Crooked Creek

SCOUR ANALYSIS AND REPORTING FORM

Bridge Structure No. 32305028 Date 10/29/11 Initials CW Region (A (B) C D)

Site ______ Location 2.5 mi W of US 85 on Cox Rd

Q_{100} = 3430 by: drainage area ratio____ flood freq. anal. ____ regional regression eq. ____

Bridge discharge (Q_2) = 3430 (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 = 60 ft. Flow angle at bridge = 2 ° Abut. Skew = 0 ° Effective Skew = 2 °

Width (W_2) iteration = 60 → Vert Wall

Avg. flow depth at bridge, y_2 iteration = 9.6

Corrected channel width at bridge Section = W_2 times cos of flow angle = 59.96 ft* $q_2 = Q_2/W_2$ = 57.2 ft²/s

Bridge Vel, V_2 = 6.4 ft/s Final $y_2 = q_2/V_2$ = 9.0 ft Δh = 0.8 ft

Average main channel depth at approach section, $y_1 = \Delta h + y_2$ = 9.8 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. = 11.5 ft

n (Channel) = 0.033

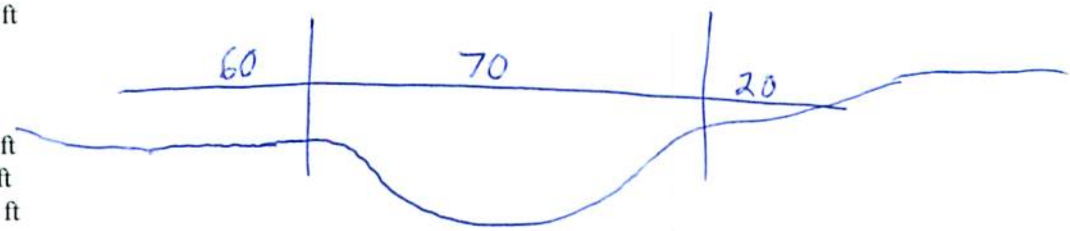
n (LOB) = 0.035

n (ROB) = 0.035

Pier Width = 1.0 ft

Pier Length = 1.0 ft

\# Piers for 100 yr = 2 ft



CONTRACTION SCOUR

PGRM: Contract

Width of main channel at approach section W_1 = 70 ft

Width of left overbank flow at approach, W_{lob} = 60 ft Average left overbank flow depth, y_{lob} = 3.7 ft

Width of right overbank flow at approach, W_{rob} = 20 ft Average right overbank flow depth, y_{rob} = 1.8/2 0.9 ft

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

x = 3.98 From Figure 9 W_2 (effective) = 58 ft y_{cs} = 4.6 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, $V_1 = Q_{100}/(y_1W_1)$ = ______ ft/s

Critical approach velocity, $V_c = 11.17y_1^{1/6}D_{50}^{1/3}$ = ______ 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, $\chi = 0.122y_1[q_2/(D_{50}^{1/3}y_1^{7/6})]^{6/7} - y_1$ = ______ From Figure 10, y_{cs} = ______ ft

PIER SCOUR CALCULATIONS

PGRM: Pier

L/a ratio = 1.0 Correction factor for flow angle of attack (from Table 1), K2 = 1.0

Froude # at bridge = 0.38 Using pier width a on Figure 11, ξ = 4.9 Pier scour y_{ps} = 4.2 ft

ABUTMENT SCOUR CALCULATIONS

PGRM: Abutment

Average flow depth blocked by: left abutment, y_{aLT} = 3.7 ft right abutment, y_{aRT} = 0.9 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} = 12.7 and ψ_{RT} = 3.9

Left abutment scour, $y_{as} = \psi_{LT}(K_1/0.55)$ = 19.0 ft Right abutment scour $y_{as} = \psi_{RT}(K_1/0.55)$ = 5.8 ft

SCOUR ANALYSIS AND REPORTING FORM

Bridge Structure No. 32305028 Date 10/29/11 Initials Gw Region (A (B) C D)

Site ______ Location 2.5 mi W of US 85 on Cox Rd

Q_{500} = 5780 by: drainage area ratio ____ flood freq. anal. ____ regional regression eq. ____

Bridge discharge (Q_2) = 5456 (should be Q_{500} unless there is a relief bridge, road overflow, or bridge overtopping)

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

Analytical Procedure for Estimating Hydraulic Variables Needed to Apply Method

Bridge Width = 60 ft. Flow angle at bridge = 2 ° Abut. Skew = 0 ° Effective Skew = 2 °

Width (W_2) iteration = 60

Avg. flow depth at bridge, y_2 iteration = 11.9 → RD Overflow

Corrected channel width at bridge Section = W_2 times cos of flow angle = 59.96 ft* $q_2 = Q_2/W_2$ = 91 ft^2/s

Bridge Vel, V_2 = 7.4 ft/s Final $y_2 = q_2/V_2$ = 11.5 ft Δh = 1.3 ft

Average main channel depth at approach section, $y_1 = \Delta h + y_2$ = 12.8 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. = 11.5 ft

n (Channel) = 0.033

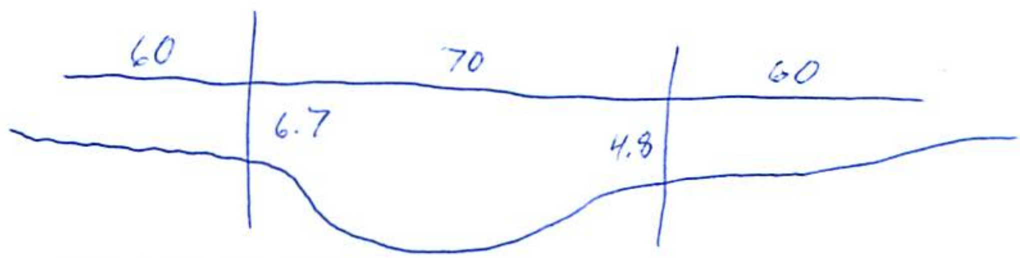
n (LOB) = 0.035

n (ROB) = 0.035

Pier Width = 1.0 ft

Pier Length = 1.0 ft

Piers for 500 yr = 1 ft



CONTRACTION SCOUR

PGRM: Contract

Width of main channel at approach section W_1 = 70 ft

Width of left overbank flow at approach, W_{lob} = 60 ft Average left overbank flow depth, y_{lob} = 6.7 ft

Width of right overbank flow at approach, W_{rob} = 60 ft Average right overbank flow depth, y_{rob} = 4.8 ft

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

x = 8.97 From Figure 9 W_2 (effective) = 59 ft y_{cs} = 9.9 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

PIER SCOUR CALCULATIONS

PGRM: Pier

L/a ratio = 1.0 Correction factor for flow angle of attack (from Table 1), K2 = 1.0

Froude # at bridge = 0.41 Using pier width a on Figure 11, ξ = 4.9 Pier scour y_{ps} = 4.3 ft

ABUTMENT SCOUR CALCULATIONS

PGRM: Abutment

Average flow depth blocked by: left abutment, y_{aLT} = 6.7 ft right abutment, y_{aRT} = 4.8 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} = 18.1 and ψ_{RT} = 14.7

Left abutment scour, $y_{as} = \psi_{LT}(K_1/0.55)$ = 26.9 ft Right abutment scour $y_{as} = \psi_{RT}(K_1/0.55)$ = 21.9 ft

Route Cox Rd Stream Crooked Ck MRM ______ Date 10/29/11 Initials CL
Bridge Structure No. 32305028 Location 2.5 mi W of US 85 on Cox Rd
GPS coordinates: N 45°54'32.2" W103°25'43.6" taken from: USL abutment X centerline of ⇑ MRM end ______
Datum of coordinates: WGS84 X NAD27 ______
Drainage area = 49.02 sq. mi.
The average bottom of the main channel was 16.5 ft below top of guardrail at a point 12 ft from left abutment.
Method used to determine flood flows: ____Freq. Anal. ____drainage area ratio ____regional regression equations.

MISCELLANEOUS CONSIDERATIONS

Flows	Q_{100} = 3430			Q_{500} = 5780		
Estimated flow passing through bridge	3430			5456		
Estimated road overflow & overtopping	—			324		
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	

Riprap at abutments? ____Yes X No ____Marginal
Evidence of past Scour? X Yes ____No ____Don't know Cattle on banks
Debris Potential? ____High ____Med X Low

Does scour countermeasure(s) appear to have been designed?
Riprap ____Yes ____No ____Don't know X NA
Spur Dike ____Yes ____No ____Don't know X NA
Other ____________ ____Yes ____No ____Don't know X NA

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

Material	Silt/Clay X	Sand X	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

10/4/11

2	229
5	688
10	1190
25	1930
50	2630
100	3430
500	5780

Photos
2169 - ID
70 - US
71 - US RB
72 - US LB
73 - US Face

Summary of Results

	Q100	Q500
Bridge flow evaluated	3430	5456
Flow depth at left abutment (yaLT), in feet	3.7	6.7
Flow depth at right abutment (yaRT), in feet	0.9	4.8
Contraction scour depth (ycs), in feet	4.6	9.9
Pier scour depth (yps), in feet	4.2	4.3
Left abutment scour depth (yas), in feet	19.0	26.9
Right abutment scour depth (yas), in feet	5.8	21.9
1Flow angle of attack	2	2

See Comments/Diagram for justification where required