0K RJT

SCOUR ANALYSIS AND REPORTING FORM

Bridge Structure No. 44006170 Date 6/29/12 Initials RJT Region (A B (C) D)

Site ______ Location 1 mi E of Emery on 281 St

Q_{100} = Q_{10} 1490 by: drainage area ratio ____ flood freq. anal. ____ regional regression eq. X

Bridge discharge (Q_2) = 1490 (should be Q_{100} unless there is a relief bridge, road overflow, or bridge overtopping)

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

Analytical Procedure for Estimating Hydraulic Variables Needed to Apply Method

Bridge Width = 69 ft. Flow angle at bridge = 50 ° Abut. Skew = 0 ° Effective Skew = 50 °

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 = 44.35 ft* $q_2 = Q_2/W_2$ = 33.6 ft^2/s

Bridge Vel, V_2 = 4.1 ft/s Final $y_2 = q_2/V_2$ = 8.2 ft Δh = 0.3 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,

Water Surface Elev. = 1.9 ft

Low Steel Elev. = 11.1 ft 2.0 1.3

n (Channel) = 0.040

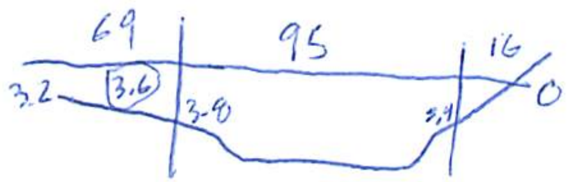
n (LOB) = 0.035

n (ROB) = 0.035

Pier Width = 1.35 ft

Pier Length = 1.35 ft

\# Piers for 100 yr = 2 ft



CONTRACTION SCOUR

PGRM: Contract

Width of main channel at approach section W_1 = 95 ft 3.8 3.2

Width of left overbank flow at approach, W_{lob} = 69 ft Average left overbank flow depth, y_{lob} = 3.6 ft

Width of right overbank flow at approach, W_{rob} = 16 ft Average right overbank flow depth, y_{rob} = 2.7 ft

5.4 – 0

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

x = 15.28 From Figure 9 W_2 (effective) = 41.7 ft y_{cs} = 15.7 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, $V_1 = Q_{100}/(y_1W_1)$ = ____ ft/s

Critical approach velocity, $V_c = 11.17y_1^{1/6}D_{50}^{1/3}$ = ____ 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 = 0.25 Using pier width a on Figure 11, ξ = 6 Pier scour y_{ps} = 4.8 ft

ABUTMENT SCOUR CALCULATIONS

PGRM: Abutment

Average flow depth blocked by: left abutment, y_{aLT} = 3.6 ft right abutment, y_{aRT} = 2.7 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} = 12.6 and ψ_{RT} = 11

Left abutment scour, $y_{as} = \psi_{LT}(K_1/0.55)$ = 22.8 ft Right abutment scour $y_{as} = \psi_{RT}(K_1/0.55)$ = 20.0 ft

SCOUR ANALYSIS AND REPORTING FORM

Bridge Structure No. 44006170 Date 6/29/17 Initials RAJ Region (A B (C) D)

Site 3070 Location 1.0 mi E of Emery on 281 St

Q_{500} = Q_{25} 2346 by: drainage area ratio____ flood freq. anal. ____ regional regression eq. X

Bridge discharge (Q_2) = 2749 (should be Q_{500} unless there is a relief bridge, road overflow, or bridge overtopping)

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

Analytical Procedure for Estimating Hydraulic Variables Needed to Apply Method

Bridge Width = 69 ft. Flow angle at bridge = 50 ° Abut. Skew = 0 ° Effective Skew = 50 °

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 = 44.35 ft* $q_2 = Q_2/W_2$ = 62 ft²/s

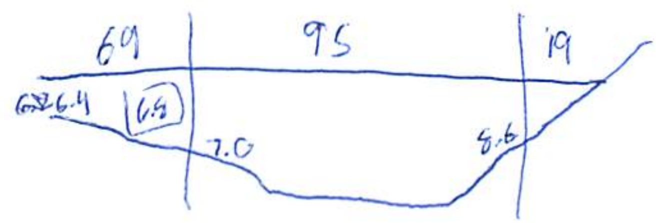
Bridge Vel, V_2 = 5.6 ft/s Final $y_2 = q_2/V_2$ = 11.1 ft Δh = 0.6 ft

Average main channel depth at approach section, $y_1 = \Delta h + y_2$ = 11.7 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. = 1.9 ft
Low Steel Elev. = 11.1 ft
n (Channel) = 0.040
n (LOB) = 0.035
n (ROB) = 0.035
Pier Width = 1.35 ft
Pier Length = 1.35 ft
Piers for 500 yr = 3 ft



PGRM: Contract

CONTRACTION SCOUR

Width of main channel at approach section W_1 = 95 ft

Width of left overbank flow at approach, W_{lob} = 69 ft Average left overbank flow depth, y_{lob} = 6.4 ft

Width of right overbank flow at approach, W_{rob} = 19 ft Average right overbank flow depth, y_{rob} = 4.3 ft

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

x = 26.34 From Figure 9 W_2 (effective) = 40.3 ft y_{cs} = 21.1 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, $V_1 = Q_{500}/(y_1 W_1)$ = ____ 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: Pie

PIER SCOUR CALCULATIONS

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

Froude # at bridge = 0.3 Using pier width a on Figure 11, ξ = 6 Pier scour y_{ps} = 5 ft

PGRM: Abutment

ABUTMENT SCOUR CALCULATIONS

Average flow depth blocked by: ~~left abutment~~, y_{aLT} = 6.5 ft right abutment, y_{aRT} = 4.3 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, ψ_{LT} = 18.2 and ψ_{RT} = 13.8

Left abutment scour, $y_{as} = \psi_{LT}(K_1/0.55)$ = 33.1 ft Right abutment scour $y_{as} = \psi_{RT}(K_1/0.55)$ = 25.1 ft

97° 35' 42.9936"
43° 36' 2.1384"

95518

97.595276
43.600594

Route 281 St Stream Wolf Ck MRM ______ Date 6/29/12. Initials [illegible]

Bridge Structure No. 44006170 Location 1 mi E of Emery on 281 St

GPS coordinates: N 43° 36' 2.3" W 97° 35' 43.1" taken from: USL abutment X centerline of ⇑ MRM end ______

Datum of coordinates: WGS84 X NAD27 ______

Drainage area = 171.71 sq. mi.

The average bottom of the main channel was 14.7 ft below top of guardrail at a point 52 ft from left abutment.

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

MISCELLANEOUS CONSIDERATIONS

Flows	Q_{100} = Q_{10} 1490			Q_{500} = Q_{25} 3070		
Estimated flow passing through bridge	1490			2749		
Estimated road overflow & overtopping	0			321		
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	

6/14

2	173
5	725
10	1490
25	3070
50	4790
100	7060
500	14900

Riprap at abutments? ____Yes ____No X Marginal Some on outside left abutment

Evidence of past Scour? X Yes ____No ____Don't know I believe the abutments used to be a spill way. lots of contraction & abutment scour.

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). right abutment erosion
5). pier
6-8). right abutment
9). left abutment
10). left abutment
11). main channel

Summary of Results

	~~Q100~~ Q_{10}	~~Q500~~ Q_{25}
Bridge flow evaluated	1490	2749
Flow depth at left abutment (yaLT), in feet	3.6	6.9
Flow depth at right abutment (yaRT), in feet	2.7	4.3
Contraction scour depth (ycs), in feet	15.1	21.1
Pier scour depth (yps), in feet	4.8	5
Left abutment scour depth (yas), in feet	22.9	~~4.3~~ 33.1
Right abutment scour depth (yas), in feet	20	25.1
1Flow angle of attack	50	50

See Comments/Diagram for justification where required