OK RT

SCOUR ANALYSIS AND REPORTING FORM

Bridge Structure No. 06203110 Date 7/25/12 Initials RA Region (A B C D) [C circled]

Site ______ Location 207 St, 0.4 mi E of int. of 207 St & 474 Ave

Q_{100} = Q_{50} 2440 by: drainage area ratio____ flood freq. anal. ____ regional regression eq. X

Bridge discharge (Q_2) = 2440 (should be Q_{100} unless there is a relief bridge, road overflow, or bridge overtopping)

96

Analytical Procedure for Estimating Hydraulic Variables Needed to Apply Method

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

Bridge Width = 99 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 = 85.74 ft* $q_2 = Q_2/W_2$ = 28.5 ft^2/s

Bridge Vel, V_2 = 3.8 ft/s Final $y_2 = q_2/V_2$ = 7.5 ft Δh = 0.3 ft

Average main channel depth at approach section, $y_1 = \Delta h + y_2$ = 7.8 ft

** NOTE: repeat above calculations until y_2 changes by less than 0.2* *Effective pier width = L sin(q) + a cos(q)* right 2.5

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

Water Surface Elev. = 6.8 ft

Low Steel Elev. = 7.9 ft

n (Channel) = 0.045

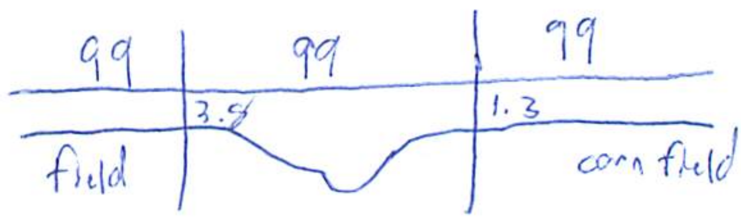
n (LOB) = 0.030

n (ROB) = 0.035

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 = 99 ft

Width of left overbank flow at approach, W_{lob} = 99 ft Average left overbank flow depth, y_{lob} = 3.8 ft

Width of right overbank flow at approach, W_{rob} = 99 ft Average right overbank flow depth, y_{rob} = 1.3 ft

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

x = 6.53 From Figure 9 W_2 (effective) = 81.7 ft y_{cs} = 7.3 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, $V_1 = Q_{100}/(y_1 W_1)$ = ________ 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} = 1 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 = 0.24 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} = 3.8 ft right abutment, y_{aRT} = 1.3 ft

Shape coefficient K_1= 1.00 for vertical-wall, 0.82 for vertical-wall with wingwalls, 0.55 for spill-through [circled]

Using values for y_{aLT} and y_{aRT} on figure 12, ψ_{LT} = 12.9 and ψ_{RT} = 5.5

Left abutment scour, $y_{as} = \psi_{LT}(K_1/0.55)$ = 12.9 ft Right abutment scour $y_{as} = \psi_{RT}(K_1/0.55)$ = 5.5 ft

SCOUR ANALYSIS AND REPORTING FORM

Bridge Structure No. 06203110 Date 7/25/12 Initials RaJ Region (A B C D) (C circled)

Site ______ Location 0.4 mi E of int. of 207 St & 474 Ave

Q_{500} = Q_{100} 3100 by: drainage area ratio____ flood freq. anal. ____ regional regression eq. X

Bridge discharge (Q_2) = 2666 (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 = 99 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 = 85.74 ft* $q_2 = Q_2/W_2$ = 31.3 ft^2/s

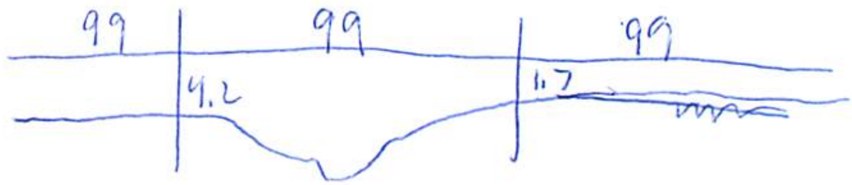
Bridge Vel, V_2 = 4 ft/s Final $y_2 = q_2/V_2$ = 7.9 ft Δh = 0.3 ft

Average main channel depth at approach section, $y_1 = \Delta h + y_2$ = 8.2 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. = 0.9 ft
Low Steel Elev. = 7.9 ft
n (Channel) = 0.045
n (LOB) = 0.030
n (ROB) = 0.035
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 = 99 ft

Width of left overbank flow at approach, W_{lob} = 99 ft Average left overbank flow depth, y_{lob} = 4.2 ft

Width of right overbank flow at approach, W_{rob} = 99 ft Average right overbank flow depth, y_{rob} = 1.7 ft

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

x = 7.54 From Figure 9 W_2 (effective) = 81.7 ft y_{cs} = 8.4 ft

PGRM: CWCSNEW

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

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

Froude # at bridge = 0.25 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} = 4.2 ft right abutment, y_{aRT} = 1.7 ft

Shape coefficient K_1= 1.00 for vertical-wall, 0.82 for vertical-wall with wingwalls, 0.55 for spill-through (circled)

Using values for y_{aLT} and y_{aRT} on figure 12, ψ_{LT} = 13.6 and ψ_{RT} = 7

Left abutment scour, $y_{as} = \psi_{LT}(K_1/0.55)$ = 13.6 ft Right abutment scour $y_{as} = \psi_{RT}(K_1/0.55)$ = 7 ft

44° 23′ 1.176″
96° 43′ 12.432″

96.72012
44.38366

Route 207 St Stream Six Mile Ck MRM ________ Date 7/25/12 Initials RaT

Bridge Structure No. 06203110 Location 0.4 mi E of int of 207 st & 474 Ave

GPS coordinates: N 44° 23' 1.3" W 96° 43' 12.5" taken from: USL abutment X centerline of ⇑ MRM end ______

Datum of coordinates: WGS84 X NAD27 ____

Drainage area = 37.34 sq. mi.

The average bottom of the main channel was 11.9 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.

7/3 8/22	
2	283
5	742
10	1170
25	1850
50	2440
100	3100
500	4840

MISCELLANEOUS CONSIDERATIONS

Flows	Q_{100} = Q_{50} 2440			Q_{500} = Q_{100} 3100		
Estimated flow passing through bridge	2440			2686		
Estimated road overflow & overtopping	0			414		
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 X Marginal – lots of gravel-small cobbles

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 ________________ ____ Yes X No ____ Don't know ____ NA

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

Comments, Diagrams & orientation of digital photos

1). left OB
2). main channel
3). right OB
4-5). pier
6). right abutment
7). left abutment
8). left abutment
9). right abutment
10). main channel

Summary of Results

	~~Q100~~ Q50	~~Q500~~ Q100
Bridge flow evaluated	2440	2686
Flow depth at left abutment (yaLT), in feet	3.8	4.2
Flow depth at right abutment (yaRT), in feet	1.3	1.7
Contraction scour depth (ycs), in feet	7.3	8.4
Pier scour depth (yps), in feet	6.5	6.5
Left abutment scour depth (yas), in feet	12.9	13.6
Right abutment scour depth (yas), in feet	5.5	7
1Flow angle of attack	30	30

See Comments/Diagram for justification where required