DUP ok-RAT

SCOUR ANALYSIS AND REPORTING FORM

Bridge Structure No. 32268030 Date 9-17-12 Initials RFT Region (A (B) C D)

Site _____ Location 6.2 mi W. of HWY 85 on FAS 6420

Q_{100} = 2720 by: drainage area ratio ____ flood freq. anal. ____ regional regression eq. ✓

Bridge discharge (Q_2) = 2720 (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 = 40 ft. Flow angle at bridge = 15 ° Abut. Skew = 0 ° Effective Skew = 15 °

Width (W_2) iteration = 40 (vert wall) _____

Avg. flow depth at bridge, y_2 iteration = 10.0 _____ _____ _____

Corrected channel width at bridge Section = W_2 times cos of flow angle = 38.64 ft* $q_2 = Q_2/W_2$ = 70.4 ft²/s

Bridge Vel, V_2 = 7.0 ft/s Final $y_2 = q_2/V_2$ = 10.0 ft Δh = 1.0 ft

Average main channel depth at approach section, $y_1 = \Delta h + y_2$ = 11.1 ft

approach section is in road ditch

** 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. = ≈9.3 ft

n (Channel) = .035

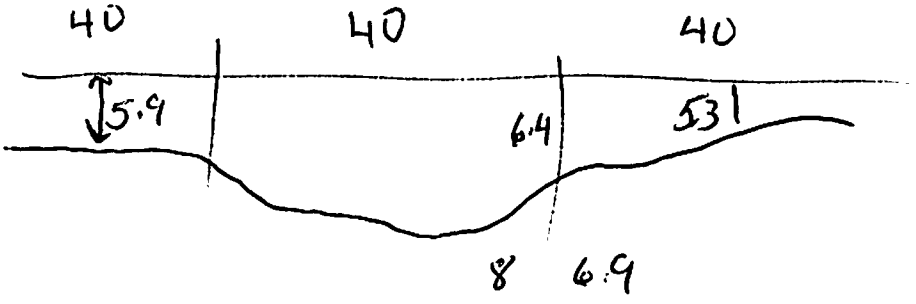
n (LOB) = .030

n (ROB) = .030

Pier Width = 1 ft

Pier Length = 1 ft

Piers for 100 yr = N/A ft



CONTRACTION SCOUR

PGRM: Contract

Width of main channel at approach section W_1 = 5505 ft

Width of left overbank flow at approach, W_{lob} = 40 ft Average left overbank flow depth, y_{lob} = 7.5 ft

Width of right overbank flow at approach, W_{rob} = 40 ft Average right overbank flow depth, y_{rob} = 7.5 ft

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

x = 17.21 From Figure 9 W_2 (effective) = 38.6 ft y_{cs} = 16.2 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 = 0.39 Using pier width a on Figure 11, ξ = 4.9 Pier scour y_{ps} = 4.2 ft

PGRM: Abutment

ABUTMENT SCOUR CALCULATIONS

Average flow depth blocked by: left abutment, y_{aLT} = 7.5 ft right abutment, y_{aRT} = 7.5 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, ψ_{LT} = 19.4 and ψ_{RT} = 19.4

Left abutment scour, $y_{as} = \psi_{LT}(K_1/0.55)$ = 28.9 ft Right abutment scour $y_{as} = \psi_{RT}(K_1/0.55)$ = 28.9 ft

SCOUR ANALYSIS AND REPORTING FORM

Bridge Structure No. 32268030 Date _____ Initials _____ Region (A (B) C D)

Site _____ Location _____

Q_{600}^{50} = 2080 by: drainage area ratio ____ flood freq. anal. ____ regional regression eq. ✓

Bridge discharge (Q_2) = 2080 (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 = 40 ft. Flow angle at bridge = 15 ° Abut. Skew = 0 ° Effective Skew = 15 °

Width (W_2) iteration = 40 (Vert wall) _____

Avg. flow depth at bridge, y_2 iteration = 8.7 _____ _____ _____

Corrected channel width at bridge Section = W_2 times cos of flow angle = 38.64 ft* $q_2 = Q_2/W_2$ = 53.8 ft^2/s

Bridge Vel, V_2 = 6.2 ft/s Final $y_2 = q_2/V_2$ = 8.7 ft Δh = 0.8 ft

Average main channel depth at approach section, $y_1 = \Delta h + y_2$ = 9.5 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. = ≈ 9.3 ft

n (Channel) = .035

n (LOB) = .030

n (ROB) = .030

Pier Width = 1 ft

Pier Length = 1 ft

Piers for 500 yr = 1 ft

CONTRACTION SCOUR

PGRM: Contract

Width of main channel at approach section W_1 50 ft

Width of left overbank flow at approach, W_{lob} = 40 ft Average left overbank flow depth, y_{lob} = 5.9 ft

Width of right overbank flow at approach, W_{rob} = 40 ft Average right overbank flow depth, y_{rob} = 5.9 ft

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

x = 13.17 From Figure 9 W_2 (effective) = 38.6 ft y_{cs} = 14 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 = .03 Using pier width a on Figure 11, ξ = 4.9 Pier scour y_{ps} = 4.2 ft

PGRM: Abutment

ABUTMENT SCOUR CALCULATIONS

Average flow depth blocked by: left abutment, y_{aLT} = 5.9 ft right abutment, y_{aRT} = 5.9 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} = 16.6 and ψ_{RT} = 16.6

Left abutment scour, $y_{as} = \psi_{LT}(K_1/0.55)$ = 24.8 ft Right abutment scour $y_{as} = \psi_{RT}(K_1/0.55)$ = 24.8 ft

Route FAS 6420 Stream Crooked Creek MRM _____ Date _____ Initials _____

Bridge Structure No. 32268030 Location 6.2 mi W. of hwy 85 on FAS 6420

GPS coordinates: N 45° 54.411' taken from: USL abutment ____ centerline of ⇑ MRM end ____

W 103° 30.163' Datum of coordinates: WGS84 ____ NAD27 ____

Drainage area = 32.53 sq. mi.

The average bottom of the main channel was 14.0 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} = 2720			Q_{500} = 2080		
Estimated flow passing through bridge	2720			2080		
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 past contraction scour

Debris Potential? ____High ____Med ✓Low

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 ✓	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 (2)
approach from bridge
LOB
ROB
Bridge section

Summary of Results

	Q100	Q500 50
Bridge flow evaluated	2720	2080
Flow depth at left abutment (yaLT), in feet	7.5	5.9
Flow depth at right abutment (yaRT), in feet	7.5	5.9
Contraction scour depth (ycs), in feet	16.2	14.0
Pier scour depth (yps), in feet	[redacted] 4.2 ~~RT~~	[redacted] 4.2 ~~RT~~
Left abutment scour depth (yas), in feet	28.9	24.8
Right abutment scour depth (yas), in feet	28.9	24.8
1Flow angle of attack	15°	15°

See Comments/Diagram for justification where required