OK RT

SCOUR ANALYSIS AND REPORTING FORM

Bridge Structure No. 34140226 Date 6/4/12 Initials RaT Region (A B C D)

Site _____ Location 0.6 mi S of Kaylor on 418 Ave

Q_{100} = 2150 by: drainage area ratio ____ flood freq. anal. ____ regional regression eq. X

Bridge discharge (Q_2) = 2150 (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 = 64 ft. Flow angle at bridge = 10 ° Abut. Skew = 0 ° Effective Skew = 10 °

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 = 63.03 ft* $q_2 = Q_2/W_2$ = 34.1 ft²/s

Bridge Vel, V_2 = 4.1 ft/s Final $y_2 = q_2/V_2$ = 8.2 ft Δh = 0.3 ft

Average main channel depth at approach section, $y_1 = \Delta h + y_2$ = 8.6 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 ft

Low Steel Elev. = 8.6 ft

n (Channel) = 0.035

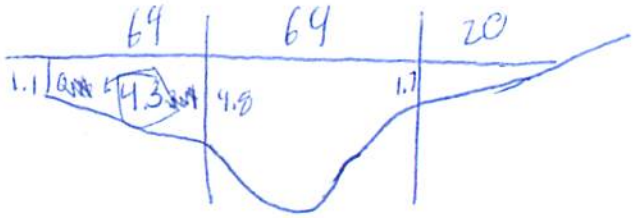
n (LOB) = 0.035

n (ROB) = 0.030

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 = 64 ft 3.1+1.2

Width of left overbank flow at approach, W_{lob} = 64 ft Average left overbank flow depth, y_{lob} = 4.3 ft

Width of right overbank flow at approach, W_{rob} = 20 ft Average right overbank flow depth, y_{rob} = 1.7 ft

2.6 · 2/3 5.2/3 1.7

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

x = ~~4.74~~ 3.74 From Figure 9 W_2 (effective) = ~~60.7~~ 59.7 ft y_{cs} = ~~4.9~~ 4.4 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

PIER SCOUR CALCULATIONS

PGRM: Pier

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

Froude # at bridge = 0.25 Using pier width a on Figure 11, ξ = 6.9 Pier scour y_{ps} = 5.6 ft

ABUTMENT SCOUR CALCULATIONS

PGRM: Abutment

Average flow depth blocked by: left abutment, y_{aLT} = 4.3 ft right abutment, y_{aRT} = 1.7 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} = 13.6 and ψ_{RT} = 7

Left abutment scour, $y_{as} = \psi_{LT}(K_1/0.55)$ = 13.6 ft Right abutment scour $y_{as} = \psi_{RT}(K_1/0.55)$ = 7 ft

SCOUR ANALYSIS AND REPORTING FORM

Bridge Structure No. 34140226 Date 6/6/12 Initials RAT Region (A B (C) D)

Site _____ Location 0.6 mi S of Kaylor on 418 Ave

Q_{500} = 4230 by: drainage area ratio ____ flood freq. anal. ____ regional regression eq. X

Bridge discharge (Q_2) = 2451 (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

Bridge Width = 64 ft. Flow angle at bridge = 10 ° Abut. Skew = 0 ° Effective Skew = 10 °

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 = 63.03 ft* $q_2 = Q_2/W_2$ = 38.9 ft²/s

Bridge Vel, V_2 = 4.4 ft/s Final $y_2 = q_2/V_2$ = 8.8 ft Δh = 0.4 ft

Average main channel depth at approach section, $y_1 = \Delta h + y_2$ = 9.2 ft

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

** 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 ft

Low Steel Elev. = 5.6 ft

n (Channel) = 0.035

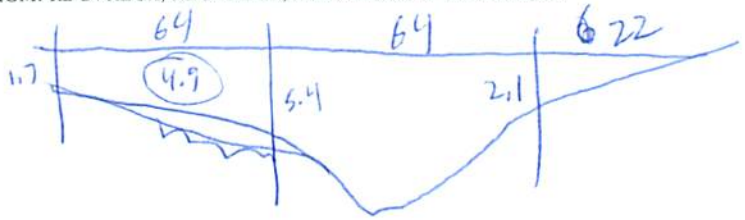
n (LOB) = 0.035

n (ROB) = 0.030

Pier Width = 1.65 ft

Pier Length = 1.65 ft

Piers for 500 yr = 2 ft



CONTRACTION SCOUR

Width of main channel at approach section W_1 = 64 ft

Width of left overbank flow at approach, W_{lob} = 64 ft Average left overbank flow depth, y_{lob} = 4.9 ft

Width of right overbank flow at approach, W_{rob} = 22 ft Average right overbank flow depth, y_{rob} = 2.1 ft

PGRM: Contract

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

x = 4.641 From Figure 9 W_2 (effective) = 59.7 ft y_{cs} = 5.1 ft

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

PGRM: CWCSNEW

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

PIER SCOUR CALCULATIONS

PGRM: Pier

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

Froude # at bridge = 0.26 Using pier width a on Figure 11, ξ = 6.9 Pier scour y_{ps} = 5.6 ft

ABUTMENT SCOUR CALCULATIONS

PGRM: Abutment

Average flow depth blocked by: left abutment, y_{aLT} = 4.9 ft right abutment, y_{aRT} = 2.1 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} = 8.6

Left abutment scour, $y_{as} = \psi_{LT}(K_1/0.55)$ = 14.8 ft Right abutment scour $y_{as} = \psi_{RT}(K_1/0.55)$ = 8.6 ft

97,83432
43.17474

Route 418 Ave Stream Dawson Clk MRM _____ Date 6/6/12 Initials rat

Bridge Structure No. 34140226 Location 0.6 mi S of Kaylor on 418 Ave

GPS coordinates: N 43° 10' 29.01" W 97° 50' 3.91" taken from: USL abutment X centerline of ↑ MRM end _____

Datum of coordinates: WGS84 X NAD27 _____

Drainage area = 25.65 sq. mi.

The average bottom of the main channel was 12.7 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.

5/24

~~5/24~~

MISCELLANEOUS CONSIDERATIONS

Flows	Q_{100} = 2150			Q_{500} = 4230		
Estimated flow passing through bridge	2150			2451		
Estimated road overflow & overtopping	0			1779		
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	77
5	277
10	525
25	1010
50	1510
100	2150
500	4230

Riprap at abutments? X Yes ____No ____Marginal

Evidence of past Scour? ____Yes X No ____Don't know

Debris Potential? ____High ____Med X Low

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

Riprap	X Yes	~~X~~ No	____Don't know	____NA	rose quartz
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 9). main channel
2). piers
3-4). left abutment
5-6). right abutment
7). left OB
8). right OB

Note: large amount of riprap spilled into the main channel under the bridge. Unsure whether to use clear water contraction

Summary of Results

	Q100	Q500
Bridge flow evaluated	2150	2451
Flow depth at left abutment (yaLT), in feet	4.3	4.9
Flow depth at right abutment (yaRT), in feet	1.7	2.1
Contraction scour depth (ycs), in feet	~~4.9~~ 4.4	5.1
Pier scour depth (yps), in feet	5.6 5.6	5.6
Left abutment scour depth (yas), in feet	13.8	~~13.8~~ 14.9
Right abutment scour depth (yas), in feet	7	8.6
1Flow angle of attack	10	10

See Comments/Diagram for justification where required