ok RT

SCOUR ANALYSIS AND REPORTING FORM

Bridge Structure No. 50241080 Date 6/25/17 Initials RAT Region (A B C D)

Site _____ Location 1 mi W of EROS on 252 St

Q_{100} = 2150 by: drainage area ratio____ flood freq. anal. ____ regional regression eq. x

Bridge discharge (Q_2) = 2150 (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 = 121 ft. Flow angle at bridge = 0 ° Abut. Skew = 0 ° Effective Skew = C °

Width (W_2) iteration = 121 77 83 ~~84~~ 82

Avg. flow depth at bridge, y_2 iteration = 6 7.5 7.2 7.2

Corrected channel width at bridge Section = W_2 times cos of flow angle = 82 ft* $q_2 = Q_2/W_2$ = 26.2 ft^2/s

Bridge Vel, V_2 = 3.6 ft/s Final $y_2 = q_2/V_2$ = 7.2 ft Δh = 0.3 ft

Average main channel depth at approach section, $y_1 = \Delta h + y_2$ = 7.5 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 -3.9 ft

Low Steel Elev. = 18.6 ft ~~22.5~~ 22.5

n (Channel) = 0.033

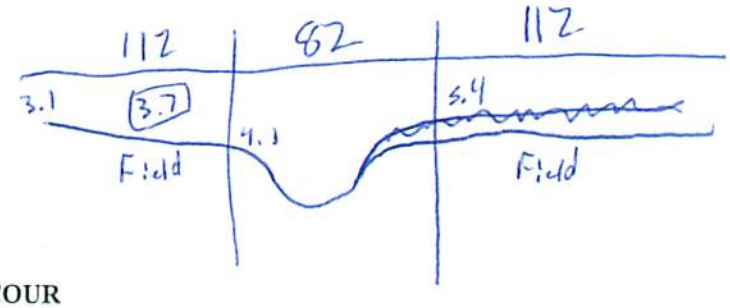
n (LOB) = 0.030

n (ROB) = 0.030

Pier Width = ~~2.3~~ 2.3 ft 7.2/π

Pier Length = 2.3 ft

Piers for 100 yr = 2 ft



CONTRACTION SCOUR

PGRM: Contract

Width of main channel at approach section W_1 = 95 ft

Width of left overbank flow at approach, W_{lob} = 112 ft Average left overbank flow depth, y_{lob} = 3.7 ft

Width of right overbank flow at approach, W_{rob} = 112 ft Average right overbank flow depth, y_{rob} = 5.4 ft

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

x = ~~12.51~~ 12.29 From Figure 9 W_2 (effective) = 77.4 ft y_{cs} = ~~13.6~~ 13.4 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, $\chi = 0.122 y_1 [q_2^2/(D_{50}^{1/3} y_1^{7/6})]^{6/7} - y_1$ = _____ From Figure 10, y_{cs} = _____ ft

PGRM: Pier

PIER SCOUR CALCULATIONS

L/a ratio = 1

Froude # at bridge = 0.24

Correction factor for flow angle of attack (from Table 1), K2 = 1

Using pier width a on Figure 11, ξ = 8.9 Pier scour y_{ps} = 7.2 ft

PGRM: Abutment

ABUTMENT SCOUR CALCULATIONS

Average flow depth blocked by: left abutment, y_{aLT} = 3.7 ft right abutment, y_{aRT} = 5.4 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} = 12.7 and ψ_{RT} = 15.7

Left abutment scour, $y_{as} = \psi_{LT}(K_1/0.55)$ = 12.7 ft Right abutment scour $y_{as} = \psi_{RT}(K_1/0.55)$ = 15.7 ft

SCOUR ANALYSIS AND REPORTING FORM

Bridge Structure No. 50241080 Date 6/25/12 Initials RAT Region (A B (C) D)

Site _____ Location 1 mi W of EROS on 252St

Q_{500} = 3230 by: drainage area ratio ____ flood freq. anal. ____ regional regression eq. X

Bridge discharge (Q_2) = 3230 (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 = 121 ft. Flow angle at bridge = 0 ° Abut. Skew = 0 ° Effective Skew = 0 °

Width (W_2) iteration = 121 82 90 87

Avg. flow depth at bridge, y_2 iteration = 7.3 8.9 8.5 6.6

Corrected channel width at bridge Section = W_2 times cos of flow angle = 87 ft* $q_2 = Q_2/W_2$ = 37.1 ft^2/s

Bridge Vel, V_2 = 4.3 ft/s Final $y_2 = q_2/V_2$ = 8.6 ft Δh = 0.4 ft

Average main channel depth at approach section, $y_1 = \Delta h + y_2$ = 9 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. = 0-3.9 ft

Low Steel Elev. = 18.6 ft

n (Channel) = 0.033

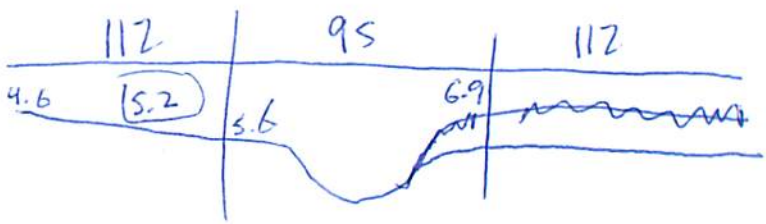
n (LOB) = 0.030

n (ROB) = 0.030

Pier Width = 2.3 ft

Pier Length = 2.3 ft

Piers for 500 yr = 2 ft



CONTRACTION SCOUR

PGRM: Contract

Width of main channel at approach section W_1 = 95 ft

Width of left overbank flow at approach, W_{lob} = 112 ft Average left overbank flow depth, y_{lob} = 5.2 ft

Width of right overbank flow at approach, W_{rob} = 112 ft Average right overbank flow depth, y_{rob} = 6.9 ft

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

x = 15.41 From Figure 9 W_2 (effective) = 82.4 ft y_{cs} = 15.2 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, $Vc = 11.17 y_1^{1/6} D_{50}^{1/3}$ = _____ 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 Correction factor for flow angle of attack (from Table 1), K2 = 1

Froude # at bridge = 0.26 Using pier width a on Figure 11, ξ = 6.9 Pier scour y_{ps} = ~~7.9~~ 7.3 ft

ABUTMENT SCOUR CALCULATIONS

PGRM: Abutment

Average flow depth blocked by: left abutment, y_{aLT} = 5.2 ft right abutment, y_{aRT} = 6.9 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} = 15.4 and ψ_{RT} = 18.4

Left abutment scour, $y_{as} = \psi_{LT}(K_1/0.55)$ = 15.4 ft Right abutment scour $y_{as} = \psi_{RT}(K_1/0.55)$ = 18.4 ft

96° 38' 48.408"
43° 43' 56.1"

96.64678
43.73225

Route 252 St Stream Slip Up Ck MRM _____ Date 6/25/12 Initials RaT

Bridge Structure No. 50241080 Location 1 mi W of EROS on 252 St

GPS coordinates: N 43° 43' 56.31" taken from: USL abutment X centerline of ↑↓ MRM end _____

W 96° 36' 48.51" Datum of coordinates: WGS84 X NAD27 _____

Drainage area = 8.52 sq. mi.

The average bottom of the main channel was 22.5 ft below top of guardrail at a point 83 ft from left abutment.

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

6/15
~~8/25~~

MISCELLANEOUS CONSIDERATIONS

Flows	Q_{100} = 2150			Q_{500} = 3230		
Estimated flow passing through bridge	2150			3230		
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	

2	231
5	571
10	874
25	1330
50	1720
100	2150
500	3230

Riprap at abutments? ____Yes ____No X Marginal - only on left abutment

Evidence of past Scour? X Yes ____No ____Don't know - contraction

Debris Potential? ____High ____Med X Low

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

Riprap X Yes ____No ____Don't know ____NA - rose quartz on left abutment

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). left OB
2). main channel
3). right OB.
4). pier
5-6). left abutment
7-8). right abutment
9). main channel

Summary of Results

	Q100	Q500
Bridge flow evaluated	2150	3230
Flow depth at left abutment (yaLT), in feet	3.7	5.2
Flow depth at right abutment (yaRT), in feet	5.4	6.9
Contraction scour depth (ycs), in feet	~~13.6~~ 13.4	15.2
Pier scour depth (yps), in feet	7.2	~~7.9~~ 7.3
Left abutment scour depth (yas), in feet	12.7	15.4
Right abutment scour depth (yas), in feet	15.7	18.4
1Flow angle of attack	0	0

See Comments/Diagram for justification where required