OK RT

SCOUR ANALYSIS AND REPORTING FORM

Bridge Structure No. 03110132 Date 7/24/12 Initials RAT Region (A B (C) D)

Site ________ Location 1.8 mi N of Wolsey - Beadle Co. on 387 Ave

Q_{100} = Q_{10} 1560 by: drainage area ratio____ flood freq. anal. ____ regional regression eq. X

Bridge discharge (Q_2) = 1560 (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 = 89 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 = 77.09 ft* $q_2 = Q_2/W_2$ = 20.2 ft^2/s

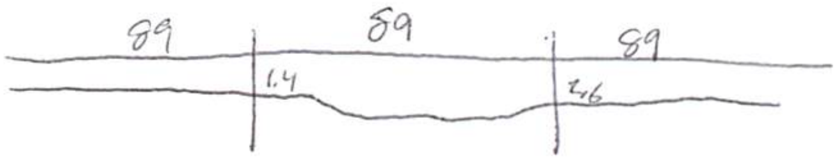
Bridge Vel, V_2 = 3.2 ft/s Final $y_2 = q_2/V_2$ = 6.4 ft Δh = 0.2 ft

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. = dry ft
Low Steel Elev. = 7.9 ft
n (Channel) = 0.045
n (LOB) = 0.030
n (ROB) = 0.030
Pier Width = 1.35 ft
Pier Length = 1.35 ft
\# Piers for 100 yr = 4 ft



CONTRACTION SCOUR

PGRM: Contract

Width of main channel at approach section W_1 = 89 ft

Width of left overbank flow at approach, W_{lob} = 89 ft Average left overbank flow depth, y_{lob} = 1.4 ft

Width of right overbank flow at approach, W_{rob} = 89 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= 5.12 From Figure 9 W_2 (effective) = 71.7 ft y_{cs} = 5.8 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, $Vc = 11.17 y_1^{1/6} D_{50}^{1/3}$ = ______ 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

PIER SCOUR CALCULATIONS

PGRM: Pier

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

Froude # at bridge = 0.22 Using pier width a on Figure 11, ξ = 6 Pier scour y_{ps} = ~~4.4~~ 4.8 ft

ABUTMENT SCOUR CALCULATIONS

PGRM: Abutment

Average flow depth blocked by: left abutment, y_{aLT} = 1.4 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} = 5.9 and ψ_{RT} = 10.6

Left abutment scour, $y_{as} = \psi_{LT}(K_1/0.55)$ = 10.6 ft Right abutment scour $y_{as} = \psi_{RT}(K_1/0.55)$ = 19.3 ft

SCOUR ANALYSIS AND REPORTING FORM

Bridge Structure No. 03110132 Date 7/24/12 Initials RAT Region (A B (C) D)

Site ______ Location 1.8 mi. N of Wolsey on 387 Ave

Q_{500} = Q_{25} 3290 by: drainage area ratio____ flood freq. anal. ____ regional regression eq. X

Bridge discharge (Q_2) = 2415 (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 = 89 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 = 77.08 ft* $q_2 = Q_2/W_2$ = 31.3 ft^2/s

Bridge Vel, V_2 = 4 ft/s Final $y_2 = q_2/V_2$ = 7.9 ft Δh = 0.3 ft

Average main channel depth at approach section, $y_1 = \Delta h + y_2$ = 8.2 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. = dry ft

Low Steel Elev. = 7.9 ft

n (Channel) = 0.045

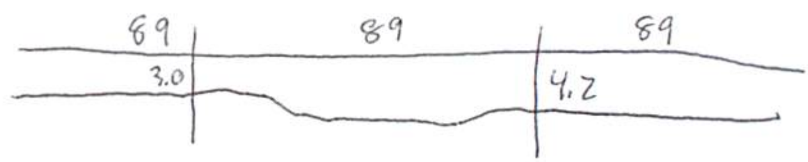
n (LOB) = 0.030

n (ROB) = 0.030

Pier Width = 1.35 ft

Pier Length = 1.35 ft

\# Piers for 500 yr = 4 ft



CONTRACTION SCOUR

PGRM: Contract

Width of main channel at approach section W_1 = 89 ft

Width of left overbank flow at approach, W_{lob} = 89 ft Average left overbank flow depth, y_{lob} = 3.0 ft

Width of right overbank flow at approach, W_{rob} = 89 ft Average right overbank flow depth, y_{rob} = 4.2 ft

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

x = 9.85 From Figure 9 W_2 (effective) = 71.7 ft y_{cs} = 10.8 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, $V_c = 11.17y_1^{1/6}D_{50}^{1/3}$ = ______ 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: Pie

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} = 3.0 ft right abutment, y_{aRT} = 4.2 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} = 11.5 and ψ_{RT} = 13.6

Left abutment scour, $y_{as} = \psi_{LT}(K_1/0.55)$ = 20.9 ft Right abutment scour $y_{as} = \psi_{RT}(K_1/0.55)$ = 24.7 ft

Route 387 Ave Stream Cain Ck MRM ________ Date 7/24/12 Initials PAT

Bridge Structure No. 03110132 Location 1.8 mi N of Wolsey on 387 Ave

GPS coordinates: N44° 26' 25.8" W 98° 28' 43.6" taken from: USL abutment X centerline of ⇑ MRM end ______

Datum of coordinates: WGS84 X NAD27 _____

Drainage area = 234.77 sq. mi.

The average bottom of the main channel was 12.4 ft below top of guardrail at a point 58 ft from left abutment.

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

8/22

2	166
5	749
10	1560
25	3290
50	5170
100	7640
500	16100

MISCELLANEOUS CONSIDERATIONS

Flows	Q100 = Q10	1560		Q500 = Q25	3290	
Estimated flow passing through bridge		1560			2415	
Estimated road overflow & overtopping		0			875	
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? _____Yes X No _____Marginal

Evidence of past Scour? X Yes _____No _____Don't know minor pier/contraction

Debris Potential? _____High _____Med X Low

5/14

2	164
5	740
10	1550
25	3260
50	5110
100	7550
500	15900

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 X	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). pier
5). pier scour
6-7). left abutment
8-9). right abutment
10). main channel

Summary of Results

	Q100 Q10	Q500 Q25
Bridge flow evaluated	1560	2415
Flow depth at left abutment (yaLT), in feet	1.4	3.0
Flow depth at right abutment (yaRT), in feet	2.6	4.2
Contraction scour depth (ycs), in feet	5.8	10.8
Pier scour depth (yps), in feet	~~4.9~~ 4.8	4.8
Left abutment scour depth (yas), in feet	10.6	20.9
Right abutment scour depth (yas), in feet	19.3	24.7
1Flow angle of attack	30	30

See Comments/Diagram for justification where required