OK by RFT

SCOUR ANALYSIS AND REPORTING FORM

Bridge Structure No. 52460329 Date 9/7/12 Initials Nal Region (A B C D)

Site _____ Location Reservoir Rd & Rapid Ck in RC

Q_{100} = 6370 by: drainage area ratio ____ flood freq. anal. ____ regional regression eq. ✓

Bridge discharge (Q_2) = 6370 (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 = 111 ft. Flow angle at bridge = 20 ° Abut. Skew = 0 ° Effective Skew = 20 °

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 = 104.31 ft* $q_2 = Q_2/W_2$ = 61.1 ft²/s

Bridge Vel, V_2 = 6.9 ft/s Final $y_2 = q_2/V_2$ = 6.8 ft Δh = 1.6 ft

Average main channel depth at approach section, $y_1 = \Delta h + y_2$ = 8.5 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, 2.7

Water Surface Elev. = 0.5 ft

Low Steel Elev. = 7.7 ft

n (Channel) = 0.035

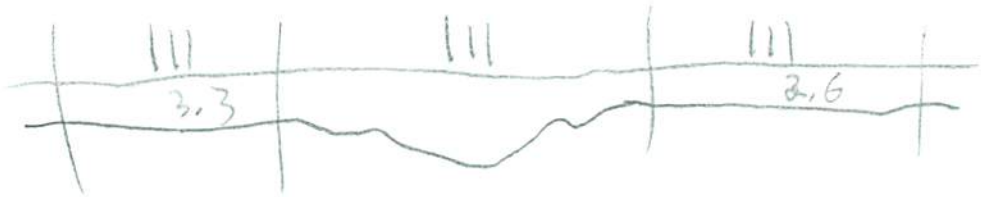
n (LOB) = 0.035

n (ROB) = 0.035

Pier Width = 1.9 ft

Pier Length = 1.9 ft

Piers for 100 yr = 2 ft



CONTRACTION SCOUR

PGRM: Contract

Width of main channel at approach section W_1 = 111 ft

Width of left overbank flow at approach, W_{lob} = 111 ft Average left overbank flow depth, y_{lob} = 3.3 ft

Width of right overbank flow at approach, W_{rob} = 111 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 = 4.13 From Figure 9 W_2 (effective) = 100.5 ft y_{cs} = 4.8 ft

Clear Water Contraction Scour (use if bed material is larger than small cobbles)

PGRM: CWCSNEW

Estimated bed material D_{50} = 0.3 ft Average approach velocity, $V_1 = Q_{100}/(y_1 W_1)$ = 2.25 ft/s

Note: Bed material ~2/3 small cobbles/gravel consid., clear water,

Critical approach velocity, $Vc = 11.17 y_1^{1/6} D_{50}^{1/3}$ = 10.68 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.

$D_{c50} = 0.0006(q_2/y_1^{7/6})^3$ = 0.076 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} = 0 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 = 0.6 Using pier width a on Figure 11, ξ = 7.7 Pier scour y_{ps} = 7.1 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 and ψ_{RT} = 10.6

Left abutment scour, $y_{as} = \psi_{LT}(K_1/0.55)$ = 12 ft Right abutment scour $y_{as} = \psi_{RT}(K_1/0.55)$ = 10.6 ft

SCOUR ANALYSIS AND REPORTING FORM

Bridge Structure No. 52460329 Date 9/7/12 Initials NAL Region (A B C D)

Site _____ Location Reservoir Rd + Rapid Ck

Q_{500} = 15700 by: drainage area ratio ____ flood freq. anal. ____ regional regression eq. X

Bridge discharge (Q_2) = 6987 (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 = 111 ft. Flow angle at bridge = 20 ° Abut. Skew = 0 ° Effective Skew = 20 °

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 = 104.31 ft* $q_2 = Q_2/W_2$ = 67 ft^2/s

Bridge Vel, V_2 = 9.3 ft/s Final $y_2 = q_2/V_2$ = 7.2 ft Δh = 1.8 ft

Average main channel depth at approach section, $y_1 = \Delta h + y_2$ = 9 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. = 0.5 ft

Low Steel Elev. = 7.2 ft

n (Channel) = 0.035

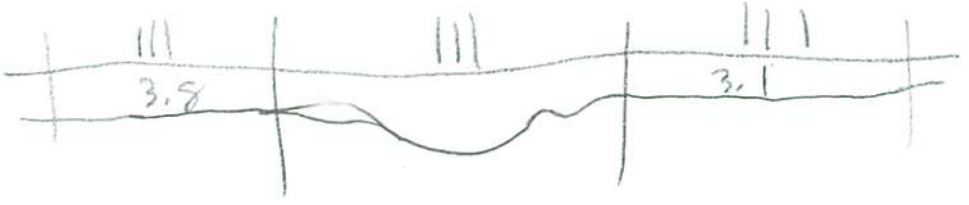
n (LOB) = 0.035

n (ROB) = 0.035

Pier Width = 1.9 ft

Pier Length = 1.9 ft

Piers for 500 yr = 2 ft



CONTRACTION SCOUR

PGRM: Contract

Width of main channel at approach section W_1 = 111 ft

Width of left overbank flow at approach, W_{lob} = 111 ft Average left overbank flow depth, y_{lob} = 3.8 ft

Width of right overbank flow at approach, W_{rob} = 111 ft Average right overbank flow depth, y_{rob} = 3.1 ft

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

x = 4.98 From Figure 9 W_2 (effective) = 100.5 ft y_{cs} = 5.7 ft

PGRM: CWCSNEW

Clear Water Contraction Scour (use if bed material is larger than small cobbles)

Estimated bed material D_{50} = 0.3 ft Average approach velocity, $V_1 = Q_{500}/(y_1 W_1)$ = 2.33 ft/s

Critical approach velocity, $Vc = 11.17 y_1^{1/6} D_{50}^{1/3}$ = 10.78 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.

$D_{c50} = 0.0006(q_2/y_1^{7/6})^3$ = 0.082 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} = 0 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 = 0.61 Using pier width a on Figure 11, ξ = 7.7 Pier scour y_{ps} = 7.1 ft

ABUTMENT SCOUR CALCULATIONS

PGRM: Abutment

Average flow depth blocked by: left abutment, y_{aLT} = 3.8 ft right abutment, y_{aRT} = 3.1 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} = 12.9 and ψ_{RT} = 11.7

Left abutment scour, $y_{as} = \psi_{LT}(K_1/0.55)$ = 12.9 ft Right abutment scour $y_{as} = \psi_{RT}(K_1/0.55)$ = 11.7 ft

103.13126
44.04007

44° 2' 24.252"
103° 7' 52.536"

Route Reservoir Rd Stream Rapid Ck MRM _____ Date 9/7/12 Initials RaT

Bridge Structure No. 52460329 Location Reservoir Rd & Rapid Ck

GPS coordinates: N 44° 7' 24.21" taken from: USL abutment X centerline of ↑ MRM end _____

W 103° 7' 52.51" Datum of coordinates: WGS84 X NAD27 _____

Drainage area = 444.35 sq. mi.

The average bottom of the main channel was 11.7 ft below top of guardrail at a point 49 ft from left abutment.

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

MISCELLANEOUS CONSIDERATIONS

Flows	Q_{100} = 6370			Q_{500} = 15700		
Estimated flow passing through bridge	6370			6987		
Estimated road overflow & overtopping	C			8713		
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	

7/3

2	227
5	663
10	1240
25	2490
50	~~6370~~ 4080
100	6370
500	15700

Riprap at abutments? ____Yes ____No X Marginal outside of bridge only

Evidence of past Scour? X Yes ____No ____Don't know some contraction/ heavy left abutment

Debris Potential? ____High ____Med X Low

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

Riprap X Yes ____No ____Don't know ____NA Rosequartz on outside of bridge only

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 X	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
6-7). left abutment
8). right abutment
9). main channel

cont'd

Summary of Results

	Q100	Q500
Bridge flow evaluated	6370	6987
Flow depth at left abutment (yaLT), in feet	3.3	3.5
Flow depth at right abutment (yaRT), in feet	2.6	3.1
Contraction scour depth (ycs), in feet	4.8	5.7
Pier scour depth (yps), in feet	7.1	7.1
Left abutment scour depth (yas), in feet	12.6	12.9
Right abutment scour depth (yas), in feet	10.6	11.7
1Flow angle of attack	20	20

See Comments/Diagram for justification where required