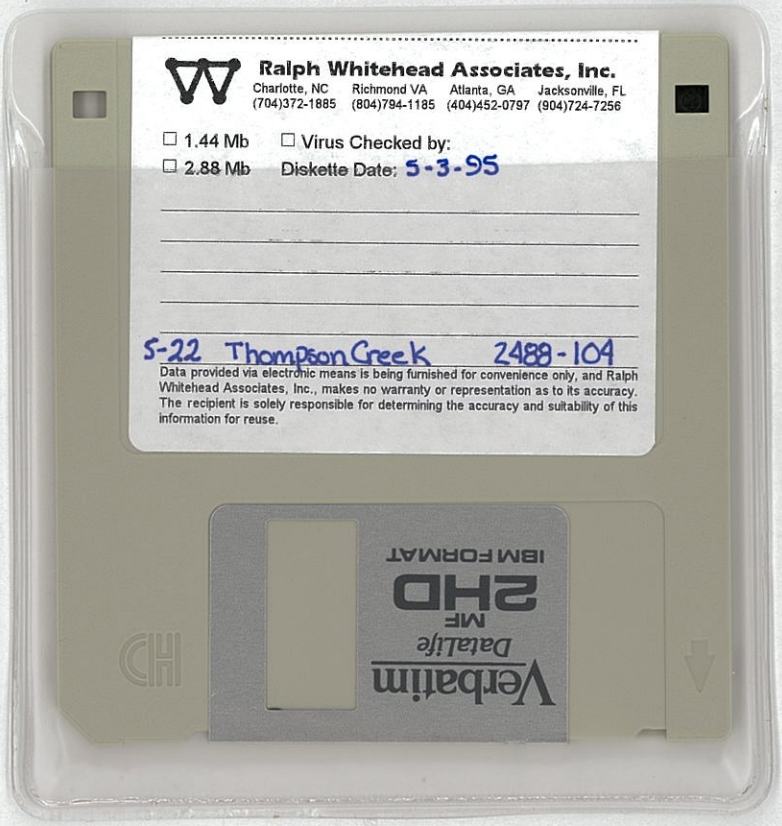
a' LENGTH OF ABUT.		
PROJ. NORMAL TO FLOW=	1638.1	
OBSTRUCTED FLOW AREA=	2697	
Ya=	1.6	
VERT. WALL	1	
VERT. WALL W/ WINGS	0.82	
SPILL THROUGH	0.55	
K1=	0.55	
EMB. ANGLE (PERP.=90)	60	SIDE WITH FLOW REVERSAL HAS HIGHER ANGLE
K2=	0.949	
OBSTRUCTED FLOW (cfs)	820	
Ve=	0.30	
Fre=Ve/(gYa)^0.5=	0.0417	

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

Ys= 6.5

APPENDIX 4

COMPUTER DISKETTE
(WSPRO INPUT AND OUTPUT)



APPENDIX 5

Selected References

1. HEC-20, Stream Stability at Highway Structures, Publication No. FHWA-IP-90-014. FHWA, U.S. Department of Transportation, February 1991

2. Techniques for Estimating Magnitude and Frequency of Floods in South Carolina, 1988, U.S. Geological Survey Water-Resources Investigations Report 91-4157.

3. The WSPRO computer program and manual, prepared by the U.S. Geological Survey for The Federal Highway Administration.

4. HEC-18, Evaluating Scour at Bridges (Second Edition), Publication No. FHWA-IP-90-017. FHWA, U.S. Department of Transportation, Revised April 1993.