OK RT

SCOUR ANALYSIS AND REPORTING FORM

Bridge Structure No. 34162052 Date 6/6/12 Initials DAT Region (A B [✓ C] D)

Site ______ Location nr Milltown on Keiper Rd

$Q_{\cancel{100}}^{25}$ = 45300 by: drainage area ratio ____ flood freq. anal. ____ regional regression eq. X

Bridge discharge (Q_2) = 45300 (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 = 360 ft. Flow angle at bridge = 5 ° Abut. Skew = 0 ° Effective Skew = 5 °

Width (W_2) iteration = 378.55 352.65 354 364 362.61

Avg. flow depth at bridge, y_2 iteration = 15.4 16 15.8 W_2 = 362.61

Corrected channel width at bridge Section = W_2 times cos of flow angle = ~~376.35~~ ft* $q_2 = Q_2/W_2$ = 124.9 ft^2/s

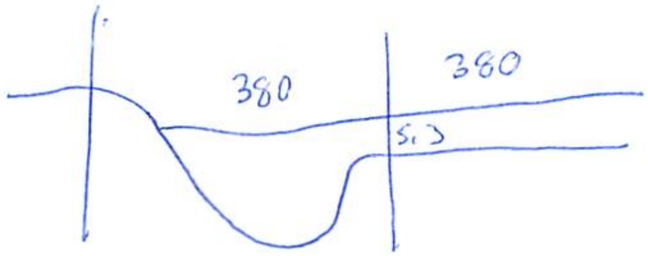
Bridge Vel, V_2 = 7.9 ft/s Final $y_2 = q_2/V_2$ = 15.8 ft Δh = 1.3 ft

Average main channel depth at approach section, $y_1 = \Delta h + y_2$ = 17.0 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. = 5.3 ft
Low Steel Elev. = 20.0 ft
n (Channel) = 0.040
n (LOB) = 0.040
n (ROB) = 0.035
Pier Width = 2.95 ft
Pier Length = 2.95 ft
Piers for 100 yr = 4 ft



CONTRACTION SCOUR

PGRM: Contract

Width of main channel at approach section W_1 = 380 ft

Width of left overbank flow at approach, W_{lob} = 0 ~~380~~ ft Average left overbank flow depth, y_{lob} = 0 ft

Width of right overbank flow at approach, W_{rob} = 380 ft Average right overbank flow depth, y_{rob} = 5.3 ft

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

x = 4.43 From Figure 9 W_2 (effective) = 350.8 ft y_{cs} = 5.1 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, $V_c = 11.17 y_1^{1/6} D_{50}^{1/3}$ = ______ 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 = 0.35 Using pier width a on Figure 11, ξ = 10.6 Pier scour y_{ps} = 9.1 ft

ABUTMENT SCOUR CALCULATIONS

PGRM: Abutment

Average flow depth blocked by: left abutment, y_{aLT} = 1.0 ft right abutment, y_{aRT} = 5.3 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} = 4.3 and ψ_{RT} = 15.6

Left abutment scour, $y_{as} = \psi_{LT}(K_1/0.55)$ = 4.3 ft Right abutment scour $y_{as} = \psi_{RT}(K_1/0.55)$ = 15.6 ft

SCOUR ANALYSIS AND REPORTING FORM

Bridge Structure No. 34162052 Date 6/6/12 Initials RQV Region (A B [✓ C] D)

Site ______ Location nr Milltown on Keiper Rd

~~Q_{500}~~ Q_{50} = 77300 by: drainage area ratio ____ flood freq. anal. ____ regional regression eq. X

Bridge discharge (Q_2) = ~~76500~~ 76200 (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 = 380 ft. Flow angle at bridge = 05 ° Abut. Skew = 0 ° Effective Skew = 05 °

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 = 379.56 ft* $q_2 = Q_2/W_2$ = 20.3 ft^2/s

Bridge Vel, V_2 = 10.1 ft/s Final $y_2 = q_2/V_2$ = 20 ft Δh = 2.1 ft

Average main channel depth at approach section, $y_1 = \Delta h + y_2$ = 22.1 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. = 5.3 ft

Low Steel Elev. = 20.0 ft

n (Channel) = 0.040

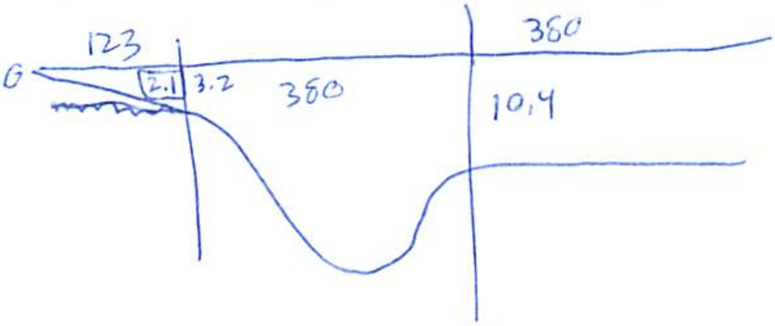
n (LOB) = 0.040

n (ROB) = 0.035

Pier Width = 2.95 ft

Pier Length = 2.95 ft

\# Piers for 500 yr = 4 ft



CONTRACTION SCOUR

PGRM: Contract

Width of main channel at approach section W_1 = 360 ft

$3.2 \cdot \frac{2}{3} = \frac{6.4}{3}$

Width of left overbank flow at approach, W_{lob} = 123 ft Average left overbank flow depth, y_{lob} = 2.1 ft

Width of right overbank flow at approach, W_{rob} = 380 ft Average right overbank flow depth, y_{rob} = 10.4 ft

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

x = ~~7.67~~ 8.4 From Figure 9 W_2 (effective) = ~~375.8~~ 366.8 ft y_{cs} = ~~8.5~~ 9.3 ft

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

PGRM: CWCSNEW

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

PIER SCOUR CALCULATIONS

PGRM: Pie

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

Froude # at bridge = 0.4 Using pier width a on Figure 11, ξ = 10.6 Pier scour y_{ps} = 9.2 ft

ABUTMENT SCOUR CALCULATIONS

PGRM: Abutment

Average flow depth blocked by: left abutment, y_{aLT} = 2.1 ft right abutment, y_{aRT} = 10.4 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} = 8.6 and ψ_{RT} = 21.7

Left abutment scour, $y_{as} = \psi_{LT}(K_1/0.55)$ = 8.6 ft Right abutment scour $y_{as} = \psi_{RT}(K_1/0.55)$ = 21.7 ft

97,79363
43,42608

Route Keiper Rd Stream James River MRM ________ Date 6/6/12 Initials RaT

Bridge Structure No. 34162052 Location nr Milltown on Keiper Rd

GPS coordinates: N43° 25' 33.7'' taken from: USL abutment X centerline of ⇑ MRM end ______

W 97° 47' 37.2'' Datum of coordinates: WGS84 X NAD27_____

Drainage area = 1774 0.55 sq. mi.

The average bottom of the main channel was 16.3 ft below top of guardrail at a point 219 ft from left abutment.

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

MISCELLANEOUS CONSIDERATIONS

Flows	Q_{100} = Q25 45300			~~Q_{500}~~ = Q50 77300		
Estimated flow passing through bridge	45300			~~[illegible]~~ 76208		
Estimated road overflow & overtopping	0			192		
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	

5/26

2	1520
5	5080
10	18900
25	45300
50	77300
100	123000
500	303000

Riprap at abutments? _____Yes _____No X Marginal along left abutment

Evidence of past Scour? X Yes _____No _____Don't know contraction

Debris Potential? _____High X Med _____Low - quite a few unfallen dead trees

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

Riprap X Yes _____No _____Don't know _____NA - along left abt. rose quartz

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). main channel
2). piers
3). right abut
4). left abut.
5). left abut
6). right abut.
7). right CB
8). main channel
9) left CB

Summary of Results

	~~Q100~~ Q25	~~Q500~~ Q50
Bridge flow evaluated	45300	76208
Flow depth at left abutment (yaLT), in feet	0	2.1
Flow depth at right abutment (yaRT), in feet	5.3	10.4
Contraction scour depth (ycs), in feet	5.1	~~8.5~~ 9.3
Pier scour depth (yps), in feet	9.1	9.2
Left abutment scour depth (yas), in feet	4.3	8.6
Right abutment scour depth (yas), in feet	15.6	21.7
1Flow angle of attack	5	5

See Comments/Diagram for justification where required