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## SCOUR ANALYSIS AND REPORTING FORM

Bridge Structure No. 681 34120 Date 5/29/12 Initials rat Region ( A B C D )

Site _____ Location 1.5 E of HWY 81 on 303 St

$Q_{100}$ = 50 6500 by: drainage area ratio ____ flood freq. anal. ____ regional regression eq. ✓

Bridge discharge ($Q_2$) = 6500 (should be $Q_{100}$ unless there is a relief bridge, road overflow, or bridge overtopping)

### Analytical Procedure for Estimating Hydraulic Variables Needed to Apply Method

PGRM: "RegionA", "RegionB", "RegionC", or "RegionD"

Bridge Width = 456 ft. Flow angle at bridge = 5 ° Abut. Skew = 0 ° Effective Skew = 5 °

Width ($W_2$) iteration = _____ _____ _____ _____

Avg. flow depth at bridge, $y_2$ iteration = _____ _____ _____ _____

Corrected channel width at bridge Section = $W_2$ times cos of flow angle = 454.26 ft* $q_2 = Q_2/W_2$ = 143.3 ft²/s

Bridge Vel, $V_2$ = 8.5 ft/s Final $y_2 = q_2/V_2$ = 16.9 ft $\Delta h$ = 1.5 ft

Average main channel depth at approach section, $y_1 = \Delta h + y_2$ = 18.41 ft

** NOTE: repeat above calculations until $y_2$ changes by less than 0.2* *Effective pier width = L sin(q) + a cos(q)*

*If $y_2$ is above LS, then account for Road Overflow using PRGM: RDOVREGA, RDOVREGB, RDOVREGC, or RDOVREGD,*

Water Surface Elev. = UNK ft

Low Steel Elev. = 19.2 ft

n (Channel) = 0.045

n (LOB) = 0.050

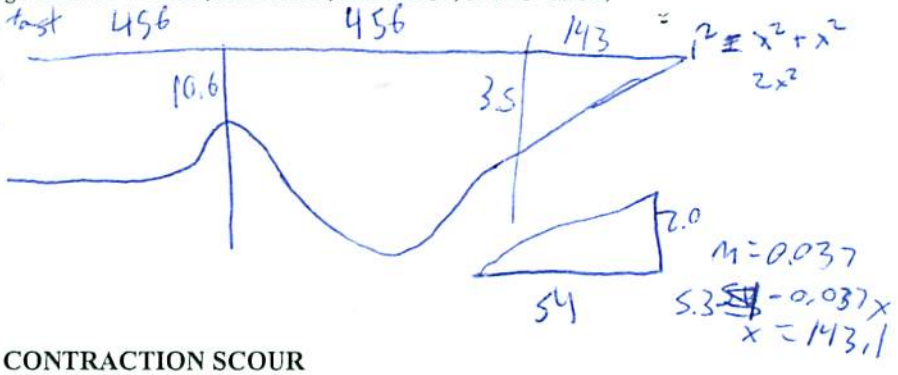
n (ROB) = 0.040

Pier Width = 1.204 ft

Pier Length = 2.4 ft

# Piers for 100 yr = 4 ft

current too fast




### CONTRACTION SCOUR

PGRM: Contract

Width of main channel at approach section $W_1$ = 456 ft

Width of left overbank flow at approach, $W_{lob}$ = 456 ft Average left overbank flow depth, $y_{lob}$ = 10.6 ft

Width of right overbank flow at approach, $W_{rob}$ = 143 ft Average right overbank flow depth, $y_{rob}$ = 3.5 ft

$5.3 - \frac{2}{3} = \frac{10.6}{3}$

Live Bed Contraction Scour (use if bed material is small cobbles or finer)

$x$ = 7.66 From Figure 9 $W_2$ (effective) = 444.7 ft $y_{cs}$ = 8.5 ft

PGRM: CWCSNEW

Clear Water Contraction Scour (use if bed material is larger than small cobbles)

Estimated bed material $D_{50}$ = _____ ft Average approach velocity, $V_1 = Q_{100}/(y_1 W_1)$ = _____ ft/s

Critical approach velocity, $Vc = 11.17 y_1^{1/6} D_{50}^{1/3}$ = _____ ft/s

If $V_1 < V_c$ and $D_{50} >= 0.2$ ft, use clear water equation below, otherwise use live bed scour equation above.

$D_{c50} = 0.0006(q_2/y_1^{7/6})^3$ = _____ ft If $D_{50} >= D_{c50}$, $\chi = 0.0$

Otherwise, $\chi = 0.122 y_1 [q_2/(D_{50}^{1/3} y_1^{7/6})]^{6/7} - y_1$ = _____ From Figure 10, $y_{cs}$ = _____ ft

PGRM: Pier

### PIER SCOUR CALCULATIONS

L/a ratio = 1 Correction factor for flow angle of attack (from Table 1), K2 = 1

Froude # at bridge = 0.36 Using pier width a on Figure 11, $\xi$ = 9.2 Pier scour $y_{ps}$ = 7.9 ft

PGRM: Abutment

### ABUTMENT SCOUR CALCULATIONS

Average flow depth blocked by: left abutment, $y_{aLT}$ = 10.6 ft right abutment, $y_{aRT}$ = 3.5 ft

Shape coefficient $K_1$= 1.00 for vertical-wall, 0.82 for vertical-wall with wingwalls, 0.55 for spill-through

Using values for $y_{aLT}$ and $y_{aRT}$ on figure 12, $\psi_{LT}$ = 21.8 and $\psi_{RT}$ = 12.4

Left abutment scour, $y_{as} = \psi_{LT}(K_1/0.55)$ = 21.8 ft Right abutment scour $y_{as} = \psi_{RT}(K_1/0.55)$ = 12.4 ft

## SCOUR ANALYSIS AND REPORTING FORM

Bridge Structure No. 68134120 Date 5/29/12 Initials RAT Region ( A B C D )

Site _____ Location 1.5 E of HWY 81 on 303 St

$Q_{500}$ = 104000 by: drainage area ratio ____ flood freq. anal. ____ regional regression eq. X

Bridge discharge ($Q_2$) = 87823 (should be $Q_{500}$ unless there is a relief bridge, road overflow, or bridge overtopping)

### Analytical Procedure for Estimating Hydraulic Variables Needed to Apply Method

PGRM: "RegionA", "RegionB", "RegionC", or "RegionD"

Bridge Width = 456 ft. Flow angle at bridge = 5 ° Abut. Skew = 0 ° Effective Skew = 5 °

Width ($W_2$) iteration = _____ _____ _____ _____

Avg. flow depth at bridge, $y_2$ iteration = _____ _____ _____ _____

Corrected channel width at bridge Section = $W_2$ times cos of flow angle = 454.26 ft* $q_2 = Q_2/W_2$ = 193.3 $ft^2/s$

Bridge Vel, $V_2$ = 9.9 ft/s Final $y_2 = q_2/V_2$ = 19.6 ft $\Delta h$ = 2 ft

Average main channel depth at approach section, $y_1 = \Delta h + y_2$ = 21.6 ft

* *NOTE: repeat above calculations until $y_2$ changes by less than 0.2* *Effective pier width = L sin(q) + a cos(q)*

*If $y_2$ is above LS, then account for Road Overflow using PRGM: RDOVREGA, RDOVREGB, RDOVREGC, or RDOVREGD,*

Water Surface Elev. = UNK ft

Low Steel Elev. = 19.6 ft

n (Channel) = 0.045

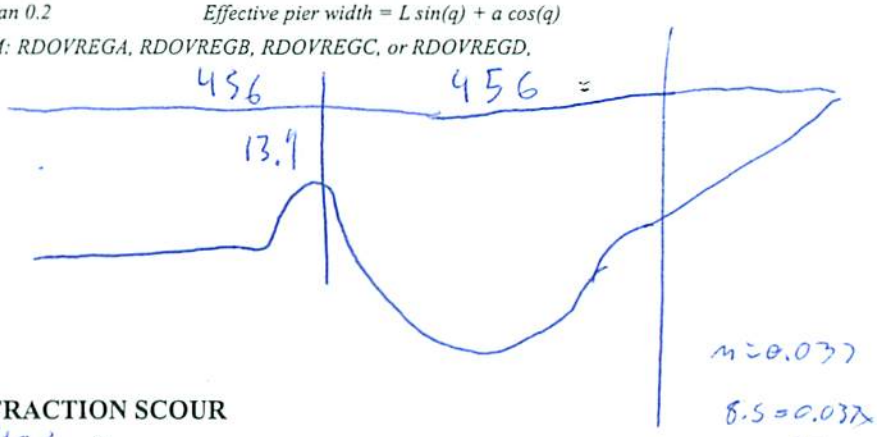
n (LOB) = 0.050

n (ROB) = 0.040

Pier Width = 2.4 ft

Pier Length = 2.4 ft

# Piers for 500 yr = 4 ft




### CONTRACTION SCOUR

PGRM: Contract

Width of main channel at approach section $W_1$ = 456 ft

Width of left overbank flow at approach, $W_{lob}$ = 456 ft Average left overbank flow depth, $y_{lob}$ = 13.8 ft

Width of right overbank flow at approach, $W_{rob}$ = 230 ft Average right overbank flow depth, $y_{rob}$ = 5.7 ft

S.S. 2/3 = 7.0/3

Live Bed Contraction Scour (use if bed material is small cobbles or finer)

$x$ = 11.36 From Figure 9 $W_2$ (effective) = 444.7 ft $y_{cs}$ = 12.4 ft

PGRM: CWCSNEW

Clear Water Contraction Scour (use if bed material is larger than small cobbles)

Estimated bed material $D_{50}$ = _____ ft Average approach velocity, $V_1 = Q_{500}/(y_1 W_1)$ = _____ ft/s

Critical approach velocity, $Vc = 11.17 y_1^{1/6} D_{50}^{1/3}$ = _____ ft/s

If $V_1 < V_c$ and $D_{50} >= 0.2$ ft, use clear water equation below, otherwise use live bed scour equation above.

$D_{c50} = 0.0006(q_2/y_1^{7/6})^3$ = _____ ft If $D_{50} >= D_{c50}$, $\chi = 0.0$

Otherwise, $\chi = 0.122 y_1 [q_2/(D_{50}^{1/3} y_1^{7/6})]^{6/7} - y_1$ = _____ From Figure 10, $y_{cs}$ = _____ ft

PGRM: Pier

### PIER SCOUR CALCULATIONS

L/a ratio = 1 Correction factor for flow angle of attack (from Table 1), K2 = 1

Froude # at bridge = 0.39 Using pier width a on Figure 11, $\xi$ = 9.2 Pier scour $y_{ps}$ = 8 ft

PGRM: Abutment

### ABUTMENT SCOUR CALCULATIONS

Average flow depth blocked by: left abutment, $y_{aLT}$ = 13.8 ft right abutment, $y_{aRT}$ = 5.7 ft

Shape coefficient $K_1$= 1.00 for vertical-wall, 0.82 for vertical-wall with wingwalls, 0.55 for spill-through

Using values for $y_{aLT}$ and $y_{aRT}$ on figure 12, $\psi_{LT}$ = 24.5 and $\psi_{RT}$ = 16.3

Left abutment scour, $y_{as} = \psi_{LT}(K_1/0.55)$ = 24.5 ft Right abutment scour $y_{as} = \psi_{RT}(K_1/0.55)$ = 16.3 ft

Route 303 St Stream James River MRM _____ Date 5/29/12 Initials RAK

Bridge Structure No. 68134120 Location 1.5 E of HWY 81 on 303 St

GPS coordinates: ~~N~~ N42° 59' 45.6" taken from: USL abutment X centerline of ↑ MRM end _____

W97° ~~28~~ 9.4" Datum of coordinates: WGS84 X NAD27 _____

Drainage area = 18904.67 sq. mi.

The average bottom of the main channel was 25.5 ft below top of guardrail at a point 207 ft from left abutment.

Method used to determine flood flows: ____Freq. Anal. ____drainage area ratio X regional regression equations.

5/23

| | |
|---|---|
| 2 | 973 |
| 5 | 6210 |
| 10 | 15300 |
| 25 | 37800 |
| 50 | 65100 |
| 100 | 104000 |
| 500 | 255000 |

## MISCELLANEOUS CONSIDERATIONS

| Flows | $Q_{\cancel{100}}^{50}$ = 65100 | | | $Q_{\cancel{500}}^{100}$ = 104000 | | |
|---|---|---|---|---|---|---|
| Estimated flow passing through bridge | 65100 | | | 87823 | | |
| Estimated road overflow & overtopping | 0 | | | 16177 | | |
| Consideration | Yes | No | Possibly | Yes | No | Possibly |
| Chance of overtopping | | X | | | | X |
| Chance of Pressure flow | | ~~X~~ | X | X | | |
| Armored appearance to channel | | X | | | X | |
| Lateral instability of channel | | X | | | X | |

Riprap at abutments? ____Yes ____No X Marginal - eroded

Evidence of past Scour? X Yes ____No ____Don't know pier, contraction

Debris Potential? ____High ____Med X Low

Does scour countermeasure(s) appear to have been designed?

| | | | | |
|---|---|---|---|---|
| Riprap | X Yes | ____No | ____Don't know | ____NA at one time |
| Spur Dike | ____Yes | X No | ____Don't know | ____NA |
| Other _____ | ____Yes | X No | ____Don't know | ____NA |

Bed Material Classification Based on Median Particle Size ($D_{50}$)

| Material | Silt/Clay X | Sand ____ | Gravel ____ | Cobbles ____ | Boulders ____ |
|---|---|---|---|---|---|
| Size range, in mm | <0.062 | 0.062-2.00 | 2.00-64 | 64-250 | >250 |

Comments, Diagrams & orientation of digital photos

1). main channel
2) left abut
3) left abut
4). piers
5) pier scour
6-7) scour
(not) right abut
8-9). right abut
10-11) left CB
12-13) right CB
14) main channel

Summary of Results

| | $Q_{\cancel{100}}$ 50 | $Q_{\cancel{500}}$ 100 |
|---|---|---|
| Bridge flow evaluated | 65100 | 87823 |
| Flow depth at left abutment (yaLT), in feet | 10.6 | 13.5 |
| Flow depth at right abutment (yaRT), in feet | 3.5 | 5.7 |
| Contraction scour depth (ycs), in feet | 6.5 | 12.4 |
| Pier scour depth (yps), in feet | 7.9 | 8 |
| Left abutment scour depth (yas), in feet | 21.8 | 24.5 |
| Right abutment scour depth (yas), in feet | 12.4 | 16.3 |
| 1Flow angle of attack | 5 | 5 |

See Comments/Diagram for justification where required