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SCOUR ANALYSIS AND REPORTING FORM

Bridge Structure No. 27010073 Date 3/16/11 Initials CW Region (A B C D)

Site _____ Location 10.7 mi N of Dallas on 333 Ave

Q_{100} = 3930 by: drainage area ratio ____ flood freq. anal. ____ regional regression eq. ✓

Bridge discharge (Q_2) = 3930 (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 = 97 ft Flow angle at bridge = 25 ° Abut. Skew = 27 ° Effective Skew = 2 °

Width (W_2) iteration = 97 75 [illegible] [illegible] 94 [illegible] [illegible] 97 vert wall

Avg. flow depth at bridge, y_2 iteration = 7.5 8.6 9.6 [illegible] [illegible]

Corrected channel width at bridge Section = W_2 times cos of flow angle = 96.94 ft* $q_2 = Q_2/W_2$ = 40.5 ft^2/s

Bridge Vel, V_2 = 5.4 ft/s Final $y_2 = q_2/V_2$ = 7.5 ft Δh = 0.6 ft

Average main channel depth at approach section, $y_1 = \Delta h + y_2$ = 8.1 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. = ____ ft

Low Steel Elev. = 12.7 ft

n (Channel) = 0.033

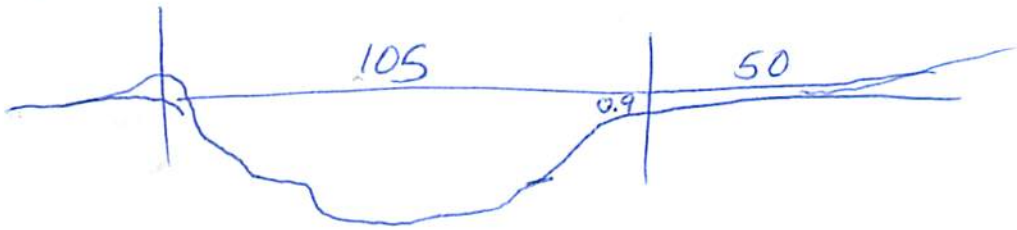
n (LOB) = 0.040

n (ROB) = 0.040

Pier Width = 2.0 ft

Pier Length = 2.0 ft

Piers for 100 yr = 2 ft



CONTRACTION SCOUR

PGRM: Contract

Width of main channel at approach section W_1 = 105 ft

Width of left overbank flow at approach, W_{lob} = 0.0 ft Average left overbank flow depth, y_{lob} = 0.0 ft

Width of right overbank flow at approach, W_{rob} = 50 ft Average right overbank flow depth, y_{rob} = 0.5 ft

0.9/2 = 0.45

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

x = 1.09 From Figure 9 W_2 (effective) = 92.9 ft y_{cs} = 1.5 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, $Vc = 11.17 y_1^{1/6} D_{50}^{1/3}$ = ____ 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

PGRM: Pier

PIER SCOUR CALCULATIONS

L/a ratio = 1.0

Froude # at bridge = 0.35

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

Using pier width a on Figure 11, ξ = 8.0 Pier scour y_{ps} = 6.8 ft

PGRM: Abutment

ABUTMENT SCOUR CALCULATIONS

Average flow depth blocked by: left abutment, y_{aLT} = 0.0 ft right abutment, y_{aRT} = 0.5 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} = 0.0 and ψ_{RT} = 2.3

Left abutment scour, $y_{as} = \psi_{LT}(K_1/0.55)$ = 0.0 ft Right abutment scour $y_{as} = \psi_{RT}(K_1/0.55)$ = 2.3 ft

SCOUR ANALYSIS AND REPORTING FORM

Bridge Structure No. 27160073 Date 8/16/11 Initials CW Region (A B C D)

Site _____ Location 10.7 mi N of Dallas on 333 Ave

Q_{500} = 6610 by: drainage area ratio ____ flood freq. anal. ____ regional regression eq. ✓

Bridge discharge (Q_2) = 6610 (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 = 97 ft. Flow angle at bridge = 25 ° Abut. Skew = 27 ° Effective Skew = 2 °

Width (W_2) iteration = 97

Avg. flow depth at bridge, y_2 iteration = 9.9 Vert wall

Corrected channel width at bridge Section = W_2 times cos of flow angle = 96.94 ft* $q_2 = Q_2/W_2$ = 68.2 ft²/s

Bridge Vel, V_2 = 6.9 ft/s Final $y_2 = q_2/V_2$ = 9.9 ft Δh = 1.0 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,

Water Surface Elev. = ____ ft

Low Steel Elev. = 12.7 ft

n (Channel) = 0.033

n (LOB) = 0.040

n (ROB) = 0.040

Pier Width = 2.0 ft

Pier Length = 2.0 ft

Piers for 500 yr = 2 ft

CONTRACTION SCOUR

PGRM: Contract

Width of main channel at approach section W_1 = 105 ft

Width of left overbank flow at approach, W_{lob} = 0.0 ft Average left overbank flow depth, y_{lob} = 0.0 ft

Width of right overbank flow at approach, W_{rob} = 97 ft Average right overbank flow depth, y_{rob} = 3.7 ft

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

x = 2.96 From Figure 9 W_2 (effective) = 92.9 ft y_{cs} = 3.5 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

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 = 0.39 Using pier width a on Figure 11, ξ = 6.0 Pier scour y_{ps} = 6.9 ft

PGRM: Abutment

ABUTMENT SCOUR CALCULATIONS

Average flow depth blocked by: left abutment, y_{aLT} = 0.0 ft right abutment, y_{aRT} = 3.7 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} = 0.0 and ψ_{RT} = 12.7

Left abutment scour, $y_{as} = \psi_{LT}(K_1/0.55)$ = 0.0 ft Right abutment scour $y_{as} = \psi_{RT}(K_1/0.55)$ = 12.7 ft

8 ft 2.4/9

Route 333 Ave Stream Bull Ck MRM _____ Date 8/16/11 Initials CW

Bridge Structure No. 27010073 Location 10.7 mi N of Dallas on 333 Ave

GPS coordinates: N 43°23'45.0" W 99°30'52.1" taken from: USL abutment X centerline of ⇑ MRM end _____

Datum of coordinates: WGS84 X NAD27 _____

Drainage area = 62.4 sq. mi.

The average bottom of the main channel was 16.6 ft below top of guardrail at a point 28 ft from left abutment.

Method used to determine flood flows: ___Freq. Anal. ___drainage area ratio ✓regional regression equations.

Pks Calc'd 8/8

2	263
5	791
10	1370
25	2210
50	3020
100	3930
500	6610

MISCELLANEOUS CONSIDERATIONS

Flows	Q_{100} = 3930			Q_{500} = 6610		
Estimated flow passing through bridge		3930			6610	
Estimated road overflow & overtopping						
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 X No ___Marginal

Evidence of past Scour? X Yes ___No ___Don't know piles exposed under abut

Debris Potential? ___High X Med ___Low

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

Riprap	___Yes	___No	___Don't know	X NA
Spur Dike	___Yes	___No	X Don't know	___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

Photos
1932 - 10
33 - US
34 - US RB
35 - US LB
36 - L. Abut
37 - scour under L. Abut
38 - R. Abut
39 - spur dike on LB
40 - US Face

Too deep to set to Piers → estim ~ 2.0'

Summary of Results

	Q100	Q500
Bridge flow evaluated	3930	6610
Flow depth at left abutment (yaLT), in feet	0	0
Flow depth at right abutment (yaRT), in feet	0.5	3.7
Contraction scour depth (ycs), in feet	1.5	3.5
Pier scour depth (yps), in feet	6.8	6.9
Left abutment scour depth (yas), in feet	0	0
Right abutment scour depth (yas), in feet	2.3	12.7
1Flow angle of attack	2	2

See Comments/Diagram for justification where required