OK RT

SCOUR ANALYSIS AND REPORTING FORM

Bridge Structure No. 53281151 Date 8/9/11 Initials CW Region (A (B) C D)

Site _____ Location 17.2 mi NE of Bison on White Butte Rd 183 Ave

Q_{100} = 4410 by: drainage area ratio____ flood freq. anal. ____ regional regression eq. ____

Bridge discharge (Q_2) = 4410 (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 = 135 ft. Flow angle at bridge = 10 ° Abut. Skew = 0 ° Effective Skew = 10 °

Width (W_2) iteration = 135 73 74 76

Avg. flow depth at bridge, y_2 iteration = 6.8 9.3 9.0 9.1

Corrected channel width at bridge Section = W_2 times cos of flow angle = 74.85 ft* $q_2 = Q_2/W_2$ = 58.9 ft^2/s

Bridge Vel, V_2 = 6.4 ft/s Final $y_2 = q_2/V_2$ = 9.1 ft Δh = 0.8 ft

Average main channel depth at approach section, $y_1 = \Delta h + y_2$ = 10.0 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. = 13.9 ft

n (Channel) = 0.045

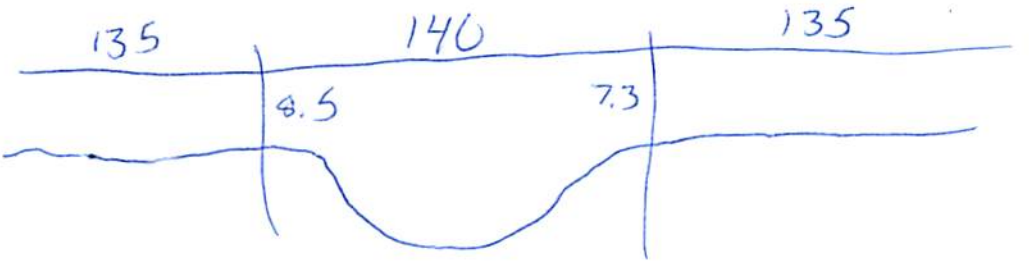
n (LOB) = 0.055

n (ROB) = 0.055

Pier Width = 2.75 ft

Pier Length = 2.75 ft

Piers for 100 yr = 2 ft



CONTRACTION SCOUR

PGRM: Contract

Width of main channel at approach section W_1 = 140 ft

Width of left overbank flow at approach, W_{lob} = 135 ft Average left overbank flow depth, y_{lob} = 8.5 ft

Width of right overbank flow at approach, W_{rob} = 135 ft Average right overbank flow depth, y_{rob} = 7.3 ft

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

x = 31.76 From Figure 9 W_2 (effective) = 69.4 ft y_{cs} = 24.0 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, $V_1 = Q_{100}/(y_1W_1)$ = _____ 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 = 0.37 Using pier width a on Figure 11, ξ = 10.1 Pier scour y_{ps} = 8.7 ft

PGRM: Abutment

ABUTMENT SCOUR CALCULATIONS

Average flow depth blocked by: left abutment, y_{aLT} = 8.5 ft right abutment, y_{aRT} = 7.3 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} = 20.2 and ψ_{RT} = 19.1

Left abutment scour, $y_{as} = \psi_{LT}(K_1/0.55)$ = 20.2 ft Right abutment scour $y_{as} = \psi_{RT}(K_1/0.55)$ = 19.1 ft

SCOUR ANALYSIS AND REPORTING FORM

Bridge Structure No. 53281151 Date 3/9/11 Initials CW Region (A (B) C D)

Site _____ Location 17.2 mi NE of Bison on White Butte Rd

Q_{500} = 7390 by: drainage area ratio____ flood freq. anal. ____ regional regression eq. ____

Bridge discharge (Q_2) = 7390 (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 = 135 ft. Flow angle at bridge = 10 ° Abut. Skew = 8 ° Effective Skew = 10 °

Width (W_2) iteration = 135 77 100 97

Avg. flow depth at bridge, y_2 iteration = 8.9 11.9 10.4 10.6

Corrected channel width at bridge Section = W_2 times cos of flow angle = 95.53 ft* $q_2 = Q_2/W_2$ = 77.4 ft^2/s

Bridge Vel, V_2 = 7.3 ft/s Final $y_2 = q_2/V_2$ = 10.6 ft Δh = 1.1 ft

Average main channel depth at approach section, $y_1 = \Delta h + y_2$ = 11.7 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. = 13.9 ft

n (Channel) = 0.045

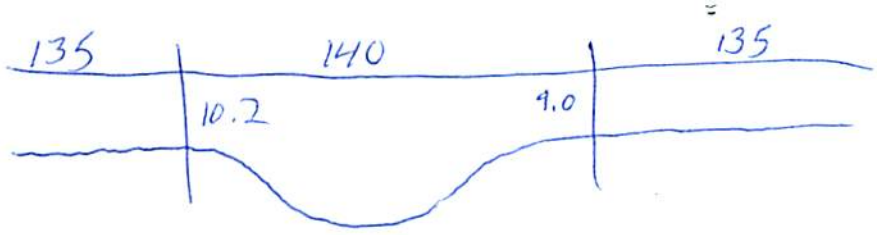
n (LOB) = 0.055

n (ROB) = 0.055

Pier Width = 2.75 ft

Pier Length = 2.75 ft

Piers for 500 yr = 2 ft



CONTRACTION SCOUR

PGRM: Contract

Width of main channel at approach section W_1 = 140 ft

Width of left overbank flow at approach, W_{lob} = 135 ft Average left overbank flow depth, y_{lob} = 10.2 ft

Width of right overbank flow at approach, W_{rob} = 135 ft Average right overbank flow depth, y_{rob} = 9.0 ft

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

x = 27.18 From Figure 9 W_2 (effective) = 90 ft y_{cs} = 21.6 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 = 0.4 Using pier width a on Figure 11, ξ = 10.1 Pier scour y_{ps} = 8.9 ft

PGRM: Abutment

ABUTMENT SCOUR CALCULATIONS

Average flow depth blocked by: left abutment, y_{aLT} = 10.2 ft right abutment, y_{aRT} = 9.0 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} = 21.5 and ψ_{RT} = 20.6

Left abutment scour, $y_{as} = \psi_{LT}(K_1/0.55)$ = 21.5 ft Right abutment scour $y_{as} = \psi_{RT}(K_1/0.55)$ = 20.6 ft

Route White Butte Rd Stream Lodgepole Clk MRM _____ Date 3/9/11 Initials CL

Bridge Structure No. 53248115 Location 17.2 mi NE of Bison on White Butte Rd

GPS coordinates: N 45° 43' 55.3" W 102° 22' 24.2" taken from: USL abutment X centerline of ⇑ MRM end _____

Datum of coordinates: WGS84 X NAD27 ____

Drainage area = 76.33 sq. mi.

The average bottom of the main channel was 19.5 ft below top of guardrail at a point 35 ft from left abutment.

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

Peak Flows calc'd on 8/8

Pk2	295
5	488
10	1540
25	2480
50	3380
100	4410
500	7390

MISCELLANEOUS CONSIDERATIONS

Flows	Q_{100} = 4410			Q_{500} = 7390		
Estimated flow passing through bridge	4410			7390		
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

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

Mature corn in flood plains → poor visibility → lots of estimating

Photos

1839 - ID
40 - US
41 - US RB
42 - US LB
43 - Scour/~~Fill~~ Erosion @ L. Abut.
44 - R. Abut
45 - L. Abut
46 - US Face of bridge

Summary of Results

	Q100	Q500
Bridge flow evaluated	4410	7390
Flow depth at left abutment (yaLT), in feet	8.5	10.2
Flow depth at right abutment (yaRT), in feet	7.3	9.0
Contraction scour depth (ycs), in feet	24.0	21.6
Pier scour depth (yps), in feet	8.7	8.8
Left abutment scour depth (yas), in feet	20.2	21.5
Right abutment scour depth (yas), in feet	14.1	20.6
1Flow angle of attack	10	10

See Comments/Diagram for justification where required