OK RT

SCOUR ANALYSIS AND REPORTING FORM

Bridge Structure No. 25297040 Date 7/13/12 Initials RaT Region (A B C (D))

Site ______ Location 1mi N, 1mi W of Cresbard

Q_{100} = Q_{10} 1680 by: drainage area ratio ____ flood freq. anal. ____ regional regression eq. X

Bridge discharge (Q_2) = 1680 (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 = 104 ft. Flow angle at bridge = 45 ° Abut. Skew = 0 ° Effective Skew = 45 °

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 = 73.54 ft* $q_2 = Q_2/W_2$ = 22.8 ft^2/s

Bridge Vel, V_2 = 2.4 ft/s Final $y_2 = q_2/V_2$ = 9.5 ft Δh = 0.1 ft

Average main channel depth at approach section, $y_1 = \Delta h + y_2$ = 9.6 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. = 2-4.1 ft 17.4

Low Steel Elev. = 13.5 ft

n (Channel) = 0.045

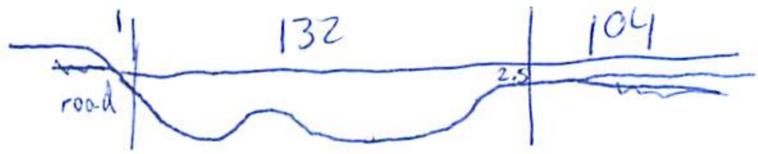
n (LOB) = ~~0.040~~ 0.035

n (ROB) = 0.035

Pier Width = 1.7 ft

Pier Length = 1.65 ft

\# Piers for 100 yr = 4 ft



CONTRACTION SCOUR

PGRM: Contract

4.6 −4.1 = 0.5 0.5/2 0.3

Width of main channel at approach section W_1 = ~~KBR~~ ft 132

Width of left overbank flow at approach, W_{lob} = 1 ft Average left overbank flow depth, y_{lob} = 0.3 ft

Width of right overbank flow at approach, W_{rob} = 104 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 = 11.43 From Figure 9 W_2 (effective) = 66.7 ft y_{cs} = 12.5 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 = 0.97 Correction factor for flow angle of attack (from Table 1), K2 = 1

Froude # at bridge = 0.14 Using pier width a on Figure 11, ξ = 7 Pier scour y_{ps} = 5.2 ft

ABUTMENT SCOUR CALCULATIONS

PGRM: Abutment

Average flow depth blocked by: left abutment, y_{aLT} = 0.3 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} = 1.4 and ψ_{RT} = 10.2

Left abutment scour, $y_{as} = \psi_{LT}(K_1/0.55)$ = 1.4 ft Right abutment scour $y_{as} = \psi_{RT}(K_1/0.55)$ = 10.2 ft

SCOUR ANALYSIS AND REPORTING FORM

Bridge Structure No. 26291040 Date 7/13/12 Initials RoJ Region (A B C (D))

Site ______ Location 1mi N, 1mi W of Cresbard

Q_{500} = Q25 3610 by: drainage area ratio ____ flood freq. anal. ____ regional regression eq. X

Bridge discharge (Q_2) = 3273 (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 = 104 ft. Flow angle at bridge = 45 ° Abut. Skew = 0 ° Effective Skew = 45 °

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 = 73.54 ft* $q_2 = Q_2/W_2$ = 44.5 ft²/s

Bridge Vel, V_2 = 3.3 ft/s Final $y_2 = q_2/V_2$ = 13.5 ft Δh = 0.2 ft

Average main channel depth at approach section, $y_1 = \Delta h + y_2$ = 13.7 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. = 24.0 ft
Low Steel Elev. = 13.4 ft
n (Channel) = 0.045
n (LOB) = 0.035
n (ROB) = 0.035
Pier Width = 1.7 ft
Pier Length = 1.65 ft
Piers for 500 yr = 4 ft

CONTRACTION SCOUR

PGRM: Contract

Width of main channel at approach section W_1 = 132 ft

Width of left overbank flow at approach, W_{lob} = 8 ft Average left overbank flow depth, y_{lob} = 2.3 ft (4.6/2)

Width of right overbank flow at approach, W_{rob} = 104 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 = 19.68 From Figure 9 W_2 (effective) = 66.7 ft y_{cs} = 12.5 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 = 0.97 Correction factor for flow angle of attack (from Table 1), K2 = 1

Froude # at bridge = 0.16 Using pier width a on Figure 11, ξ = 7 Pier scour y_{ps} = 5.3 ft

ABUTMENT SCOUR CALCULATIONS

PGRM: Abutment

Average flow depth blocked by: left abutment, y_{aLT} = 2.3 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} = 9.4 and ψ_{RT} = 16.1

Left abutment scour, $y_{as} = \psi_{LT}(K_1/0.55)$ = 9.4 ft Right abutment scour $y_{as} = \psi_{RT}(K_1/0.55)$ = 16.1 ft

98.96555
45.18694

98° 57′ 55.98″
45° 11′ 12.984″

Route 152nd St Stream North Fork Snake Ck MRM________ Date 7/13/12 Initials [illegible]

Bridge Structure No. 25297040 Location 1 mi N, 1 mi W of Cresbard

GPS coordinates: N45° 11' 13.2" W 98° 57' 55.91" taken from: USL abutment X centerline of ⇑ MRM end ______

Datum of coordinates: WGS84 X NAD27_____

Drainage area = 323.53 sq. mi.

The average bottom of the main channel was 17.4 ft below top of guardrail at a point 49 ft from left abutment.

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

MISCELLANEOUS CONSIDERATIONS

Flows	~~Q100~~ = Q10 1680			~~Q500~~ = Q25 3610		
Estimated flow passing through bridge	1680			3273		
Estimated road overflow & overtopping	0			337		
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	

7/12	
2	165
5	790
10	1680
25	3610
50	5710
100	8470
500	17900

Riprap at abutments? _____Yes _____No X Marginal ~~[illegible]~~ -only on ~~left~~ right abutment

Evidence of past Scour? X Yes _____No _____Don't know - some contraction/pier and significant abutment

Debris Potential? _____High _____Med X Low

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

Riprap _____Yes _____No X 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). left OB
2). main channel
3). right OB
4). pier
5-8). right abutment
9-11). left abutment
12). main channel

Summary of Results

	~~Q100~~ Q10	~~Q500~~ Q25
Bridge flow evaluated	1680	3273
Flow depth at left abutment (yaLT), in feet	0.3	2.3
Flow depth at right abutment (yaRT), in feet	2.5	5.6
Contraction scour depth (ycs), in feet	12.5	17.5
Pier scour depth (yps), in feet	5.2	5.3
Left abutment scour depth (yas), in feet	1.4	9.4
Right abutment scour depth (yas), in feet	10.2	16.1
1Flow angle of attack	45	45

See Comments/Diagram for justification where required