OK RT

SCOUR ANALYSIS AND REPORTING FORM

Bridge Structure No. 08145098 Date 6/12/12 Initials RaT Region (A B C D)

Site _____ Location 0.5 mi N of Pukwana on 350 Ave

Q_{100} = Q_{10} 966 by: drainage area ratio ____ flood freq. anal. ____ regional regression eq. X

Bridge discharge (Q_2) = 966 (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 = 71 ft. Flow angle at bridge = 0 ° Abut. Skew = 0 ° Effective Skew = ~~30~~ 0 °

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 = 71 ft* $q_2 = Q_2/W_2$ = 13.6 ft^2/s

Bridge Vel, V_2 = 2.6 ft/s Final $y_2 = q_2/V_2$ = 5.2 ft Δh = 1 ft

Average main channel depth at approach section, $y_1 = \Delta h + y_2$ = 5.3 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. = dry ft

Low Steel Elev. = 5.9 ft

n (Channel) = 0.045

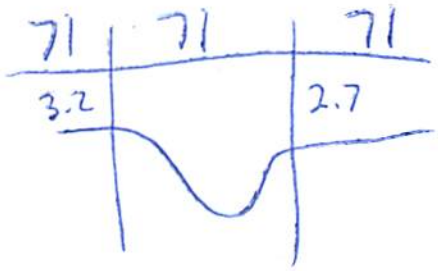
n (LOB) = 0.035

n (ROB) = 0.035

Pier Width = 1.65 ft

Pier Length = 1.65 ft

Piers for 100 yr = 2 ft



CONTRACTION SCOUR

PGRM: Contract

Width of main channel at approach section W_1 = 71 ft

Width of left overbank flow at approach, W_{lob} = 71 ft Average left overbank flow depth, y_{lob} = 3.2 ft

Width of right overbank flow at approach, W_{rob} = 71 ft Average right overbank flow depth, y_{rob} = 2.7 ft

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

x = 5.66 From Figure 9 W_2 (effective) = 67.7 ft y_{cs} = 6.4 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, $V_1 = Q_{100}/(y_1 W_1)$ = _____ 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

PGRM: Pier

PIER SCOUR CALCULATIONS

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

Froude # at bridge = 0.2 Using pier width a on Figure 11, ξ = 6.9 Pier scour y_{ps} = 5.4 ft

PGRM: Abutment

ABUTMENT SCOUR CALCULATIONS

Average flow depth blocked by: left abutment, y_{aLT} = 3.2 ft right abutment, y_{aRT} = 2.7 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} = 11.9 and ψ_{RT} = 11.0

Left abutment scour, $y_{as} = \psi_{LT}(K_1/0.55)$ = 11.9 ft Right abutment scour $y_{as} = \psi_{RT}(K_1/0.55)$ = 11.0 ft

SCOUR ANALYSIS AND REPORTING FORM

Bridge Structure No. 08145098 Date 6/12/12 Initials RaT Region (A B C D)

Site _____ Location 0.5 mi N of Pukwana on 350 Ave

Q_{500} = Gis 1980 by: drainage area ratio____ flood freq. anal. ____ regional regression eq. X

Bridge discharge (Q_2) = 1240 (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 = 71 ft. Flow angle at bridge = 0 ° Abut. Skew = 0 ° Effective Skew = 0 °

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 = 71 ft* $q_2 = Q_2/W_2$ = 17.5 ft^2/s

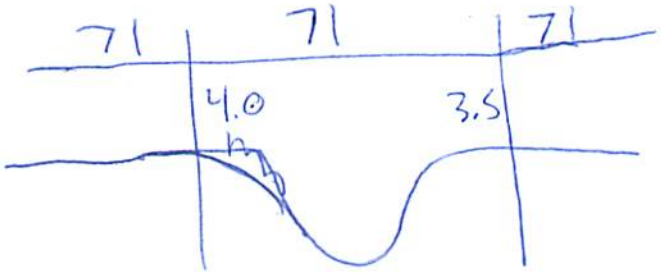
Bridge Vel, V_2 = 3 ft/s Final $y_2 = q_2/V_2$ = 5.9 ft Δh = 0.2 ft

Average main channel depth at approach section, $y_1 = \Delta h + y_2$ = 6.1 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. = dry ft
Low Steel Elev. = 5.9 ft
n (Channel) = 0.045
n (LOB) = 0.035
n (ROB) = 0.035
Pier Width = 1.65 ft
Pier Length = 1.65 ft
Piers for 500 yr = 2 ft



CONTRACTION SCOUR

PGRM: Contract

Width of main channel at approach section W_1 = 71 ft

Width of left overbank flow at approach, W_{lob} = 71 ft Average left overbank flow depth, y_{lob} = 4.0 ft

Width of right overbank flow at approach, W_{rob} = 71 ft Average right overbank flow depth, y_{rob} = 3.5 ft

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

x = 7.63 From Figure 9 W_2 (effective) = 67.7 ft y_{cs} = 8.5 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 $D_{50} >= D_{c50}$, 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} = _____ 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 = 0.22 Using pier width a on Figure 11, ξ = 6.9 Pier scour y_{ps} = 35.5 ft

PGRM: Abutment

ABUTMENT SCOUR CALCULATIONS

Average flow depth blocked by: left abutment, y_{aLT} = 4.0 ft right abutment, y_{aRT} = 3.5 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} = 13.3 and ψ_{RT} = 12.4

Left abutment scour, $y_{as} = \psi_{LT}(K_1/0.55)$ = 13.3 ft Right abutment scour $y_{as} = \psi_{RT}(K_1/0.55)$ = 12.4 ft

99.163347
43.79066
poss
middle

Route 350 Ave FAS 6471 Stream American Ck MRM _____ Date 6/12/12 Initials RaT

Bridge Structure No. 08145098 Location 0.5 mi N of Pukwana on 350 Ave

GPS coordinates: N 43° 47' 26.1" W 97° 10' 39.9" taken from: USL abutment X centerline of ⇑ MRM end _____

Datum of coordinates: WGS84 X NAD27 _____

Drainage area = 100.60 sq. mi.

The average bottom of the main channel was 9.6 ft below top of guardrail at a point 51 ft from left abutment.

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

8/23

2	113
5	477
10	966
25	1970
50	3040
100	4420
500	9020

5/30

2	113
5	479
10	966
25	1980
50	3040
100	4430
500	9030

MISCELLANEOUS CONSIDERATIONS

Flows	Q_{100} = Q10 968			Q_{500} = Q25 1960		
Estimated flow passing through bridge	968			1246		
Estimated road overflow & overtopping	0			740		
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 X No ____Marginal

Evidence of past Scour? X Yes ____No ____Don't know small amounts of contraction, pier, abutment

Debris Potential? ____High ____Med X Low

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 X	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
4-6). left abutment
7-8). right abutment
9). piers
10). bridge deck
11). pier
12). main channel

Note: Channel wide, bridge has a fair, about of gravel - small cobble sized rock (see pictures 4, 10, 12)

Summary of Results

	~~Q100~~ 10	~~Q500~~ 25
Bridge flow evaluated	968	1246
Flow depth at left abutment (yaLT), in feet	3.2	4.0
Flow depth at right abutment (yaRT), in feet	2.7	3.5
Contraction scour depth (ycs), in feet	6.4	8.3
Pier scour depth (yps), in feet	5.4	5.5
Left abutment scour depth (yas), in feet	11.9	13.3
Right abutment scour depth (yas), in feet	11.0	12.4
1Flow angle of attack	0	0

See Comments/Diagram for justification where required