Lance Creek 0KRT

SCOUR ANALYSIS AND REPORTING FORM

Bridge Structure No. 59255358 Date 10/14/11 Initials CW Region (A B C D)

Site _____ Location ~1 mi NE of Wendte on Bad River Rd

Q_{100} = 33200 by: drainage area ratio ____ flood freq. anal. ____ regional regression eq. ✓

Bridge discharge (Q_2) = 33200 (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 = 200 ft. Flow angle at bridge = 4 ° Abut. Skew = 0 ° Effective Skew = 4 °

Width (W_2) iteration = 200 95 132 109 130 107 110 106 107

Avg. flow depth at bridge, y_2 iteration = 15.8 23.4 19.7 21.7 19.4 22.5 21.6 22.1 22

Corrected channel width at bridge Section = W_2 times cos of flow angle = 106.74 ft* $q_2 = Q_2/W_2$ = 311 ft^2/s

Bridge Vel, V_2 = 14.2 ft/s Final $y_2 = q_2/V_2$ = 22 ft Δh = 4.1 ft

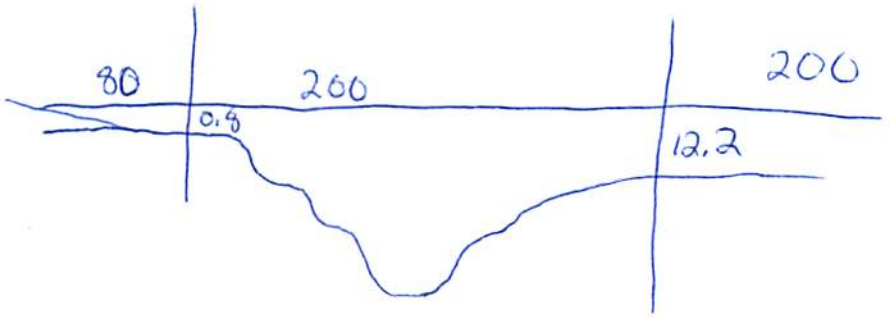
Average main channel depth at approach section, $y_1 = \Delta h + y_2$ = 26.1 ft

** 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,

2.6
1.6
1.6
5.8
41.8
5.8
35.5

Water Surface Elev. = ____ ft
Low Steel Elev. = 35.5 ft
n (Channel) = 0.040
n (LOB) = 0.033
n (ROB) = 0.035
Pier Width = 2.5 ft
Pier Length = 2.5 ft
Piers for 100 yr = 2 ft



123
19
142

CONTRACTION SCOUR

PGRM: Contract

Width of main channel at approach section W_1 = 200 ft

Width of left overbank flow at approach, W_{lob} = 80 ft Average left overbank flow depth, y_{lob} = ~~1.6~~ 6.7 ft ~~0.8~~ 7.1

Width of right overbank flow at approach, W_{rob} = 200 ft Average right overbank flow depth, y_{rob} = 12.2 ft

Given the difference in water surface between Q_{100} and Q_{500}, I believe the y_{lob} value has a math error. I think the value should be closer to 6.7

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

x = ~~41.79~~ 44.29 From Figure 9 W_2 (effective) = 101.7 ft y_{cs} = ~~29.4~~ 30.8 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

PIER SCOUR CALCULATIONS

PGRM: Pier

L/a ratio = 1.0 Correction factor for flow angle of attack (from Table 1), K2 = 1.0

Froude # at bridge = 0.53 Using pier width a on Figure 11, ξ = 9.5 Pier scour y_{ps} = 8.7 ft

ABUTMENT SCOUR CALCULATIONS

PGRM: Abutment

Average flow depth blocked by: left abutment, y_{aLT} = ~~0.86.7~~ ft right abutment, y_{aRT} = 12.2 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} = ~~3.5~~ 18.1 and ψ_{RT} = 23.2

Left abutment scour, $y_{as} = \psi_{LT}(K_1/0.55)$ = ~~3.5~~ 18.1 ft Right abutment scour $y_{as} = \psi_{RT}(K_1/0.55)$ = 23.2 ft

126
38
32

7.1
5.1

SCOUR ANALYSIS AND REPORTING FORM

Bridge Structure No. 59255358 Date 10/14/11 Initials CW Region (A (B) C D)

Site _____ Location ~1 mi NE of Wendte on Bad River Rd

Q_{500} = 78500 by: drainage area ratio____ flood freq. anal. ____ regional regression eq. ✓

Bridge discharge (Q_2) = 78500 (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 = 200 ft. Flow angle at bridge = 4 ° Abut. Skew = 0 ° Effective Skew = 4 °

Width (W_2) iteration = 200 166 175 171 169

Avg. flow depth at bridge, y_2 iteration = 24.9 27.4 26.7 27.0 27.2

Corrected channel width at bridge Section = W_2 times cos of flow angle = 168.59 ft* $q_2 = Q_2/W_2$ = 465.6 ft^2/s

Bridge Vel, V_2 = 17.1 ft/s Final $y_2 = q_2/V_2$ = 27.2 ft Δh = 6.1 ft

Average main channel depth at approach section, $y_1 = \Delta h + y_2$ = 33.2 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. = _____ ft

Low Steel Elev. = 35.5 ft

n (Channel) = 0.040

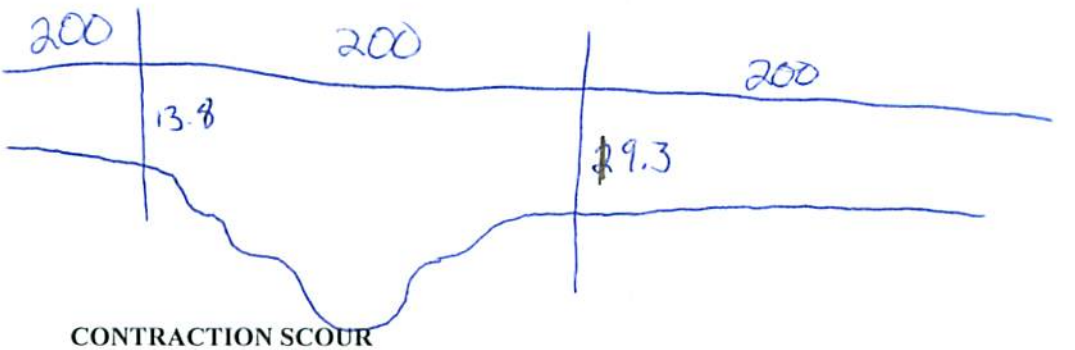
n (LOB) = 0.033

n (ROB) = 0.035

Pier Width = 2.5 ft

Pier Length = 2.5 ft

Piers for 500 yr = 2 ft



CONTRACTION SCOUR

PGRM: Contract

Width of main channel at approach section W_1 = 200 ft

Width of left overbank flow at approach, W_{lob} = 200 ft Average left overbank flow depth, y_{lob} = 13.8 ft

Width of right overbank flow at approach, W_{rob} = 200 ft Average right overbank flow depth, y_{rob} = 19.3 ft

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

x = ~~56.45~~ 37.56 From Figure 9 W_2 (effective) = 163.6 ft y_{cs} = ~~30.3~~ ~~29.4~~ 27.1 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, $V_1 = Q_{500}/(y_1W_1)$ = _____ 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 = 0.58 Using pier width a on Figure 11, ξ = 9.5 Pier scour y_{ps} = 8.8 ft

PGRM: Abutment

ABUTMENT SCOUR CALCULATIONS

Average flow depth blocked by: left abutment, y_{aLT} = 13.8 ft right abutment, y_{aRT} = ~~19.3~~ 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} = 24.5 and ψ_{RT} = ~~0.6~~ 29

Left abutment scour, $y_{as} = \psi_{LT}(K_1/0.55)$ = 24.5 ft Right abutment scour $y_{as} = \psi_{RT}(K_1/0.55)$ = ~~0.6~~ 29 ft

24.5 / 5.7 / 5.1 / 13.8

19.0 / 24.1 / 5.1 / 29.3

Route Bad River Rd Stream Lance Clk MRM _____ Date 10/14/11 Initials CW

Bridge Structure No. 59255358 Location ~1 mi NE of Wendte on Bad River Rd

GPS coordinates: N 44° 15' 29.6" W 100° 39' 23.8" taken from: USL abutment X centerline of ↑ MRM end _____

Datum of coordinates: WGS84 X NAD27 _____

Drainage area = 105.41 sq. mi.

The average bottom of the main channel was 11.3 ft below top of guardrail at a point 91 ft from left abutment.

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

MISCELLANEOUS CONSIDERATIONS

Flows	Q_{100} = 33200			Q_{500} = 78500		
Estimated flow passing through bridge		33200			78500	
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? 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 ____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 X	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

10/4/11

2	770
5	2990
10	6210
25	13300
50	21600
100	33200
500	78500

* Super windy! Had to fix tape several times from moving.

Photos

2117-1D
18-US
19-US RB
20-US LB
21-L. Abut
22-LB RipRap
23-R. Abut
24-erosion@ L. Abut
25-US Face

Summary of Results

	Q100	Q500
Bridge flow evaluated	33200	78500
Flow depth at left abutment (yaLT), in feet	~~0.8~~ 6.7	13.8
Flow depth at right abutment (yaRT), in feet	12.2	~~24.3~~ 19.3
Contraction scour depth (ycs), in feet	~~29.4~~ 30.8	~~29.4~~ ~~30.3~~ 27.1
Pier scour depth (yps), in feet	8.7	8.8
Left abutment scour depth (yas), in feet	~~3.5~~ 18.1	24.5
Right abutment scour depth (yas), in feet	23.2	~~0.5~~ 29
1Flow angle of attack	4°	4°

See Comments/Diagram for justification where required