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SCOUR ANALYSIS AND REPORTING FORM

Bridge Structure No. 50150202 Date 9-18-10 Initials RRL Region (A B C D)

Site _____ Location From I-29 Exit 79, 2.5W, 0.9N

Q_{100} = 17,300 by: drainage area ratio ✓ flood freq. anal. ____ regional regression eq. ____

Bridge discharge (Q_2) = 17300 (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 = 207 ft. Flow angle at bridge = 10 ° Abut. Skew = 0 Effective Skew = 10 °

Width (W_2) iteration = 207

Avg. flow depth at bridge, y_2 iteration = 13

Corrected channel width at bridge Section = W_2 times cos of flow angle = 203.86 ft* $q_2 = Q_2/W_2$ = 84.9 ft^2/s

Bridge Vel, V_2 = 6.5 ft/s Final $y_2 = q_2/V_2$ = 13 ft Δh = 0.9 ft

Average main channel depth at approach section, $y_1 = \Delta h + y_2$ = 13.9 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. = 1 ft

Low Steel Elev. = 13.1 ft

n (Channel) = 0.03

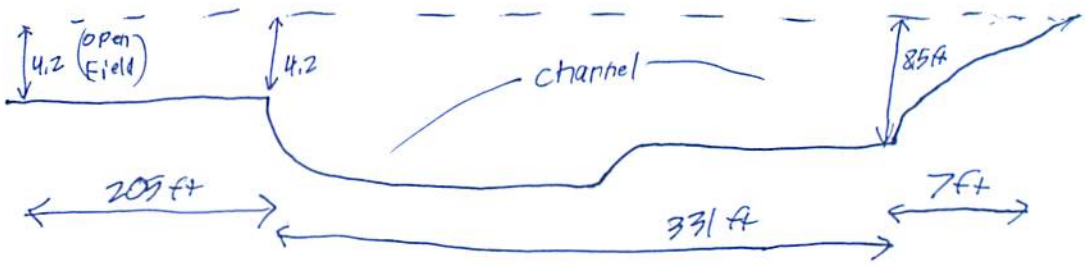
n (LOB) = 0.032

n (ROB) = 0.032

Pier Width = 2.8 ft

Pier Length = 2.8 ft

Piers for 100 yr = 2 ft



CONTRACTION SCOUR

PGRM: Contract

Width of main channel at approach section W_1 = 331 ft

Width of left overbank flow at approach, W_{lob} = 205 ft Average left overbank flow depth, y_{lob} = 4.2 ft

Width of right overbank flow at approach, W_{rob} = 7 ft Average right overbank flow depth, y_{rob} = 4.25 ft

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

x = 11.2 From Figure 9 W_2 (effective) = 198.3 ft y_{cs} = 12.2 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, $V_1 = Q_{100}/(y_1 W_1)$ = _____ 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 Correction factor for flow angle of attack (from Table 1), K2 = 1

Froude # at bridge = 0.32 Using pier width a on Figure 11, ξ = 10.2 Pier scour y_{ps} = 8.6 ft

ABUTMENT SCOUR CALCULATIONS

PGRM: Abutment

Average flow depth blocked by: left abutment, y_{aLT} = 4.2 ft right abutment, y_{aRT} = 4.25 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} = 13.6 and ψ_{RT} = 13.7

Left abutment scour, $y_{as} = \psi_{LT}(K_1/0.55)$ = 13.6 ft Right abutment scour $y_{as} = \psi_{RT}(K_1/0.55)$ = 13.7 ft

SCOUR ANALYSIS AND REPORTING FORM

Bridge Structure No. 50150202 Date 9-18-10 Initials RRR Region (A B C D)

Site _____ Location From I 29 Exit 79 2.5 W, 0.9 N

Q_{500} = 29,300 by: drainage area ratio ✓ flood freq. anal. ____ regional regression eq. ____

Bridge discharge (Q_2) = 17,586 (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

Bridge Width = 207 ft. Flow angle at bridge = 10 ° Abut. Skew = 0 Effective Skew = 10 °

Width (W_2) iteration = 207 _____ _____ _____

Avg. flow depth at bridge, y_2 iteration = 13.1 _____ _____ _____

Corrected channel width at bridge Section = W_2 times cos of flow angle = 203.86 ft* $q_2 = Q_2/W_2$ = 86.3 ft^2/s

Bridge Vel, V_2 = 6.6 ft/s Final $y_2 = q_2/V_2$ = 13.1 ft Δh = 0.9 ft

Average main channel depth at approach section, $y_1 = \Delta h + y_2$ = 14 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.

PGRM: "RegionA", "RegionB", "RegionC", or "RegionD"

see 100 yr diag.

Water Surface Elev. = _____ ft

Low Steel Elev. = 13.1 ft

n (Channel) = 0.03

n (LOB) = 0.032

n (ROB) = 0.032

Pier Width = 2.8 ft

Pier Length = 2.8 ft

Piers for 500 yr = 2 ft

CONTRACTION SCOUR

PGRM: Contract

Width of main channel at approach section W_1 = 331 ft

Width of left overbank flow at approach, W_{lob} = 205 ft Average left overbank flow depth, y_{lob} = 4.3 ft

Width of right overbank flow at approach, W_{rob} = 7 ft Average right overbank flow depth, y_{rob} = 4.3 ft

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

x = 11.34 From Figure 9 W_2 (effective) = 198.3 ft y_{cs} = 12.4 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

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

Froude # at bridge = 0.32 Using pier width a on Figure 11, ξ = 10.2 Pier scour y_{ps} = 8.6 ft

ABUTMENT SCOUR CALCULATIONS

PGRM: Abutment

Average flow depth blocked by: left abutment, y_{aLT} = 4.3 ft right abutment, y_{aRT} = 4.3 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} = 13.8 and ψ_{RT} = 13.8

Left abutment scour, $y_{as} = \psi_{LT}(K_1/0.55)$ = 13.8 ft Right abutment scour $y_{as} = \psi_{RT}(K_1/0.55)$ = 13.8 ft

Route Ellig Rd Stream Skunk Creek MRM _____ Date 9-18-10 Initials RRL

Bridge Structure No. 50150202 Location From I-29 Exit 79, 2.5W, 0.9N

GPS coordinates: N43° 33.385' W96° 49.839' taken from: USL abutment ✓ centerline of ⇑ MRM end _____

Datum of coordinates: WGS84 _____ NAD27 _____

Drainage area = 498.28 sq. mi.

The average bottom of the main channel was 19.1 ft below top of guardrail at a point 106 ft from left abutment.

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

MISCELLANEOUS CONSIDERATIONS

Flows	Q_{100} = 17300			Q_{500} = 29300		
Estimated flow passing through bridge	17300			17,586		
Estimated road overflow & overtopping	0			11,714		
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? ____Yes ____No X Don't know

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 - Bridge Deck
2 - Looking upstream
3 - Looking Downstream
4 - Left overbank
5 - Right overbank
6 - Left Abutment
7 - Right Abutment
8 - Piers
9 - Hills at Upstream Trans.

Summary of Results

	Q100	Q500
Bridge flow evaluated	17,300	17,586
Flow depth at left abutment (yaLT), in feet	4.2	4.3
Flow depth at right abutment (yaRT), in feet	4.25	4.3
Contraction scour depth (ycs), in feet	12.2	12.4
Pier scour depth (yps), in feet	8.6	8.6
Left abutment scour depth (yas), in feet	13.6	13.8
Right abutment scour depth (yas), in feet	13.7	13.8
1Flow angle of attack	10	10

See Comments/Diagram for justification where required