ok RT

SCOUR ANALYSIS AND REPORTING FORM

Bridge Structure No. 44095080 Date 6/18/12 Initials RT Region (A B (C) D)

Site ______ Location 1.3 mi W of Salem on 252 St

Q_{100} = Q5 655 by: drainage area ratio ____ flood freq. anal. ____ regional regression eq. ✗

Bridge discharge (Q_2) = 655 (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 = 35 ft. Flow angle at bridge = 30 ° Abut. Skew = 0 ° Effective Skew = 30 °

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 = 30.31 ft* $q_2 = Q_2/W_2$ = 21.6 ft^2/s

Bridge Vel, V_2 = 3.3 ft/s Final $y_2 = q_2/V_2$ = 6.6 ft Δh = 0.2 ft

Average main channel depth at approach section, $y_1 = \Delta h + y_2$ = 6.8 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. = 1.6 ft

Low Steel Elev. = 9.1 ft

n (Channel) = 0.033

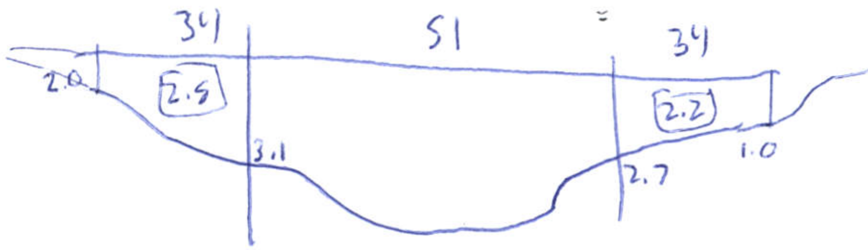
n (LOB) = 0.030

n (ROB) = 0.035

Pier Width = 1.35 ft

Pier Length = 1.35 ft

Piers for 100 yr = 1 ft



PGRM: Contract

CONTRACTION SCOUR

3.1 2.0

Width of main channel at approach section W_1 = 51 ft

Width of left overbank flow at approach, W_{lob} = 34 ft Average left overbank flow depth, y_{lob} = 2.8 ft

Width of right overbank flow at approach, W_{rob} = 34 ft Average right overbank flow depth, y_{rob} = 2.2 ft

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

x = 8.32 From Figure 9 W_2 (effective) = 29 ft y_{cs} = 9.2 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, $V_1 = Q_{100}/(y_1 W_1)$ = ____ ft/s

Critical approach velocity, $V_c = 11.17 y_1^{1/6} D_{50}^{1/3}$ = ____ 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 Correction factor for flow angle of attack (from Table 1), K2 = 1

Froude # at bridge = 0.23 Using pier width a on Figure 11, ξ = 6 Pier scour y_{ps} = 4.8 ft

PGRM: Abutment

ABUTMENT SCOUR CALCULATIONS

Average flow depth blocked by: left abutment, y_{aLT} = 2.8 ft right abutment, y_{aRT} = 2.2 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} = 11.2 and ψ_{RT} = 9

Left abutment scour, $y_{as} = \psi_{LT}(K_1/0.55)$ = 20.3 ft Right abutment scour $y_{as} = \psi_{RT}(K_1/0.55)$ = 16.4 ft

SCOUR ANALYSIS AND REPORTING FORM

Bridge Structure No. 44095080 Date 6/18/12 Initials [illegible] Region (A B C D) (D circled)

Site ____________ Location 1.3 mi W of Salem on 252 St

Q_{500} = Q_{10} 1320 by: drainage area ratio____ flood freq. anal. ____ regional regression eq. X

Bridge discharge (Q_2) = 1260 (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 = 35 ft. Flow angle at bridge = 30 ° Abut. Skew = 0 ° Effective Skew = 35 °

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 = 30.31 ft* $q_2 = Q_2/W_2$ = 41.6 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. = 1.0 ft

Low Steel Elev. = 9.1 ft

n (Channel) = 0.033

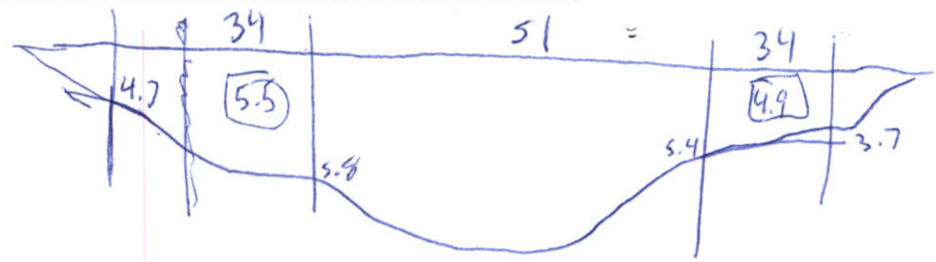
n (LOB) = 0.030

n (ROB) = 0.035

Pier Width = 1.35 ft

Pier Length = 1.35 ft

Piers for 500 yr = 1 ft



CONTRACTION SCOUR

PGRM: Contract

Width of main channel at approach section W_1 = 51 ft

Width of left overbank flow at approach, W_{lob} = 34 ft Average left overbank flow depth, y_{lob} = 5.5 ft (5.8, 4.7)

Width of right overbank flow at approach, W_{rob} = 34 ft Average right overbank flow depth, y_{rob} = 4.9 ft (5.4, 3.7)

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

x = 15.65 From Figure 9 W_2 (effective) = 29 ft y_{cs} = 15.3 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}, χ = 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 = 0.27 Using pier width a on Figure 11, ξ = 6 Pier scour y_{ps} = 4.9 ft

ABUTMENT SCOUR CALCULATIONS

PGRM: Abutment

Average flow depth blocked by: ~~left abutment~~, y_{aLT} = 5.5 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 for spill-through

Using values for y_{aLT} and y_{aRT} on figure 12, ψ_{LT} = 15.9 and ψ_{RT} = 14.8

Left abutment scour, $y_{as} = \psi_{LT}(K_1/0.55)$ = 28.9 ft Right abutment scour $y_{as} = \psi_{RT}(K_1/0.55)$ = 27 ft

Route 252 St Stream W Fk Vermillion River MRM________ Date 6/18/22 Initials [illegible]

Bridge Structure No. 44095080 Location 1.3 mi W of Salem on 252 St

GPS coordinates: N 43° 43' 53.9" N 97° 25' 16.5" taken from: USL abutment X centerline of ⇑ MRM end ______

Datum of coordinates: WGS84 X NAD27_____

Drainage area = 137.68 sq. mi. 137.67

The average bottom of the main channel was 13.6 ft below top of guardrail at a point 23 ft from left abutment.

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

6/18 ~~8/24~~

MISCELLANEOUS CONSIDERATIONS

Flows	~~Q100~~ = Q5 655			~~Q500~~ = Q10 1320		
Estimated flow passing through bridge	655			1260		
Estimated road overflow & overtopping	0			60		
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	

2	159
5	655
10	1320
25	2720
50	4220
100	6190
500	12900

Riprap at abutments? X Yes ____No ____Marginal

Evidence of past Scour? X Yes ____No ____Don't know very minor contraction/abutment. maybe some pier

Debris Potential? ____High ____Med X Low

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

Riprap X Yes ____No ____Don't know ____NA loose quartz around abutment

Spur Dike ____Yes X No ____Don't know ____NA

Other ________________ ____Yes ~~X~~ No X Don't know ____NA

Bed Material Classification Based on Median Particle Size (D_{50})

Material	Silt/Clay ~~X~~	Sand X	Gravel____	Cobbles____	Boulders____
Size range, in mm	<0.062	0.062-2.00	2.00-64	64-250	>250

Note: fair amount of riprap in main channel under bridge. consider clear water scour.

Comments, Diagrams & orientation of digital photos

1). left OB
2) main channel
3). right OB
4-5). left abutment
6). pier.
7). eek
8-9). right abutment
10). main channel

Summary of Results

	Q~~100~~ 5	Q~~500~~ 10
Bridge flow evaluated	655	1260
Flow depth at left abutment (yaLT), in feet	2.8	5.5
Flow depth at right abutment (yaRT), in feet	2.2	4.9
Contraction scour depth (ycs), in feet	9.2	~~8~~ 15.3
Pier scour depth (yps), in feet	4.8	4.9
Left abutment scour depth (yas), in feet	20.3	28.9
Right abutment scour depth (yas), in feet	16.4	27
1Flow angle of attack	30	30

See Comments/Diagram for justification where required

97' 25' 15.96
43° 43 53.75

97.4211
43.7316