OK RT

SCOUR ANALYSIS AND REPORTING FORM

Bridge Structure No. 52326320 Date 10/14/10 Initials CW Region ([✓ A] B C D)

Site ______ Location near intersection Hisega Rd and Hisega Dr

Q_{100} = 865 by: drainage area ratio ✓ flood freq. anal. ____ regional regression eq. ____

Bridge discharge (Q_2) = 865 (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 = 38 ft. Flow angle at bridge = 10 ° Abut. Skew = -5 7. ° Effective Skew = 15 °

Width (W_2) iteration = 38 37 ____ ____

Avg. flow depth at bridge, y_2 iteration = 4.1 4.1 ____ ____

Corrected channel width at bridge Section = W_2 times cos of flow angle = 35.74 ft* $q_2 = Q_2/W_2$ = 24.2 ft²/s

Bridge Vel, V_2 = 5.9 ft/s Final $y_2 = q_2/V_2$ = 4.1 ft Δh = 0.7 ft

Average main channel depth at approach section, $y_1 = \Delta h + y_2$ = 4.8 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. = —— ft

Low Steel Elev. = —— ft

n (Channel) = 0.040

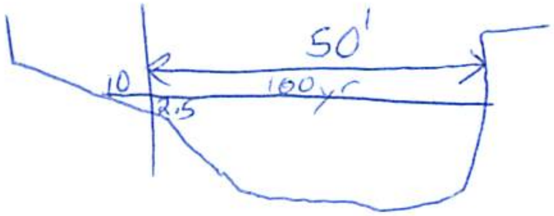
n (LOB) = 0.070

n (ROB) = 0.070

Pier Width = —— ft

Pier Length = —— ft

\# Piers for 100 yr = 0 ft



CONTRACTION SCOUR

PGRM: Contract

Width of main channel at approach section W_1 = 50 ft

Width of left overbank flow at approach, W_{lob} = 10 ft Average left overbank flow depth, y_{lob} = 1.25 ft

Width of right overbank flow at approach, W_{rob} = 0 ft Average right overbank flow depth, y_{rob} = 0 ft

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

x = 2.0 From Figure 9 W_2 (effective) = 35.7 ft y_{cs} = 2.5 ft See Comments

PGRM: CWCSNEW

Clear Water Contraction Scour (use if bed material is larger than small cobbles) ~~2 = 1.85~~ 2=0

Estimated bed material D_{50} = 0.2 ft Average approach velocity, $V_1 = Q_{100}/(y_1W_1)$ = ~~3.6~~ 3.0 ft/s

Critical approach velocity, $Vc = 11.52y_1^{1/6}D_{50}^{1/3}$ = 4.48 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.

$D_{c50} = 0.0006(q_2/y_1^{7/6})^3$ = 0.035 ft If $D_{50} >= D_{c50}$, $\chi = 0.0$

Otherwise, $\chi = 0.122y_1[q_2/(D_{50}^{1/3}y_1^{7/6})]^{6/7} - y_1$ = 0.0 From Figure 10, y_{cs} = 0.0 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} = 1.25 ft right abutment, y_{aRT} = 0 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} = 5.3 and ψ_{RT} = 0

Left abutment scour, $y_{as} = \psi_{LT}(K_1/0.55)$ = ~~7.2~~ 9.6 ft CW Right abutment scour $y_{as} = \psi_{RT}(K_1/0.55)$ = 0 ft

~~0/75~~ CW

3.7
1.2
2.5

SCOUR ANALYSIS AND REPORTING FORM

Bridge Structure No. 52326320 Date 10/14/10 Initials CW Region ([✓ A] B C D)

Site ______ Location near intersection Hisega Rd and Hisega Dr

Q_{500} = 1290 by: drainage area ratio ✓ flood freq. anal. ____ regional regression eq. ____

Bridge discharge (Q_2) = 1290 (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 = 10 ° Abut. Skew = ~5 ° Effective Skew = 15 °

Width (W_2) iteration = 38 ____ ____ ____

Avg. flow depth at bridge, y_2 iteration = 5.1 At vert wall ____

Corrected channel width at bridge Section = W_2 times cos of flow angle = 36.71 ft* $q_2 = Q_2/W_2$ = 35.1 ft²/s

Bridge Vel, V_2 = 7.0 ft/s Final $y_2 = q_2/V_2$ = 5.1 ft Δh = 1.0 ft

Average main channel depth at approach section, $y_1 = \Delta h + y_2$ = 6.0 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. = — ft

Low Steel Elev. = — ft

n (Channel) = 0.040

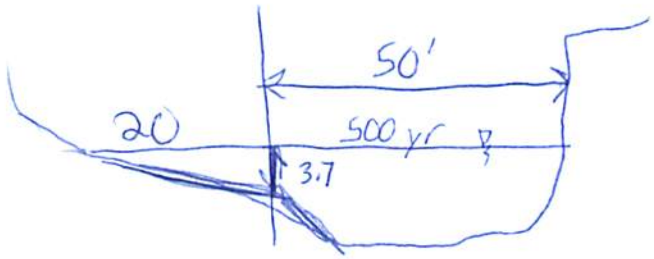
n (LOB) = 0.070

n (ROB) = 0.070

Pier Width = — ft

Pier Length = — ft

\# Piers for 500 yr = 0 ft



CONTRACTION SCOUR

PGRM: Contract

Width of main channel at approach section W_1 = 50 ft

Width of left overbank flow at approach, W_{lob} = 20 ft Average left overbank flow depth, y_{lob} = 1.85 ft

Width of right overbank flow at approach, W_{rob} = 0 ft Average right overbank flow depth, y_{rob} = 0 ft

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

x = 2.44 From Figure 9 W_2 (effective) = 36.7 ft y_{cs} = 3 ft See Comments

PGRM: CWCSNEW

Clear Water Contraction Scour (use if bed material is larger than small cobbles) ~~z=1.85~~ ~~z=0.99~~ z=0

Estimated bed material D_{50} = 0.2 ft Average approach velocity, $V_1 = Q_{500}/(y_1W_1)$ = ~~4.3~~ ft/s 3.07

Critical approach velocity, $Vc = 11.52y_1^{1/6}D_{50}^{1/3}$ = 8.81 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.

$D_{c50} = 0.0006(q_2/y_1^{7/6})^3$ = 0.049 ft If D_{50} >=D_{c50}, χ = 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} = 0.0 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} = 1.85 ft right abutment, y_{aRT} = 0 ft

Shape coefficient K_1= [✓ 1.00] for vertical-wall, 0.82 for vertical-wall with wingwalls, 0.55 for spill-through ~~0/75~~ CW

Using values for y_{aLT} and y_{aRT} on figure 12, ψ_{LT} = 7.6 and ψ_{RT} = 0

Left abutment scour, $y_{as} = \psi_{LT}(K_1/0.55)$ = ~~10.4~~ ft CW Right abutment scour $y_{as} = \psi_{RT}(K_1/0.55)$ = 0 ft

13.9

Route Hisega ~~Dr.~~ Rd Stream Rapid Creek MRM______ Date 10/14/10 Initials Cw

Bridge Structure No. 52326320 Location near intersection Hisega Rd and Hisega Dr

GPS coordinates: N44°03'11.6" W103°24'06.3" taken from: USL abutment _X_ centerline of ⇑ MRM end ______

Datum of coordinates: WGS84 _X_ NAD27_____

Drainage area = 340.23 sq. mi.

The average bottom of the main channel was 11.7 ft below top of guardrail at a point 12 ft from left abutment.

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

MISCELLANEOUS CONSIDERATIONS

Flows	Q_{100} = 865			Q_{500} = 1290		
Estimated flow passing through bridge	865			1290		
Estimated road overflow & overtopping	—			—		
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 _X_ No ____Don't know

Debris Potential? _X_ High ____Med ____Low

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

Riprap ____Yes ____No _X_ Don't know ____NA Looks like boulders

Spur Dike ____Yes ____No ____Don't know _X_ NA

Other __________ ____Yes ____No ____Don't know _X_ NA

Bed Material Classification Based on Median Particle Size (D_{50})

Material	Silt/Clay____	Sand____	Gravel _X_	Cobbles _X_	Boulders____
Size range, in mm	<0.062	0.062-2.00	2.00-64	64-250	>250

Comments, Diagrams & orientation of digital photos

Large Boulder in center of channel

Lots of gravel (large) + small cobbles → ~~Not anticipating Live Bed But will check~~

Not sure if Live Bed or Clear → Checked both

D_{50} might be more like 0.1 < D_{c50} → Live Bed

Photos
1331 - ID
32 - US
33 - R. B US
34 - LB US
35 - R. Abnt
36 - L. Abnt
37 - US Face Bridge

Summary of Results

	Q100	Q500
Bridge flow evaluated	865	1290
Flow depth at left abutment (yaLT), in feet	1.25	1.85
Flow depth at right abutment (yaRT), in feet	0.0	0.0
Contraction scour depth (ycs), in feet	~~0.0~~ 2.5	~~0.0~~ 3
Pier scour depth (yps), in feet	NA	NA
Left abutment scour depth (yas), in feet	cw ~~7.2~~ 9.6	cw ~~10.4~~ 13.9
Right abutment scour depth (yas), in feet	0.0	0.0
1Flow angle of attack	15°	15°

assume live bed

See Comments/Diagram for justification where required