OK RJ

SCOUR ANALYSIS AND REPORTING FORM

Bridge Structure No. 50330183 Date 10-9-10 Initials RRL Region (A B C D) [D circled]

Site 06482745 Location 1W 0.2S from SD/MN line @ Valley Springs

Q_{100} = 5770 by: drainage area ratio ____ flood freq. anal. ✓ regional regression eq. ____

Bridge discharge (Q_2) = 5770 (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 = 117 ft. Flow angle at bridge = 0 ° Abut. Skew = 0 ° Effective Skew = 0 ° *- Low Flow is winding. High Flow is 0.

Width (W_2) iteration = 100 103

Avg. flow depth at bridge, y_2 iteration = 10.7 10.6

Corrected channel width at bridge Section = W_2 times cos of flow angle = 103 ft* $q_2 = Q_2/W_2$ = 56 ft^2/s

Bridge Vel, V_2 = 5.3 ft/s Final $y_2 = q_2/V_2$ = 10.6 ft Δh = 0.6 ft

Average main channel depth at approach section, $y_1 = \Delta h + y_2$ = 11.1 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. = 0 ft

Low Steel Elev. = 15.6 ft

n (Channel) = 0.035

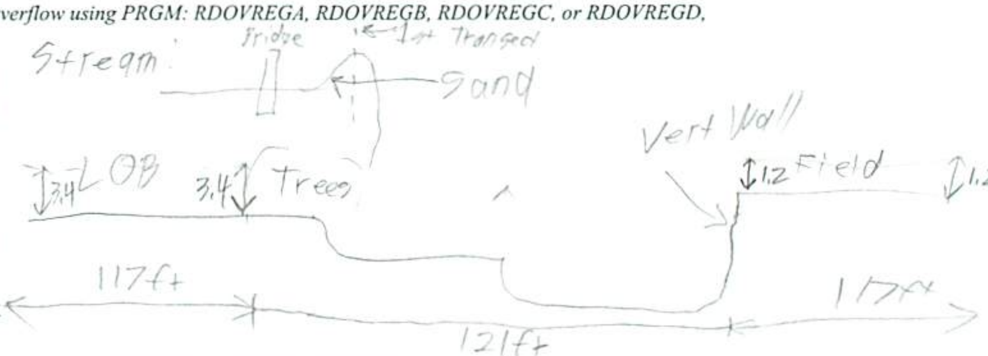
n (LOB) = 0.05

n (ROB) = 0.045

Pier Width = 3 ft

Pier Length = 3 ft

Piers for 100 yr = 2 ft



CONTRACTION SCOUR

PGRM: Contract

Width of main channel at approach section W_1 = 121 ft

Width of left overbank flow at approach, W_{lob} = 117 ft Average left overbank flow depth, y_{lob} = 3.4 ft

Width of right overbank flow at approach, W_{rob} = 117 ft Average right overbank flow depth, y_{rob} = 1.2 ft

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

x = 4.31 From Figure 9 W_2 (effective) = 97 ft y_{cs} = 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, $Vc = 11.52 y_1^{1/6} D_{50}^{1/3}$ = ____ 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 = 0.29 Using pier width a on Figure 11, ξ = 10.7 Pier scour y_{ps} = 8.9 ft

ABUTMENT SCOUR CALCULATIONS

PGRM: Abutment

Average flow depth blocked by: left abutment, y_{aLT} = 3.4 ft right abutment, y_{aRT} = 1.2 ft

Shape coefficient K_1= 1.00 for vertical-wall, 0.82 for vertical-wall with wingwalls, 0.55 for spill-through [circled]

Using values for y_{aLT} and y_{aRT} on figure 12, ψ_{LT} = 12.2 and ψ_{RT} = 5.1

Left abutment scour, $y_{as} = \psi_{LT}(K_1/0.55)$ = 12.2 ft Right abutment scour $y_{as} = \psi_{RT}(K_1/0.55)$ = 5.1 ft

SCOUR ANALYSIS AND REPORTING FORM

Bridge Structure No. 50330183 Date 10-9-10 Initials RRL Region (A B (C) D)

Site 06482745 Location 1W 0.2S from SD/MN line @ Valley Springs

Q_{500} = 9110 by: drainage area ratio ____ flood freq. anal. ✓ regional regression eq. ____

Bridge discharge (Q_2) = 9110 (should be Q_{500} unless there is a relief bridge, road overflow, or bridge overtopping)

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

Analytical Procedure for Estimating Hydraulic Variables Needed to Apply Method

Note: Low Flow Winding, High Flow at 0°

Bridge Width = 117 ft. Flow angle at bridge = 0 ° Abut. Skew = 0 ° Effective Skew = 0 °

Width (W_2) iteration = 117 ________ ________

Avg. flow depth at bridge, y_2 iteration = 12.4 ________ ________ ________

Corrected channel width at bridge Section = W_2 times cos of flow angle = 117 ft* $q_2 = Q_2/W_2$ = 779 ft^2/s

Bridge Vel, V_2 = 6.3 ft/s Final $y_2 = q_2/V_2$ = 12.4 ft Δh = 0.8 ft

Average main channel depth at approach section, $y_1 = \Delta h + y_2$ = 13.2 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. = 0 ft

Low Steel Elev. = 15.6 ft

n (Channel) = 0.035

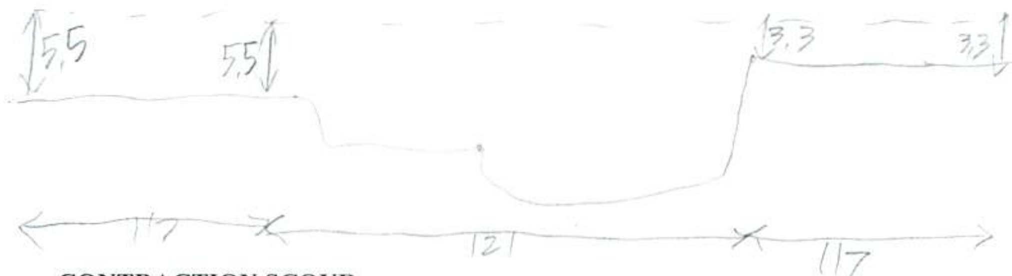
n (LOB) = 0.09

n (ROB) = 0.045

Pier Width = 3 ft

Pier Length = 3 ft

\# Piers for 500 yr = 2 ft



PGRM: Contract

CONTRACTION SCOUR

Width of main channel at approach section W_1 = 121 ft

Width of left overbank flow at approach, W_{lob} = 117 ft Average left overbank flow depth, y_{lob} = 5.5 ft

Width of right overbank flow at approach, W_{rob} = 117 ft Average right overbank flow depth, y_{rob} = 3.3 ft

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

x = 4.53 From Figure 9 W_2 (effective) = 111 ft y_{cs} = 5.2 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, $V_1 = Q_{500}/(y_1 W_1)$ = ________ 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: Pie

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 = 10.7 Pier scour y_{ps} = 9 ft

PGRM: Abutment

ABUTMENT SCOUR CALCULATIONS

Average flow depth blocked by: left abutment, y_{aLT} = 5.5 ft right abutment, y_{aRT} = 3.3 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} = 15.9 and ψ_{RT} = 12

Left abutment scour, $y_{as} = \psi_{LT}(K_1/0.55)$ = 15.9 ft Right abutment scour $y_{as} = \psi_{RT}(K_1/0.55)$ = 12 ft

Route 487 Ave Stream Beaver Creek MRM________ Date 10-9-10 Initials RRL

Bridge Structure No. 50330183 Location 1W, 0.2S from SD/MN line @ Valley Springs

GPS coordinates: N 43° 35.165' W 096° 28.335' taken from: USL abutment X centerline of ⇑ MRM end ______

Datum of coordinates: WGS84_____ NAD27_____

Drainage area = 104 sq. mi.

The average bottom of the main channel was 19.6 ft below top of guardrail at a point 38 ft from left abutment.

Method used to determine flood flows: ✓ Freq. Anal. ____drainage area ratio ____regional regression equations.

MISCELLANEOUS CONSIDERATIONS

Flows	Q_{100} = 5770			Q_{500} = 9110		
Estimated flow passing through bridge	5770			9110		
Estimated road overflow & overtopping	0			0		
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

Evidence of past Scour? X Yes ______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

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

Summary of Results

	Q100	Q500
Bridge flow evaluated	5770	9110
Flow depth at left abutment (yaLT), in feet	3.4	5.5
Flow depth at right abutment (yaRT), in feet	1.2	3.3
Contraction scour depth (ycs), in feet	5	5.2
Pier scour depth (yps), in feet	8.9	9
Left abutment scour depth (yas), in feet	12.2	15.9
Right abutment scour depth (yas), in feet	5.1	12
1Flow angle of attack	0	0

See Comments/Diagram for justification where required