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SCOUR ANALYSIS AND REPORTING FORM

Bridge Structure No. 12560321 Date 6/10/12 Initials RaT Region (A B (C) D)

Site ______ Location in Dank on 400 Ave

Q_{100}^{25} = 5440 by: drainage area ratio____ flood freq. anal. ____ regional regression eq. X

Bridge discharge (Q_2) = 5440 (should be Q_{100} 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 = 169 ft. Flow angle at bridge = 25 ° Abut. Skew = 0 ° Effective Skew = 25 °

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 = 152.26 ft* $q_2 = Q_2/W_2$ = 35.7 ft²/s

Bridge Vel, V_2 = 4.2 ft/s Final $y_2 = q_2/V_2$ = 8.4 ft Δh = 0.4 ft

Average main channel depth at approach section, $y_1 = \Delta h + y_2$ = 8.8 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. = 0-1.0 ft

Low Steel Elev. = 10.3 ft 15.3

n (Channel) = 0.050

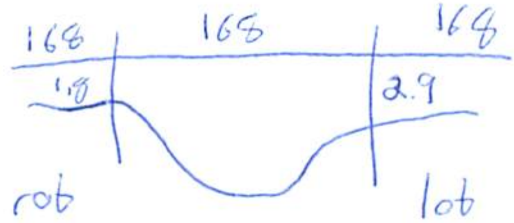
n (LOB) = 0.060

n (ROB) = 0.035

Pier Width = 2.1 ft

Pier Length = 2.25 ft

Piers for 100 yr = 2 ft



PGRM: Contract

CONTRACTION SCOUR

Width of main channel at approach section W_1 = 166 ft

Width of left overbank flow at approach, W_{lob} = 168 ft Average left overbank flow depth, y_{lob} = 2.9 ft

Width of right overbank flow at approach, W_{rob} = 166 ft Average right overbank flow depth, y_{rob} = 1.8 ft

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

x = 3.51 From Figure 9 W_2 (effective) = 148.1 ft y_{cs} = 4.1 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, $V_1 = Q_{100}/(y_1 W_1)$ = ________ 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 = 1.07 Correction factor for flow angle of attack (from Table 1), K2 = 1.02

Froude # at bridge = 0.26 Using pier width a on Figure 11, ξ = 8.3 Pier scour y_{ps} = 6.9 ft

PGRM: Abutment

ABUTMENT SCOUR CALCULATIONS

Average flow depth blocked by: left abutment, y_{aLT} = 2.9 ft right abutment, y_{aRT} = 1.8 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} = 11.3 and ψ_{RT} = 7.4

Left abutment scour, $y_{as} = \psi_{LT}(K_1/0.55)$ = 11.3 ft Right abutment scour $y_{as} = \psi_{RT}(K_1/0.55)$ = 7.4 ft

SCOUR ANALYSIS AND REPORTING FORM

Bridge Structure No. 12560321 Date 6/10/12 Initials [illegible] Region (A B (C) D)

Site ______ Location in Dank on 400 Ave

Q_{500} = 8670 by: drainage area ratio ____ flood freq. anal. ____ regional regression eq. X

Bridge discharge (Q_2) = 8115 (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 = 168 ft. Flow angle at bridge = 25 ° Abut. Skew = 0 ° Effective Skew = 24 °

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 = 152.26 ft* $q_2 = Q_2/W_2$ = 53.3 ft^2/s

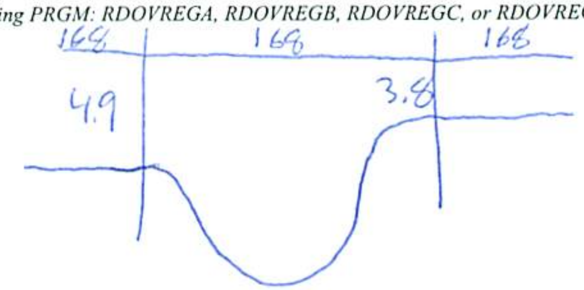
Bridge Vel, V_2 = 5.2 ft/s Final $y_2 = q_2/V_2$ = 10.3 ft Δh = 0.5 ft

Average main channel depth at approach section, $y_1 = \Delta h + y_2$ = 10.8 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. = 0-10 ft
Low Steel Elev. = 10.3 ft
n (Channel) = 0050
n (LOB) = 0.060
n (ROB) = 0.035
Pier Width = 2.1 ft
Pier Length = 2.25 ft
Piers for 500 yr = 7 ft



CONTRACTION SCOUR

PGRM: Contract

Width of main channel at approach section W_1 = 168 ft
Width of left overbank flow at approach, W_{lob} = 168 ft Average left overbank flow depth, y_{lob} = 4.9 ft
Width of right overbank flow at approach, W_{rob} = 168 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 = 7.26 From Figure 9 W_2 (effective) = 148.1 ft y_{cs} = 9.1 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, $V_c = 11.17 y_1^{1/6} D_{50}^{1/3}$ = ____ 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 = 1.07 Correction factor for flow angle of attack (from Table 1), K2 = 1.02

Froude # at bridge = 0.29 Using pier width a on Figure 11, ξ = 9.3 Pier scour y_{ps} = 17 ft

ABUTMENT SCOUR CALCULATIONS

PGRM: Abutment

Average flow depth blocked by: left abutment, y_{aLT} = 4.9 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} = 14.8 and ψ_{RT} = 12.9

Left abutment scour, $y_{as} = \psi_{LT}(K_1/0.55)$ = 14.8 ft Right abutment scour $y_{as} = \psi_{RT}(K_1/0.55)$ = 12.9 ft

43.03746
98.18744

Route 400 Ave Stream Chotean Ck MRM______ Date 6/10/12 Initials [illegible]

Bridge Structure No. 12560321 Location in Dante on 400 Ave

GPS coordinates: N 43° 02' 14.9'' W 98° 11' 14.9'' taken from: USL abutment X centerline of ⇑ MRM end ______

Datum of coordinates: WGS84 X NAD27_____

Drainage area = 478.69 sq. mi.

The average bottom of the main channel was 15.3 ft below top of guardrail at a point 96 ft from left abutment.

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

6/4
8/23

2	256
5	1190
10	2520
25	5440
50	8670
100	13000
500	28400

W[illegible]

MISCELLANEOUS CONSIDERATIONS

Flows	Q_{100}= Q_{25} 5440			Q_{500}= Q_{50} 8670		
Estimated flow passing through bridge	5440			8115		
Estimated road overflow & overtopping	0			555		
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 abutment 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

1). right OB
2). main channel
3). left OB
4). piers
5). right of abutment
6-8) left abutment (scour)
9). right abutment scour
10. main channel

Summary of Results

	~~Q100~~ Q_{25}	~~Q500~~ Q_{50}
Bridge flow evaluated	5440	8115
Flow depth at left abutment (yaLT), in feet	2.9	4.9
Flow depth at right abutment (yaRT), in feet	1.8	3.8
Contraction scour depth (ycs), in feet	4.1	8.1
Pier scour depth (yps), in feet	6.9	7
Left abutment scour depth (yas), in feet	11.3	~~4.9~~ 14.8
Right abutment scour depth (yas), in feet	7.4	~~3.8~~ 12.9
1Flow angle of attack	25	25

See Comments/Diagram for justification where required