ok RT

SCOUR ANALYSIS AND REPORTING FORM

Bridge Structure No. 15190063 Date 8/2/12 Initials [illegible] Region (A B C D) (C circled)

Site ______ Location 9.7 mi N of Watertown on 455 Ave

Q_{100} = 1070 by: drainage area ratio____ flood freq. anal. ____ regional regression eq. X

Bridge discharge (Q_2) = 1070 (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 = 85 ft. Flow angle at bridge = 30 ° Abut. Skew = 0 ° Effective Skew = 30 °

Width (W_2) iteration = 85 68 69 ____

Avg. flow depth at bridge, y_2 iteration = 5.4 6.0 ____ ____

Corrected channel width at bridge Section = W_2 times cos of flow angle = 59.76 ft* $q_2 = Q_2/W_2$ = 17.9 ft^2/s

Bridge Vel, V_2 = 3 ft/s Final $y_2 = q_2/V_2$ = 6 ft Δh = 0.2 ft

Average main channel depth at approach section, $y_1 = \Delta h + y_2$ = 6.2 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. = 3.2 ft 16 / 17.2 / 6.5 / 10.7
Low Steel Elev. = 10.7 ft
n (Channel) = 0.045
n (LOB) = 0.035
n (ROB) = 0.070
Pier Width = 2.35 ft
Pier Length = 2.25 ft
Piers for 100 yr = 2 ft

9+0.7 / 3.9 / 6ft 6.8 / 5.9

CONTRACTION SCOUR

PGRM: Contract

Width of main channel at approach section W_1 = 65 ft

Width of left overbank flow at approach, W_{lob} = 0 ft Average left overbank flow depth, y_{lob} = 0 ft

Width of right overbank flow at approach, W_{rob} = 1 ft Average right overbank flow depth, y_{rob} = 0.1 ft

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

x = 3.37 From Figure 9 W_2 (effective) = 55.1 ft y_{cs} = 4 ft

PGRM: CWCSNEW

Clear Water Contraction Scour (use if bed material is larger than small cobbles) (crossed out)

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 = 0.96 Correction factor for flow angle of attack (from Table 1), K2 = 1

Froude # at bridge = 0.22 Using pier width a on Figure 11, ξ = 9.1 Pier scour y_{ps} = 7.2 ft

ABUTMENT SCOUR CALCULATIONS

PGRM: Abutment

K_1 = 0.55

Average flow depth blocked by: left abutment, y_{aLT} = 0 (K_1 = 1) ft right abutment, y_{aRT} = 0.1 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 and ψ_{RT} = 0.5

Left abutment scour, $y_{as} = \psi_{LT}(K_1/0.55)$ = 0 ft Right abutment scour $y_{as} = \psi_{RT}(K_1/0.55)$ = 0.5 ft

SCOUR ANALYSIS AND REPORTING FORM

Bridge Structure No. 15190063 Date 8/2/12 Initials Ral Region (A B (C) D)

Site ________ Location 9.7 mi N of Watertown on 455 Ave

Q_{500} = 1700 by: drainage area ratio____ flood freq. anal. ____ regional regression eq. X

Bridge discharge (Q_2) = 1700 (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 = 85 ft. Flow angle at bridge = 30 ° Abut. Skew = 0 ° Effective Skew = 30 °

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 = 73.61 ft* $q_2 = Q_2/W_2$ = 23.1 ft^2/s

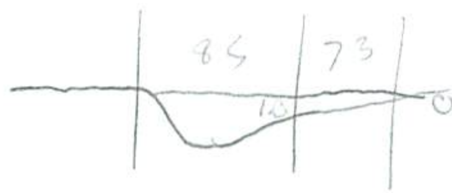
Bridge Vel, V_2 = 3.4 ft/s Final $y_2 = q_2/V_2$ = 6.8 ft Δh = 0.2 ft

Average main channel depth at approach section, $y_1 = \Delta h + y_2$ = 7 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. = 32 ft
Low Steel Elev. = 10.7 ft
n (Channel) = 0.048
n (LOB) = 0.035
n (ROB) = 0.070
Pier Width = 2.35 ft
Pier Length = 2.25 ft
Piers for 500 yr = 2 ft



CONTRACTION SCOUR

PGRM: Contract

Width of main channel at approach section W_1 = 85 ft

Width of left overbank flow at approach, W_{lob} = 0 ft Average left overbank flow depth, y_{lob} = 0 ft

Width of right overbank flow at approach, W_{rob} = 73 ft Average right overbank flow depth, y_{rob} = 0.6 ft

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

x = 1.72 From Figure 9 W_2 (effective) = 68.9 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, $V_1 = Q_{500}/(y_1W_1)$ = ________ 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: Pie

L/a ratio = 0.96 Correction factor for flow angle of attack (from Table 1), K2 = 1

Froude # at bridge = 0.23 Using pier width a on Figure 11, ξ = 9.1 Pier scour y_{ps} = 7.3 ft

ABUTMENT SCOUR CALCULATIONS

PGRM: Abutment

K_1 = 0.55

Average flow depth blocked by: left abutment, y_{aLT} = 0 (K_1 = 1) ft right abutment, y_{aRT} = 0.6 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} = 0 and ψ_{RT} = 2.7

Left abutment scour, $y_{as} = \psi_{LT}(K_1/0.55)$ = 0 ft Right abutment scour $y_{as} = \psi_{RT}(K_1/0.55)$ = 2.7 ft

45° 3' 36.576"
97° 6' 23.76"

97.1066
45.06016

Route 455 Ave Stream Mahoney Ck MRM________ Date 8/2/12 Initials RaT

Bridge Structure No. 15190063 Location 9.7 mi N of Watertown on 455 Ave

GPS coordinates: N 45° 3' 35.9" W 97° 6' 23.5" taken from: USL abutment X centerline of ⇑ MRM end ______

Datum of coordinates: WGS84 X NAD27_____

Drainage area = 12.5 sq. mi.

The average bottom of the main channel was 17.2 ft below top of guardrail at a point 53 ft from left abutment.

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

	8/23
2	82.4
5	234
10	382
25	623
50	836
100	1070
500	1700

MISCELLANEOUS CONSIDERATIONS

Flows	Q_{100} =	1070		Q_{500} =	1700	
Estimated flow passing through bridge		1070			1700	
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	

Riprap at abutments? _____Yes _____No X Marginal - Sand/gravel on right abutment. Broken asphalt on outside of left

Evidence of past Scour? X Yes _____No _____Don't know Right amount of pier/contraction abutment, left abutment exposed except for previous abutment still in the channel

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 ____________	____Yes	____No	X Don't know	____NA

- old abutment infront of left abutment

Bed Material Classification Based on Median Particle Size (D_{50})

Material	Silt/Clay X	Sand____	Gravel X	Cobbles____	Boulders____
Size range, in mm	<0.062	0.062-2.00	2.00-64	64-250	>250

lots of gravel from ~~left~~ right abutment, likely silty in the middle but water level too deep to safely check

Comments, Diagrams & orientation of digital photos

1). left CB
2). main channel
3). right CB
4). pier
5-9). right abutment
10). pier scour
11-15). ~~right~~ left abutment
16). main channel

Note: previous high water mark matches Q500. bridge date 1940 - possibly because of heavy scour.

Summary of Results

	Q100	Q500
Bridge flow evaluated	1070	1700
Flow depth at left abutment (yaLT), in feet	0	0
Flow depth at right abutment (yaRT), in feet	0.1	0.6
Contraction scour depth (ycs), in feet	4	2.2
Pier scour depth (yps), in feet	7.2	7.3
Left abutment scour depth (yas), in feet	0	0
Right abutment scour depth (yas), in feet	0.5	2.7
1Flow angle of attack	30	30

See Comments/Diagram for justification where required