OK RT

SCOUR ANALYSIS AND REPORTING FORM

Bridge Structure No. 3424611 Date 6/7/12 Initials Let Region (A B C D) (C circled)

Site ____________ Location nr Wolf Ck Colony, NW of Menno

Q_{100} = 81000 by: drainage area ratio ____ flood freq. anal. ____ regional regression eq. X

Bridge discharge (Q_2) = 81000 (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 = ~~373~~ 346 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 = 334.21 ft* $q_2 = Q_2/W_2$ = 242.4 ft^2/s

Bridge Vel, V_2 = 11 ft/s Final $y_2 = q_2/V_2$ = 21.9 ft Δh = 2.5 ft

Average main channel depth at approach section, $y_1 = \Delta h + y_2$ = 24.4 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. = 0-5.0 ft (27, 28.1, 5.6, 22.5)

Low Steel Elev. = 22.5 ft

n (Channel) = 0.033

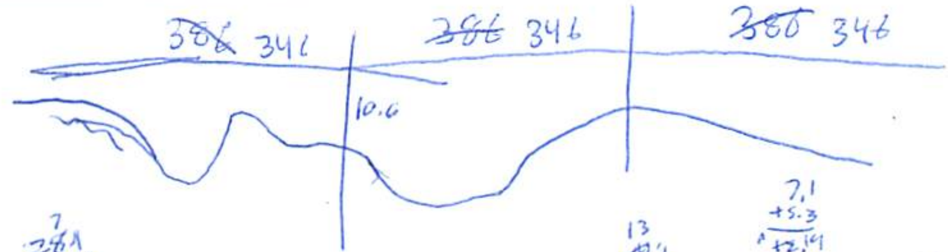
n (LOB) = ~~0.035~~ 0.050

n (ROB) = 0.080

Pier Width = 2.2 ft

Pier Length = 2.3 ft

\# Piers for 100 yr = 4 ft



28.1 − 24.4 = 3.7; bottom pier ledge 17.7 − 1.1 = 8.8, 5.7; 13, 19.1 − 3.7 = 10.4; 17, 14.1, 9.9, −2.5; 7.1 + 5.3 + 12.4 − 3.7 = 8.7; 2.5. 1/3

CONTRACTION SCOUR

PGRM: Contract

Width of main channel at approach section W_1 = 346 ft

Width of left overbank flow at approach, W_{lob} = 346 ft Average left overbank flow depth, y_{lob} = ~~16.6~~ 9.9 ft (8.7+1.3)

Width of right overbank flow at approach, W_{rob} = 346 ft Average right overbank flow depth, y_{rob} = 10.0 ft

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

x = 7.77 From Figure 9 W_2 (effective) = 325.4 ft y_{cs} = 8.6 ft

PGRM: CWCSNEW

Clear Water Contraction Scour (use if bed material is larger than small cobbles) (crossed out)

Estimated bed material D_{50} = ________ ft Average approach velocity, $V_1 = Q_{100}/(y_1W_1)$ = ________ 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

PIER SCOUR CALCULATIONS

PGRM: Pier

L/a ratio = 1.14 Correction factor for flow angle of attack (from Table 1), K2 = 1

Froude # at bridge = 0.41 Using pier width a on Figure 11, ξ = 8.6 Pier scour y_{ps} = 7.5 ft

ABUTMENT SCOUR CALCULATIONS

PGRM: Abutment

Average flow depth blocked by: left abutment, y_{aLT} = 9.9 ft right abutment, y_{aRT} = 10.0 ft

Shape coefficient K_1= 1.00 for vertical-wall, 0.82 for vertical-wall with wingwalls, 0.55 for spill-through (circled)

Using values for y_{aLT} and y_{aRT} on figure 12, ψ_{LT} = 21.3 and ψ_{RT} = 21.3

Left abutment scour, $y_{as} = \psi_{LT}(K_1/0.55)$ = 21.3 ft Right abutment scour $y_{as} = \psi_{RT}(K_1/0.55)$ = 21.3 ft

SCOUR ANALYSIS AND REPORTING FORM

Bridge Structure No. 34246111 Date 6/7/12 Initials LaJ Region (A B (C) D)

Site ______ Location nr Wolf Ck Colony, NW of Menno

Q_{500} = 129000 by: drainage area ratio ____ flood freq. anal. ____ regional regression eq. X

Bridge discharge (Q_2) = 84936 (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 = 346 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 = 334.21 ft* $q_2 = Q_2/W_2$ = 254.1 ft^2/s

Bridge Vel, V_2 = 11.3 ft/s Final $y_2 = q_2/V_2$ = 22.5 ft Δh = 2.6 ft

Average main channel depth at approach section, $y_1 = \Delta h + y_2$ = 25.1 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. = 0-5.0 ft

Low Steel Elev. = 22.5 ft

n (Channel) = 0.033

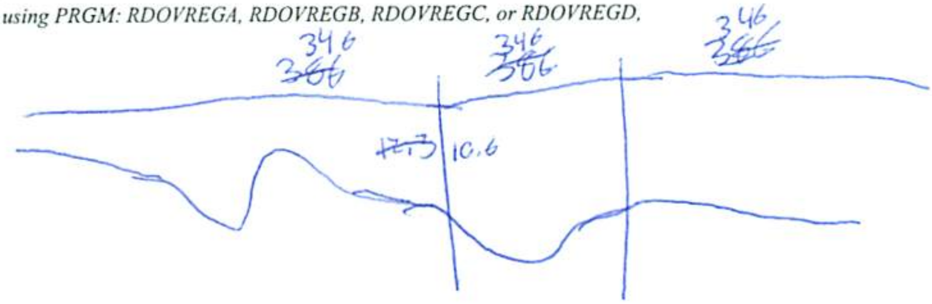
n (LOB) = 0.050

n (ROB) = 0.030

Pier Width = 2.2 ft

Pier Length = 2.5 ft

Piers for 500 yr = 4 ft



CONTRACTION SCOUR

PGRM: Contract

Width of main channel at approach section W_1 = 346 ft

Width of left overbank flow at approach, W_{lob} = 346 ft Average left overbank flow depth, y_{lob} = ~~12.3~~ 10.6 ft

Width of right overbank flow at approach, W_{rob} = 346 ft Average right overbank flow depth, y_{rob} = 10.7 ft

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

x = 8.43 From Figure 9 W_2 (effective) = 325.4 ft y_{cs} = 9.3 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

PIER SCOUR CALCULATIONS

PGRM: Pier

L/a ratio = 1.14 Correction factor for flow angle of attack (from Table 1), K2 = 1

Froude # at bridge = 0.42 Using pier width a on Figure 11, ξ = 8.6 Pier scour y_{ps} = 7.6 ft

ABUTMENT SCOUR CALCULATIONS

PGRM: Abutment

Average flow depth blocked by: left abutment, y_{aLT} = 10.6 ft right abutment, y_{aRT} = 10.7 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} = 21.8 and ψ_{RT} = 21.9

Left abutment scour, $y_{as} = \psi_{LT}(K_1/0.55)$ = 21.8 ft Right abutment scour $y_{as} = \psi_{RT}(K_1/0.55)$ = 21.9 ft

-97.62599

43.31355

Route Colony RD Stream James River MRM ______ Date 6/7/12 Initials [illegible]

Bridge Structure No. 3424611 Location nr Wolf Ck Colony NW of Menno

GPS coordinates: N 43° 20' 37.0'' W 97° 37' 33.4'' taken from: USL abutment X centerline of ⇑ MRM end ______

Datum of coordinates: WGS84 X NAD27 ______

Drainage area = 18364.39 sq. mi.

The average bottom of the main channel was 28.1 ft below top of guardrail at a point 183 ft from left abutment.

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

MISCELLANEOUS CONSIDERATIONS

Flows	Q_{100} = (50)	81000		Q_{500} = (100) 129000		
Estimated flow passing through bridge		81000			84936	
Estimated road overflow & overtopping		0			44064	
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 (crossed out)	X		X (crossed out)	X

5/26

2	1640
5	6550
10	19800
25	47500
50	81000
100	129000
500	318000

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? rose quartz

Riprap	X Yes	____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). piers
3-4) right abutment
4-7). left abutment
8). right abutment
9). pier scour
10). right OB
11). main channel
12). left OB
13). lateral instability

Summary of Results

	~~Q100~~ 50	~~Q500~~ 100
Bridge flow evaluated	81000	84936
Flow depth at left abutment (yaLT), in feet	9.9	10.6
Flow depth at right abutment (yaRT), in feet	10.0	10.7
Contraction scour depth (ycs), in feet	8.6	9.3
Pier scour depth (yps), in feet	7.5	7.6
Left abutment scour depth (yas), in feet	21.3	21.8
Right abutment scour depth (yas), in feet	21.3	21.9
1Flow angle of attack	15	15

See Comments/Diagram for justification where required