Medicine Creek

SCOUR ANALYSIS AND REPORTING FORM

Bridge Structure No. 43043180 Date 10/10/11 Initials CW Region (A B C D)

Site _____ Location ½ mi N & ½ mi E of Vivian on 239 Ave.

Q_{100} = 4760 by: drainage area ratio ____ flood freq. anal. ____ regional regression eq. ✓

Bridge discharge (Q_2) = 4760 (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 = 64 ft. Flow angle at bridge = 5 ° Abut. Skew = 0 ° Effective Skew = 5 °

Width (W_2) iteration = 64

Avg. flow depth at bridge, y_2 iteration = 10.4 → Vert Wall

Corrected channel width at bridge Section = W_2 times cos of flow angle = 63.76 ft* $q_2 = Q_2/W_2$ = 74.7 ft²/s

Bridge Vel, V_2 = 7.2 ft/s Final $y_2 = q_2/V_2$ = 10.4 ft Δh = 1.1 ft

Average main channel depth at approach section, $y_1 = \Delta h + y_2$ = 11.4 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. = 13.7 ft

11.4 n (Channel) = 0.050

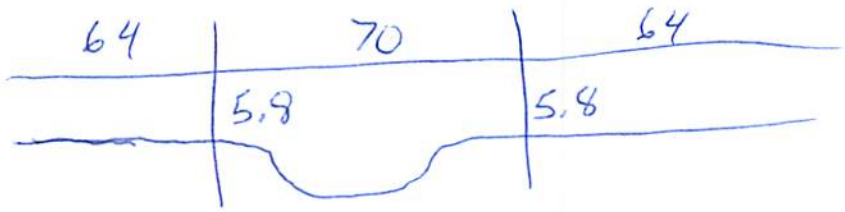
10.7 n (LOB) = 0.050

0.7 n (ROB) = 0.050

5.1 Pier Width = 1.3 ft

5.4 Pier Length = 30 ft

Piers for 100 yr = 2 ft



CONTRACTION SCOUR

PGRM: Contract

11.4 − 3.9 = 15.3

Width of main channel at approach section W_1 = 70 ft

Width of left overbank flow at approach, W_{lob} = 64 ft Average left overbank flow depth, y_{lob} = 5.8 ft

Width of right overbank flow at approach, W_{rob} = 64 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 = 9.38 From Figure 9 W_2 (effective) = 61.2 ft y_{cs} = 10.3 ft

PGRM: CWCSNEW

5.4 − 3.9 = 9.7

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

PIER SCOUR CALCULATIONS

PGRM: Pier

L/a ratio = 23.1 Correction factor for flow angle of attack (from Table 1), K2 = 1.5

Froude # at bridge = 0.39 Using pier width a on Figure 11, ξ = 5.8 Pier scour y_{ps} = 7.6 ft

ABUTMENT SCOUR CALCULATIONS

PGRM: Abutment

Average flow depth blocked by: left abutment, y_{aLT} = 5.4 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} = 16.5 and ψ_{RT} = 16.5

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

SCOUR ANALYSIS AND REPORTING FORM

Bridge Structure No. 43043180 Date 10/10/11 Initials CW Region (A (B) C D)

Site _____ Location ½ mi N & ½ mi E of Vivian on 239 Ave

Q_{500} = 7970 by: drainage area ratio____ flood freq. anal. ____ regional regression eq. ✓

Bridge discharge (Q_2) = 7970 (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 = 64 ft. Flow angle at bridge = 5 ° Abut. Skew = 0 ° Effective Skew = 5 °

Width (W_2) iteration = 64

Avg. flow depth at bridge, y_2 iteration = 13.6 + Vert Wall

Corrected channel width at bridge Section = W_2 times cos of flow angle = 63.76 ft* $q_2 = Q_2/W_2$ = 125 ft^2/s

Bridge Vel, V_2 = 9.2 ft/s Final $y_2 = q_2/V_2$ = 13.6 ft Δh = 1.7 ft

Average main channel depth at approach section, $y_1 = \Delta h + y_2$ = 15.3 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. = _____ ft

Low Steel Elev. = 13.7 ft

n (Channel) = 0.050

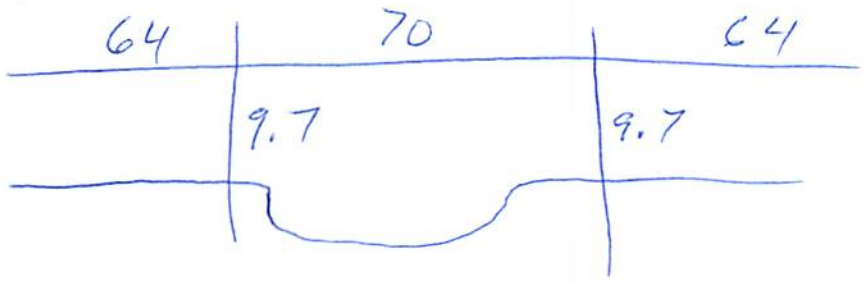
n (LOB) = 0.050

n (ROB) = 0.050

Pier Width = 1.3 ft

Pier Length = 30 ft

Piers for 500 yr = 2 ft



CONTRACTION SCOUR

PGRM: Contract

Width of main channel at approach section W_1 = 70 ft

Width of left overbank flow at approach, W_{lob} = 64 ft Average left overbank flow depth, y_{lob} = 9.7 ft

Width of right overbank flow at approach, W_{rob} = 64 ft Average right overbank flow depth, y_{rob} = 9.7 ft

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

x = 17.19 From Figure 9 W_2 (effective) = 61.2 ft y_{cs} = 16.2 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, $Vc = 11.17 y_1^{1/6} D_{50}^{1/3}$ = _____ 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 = 23.1 Correction factor for flow angle of attack (from Table 1), K2 = 1.5

Froude # at bridge = 0.44 Using pier width a on Figure 11, ξ = 5.8 Pier scour y_{ps} = 7.7 ft

PGRM: Abutment

ABUTMENT SCOUR CALCULATIONS

Average flow depth blocked by: left abutment, y_{aLT} = 9.7 ft right abutment, y_{aRT} = 9.7 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} = 21.1 and ψ_{RT} = 21.1

Left abutment scour, $y_{as} = \psi_{LT}(K_1/0.55)$ = 21.1 ft Right abutment scour $y_{as} = \psi_{RT}(K_1/0.55)$ = 21.1 ft

Route 239 Ave Stream Medicine Ck MRM _____ Date 10/10/11 Initials CW

Bridge Structure No. 43043180 Location ½ mi N + ½ mi E of Vivian on 239 Ave

GPS coordinates: N 43° 56' 03.2" taken from: USL abutment X centerline of ⇑ MRM end _____

W 100° 16' 48.0" Datum of coordinates: WGS84 X NAD27 _____

Drainage area = 87.32 sq. mi.

The average bottom of the main channel was 17.2 ft below top of guardrail at a point 27 ft from left abutment.

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

MISCELLANEOUS CONSIDERATIONS

Flows	Q_{100} = 4760			Q_{500} = 7970		
Estimated flow passing through bridge	4760			7970		
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? X Yes ____No ____Don't know L. Abut

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 ____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 X	Sand X	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

16/4/11

2	318
5	960
10	1160
25	2680
50	3650
100	4760
500	7970

2099 - ID
2100 - us
01 - us RB
02 - us LB
03 - L. Abut Scour
04 - L. Abut
05 - R. Abut
06 - Channel
07 - L. Abut Scour
08 - us Face

Summary of Results

	Q100	Q500
Bridge flow evaluated	4760	7970
Flow depth at left abutment (yaLT), in feet	5.8	9.7
Flow depth at right abutment (yaRT), in feet	5.8	9.7
Contraction scour depth (ycs), in feet	10.3	16.2
Pier scour depth (yps), in feet	7.6	7.7
Left abutment scour depth (yas), in feet	16.5	21.1
Right abutment scour depth (yas), in feet	16.5	21.1
1Flow angle of attack	5°	5°

See Comments/Diagram for justification where required