OK TZJ

SCOUR ANALYSIS AND REPORTING FORM

Bridge Structure No. 63039010 Date 10-11-10 Initials RRL Region (A B [✓ C] D)

Site ____________ Location 2.9 E Dolton

Q_{100} = 9720 by: drainage area ratio ✓ flood freq. anal. ____ regional regression eq. ____

Bridge discharge (Q_2) = 9720 (should be Q_{100} unless there is a relief bridge, road overflow, or bridge overtopping)

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

Analytical Procedure for Estimating Hydraulic Variables Needed to Apply Method

Bridge Width = 150 ft. Flow angle at bridge = 15 ° Abut. Skew = 20 ° Effective Skew = 5 °

Width (W_2) iteration = 150 144 145 ____

Avg. flow depth at bridge, y_2 iteration = 11.4 11.6 ____ ____

Corrected channel width at bridge Section = W_2 times cos of flow angle = 144.45 ft* $q_2 = Q_2/W_2$ = 67.3 ft²/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.

* overbank has been removed under bridge

Water Surface Elev. = 2.5 ft

Low Steel Elev. = 14.7 ft

n (Channel) = 0.028

n (LOB) = 0.04

n (ROB) = 0.037

Pier Width = 2 ft

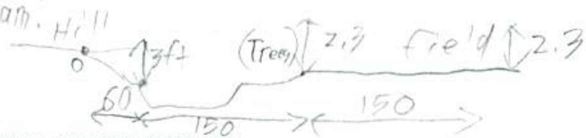
Pier Length = 2 ft

\# Piers for 100 yr = 4 ft

Bride view:

Dug out. i.e. Deposition may occur

upstream:



PGRM: Contract

CONTRACTION SCOUR

Width of main channel at approach section W_1 = 150 ft

Width of left overbank flow at approach, W_{lob} = 60 ft Average left overbank flow depth, y_{lob} = 1.5 ft

Width of right overbank flow at approach, W_{rob} = 150 ft Average right overbank flow depth, y_{rob} = 2.3 ft

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

x = 1.96 From Figure 9 W_2 (effective) = 136.5 ft y_{cs} = 2.5 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, $Vc = 11.52y_1^{1/6}D_{50}^{1/3}$ = ____ 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

PGRM: Pier

PIER SCOUR CALCULATIONS

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

Froude # at bridge = 0.3 Using pier width a on Figure 11, ξ = 8 Pier scour y_{ps} = 6.7 ft

PGRM: Abutment

ABUTMENT SCOUR CALCULATIONS

Average flow depth blocked by: left abutment, y_{aLT} = 1.5 ft right abutment, y_{aRT} = 2.3 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} = 6.3 and ψ_{RT} = 9.4

Left abutment scour, $y_{as} = \psi_{LT}(K_1/0.55)$ = 6.3 ft Right abutment scour $y_{as} = \psi_{RT}(K_1/0.55)$ = 9.4 ft

SCOUR ANALYSIS AND REPORTING FORM

Bridge Structure No. 63039010 Date 10-11-16 Initials RRL Region (A B [✓ C] D)

Site ______ Location 2.9 E Dolton

Q_{500} = 17100 by: drainage area ratio ✓ flood freq. anal. ____ regional regression eq. ____

Bridge discharge (Q_2) = 16237 (should be Q_{500} unless there is a relief bridge, road overflow, or bridge overtopping)

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

Analytical Procedure for Estimating Hydraulic Variables Needed to Apply Method

Bridge Width = 150 ft. Flow angle at bridge = 15 ° Abut. Skew = 20 ° Effective Skew = 5 °

Width (W_2) iteration = 150 ____ ____ ____

Avg. flow depth at bridge, y_2 iteration = 14.7 ____ ____ ____

Corrected channel width at bridge Section = W_2 times cos of flow angle = 149.43 ft* $q_2 = Q_2/W_2$ = 108.7 ft^2/s

Bridge Vel, V_2 = 7.4 ft/s Final $y_2 = q_2/V_2$ = 14.7 ft Δh = 1.1 ft

Average main channel depth at approach section, $y_1 = \Delta h + y_2$ = 15.8 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,

Water Surface Elev. = 2.5 ft

Low Steel Elev. = 14.7 ft

n (Channel) = 0.028

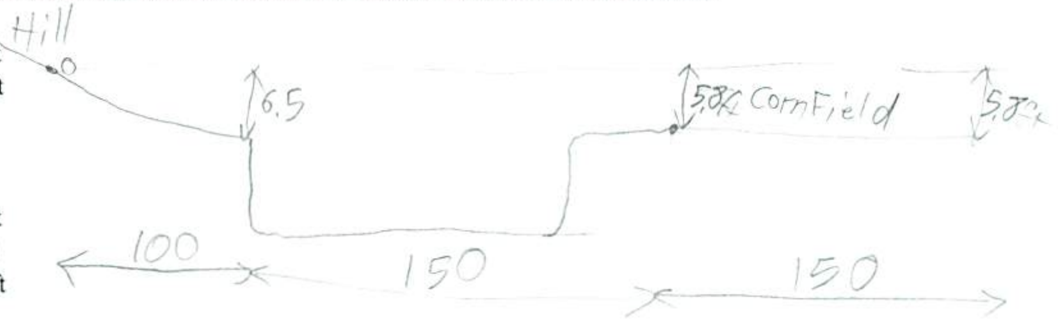
n (LOB) = 0.04

n (ROB) = 0.037

Pier Width = 2 ft

Pier Length = 2 ft

\# Piers for 500 yr = 4 ft



CONTRACTION SCOUR

PGRM: Contract

Width of main channel at approach section W_1 = 150 ft

Width of left overbank flow at approach, W_{lob} = 100 ft Average left overbank flow depth, y_{lob} = 3.25 ft

Width of right overbank flow at approach, W_{rob} = 150 ft Average right overbank flow depth, y_{rob} = 5.8 ft

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

x = 3.9 From Figure 9 W_2 (effective) = 141.4 ft y_{cs} = 4.5 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, $V_1 = Q_{500}/(y_1 W_1)$ = ______ ft/s

Critical approach velocity, $Vc = 11.52y_1^{1/6}D_{50}^{1/3}$ = ______ 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: Pie

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

Froude # at bridge = 0.34 Using pier width a on Figure 11, ξ = 8 Pier scour y_{ps} = 6.8 ft

ABUTMENT SCOUR CALCULATIONS

PGRM: Abutment

Average flow depth blocked by: left abutment, y_{aLT} = 3.25 ft right abutment, y_{aRT} = 5.8 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} = 16.5

Left abutment scour, $y_{as} = \psi_{LT}(K_1/0.55)$ = 12 ft Right abutment scour $y_{as} = \psi_{RT}(K_1/0.55)$ = 16.5 ft

Route 269 St Stream W Fork Vermillion Riv MRM ______ Date 10-11-10 Initials RRL

Bridge Structure No. 63039010 Location 2.9 E Dolton

GPS coordinates: N43° 29.268' W97° 19.760' taken from: USL abutment ✓ centerline of ⇑ MRM end ______

Datum of coordinates: WGS84 ______ NAD27 ______

Drainage area = 309.24 sq. mi.

The average bottom of the main channel was 18.5 ft below top of guardrail at a point 30 ft from left abutment.

Method used to determine flood flows: ____Freq. Anal. ✓ drainage area ratio ____regional regression equations.

MISCELLANEOUS CONSIDERATIONS

Flows	Q_{100} = 9720			Q_{500} = 17100		
Estimated flow passing through bridge	9720			16237		
Estimated road overflow & overtopping	0			863		
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		

Riprap at abutments? ____Yes ____No X Marginal

Evidence of past Scour? ____Yes ____No X Don't know

Debris Potential? ____High X Med ____Low

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

Riprap ____Yes ____No X Don't know ____NA

Spur Dike ____Yes ____No X Don't know ____NA

Other ______________ ____Yes ____No X 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 - Bridge Deck
2 - Upstream
3 - Downstream
4 - Left Overbank
5 - Right Overbank
6 - Left Abutment
7 - Right Abutment
8 - Piers

notes; channel has been dug out under bridge on right side,

Summary of Results

	Q100	Q500
Bridge flow evaluated	9720	16237
Flow depth at left abutment (yaLT), in feet	1.5	3.25
Flow depth at right abutment (yaRT), in feet	2.3	5.8
Contraction scour depth (ycs), in feet	2.5	4.5
Pier scour depth (yps), in feet	6.7	6.8
Left abutment scour depth (yas), in feet	6.3	12
Right abutment scour depth (yas), in feet	9.4	16.5
1Flow angle of attack	5	5

See Comments/Diagram for justification where required