OK RT

SCOUR ANALYSIS AND REPORTING FORM

Bridge Structure No. 64010119 Date 5/27/12 Initials rat Region (A B [✓ C] D)

Site ____ Location 30890 471 Ave, Brule Creek 308-309st

Q_{100} = ~~7830~~ 12500 by: drainage area ratio ____ flood freq. anal. ____ regional regression eq. X

Bridge discharge (Q_2) = 12500 (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 = 124 ft. Flow angle at bridge = 10 ° Abut. Skew = 0 ° Effective Skew = 10 °

Width (W_2) iteration = 124 ____ ____ ____

Avg. flow depth at bridge, y_2 iteration = ____ ____ ____ ____

Corrected channel width at bridge Section = W_2 times cos of flow angle = 122.12 ft* $q_2 = Q_2/W_2$ = ~~704~~ 102,4 ft²/s

Bridge Vel, V_2 = 7.2 ft/s Final $y_2 = q_2/V_2$ = 14,3 ft Δh = 1.1 ft

Average main channel depth at approach section, $y_1 = \Delta h + y_2$ = 15,3 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. = 0-1,5 ft

Low Steel Elev. = 15,2 ft

n (Channel) = 0.045

n (LOB) = 0.030

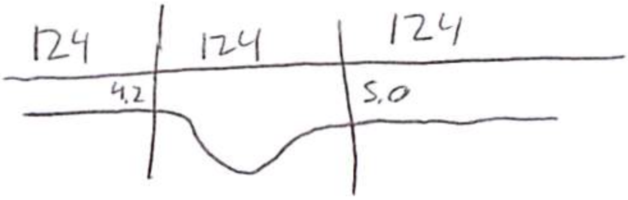
n (ROB) = 0.03

Pier Width = 2.35 ft

Pier Length = 2.35 ft

\# Piers for 100 yr = 2 ft

$$\begin{array}{r} 20.9 \\ -5.7 \\ \hline 15.2 \end{array}$$



CONTRACTION SCOUR

PGRM: Contract

Width of main channel at approach section W_1 = 124 ft

Width of left overbank flow at approach, W_{lob} = 124 ft Average left overbank flow depth, y_{lob} = 5.0 ft

Width of right overbank flow at approach, W_{rob} = 124 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 = 2.43 From Figure 9 W_2 (effective) = 117.4 ft y_{cs} = 8.2 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, $V_1 = Q_{100}/(y_1W_1)$ = ____ ft/s

Critical approach velocity, $Vc = 11.52y_1^{1/6}D_{50}^{1/3}$ = ____ 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 = 0.34 Using pier width a on Figure 11, ξ = 9.1 Pier scour y_{ps} = 7.7 ft

ABUTMENT SCOUR CALCULATIONS

PGRM: Abutment

Average flow depth blocked by: left abutment, y_{aLT} = 5.0 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} = 15 and ψ_{RT} = 13.6

Left abutment scour, $y_{as} = \psi_{LT}(K_1/0.55)$ = 15 ft Right abutment scour $y_{as} = \psi_{RT}(K_1/0.55)$ = 13.6 ft

SCOUR ANALYSIS AND REPORTING FORM

Bridge Structure No. 64010119 Date 5/27/12 Initials RAL Region (A B [✓ C] D)

Site ______ Location 30890 471 & Ave

Q_{500} = ~~12300~~ 19106 by: drainage area ratio ✓ flood freq. anal. ____ regional regression eq. X

Bridge discharge (Q_2) = 14149 (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 = 124 ft. Flow angle at bridge = 10 ° Abut. Skew = 0 ° Effective Skew = 10 °

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 = 122.12 ft* $q_2 = Q_2/W_2$ = 116.2 ft²/s

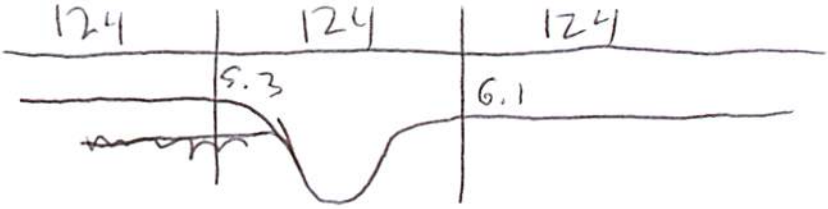
Bridge Vel, V_2 = 7.6 ft/s Final $y_2 = q_2/V_2$ = 15.2 ft Δh = 1.2 ft

Average main channel depth at approach section, $y_1 = \Delta h + y_2$ = 16.4 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. = 0-1.5 ft
Low Steel Elev. = 15.2 ft
n (Channel) = 0.045
n (LOB) = 0.030
n (ROB) = 0.030
Pier Width = 2.35 ft
Pier Length = 2.35 ft
Piers for 500 yr = 2 ft



CONTRACTION SCOUR

PGRM: Contract

Width of main channel at approach section W_1 = 121 ft

Width of left overbank flow at approach, W_{lob} = 124 ft Average left overbank flow depth, y_{lob} = 6.1 ft

Width of right overbank flow at approach, W_{rob} = 124 ft Average right overbank flow depth, y_{rob} = 5.3 ft

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

x = 9.87 From Figure 9 W_2 (effective) = 117.4 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, $V_1 = Q_{500}/(y_1 W_1)$ = ______ ft/s

Critical approach velocity, $Vc = 11.52 y_1^{1/6} D_{50}^{1/3}$ = ______ 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: Pie

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

Froude # at bridge = 0.34 Using pier width a on Figure 11, ξ = 9.1 Pier scour y_{ps} = 7.7 ft

ABUTMENT SCOUR CALCULATIONS

PGRM: Abutment

Average flow depth blocked by: left abutment, y_{aLT} = 6.1 ft right abutment, y_{aRT} = 5.3 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} = 17 and ψ_{RT} = 15.6

Left abutment scour, $y_{as} = \psi_{LT}(K_1/0.55)$ = 17 ft Right abutment scour $y_{as} = \psi_{RT}(K_1/0.55)$ = 15.6 ft

Route 471 Ave Stream Brule Creek MRM ______ Date 5/27/12 Initials Ral

Bridge Structure No. 64010119 Location 30890 471 Ave

GPS coordinates: N 42° 54' 44.1" taken from: USL abutment X centerline of ⇑ MRM end ______

W 96° 47' 8.6" Datum of coordinates: WGS84 X NAD27 ______

Drainage area = ~~154.42~~ 154.37 sq. mi.

The average bottom of the main channel was 20.9 ft below top of guardrail at a point 46 ft from left abutment.

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

MISCELLANEOUS CONSIDERATIONS

Flows	Q$_{100}$ =	12500		Q$_{500}$ =	19100	
Estimated flow passing through bridge	12500			14189		
Estimated road overflow & overtopping	0			4911		
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	

5/21

2	102
5	324
10	561
25	973
50	1360
100	1810
500	3080

5/24

2	1420
5	3350
10	5060
25	7670
50	9950
100	12500
500	19100

Riprap at abutments? X Yes ____No ____Marginal

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

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 ______________ ____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). main channel
2). right OB
3). right ab.
4). piers
5). pier scour

6). left OB
7). left ab
8) main channel
9), main chanel

Summary of Results

	Q100	Q500
Bridge flow evaluated	12500	14189
Flow depth at left abutment (yaLT), in feet	5.0	6.1
Flow depth at right abutment (yaRT), in feet	4.2	5.3
Contraction scour depth (ycs), in feet	8.2	10.8
Pier scour depth (yps), in feet	7.7	7.7
Left abutment scour depth (yas), in feet	15	17
Right abutment scour depth (yas), in feet	13.6	15.6
1Flow angle of attack	10	10

See Comments/Diagram for justification where required