OK RT

SCOUR ANALYSIS AND REPORTING FORM

Bridge Structure No. 50201173 Date 6/19/12 Initials RAT Region (A B [✓ C] D)

Site ____ Location on N Minnesota Ave 0.3 mi S of 261 St

~~Q_{100} =~~ See notes by: drainage area ratio ____ flood freq. anal. ____ regional regression eq. ____

Bridge discharge (Q_2) = 85120 (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 = 298 ft. Flow angle at bridge = 25 ° Abut. Skew = 35 ° 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 = 296 ft* $q_2 = Q_2/W_2$ = 290 ft^2/s

Bridge Vel, V_2 = 12.1 ft/s Final $y_2 = q_2/V_2$ = 24 ft 293.47 Δh = 3 ft

Average main channel depth at approach section, $y_1 = \Delta h + y_2$ = 27 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. = 0-2.8 ft 31.4

Low Steel Elev. = 24.0 ft - 7.4

24.0

n (Channel) = 0.033

n (LOB) = 0.020 - gravel

n (ROB) = 0.030

Pier Width = 2 ft - rounded

Pier Length = 46 ft cement

Piers for 100 yr = 3 ft face.

CONTRACTION SCOUR

PGRM: Contract

Width of main channel at approach section W_1 = 298 ft

Width of left overbank flow at approach, W_{lob} = 42 ft Average left overbank flow depth, y_{lob} = 1.4 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 = 1.04 From Figure 9 W_2 (effective) = 287.5 ft y_{cs} = 1.5 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 = 23 Correction factor for flow angle of attack (from Table 1), K2 = 2

Froude # at bridge = 0.44 Using pier width a on Figure 11, ξ = 8 Pier scour y_{ps} = 14.1 ft

ABUTMENT SCOUR CALCULATIONS

PGRM: Abutment

Average flow depth blocked by: left abutment, y_{aLT} = 0 ft right abutment, y_{aRT} = 1.4 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} = 0 and ψ_{RT} = 5.9

Left abutment scour, $y_{as} = \psi_{LT}(K_1/0.55)$ = 0 ft Right abutment scour $y_{as} = \psi_{RT}(K_1/0.55)$ = 5.9 ft

SCOUR ANALYSIS AND REPORTING FORM

Bridge Structure No. 50201173 Date 6/19/12 Initials [illegible] Region (A B [✓ C] D)

Site ______ Location on N Minnesota Ave 0.3 mi S of 261 St

~~Q_{500}~~ = 50,000 by: drainage area ratio ____ flood freq. anal. ____ regional regression eq. ____

Bridge discharge (Q_2) = 50,000 (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 = 298 ft. 293.47 Flow angle at bridge = 25 ° Abut. Skew = 35 ° Effective Skew = 10 °

Width (W_2) iteration = 254 269 280 270 265.9

Avg. flow depth at bridge, y_2 iteration = 20.2 21.5 21.3

Corrected channel width at bridge Section = W_2 times cos of flow angle = 283.47 ft* $q_2 = Q_2/W_2$ = 198 176.4 ft^2/s

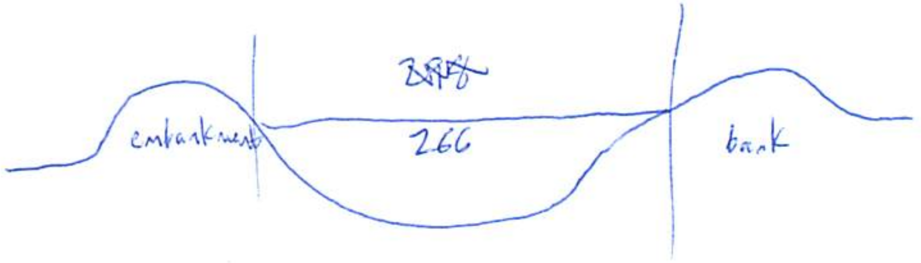
Bridge Vel, V_2 = 9.39.7 ft/s Final $y_2 = q_2/V_2$ = [illegible] 19.3 ft 265.9 Δh = [illegible] 1.9 ft

Average main channel depth at approach section, $y_1 = \Delta h + y_2$ = ~~[illegible]~~ 21.3 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. = 0-2.9 ft
Low Steel Elev. = 24.0 ft
n (Channel) = 0.033
n (LOB) = 0.020
n (ROB) = 0.030
Pier Width = 2 ft
Pier Length = 46 ft
\# Piers for 500 yr = 2 ft



CONTRACTION SCOUR

PGRM: Contract

Width of main channel at approach section W_1 = [illegible] ft 266

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 = 0.33 From Figure 9 W_2 (effective) = 261.9 ft y_{cs} = 0.6 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, $V_1 = Q_{500}/(y_1W_1)$ = ______ 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: Pier

L/a ratio = 23 Correction factor for flow angle of attack (from Table 1), K2 = 2

Froude # at bridge = 0.39 Using pier width a on Figure 11, ξ = 8 Pier scour y_{ps} = 13.9 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

96.72867
43.597

Route N Minnesota Ave Stream Big Sioux Diversion MRM______ Date 6/19/12 Initials RAT

Bridge Structure No. 50201173 Location N Minnesota Ave 0.3 mi S of 261 St

GPS coordinates: N 43° 35 49.2" taken from: USL abutment X centerline of ⇑ MRM end ______

W 96° 43 43.6" Datum of coordinates: WGS84 X NAD27_____

Drainage area = ? sq. mi.

The average bottom of the main channel was 31.4 ft below top of guardrail at a point 92 ft from left abutment.

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

Road height/ ~~Rd.~~ crown

0.07

615

2	19.6
5	49.6
10	75.5
25	114
50	144
100	176
500	252

MISCELLANEOUS CONSIDERATIONS

Flows	Q_{100} =	85120		Q_{500} =	50000	
Estimated flow passing through bridge		85120			50000	
Estimated road overflow & overtopping		0			0	
Consideration	Yes	No	Possibly	Yes	No	Possibly
Chance of overtopping			+		X	
Chance of Pressure flow	X				X	
Armored appearance to channel		X			X	
Lateral instability of channel		X			X	

32.66

2	460
5	1130
10	1730
25	2660
50	3450
100	4320
500	6580

Riprap at abutments? X Yes _____No _____Marginal primarily on right abutment

Evidence of past Scour? _____Yes X No _____Don't know

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 up and down both banks/abutments

Spur Dike _____Yes X No _____Don't know _____NA

Other ________________ X Yes ~~X~~ No _____Don't know _____NA - man made banks @ road ~~the~~ height

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). piers
5). right abutment
6). left abutment
7). left abutment
8-9). right abutment
10). main channel

Note: Used low steel as estimate as streamstats does not ~~&~~ reflect the flow, also calculated @ ~~[illegible]~~, 50,000 cfs as that's similar to Q_{100} for Sioux river

Summary of Results

	Q100	Q500
Bridge flow evaluated	85120	50000
Flow depth at left abutment (yaLT), in feet	1.4	0
Flow depth at right abutment (yaRT), in feet	0	0
Contraction scour depth (ycs), in feet	1.5	0.6
Pier scour depth (yps), in feet	14.1	13.9
Left abutment scour depth (yas), in feet	0	0
Right abutment scour depth (yas), in feet	5.9	0
1Flow angle of attack	10	10

See Comments/Diagram for justification where required