OK RJ

SCOUR ANALYSIS AND REPORTING FORM

Bridge Structure No. 51177030 Date 7/26/12 Initials KAT Region (A B [✓ C] D)

Site ______ Location 3.7 mi W of Ward on 223 St

Q_{100} = 3890 by: drainage area ratio____ flood freq. anal. ____ regional regression eq. X

Bridge discharge (Q_2) = 3890 (should be Q_{100} unless there is a relief bridge, road overflow, or bridge overtopping)

PGRM: "RegionA", "RegionB", "RegionC", or "RegionD"

Analytical Procedure for Estimating Hydraulic Variables Needed to Apply Method

Bridge Width = 119 ft. Flow angle at bridge = 15 ° Abut. Skew = 0 ° Effective Skew = 15 °

Width (W_2) iteration = 119 110 111 ____

Avg. flow depth at bridge, y_2 iteration = 8.2 8.5 8.5 ____

Corrected channel width at bridge Section = W_2 times cos of flow angle = 107.22 ft* $q_2 = Q_2/W_2$ = 36.3 ft^2/s 1.8

Bridge Vel, V_2 = 4.3 ft/s Final $y_2 = q_2/V_2$ = 8.5 ft Δh = 0.4 ft

Average main channel depth at approach section, $y_1 = \Delta h + y_2$ = 8.9 ft 5.6

3.5

** NOTE: repeat above calculations until y_2 changes by less than 0.2* *Effective pier width = L sin(q) + a cos(q)* 5.4 3.6

If y_2 is above LS, then account for Road Overflow using PRGM: RDOVREGA, RDOVREGB, RDOVREGC, or RDOVREGD, 15 1.5

Water Surface Elev. = 1.5 ft 18.5

Low Steel Elev. = 14.7 ft 3.8

14.7

n (Channel) = 0.048

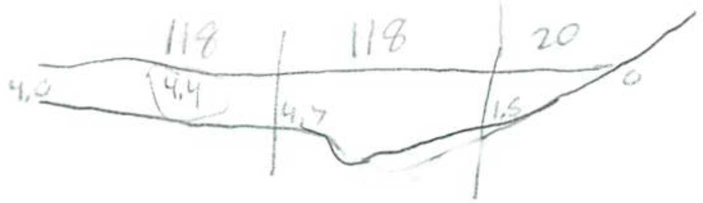
n (LOB) = 0.030

n (ROB) = 0.030

Pier Width = 1.7 ft

Pier Length = 1.7 ft

\# Piers for 100 yr = 4 ft



CONTRACTION SCOUR

PGRM: Contract

4.7 4.0

Width of main channel at approach section W_1 = 118 ft

Width of left overbank flow at approach, W_{lob} = 118 ft Average left overbank flow depth, y_{lob} = 4.4 ft

Width of right overbank flow at approach, W_{rob} = 20 ft Average right overbank flow depth, y_{rob} = 0.8 ft

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

x = 6.78 From Figure 9 W_2 (effective) = 100.4 ft y_{cs} = 7.6 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, $V_1 = Q_{100}/(y_1W_1)$ = ______ 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

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 = 7 Pier scour y_{ps} = 5.8 ft

ABUTMENT SCOUR CALCULATIONS

PGRM: Abutment

Average flow depth blocked by: left abutment, y_{aLT} = 4.4 ft right abutment, y_{aRT} = 0.8 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} = 14 and ψ_{RT} = 3.5

Left abutment scour, $y_{as} = \psi_{LT}(K_1/0.55)$ = 14 ft Right abutment scour $y_{as} = \psi_{RT}(K_1/0.55)$ = 3.5 ft

SCOUR ANALYSIS AND REPORTING FORM

Bridge Structure No. 51177030 Date 7/26/12 Initials RaT Region (A B [✓ C] D)

Site ______ Location 3.7 mi W of Ward on 223 St

Q_{500} = 5990 by: drainage area ratio ____ flood freq. anal. ____ regional regression eq. X

Bridge discharge (Q_2) = 5990 (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 = 118 ft. Flow angle at bridge = 15 ° Abut. Skew = 0 ° Effective Skew = 15 °

Width (W_2) iteration = 118 114 ______ ______

Avg. flow depth at bridge, y_2 iteration = 10.2 10.4 ______ ______

Corrected channel width at bridge Section = W_2 times cos of flow angle = 110.12 ft* $q_2 = Q_2/W_2$ = 54.11 ft²/s

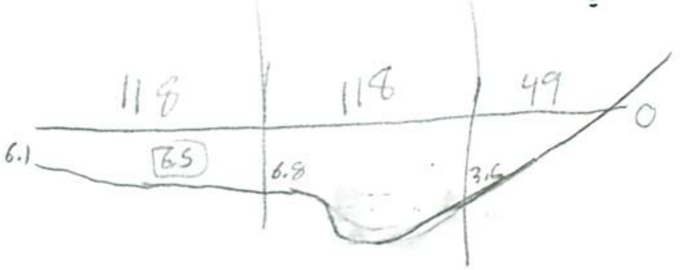
Bridge Vel, V_2 = 5.2 ft/s Final $y_2 = q_2/V_2$ = 10.4 ft Δh = 0.6 ft

Average main channel depth at approach section, $y_1 = \Delta h + y_2$ = 11 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. = 1.5 ft
Low Steel Elev. = 14.7 ft
n (Channel) = 0.048
n (LOB) = 0.030
n (ROB) = 0.030
Pier Width = 1.7 ft
Pier Length = 1.7 ft
Piers for 500 yr = 4 ft



CONTRACTION SCOUR

PGRM: Contract

Width of main channel at approach section W_1 = 118 ft

Width of left overbank flow at approach, W_{lob} = 118 ft Average left overbank flow depth, y_{lob} = 6.5 ft

Width of right overbank flow at approach, W_{rob} = 49 ft Average right overbank flow depth, y_{rob} = 1.8 ft

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

x = 10.34 From Figure 9 W_2 (effective) = 103.3 ft y_{cs} = 11.3 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: Pie

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

Froude # at bridge = 0.28 Using pier width a on Figure 11, ξ = 7 Pier scour y_{ps} = 5.8 ft

ABUTMENT SCOUR CALCULATIONS

PGRM: Abutment

Average flow depth blocked by: left abutment, y_{aLT} = 6.5 ft right abutment, y_{aRT} = 1.8 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} = 17.7 and ψ_{RT} = 7.4

Left abutment scour, $y_{as} = \psi_{LT}(K_1/0.55)$ = 17.7 ft Right abutment scour $y_{as} = \psi_{RT}(K_1/0.55)$ = 7.4 ft

Route 223 St Stream Spring Ck MRM ______ Date 7/26/12 Initials FaT
Bridge Structure No. 51177030 Location 3.7 mi W of Ward on 223 St
GPS coordinates: N 44° 09' 16.9" W 96° 32' 11.5" taken from: USL abutment _X_ centerline of ⇑ MRM end ______
Datum of coordinates: WGS84 _X_ NAD27 ______

Drainage area = 36.09 sq. mi.
The average bottom of the main channel was 18.5 ft below top of guardrail at a point 68 ft from left abutment.
Method used to determine flood flows: ___Freq. Anal. ___drainage area ratio _X_ regional regression equations.

MISCELLANEOUS CONSIDERATIONS

Flows	Q_{100} =	3890		Q_{500} =	5990	
Estimated flow passing through bridge		3890			5990	
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	

6/29
~~8/25~~

2	390
5	984
10	1520
25	2360
50	3090
100	3890
500	5990

Riprap at abutments? ___Yes _X_ No ___Marginal
Evidence of past Scour? _X_ Yes ___No ___Don't know
Debris Potential? ___High ___Med _X_ Low

heavy abutment
some pier/contraction

Does scour countermeasure(s) appear to have been designed?
Riprap ___Yes _X_ No ___Don't know ___NA
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). right abutment
7). pier scour
8-10). left abutment
11). main channel

Summary of Results

	Q100	Q500
Bridge flow evaluated	3890	5990
Flow depth at left abutment (yaLT), in feet	4.4	6.5
Flow depth at right abutment (yaRT), in feet	0.8	1.5
Contraction scour depth (ycs), in feet	2.6 7.6	11.3
Pier scour depth (yps), in feet	5.8	5.8
Left abutment scour depth (yas), in feet	14.0	17.7
Right abutment scour depth (yas), in feet	3.5	7.4
1Flow angle of attack	15	15

See Comments/Diagram for justification where required