OK RJ

SCOUR ANALYSIS AND REPORTING FORM

Bridge Structure No. 14103090 Date 5/28/12 Initials RAT Region (A B (C) D)

Site ______ Location 11.6 mi N of Vermillion on 306 St

Q_{100} = 1120 by: drainage area ratio ____ flood freq. anal. ____ regional regression eq. X

Bridge discharge (Q_2) = 1120 (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 = 67 ft. Flow angle at bridge = 40 ° Abut. Skew = 0 ° Effective Skew = 40 °

Width (W_2) iteration = ~~51.32~~ ... 51.32, 40.6, 42.9

Avg. flow depth at bridge, y_2 iteration = ~~6.6~~ ~~7.4~~ ... 6.6, 7.4, 7.2

Corrected channel width at bridge Section = W_2 times cos of flow angle = 42.9 ft* $q_2 = Q_2/W_2$ = 26.1 ft^2/s

Bridge Vel, V_2 = 3.6 ft/s Final $y_2 = q_2/V_2$ = 7.2 ft Δh = 0.3 ft

Average main channel depth at approach section, $y_1 = \Delta h + y_2$ = 7.5 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. = 15.4 ft

Low Steel Elev. = 11.6 ft

n (Channel) = 0.045

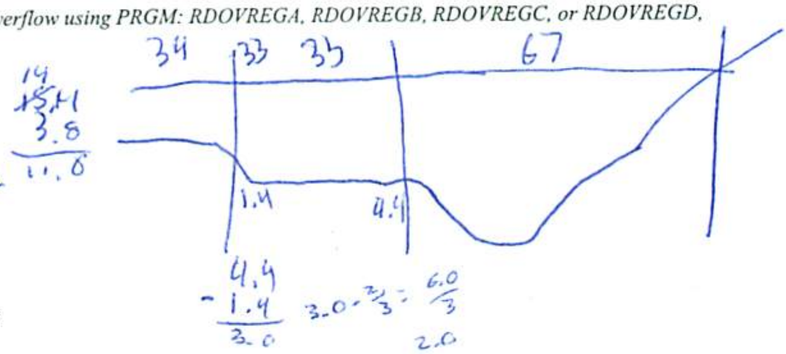
n (LOB) = ~~0.045~~ ~~0.045~~ ~~0.050~~

n (ROB) = 0.040

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 = 67 ft

Width of left overbank flow at approach, W_{lob} = 67 ft Average left overbank flow depth, y_{lob} = 3.4 ft

Width of right overbank flow at approach, W_{rob} = 0 ft Average right overbank flow depth, y_{rob} = 0 ft

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

x = 8.79 From Figure 9 W_2 (effective) = 39.1 ft y_{cs} = 9.7 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, $Vc = 11.17y_1^{1/6}D_{50}^{1/3}$ = ______ 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

PIER SCOUR CALCULATIONS

PGRM: Pier

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

Froude # at bridge = 0.24 Using pier width a on Figure 11, ξ = 7.7 Pier scour y_{ps} = 6.2 ft

ABUTMENT SCOUR CALCULATIONS

PGRM: Abutment

Average flow depth blocked by: left abutment, y_{aLT} = 3.4 ft right abutment, y_{aRT} = 0 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} = 12.2 and ψ_{RT} = 0

Left abutment scour, $y_{as} = \psi_{LT}(K_1/0.55)$ = 12.2 ft Right abutment scour $y_{as} = \psi_{RT}(K_1/0.55)$ = 0 ft

SCOUR ANALYSIS AND REPORTING FORM

Bridge Structure No. 14103090 Date 5/28/12 Initials Ral Region (A B (C) D)

Site ________ Location 11.6 mi N of Vermillion on 306 St

Q_{500} = 2140 by: drainage area ratio ____ flood freq. anal. ____ regional regression eq. X

Bridge discharge (Q_2) = 2140 (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 = 67 ft. Flow angle at bridge = 40 ° Abut. Skew = 0 ° Effective Skew = 40 °

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 = 51.32 ft* $q_2 = Q_2/W_2$ = 41.7 ft^2/s

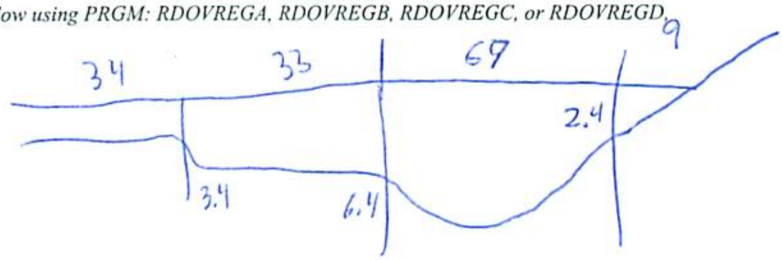
Bridge Vel, V_2 = 4.6 ft/s Final $y_2 = q_2/V_2$ = 9.1 ft Δh = 0.4 ft

Average main channel depth at approach section, $y_1 = \Delta h + y_2$ = 9.5 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. = 1ft ft
Low Steel Elev. = 11.6 ft
n (Channel) = 0.045
n (LOB) = 0.045
n (ROB) = 0.040
Pier Width = 1.9 ft
Pier Length = 1.9 ft
Piers for 500 yr = 2 ft



3.4
+2.0

CONTRACTION SCOUR

PGRM: Contract

Width of main channel at approach section W_1 = 67 ft

Width of left overbank flow at approach, W_{lob} = 67 ft Average left overbank flow depth, y_{lob} = 5.4 ft

Width of right overbank flow at approach, W_{rob} = 9 ft Average right overbank flow depth, y_{rob} = 2.4 ft

Live Bed Contraction Scour (use if bed material is small cobbles or finer) 3.6·2/3

x = 9.32 From Figure 9 W_2 (effective) = 47.5 ft y_{cs} = ~~10.5~~ 10.2 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, $V_1 = Q_{500}/(y_1W_1)$ = ________ 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

PIER SCOUR CALCULATIONS

PGRM: Pie

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

Froude # at bridge = 0.27 Using pier width a on Figure 11, ξ = 7.7 Pier scour y_{ps} = 6.3 ft

ABUTMENT SCOUR CALCULATIONS

PGRM: Abutment

Average flow depth blocked by: left abutment, y_{aLT} = 5.4 ft right abutment, y_{aRT} = 2.4 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} = 15.7 and ψ_{RT} = 9.8

Left abutment scour, $y_{as} = \psi_{LT}(K_1/0.55)$ = 15.7 ft Right abutment scour $y_{as} = \psi_{RT}(K_1/0.55)$ = 9.8 ft

Route 306 St Stream Vermillion River Overflow MRM ______ Date 5/28/12 Initials RAT

Bridge Structure No. 14103090 Location 11.6 mi N of Vermillion on 306 St

GPS coordinates: N 42° 57' 13.0" W 96° 57' 31.5" taken from: USL abutment X centerline of ⇑ MRM end ______

Datum of coordinates: WGS84 X NAD27 ____

Drainage area = 7.65 sq. mi.

The average bottom of the main channel was 15.4 ft below top of guardrail at a point 43 ft from left abutment.

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

5/22
8/23

2	54
5	169
10	303
25	555
50	807
100	1120
500	2140

MISCELLANEOUS CONSIDERATIONS

Flows	Q_{100} = 1120			Q_{500} = 2140		
Estimated flow passing through bridge	1120			2140		
Estimated road overflow & overtopping	0			0		
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	

Riprap at abutments? X Yes ____No ____Marginal

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

Debris Potential? ____High ____Med X Low

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

Riprap X Yes ____No ____Don't know ____NA - rose quartz

Spur Dike ____Yes X No ____Don't know ____NA

Other ____________ X Yes ____No ____Don't know ____NA trees on right bank

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). main channel
2). right abutment
3). right ab
4). piers
5). abutment scour (left)
6. left ab
7). left ab
8). right ab
9). left OB
10). right OB
11). main channel
12). left OB
13). right OB

Note: high water mark is around 2 ft below low steel. This is around the level of Q_{500}.

Summary of Results

	Q100	Q500
Bridge flow evaluated	1120	2140
Flow depth at left abutment (yaLT), in feet	3.4	5.4
Flow depth at right abutment (yaRT), in feet	0	2.4
Contraction scour depth (ycs), in feet	9.7	~~10.5~~ 10.2
Pier scour depth (yps), in feet	6.2	6.3
Left abutment scour depth (yas), in feet	12.2	15.7
Right abutment scour depth (yas), in feet	0	9.8
1Flow angle of attack	90	90

See Comments/Diagram for justification where required