OK RT

SCOUR ANALYSIS AND REPORTING FORM

Bridge Structure No. 06176050 Date 8/17/10 Initials CW Region (A B C D)

Site _____ Location from Bruce, 2N, 5.6 E

Q_{100} = 8720 by: drainage area ✓ flood frequency anal. ____ regional regression eq. ____

Bridge discharge (Q_2) = 5916 (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 = 111 ft. Flow angle at bridge = 5 ° Abut. Skew = 0 ° Effective Skew = 5 °

Width (W_2) iteration = 111 _____ _____ _____

Avg. flow depth at bridge, y_2 iteration = 12.5 _____ _____ _____

Corrected channel width at bridge Section = W_2 times cos of flow angle = 110.54 ft* $q_2 = Q_2/W_2$ = 53.5 ft^2/s

Bridge Vel, V_2 = 5.2 ft/s Final $y_2 = q_2/V_2$ = 10.3 ft Δh = 0.5 ft

Average main channel depth at approach section, $y_1 = \Delta h + y_2$ = 10.9 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,

$Y_2 > LS \rightarrow$ RD Overflow

Water Surface Elev. = _____ ft

Low Steel Elev. = 10.3 ft

n (Channel) = 0.033

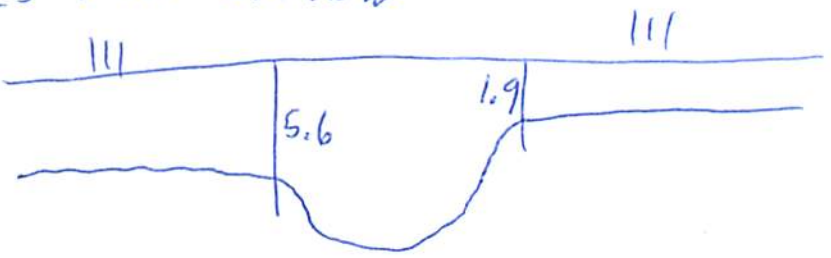
n (LOB) = 0.033

n (ROB) = 0.033

Pier Width = 1.5 ft

Pier Length = 1.5 ft

Piers for 100 yr = 2 ft



CONTRACTION SCOUR

PGRM: Contract

Width of main channel at approach section W_1 = 130 ft

Width of left overbank flow at approach, W_{lob} = 111 ft Average left overbank flow depth, y_{lob} = 5.6 ft

Width of right overbank flow at approach, W_{rob} = 111 ft Average right overbank flow depth, y_{rob} = 1.9 ft

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

x = 6.59 From Figure 9 W_2 (effective) = ~~110.7~~ 107.6 ft y_{cs} = 7.4 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, $V_1 = Q_{100}/(y_1 W_1)$ = _____ 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 = 1.0 Correction factor for flow angle of attack (from Table 1), K2 = 1.0

Froude # at bridge = 0.29 Using pier width a on Figure 11, ξ = 6.4 Pier scour y_{ps} = 5.3 ft

ABUTMENT SCOUR CALCULATIONS

PGRM: Abutment

Average flow depth blocked by: left abutment, y_{aLT} = 5.6 ft right abutment, y_{aRT} = 1.9 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} = 16.1 and ψ_{RT} = ~~16.1~~ 7.8

Left abutment scour, $y_{as} = \psi_{LT}(K_1/0.55)$ = ~~7.8~~ 16.1 ft Right abutment scour $y_{as} = \psi_{RT}(K_1/0.55)$ = 7.8 ft

SCOUR ANALYSIS AND REPORTING FORM

Bridge Structure No. 06176050 Date 8/17/10 Initials CW Region (A B (C) D)

Site _____ Location from Bruce, 2N, 5.6 E

Q_{500} = 22400 by: drainage area ✓ flood frequency anal. ____ regional regression eq. ____

Bridge discharge (Q_2) = 5916 (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 = 111 ft. Flow angle at bridge = 5 ° Abut. Skew = 0 ° Effective Skew = 5 °

Width (W_2) iteration = 111 _____ _____ _____

Avg. flow depth at bridge, y_2 iteration = 20.1 _____ _____ _____

Corrected channel width at bridge Section = W_2 times cos of flow angle = 110.54 ft* $q_2 = Q_2/W_2$ = 53.5 ft^2/s

Bridge Vel, V_2 = 5.2 ft/s Final $y_2 = q_2/V_2$ = 10.3 ft Δh = 0.5 ft

Average main channel depth at approach section, $y_1 = \Delta h + y_2$ = 10.9 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,

$Y_2 > LS \rightarrow$ RD Overflow

Water Surface Elev. = _____ ft

Low Steel Elev. = 10.3 ft

n (Channel) = 0.033

n (LOB) = 0.033

n (ROB) = 0.033

Pier Width = 1.5 ft

Pier Length = 1.5 ft

Piers for 500 yr = 2 ft

CONTRACTION SCOUR

PGRM: Contract

Width of main channel at approach section W_1 = 130 ft

Width of left overbank flow at approach, W_{lob} = 111 ft Average left overbank flow depth, y_{lob} = 5.6 ft

Width of right overbank flow at approach, W_{rob} = 111 ft Average right overbank flow depth, y_{rob} = 1.9 ft

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

x = 7.4 / 6.59 From Figure 9 W_2 (effective) = 107.6 ft y_{cs} = 7.4 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, $V_1 = Q_{500}/(y_1 W_1)$ = _____ 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 = 1.0 Correction factor for flow angle of attack (from Table 1), K2 = 1.0

Froude # at bridge = 0.29 Using pier width a on Figure 11, ξ = 6.4 Pier scour y_{ps} = 5.3 ft

ABUTMENT SCOUR CALCULATIONS

PGRM: Abutment

Average flow depth blocked by: left abutment, y_{aLT} = 5.6 ft right abutment, y_{aRT} = 1.9 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} = 16.1 and ψ_{RT} = ~~16.1~~ 7.8

Left abutment scour, $y_{as} = \psi_{LT}(K_1/0.55)$ = ~~7.8~~ / 16.1 ft Right abutment scour $y_{as} = \psi_{RT}(K_1/0.55)$ = 7.8 ft

Route 201st St Stream North Deer Creek MRM _____ Date 8/17/10 Initials CW

Bridge Structure No. 06176050 Location from Bruce, 2N, 5.6 E

GPS coordinates: N 44°28'15.0" W 096°46'24.4" taken from: USL abutment X centerline of ⇑ MRM end _____

Datum of coordinates: WGS84 X NAD27 _____

Drainage area = 46.55 sq. mi.

The average bottom of the main channel was 14.0 ft below top of guardrail at a point 26 ft from left abutment.

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

MISCELLANEOUS CONSIDERATIONS

Flows	Q_{100} = 8720			Q_{500} = 22400		
Estimated flow passing through bridge	5916			5916		
Estimated road overflow & overtopping	2804			16484		
Consideration	Yes	No	Possibly	Yes	No	Possibly
Chance of overtopping	X			X		
Chance of Pressure flow	~~X~~	X			X	
Armored appearance to channel		X			X	
Lateral instability of channel		X			X	

Riprap at abutments? X Yes ____No ____Marginal

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

Spur Dike ____Yes ____No ____Don't know X NA

Other _____ ____Yes ____No ____Don't know X 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

1126 - Bridge #
27 - Upstream
28 - RB US
29 - US LB
30 - US face of bridge
31 - L. Abut
32 - R. Abut

Summary of Results

	Q100	Q500
Bridge flow evaluated	5916	5916
Flow depth at left abutment (yaLT), in feet	5.6	5.6
Flow depth at right abutment (yaRT), in feet	1.9	1.9
Contraction scour depth (ycs), in feet	7.4	7.4
Pier scour depth (yps), in feet	5.3	5.3
Left abutment scour depth (yas), in feet	~~7.8~~ 16.1	~~7.8~~ 16.1
Right abutment scour depth (yas), in feet	7.8	7.8
1Flow angle of attack	5	5

See Comments/Diagram for justification where required