OK RT

SCOUR ANALYSIS AND REPORTING FORM

Bridge Structure No. 50183195 Date 6/20/12 Initials RaT Region (A B (C) D)

Site ______ Location Big Sioux River & Russell St (SD 38 W)

Q_{100} = Q10 17800 by: drainage area ratio ____ flood freq. anal. ____ regional regression eq. X

Bridge discharge (Q_2) = 17800 (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 = 283 ft. Flow angle at bridge = 45 ° Abut. Skew = 0 ° Effective Skew = 45 °

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 = 200.1 ft* $q_2 = Q_2/W_2$ = 89 ft²/s

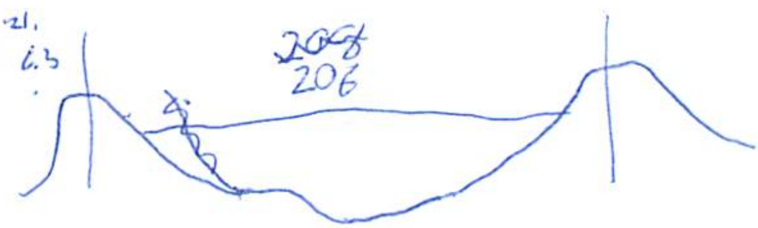
Bridge Vel, V_2 = 6.7 ft/s Final $y_2 = q_2/V_2$ = 13.3 ft Δh = 0.9 ft

Average main channel depth at approach section, $y_1 = \Delta h + y_2$ = 14.2 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. = 0-0.5 ft
Low Steel Elev. = 14.7 ft see notes
n (Channel) = 0.040
n (LOB) = 0.030
n (ROB) = 0.030
Pier Width = 10.2 ft see notes
Pier Length = 9.2 ft
\# Piers for 100 yr = 2 ft



CONTRACTION SCOUR

PGRM: Contract

Width of main channel at approach section W_1 = 206 ft

Width of left overbank flow at approach, W_{lob} = 0 ft Average left overbank flow depth, y_{lob} = 0 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 = 2.08 From Figure 9 W_2 (effective) = 179.7 ft y_{cs} = 2.6 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

PIER SCOUR CALCULATIONS - see chart A>5

PGRM: Pier

L/a ratio = ~~8~~ 6.9 ~~Correction factor for flow angle of attack (from Table 1), K2~~ = 1

Froude # at bridge = 0.32 Using pier width a on Figure 11, ξ = ~~7.9~~ 8.5 Pier scour y_{ps} = ~~6.2~~ 7.2 ft

ABUTMENT SCOUR CALCULATIONS

PGRM: Abutment

Average flow depth blocked by: left abutment, y_{aLT} = 0 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} = 0 and ψ_{RT} = 0

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

SCOUR ANALYSIS AND REPORTING FORM

Bridge Structure No. 50183195 Date 6/20/12 Initials RJT Region (A B (C) D)

Site ______ Location Big Sioux River & Russell St (SD 38W)

Q_{500} = 0.25 27600 by: drainage area ratio____ flood freq. anal. ____ regional regression eq. X

Bridge discharge (Q_2) = 21745 (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 = 283 ft. Flow angle at bridge = 45 ° Abut. Skew = 0 ° Effective Skew = 45 °

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 = 200.1 ft* $q_2 = Q_2/W_2$ = 108.7 ft^2/s

Bridge Vel, V_2 = 7.4 ft/s Final $y_2 = q_2/V_2$ = 14.7 ft Δh = 1.1 ft

Average main channel depth at approach section, $y_1 = \Delta h + y_2$ = 15.8 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. = 0-0.5 ft

Low Steel Elev. = 14.7 ft

n (Channel) = 0.040

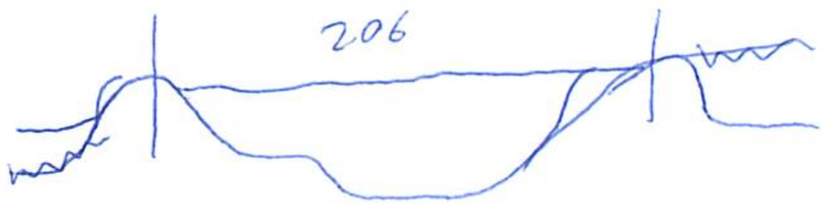
n (LOB) = 0.030

n (ROB) = 0.036

Pier Width = 18.2 ft

Pier Length = 9.2 ft

Piers for 500 yr = 2 ft



CONTRACTION SCOUR

PGRM: Contract

Width of main channel at approach section W_1 = 206 ft

Width of left overbank flow at approach, W_{lob} = 0 ft Average left overbank flow depth, y_{lob} = 0 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 = 2.31 From Figure 9 W_2 (effective) = 179.7 ft y_{cs} = 2.9 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, $V_c = 11.17 y_1^{1/6} D_{50}^{1/3}$ = ______ 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

PIER SCOUR CALCULATIONS

PGRM: Pier

L/a ratio = 6.9 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 = ~~7.1~~ 8.5 Pier scour y_{ps} = ~~6.5~~ 7.2 ft

ABUTMENT SCOUR CALCULATIONS

PGRM: Abutment

Average flow depth blocked by: left abutment, y_{aLT} = 0 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} = 0 and ψ_{RT} = 0

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

96° 45' 54.936"
43° 33' 56.808"

96.76526
43.56578

Route Russell St Stream Big Sioux River MRM ______ Date 6/20/12 Initials RcT

Bridge Structure No. 50183195 Location Big Sioux River & Russell St (SD 38b)

GPS coordinates: N 43° 33' 57.1" W 96° 45' 54.9" taken from: USL abutment X centerline of ⇑ MRM end ______

Datum of coordinates: WGS84 X NAD27 ______

Drainage area = 3130.07 sq. mi.

The average bottom of the main channel was 21.0 ft below top of guardrail at a point 107 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} 17800			~~Q_{500}~~ = Q_{25} 27600		
Estimated flow passing through bridge	17800			21745		
Estimated road overflow & overtopping	0			5855		
Consideration	Yes	No	Possibly	Yes	No	Possibly
Chance of overtopping		X		~~X~~		X
Chance of Pressure flow			X	X		
Armored appearance to channel		X			X	
Lateral instability of channel		X			X	

#	6115
2	4770
5	11500
10	17800
25	27600
50	36500
100	46600
500	74300

Riprap at abutments? X Yes ____ No X Marginal - Scattered

Evidence of past Scour? X Yes ____ No ____ Don't know - some abutment, 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 in "strategic" location

Spur Dike ____ Yes X No ____ Don't know ____ NA

Other ______________ X Yes ____ No ____ Don't know ____ NA - embankment @ road level in line w/ left/right abutments

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). pier
5-8). left abutment

9-10). right abutment
11). pier scour
12). right abutment

50183196

13). main channel
14). gap
15). right abutment

16-18). left abutment.
19). pier scour
20-xx) right abutment

Note: Pier ~~measurement~~ cone shaped. took ~~measured~~ measured from ground level. Estimated width by using best judgement with flow angle.

Summary of Results

	~~Q100~~ Q_{10}	~~Q500~~ Q_{25}
Bridge flow evaluated	17800	21745
Flow depth at left abutment (yaLT), in feet	0	0
Flow depth at right abutment (yaRT), in feet	0	0
Contraction scour depth (ycs), in feet	2.6	2.9
Pier scour depth (yps), in feet		8
Left abutment scour depth (yas), in feet	0	0
Right abutment scour depth (yas), in feet	0	0
1Flow angle of attack	45	45

low steel a.r.c.s, used low steel at top of middle section a.r.c.

See Comments/Diagram for justification where required