DUP ok-RAT

SCOUR ANALYSIS AND REPORTING FORM

Bridge Structure No. 03286120 Date 9-28-12 Initials RFT Region (A B (C) D)

Site _____ Location 40470 202nd St, James River

Q_{500} = 58600 by: drainage area ratio ____ flood freq. anal. ____ regional regression eq. X

Bridge discharge (Q_2) = 58600 (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 = 328 ft. Flow angle at bridge = 12 ° Abut. Skew = 0 ° Effective Skew = 12 °

Width (W_2) iteration = 328 _____ _____ _____

Avg. flow depth at bridge, y_2 iteration = 19.1 _____ _____ _____

Corrected channel width at bridge Section = W_2 times cos of flow angle = 320.83 ft* $q_2 = Q_2/W_2$ = 182.6 ft^2/s

Bridge Vel, V_2 = 9.6 ft/s Final $y_2 = q_2/V_2$ = 19.1 ft Δh = 1.9 ft

Average main channel depth at approach section, $y_1 = \Delta h + y_2$ = 20.9 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. = _____ ft

Low Steel Elev. = 19.8 ft

n (Channel) = .035

n (LOB) = .035

n (ROB) = .035

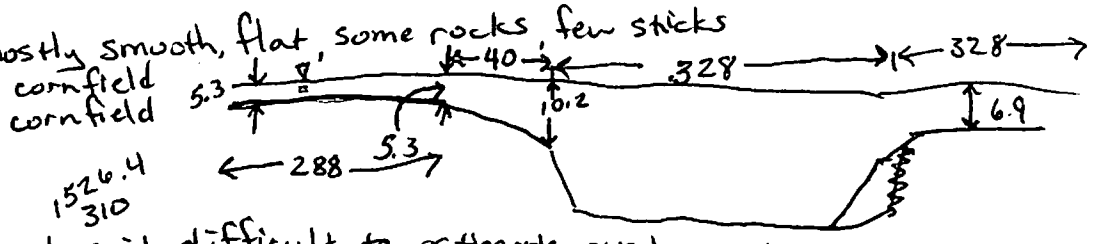
Pier Width = 3.0 ft

Pier Length = 3.0 ft

Piers for 100 yr = 3 ft

mostly smooth, flat, some rocks, few sticks

cornfield cornfield



Standing corn makes it difficult to estimate overbank depths

CONTRACTION SCOUR

PGRM: Contract

Width of main channel at approach section W_1 = 328 ft

Width of left overbank flow at approach, W_{lob} = 328 ft Average left overbank flow depth, y_{lob} = 5.6 ft

Width of right overbank flow at approach, W_{rob} = 328 ft Average right overbank flow depth, y_{rob} = 6.9 ft estimated

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

x = 7 From Figure 9 W_2 (effective) = 311.8 ft y_{cs} = 7.8 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, $V_1 = Q_{100}/(y_1 W_1)$ = _____ 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

PIER SCOUR CALCULATIONS

PGRM: Pier

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, ξ = 10.7 Pier scour y_{ps} = 9.3 ft

ABUTMENT SCOUR CALCULATIONS

PGRM: Abutment

Average flow depth blocked by: left abutment, y_{aLT} = 5.6 ft right abutment, y_{aRT} = 6.9 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} = 16.1 and ψ_{RT} = 18.4

Left abutment scour, $y_{as} = \psi_{LT}(K_1/0.55)$ = 16.1 ft Right abutment scour $y_{as} = \psi_{RT}(K_1/0.55)$ = 18.4 ft

SCOUR ANALYSIS AND REPORTING FORM

Bridge Structure No. 03286120 Date _____ Initials _____ Region (A B C D)

Site _____ Location _____

Q_{500}^{100} = 93100 by: drainage area ratio ____ flood freq. anal. ____ regional regression eq. X

Bridge discharge (Q_2) = 93100 (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 = 328 ft. Flow angle at bridge = 12 ° Abut. Skew = 0 ° Effective Skew = 12 °

Width (W_2) iteration = 328 _____ _____ _____

Avg. flow depth at bridge, y_2 iteration = 24.0 _____ _____ _____

Corrected channel width at bridge Section = W_2 times cos of flow angle = 320.83 ft* $q_2 = Q_2/W_2$ = 290.2 ft^2/s

Bridge Vel, V_2 = 12.1 ft/s Final $y_2 = q_2/V_2$ = 24 ft Δh = 3.0 ft

Average main channel depth at approach section, $y_1 = \Delta h + y_2$ = 27.0 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.

road overflow will occur at $y_2 \approx 24.7$ ft

Water Surface Elev. = _____ ft

Low Steel Elev. = 19.8 ft

n (Channel) = .035

n (LOB) = .035

n (ROB) = .035

Pier Width = 3.0 ft

Pier Length = 3.0 ft

Piers for 500 yr = 3 ft

3283.2
554

CONTRACTION SCOUR

PGRM: Contract

Width of main channel at approach section W_1 = 328 ft

Width of left overbank flow at approach, W_{lob} = 328 ft Average left overbank flow depth, y_{lob} = 11.7 ft

Width of right overbank flow at approach, W_{rob} = 328 ft Average right overbank flow depth, y_{rob} = 13.0 ft

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

x = 16.85 From Figure 9 W_2 (effective) = 311.8 ft y_{cs} = 16.0 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 = 0.44 Using pier width a on Figure 11, ξ = 10.7 Pier scour y_{ps} = 9.5 ft

PGRM: Abutment

ABUTMENT SCOUR CALCULATIONS

Average flow depth blocked by: left abutment, y_{aLT} = 11.7 ft right abutment, y_{aRT} = 13.0 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} = 22.7 and ψ_{RT} = 23.8

Left abutment scour, $y_{as} = \psi_{LT}(K_1/0.55)$ = 22.7 ft Right abutment scour $y_{as} = \psi_{RT}(K_1/0.55)$ = 23.8 ft

Route 202 St Stream James River MRM _____ Date _____ Initials _____

Bridge Structure No. 03286120 Location 40470 202nd St

GPS coordinates: N 44° 27.440' taken from: USL abutment ✓ centerline of ∩ MRM end _____

W 98° 7.231' Datum of coordinates: WGS84 ✓ NAD27 _____

Drainage area = 13381.1 sq. mi.

The average bottom of the main channel was 27.5 ft below top of guardrail at a point 108 ft from left abutment.

Method used to determine flood flows: ____Freq. Anal. ~~✓~~ drainage area ratio ✓ regional regression equations.

MISCELLANEOUS CONSIDERATIONS

Flows	Q_{50}= 58600			Q_{100}= 93100		
Estimated flow passing through bridge	58600			93100		
Estimated road overflow & overtopping	0			0?		
Consideration	Yes	No	Possibly	Yes	No	Possibly
Chance of overtopping		✓				✓
Chance of Pressure flow		✓		✓		
Armored appearance to channel		✓			✓	
Lateral instability of channel		✓			✓	

Riprap at abutments? ____Yes ✓ No ____Marginal

Evidence of past Scour? ✓ Yes ____No ____Don't know abutments eroded

Debris Potential? ____High X Med ____Low some dead trees in floodplain upstream

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

Riprap ____Yes ____No ____Don't know ✓ NA

Spur Dike ____Yes ____No ____Don't know ✓ NA

Other _____ ____Yes ____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

Str. no.

approach from bridge

LOB from road

ROB from road

bridge from rt. approach

rt. abut. from water edge

rt abut. scour

left abut. from water edge

left abut scour

Summary of Results

	Q_{100}50	Q_{500}100
Bridge flow evaluated	58600	93100
Flow depth at left abutment (yaLT), in feet	5.6	11.7
Flow depth at right abutment (yaRT), in feet	6.9	13.0
Contraction scour depth (ycs), in feet	7.8	16.0
Pier scour depth (yps), in feet	9.3	9.5
Left abutment scour depth (yas), in feet	16.1	22.7
Right abutment scour depth (yas), in feet	18.4	23.8
!Flow angle of attack	12°	12°

See Comments/Diagram for justification where required