OK RT

SCOUR ANALYSIS AND REPORTING FORM

Bridge Structure No. 50335090 Date 6/15/12 Initials RCT Region (A B (C) D)

Site ______ Location 15 mi E of Garretson on 253 St

Q_{100} = Q_5 941 by: drainage area ratio ____ flood freq. anal. ____ regional regression eq. X

Bridge discharge (Q_2) = 941 (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 = 56 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 = 48.5 ft* $q_2 = Q_2/W_2$ = 19.4 ft^2/s

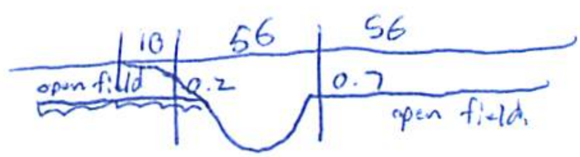
Bridge Vel, V_2 = 3.1 ft/s Final $y_2 = q_2/V_2$ = 6.2 ft Δh = 0.2 ft

Average main channel depth at approach section, $y_1 = \Delta h + y_2$ = 6.4 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. = 671.0 ft
Low Steel Elev. = 685 ft
n (Channel) = 0.030
n (LOB) = 0.030
n (ROB) = 0.030
Pier Width = 2.85 ft
Pier Length = 78 ft
\# Piers for 100 yr = 3 ft



CONTRACTION SCOUR

PGRM: Contract

Width of main channel at approach section W_1 = 56 ft

Width of left overbank flow at approach, W_{lob} = ~~65~~ 56 ft Average left overbank flow depth, y_{lob} = 0.7 ft

Width of right overbank flow at approach, W_{rob} = 10 ft Average right overbank flow depth, y_{rob} = 0.2 ft

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

x = 2.8 From Figure 9 W_2 (effective) = 48 ft y_{cs} = ~~3.8~~ 3.4 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, $Vc = 11.17y_1^{1/6}D_{50}^{1/3}$ = ____ 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 = 27.37 Correction factor for flow angle of attack (from Table 1), K2 = 3.5

Froude # at bridge = 0.22 Using pier width a on Figure 11, ξ = 10.4 Pier scour y_{ps} = 28.9 ft

ABUTMENT SCOUR CALCULATIONS

PGRM: Abutment

Average flow depth blocked by: left abutment, y_{aLT} = 0.7 ft right abutment, y_{aRT} = 0.2 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} = 3.1 and ψ_{RT} = 1

Left abutment scour, $y_{as} = \psi_{LT}(K_1/0.55)$ = 5.6 ft Right abutment scour $y_{as} = \psi_{RT}(K_1/0.55)$ = 1.7 ft

SCOUR ANALYSIS AND REPORTING FORM

Bridge Structure No. 50335090 Date 6/25/12 Initials [illegible] Region (A B (C) D)

Site ______ Location 1.5 mi E of Garretson on 253 St

~~Q_{500}~~ = Q_{O} 1430 by: drainage area ratio ____ flood freq. anal. ____ regional regression eq. X

Bridge discharge (Q_2) = 1142 (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 = 56 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 = 48.5 ft* $q_2 = Q_2/W_2$ = 23.5 ft^2/s

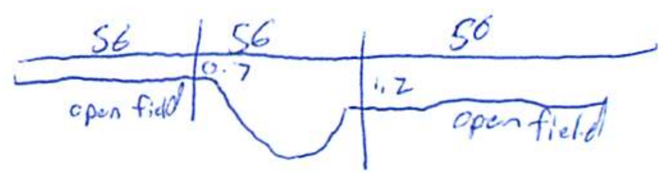
Bridge Vel, V_2 = 3.4 ft/s Final $y_2 = q_2/V_2$ = 6.9 ft Δh = 0.2 ft

Average main channel depth at approach section, $y_1 = \Delta h + y_2$ = 7.1 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. = 0-1.0 ft
Low Steel Elev. = 6.85 ft
n (Channel) = 0.030
n (LOB) = 0.030
n (ROB) = 0.030
Pier Width = 2.85 ft
Pier Length = 78 ft
\# Piers for 500 yr = 3 ft



CONTRACTION SCOUR

PGRM: Contract

Width of main channel at approach section W_1 = 56 ft

Width of left overbank flow at approach, W_{lob} = 56 ft Average left overbank flow depth, y_{lob} = 1.2 ft

Width of right overbank flow at approach, W_{rob} = 56 ft Average right overbank flow depth, y_{rob} = 0.7 ft

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

x = 3.58 From Figure 9 W_2 (effective) = 40 ft y_{cs} = 4.2 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, $V_1 = Q_{500}/(y_1 W_1)$ = ______ 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: Pie

L/a ratio = 27.37 Correction factor for flow angle of attack (from Table 1), K2 = 3.5

Froude # at bridge = 0.23 Using pier width a on Figure 11, ξ = 10.4 Pier scour y_{ps} = 29 ft

ABUTMENT SCOUR CALCULATIONS

PGRM: Abutment

Average flow depth blocked by: left abutment, y_{aLT} = 1.2 ft right abutment, y_{aRT} = 0.7 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} = 5.1 and ψ_{RT} = 3.1

Left abutment scour, $y_{as} = \psi_{LT}(K_1/0.55)$ = 9.2 ft Right abutment scour $y_{as} = \psi_{RT}(K_1/0.55)$ = 5.6 ft

96° 27′ 39.166″
43° 43′ 5.412

96.46088
43.71817

Route 253 St Stream ______ MRM ______ Date 6/25/12 Initials RaT

Bridge Structure No. 50335090 Location 1.5 mi E of Garretson on 253 St

GPS coordinates: N 43° 43 53.1" W 96 27 40.3 taken from: USL abutment X centerline of ⇑ MRM end ____

Datum of coordinates: WGS84 X NAD27 ____

Drainage area = 17.29 sq. mi.

The average bottom of the main channel was 8.4 ft below top of guardrail at a point 15 ft from left abutment.

Method used to determine flood flows: ____ Freq. Anal. ____ drainage area ratio X regional regression equations.

MISCELLANEOUS CONSIDERATIONS

Flows	Q~~100~~ 5 =	941		Q~~500~~ 10 =	1430	
Estimated flow passing through bridge		941			1142	
Estimated road overflow & overtopping		0			288	
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	

8/25 6/16	
2	388
5	941
10	1430
25	2170
50	2800
100	3480
500	5230

Riprap at abutments? ____ Yes X No ____ Marginal

Evidence of past Scour? ____ Yes ____ No X Don't know very minor if any

Debris Potential? ____ High ____ Med X Low

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 ____	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 cB
2). main channel
3). right cB.
4) left abutment
5). right abutment
6). main Channel

Summary of Results

	Q~~100~~ 5	Q~~500~~ 10
Bridge flow evaluated	941	1142
Flow depth at left abutment (yaLT), in feet	0.7	1.2
Flow depth at right abutment (yaRT), in feet	0.2	0.7
Contraction scour depth (ycs), in feet	~~3.9~~ 3.4	4.2
Pier scour depth (yps), in feet	25.9	29
Left abutment scour depth (yas), in feet	~~[illegible]~~ 5.6	~~[illegible]~~ 9.2
Right abutment scour depth (yas), in feet	~~[illegible]~~ 1.7	~~[illegible]~~ 5.6
1Flow angle of attack	30	30

See Comments/Diagram for justification where required