OK RT

SCOUR ANALYSIS AND REPORTING FORM

Bridge Structure No. 50072100 Date 8/26/12 Initials RnJ Region (A B (C) D)

Site ______ Location 5 mi N + 1.8 mi W of Hartford on 254 St

Q_{100} = Q_{50} 3780 by: drainage area ratio ____ flood freq. anal. ____ regional regression eq. X

Bridge discharge (Q_2) = 3780 (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 = 93 ft. Flow angle at bridge = 0 ° Abut. Skew = 0 ° Effective Skew = 0 °

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 = 93 ft* $q_2 = Q_2/W_2$ = 40.6 ft^2/s

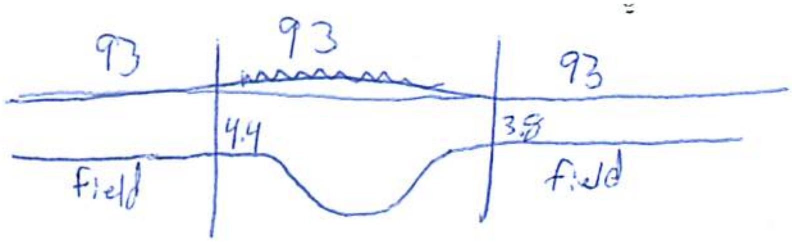
Bridge Vel, V_2 = 4.5 ft/s Final $y_2 = q_2/V_2$ = 9 ft Δh = 0.4 ft

Average main channel depth at approach section, $y_1 = \Delta h + y_2$ = 9.4 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. = 0-0.5 ft
Low Steel Elev. = 9.1 ft
n (Channel) = 0.033
n (LOB) = 0.030
n (ROB) = 0.030
Pier Width = 2 ft
Pier Length = 2 ft
\# Piers for 100 yr = 2 ft



CONTRACTION SCOUR

PGRM: Contract

Width of main channel at approach section W_1 = 93 ft

Width of left overbank flow at approach, W_{lob} = 93 ft Average left overbank flow depth, y_{lob} = 4.4 ft

Width of right overbank flow at approach, W_{rob} = 93 ft Average right overbank flow depth, y_{rob} = 3.8 ft

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

x = 5.86 From Figure 9 W_2 (effective) = 89 ft y_{cs} = 6.6 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, $V_1 = Q_{100}/(y_1 W_1)$ = ____ ft/s

Critical approach velocity, $V_c = 11.17 y_1^{1/6} D_{50}^{1/3}$ = ____ 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 = 8 Pier scour y_{ps} = 6.5 ft

ABUTMENT SCOUR CALCULATIONS

PGRM: Abutment

Average flow depth blocked by: left abutment, y_{aLT} = 4.4 ft right abutment, y_{aRT} = 3.8 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} = 12.9

Left abutment scour, $y_{as} = \psi_{LT}(K_1/0.55)$ = 14 ft Right abutment scour $y_{as} = \psi_{RT}(K_1/0.55)$ = 12.9 ft

SCOUR ANALYSIS AND REPORTING FORM

Bridge Structure No. 50072100 Date 6/26/12 Initials RAJ Region (A B (C) D)

Site ______________ Location 5 mi N + 1.8 mi W of Hartford on 254 St

Q_{500} = Q100 4770 by: drainage area ratio_____ flood freq. anal. _____ regional regression eq. X

Bridge discharge (Q_2) = 3867 (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 = 93 ft. Flow angle at bridge = 0 ° Abut. Skew = 0 ° Effective Skew = 0 °

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 = 93 ft* $q_2 = Q_2/W_2$ = 41.6 ft^2/s

Bridge Vel, V_2 = 4.6 ft/s Final $y_2 = q_2/V_2$ = 9.1 ft Δh = 0.4 ft

Average main channel depth at approach section, $y_1 = \Delta h + y_2$ = 9.5 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. = 00.4 ft

Low Steel Elev. = 9.1 ft

n (Channel) = 0.033

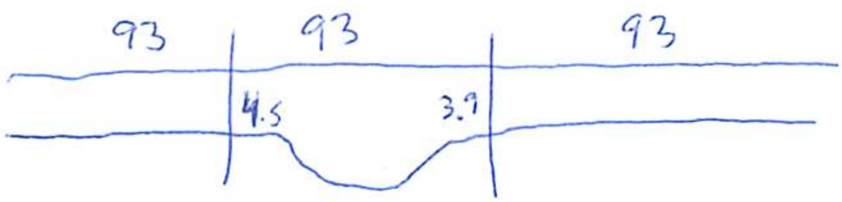
n (LOB) = 0.030

n (ROB) = 0.030

Pier Width = 2 ft

Pier Length = 2 ft

\# Piers for 500 yr = 2 ft



CONTRACTION SCOUR

PGRM: Contract

Width of main channel at approach section W_1 = 93 ft

Width of left overbank flow at approach, W_{lob} = 93 ft Average left overbank flow depth, y_{lob} = 4.5 ft

Width of right overbank flow at approach, W_{rob} = 93 ft Average right overbank flow depth, y_{rob} = 3.9 ft

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

x = 6.05 From Figure 9 W_2 (effective) = 89 ft y_{cs} = 6.8 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, $V_c = 11.17y_1^{1/6}D_{50}^{1/3}$ = __________ 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 = 1 Correction factor for flow angle of attack (from Table 1), K2 = 1

Froude # at bridge = 0.27 Using pier width a on Figure 11, ξ = 8 Pier scour y_{ps} = 6.6 ft

ABUTMENT SCOUR CALCULATIONS

PGRM: Abutment

Average flow depth blocked by: left abutment, y_{aLT} = 4.5 ft right abutment, y_{aRT} = 3.9 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} = 14.1 and ψ_{RT} = 13.1

Left abutment scour, $y_{as} = \psi_{LT}(K_1/0.55)$ = 14.1 ft Right abutment scour $y_{as} = \psi_{RT}(K_1/0.55)$ = 13.1 ft

96° 59' 13.812"
43° 42' 12.348"

96.98717
43.70343

Route 254 St Stream W. Br. Skunk Ck MRM ________ Date 6/26/12 Initials RAT

Bridge Structure No. 50072100 Location 5 mi N & 1.8 mi W of Hartford on 254 St

GPS coordinates: N 43° 42' 12.4" W 96° 59' 13.7" taken from: USL abutment X centerline of ⇑ MRM end ____

Datum of coordinates: WGS84 X NAD27 ____

Drainage area = 57.67 sq. mi.

The average bottom of the main channel was 13 ft below top of guardrail at a point 57 ft from left abutment.

Method used to determine flood flows: ____ Freq. Anal. ____ drainage area ratio Y regional regression equations.

MISCELLANEOUS CONSIDERATIONS

Flows	~~Q100~~ = Q50 3780			~~Q500~~ = Q100 4770		
Estimated flow passing through bridge	3780			3867		
Estimated road overflow & overtopping	0			903		
Consideration	Yes	No	Possibly	Yes	No	Possibly
Chance of overtopping			Y			X
Chance of Pressure flow	X			X		
Armored appearance to channel		X			X	
Lateral instability of channel		X			X	

8 57.67
6/15

2	469
5	1190
10	1850
25	2880
50	3780
100	4770
500	7400

Riprap at abutments? ____ Yes X No ____ Marginal

Evidence of past Scour? X Yes ____ No ____ Don't know — some pier/~~contraction~~ contraction, minor abutment

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	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
7-8), left abutment
9). pier ~~scour~~ scour
10) main channel

Summary of Results

	~~Q100~~ Q50	~~Q500~~ Q100
Bridge flow evaluated	3780	3867
Flow depth at left abutment (yaLT), in feet	4.4	4.5
Flow depth at right abutment (yaRT), in feet	3.8	3.9
Contraction scour depth (ycs), in feet	6.6	6.9
Pier scour depth (yps), in feet	6.5	6.6
Left abutment scour depth (yas), in feet	14	14.1
Right abutment scour depth (yas), in feet	12.9	13.1
1Flow angle of attack	0	0

See Comments/Diagram for justification where required