

OK RTJ

SCOUR ANALYSIS AND REPORTING FORM

Bridge Structure No. 52427308 Date 4/8/2011 Initials CLW Region (A B C D)

Site Cherry Ave over Rapid Creek Location Cherry Ave over Rapid Creek

$Q_{100} = 4820$ by: drainage area ratio flood freq. anal. regional regression eq.

Bridge discharge (Q_2) = 3484 (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

Bridge Width = 85 ft. Flow angle at bridge = 0 ° Abut. Skew = 0 ° Effective Skew = 0 °

Width (W_2) iteration = 85

Avg. flow depth at bridge, y_2 iteration = 6.6 > 5.5 → RD overflow → 85

Corrected channel width at bridge Section = W_2 times cos of flow angle = 85 ft* $q_2 = Q_2/W_2 = 41$ ft²/s

Bridge Vel, $V_2 = 7.5$ ft/s Final $y_2 = q_2/V_2 = 5.5$ ft $\Delta h = 1.1$ ft

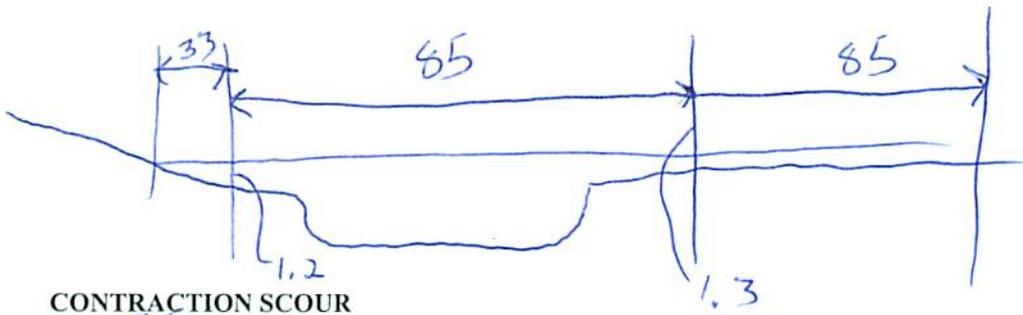
Average main channel depth at approach section, $y_1 = \Delta h + y_2 = 6.6$ ft

* 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.

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

Water Surface Elev. = _____ ft
Low Steel Elev. = 5.5 ft
 n (Channel) = 0.035
 n (LOB) = 0.033
 n (ROB) = 0.033
Pier Width = 1.5 ft
Pier Length = 38 ft
Piers for 100 yr = 2 ft



CONTRACTION SCOUR

Width of main channel at approach section $W_1 = 85$ ft

Width of left overbank flow at approach, $W_{lob} = 33$ ft

Width of right overbank flow at approach, $W_{rob} = 85$ ft

Average left overbank flow depth, $y_{lob} = 0.6$ ft ch

Average right overbank flow depth, $y_{rob} = 1.3$ ft ch

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

$x =$ _____ From Figure 9 W_2 (effective) = _____ ft $y_{cs} =$ _____ ft

Clear Water Contraction Scour (use if bed material is larger than small cobbles) 2=0

Estimated bed material $D_{50} = 0.20$ ft Average approach velocity, $V_1 = Q_{100}/(y_1 W_1) = 2.6$ ft/s

Critical approach velocity, $V_c = 11.52 y_1^{1/6} D_{50}^{1/3} = 8.75$ ft/s

If $V_1 < V_c$ and $D_{50} \geq 0.2$ ft, use clear water equation below, otherwise use live bed scour equation above.

$D_{c50} = 0.0006 (q_2/y_1^{7/6})^3 = 0.05599$ ft

If $D_{50} \geq D_{c50}$ $\chi = 0.0$

Otherwise, $\chi = 0.122 y_1 [q_2 / (D_{50}^{1/3} y_1^{7/6})]^{6/7} - y_1 =$ _____ From Figure 10, $y_{cs} = 0.0$ ft

PRGM: Contract

PRGM: CWCNEW

PRGM: Pier

PIER SCOUR CALCULATIONS

L/a ratio = 25.3

Froude # at bridge = 0.56

Correction factor for flow angle of attack (from Table 1), $K_2 = 1.0$

Using pier width a on Figure 11, $\xi = 6.4$ Pier scour $y_{ps} = 5.9$ ft

ABUTMENT SCOUR CALCULATIONS

Average flow depth blocked by: left abutment, $y_{aLT} = 0.6$ ft right abutment, $y_{aRT} = 0.6$ ft ch 1.3

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, $\psi_{LT} = 2.7$ and $\psi_{RT} = 2.7$ 5.5

Left abutment scour, $y_{as} = \psi_{LT}(K_1/0.55) = 2.7$ ft Right abutment scour $y_{as} = \psi_{RT}(K_1/0.55) = 2.7$ ft 5.5

PRGM: Abutment

SCOUR ANALYSIS AND REPORTING FORM

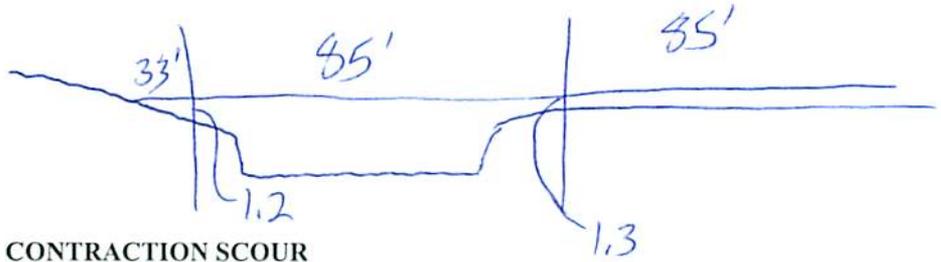
Bridge Structure No. 52427308 Date 4/8/11 Initials CW Region (A B C D)
 Site _____ Location Cherry Ave over Rapid Creek
 $Q_{500} = 18100$ by: drainage area ratio flood freq. anal. _____ regional regression eq. _____
 Bridge discharge (Q_2) = 3484 (should be Q_{500} unless there is a relief bridge, road overflow, or bridge overtopping)

Analytical Procedure for Estimating Hydraulic Variables Needed to Apply Method

Bridge Width = 85 ft. Flow angle at bridge = 0° Abut. Skew = 0° Effective Skew = 0°
 Width (W_2) iteration = 85
 Avg. flow depth at bridge, y_2 iteration = 6.6 > 5.5 → RD overflow
 Corrected channel width at bridge Section = W_2 times cos of flow angle = 85 ft* $q_2 = Q_2/W_2 = 41$ ft²/s
 Bridge Vel, $V_2 = 7.5$ ft/s Final $y_2 = q_2/V_2 = 5.5$ ft $\Delta h = 1.1$ ft
 Average main channel depth at approach section, $y_1 = \Delta h + y_2 = 6.6$ 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. = 5.5 ft
 n (Channel) = 0.035
 n (LOB) = 0.033
 n (ROB) = 0.033
 Pier Width = 1.5 ft
 Pier Length = 38 ft
 # Piers for 500 yr = 2 ft



CONTRACTION SCOUR

Width of main channel at approach section $W_1 = 85$ ft
 Width of left overbank flow at approach, $W_{lob} = 33$ ft Average left overbank flow depth, $y_{lob} = 0.6$ ft
 Width of right overbank flow at approach, $W_{rob} = 35$ ft Average right overbank flow depth, $y_{rob} = 1.3$ ft

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

$x =$ _____ From Figure 9 W_2 (effective) = _____ ft $y_{cs} =$ _____ ft

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

Estimated bed material $D_{50} = 0.2$ ft Average approach velocity, $V_1 = Q_{500}/(y_1 W_1) = 6.21$ ft/s $Z = 0$
 Critical approach velocity, $V_c = 11.52 y_1^{1/6} D_{50}^{1/3} = 8.95$ ft/s
 If $V_1 < V_c$ and $D_{50} \geq 0.2$ ft, use clear water equation below, otherwise use live bed scour equation above.
 $D_{c50} = 0.0006 (q_2/y_1^{7/6})^3 = 0.056$ ft If $D_{50} \geq D_{c50}$, $\chi = 0.0$
 Otherwise, $\chi = 0.122 y_1 [q_2 / (D_{50}^{1/3} y_1^{7/6})]^{6/7} - y_1 =$ _____ From Figure 10, $y_{cs} = 0.0$ ft

PIER SCOUR CALCULATIONS

L/a ratio = 25.3 Correction factor for flow angle of attack (from Table 1), $K_2 = 1.0$
 Froude # at bridge = 0.56 Using pier width a on Figure 11, $\xi = 6.4$ Pier scour $y_{ps} = 5.9$ ft

ABUTMENT SCOUR CALCULATIONS

Average flow depth blocked by: left abutment, $y_{aLT} = 0.6$ ft right abutment, $y_{aRT} = 1.3$ 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, $\psi_{LT} = 2.7$ and $\psi_{RT} = 2.9$
 Left abutment scour, $y_{as} = \psi_{LT}(K_1/0.55) = 2.7$ ft Right abutment scour $y_{as} = \psi_{RT}(K_1/0.55) = 2.9$ ft 5.5

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

PRGM: Contract

PRGM: CWCNEW

PRGM: Pie

PRGM: Abutment

Route Cherry Ave Stream Rapid Creek MRM _____ Date 4/8/11 Initials Ch
 Bridge Structure No. 52427308 Location Cherry Ave over Rapid Creek
 GPS coordinates: N 44° 04' 36.3" taken from: USL abutment centerline of MRM end _____
W 103° 11' 49.1" Datum of coordinates: WGS84 NAD27 _____
 Drainage area = 421.52 sq. mi.
 The average bottom of the main channel was 9.8 ft below top of guardrail at a point 23 ft from left abutment.
 Method used to determine flood flows: Freq. Anal. drainage area ratio regional regression equations.

MISCELLANEOUS CONSIDERATIONS

Flows	Q ₁₀₀ = <u>4820</u>			Q ₅₀₀ = <u>18100</u>		
Estimated flow passing through bridge	<u>3484</u>			<u>3484</u>		
Estimated road overflow & overtopping	<u>13.36</u>			<u>14616</u>		
Consideration	Yes	No	Possibly	Yes	No	Possibly
Chance of overtopping	<input checked="" type="checkbox"/>			<input checked="" type="checkbox"/>		
Chance of Pressure flow	<input checked="" type="checkbox"/>			<input checked="" type="checkbox"/>		
Armored appearance to channel		<input checked="" type="checkbox"/>			<input checked="" type="checkbox"/>	
Lateral instability of channel		<input checked="" type="checkbox"/>			<input checked="" type="checkbox"/>	

Riprap at abutments? Yes No Marginal
 Evidence of past Scour? Yes No Don't know
 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 (D₅₀)

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

Photos
 1564 - ID
 70 - US
 71 - US RB
 72 - US LB
 73 - L. Abut
 74 - L. Abut
 75 - R. Abut
 76 - US Face bridge

Summary of Results

	Q ₁₀₀	Q ₅₀₀
Bridge flow evaluated	<u>3484</u>	<u>3484</u>
Flow depth at left abutment (yaLT), in feet	<u>0.60</u>	0.65 <u>0.60</u>
Flow depth at right abutment (yaRT), in feet	0.65 <u>1.3</u>	0.65 <u>1.3</u>
Contraction scour depth (y _{cs}), in feet	<u>0.0</u>	<u>0.0</u>
Pier scour depth (y _{ps}), in feet	<u>5.9</u>	<u>5.9</u>
Left abutment scour depth (y _{as}), in feet	0.60 <u>2.7</u>	0.60 <u>2.7</u>
Right abutment scour depth (y _{as}), in feet	0.65 <u>5.5</u>	0.65 <u>5.5</u>
Flow angle of attack	<u>0°</u>	<u>0°</u>

See Comments/Diagram for justification where required