OK RT

SCOUR ANALYSIS AND REPORTING FORM

Bridge Structure No. 58038160 Date 7/18/12 Initials RAJ Region (A B C (D))

Site ______ Location 2.2 mi W of Athol on 164 St

Q_{100} = Q_{10} 3890 by: drainage area ratio____ flood freq. anal. ____ regional regression eq. X

Bridge discharge (Q_2) = 3890 (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 = 117 ft. Flow angle at bridge = 20 ° Abut. Skew = 0 ° Effective Skew = 20 °

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 = 109.94 ft* $q_2 = Q_2/W_2$ = 35.4 ft^2/s

Bridge Vel, V_2 = 3 ft/s Final $y_2 = q_2/V_2$ = 12 ft Δh = 0.2 ft

Average main channel depth at approach section, $y_1 = \Delta h + y_2$ = 12.1 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. = 1.4-6.0 ft 21 2.4 5.6 16.8

Low Steel Elev. = 16.8 ft

n (Channel) = 0.035

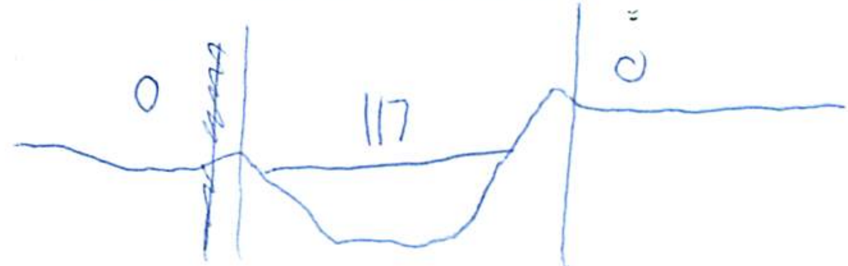
n (LOB) = 0.030

n (ROB) = 0.035

Pier Width = 1 ft

Pier Length = 1 ft

Piers for 100 yr = 2 ft



CONTRACTION SCOUR

PGRM: Contract

Width of main channel at approach section W_1 = 117 ft

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

Width of right overbank flow at approach, W_{rob} = 117 ft Average right overbank flow depth, y_{rob} = 0 ft

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

x = 1.02 From Figure 9 W_2 (effective) = 107.9 ft y_{cs} = 1.5 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, $V_1 = Q_{100}/(y_1W_1)$ = ______ 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 $D_{50} >= D_{c50}$, $\chi = 0.0$

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

PIER SCOUR CALCULATIONS

PGRM: Pier

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

Froude # at bridge = 0.15 Using pier width a on Figure 11, ξ = 4.9 Pier scour y_{ps} = 3.7 ft

ABUTMENT SCOUR CALCULATIONS

PGRM: Abutment

Average flow depth blocked by: left abutment, y_{aLT} = 0 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} = 0 and ψ_{RT} = 0

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

SCOUR ANALYSIS AND REPORTING FORM

Bridge Structure No. 58038160 Date 7/18/12 Initials [illegible] Region (A B C (D))

Site ________ Location 2.2 mi W of Athol on 164 St

Q_{500} = Q_{2c} 8800 by: drainage area ratio____ flood freq. anal. ____ regional regression eq. X

Bridge discharge (Q_2) = 7391 (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 = 117 ft. Flow angle at bridge = 20 ° Abut. Skew = 0 ° Effective Skew = 20 °

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 = 109.94 ft* $q_2 = Q_2/W_2$ = 67.2 ft²/s

Bridge Vel, V_2 = 4 ft/s Final $y_2 = q_2/V_2$ = 16.8 ft Δh = 0.3 ft

Average main channel depth at approach section, $y_1 = \Delta h + y_2$ = 17.1 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. = 1.4-8.0 ft

Low Steel Elev. = 16.8 ft

n (Channel) = 0.035

n (LOB) = 0.030

n (ROB) = 0.035

Pier Width = 1 ft

Pier Length = 1 ft

\# Piers for 500 yr = 2 ft

CONTRACTION SCOUR

PGRM: Contract

Width of main channel at approach section W_1 = 117 ft

Width of left overbank flow at approach, W_{lob} = 117 ft Average left overbank flow depth, y_{lob} = ~~[illegible]~~ 4.4 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 = 3.69 From Figure 9 W_2 (effective) = 107.9 ft y_{cs} = 4.3 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, $V_c = 11.17 y_1^{1/6} D_{50}^{1/3}$ = ________ 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 = 1 Correction factor for flow angle of attack (from Table 1), K2 = 1

Froude # at bridge = 0.17 Using pier width a on Figure 11, ξ = 4.9 Pier scour y_{ps} = 3.7 ft

ABUTMENT SCOUR CALCULATIONS

PGRM: Abutment

Average flow depth blocked by: left abutment, y_{aLT} = 4.4 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} = 14 and ψ_{RT} = 0

Left abutment scour, $y_{as} = \psi_{LT}(K_1/0.55)$ = 14 ft Right abutment scour $y_{as} = \psi_{RT}(K_1/0.55)$ = 0 ft

Route 164 St Stream S Fk. Snake Ck MRM ________ Date 7/16/12 Initials [illegible]

Bridge Structure No. 58038160 Location 2.2 mi W of Athol on 164 St

GPS coordinates: N 45° 00' 46.4" W 98° 35' 23.3" taken from: USL abutment X centerline of ⇑ MRM end ______

Datum of coordinates: WGS84 X NAD27 ______

Drainage area = 1400 sq. mi.

The average bottom of the main channel was 22.4 ft below top of guardrail at a point 46 ft from left abutment.

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

MISCELLANEOUS CONSIDERATIONS

Flows	~~Q100~~ = Q10 3890			~~Q500~~ = Q25 5800		
Estimated flow passing through bridge	3890			7391 ~~1409~~		
Estimated road overflow & overtopping	0			1409		
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	

7/12	
2	325
5	1730
10	3890
25	5800
50	14400
100	22000
500	49100

Riprap at abutments? X Yes ____No ____Marginal heavy abutment, contraction

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

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____	Cobbles X	Boulders X
Size range, in mm	<0.062	0.062-2.00	2.00-64	64-250	>250

Notes: lots of riprap spilled into channel. consider clear water contraction. Much >250 mm making it difficult to determine channel depth

Comments, Diagrams & orientation of digital photos

1). left ob
2). main channel
3). right ob.
4-5). right ~~ob~~ abutment
6). left abutment
7-8). p.e.r.
~~9). left a~~
~~9). left abutment~~
9-10). left abutment
11). right abutment
12). main channel

Summary of Results

	~~Q100~~ Q10	~~Q500~~ Q25
Bridge flow evaluated	3890	7391
Flow depth at left abutment (yaLT), in feet	0	4.4
Flow depth at right abutment (yaRT), in feet	0	0
Contraction scour depth (ycs), in feet	1.5	4.3
Pier scour depth (yps), in feet	3.7	3.7
Left abutment scour depth (yas), in feet	0	~~4.4~~ 14
Right abutment scour depth (yas), in feet	0	0
1Flow angle of attack	20	20

See Comments/Diagram for justification where required