OK RT

SCOUR ANALYSIS AND REPORTING FORM

Bridge Structure No. 42020156 Date 5/25/12 Initials RT Region (A B C D)

Site _____ Location 4.7 mi S of Lennox on 466th Ave

Q_{100} = 5600 by: drainage area ratio ____ flood freq. anal. ____ regional regression eq. X

Bridge discharge (Q_2) = 5600 (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 = 92 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 = 86.45 ft* $q_2 = Q_2/W_2$ = 64.5 ft^2/s

Bridge Vel, V_2 = 5.7 ft/s Final $y_2 = q_2/V_2$ = 11.4 ft Δh = 0.7 ft

Average main channel depth at approach section, $y_1 = \Delta h + y_2$ = 12 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. = ~~NA~~ 0-0.5 ft 14.3 7

Low Steel Elev. = 14.4 ft 3.9

n (Channel) = 0.030 50 M.4

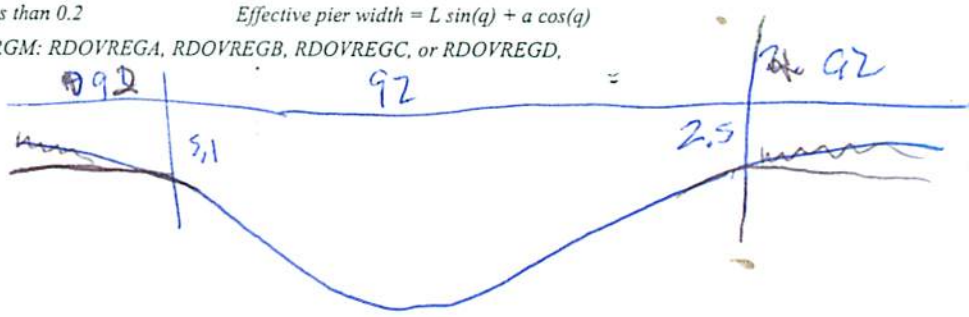
n (LOB) = 0.030

n (ROB) = 0.030

Pier Width = 1.7 ft

Pier Length = 1.7 ft

Piers for 100 yr = 3 ft



CONTRACTION SCOUR

PGRM: Contract

Width of main channel at approach section W_1 = 92 ft 4.9 - 5.3

Width of left overbank flow at approach, W_{lob} = 92 ft Average left overbank flow depth, y_{lob} = 5.1 ft

Width of right overbank flow at approach, W_{rob} = 92 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 = 5.82 From Figure 9 W_2 (effective) = 81.4 ft y_{cs} = 6.6 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.

$D_{c50} = 0.0006(q_2^2/y_1^{7/6})^3$ = _____ ft If $D_{50} >= D_{c50}$, $\chi = 0.0$

Otherwise, $\chi = 0.122 y_1 [q_2^2/(D_{50}^{1/3} y_1^{7/6})]^{6/7} - y_1$ = _____ 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 = 0.3 Using pier width a on Figure 11, ξ = 7 Pier scour y_{ps} = 5.9 ft

ABUTMENT SCOUR CALCULATIONS

PGRM: Abutment

Average flow depth blocked by: left abutment, y_{aLT} = 5.1 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} = 15.2 and ψ_{RT} = 10.2

Left abutment scour, $y_{as} = \psi_{LT}(K_1/0.55)$ = 15.2 ft Right abutment scour $y_{as} = \psi_{RT}(K_1/0.55)$ = 10.2 ft

SCOUR ANALYSIS AND REPORTING FORM

Bridge Structure No. 42026156 Date 5/25/12 Initials RaT Region (A B C D)

Site _____ Location 4.7 mi S of Lennox on 466 Ave

Q_{500} = 10100 by: drainage area ratio ____ flood freq. anal. ____ regional regression eq. X

Bridge discharge (Q_2) = 9014 (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 = 92 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 = 86.45 ft* $q_2 = Q_2/W_2$ = 104.3 ft^2/s

Bridge Vel, V_2 = 7.2 ft/s Final $y_2 = q_2/V_2$ = 14.4 ft Δh = 1.1 ft

Average main channel depth at approach section, $y_1 = \Delta h + y_2$ = 15.5 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. = 0.3 ft

Low Steel Elev. = 14.4 ft

n (Channel) = 0.036

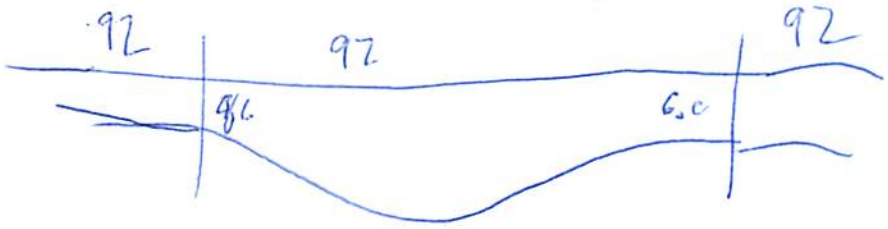
n (LOB) = 0.030

n (ROB) = 0.035

Pier Width = 1.7 ft

Pier Length = 1.7 ft

Piers for 500 yr = 3 ft



CONTRACTION SCOUR

PGRM: Contract

Width of main channel at approach section W_1 = 92 ft

Width of left overbank flow at approach, W_{lob} = 92 ft Average left overbank flow depth, y_{lob} = 8.6 ft

Width of right overbank flow at approach, W_{rob} = 92 ft Average right overbank flow depth, y_{rob} = 6.0 ft

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

x = 12.2 From Figure 9 W_2 (effective) = 61.4 ft y_{cs} = 13.3 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, $V_1 = Q_{500}/(y_1W_1)$ = _____ 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

PGRM: Pier

PIER SCOUR CALCULATIONS

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

Froude # at bridge = 0.33 Using pier width a on Figure 11, ξ = 7 Pier scour y_{ps} = 6 ft

ABUTMENT SCOUR CALCULATIONS

PGRM: Abutment

Average flow depth blocked by: left abutment, y_{aLT} = 6.0 ft right abutment, y_{aRT} = 6.0 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} = 20.2 and ψ_{RT} = 16.8

Left abutment scour, $y_{as} = \psi_{LT}(K_1/0.55)$ = 20.2 ft Right abutment scour $y_{as} = \psi_{RT}(K_1/0.55)$ = 16.8 ft

Route 466 Ave Stream Long Ck MRM _____ Date 5/25/12 Initials RDJ

Bridge Structure No. 42020156 Location 4.7 mi S of Lennox on 466 Ave

GPS coordinates: N 43° 16' 35.91" W 96° 53' 9.61" taken from: USL abutment X centerline of ⇑ MRM end _____

Datum of coordinates: WGS84 X NAD27 _____

Drainage area = 75.39 sq. mi.

The average bottom of the main channel was 19.3 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.

8/24

2	924
5	2430
10	3940
25	6520
50	8950
100	11800
500	20600

5/22

2	381
5	1040
10	1710
25	2960
50	4150
100	5600
500	10100

MISCELLANEOUS CONSIDERATIONS

Flows	Q_{100} = 5600			Q_{500} = 10100		
Estimated flow passing through bridge		5600			9014	
Estimated road overflow & overtopping		0			1086	
Consideration	Yes	No	Possibly	Yes	No	Possibly
Chance of overtopping		X		X		X
Chance of Pressure flow		X		X		
Armored appearance to channel		X			X	
Lateral instability of channel		X			X	

Riprap at abutments? X Yes ____No ____Marginal

Evidence of past Scour? X Yes ____No ____Don't know - pier, contraction

Debris Potential? ____High ____Med X Low

Does scour countermeasure(s) appear to have been designed?

Riprap	X Yes	____No	____Don't know	____NA (less quality)
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). Rab
3). Lab
4). LOB
5). ROB
6). Main channel

Summary of Results

	Q100	Q500
Bridge flow evaluated	5600	9014
Flow depth at left abutment (yaLT), in feet	5.1	8.6
Flow depth at right abutment (yaRT), in feet	2.5	6.0
Contraction scour depth (ycs), in feet	6.6	13.3
Pier scour depth (yps), in feet	5.9	6
Left abutment scour depth (yas), in feet	15.2	20.2
Right abutment scour depth (yas), in feet	10.2	16.8
1Flow angle of attack	20	20

See Comments/Diagram for justification where required