OK RJ

SCOUR ANALYSIS AND REPORTING FORM

Bridge Structure No. 39309120 Date 8/4/12 Initials RaT Region (A B C D)

Site _____ Location 0.3mi S, 0.2mi E of Hetland on 208 st

Q_{100} = 1570 by: drainage area ratio____ flood freq. anal. ____ regional regression eq. X

Bridge discharge (Q_2) = 1570 (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 = 36 ft. Flow angle at bridge = 35 ° Abut. Skew = 0 ° Effective Skew = 35 °

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 = 29.49 ft* $q_2 = Q_2/W_2$ = 53.2 ft²/s

Bridge Vel, V_2 = 5.2 ft/s Final $y_2 = q_2/V_2$ = 10.3 ft Δh = 0.5 ft

Average main channel depth at approach section, $y_1 = \Delta h + y_2$ = 10.8 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. = 0.6 ft

Low Steel Elev. = 11.6 ft

n (Channel) = 0.049

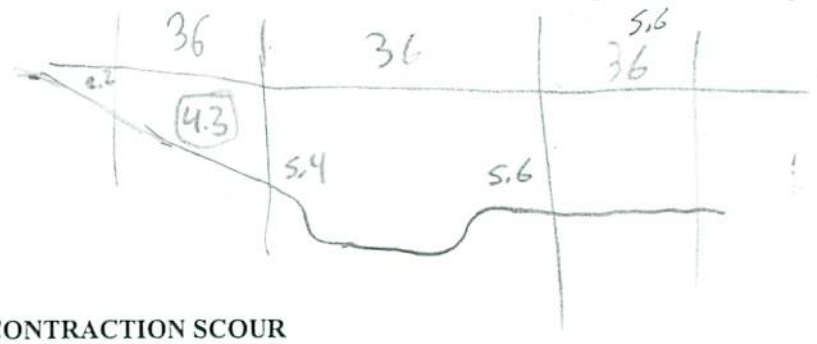
n (LOB) = 0.030

n (ROB) = 0.060

Pier Width = 8 ft

Pier Length = 8 ft

Piers for 100 yr = 0 ft



CONTRACTION SCOUR

PGRM: Contract

Width of main channel at approach section W_1 = 36 ft

Width of left overbank flow at approach, W_{lob} = 36 ft Average left overbank flow depth, y_{lob} = 4.3 ft

Width of right overbank flow at approach, W_{rob} = 36 ft Average right overbank flow depth, y_{rob} = 5.6 ft

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

x = 10.96 From Figure 9 W_2 (effective) = 29.5 ft y_{cs} = 11.1 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, $V_1 = Q_{100}/(y_1W_1)$ = _____ 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 = _____ Correction factor for flow angle of attack (from Table 1), K2 = _____

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

ABUTMENT SCOUR CALCULATIONS

PGRM: Abutment

Average flow depth blocked by: left abutment, y_{aLT} = 4.3 ft right abutment, y_{aRT} = 5.6 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} = 13.8 and ψ_{RT} = 16.1

Left abutment scour, $y_{as} = \psi_{LT}(K_1/0.55)$ = 25.1 ft Right abutment scour $y_{as} = \psi_{RT}(K_1/0.55)$ = 29.3 ft

SCOUR ANALYSIS AND REPORTING FORM

Bridge Structure No. 39309120 Date 8/4/12 Initials RAT Region (A B C D)

Site _____ Location 8.3 mi S, 0.2 mi E of Hetland on 208 st

Q_{500} = 2460 by: drainage area ratio____ flood freq. anal. ____ regional regression eq. X

Bridge discharge (Q_2) = 1994 (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 = 36 ft. Flow angle at bridge = 35 ° Abut. Skew = 0 ° Effective Skew = 35 °

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 = 29.49 ft* $q_2 = Q_2/W_2$ = 67.6 ft^2/s

Bridge Vel, V_2 = 5.8 ft/s Final $y_2 = q_2/V_2$ = 11.6 ft Δh = 0.7 ft

Average main channel depth at approach section, $y_1 = \Delta h + y_2$ = 12.3 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,

Water Surface Elev. = 0.6 ft

Low Steel Elev. = 11.6 ft

n (Channel) = 0.048

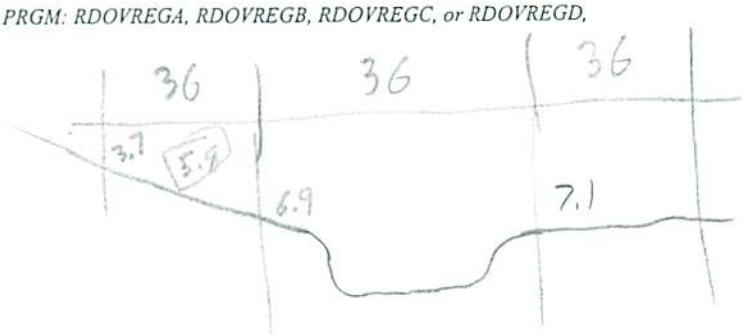
n (LOB) = 0.030

n (ROB) = 0.060

Pier Width = 0 ft

Pier Length = 0 ft

Piers for 500 yr = 0 ft



CONTRACTION SCOUR

PGRM: Contract

Width of main channel at approach section W_1 = 36 ft

Width of left overbank flow at approach, W_{lob} = 36 ft Average left overbank flow depth, y_{lob} = 5.8 ft

Width of right overbank flow at approach, W_{rob} = 36 ft Average right overbank flow depth, y_{rob} = 7.1 ft

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

x = 14.39 From Figure 9 W_2 (effective) = 29.5 ft y_{cs} = 14.7 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

PIER SCOUR CALCULATIONS

PGRM: Pier

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

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

ABUTMENT SCOUR CALCULATIONS

PGRM: Abutment

Average flow depth blocked by: left abutment, y_{aLT} = 5.8 ft right abutment, y_{aRT} = 7.1 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} = 16.5 and ψ_{RT} = 18.8

Left abutment scour, $y_{as} = \psi_{LT}(K_1/0.55)$ = 29.9 ft Right abutment scour $y_{as} = \psi_{RT}(K_1/0.55)$ = 34.1 ft

44° 22' 9.59"
97° 13' 48.612"

44.369331
97.23017

Route _____ Stream _____ MRM _____ Date 8/4/17 Initials RaT

Bridge Structure No. _____ Location 0.3 mi S 0.2 mi E of Hetland on 205 St

GPS coordinates: N44° 22' 9.41" W97° 13' 49.0" taken from: USL abutment X centerline of ↑ MRM end _____

Datum of coordinates: WGS84 X NAD27 _____

Drainage area = 16.7 sq. mi.

The average bottom of the main channel was 16.5 ft below top of guardrail at a point 8 ft from left abutment.

Method used to determine flood flows: ___Freq. Anal. ___drainage area ratio X regional regression equations.

Ryan Thompson

MISCELLANEOUS CONSIDERATIONS

Flows	Q_{100} = 1570			Q_{500} = 2460		
Estimated flow passing through bridge	1570			1994		
Estimated road overflow & overtopping	0			466		
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	131
5	359
10	575
25	923
50	1230
100	1570
500	2460

Riprap at abutments? ___Yes X No ___Marginal

Evidence of past Scour? X Yes ___No ___Don't know minor contraction

Debris Potential? ___High ___Med X Low

1 streamstats calcs on 8/1/17; set $DA_{contrib} = DA_{tot}$

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

Note: assume flow south-North

1). left OB
2). Main Channel
3). right OB
4-5). Right abutment
6-7). left abutment
8). main channel

Summary of Results

	Q100	Q500
Bridge flow evaluated	1570	1994
Flow depth at left abutment (yaLT), in feet	4.3	5.8
Flow depth at right abutment (yaRT), in feet	5.6	7.1
Contraction scour depth (ycs), in feet	11.4	14.7
Pier scour depth (yps), in feet	N/A	N/A
Left abutment scour depth (yas), in feet	25.1	29.9
Right abutment scour depth (yas), in feet	29.3	34.1
1Flow angle of attack	35	35

See Comments/Diagram for justification where required