OK RT

SCOUR ANALYSIS AND REPORTING FORM

Bridge Structure No. 06122010 Date 5-17-12 Initials CW/RaT Region (A B C D)

Site ______ Location 197 St, 6 mi N, 0.2 mi E of Bruce

Q_{100} = 559 by: drainage area ratio ____ flood freq. anal. ____ regional regression eq. ✓

Bridge discharge (Q_2) = ______ (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 = 52 ft. Flow angle at bridge = 40 ° Abut. Skew = 0 ° Effective Skew = 40° °

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 = 39.83 ft* $q_2 = Q_2/W_2$ = 14 ft^2/s

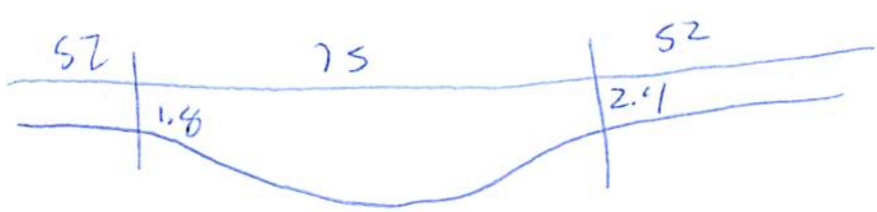
Bridge Vel, V_2 = 2.7 ft/s Final $y_2 = q_2/V_2$ = 5.3 ft Δh = 0.1 ft

Average main channel depth at approach section, $y_1 = \Delta h + y_2$ = 5.4 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. = 6.5 ft
Low Steel Elev. = 5.6 ft
n (Channel) = 0.045
n (LOB) = 0.045
n (ROB) = 0.045
Pier Width = 0 ft
Pier Length = 0 ft
\# Piers for 100 yr = 0 ft



1.7 2.6

CONTRACTION SCOUR

PGRM: Contract

Width of main channel at approach section W_1 = 75 ft

Width of left overbank flow at approach, W_{lob} = 52 ft Average left overbank flow depth, y_{lob} = 1.8 ft

Width of right overbank flow at approach, W_{rob} = 52 ft Average right overbank flow depth, y_{rob} = 2.4 ft

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

x = 7.73 From Figure 9 W_2 (effective) = 39.8 ft y_{cs} = 8.6 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, $V_1 = Q_{100}/(y_1W_1)$ = ______ 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 = ∞ Correction factor for flow angle of attack (from Table 1), K2 = 3

Froude # at bridge = 0.21 Using pier width a on Figure 11, ξ = 0 Pier scour y_{ps} = 0 ft

ABUTMENT SCOUR CALCULATIONS

PGRM: Abutment

Average flow depth blocked by: left abutment, y_{aLT} = 1.8 ft right abutment, y_{aRT} = 2.4 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} = 7.4 and ψ_{RT} = 9.8

Left abutment scour, $y_{as} = \psi_{LT}(K_1/0.55)$ = 13.5 ft Right abutment scour $y_{as} = \psi_{RT}(K_1/0.55)$ = 17.8 ft

SCOUR ANALYSIS AND REPORTING FORM

Bridge Structure No. 06122010 Date ______ Initials ______ Region (A B C D)

Site ______ Location 197 St, 6 mi N, 0.2 mi E of Bruce

Q_{500} = 855 by: drainage area ratio ____ flood freq. anal. ____ regional regression eq. ✓

Bridge discharge (Q_2) = 626 (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 = 52 ft. Flow angle at bridge = ____ ° Abut. Skew = ____ ° Effective Skew = ____ °

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 = 39.83 ft* $q_2 = Q_2/W_2$ = 15.7 ft^2/s

Bridge Vel, V_2 = 2.8 ft/s Final $y_2 = q_2/V_2$ = 5.6 ft Δh = 0.2 ft

Average main channel depth at approach section, $y_1 = \Delta h + y_2$ = 5.8 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. = 0.5 ft

Low Steel Elev. = 5.6 ft

n (Channel) = 0.045

n (LOB) = 0.045

n (ROB) = 0.045

Pier Width = 0 ft

Pier Length = 0 ft

\# Piers for 500 yr = 0 ft

PGRM: Contract

CONTRACTION SCOUR

Width of main channel at approach section W_1 = 75 ft

Width of left overbank flow at approach, W_{lob} = 52 ft Average left overbank flow depth, y_{lob} = 2.2 ft

Width of right overbank flow at approach, W_{rob} = 52 ft Average right overbank flow depth, y_{rob} = 2.8 ft

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

x = 8.88 From Figure 9 W_2 (effective) = 39.8 ft y_{cs} = 9.8 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, $V_1 = Q_{500}/(y_1W_1)$ = ____ 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

PGRM: Pier

PIER SCOUR CALCULATIONS

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

Froude # at bridge = — Using pier width a on Figure 11, ξ = — Pier scour y_{ps} = 0 ft

PGRM: Abutment

ABUTMENT SCOUR CALCULATIONS

Average flow depth blocked by: left abutment, y_{aLT} = 2.2 ft right abutment, y_{aRT} = 2.8 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 and ψ_{RT} = 11.2

Left abutment scour, $y_{as} = \psi_{LT}(K_1/0.55)$ = 16.4 ft Right abutment scour $y_{as} = \psi_{RT}(K_1/0.55)$ = 20.3 ft

Route 197th St Stream ____ MRM ____ Date ____ Initials ____

Bridge Structure No. 06122010 Location 197 St, 6 mi N, 0.2 mi E of Bruce

GPS coordinates: N 44° 31' 45.0" W 96° 50' 46.8" taken from: USL abutment ____ centerline of ⇑ MRM end ____

Datum of coordinates: WGS84 X NAD27 ____

Drainage area = 1.94 sq. mi.

The average bottom of the main channel was 9.7 ft below top of guardrail at a point 67 ft from left abutment.

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

5/14
~~8/22~~

2	49
5	133
10	213
25	337
50	443
100	559
500	855

MISCELLANEOUS CONSIDERATIONS

Flows	Q100 = 559			Q500 = 855		
Estimated flow passing through bridge	559			626		
Estimated road overflow & overtopping				229		
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? X Yes ____ No ____ Don't know contraction

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

2293 Str. no
2294 LOB from bridge
2295 approach ~~ROB~~ from bridge
2296 ROB from bridge
2297 left abut. from channel in ditch
2298 right abut. from ditch
2299 bridge section from approach
2300 bridge section from approach
2301 bridge section from right ditch

Summary of Results

	Q100	Q500
Bridge flow evaluated	559	~~855~~ 626
Flow depth at left abutment (yaLT), in feet	1.8	2.2
Flow depth at right abutment (yaRT), in feet	2.4	2.8
Contraction scour depth (ycs), in feet	8.6	9.8
Pier scour depth (yps), in feet	~~0~~ NA	~~0~~ NA
Left abutment scour depth (yas), in feet	13.5	16.4
Right abutment scour depth (yas), in feet	17.8	20.3
1Flow angle of attack	40°	40°

See Comments/Diagram for justification where required