OK RT

SCOUR ANALYSIS AND REPORTING FORM

Bridge Structure No. 43150186 Date 8/17/11 Initials CW Region (A B C D)

Site _____ Location 1 mi N of Presho on 304 Ave

Q_{100} = 5280 by: drainage area ratio ____ flood freq. anal. ____ regional regression eq. ✓

Bridge discharge (Q_2) = 5280 (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 = 117 ft. Flow angle at bridge = 10 ° Abut. Skew = 0 ° Effective Skew = 10 °

Width (W_2) iteration = 117 ~~120~~ 86 ~~84~~ ~~82~~ OK

Avg. flow depth at bridge, y_2 iteration = 8.0 ~~9.8~~ 9.5 ~~9.4~~ 9.7

Corrected channel width at bridge Section = W_2 times cos of flow angle = 80.75 ft* $q_2 = Q_2/W_2$ = 65.4 ft^2/s

Bridge Vel, V_2 = 6.8 ft/s Final $y_2 = q_2/V_2$ = 9.7 ft Δh = 0.9 ft

Average main channel depth at approach section, $y_1 = \Delta h + y_2$ = 10.6 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. = _____ ft

Low Steel Elev. = _____ ft

n (Channel) = 0.090

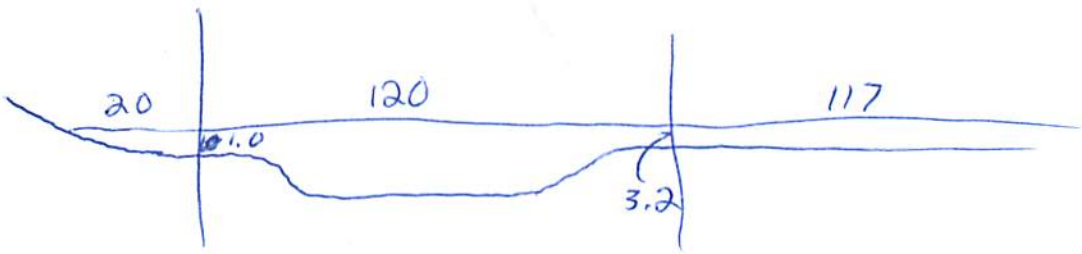
n (LOB) = 0.050

n (ROB) = 0.120

Pier Width = 3.0 ft

Pier Length = 3.0 ft

Piers for 100 yr = 2 ft



CONTRACTION SCOUR

PGRM: Contract

Width of main channel at approach section W_1 = 120 ft

Width of left overbank flow at approach, W_{lob} = 20 ft Average left overbank flow depth, y_{lob} = 0.5 ft (1 ÷ 2 = 0.5)

Width of right overbank flow at approach, W_{rob} = 117 ft Average right overbank flow depth, y_{rob} = 3.2 ft

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

x = 8.14 From Figure 9 W_2 (effective) = 74.8 ft y_{cs} = 9.0 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, $V_1 = Q_{100}/(y_1W_1)$ = _____ 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

PGRM: Pier

PIER SCOUR CALCULATIONS

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 = 10.7 Pier scour y_{ps} = 9.3 ft

PGRM: Abutment

ABUTMENT SCOUR CALCULATIONS

Average flow depth blocked by: left abutment, y_{aLT} = 0.5 ft right abutment, y_{aRT} = 3.2 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} = 2.3 and ψ_{RT} = 11.9

Left abutment scour, $y_{as} = \psi_{LT}(K_1/0.55)$ = 2.3 ft Right abutment scour $y_{as} = \psi_{RT}(K_1/0.55)$ = 11.9 ft

SCOUR ANALYSIS AND REPORTING FORM

Bridge Structure No. 43|50|46 Date 8/17/4 Initials CW Region (A B C D)

Site _____ Location 1 mi N of Prosho on 304 Ave

Q_{500} = 8430 by: drainage area ratio ____ flood freq. anal. ____ regional regression eq. ✓

Bridge discharge (Q_2) = 8430 (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

Bridge Width = 117 ft. Flow angle at bridge = 10 ° Abut. Skew = 0 ° Effective Skew = 10 °

Width (W_2) iteration = 117 102 107 105

Avg. flow depth at bridge, y_2 iteration = 10.5 11.3 11.1 _____

Corrected channel width at bridge Section = W_2 times cos of flow angle = 103.4 ft* $q_2 = Q_2/W_2$ = 85.4 ft^2/s

Bridge Vel, V_2 = 7.7 ft/s Final $y_2 = q_2/V_2$ = 11.1 ft Δh = 1.2 ft

Average main channel depth at approach section, $y_1 = \Delta h + y_2$ = 12.3 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.

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

Water Surface Elev. = _____ ft

Low Steel Elev. = _____ ft

n (Channel) = 0.090

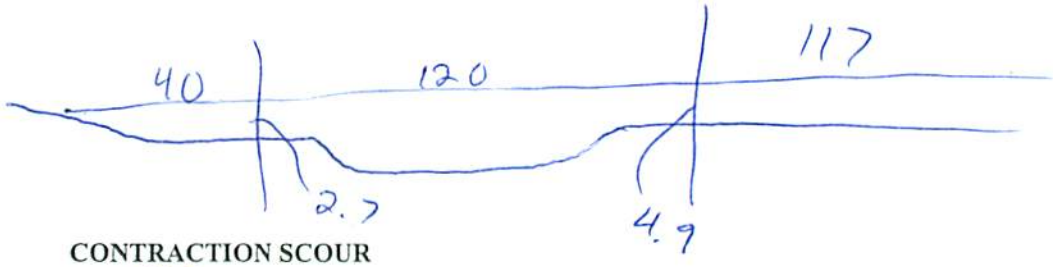
n (LOB) = 0.050

n (ROB) = 0.120

Pier Width = 3.0 ft

Pier Length = 3.0 ft

Piers for 500 yr = 2 ft



CONTRACTION SCOUR

PGRM: Contract

Width of main channel at approach section W_1 = 120 ft

Width of left overbank flow at approach, W_{lob} = 40 ft Average left overbank flow depth, y_{lob} = ~~2.7~~ 2.7 ÷ 2 = 1.4 ft

Width of right overbank flow at approach, W_{rob} = 117 ft Average right overbank flow depth, y_{rob} = 4.9 ft

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

x = 5.49 From Figure 9 W_2 (effective) = 97.4 ft y_{cs} = 6.2 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, $V_1 = Q_{500}/(y_1 W_1)$ = _____ 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 = 1.0 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 = 10.7 Pier scour y_{ps} = 9.4 ft

PGRM: Abutment

ABUTMENT SCOUR CALCULATIONS

Average flow depth blocked by: left abutment, y_{aLT} = 1.4 ft right abutment, y_{aRT} = 4.9 ft

Shape coefficient K_1= 1.00 for vertical-wall, 0.82 for vertical-wall with wingwalls, ~~0.55~~ 0.55 for spill-through

Using values for y_{aLT} and y_{aRT} on figure 12, ψ_{LT} = 5.9 and ψ_{RT} = 14.8

Left abutment scour, $y_{as} = \psi_{LT}(K_1/0.55)$ = 5.9 ft Right abutment scour $y_{as} = \psi_{RT}(K_1/0.55)$ = 14.8 ft

Route 304 Ave Stream Stony Butte Ck MRM _____ Date 8/17/11 Initials _____

Bridge Structure No. 43150186 Location 1 mi N of Presho on 304 Ave

GPS coordinates: N43° 55' 29.0" W100° 03' 57.8" taken from: USL abutment X centerline of ⇑ MRM end _____

Datum of coordinates: WGS84 X NAD27 _____

Drainage area = 105.4 sq. mi.

The average bottom of the main channel was 20.3 ft below top of guardrail at a point 48 ft from left abutment.

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

MISCELLANEOUS CONSIDERATIONS

Flows	Q_{100} = 5280			Q_{500} = 8830		
Estimated flow passing through bridge		5280			8830	
Estimated road overflow & overtopping						
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	

Peak calc'd 8/18

2	353
5	1070
10	1850
25	2980
50	4060
100	5280
500	8830

Riprap at abutments? ____Yes ____X____No ____Marginal

Evidence of past Scour? ____X____Yes ____No ____Don't know Pier Scour

Debris Potential? ____X____High ____Med ____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	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

ID-2009
10-US
11-USRB
12-USLB
13-L. Abut Scour
14-R. Abut
15-US Face
16-Pier Scour hole

Thick vegetation on RB limits view. Estimates made for ½ ROB depth + width of flow

Summary of Results

	Q100	Q500
Bridge flow evaluated	5280	8830
Flow depth at left abutment (yaLT), in feet	0.5	1.4
Flow depth at right abutment (yaRT), in feet	3.2	4.9
Contraction scour depth (ycs), in feet	9.0	6.2
Pier scour depth (yps), in feet	9.3	9.4
Left abutment scour depth (yas), in feet	2.3	5.9
Right abutment scour depth (yas), in feet	11.9	14.8
1Flow angle of attack	10°	10°

See Comments/Diagram for justification where required