OK RT

SCOUR ANALYSIS AND REPORTING FORM

Bridge Structure No. 42170155 Date 10-13-11 10 aw Initials RRL Region (A B C D)

Site _____ Location 1.6 S Canton

Q_{100} = 5310 by: drainage area ratio ✓ flood freq. anal. ____ regional regression eq. ____

Bridge discharge (Q_2) = 5310 (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 = 127 ft. Flow angle at bridge = 28 ° Abut. Skew = 0 ° Effective Skew = 28 °

Width (W_2) iteration = 127 _____ _____ _____

Avg. flow depth at bridge, y_2 iteration = 9.7 _____ _____ _____

Corrected channel width at bridge Section = W_2 times cos of flow angle = 112.13 ft* $q_2 = Q_2/W_2$ = 47.4 ft^2/s

Bridge Vel, V_2 = 4.9 ft/s Final $y_2 = q_2/V_2$ = 9.7 ft Δh = 0.5 ft

Average main channel depth at approach section, $y_1 = \Delta h + y_2$ = 10.2 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. = 0.1 ft Road

Low Steel Elev. = 10.8 ft

n (Channel) = 0.05

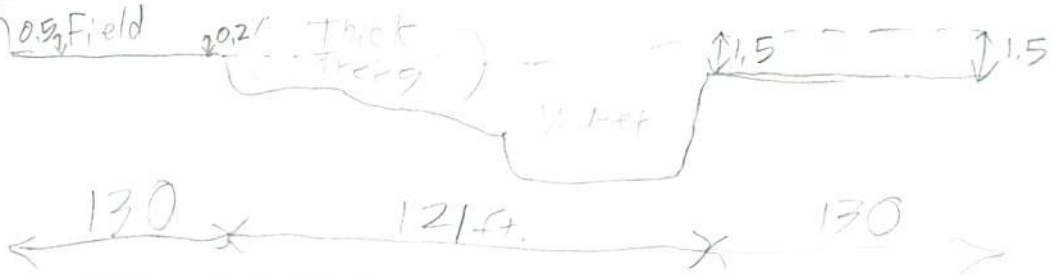
n (LOB) = 0.03

n (ROB) = 0.045

Pier Width = 2 ft

Pier Length = 24 ft

Piers for 100 yr = 4 ft



CONTRACTION SCOUR

PGRM: Contract

Width of main channel at approach section W_1 = 121 ft

Width of left overbank flow at approach, W_{lob} = 130 ft Average left overbank flow depth, y_{lob} = 0.315 ft

Width of right overbank flow at approach, W_{rob} = 130 ft Average right overbank flow depth, y_{rob} = 1.5 ft

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

x = 2.3 From Figure 9 W_2 (effective) = 104.1 ft y_{cs} = 2.8 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 = 0.28 Using pier width a on Figure 11, ξ = 8 Pier scour y_{ps} = 6.6 ft

PGRM: Abutment

ABUTMENT SCOUR CALCULATIONS

Average flow depth blocked by: left abutment, y_{aLT} = 0.315 ft right abutment, y_{aRT} = 1.5 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} = 1.5 and ψ_{RT} = 6.3

Left abutment scour, $y_{as} = \psi_{LT}(K_1/0.55)$ = 1.5 ft Right abutment scour $y_{as} = \psi_{RT}(K_1/0.55)$ = 6.3 ft

SCOUR ANALYSIS AND REPORTING FORM

Bridge Structure No. 42170155 Date 10/13/10 CW Initials RL CW Region (A B C D)

Site _____ Location 1.6 S Canton

Q_{500} = 8330 by: drainage area ratio ✓ flood freq. anal. ____ regional regression eq. ____

Bridge discharge (Q_2) = 6571 (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 = 127 ft. Flow angle at bridge = 28 ° Abut. Skew = 0 ° Effective Skew = 28 °

Width (W_2) iteration = 127 _____ _____ _____

Avg. flow depth at bridge, y_2 iteration = 10.8 _____ _____ _____

Corrected channel width at bridge Section = W_2 times cos of flow angle = 112.13 ft* $q_2 = Q_2/W_2$ = 58.6 ft^2/s

Bridge Vel, V_2 = 5.4 ft/s Final $y_2 = q_2/V_2$ = 10.8 ft Δh = 0.6 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. = 0.1 ft

Low Steel Elev. = 10.8 ft

n (Channel) = 0.03

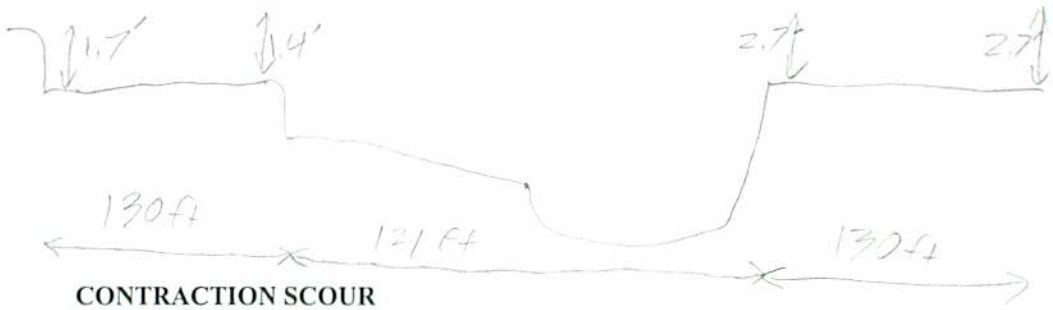
n (LOB) = 0.04

n (ROB) = 0.045

Pier Width = 3 ft

Pier Length = 2 ft

Piers for 500 yr = 4 ft



CONTRACTION SCOUR

PGRM: Contract

Width of main channel at approach section W_1 = 121 ft

Width of left overbank flow at approach, W_{lob} = 130 ft Average left overbank flow depth, y_{lob} = 1.55 ft

Width of right overbank flow at approach, W_{rob} = 130 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 = 3.01 From Figure 9 W_2 (effective) = 104.1 ft y_{cs} = 3.6 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, $Vc = 11.52 y_1^{1/6} D_{50}^{1/3}$ = _____ 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 = 1

Froude # at bridge = 0.29

Correction factor for flow angle of attack (from Table 1), K2 = 1

Using pier width a on Figure 11, ξ = 8 Pier scour y_{ps} = 6.6 ft

ABUTMENT SCOUR CALCULATIONS

PGRM: Abutment

Average flow depth blocked by: left abutment, y_{aLT} = 1.55 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} = 6.4 and ψ_{RT} = 11

Left abutment scour, $y_{as} = \psi_{LT}(K_1/0.55)$ = 6.4 ft Right abutment scour $y_{as} = \psi_{RT}(K_1/0.55)$ = 11 ft

Route 481 Ave Stream Beaver Creek MRM _____ Date _____ Initials _____

Bridge Structure No. 42170155 Location 1.6 S Canton

GPS coordinates: N 43° 16. 752' taken from: USL abutment ____ centerline of ⇑ MRM end ____

W 96° 35. 267' Datum of coordinates: WGS84 ____ NAD27 ____

Drainage area = 126.96 sq. mi.

The average bottom of the main channel was 14.3 ft below top of guardrail at a point 44 ft from left abutment.

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

MISCELLANEOUS CONSIDERATIONS

Flows	Q_{100} = 5310			Q_{500} = 8330		
Estimated flow passing through bridge	5310			6571		
Estimated road overflow & overtopping	0			1759		
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 (on right side only)

Evidence of past Scour? X Yes ____No ____Don't know

Debris Potential? X High ____Med ____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 ____	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 - Pier 9

Summary of Results

	Q100	Q500
Bridge flow evaluated	5310	6571
Flow depth at left abutment (yaLT), in feet	0.315	1.55
Flow depth at right abutment (yaRT), in feet	1.9	2.7
Contraction scour depth (ycs), in feet	2.8	3.6
Pier scour depth (yps), in feet	6.6	6.6
Left abutment scour depth (yas), in feet	1.5	6.4
Right abutment scour depth (yas), in feet	6.3	11
1Flow angle of attack	28	28

See Comments/Diagram for justification where required