West Firesteel Creek

SCOUR ANALYSIS AND REPORTING FORM

Bridge Structure No. 02223090 Date 10/7/11 Initials CW Region (A B C D)

Site _____ Location 4 mi S of Storla on 247 St

Q_{100} = 10700 by: drainage area ratio ____ flood freq. anal. ____ regional regression eq. ✓

Bridge discharge (Q_2) = 8247 (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 = 107 ft. Flow angle at bridge = 15 ° Abut. Skew = 0 ° Effective Skew = 15 °

Width (W_2) iteration = 107

Avg. flow depth at bridge, y_2 iteration = 14.3 > 12.6 → Bridge Full

Corrected channel width at bridge Section = W_2 times cos of flow angle = 103.35 ft* $q_2 = Q_2/W_2$ = 79.8 ft^2/s

Bridge Vel, V_2 = 6.3 ft/s Final $y_2 = q_2/V_2$ = 12.6 ft Δh = 0.6 ft

Average main channel depth at approach section, $y_1 = \Delta h + y_2$ = 13.4 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. = 12.6 ft

n (Channel) = 0.043

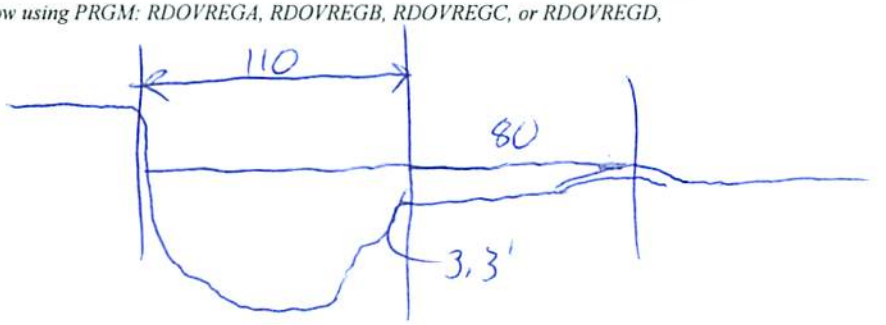
n (LOB) = 0.040

n (ROB) = 0.040

Pier Width = 1.1 ft

Pier Length = 1.1 ft

Piers for 100 yr = 2 ft



CONTRACTION SCOUR

PGRM: Contract

Width of main channel at approach section W_1 = 110 ft

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

Width of right overbank flow at approach, W_{rob} = 80 ft Average right overbank flow depth, y_{rob} = 2.2 ft

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

x = 1.73 From Figure 9 W_2 (effective) = 101.2 ft y_{cs} = 2.2 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, $V_1 = Q_{100}/(y_1 W_1)$ = ____ 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 = 0.31 Using pier width a on Figure 11, ξ = 5.2 Pier scour y_{ps} = 4.3 ft

ABUTMENT SCOUR CALCULATIONS

PGRM: Abutment

Average flow depth blocked by: left abutment, y_{aLT} = 0.0 ft right abutment, y_{aRT} = 2.2 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} = 0.0 and ψ_{RT} = 9.0

Left abutment scour, $y_{as} = \psi_{LT}(K_1/0.55)$ = 0.0 ft Right abutment scour $y_{as} = \psi_{RT}(K_1/0.55)$ = 9.0 ft

3.3 .66 1.46 1.46 1.46

2.3 .66 1.34 1.34 1.34

SCOUR ANALYSIS AND REPORTING FORM

Bridge Structure No. 02223090 Date 10/7/11 Initials CM Region (A B C D)

Site _____ Location 4 mi S of Starla on 247 St

Q50 ~~Q_{500}~~ = 7160 by: drainage area ratio ____ flood freq. anal. ____ regional regression eq. ✓

Bridge discharge (Q_2) = 7160 (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 = 107 ft. Flow angle at bridge = 15 ° Abut. Skew = 0 ° Effective Skew = 15 °

Width (W_2) iteration = 107 107 ____ ____

Avg. flow depth at bridge, y_2 iteration = 11.7 11.7 ____ ____

Corrected channel width at bridge Section = W_2 times cos of flow angle = 103.35 ft* $q_2 = Q_2/W_2$ = 69.3 ft²/s

Bridge Vel, V_2 = 5.9 ft/s Final $y_2 = q_2/V_2$ = 11.7 ft Δh = 0.7 ft

Average main channel depth at approach section, $y_1 = \Delta h + y_2$ = 12.4 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. = 12.6 ft

n (Channel) = 0.043

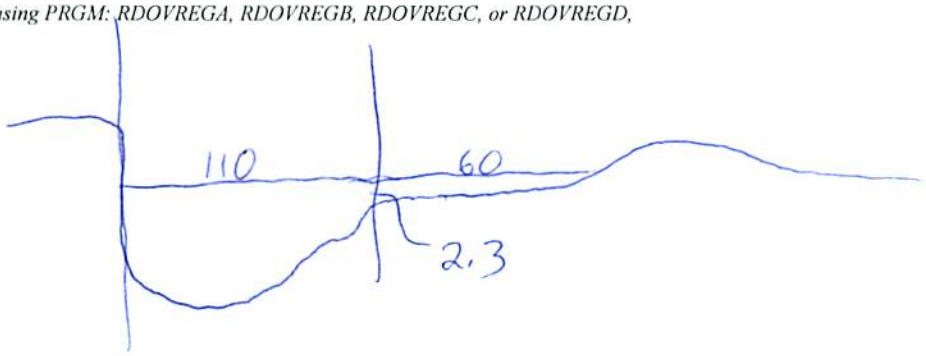
n (LOB) = 0.040

n (ROB) = 0.040

Pier Width = 1.1 ft

Pier Length = 1.1 ft

Piers for 500 yr = 2 ft



CONTRACTION SCOUR

PGRM: Contract

Width of main channel at approach section W_1 = 110 ft

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

Width of right overbank flow at approach, W_{rob} = 60 ft Average right overbank flow depth, y_{rob} = 1.5 ft

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

x = 1.32 From Figure 9 W_2 (effective) = 101.2 ft y_{cs} = 1.4 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, $V_1 = Q_{500}/(y_1 W_1)$ = ____ 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 = 5.2 Pier scour y_{ps} = 4.3 ft

PGRM: Abutment

ABUTMENT SCOUR CALCULATIONS

Average flow depth blocked by: left abutment, y_{aLT} = 0.0 ft right abutment, y_{aRT} = 1.5 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} = 0.0 and ψ_{RT} = 6.3

Left abutment scour, $y_{as} = \psi_{LT}(K_1/0.55)$ = 0.0 ft Right abutment scour $y_{as} = \psi_{RT}(K_1/0.55)$ = 6.3 ft

Route 247 St Stream West Firesteel Ck MRM _____ Date 10/7/11 Initials Cw
Bridge Structure No. 02223090 Location 4 mi S of Storla on 247 St
GPS coordinates: N 43° 48' 16.6" W 98° 21' 35.1" taken from: USL abutment X centerline of ⇑ MRM end _____
Datum of coordinates: WGS84 X NAD27 _____
Drainage area = 53.44 sq. mi.
The average bottom of the main channel was 17.0 ft below top of guardrail at a point 27 ft from left abutment.
Method used to determine flood flows: ____Freq. Anal. ____drainage area ratio ✓ regional regression equations.

MISCELLANEOUS CONSIDERATIONS

Flows	Q_{100} = 10700			~~Q_{500}~~ Q_{50} = 7160		
Estimated flow passing through bridge	8247			7160		
Estimated road overflow & overtopping	2553					
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 Looks like lots has been washed away
Evidence of past Scour? X Yes ____No ____Don't know At L. Abut.
Debris Potential? ____High ____Med X Low

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

Riprap	____Yes	____No	X 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 ____	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

10/3/11

2	217
5	999
10	2110
25	4520
50	7160
100	10700
500	23,000

Photos
2017 - 1D
18 - US
19 - US RB
20 - US LB
21 - L. Abut
22 - L. Abut
23 - R. Abut
24 - US Face
25 - LB App. XS
26 - RB App. XS
27 - Scour @ LB

Channel appears incised

Summary of Results

	Q100	~~Q500~~ 50
Bridge flow evaluated	8247	7160
Flow depth at left abutment (yaLT), in feet	0.0	0.0
Flow depth at right abutment (yaRT), in feet	2.2	1.5
Contraction scour depth (ycs), in feet	2.2	1.8
Pier scour depth (yps), in feet	4.3	4.3
Left abutment scour depth (yas), in feet	0.0	0.0
Right abutment scour depth (yas), in feet	9.0	6.3
1Flow angle of attack	15	15

See Comments/Diagram for justification where required