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SCOUR ANALYSIS AND REPORTING FORM

Bridge Structure No. 58116170 Date 7/16/12 Initials RAT Region (A B C (D))

Site 06473000 Location 0.6 E Ashton, James River

Q_{100} = ~~Q_{500}~~ Q_{100} by: drainage area ratio ____ flood freq. anal. ~~X~~ regional regression eq. X

Bridge discharge (Q_2) = 10,000 (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 = 264 ft. Flow angle at bridge = 20 ° Abut. Skew = 0 ° Effective Skew = 20 °

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 = 270.63 ft* $q_2 = Q_2/W_2$ = 37 ft^2/s

Bridge Vel, V_2 = 3 ft/s Final $y_2 = q_2/V_2$ = 12.2 ft Δh = 0.2 ft

Average main channel depth at approach section, $y_1 = \Delta h + y_2$ = 12.4 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. = 0-3.0 ft

Low Steel Elev. = 17.0 ft

n (Channel) = 0.035

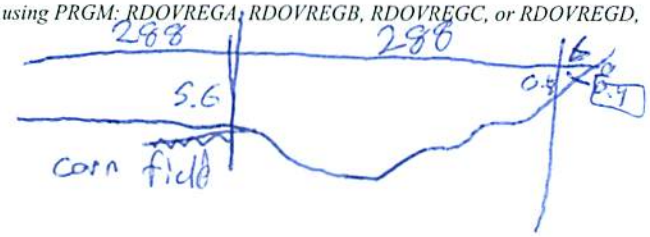
n (LOB) = 0.035

n (ROB) = 0.040

Pier Width = ~~2.0~~ 2.0 ft

Pier Length = 2.25 ft

Piers for 100 yr = 3 ft



0.8

18.1

3.1
24

CONTRACTION SCOUR

PGRM: Contract

Width of main channel at approach section W_1 = 288 ft

Width of left overbank flow at approach, W_{lob} = 288 ft Average left overbank flow depth, y_{lob} = 5.6 ft

Width of right overbank flow at approach, W_{rob} = 6 ft Average right overbank flow depth, y_{rob} = 0.4 ft

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

x = 4.68 From Figure 9 W_2 (effective) = 264.6 ft y_{cs} = 5.4 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, $V_1 = Q_{100}/(y_1 W_1)$ = _____ ft/s

Critical approach velocity, $Vc = 11.52 y_1^{1/6} D_{50}^{1/3}$ = _____ 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

PIER SCOUR CALCULATIONS

PGRM: Pier

L/a ratio = 1.125 Correction factor for flow angle of attack (from Table 1), K2 = 1

Froude # at bridge = 0.15 Using pier width a on Figure 11, ξ = 8 Pier scour y_{ps} = 6 ft

ABUTMENT SCOUR CALCULATIONS

PGRM: Abutment

Average flow depth blocked by: left abutment, y_{aLT} = 5.6 ft right abutment, y_{aRT} = 0.4 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, ψ_{LT} = 16.1 and ψ_{RT} = 1.9

Left abutment scour, $y_{as} = \psi_{LT}(K_1/0.55)$ = 16.1 ft Right abutment scour $y_{as} = \psi_{RT}(K_1/0.55)$ = 1.9 ft

SCOUR ANALYSIS AND REPORTING FORM

Bridge Structure No. 58116170 Date 7/18/12 Initials RaT Region (A B C (D)

Site 06473000 Location 0.6 E Ashton

Q_{500} = ~~[illegible]~~ 233,00 by: drainage area ratio ____ flood freq. anal. ____ regional regression eq. X

Bridge discharge (Q_2) = 19603 (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 = 288 ft. Flow angle at bridge = 20 ° Abut. Skew = 0 ° Effective Skew = 20 °

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 = 270.63 ft* $q_2 = Q_2/W_2$ = 68.7 ft²/s

Bridge Vel, V_2 = 4 ft/s Final $y_2 = q_2/V_2$ = 17 ft Δh = 0.3 ft

Average main channel depth at approach section, $y_1 = \Delta h + y_2$ = 17.3 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. = 03.0 ft

Low Steel Elev. = 17.0 ft

n (Channel) = 0.035

n (LOB) = 0.035

n (ROB) = 0.040

Pier Width = 2 ft

Pier Length = 2.25 ft

Piers for 500 yr = 3 ft

5.7

CONTRACTION SCOUR

PGRM: Contract

Width of main channel at approach section W_1 = 288 ft

Width of left overbank flow at approach, W_{lob} = 288 ft Average left overbank flow depth, y_{lob} = 10.5 ft

Width of right overbank flow at approach, W_{rob} = 44 ft Average right overbank flow depth, y_{rob} = 2.9 ft

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

x = 9.85 From Figure 9 W_2 (effective) = 264.6 ft y_{cs} = 10.8 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, $Vc = 11.52 y_1^{1/6} D_{50}^{1/3}$ = _____ 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

PIER SCOUR CALCULATIONS

PGRM: Pier

L/a ratio = 1.125 Correction factor for flow angle of attack (from Table 1), K2 = 1

Froude # at bridge = 0.17 Using pier width a on Figure 11, ξ = 8 Pier scour y_{ps} = 6.1 ft

ABUTMENT SCOUR CALCULATIONS

PGRM: Abutment

Average flow depth blocked by: left abutment, y_{aLT} = 10.5 ft right abutment, y_{aRT} = 2.9 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, ψ_{LT} = 21.7 and ψ_{RT} = 11.3

Left abutment scour, $y_{as} = \psi_{LT}(K_1/0.55)$ = 21.7 ft Right abutment scour $y_{as} = \psi_{RT}(K_1/0.55)$ = 11.3 ft

Route 165 St Stream James River MRM _____ Date 7/18/12 Initials RAL

Bridge Structure No. 58116170 Location 0.6 E Ashton

GPS coordinates: N 40° 59' 54.31" W 98° 28' 49.12" taken from: USL abutment X centerline of ⇑ MRM end _____

Datum of coordinates: WGS84 X NAD27 _____

Drainage area = ~~9705.11~~ sq. mi. 8330.82

The average bottom of the main channel was ~~22.6~~ 22.9 ft below top of guardrail at a point 131 ft from left abutment.

Method used to determine flood flows: ~~X~~ Freq. Anal. ____ drainage area ratio X regional regression equations.

main channel depth 22.6

MISCELLANEOUS CONSIDERATIONS

Flows	Q_{100} = ~~9060~~ Q_{10} 10000			Q_{500} = ~~Q25~~ 23800		
Estimated flow passing through bridge			10000			18603
Estimated road overflow & overtopping			○			5197
Consideration	Yes	No	Possibly	Yes	No	Possibly
Chance of overtopping		X				X
Chance of Pressure flow		X		X		
Armored appearance to channel		X			X	
Lateral instability of channel		X			X	

7/12

2	75,
5	7260
10	10000
25	23800
50	40100
100	63000
500	149000

Riprap at abutments? ____Yes ____No X Marginal on outside of abutments.

Evidence of past Scour? X Yes ____No ____Don't know -some pier/abutment/contraction

Debris Potential? ____High ____Med X Low

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

-riprap has been laid to protect the road from overbank flow

Riprap	~~X~~ Yes	~~X~~ No	____Don't know	____NA
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). ~~right~~ left OB
2). main channel
3). right OB
4). pier
5). pier scour
6-8). left abutment
9-11). right abutment
12). main channel

Note: left overbank is a corn field. Had to assume it is flat.

Summary of Results

	Q100 Q10	~~Q500~~ Q25
Bridge flow evaluated	10000	18603
Flow depth at left abutment (yaLT), in feet	5.6	10.5
Flow depth at right abutment (yaRT), in feet	0.4	2.9
Contraction scour depth (ycs), in feet	5.4	10.5
Pier scour depth (yps), in feet	6	6.1
Left abutment scour depth (yas), in feet	16.1	~~21.8~~ 21.7
Right abutment scour depth (yas), in feet	1.9	~~11.8~~ 11.3
1Flow angle of attack	20	20

See Comments/Diagram for justification where required