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SCOUR ANALYSIS AND REPORTING FORM

Bridge Structure No. 6139009S6 Date 8/17/11 Initials CW Region (A B C D)

Site _____ Location 2.5 W & 1.4 N of Hidden Timber on 150 0.1 St or Hidden Timber Rd

Q_{100} = 1920 by: drainage area ratio ____ flood freq. anal. ____ regional regression eq. ✓

Bridge discharge (Q_2) = 1920 (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 = 90 ft Flow angle at bridge = 0 ° Abut. Skew = 0 ° Effective Skew = 0 °

Width (W_2) iteration = 90

Avg. flow depth at bridge, y_2 iteration = 5.4 Vert Wall

Corrected channel width at bridge Section = W_2 times cos of flow angle = 90 ft* $q_2 = Q_2/W_2$ = 21.3 ft^2/s

Bridge Vel, V_2 = 4.0 ft/s Final $y_2 = q_2/V_2$ = 5.4 ft Δh = 0.3 ft

Average main channel depth at approach section, $y_1 = \Delta h + y_2$ = 5.7 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. = _____ ft

n (Channel) = 0.037

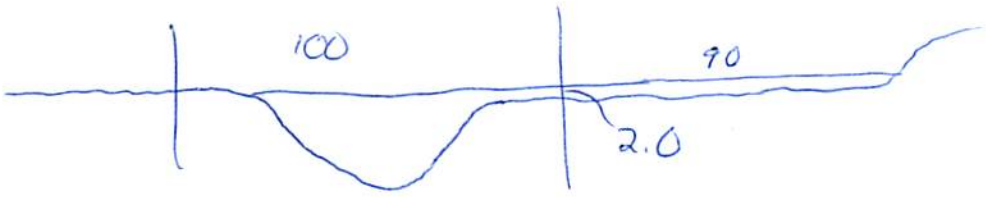
n (LOB) = 0.037

n (ROB) = 0.037

Pier Width = 1.7 ft

Pier Length = 1.7 ft

Piers for 100 yr = 2 ft



CONTRACTION SCOUR

PGRM: Contract

Width of main channel at approach section W_1 = 100 ft

Width of left overbank flow at approach, W_{lob} = 0 ft Average left overbank flow depth, y_{lob} = 0.0 ft

Width of right overbank flow at approach, W_{rob} = 90 ft Average right overbank flow depth, y_{rob} = 2.0 ft

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

x = 1.92 From Figure 9 W_2 (effective) = 86.6 ft y_{cs} = 2.4 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, $V_1 = Q_{100}/(y_1 W_1)$ = _____ 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 Correction factor for flow angle of attack (from Table 1), K2 = 1.0

Froude # at bridge = 0.3 Using pier width a on Figure 11, ξ = 7.0 Pier scour y_{ps} = 5.9 ft

PGRM: Abutment

ABUTMENT SCOUR CALCULATIONS

Average flow depth blocked by: left abutment, y_{aLT} = 0.0 ft right abutment, y_{aRT} = 2.0 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} = 8.2

Left abutment scour, $y_{as} = \psi_{LT}(K_1/0.55)$ = 0.0 ft Right abutment scour $y_{as} = \psi_{RT}(K_1/0.55)$ = 8.2 ft

SCOUR ANALYSIS AND REPORTING FORM

Bridge Structure No. 61396096 Date 8/17/11 Initials CN Region (A B C D)

Site _____ Location 2.5 W & 1.4 N of Hidden Timber on Hidden Timber Rd #

Q_{500} = 3370 by: drainage area ratio ____ flood freq. anal. ____ regional regression eq. ✓

Bridge discharge (Q_2) = 3370 (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 = 90 ft. Flow angle at bridge = 0 ° Abut. Skew = 0 ° Effective Skew = 0 °

Width (W_2) iteration = 90

Avg. flow depth at bridge, y_2 iteration = 7.2 Vert Wall

Corrected channel width at bridge Section = W_2 times cos of flow angle = 90 ft* $q_2 = Q_2/W_2$ = 37.4 ft^2/s

Bridge Vel, V_2 = 5.2 ft/s Final $y_2 = q_2/V_2$ = 7.2 ft Δh = 0.5 ft

Average main channel depth at approach section, $y_1 = \Delta h + y_2$ = 7.8 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. = ____ ft

Low Steel Elev. = ____ ft

n (Channel) = 0.037

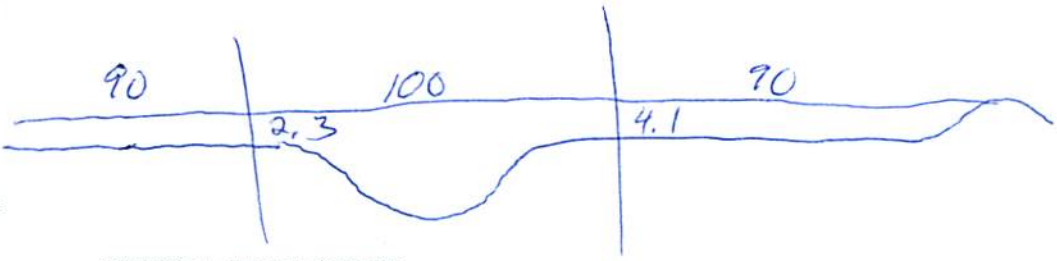
n (LOB) = 0.037

n (ROB) = 0.037

Pier Width = 1.7 ft

Pier Length = 1.7 ft

Piers for 500 yr = 2 ft



CONTRACTION SCOUR

PGRM: Contract

Width of main channel at approach section W_1 = 100 ft

Width of left overbank flow at approach, W_{lob} = 90 ft Average left overbank flow depth, y_{lob} = 2.3 ft

Width of right overbank flow at approach, W_{rob} = 90 ft Average right overbank flow depth, y_{rob} = 4.1 ft

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

x = 5.04 From Figure 9 W_2 (effective) = 86.6 ft y_{cs} = 5.7 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, $V_1 = Q_{500}/(y_1W_1)$ = ____ ft/s

Critical approach velocity, $Vc = 11.17y_1^{1/6}D_{50}^{1/3}$ = ____ 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, $\chi = 0.122y_1[q_2/(D_{50}^{1/3}y_1^{7/6})]^{6/7} - y_1$ = ____ 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 = 0.34 Using pier width a on Figure 11, ξ = 7.0 Pier scour y_{ps} = 6.0 ft

PGRM: Abutment

ABUTMENT SCOUR CALCULATIONS

Average flow depth blocked by: left abutment, y_{aLT} = 2.3 ft right abutment, y_{aRT} = 4.1 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} = 9.4 and ψ_{RT} = 13.4

Left abutment scour, $y_{as} = \psi_{LT}(K_1/0.55)$ = 9.4 ft Right abutment scour $y_{as} = \psi_{RT}(K_1/0.55)$ = 13.4 ft

Route Hidden Timber Rd Stream Antelope C/C MRM _____ Date 8/17/11 Initials CM

Bridge Structure No. 61390096 Location 2.5 W + 1.4 N of Hidden Timber on 150 Oil St

GPS coordinates: N43°15'07.2" W100°28'17.5" taken from: USL abutment X centerline of ⇑ MRM end _____

Datum of coordinates: WGS84 X NAD27 _____

Drainage area = 167 sq. mi.

The average bottom of the main channel was 12.2 ft below top of guardrail at a point 43 ft from left abutment.

Method used to determine flood flows: ____Freq. Anal. ____drainage area ratio ✓ regional regression equations.

PK calc'd 8/18

2	217
5	468
10	707
25	1090
50	1470
100	1920
500	3370

MISCELLANEOUS CONSIDERATIONS

Flows	Q_{100} = 1920			Q_{500} = 3370		
Estimated flow passing through bridge		1920			3370	
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 L. Abut

Debris Potential? ____High ____Med X Low

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

Riprap ____Yes ____No ____Don't know X NA

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

1989-1D
90- US
91- USRB
92- USLB
93- L. Abut
94_R. Abut
95- US Face

Summary of Results

	Q100	Q500
Bridge flow evaluated	1920	3370
Flow depth at left abutment (yaLT), in feet	0	2.3
Flow depth at right abutment (yaRT), in feet	2.0	4.1
Contraction scour depth (ycs), in feet	2.4	5.7
Pier scour depth (yps), in feet	5.9	6.0
Left abutment scour depth (yas), in feet	0	9.4
Right abutment scour depth (yas), in feet	8.2	13.4
1Flow angle of attack	0°	0°

See Comments/Diagram for justification where required