OK RT

SCOUR ANALYSIS AND REPORTING FORM

Bridge Structure No. 64042050 Date 5/26/12 Initials rat Region (A B C D)

Site _____ Location 3.4 mi E of Exit 42 on 302 St

Q_{100} = Qsc 5770 4820 by: drainage area ratio____ flood freq. anal. ____ regional regression eq. ____

Bridge discharge (Q_2) = 4820 (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 = 107 ft. Flow angle at bridge = 15 ° Abut. Skew = 0 ° Effective Skew = 15 °

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 = 103.35 ft* $q_2 = Q_2/W_2$ = 46.6 ft²/s

Bridge Vel, V_2 = 4.5 ft/s Final $y_2 = q_2/V_2$ = 9.6 ft Δh = 0.5 ft

Average main channel depth at approach section, $y_1 = \Delta h + y_2$ = 10.1 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. = 0-2 ft 13.3 − 3.5 = 9.8

Low Steel Elev. = ~~14.0~~ 10.2 ft 14.5

n (Channel) = 0.040

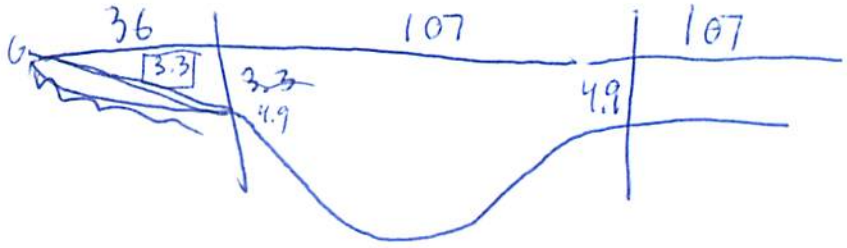
n (LOB) = 0.040 0.040 0.035

n (ROB) = 0.040 0.040 0.035

Pier Width = 1.75 ft

Pier Length = 1.75 ft

Piers for 100 yr = 4 ft



CONTRACTION SCOUR

PGRM: Contract

Width of main channel at approach section W_1 = 107 ft 4.9 · ⅔ = 9.8/3

Width of left overbank flow at approach, W_{lob} = 36 ft Average left overbank flow depth, y_{lob} = 3.3 ft

Width of right overbank flow at approach, W_{rob} = 107 ft Average right overbank flow depth, y_{rob} = 4.9 ft

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

x = 5.06 From Figure 9 W_2 (effective) = 96.4 ft y_{cs} = 5.6 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.

$D_{c50} = 0.0006(q_2/y_1^{7/6})^3$ = _____ 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 = 0.27 Using pier width a on Figure 11, ξ = 7.2 Pier scour y_{ps} = 5.9 ft

PGRM: Abutment

ABUTMENT SCOUR CALCULATIONS

Average flow depth blocked by: left abutment, y_{aLT} = 3.3 ft right abutment, y_{aRT} = 4.9 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} = 12 and ψ_{RT} = 14.8

Left abutment scour, $y_{as} = \psi_{LT}(K_1/0.55)$ = 12 ft Right abutment scour $y_{as} = \psi_{RT}(K_1/0.55)$ = 14.4 ft

SCOUR ANALYSIS AND REPORTING FORM

Bridge Structure No. 64042050 Date 5/26/12 Initials RaT Region (A B C D)

Site _____ Location 3.4 mi E of Exit 42 on 302 St

Q_{500} = ~~Q_{100}~~ 4990 by: drainage area ratio____ flood freq. anal. ____ regional regression eq. X

Bridge discharge (Q_2) = ~~5730~~ 5191 (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 = 107 ft. Flow angle at bridge = 15 ° Abut. Skew = 0 ° Effective Skew = 15 °

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 = 103.35 ft* $q_2 = Q_2/W_2$ = 50.2 ft²/s

Bridge Vel, V_2 = 5.08 ft/s Final $y_2 = q_2/V_2$ = ~~9~~ 10 ft Δh = ~~0.0~~ 0.5 ft

Average main channel depth at approach section, $y_1 = \Delta h + y_2$ = ~~10.0~~ 10.5 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. = 0-7 ft

Low Steel Elev. = ~~11.0~~ 10.0 ft

n (Channel) = 0.040

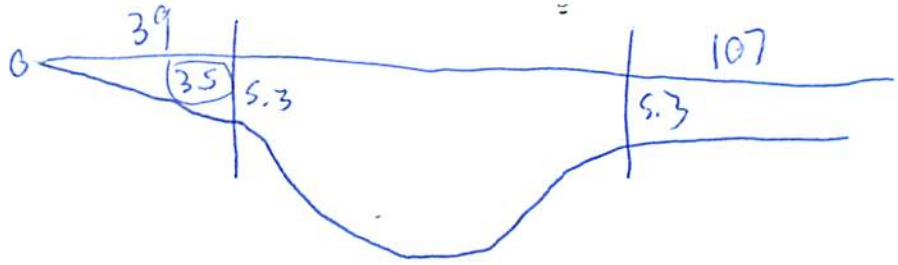
n (LOB) = 0.040

n (ROB) = 0.040

Pier Width = 1.75 ft

Pier Length = 1.75 ft

Piers for 500 yr = 4 ft



CONTRACTION SCOUR

PGRM: Contract

Width of main channel at approach section W_1 = 107 ft 5.3 2/3 10.6

Width of left overbank flow at approach, W_{lob} = 39 ft Average left overbank flow depth, y_{lob} = 3.5 ft

Width of right overbank flow at approach, W_{rob} = 107 ft Average right overbank flow depth, y_{rob} = ~~9~~ 5.3 ft

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

x = 5.57 From Figure 9 W_2 (effective) = 96.4 ft y_{cs} = 6.3 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, $V_1 = Q_{500}/(y_1 W_1)$ = _____ 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 = 0.25 Using pier width a on Figure 11, ξ = 7.2 Pier scour y_{ps} = 5.9 ft

PGRM: Abutment

ABUTMENT SCOUR CALCULATIONS

Average flow depth blocked by: left abutment, y_{aLT} = 3.5 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} = 12.4 and ψ_{RT} = 15.6

Left abutment scour, $y_{as} = \psi_{LT}(K_1/0.55)$ = 12.4 ft Right abutment scour $y_{as} = \psi_{RT}(K_1/0.55)$ = 15.6 ft

Route 302 St Stream W. Brule Cl MRM _____ Date 5/26/12 Initials RaT

Bridge Structure No. 64042050 Location 3.4 mi E of Exit 42 on 302 St

GPS coordinates: N 43° 00' 41.1" W 98° 43' 31.2" taken from: USL abutment ____ centerline of ↑ MRM end ____

Datum of coordinates: WGS84 X NAD27 ____

Drainage area = 36.8 sq. mi.

The average bottom of the main channel was 14.5 ft below top of guardrail at a point 66 ft from left abutment.

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

5/24

8/26

MISCELLANEOUS CONSIDERATIONS

Flows	$Q_{\frac{50}{100}}$ = 4820			$Q_{\frac{100}{500}}$ = ~~4820~~ 5970		
Estimated flow passing through bridge	4820			5191		
Estimated road overflow & overtopping	0			779		
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	

2	700
5	1660
10	2490
25	3740
50	4820
100	5970
500	8980

Riprap at abutments? ____Yes X No ____Marginal

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

Debris Potential? ____High ____Med X Low

5/24

2	49
5	159
10	275
25	475
50	660
100	874
500	1460

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). left ab.
3). right ab.
4). right ab.
5) ~~left~~ right ab
6). left ab
7). left ab

5). pier scour
9). left OB
10). main channel
11). right OB

Summary of Results

	~~Q100~~ Q50	~~Q500~~ Q100
Bridge flow evaluated	4820	5191
Flow depth at left abutment (yaLT), in feet	3.3	3.5
Flow depth at right abutment (yaRT), in feet	4.9	5.3
Contraction scour depth (ycs), in feet	5.5	6.3
Pier scour depth (yps), in feet	5.9	5.9
Left abutment scour depth (yas), in feet	12	12.4
Right abutment scour depth (yas), in feet	14.8	15.6
1Flow angle of attack	15	15

See Comments/Diagram for justification where required