ok RT

SCOUR ANALYSIS AND REPORTING FORM

Bridge Structure No. 06160158 Date 8/18/10 Initials CW Region (A B C D)

Site _____ Location in Brookings, near the intersection of Western Ave and 8th St

Q_{100} = 4050 by: drainage area ✓ flood frequency anal. ____ regional regression eq. ____

Bridge discharge (Q_2) = 2140 (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 = 0 ° Abut. Skew = 0 ° Effective Skew = 0 °

Width (W_2) iteration = 111 _____ _____ _____

Avg. flow depth at bridge, y_2 iteration = 9.5 _____ _____ _____

Corrected channel width at bridge Section = W_2 times cos of flow angle = 111 ft* $q_2 = Q_2/W_2$ = 19.3 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,

$Y_2 > LS \rightarrow$ RD overflow

Water Surface Elev. = _____ ft

Low Steel Elev. = 6.2 ft

n (Channel) = 0.070

n (LOB) = 0.037

n (ROB) = 0.037

Pier Width = 2.5 ft

Pier Length = 2.5 ft

Piers for 100 yr = 2 ft

CONTRACTION SCOUR

PGRM: Contract

Width of main channel at approach section W_1 = 120 ft

Width of left overbank flow at approach, W_{lob} = ~~0~~ ft 0 Average left overbank flow depth, y_{lob} = 0 ft

Width of right overbank flow at approach, W_{rob} = 111 ft Average right overbank flow depth, y_{rob} = 1.7 ft

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

x = 2.24 From Figure 9 W_2 (effective) = 106 ft y_{cs} = 2.8 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, $V_1 = Q_{100}/(y_1 W_1)$ = _____ 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

PGRM: Pier

PIER SCOUR CALCULATIONS

L/a ratio = 1.0 Correction factor for flow angle of attack (from Table 1), K2 = 1.0

Froude # at bridge = 0.22 Using pier width a on Figure 11, ξ = 9.5 Pier scour y_{ps} = 7.6 ft

PGRM: Abutment

ABUTMENT SCOUR CALCULATIONS

Average flow depth blocked by: left abutment, y_{aLT} = 0 ft right abutment, y_{aRT} = 1.7 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} = 0 and ψ_{RT} = 7

Left abutment scour, $y_{as} = \psi_{LT}(K_1/0.55)$ = 0 ft Right abutment scour $y_{as} = \psi_{RT}(K_1/0.55)$ = 12.8 ft

SCOUR ANALYSIS AND REPORTING FORM

Bridge Structure No. 06160158 Date 8/18/10 Initials CW Region (A B (C) D)

Site _____ Location in Brookings, near the intersection of Western Ave and 8th St

Q_{500} = 6310 by: drainage area ✓ flood frequency anal. ____ regional regression eq. ____

Bridge discharge (Q_2) = ~~6310~~ 2140 (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 = 0 ° Abut. Skew = 0 ° Effective Skew = 0 °

Width (W_2) iteration = 111 _____ _____ _____

Avg. flow depth at bridge, y_2 iteration = 10.6 _____ _____ _____

Corrected channel width at bridge Section = W_2 times cos of flow angle = 111 ft* $q_2 = Q_2/W_2$ = 19.3 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,

$y_2 > 6.2 \rightarrow$ Road overflow

Water Surface Elev. = _____ ft

Low Steel Elev. = 6.2 ft

n (Channel) = 0.070

n (LOB) = 0.037

n (ROB) = 0.037

Pier Width = 2.5 ft

Pier Length = 2.5 ft

Piers for 500 yr = 2 ft

CONTRACTION SCOUR

PGRM: Contract

Width of main channel at approach section W_1 = 120 ft

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} = 14 ft Average right overbank flow depth, y_{rob} = 1.7 ft

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

x = 2.24 From Figure 9 W_2 (effective) = 106 ft y_{cs} = 2.8 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, $V_1 = Q_{500}/(y_1 W_1)$ = _____ 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

PGRM: Pier

PIER SCOUR CALCULATIONS

L/a ratio = 1.0 Correction factor for flow angle of attack (from Table 1), K2 = 1.0

Froude # at bridge = 0.22 Using pier width a on Figure 11, ξ = 9.5 Pier scour y_{ps} = 7.6 ft

PGRM: Abutment

ABUTMENT SCOUR CALCULATIONS

Average flow depth blocked by: left abutment, y_{aLT} = 0 ft right abutment, y_{aRT} = 1.7 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} = 0 and ψ_{RT} = 7

Left abutment scour, $y_{as} = \psi_{LT}(K_1/0.55)$ = 0 ft Right abutment scour $y_{as} = \psi_{RT}(K_1/0.55)$ = 12.8 ft

Route Western Ave Stream Sixmile Creek MRM _____ Date 8/18/10 Initials CW

Bridge Structure No. 06160158 Location In Brookings, near the intersection of Western Ave and 8th St.

GPS coordinates: N 44° 18' 52.5" W 096° 48' 31.2" taken from: USL abutment X centerline of ⇑ MRM end _____

Datum of coordinates: WGS84 X NAD27 _____

Drainage area = 70.5 sq. mi.

The average bottom of the main channel was 11.7 ft below top of guardrail at a point 25 ft from left abutment.

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

MISCELLANEOUS CONSIDERATIONS

Flows	Q_{100} = 4050			Q_{500} = 6310		
Estimated flow passing through bridge	2140			2140		
Estimated road overflow & overtopping	1910			4170		
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 Looks like most has been washed away

Evidence of past Scour? ____Yes ___X___No ____Don't know

Debris Potential? ___X___High ____Med ____Low

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

Riprap ___X___Yes ____No ____Don't know ____NA What was there was designed

Spur Dike ____Yes ____No ____Don't know ___X___NA

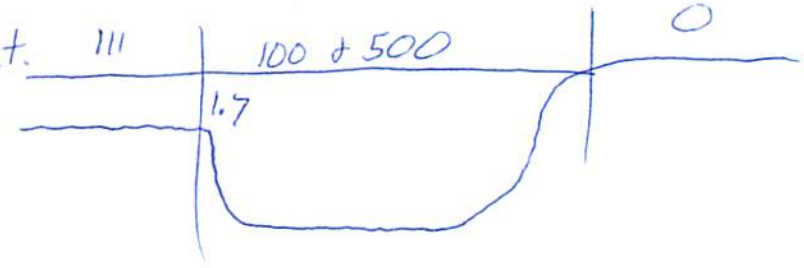
Other _____ ____Yes ____No ____Don't know ___X___NA

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

1148 - Bridge #
49 - US from bridge
50 - US RB
51 - US LB
52 - US face of bridge
53 - Left Abut
54 - R. Abut.



Summary of Results

	Q100	Q500
Bridge flow evaluated	2140	2140
Flow depth at left abutment (yaLT), in feet	0.0	0.0
Flow depth at right abutment (yaRT), in feet	1.7	1.7
Contraction scour depth (ycs), in feet	2.8	2.8
Pier scour depth (yps), in feet	7.6	7.6
Left abutment scour depth (yas), in feet	0.0	0.0
Right abutment scour depth (yas), in feet	12.8	12.8
1Flow angle of attack	0	0

See Comments/Diagram for justification where required