OK RT

SCOUR ANALYSIS AND REPORTING FORM

Bridge Structure No. 07285190 Date 7/21/12 Initials RaT Region (A B C (D)

Site _____ Location 1.5 mi W HWY 37 on 119 St

Q_{100}^{25} = 2190 by: drainage area ratio ____ flood freq. anal. ____ regional regression eq. X

Bridge discharge (Q_2) = 2190 (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 = 78 ft. Flow angle at bridge = 25 ° Abut. Skew = 15 ° Effective Skew = 10 °

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 = 76.62 ft* $q_2 = Q_2/W_2$ = 28.4 ft^2/s

Bridge Vel, V_2 = 2.7 ft/s Final $y_2 = q_2/V_2$ = 10.6 ft Δh = 0.1 ft

Average main channel depth at approach section, $y_1 = \Delta h + y_2$ = 10.8 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,

left 4.0 in steel right.

Water Surface Elev. = 3-64.5 ft

Low Steel Elev. = 10.7 ft

n (Channel) = 0.035 — 1.4 one 2nd straight full, clean, winding.

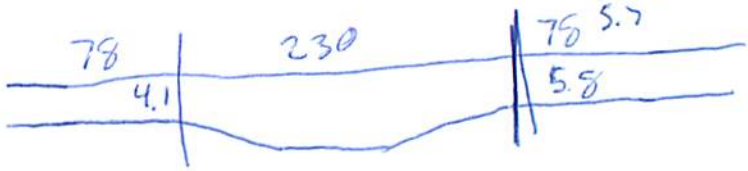
n (LOB) = 0.040

n (ROB) = ~~0.04~~ 0.040

Pier Width = 1.7 ft

Pier Length = 1.7 ft

Piers for 100 yr = 2 ft



CONTRACTION SCOUR

PGRM: Contract

Width of main channel at approach section W_1 = 230 ft

Width of left overbank flow at approach, W_{lob} = 78 ft Average left overbank flow depth, y_{lob} = 4.1 ft

Width of right overbank flow at approach, W_{rob} = 78 ft Average right overbank flow depth, y_{rob} = 5.8 ft

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

x = 28.59 From Figure 9 W_2 (effective) = 73.4 ft y_{cs} = 22.3 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 = 0.15 Using pier width a on Figure 11, ξ = 7 Pier scour y_{ps} = 5.3 ft

PGRM: Abutment

ABUTMENT SCOUR CALCULATIONS

Average flow depth blocked by: left abutment, y_{aLT} = 4.1 ft right abutment, y_{aRT} = 5.8 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} = 13.4 and ψ_{RT} = 16.5

Left abutment scour, $y_{as} = \psi_{LT}(K_1/0.55)$ = 13.4 ft Right abutment scour $y_{as} = \psi_{RT}(K_1/0.55)$ = 16.5 ft

SCOUR ANALYSIS AND REPORTING FORM

Bridge Structure No. 07285190 Date 7/24/12 Initials RAJ Region (A B C D)

Site _____ Location 1.5 mi W of HWY 37 on 119 St

Q_{500} = 4470 by: drainage area ratio ____ flood freq. anal. ____ regional regression eq. X

Bridge discharge (Q_2) = 2205 (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 = 78 ft. Flow angle at bridge = 25 ° Abut. Skew = 15 ° Effective Skew = 10 °

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 = 76.52 ft* $q_2 = Q_2/W_2$ = 28.7 ft²/s

Bridge Vel, V_2 = 2.7 ft/s Final $y_2 = q_2/V_2$ = 10.7 ft Δh = 0.1 ft

Average main channel depth at approach section, $y_1 = \Delta h + y_2$ = 10.8 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. = 3-4.5 ft

Low Steel Elev. = 10.7 ft

n (Channel) = 0.035

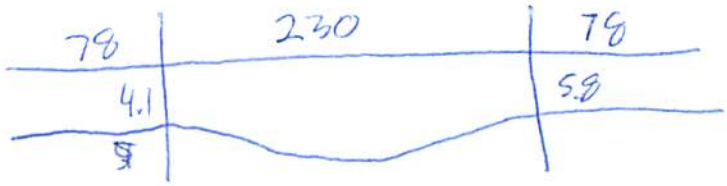
n (LOB) = 0.040

n (ROB) = 0.040

Pier Width = 1.7 ft

Pier Length = 1.7 ft

Piers for 500 yr = 2 ft



CONTRACTION SCOUR

PGRM: Contract

Width of main channel at approach section W_1 = 230 ft

Width of left overbank flow at approach, W_{lob} = 78 ft Average left overbank flow depth, y_{lob} = 4.1 ft

Width of right overbank flow at approach, W_{rob} = 78 ft Average right overbank flow depth, y_{rob} = 5.8 ft

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

x = 28.59 From Figure 9 W_2 (effective) = 73.4 ft y_{cs} = 22.3 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 = 0.13 Using pier width a on Figure 11, ξ = 7 Pier scour y_{ps} = 5.3 ft

PGRM: Abutment

ABUTMENT SCOUR CALCULATIONS

Average flow depth blocked by: left abutment, y_{aLT} = 4.1 ft right abutment, y_{aRT} = 5.8 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} = 13.4 and ψ_{RT} = 16.5

Left abutment scour, $y_{as} = \psi_{LT}(K_1/0.55)$ = 13.4 ft Right abutment scour $y_{as} = \psi_{RT}(K_1/0.55)$ = 16.5 ft

98.13433
45.66124

98° 8' 3.568"
45° 39" 40.464"

Route 119 St Stream Crow Clk Ditch MRM _____ Date 7/24/12 Initials EAL

Bridge Structure No. 07285190 Location 1.5 mi W of HWY 37 on 119 St

GPS coordinates: N 45° 39' 40.91"
W 96° 8' 3.21"

taken from: USL abutment X centerline of ↑ MRM end ~~X~~

Datum of coordinates: WGS84 X NAD27 ____

Drainage area = 849.4e sq. mi.

The average bottom of the main channel was 13.4 ft below top of guardrail at a point 58 ft from left abutment.

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

MISCELLANEOUS CONSIDERATIONS

Flows	Q_{100} = Q25 2180			Q_{500} = Q50 4470		
Estimated flow passing through bridge		2180			2205	
Estimated road overflow & overtopping		0			2265	
Consideration	Yes	No	Possibly	Yes	No	Possibly
Chance of overtopping		~~X~~ X		X		
Chance of Pressure flow	X			X		
Armored appearance to channel			X			X
Lateral instability of channel		X			X	

7/2

2	265
5	1030
10	2180
25	4470
50	6950
100	10200
500	21200

Riprap at abutments? X Yes ____No ____Marginal

Evidence of past Scour? X Yes ____No ____Don't know Some abutment, significant contraction

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 X	Cobbles____	Boulders____
Size range, in mm	<0.062	0.062-2.00	2.00-64	64-250	>250

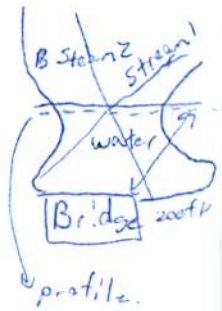
Comments, Diagrams & orientation of digital photos

1). left OB
2). main channel
3). right OB
4). right abutment
5). pier
6). left abutment
7). pier channel
8). left abutment
9). right abutment
10). main channel

Note: ~~over pt~~ overbank profile taken from a pt. 20e from left abutment, Water level too deep for accurate pier measurement. There are two streams feeding into the bridge. Both coming from a nearby lake.

Summary of Results

	~~Q100~~ Q_{25}	~~Q500~~ Q_{50}
Bridge flow evaluated	2180	2205
Flow depth at left abutment (yaLT), in feet	4.1	4.1
Flow depth at right abutment (yaRT), in feet	5.8	5.8
Contraction scour depth (ycs), in feet	22.3	22.3
Pier scour depth (yps), in feet	5.3	5.3
Left abutment scour depth (yas), in feet	13.4	13.4
Right abutment scour depth (yas), in feet	16.5	16.5
1Flow angle of attack	10	10



See Comments/Diagram for justification where required