OK RAT

SCOUR ANALYSIS AND REPORTING FORM

Bridge Structure No. 06240070 Date 7/25/12 Initials RAT Region (A B (C) D)

Site ________ Location 0.3 mi. N of White on 478 Ave

Q_{100} = 2660 by: drainage area ratio ____ flood freq. anal. ____ regional regression eq. X

Bridge discharge (Q_2) = 2660 (should be Q_{100} unless there is a relief bridge, road overflow, or bridge overtopping)

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Analytical Procedure for Estimating Hydraulic Variables Needed to Apply Method

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

Bridge Width = 120 ft. 120 Flow angle at bridge = 50 ° Abut. Skew = 0 ° Effective Skew = 50 °

Width (W_2) iteration = 77.13 109 70.06 109 109

Avg. flow depth at bridge, y_2 iteration = 8.3 8.7 8.7 ____

Corrected channel width at bridge Section = W_2 times cos of flow angle = 70.06 ft* $q_2 = Q_2/W_2$ = 38 ft^2/s

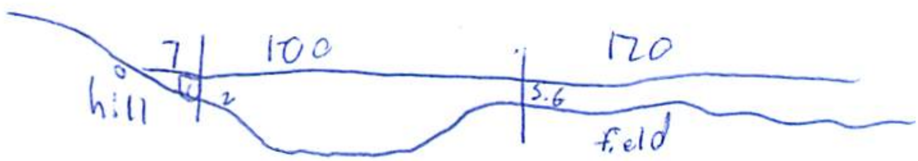
Bridge Vel, V_2 = 4.4 ft/s Final $y_2 = q_2/V_2$ = 8.7 ft Δh = 0.4 ft

Average main channel depth at approach section, $y_1 = \Delta h + y_2$ = 9.1 ft

** NOTE: repeat above calculations until y_2 changes by less than 0.2* *Effective pier width = L sin(q) + a cos(q)* 5.4 / 1.8

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

Water Surface Elev. = 07.5 ft
Low Steel Elev. = 11.1 ft
n (Channel) = 0.045
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

Width of main channel at approach section W_1 = 100 ft

Width of left overbank flow at approach, W_{lob} = 7 ft Average left overbank flow depth, y_{lob} = 1 ft

Width of right overbank flow at approach, W_{rob} = 120 ft Average right overbank flow depth, y_{rob} = 5.6 ft

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

x = 16.85 From Figure 9 W_2 (effective) = 63.3 ft y_{cs} = 16 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 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} = 5.5 ft

ABUTMENT SCOUR CALCULATIONS

PGRM: Abutment

Average flow depth blocked by: left abutment, y_{aLT} = 1 ft right abutment, y_{aRT} = 5.6 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} = 4.3 and ψ_{RT} = 16.1

Left abutment scour, $y_{as} = \psi_{LT}(K_1/0.55)$ = 4.3 ft Right abutment scour $y_{as} = \psi_{RT}(K_1/0.55)$ = 16.1 ft

SCOUR ANALYSIS AND REPORTING FORM

Bridge Structure No. 06240070 Date 7/25/12 Initials RAL Region (A B (C) D)

Site ______ Location 0.3 mi N of White on 478 Ave

Q_{500} = 4130 by: drainage area ratio ____ flood freq. anal. ____ regional regression eq. X

Bridge discharge (Q_2) = 4130 (should be Q_{500} 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 = 120 ft. Flow angle at bridge = 50 ° Abut. Skew = 0 ° Effective Skew = 50 °

Width (W_2) iteration = ______ ______ ______ ______

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

Corrected channel width at bridge Section = W_2 times cos of flow angle = 77.13 ft* $q_2 = Q_2/W_2$ = 53.5 ft^2/s

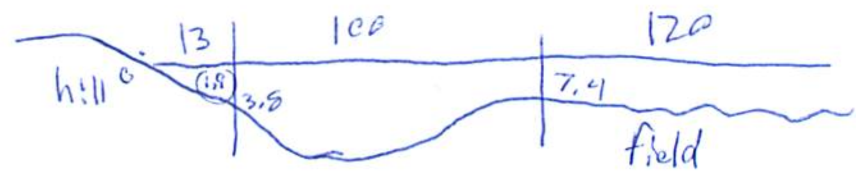
Bridge Vel, V_2 = 5.2 ft/s Final $y_2 = q_2/V_2$ = 10.3 ft Δh = 0.5 ft

Average main channel depth at approach section, $y_1 = \Delta h + y_2$ = 10.9 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. = 0-1.5 ft
Low Steel Elev. = 11.1 ft
n (Channel) = 0.045
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 = 100 ft

Width of left overbank flow at approach, W_{lob} = 13 ft Average left overbank flow depth, y_{lob} = 1.9 ft

Width of right overbank flow at approach, W_{rob} = 120 ft Average right overbank flow depth, y_{rob} = 7.4 ft

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

x = 19.39 From Figure 9 W_2 (effective) = 70.3 ft y_{cs} = 17.4 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, $V_1 = Q_{500}/(y_1W_1)$ = ______ 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 = 0.29 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} = 1.9 ft right abutment, y_{aRT} = 7.4 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} = 7.8 and ψ_{RT} = 19.3

Left abutment scour, $y_{as} = \psi_{LT}(K_1/0.55)$ = 7.8 ft Right abutment scour $y_{as} = \psi_{RT}(K_1/0.55)$ = 19.3 ft

$44° 26' 29''.436$
$96° 38' 46''.14$

96.64613
44.44151

Route 478 Ave Stream Six Mile Ck MRM ______ Date 7/25/12 Initials [illegible]

Bridge Structure No. 06240070 Location 0.3 mi N of White on 478 Ave

GPS coordinates: N 44° 26' 28.2'' taken from: USL abutment X centerline of ⇑ MRM end ______

W 96° 38' 46.2'' Datum of coordinates: WGS84 X NAD27 ____

Drainage area = 21.82 sq. mi.

The average bottom of the main channel was 15.3 ft below top of guardrail at a point 81 ft from left abutment.

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

7/3 8/22	
2	243
5	639 ~~638~~
10	1010
25	1590
50	2100
100	2660
500	4140 4130

MISCELLANEOUS CONSIDERATIONS

Flows	Q_{100} = 2660			Q_{500} = 4130		
Estimated flow passing through bridge	2660			4130		
Estimated road overflow & overtopping	0			0		
Consideration	Yes	No	Possibly	Yes	No	Possibly
Chance of overtopping		X			~~X~~	X
Chance of Pressure flow		X			~~X~~	X
Armored appearance to channel		X			X	
Lateral instability of channel		X			X	

(Possibly →) due to left abutment... much of the bridge is only ~110 ft wide.

Riprap at abutments? ____Yes X No ____Marginal

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

Debris Potential? ____High ____Med X Low

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 #2 left abutments ____Yes ____No X 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). right abutment
5). pier
6). right abutment
7-8). left abutment
9). main channel

Note: The ~~old~~ abutment from the previous bridge is still in the channel. Using K_1 = 0.55 for abutment scour as I believe this should protect the actual abutment. The old abutment will have vertical wall scour. The ~~old~~ old right abutment appears to be there as well, just a bit broken and still due to the flow angle, still buried with dirt.

Summary of Results

	Q100	Q500
Bridge flow evaluated	2660	4130
Flow depth at left abutment (yaLT), in feet	1	1.9
Flow depth at right abutment (yaRT), in feet	5.6	7.4
Contraction scour depth (ycs), in feet	16.0	17.4
Pier scour depth (yps), in feet	5.8	5.8
Left abutment scour depth (yas), in feet	4.3	7.8
Right abutment scour depth (yas), in feet	~~16.0~~ 16.1	19.3
1Flow angle of attack	50	50

See Comments/Diagram for justification where required