OK RT

SCOUR ANALYSIS AND REPORTING FORM

Bridge Structure No. 03155240 Date 7/24/12 Initials RoT Region (A B (C) D)

Site ______ Location 3.4 mi E of HWY 281 on 214 St

Q_{100} = Q_5 923 by: drainage area ratio____ flood freq. anal. ____ regional regression eq. X

Bridge discharge (Q_2) = 923 (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 = 105 ft. Flow angle at bridge = 30 ° Abut. Skew = 0 ° Effective Skew = 30 °

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 = 90.93 ft* $q_2 = Q_2/W_2$ = 10.2 ft^2/s

Bridge Vel, V_2 = 2.3 ft/s Final $y_2 = q_2/V_2$ = 4.5 ft Δh = 0.1 ft

Average main channel depth at approach section, $y_1 = \Delta h + y_2$ = 4.6 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. = dry ft

Low Steel Elev. = 5.9 ft

n (Channel) = 0.045

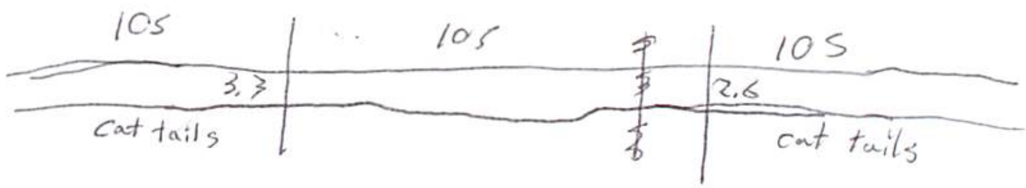
n (LOB) = 0.040

n (ROB) = 0.040

Pier Width = 1.65 ft

Pier Length = 1.65 ft

\# Piers for 100 yr = 4 ft



CONTRACTION SCOUR

PGRM: Contract

Width of main channel at approach section W_1 = 105 ft

Width of left overbank flow at approach, W_{lob} = 105 ft Average left overbank flow depth, y_{lob} = 3.3 ft

Width of right overbank flow at approach, W_{rob} = 105 ft Average right overbank flow depth, y_{rob} = 2.6 ft

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

x = 7.32 From Figure 9 W_2 (effective) = 84.3 ft y_{cs} = 8.1 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, $Vc = 11.17y_1^{1/6}D_{50}^{1/3}$ = ______ 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 Correction factor for flow angle of attack (from Table 1), K2 = 1

Froude # at bridge = 0.19 Using pier width a on Figure 11, ξ = 6.9 Pier scour y_{ps} = 5.4 ft

ABUTMENT SCOUR CALCULATIONS

PGRM: Abutment

Average flow depth blocked by: left abutment, y_{aLT} = 3.3 ft right abutment, y_{aRT} = 2.6 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} = 12.0 and ψ_{RT} = ~~24~~ 10.6

Left abutment scour, $y_{as} = \psi_{LT}(K_1/0.55)$ = 21.9 ft Right abutment scour $y_{as} = \psi_{RT}(K_1/0.55)$ = 19.3 ft

SCOUR ANALYSIS AND REPORTING FORM

Bridge Structure No. 03155240 Date 7/24/12 Initials Ral Region (A B (C) D)

Site ______ Location 3.4 mi E of HWY 281 on 214 St.

Q_{500} = Q10 1950 by: drainage area ratio____ flood freq. anal. ____ regional regression eq. X

Bridge discharge (Q_2) = 1589 (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 = 105 ft. Flow angle at bridge = 30 ° Abut. Skew = 0 ° Effective Skew = 30 °

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 = 90.93 ft* $q_2 = Q_2/W_2$ = 17.5 ft^2/s

Bridge Vel, V_2 = 3 ft/s Final $y_2 = q_2/V_2$ = 5.9 ft Δh = 0.2 ft

Average main channel depth at approach section, $y_1 = \Delta h + y_2$ = 6.1 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. = dry ft

Low Steel Elev. = 5.9 ft

n (Channel) = 0.045

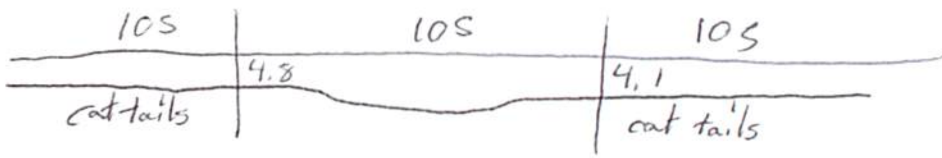
n (LOB) = 0.040

n (ROB) = 0.040

Pier Width = 1.65 ft

Pier Length = 1.65 ft

\# Piers for 500 yr = 4 ft



CONTRACTION SCOUR

PGRM: Contract

Width of main channel at approach section W_1 = 105 ft

Width of left overbank flow at approach, W_{lob} = 105 ft Average left overbank flow depth, y_{lob} = 4.8 ft

Width of right overbank flow at approach, W_{rob} = 105 ft Average right overbank flow depth, y_{rob} = 4.1 ft

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

x = 11.63 From Figure 9 W_2 (effective) = 84.3 ft y_{cs} = 12.7 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, $V_c = 11.17 y_1^{1/6} D_{50}^{1/3}$ = ______ 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: Pie

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

Froude # at bridge = 0.22 Using pier width a on Figure 11, ξ = 6.9 Pier scour y_{ps} = 5.5 ft

ABUTMENT SCOUR CALCULATIONS

PGRM: Abutment

Average flow depth blocked by: left abutment, y_{aLT} = 4.8 ft right abutment, y_{aRT} = 4.1 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} = 14.7 and ψ_{RT} = 13.4

Left abutment scour, $y_{as} = \psi_{LT}(K_1/0.55)$ = 26.7 ft Right abutment scour $y_{as} = \psi_{RT}(K_1/0.55)$ = 24.4 ft

44° 17' 0.9996"
98° 23' 22.992"

98.38972
44.283611

Route 214 St. Stream Cain Creek MRM ________ Date 7/24/12 Initials RAT

Bridge Structure No. 03155240 Location 3.4 mi E of HWY 281 on 214 St

GPS coordinates: N 44° 17' 6.3' taken from: USL abutment X centerline of ⥣ MRM end ______

W 98° 23' 22.8'' Datum of coordinates: WGS84 X NAD27 _____

Drainage area = 341 sq. mi.

The average bottom of the main channel was 9.7 ft below top of guardrail at a point 45 ft from left abutment.

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

5/14

~~8/22~~

Pk2	200
5	~~922~~ 923
10	1950
25	4160
50	6590
100	9810
500	21000

MISCELLANEOUS CONSIDERATIONS

Flows	Q_{100} = ~~Q_{100}~~ Q_5 923			Q_{500} = Q_{10} 1950		
Estimated flow passing through bridge	923			1588		
Estimated road overflow & overtopping	0			362		
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 minor pier/contraction/abutment

Debris Potential? _____High _____Med X Low

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

Riprap	____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). left OB
2). main channel
3). right OB
4-5). right abutment
~~6-7)~~
6). pier
7). pier scour
8-9). left abutment
10). main channel

Summary of Results

	~~Q100~~ Q_5	~~Q500~~ Q_{10}
Bridge flow evaluated	923	1950
Flow depth at left abutment (yaLT), in feet	3.3	4.8
Flow depth at right abutment (yaRT), in feet	2.6	4.1
Contraction scour depth (ycs), in feet	8.1	12.7
Pier scour depth (yps), in feet	5.4	5.5
Left abutment scour depth (yas), in feet	21.9	26.7
Right abutment scour depth (yas), in feet	19.3	24.4
1Flow angle of attack	30	30

See Comments/Diagram for justification where required