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SCOUR ANALYSIS AND REPORTING FORM

Bridge Structure No. 65166080 Date 7/12/12 Initials RaT Region (A B C D)

Site _____ Location 1.4 mi W of int of 132 St & 304 Ave

Q_{100} = 1690 by: drainage area ratio____ flood freq. anal. ____ regional regression eq. X

Bridge discharge (Q_2) = _____ (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 ~~79.87~~ ft. Flow angle at bridge = 20 ° Abut. Skew = 0 ° Effective Skew = 20 °

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 = 79.87 ft* $q_2 = Q_2/W_2$ = 21.2 ft^2/s

Bridge Vel, V_2 = 3.3 ft/s Final $y_2 = q_2/V_2$ = 6.5 ft Δh = 0.2 ft

Average main channel depth at approach section, $y_1 = \Delta h + y_2$ = 6.7 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. = dry ft

Low Steel Elev. = 12.2 ft

n (Channel) = 0.048

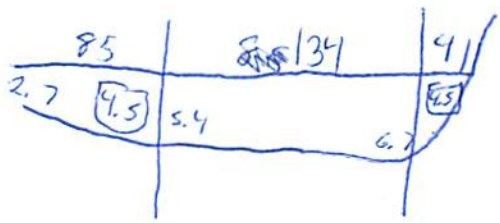
n (LOB) = 0.030

n (ROB) = 0.033

Pier Width = 1.65 ft

Pier Length = 1.65 ft

Piers for 100 yr = 2 ft



CONTRACTION SCOUR

PGRM: Contract

Width of main channel at approach section W_1 = 134 ft

Width of left overbank flow at approach, W_{lob} = 85 ft Average left overbank flow depth, y_{lob} = 4.5 ft

Width of right overbank flow at approach, W_{rob} = 41 ft Average right overbank flow depth, y_{rob} = 4.5 ft

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

x = 14.11 From Figure 9 W_2 (effective) = 76.6 ft y_{cs} = 14.5 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

PGRM: Pier

PIER SCOUR CALCULATIONS

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

Froude # at bridge = 0.23 Using pier width a on Figure 11, ξ = 6.9 Pier scour y_{ps} = 5.5 ft

PGRM: Abutment

ABUTMENT SCOUR CALCULATIONS

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

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

SCOUR ANALYSIS AND REPORTING FORM

Bridge Structure No. 65166080 Date 7/12/12 Initials RJ Region (A B C D)

Site _____ Location 1 mi W of int of 132 St + 304 Ave

Q_{500} = 3230 by: drainage area ratio ____ flood freq. anal. ____ regional regression eq. X

Bridge discharge (Q_2) = 3230 (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 = 20 ° Abut. Skew = 0 ° Effective Skew = 20 °

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 = 79.87 ft* $q_2 = Q_2/W_2$ = 40.4 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. = dry ft

Low Steel Elev. = 12.2 ft

n (Channel) = 0.048

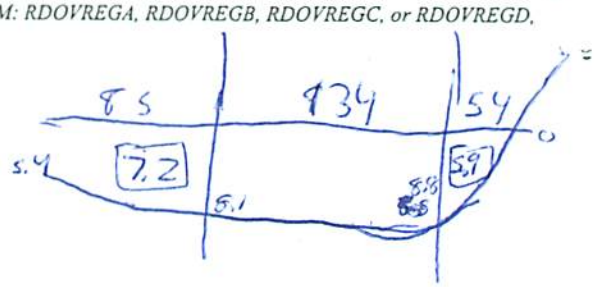
n (LOB) = 0.030

n (ROB) = 0.030

Pier Width = 1.65 ft

Pier Length = 1.65 ft

Piers for 500 yr = 2 ft



CONTRACTION SCOUR

PGRM: Contract

Width of main channel at approach section W_1 = 134 ft

Width of left overbank flow at approach, W_{lob} = 85 ft Average left overbank flow depth, y_{lob} = 7.2 ft

Width of right overbank flow at approach, W_{rob} = 54 ft Average right overbank flow depth, y_{rob} = 5.9 ft

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

x = ~~7.79~~ 22.64 From Figure 9 W_2 (effective) = ~~76.5~~ 76.6 ft y_{cs} = ~~8.6~~ 19.1 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 = 0.26 Using pier width a on Figure 11, ξ = 6.9 Pier scour y_{ps} = 5.6 ft

PGRM: Abutment

ABUTMENT SCOUR CALCULATIONS

Average flow depth blocked by: left abutment, y_{aLT} = 7.2 ft right abutment, y_{aRT} = 5.9 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} = 18.9 and ψ_{RT} = 16.6

Left abutment scour, $y_{as} = \psi_{LT}(K_1/0.55)$ = 18.9 ft Right abutment scour $y_{as} = \psi_{RT}(K_1/0.55)$ = 16.6 ft

This bridge is within an area that is typically noncontributing to the rest of the basin. A point was delineated downstream of the bridge on a stream grid line that is unaffected by the filled area within the noncontributing area. The basin was then edited to subtract the area between the delineated point and the bridge. Basin characteristics were computed, but the "Edit parameters and recompute flows" button was used. The drainage area value was edited and set equal to the total drainage area (31.55) and the flows were computed.

100.12905
45.478389

Route 132 St Stream _____ MRM _____ Date 7/12/12 Initials RJT

Bridge Structure No. 65166080 Location 1.4 mi W of int of 132 St & 304 Ave

GPS coordinates: _____ taken from: USL abutment X centerline of ⇑ MRM end _____

_____ Datum of coordinates: WGS84 X NAD27 _____

Drainage area = 31.55 sq. mi.

The average bottom of the main channel was 16.1 ft below top of guardrail at a point 29 ft from left abutment.

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

MISCELLANEOUS CONSIDERATIONS

Flows	Q_{100} = 1690			Q_{500} = 3230		
Estimated flow passing through bridge	1690			3230		
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 mostly on left abutment

Evidence of past Scour? X Yes ____No ____Don't know some pier/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____	Cobbles____	Boulders____
Size range, in mm	<0.062	0.062-2.00	2.00-64	64-250	>250

Comments, Diagrams & orientation of digital photos

Pk	Q by RFT on 7-10-12
2	48.5
5	203
10	401
25	793
50	1190
100	1690
500	3230

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

Summary of Results

	Q100	Q500
Bridge flow evaluated	1690	3230
Flow depth at left abutment (yaLT), in feet	4.5	7.2
Flow depth at right abutment (yaRT), in feet	4.5	5.9
Contraction scour depth (ycs), in feet	14.5	~~5.6~~ 19.1
Pier scour depth (yps), in feet	5.5	5.6
Left abutment scour depth (yas), in feet	14.1	18.9
Right abutment scour depth (yas), in feet	14.1	16.6
1Flow angle of attack	20	20

See Comments/Diagram for justification where required