OK RT

SCOUR ANALYSIS AND REPORTING FORM

Bridge Structure No. 11149090 Date 7/12/12 Initials RaT Region (A B C D)

Site [redacted] Location 0.1mi W&301 Ave & 109 St

Q_{100} = 737 by: drainage area ratio ____ flood freq. anal. ____ regional regression eq. X

Bridge discharge (Q_2) = 737 (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 = 115 ft. Flow angle at bridge = 5 ° Abut. Skew = 0 ° Effective Skew = 5 °

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 = 114.56 ft* $q_2 = Q_2/W_2$ = 6.4 ft^2/s

Bridge Vel, V_2 = 1.9 ft/s Final $y_2 = q_2/V_2$ = 3.6 ft Δh = 0.1 ft

Average main channel depth at approach section, $y_1 = \Delta h + y_2$ = 3.6 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. = 6-0.5 ft

Low Steel Elev. = 11.2 ft 4.7 took low steel at bridge depth

n (Channel) = 0.048

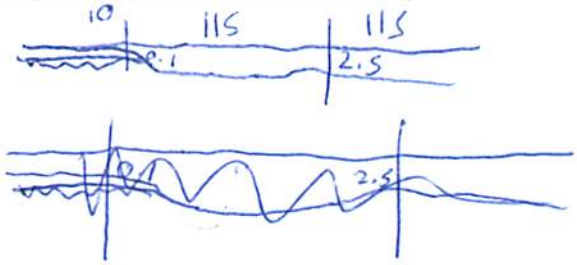
n (LOB) = 0.035

n (ROB) = 0.035

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 = 115 ft

Width of left overbank flow at approach, W_{lob} = 10 ft Average left overbank flow depth, y_{lob} = 0.1 ft

Width of right overbank flow at approach, W_{rob} = 115 ft Average right overbank flow depth, y_{rob} = 2.5 ft

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

x = 3.11 From Figure 9 W_2 (effective) = 107.8 ft y_{cs} = 3.7 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 = 0.17 Using pier width a on Figure 11, ξ = 1.8 / 7 Pier scour y_{ps} = 3.7 / 5.4 ft

ABUTMENT SCOUR CALCULATIONS

PGRM: Abutment

Average flow depth blocked by: left abutment, y_{aLT} = 0.1 ft right abutment, y_{aRT} = 2.5 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} = 0.5 and ψ_{RT} = 10.2

Left abutment scour, $y_{as} = \psi_{LT}(K_1/0.55)$ = 0.5 ft Right abutment scour $y_{as} = \psi_{RT}(K_1/0.55)$ = 10.2 ft

SCOUR ANALYSIS AND REPORTING FORM

Bridge Structure No. 11149090 Date 7/12/12 Initials RAL Region (A B C D)

Site _____ Location 0.1 mi W of 301 Ave & 109 St

Q_{500} = 1340 by: drainage area ratio ____ flood freq. anal. ____ regional regression eq. X

Bridge discharge (Q_2) = 1340 (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 = 113 ft. Flow angle at bridge = 15 ° Abut. Skew = 0 ° Effective Skew = 15 °

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 = 114.56 ft* $q_2 = Q_2/W_2$ = 11.7 ft^2/s

Bridge Vel, V_2 = 2.4 ft/s Final $y_2 = q_2/V_2$ = 4.8 ft Δh = 0.1 ft

Average main channel depth at approach section, $y_1 = \Delta h + y_2$ = 4.9 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. = 0-0.5 ft

Low Steel Elev. = 11.2 ft

n (Channel) = 0.045

n (LOB) = 0.035

n (ROB) = 0.035

Pier Width = 1.7 ft

Pier Length = 1.7 ft

Piers for 500 yr = 2 ft

CONTRACTION SCOUR

PGRM: Contract

Width of main channel at approach section W_1 = 115 ft

Width of left overbank flow at approach, W_{lob} = 115 ft Average left overbank flow depth, y_{lob} = 1.5 ft

Width of right overbank flow at approach, W_{rob} = 113 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 = 5.69 From Figure 9 W_2 (effective) = 111.2 ft y_{cs} = 6.4 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, $V_1 = Q_{500}/(y_1 W_1)$ = _____ 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

PGRM: Pier

PIER SCOUR CALCULATIONS

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

Froude # at bridge = 0.19 Using pier width a on Figure 11, ξ = 7 Pier scour y_{ps} = 5.5 ft

PGRM: Abutment

ABUTMENT SCOUR CALCULATIONS

Average flow depth blocked by: left abutment, y_{aLT} = 1.5 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} = 6.3 and ψ_{RT} = 12.9

Left abutment scour, $y_{as} = \psi_{LT}(K_1/0.55)$ = 6.3 ft Right abutment scour $y_{as} = \psi_{RT}(K_1/0.55)$ = 12.9 ft

100.1797
45.61136

100° 10' 30.612"
45° 48' 40.896"

Route 109th St Stream Br Spring Ck MRM _____ Date 7/12/12 Initials RaT

Bridge Structure No. 11149090 Location 0.1 mi. W of 301 Ave & 109 St

GPS coordinates: N 45° 48' 40.91" W 100° 10' 32.51" taken from: USL abutment X centerline of ⇑ MRM end _____

Datum of coordinates: WGS84 X NAD27 _____

Drainage area = 9.05 sq. mi.

The average bottom of the main channel was 15.7 ft below top of guardrail at a point 79 ft from left abutment.

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

7/2
~~8/23~~

2	26.5
5	102
10	193
25	364
50	533
100	737
500	1340

MISCELLANEOUS CONSIDERATIONS

Flows	Q_{100} = 737			Q_{500} = 1340		
Estimated flow passing through bridge	737			1340		
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 X No ____Marginal

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

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

Note took low steel at Bridge deph - bridge on hill.

1). left OB
2). main channel
3). right OB
4). left abutment
5). pier
6). ~~left~~ left abutment
7). right abutment
8). right abutment
9). pier scour
10). right abutment
11). left abutment
12). main channel

Summary of Results

	Q100	Q500
Bridge flow evaluated	737	1340
Flow depth at left abutment (yaLT), in feet	0.1	1.5
Flow depth at right abutment (yaRT), in feet	2.5	3.9
Contraction scour depth (ycs), in feet	3.7	6.4
Pier scour depth (yps), in feet	5.4	5.5
Left abutment scour depth (yas), in feet	0.5	6.3
Right abutment scour depth (yas), in feet	10.2	12.9
1Flow angle of attack	5	5

See Comments/Diagram for justification where required