OK RT

SCOUR ANALYSIS AND REPORTING FORM

Bridge Structure No. 42020264 Date 5/25/12 Initials AaL Region (A B (C) D)

Site _____ Location 15.3 mi S of Lennox on 466 ave

Q_{100} = 4000 by: drainage area ratio____ flood freq. anal. ____ regional regression eq. X

Bridge discharge (Q_2) = 4000 (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

Bridge Width = 94 ft. Flow angle at bridge = 20 ° Abut. Skew = 0 ° Effective Skew = 20 °

Width (W_2) iteration = 84.73 81.75 88.73 81.75 assume 9.8 W_2 = 84.57

Avg. flow depth at bridge, y_2 iteration = 9.6 10 9.6 10

Corrected channel width at bridge Section = W_2 times cos of flow angle = 84.33 ft* $q_2 = Q_2/W_2$ = 48.2 ft^2/s

Bridge Vel, V_2 = 4.9 ft/s Final $y_2 = q_2/V_2$ = 9.8 ft Δh = 0.5 ft

Average main channel depth at approach section, $y_1 = \Delta h + y_2$ = 10.3 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,

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

Water Surface Elev. = 10.5 ft 13.1 − 2.9 = 10.2

Low Steel Elev. = 14.2 ft

n (Channel) = 0.035

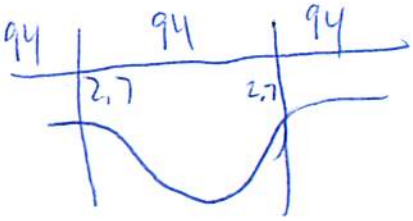
n (LOB) = 0.030

n (ROB) = 0.030

Pier Width = 2.8 ft

Pier Length = 2.0 ft

Piers for 100 yr = 2 ft



CONTRACTION SCOUR

PGRM: Contract

Width of main channel at approach section W_1 = 94 ft

Width of left overbank flow at approach, W_{lob} = 94 ft Average left overbank flow depth, y_{lob} = 2.7 ft

Width of right overbank flow at approach, W_{rob} = 94 ft Average right overbank flow depth, y_{rob} = 2.7 ft

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

x = 4.06 From Figure 9 W_2 (effective) = 84.3 ft y_{cs} = 4.7 ft 48.13 − 2.6 = 2.7

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 = 0.28 Using pier width a on Figure 11, ξ = 8 Pier scour y_{ps} = 6.6 ft

PGRM: Abutment

ABUTMENT SCOUR CALCULATIONS

Average flow depth blocked by: left abutment, y_{aLT} = 2.7 ft right abutment, y_{aRT} = 2.7 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 , and ψ_{RT} = 11

Left abutment scour, $y_{as} = \psi_{LT}(K_1/0.55)$ = 11 ft Right abutment scour $y_{as} = \psi_{RT}(K_1/0.55)$ = 11 ft

SCOUR ANALYSIS AND REPORTING FORM

Bridge Structure No. 42020264 Date 5/25/12 Initials Rat Region (A B C D)

Site _____ Location 15.3 mi S of Lennox on 466 Ave

Q_{500} = 6500 by: drainage area ratio ____ flood freq. anal. ____ regional regression eq. X

Bridge discharge (Q_2) = 6500 (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 = 94 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 = 88.33 ft* $q_2 = Q_2/W_2$ = 73.6 ft^2/s

Bridge Vel, V_2 = 6.1 ft/s Final $y_2 = q_2/V_2$ = 12.1 ft Δh = 0.4 ft

Average main channel depth at approach section, $y_1 = \Delta h + y_2$ = 12.9 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. = 14.2 ft

n (Channel) = 0.035

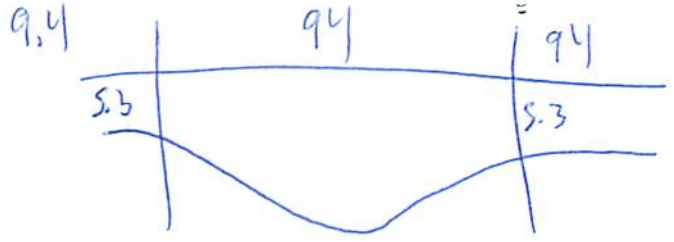
n (LOB) = 0.030

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 = 94 ft

Width of left overbank flow at approach, W_{lob} = 94 ft Average left overbank flow depth, y_{lob} = 5.3 5.3 ft

Width of right overbank flow at approach, W_{rob} = 94 ft Average right overbank flow depth, y_{rob} = 5.3 ft

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

x = 9.1 From Figure 9 W_2 (effective) = 84.3 ft y_{cs} = 10 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 = 0.31 Using pier width a on Figure 11, ξ = 8 Pier scour y_{ps} = 6.7 ft

PGRM: Abutment

ABUTMENT SCOUR CALCULATIONS

Average flow depth blocked by: left abutment, y_{aLT} = 5.3 ft right abutment, y_{aRT} = 5.3 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} = 15.6 and ψ_{RT} = 15.6

Left abutment scour, $y_{as} = \psi_{LT}(K_1/0.55)$ = 15.6 ft Right abutment scour $y_{as} = \psi_{RT}(K_1/0.55)$ = 15.6 ft

Route 466 Ave Stream Blind Ck MRM _____ Date 5/25/12 Initials RAT

Bridge Structure No. 42020264 Location 15.3 mi S of Lennox on 466 Ave

GPS coordinates: N 43° 07' 26.3" W 96° 54' 5.3" taken from: USL abutment X centerline of ⇑ MRM end _____

Datum of coordinates: WGS84 X NAD27 _____

Drainage area = 28.23 sq. mi.

The average bottom of the main channel was 17.1 ft below top of guardrail at a point 40 ft from left abutment.

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

MISCELLANEOUS CONSIDERATIONS

Flows	Q_{100} = 4050			Q_{500} = 6500		
Estimated flow passing through bridge		4050			6500	
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		Y			Y	

Riprap at abutments? ____Yes ____No X Marginal yes on left ab, no on right ab.

Evidence of past Scour? X Yes ____No ____Don't know

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). main channel
2). R. ab.
3). piers
4). contraction scour
5). L ab.
6). Main channel
7). L ob

Summary of Results

	Q100	Q500
Bridge flow evaluated	4050	6500
Flow depth at left abutment (yaLT), in feet	2.7	5.3
Flow depth at right abutment (yaRT), in feet	2.7	5.3
Contraction scour depth (ycs), in feet	4.7	10
Pier scour depth (yps), in feet	6.6	6.7
Left abutment scour depth (yas), in feet	11	15.6
Right abutment scour depth (yas), in feet	11	15.6
1Flow angle of attack	20	20

See Comments/Diagram for justification where required

8/24

2	620
5	1590
10	2530
25	4090
50	5530
100	7200
500	12100

5/21

2	405
5	1010
10	1566
25	2430
50	3210
100	4050
500	6500