ok RJ

SCOUR ANALYSIS AND REPORTING FORM

Bridge Structure No. 50196170 Date 9-14-10 Initials RRL Region (A B C D)

Site _____ Location From I-29 Exit 83, 1.6 E

Q_{100} = 33,200 by: drainage area ratio ✓ flood freq. anal. ____ regional regression eq. ____

Bridge discharge (Q_2) = 19,796 (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 = 226 ft. Flow angle at bridge = 0 ° Abut. Skew = 0 ° Effective Skew = 0 °

Width (W_2) iteration = 226

Avg. flow depth at bridge, y_2 iteration = 13.2

Corrected channel width at bridge Section = W_2 times cos of flow angle = 226 ft* $q_2 = Q_2/W_2$ = 87.6 ft^2/s

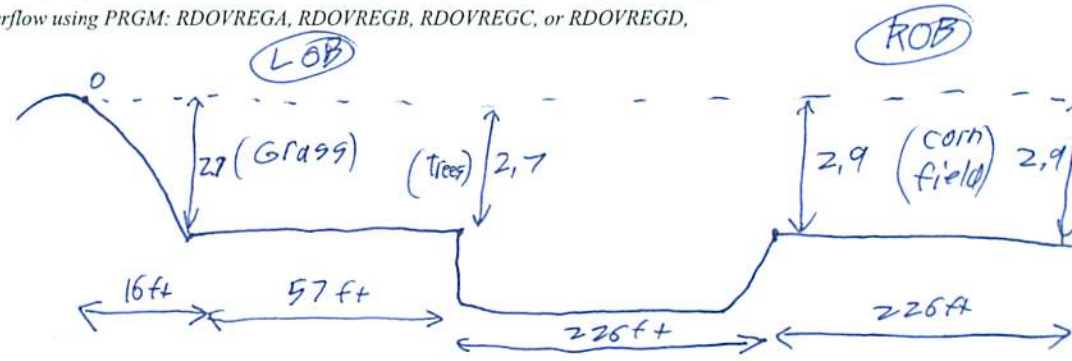
Bridge Vel, V_2 = 6.6 ft/s Final $y_2 = q_2/V_2$ = 13.2 ft Δh = 0.9 ft

Average main channel depth at approach section, $y_1 = \Delta h + y_2$ = 14.1 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. = 5.5 ft
Low Steel Elev. = 13.2 ft
n (Channel) = 0.03
n (LOB) = 0.04
n (ROB) = 0.03
Pier Width = 3 ft
Pier Length = 3 ft
Piers for 100 yr = 2 ft



CONTRACTION SCOUR

PGRM: Contract

Width of main channel at approach section W_1 = 226 ft

Width of left overbank flow at approach, W_{lob} = 73 ft Average left overbank flow depth, y_{lob} = 2.4 ft

Width of right overbank flow at approach, W_{rob} = 226 ft Average right overbank flow depth, y_{rob} = 2.9 ft

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

x = 1.61 From Figure 9 W_2 (effective) = 220 ft y_{cs} = 2.1 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, $Vc = 11.52 y_1^{1/6} D_{50}^{1/3}$ = _____ 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: Pier

L/a ratio = 1 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 = 10.7 Pier scour y_{ps} = 9 ft

ABUTMENT SCOUR CALCULATIONS

PGRM: Abutment

Average flow depth blocked by: left abutment, y_{aLT} = 2.4 ft right abutment, y_{aRT} = 2.9 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} = 9.8 and ψ_{RT} = 11.3

Left abutment scour, $y_{as} = \psi_{LT}(K_1/0.55)$ = 9.8 ft Right abutment scour $y_{as} = \psi_{RT}(K_1/0.55)$ = 11.3 ft

SCOUR ANALYSIS AND REPORTING FORM

Bridge Structure No. 50196170 Date 9-14-10 Initials KRL Region (A B C D)

Site _____ Location From I-29, Exit 83, 1.6E

Q_{500} = 55 600 by: drainage area ratio ✓ flood freq. anal. ____ regional regression eq. ____

Bridge discharge (Q_2) = 19796 (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 = 226 ft. Flow angle at bridge = 0 ° Abut. Skew = 0 ° Effective Skew = 0 °

Width (W_2) iteration = 226 _____ _____ _____

Avg. flow depth at bridge, y_2 iteration = 13.2 _____ _____ _____ 226

Corrected channel width at bridge Section = W_2 times cos of flow angle = 226 ft* $q_2 = Q_2/W_2$ = 87.6 ft^2/s

Bridge Vel, V_2 = 6.6 ft/s Final $y_2 = q_2/V_2$ = 13.2 ft Δh = 0.9 ft

Average main channel depth at approach section, $y_1 = \Delta h + y_2$ = 14.1 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,

(see 100 yr. Diag)

Water Surface Elev. = 5.5 ft

Low Steel Elev. = 13.2 ft

n (Channel) = 0.03

n (LOB) = 0.04

n (ROB) = 0.03

Pier Width = 3 ft

Pier Length = 3 ft

Piers for 500 yr = 2 ft

CONTRACTION SCOUR

PGRM: Contract

Width of main channel at approach section W_1 = 226 ft

Width of left overbank flow at approach, W_{lob} = 73 ft Average left overbank flow depth, y_{lob} = 2.4 ft

Width of right overbank flow at approach, W_{rob} = 226 ft Average right overbank flow depth, y_{rob} = 2.9 ft

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

x = 1.61 From Figure 9 W_2 (effective) = 220 ft y_{cs} = 2.1 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, $Vc = 11.52y_1^{1/6}D_{50}^{1/3}$ = _____ 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

PGRM: Pier

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Average flow depth blocked by: left abutment, y_{aLT} = 2.4 ft right abutment, y_{aRT} = 2.9 ft

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Route SD 38A Stream Big Sioux River MRM _____ Date 9-14-10 Initials RLL

Bridge Structure No. 50196170 Location From I-29, Exit 83, 1.6E

GPS coordinates: 43° 36, 171' taken from: USL abutment ✓ centerline of ⇑ MRM end _____

96° 44, 383' Datum of coordinates: WGS84 ____ NAD27 ____

Drainage area = 3092.9 sq. mi.

The average bottom of the main channel was 19.5 ft below top of guardrail at a point 36 ft from left abutment.

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

MISCELLANEOUS CONSIDERATIONS

Flows	Q_{100} = 33,200			Q_{500} = 55,600		
Estimated flow passing through bridge	19,796			19,796		
Estimated road overflow & overtopping	13,404			35,804		
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 ____No X Marginal

Evidence of past Scour? ____Yes ____No X Don't know

Debris Potential? ____High X Med ____Low

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

Riprap ____Yes ____No X Don't know ____NA

Spur Dike ____Yes ____No X Don't know ____NA

Other _____ ____Yes ____No X 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

Pictures: 1 - Bridge Deck
2 - Looking upstream
3 - Looking Downstream
4 - Left overbank
5 - Right overbank
6 - Left Abutment
7 - Right Abutment
8 - Bridge Piers
9 - Downstream water Intake

Notes: Left side has full road height guide bank. Right side has ~100ft guide bank. Was not included in upstream x-sect. Downstream is water intake structure and Dam structure along with a "Y" channel split.

Summary of Results

	Q100	Q500
Bridge flow evaluated	19,796	19,796
Flow depth at left abutment (yaLT), in feet	2.4	2.4
Flow depth at right abutment (yaRT), in feet	2.9	2.9
Contraction scour depth (ycs), in feet	2.1	2.1
Pier scour depth (yps), in feet	9	9
Left abutment scour depth (yas), in feet	9.8	9.8
Right abutment scour depth (yas), in feet	11.3	11.3
IFlow angle of attack	0	0

See Comments/Diagram for justification where required