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SCOUR ANALYSIS AND REPORTING FORM

Bridge Structure No. 50126190 Date 9-18-10 Initials RRL Region (A B C D)

Site _____ Location From I-29 Exit 79, 4.5W, 2N, 0.3W

Q_{100} = 17,200 by: drainage area ratio ✓ flood freq. anal. ____ regional regression eq. ____

Bridge discharge (Q_2) = 15,702 (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 = 164 ft. Flow angle at bridge = 0 ° Abut. Skew = 0 Effective Skew = 0 °

Width (W_2) iteration = 164 _____ _____ _____

Avg. flow depth at bridge, y_2 iteration = 13.8 _____ _____ _____

Corrected channel width at bridge Section = W_2 times cos of flow angle = 164 ft* $q_2 = Q_2/W_2$ = 95.7 ft^2/s

Bridge Vel, V_2 = 6.9 ft/s Final $y_2 = q_2/V_2$ = 13.8 ft Δh = 1 ft

Average main channel depth at approach section, $y_1 = \Delta h + y_2$ = 14.8 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. = 3.3 ft

Low Steel Elev. = 13.8 ft

n (Channel) = 0.028

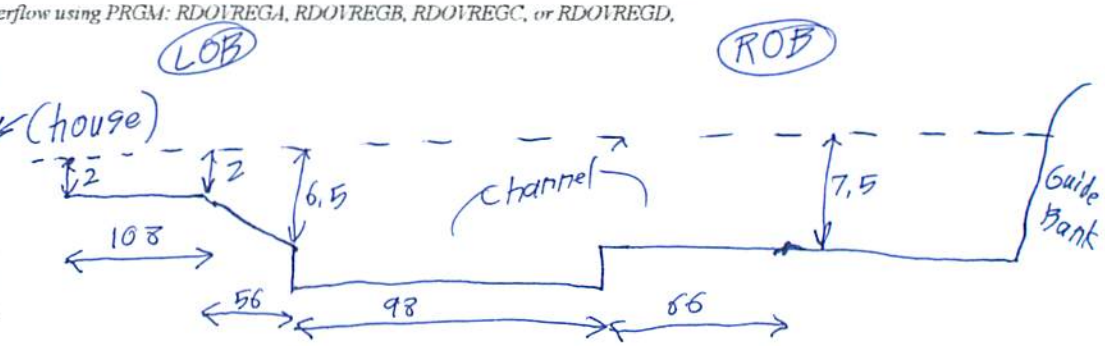
n (LOB) = 0.029

n (ROB) = 0.028

Pier Width = 1.5 ft

Pier Length = 32 ft

Piers for 100 yr = 3 ft



CONTRACTION SCOUR

PGRM: Contract

Width of main channel at approach section W_1 = 164 ft

Width of left overbank flow at approach, W_{lob} = 164 ft Average left overbank flow depth, y_{lob} = 2.77 ft

Width of right overbank flow at approach, W_{rob} = 137 ft Average right overbank flow depth, y_{rob} = 7.5 ft

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

x = 5.41 From Figure 9 W_2 (effective) = 159.5 ft y_{cs} = 6.1 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 = 21 Correction factor for flow angle of attack (from Table 1), K2 = 1

Froude # at bridge = 0.33 Using pier width a on Figure 11, ξ = 6.4 Pier scour y_{ps} = 5.4 ft

PGRM: Abutment

ABUTMENT SCOUR CALCULATIONS

Average flow depth blocked by: left abutment, y_{aLT} = 2.77 ft right abutment, y_{aRT} = 7.5 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} = 11.1 and ψ_{RT} = 19.4

Left abutment scour, $y_{as} = \psi_{LT}(K_1/0.55)$ = 11.1 ft Right abutment scour $y_{as} = \psi_{RT}(K_1/0.55)$ = 19.4 ft

SCOUR ANALYSIS AND REPORTING FORM

Bridge Structure No. 50126190 Date 9-18-10 Initials RRL Region (A B (C) D)

Site _____ Location From I-29 Exit 79, 4.5 W, 2 N, 0.3 W

Q_{500} = 29,100 by: drainage area ratio ✓ flood freq. anal. _____ regional regression eq. _____

Bridge discharge (Q_2) = 15,702 (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 = 164 ft. Flow angle at bridge = 0 ° Abut. Skew = 0 Effective Skew = 0 °

Width (W_2) iteration = 164 _____ _____ _____

Avg. flow depth at bridge, y_2 iteration = 13.8 _____ _____ _____

Corrected channel width at bridge Section = W_2 times cos of flow angle = 164 ft* $q_2 = Q_2/W_2$ = 95.7 ft^2/s

Bridge Vel, V_2 = 6.9 ft/s Final $y_2 = q_2/V_2$ = 13.8 ft Δh = 1 ft

Average main channel depth at approach section, $y_1 = \Delta h + y_2$ = 14.8 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,

see 100 yr diag.

Water Surface Elev. = 3.3 ft

Low Steel Elev. = 13.8 ft

n (Channel) = 0.028

n (LOB) = 0.029

n (ROB) = 0.028

Pier Width = 1.5 ft

Pier Length = 32 ft

Piers for 500 yr = 3 ft

CONTRACTION SCOUR

PGRM: Contract

Width of main channel at approach section W_1 = 164 ft

Width of left overbank flow at approach, W_{lob} = 164 ft Average left overbank flow depth, y_{lob} = 2.77 ft

Width of right overbank flow at approach, W_{rob} = 137 ft Average right overbank flow depth, y_{rob} = 7.5 ft

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

x = 5.41 From Figure 9 W_2 (effective) = 159.5 ft y_{cs} = 6.1 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 = 21 Correction factor for flow angle of attack (from Table 1), K2 = 1

Froude # at bridge = 0.33 Using pier width a on Figure 11, ξ = 6.4 Pier scour y_{ps} = 5.4 ft

ABUTMENT SCOUR CALCULATIONS

PGRM: Abutment

Average flow depth blocked by: left abutment, y_{aLT} = 2.77 ft right abutment, y_{aRT} = 7.5 ft

Shape coefficient K_1= 1.00 for vertical-wall, 0.82 for vertical-wall with wingwalls, 0.55 for spill-through (SW)

Using values for y_{aLT} and y_{aRT} on figure 12, ψ_{LT} = 11.1 and ψ_{RT} = 19.4

Left abutment scour, $y_{as} = \psi_{LT}(K_1/0.55)$ = 11.1 ft Right abutment scour $y_{as} = \psi_{RT}(K_1/0.55)$ = 19.4 ft

Route 263rd St. Stream Skunk Cr. MRM _____ Date 9-18-10 Initials RKL

Bridge Structure No. 50126190 Location From I-29 Exit 79, 4.5W, 2N, 0.3W

GPS coordinates: N43° 34.371' W96° 52.629' taken from: USL abutment _____ centerline of ⇑ MRM end _____

Datum of coordinates: WGS84 _____ NAD27 _____

Drainage area = 491.45 sq. mi.

The average bottom of the main channel was 17.3 ft below top of guardrail at a point 33 ft from left abutment.

Method used to determine flood flows: ___Freq. Anal. ✓ drainage area ratio ___regional regression equations.

MISCELLANEOUS CONSIDERATIONS

Flows	Q_{100} = 17200			Q_{500} = 29,100		
Estimated flow passing through bridge	15,702			15,702		
Estimated road overflow & overtopping	1,498			13,398		
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? ___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	___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

Notes: Channel base comes at angle but at 100+500 flows will be straight on. An angle of 0° was used.

Summary of Results

	Q100	Q500
Bridge flow evaluated	15,702	15,702
Flow depth at left abutment (yaLT), in feet	2.77	2.77
Flow depth at right abutment (yaRT), in feet	7.5	7.5
Contraction scour depth (ycs), in feet	6.1	6.1
Pier scour depth (yps), in feet	5.4	5.4
Left abutment scour depth (yas), in feet	11.1	11.1
Right abutment scour depth (yas), in feet	19.4	19.4
1Flow angle of attack	0	0

See Comments/Diagram for justification where required