OK RJ

SCOUR ANALYSIS AND REPORTING FORM

Bridge Structure No. 52604298 Date 8/11/14 Initials CW Region (A B C D)

Site _____ Location 0.3 mi S of New Underwood on 16/Alt

Q_{100} = 152 by: drainage area ratio____ flood freq. anal. ____ regional regression eq. ____

Bridge discharge (Q_2) = 152 (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 = 50 ft. Flow angle at bridge = ~~40~~ 0° Abut. Skew = 0 ° Effective Skew = ~~40~~ 0°

Width (W_2) iteration = 50 ~~37~~ ~~44~~ ~~40~~ 33 44 38

Avg. flow depth at bridge, y_2 iteration = ~~2.2~~ ~~2.0~~ ~~2.4~~ ~~2.5~~ 2.4 1.9 2.4 2.1 2.2

Corrected channel width at bridge Section = W_2 times cos of flow angle = ~~37.11~~ ft* 38 $q_2 = Q_2/W_2$ = ~~4.5~~ ft^2/s 4.0

Bridge Vel, V_2 = ~~1.9~~ ft/s 1.6 Final $y_2 = q_2/V_2$ = ~~2.4~~ ft 2.2 Δh = 0.1 ft

Average main channel depth at approach section, $y_1 = \Delta h + y_2$ = ~~2.4~~ ft 2.3

* 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. = 5.9 ft

n (Channel) = 0.035

n (LOB) = 0.033

n (ROB) = 0.033

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} = 0 ft Average left overbank flow depth, y_{lob} = 0.0 ft

Width of right overbank flow at approach, W_{rob} = 0 ft Average right overbank flow depth, y_{rob} = 0.0 ft

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

x = _____ From Figure 9 W_2 (effective) = _____ ft y_{cs} = _____ ft

PGRM: CWCSNEW

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

Estimated bed material D_{50} = 0.14 ft Average approach velocity, $V_1 = Q_{100}/(y_1W_1)$ = 1.32 ft/s

Critical approach velocity, $Vc = 11.17y_1^{1/6}D_{50}^{1/3}$ = 9.46 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.

$D_{c50} = 0.0006(q_2/y_1^{7/6})^3$ = 0.002 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} = 0.0 ft right abutment, y_{aRT} = 0.0 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} = 0.0 and ψ_{RT} = 0.0

Left abutment scour, $y_{as} = \psi_{LT}(K_1/0.55)$ = 0.0 ft Right abutment scour $y_{as} = \psi_{RT}(K_1/0.55)$ = 0.0 ft

SCOUR ANALYSIS AND REPORTING FORM

Bridge Structure No. 52608298 Date 8/11/11 Initials CW Region (A B C D)

Site _____ Location 0.3 mi S of New Underwood on 16L Rte

Q_{500} = 271 by: drainage area ratio____ flood freq. anal. ____ regional regression eq. ____

Bridge discharge (Q_2) = 271 (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 = 50 ft. Flow angle at bridge = ~~40.0~~ ° Abut. Skew = 0 ° Effective Skew = ~~40.0~~ 0

Width (W_2) iteration = 50 ~~45~~ ~~46~~ ~~42.5~~ 34 46 36 44 38

Avg. flow depth at bridge, y_2 iteration = ~~3.0~~ ~~3.2~~ ~~3.1~~ 2.6 3.2 2.7 3.1 2.8 3.0

Corrected channel width at bridge Section = W_2 times cos of flow angle = ~~35.74~~ ft 38 $q_2 = Q_2/W_2$ = ~~7.7~~ ~~ft²/s~~ 7.1

Bridge Vel, V_2 = ~~2.5~~ ft/s 2.4 Final $y_2 = q_2/V_2$ = ~~3.1~~ ft 3.0 Δh = 0.1 ft

Average main channel depth at approach section, $y_1 = \Delta h + y_2$ = ~~3.2~~ ft 3.1

* 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. = 5.9 ft

n (Channel) = 0.035

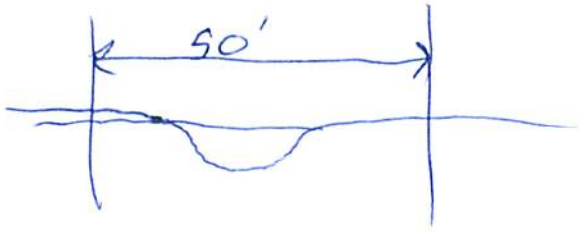
n (LOB) = 0.033

n (ROB) = 0.033

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} = 0 ft Average left overbank flow depth, y_{lob} = 0.0 ft

Width of right overbank flow at approach, W_{rob} = 0 ft Average right overbank flow depth, y_{rob} = 0.0 ft

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

x = _____ From Figure 9 W_2 (effective) = _____ ft y_{cs} = _____ ft

PGRM: CWCSNEW

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

Estimated bed material D_{50} = 0.4 ft Average approach velocity, $V_1 = Q_{500}/(y_1W_1)$ = 1.75 ft/s

Critical approach velocity, $Vc = 11.17y_1^{1/6}D_{50}^{1/3}$ = 9.99 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.

$D_{c50} = 0.0006(q_2/y_1^{7/6})^3$ = 0.004 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

PGRM: Pier

PIER SCOUR CALCULATIONS

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

PGRM: Abutment

ABUTMENT SCOUR CALCULATIONS

Average flow depth blocked by: left abutment, y_{aLT} = 0.0 ft right abutment, y_{aRT} = 0.0 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} = 0.0 and ψ_{RT} = 0.0

Left abutment scour, $y_{as} = \psi_{LT}(K_1/0.55)$ = 0.0 ft Right abutment scour $y_{as} = \psi_{RT}(K_1/0.55)$ = 0.0 ft

Route 161 Ave Stream _____ MRM _____ Date 8/11/11 Initials GA

Bridge Structure No. 52604296 Location 0.3 mi S of New Underwood on 161 Ave

GPS coordinates: N44° 05' 04.8" W102° 50' 03.5" taken from: USL abutment X centerline of ⇑ MRM end _____

Datum of coordinates: WGS84 X NAD27 _____

Drainage area = 0.2 sq. mi.

The average bottom of the main channel was 10.3 ft below top of guardrail at a point 17 ft from left abutment.

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

Pk calc'd 8/8

Pk	
2	10
5	28.6
10	49.2
25	82.3
50	114
100	152
500	271

MISCELLANEOUS CONSIDERATIONS

Flows	Q_{100} = 152			Q_{500} = 271		
Estimated flow passing through bridge		152			271	
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? X Yes ____No ____Marginal

Evidence of past Scour? ____Yes X No ____Don't know

Debris Potential? ____High X Med ____Low

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

Riprap X Yes ____No ____Don't know ____NA

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____	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

92- ID
93- US
94- US RB
95- US LB
96- R. Abut
97- L. Abut
98- US Face

Summary of Results

	Q100	Q500
Bridge flow evaluated	152	271
Flow depth at left abutment (yaLT), in feet	0.0	0.0
Flow depth at right abutment (yaRT), in feet	0.0	0.0
Contraction scour depth (ycs), in feet	0.0	0.0
Pier scour depth (yps), in feet	~~0.0~~ NA	NA
Left abutment scour depth (yas), in feet	0.0	0.0
Right abutment scour depth (yas), in feet	0.0	0.0
1Flow angle of attack	0	0

See Comments/Diagram for justification where required