OK RT

1816060 from Riverside, 2.6N, 2W, James River

SCOUR ANALYSIS AND REPORTING FORM

Bridge Structure No. ~~18155030~~ Date 6/5/12 Initials RAT Region (A B C D)

Site _____ Location ~~from Lobmis 0.6N, 4.2E,~~ James River

Q_{100} = ~~28700~~ ^{025} 40700 by: drainage area ratio ____ flood freq. anal. ____ regional regression eq. Y

Bridge discharge (Q_2) = 40700 (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 = 326 ft. Flow angle at bridge = 15 ° Abut. Skew = 0 ° Effective Skew = 15 °

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 = 314.89 ft* $q_2 = Q_2/W_2$ = 129.3 ft^2/s

Bridge Vel, V_2 = 8.1 ft/s Final $y_2 = q_2/V_2$ = 16 ft Δh = 1.3 ft

Average main channel depth at approach section, $y_1 = \Delta h + y_2$ = 17.4 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. = 4.6 ft 21

Low Steel Elev. = 16.7 ft 22.2

n (Channel) = 0.030 5.5

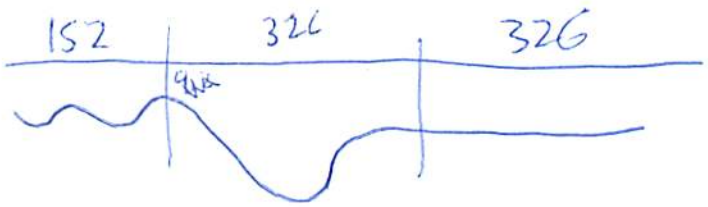
n (LOB) = 0.060 16.7

n (ROB) = 0.025

Pier Width = 2.2 ft

Pier Length = 2.5 ft

Piers for 100 yr = 3 ft



CONTRACTION SCOUR

PGRM: Contract

Width of main channel at approach section W_1 = 326 ft

Width of left overbank flow at approach, W_{lob} = 152 ft Average left overbank flow depth, y_{lob} = 3.5 ft

Width of right overbank flow at approach, W_{rob} = 326 ft Average right overbank flow depth, y_{rob} = 10.6 ft

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

x = 10.96 From Figure 9 W_2 (effective) = 308.3 ft y_{cs} = 12 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, $Vc = 11.52 y_1^{1/6} D_{50}^{1/3}$ = _____ 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

PGRM: Pier

PIER SCOUR CALCULATIONS

L/a ratio = 1.136 Correction factor for flow angle of attack (from Table 1), K2 = 1

Froude # at bridge = 0.36 Using pier width a on Figure 11, ξ = 4.6 Pier scour y_{ps} = 7.4 ft

PGRM: Abutment

ABUTMENT SCOUR CALCULATIONS

Average flow depth blocked by: left abutment, y_{aLT} = 3.5 ft right abutment, y_{aRT} = 10.6 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} = 12.41 and ψ_{RT} = 21.8

Left abutment scour, $y_{as} = \psi_{LT}(K_1/0.55)$ = 12.4 ft Right abutment scour $y_{as} = \psi_{RT}(K_1/0.55)$ = 21.8 ft

1816060 from Riverside, 2.6 N, 2W, James River

SCOUR ANALYSIS AND REPORTING FORM

Bridge Structure No. ~~18153030~~ Date 6/5/12 Initials RAT Region (A B C D)

Site _____ Location ~~from Loomis, 0.6N, 4.2E~~

Q_{500} = ~~54800~~ Q50 69400 by: drainage area ratio ~~VT~~ flood freq. anal. ____ regional regression eq. λ

Bridge discharge (Q_2) = 44176 (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 = 326 ft. Flow angle at bridge = 15 ° Abut. Skew = 0 ° Effective Skew = 15 °

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 = 314.89 ft* $q_2 = Q_2/W_2$ = 140.3 ft^2/s

Bridge Vel, V_2 = 8.4 ft/s Final $y_2 = q_2/V_2$ = 16.7 ft Δh = 1.4 ft

Average main channel depth at approach section, $y_1 = \Delta h + y_2$ = 18.1 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. = 4.6 ft

Low Steel Elev. = 16.7 ft

n (Channel) = 0.030

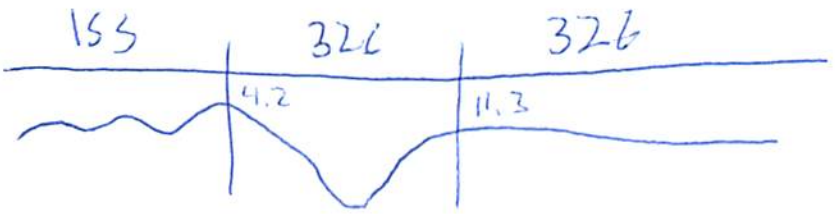
n (LOB) = 0.060

n (ROB) = 0.025

Pier Width = 2.2 ft

Pier Length = 2.5 ft

Piers for 500 yr = 3 ft



CONTRACTION SCOUR

PGRM: Contract

Width of main channel at approach section W_1 = 326 ft

Width of left overbank flow at approach, W_{lob} = 155 ft Average left overbank flow depth, y_{lob} = 4.2 ft

Width of right overbank flow at approach, W_{rob} = 326 ft Average right overbank flow depth, y_{rob} = ~~10.6~~ 11.3 ft

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

x = 1.91 From Figure 9 W_2 (effective) = 308.3 ft y_{cs} = 13 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, $Vc = 11.52y_1^{1/6}D_{50}^{1/3}$ = _____ 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

PIER SCOUR CALCULATIONS

PGRM: Pier

L/a ratio = 1.136 Correction factor for flow angle of attack (from Table 1), K2 = 1

Froude # at bridge = 0.36 Using pier width a on Figure 11, ξ = 6.6 Pier scour y_{ps} = 7.4 ft

ABUTMENT SCOUR CALCULATIONS

PGRM: Abutment

Average flow depth blocked by: left abutment, y_{aLT} = 4.2 ft right abutment, y_{aRT} = 11.3 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} = 13.6 and ψ_{RT} = 22.4

Left abutment scour, $y_{as} = \psi_{LT}(K_1/0.55)$ = 13.6 ft Right abutment scour $y_{as} = \psi_{RT}(K_1/0.55)$ = 22.4 ft

99.0226
43.80426

1815300 Riverside 26N, 2W

Route 247th St Stream James River MRM _____ Date 6/5/12 Initials RAT

Bridge Structure No. ~~1815300~~ Location ~~from Loomis~~, 0.6 N, 4.2 E

GPS coordinates: N 43° 45' 39.9" W 97° 59' 15.5" taken from: USL abutment X centerline of ⇑ MRM end _____

Datum of coordinates: WGS84 Y NAD27 _____

Drainage area = 15737.60 sq. mi. 157 47.03

The average bottom of the main channel was 22.2 ft below top of guardrail at a point 99 ft from left abutment.

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

5130
2 1310
5 7110
10 16800
25 40300
50 65800
100 109000
500 267000

2 1320
5 7210
10 16900
25 40700
50 64900
100 111000
500 270000

MISCELLANEOUS CONSIDERATIONS

Flows	~~Q_{100}~~ = Q_{25} ~~3[illegible]~~ 40700			Q_{500} = ~~Q_{50} 54800~~ 69100		
Estimated flow passing through bridge	40700			44176		
Estimated road overflow & overtopping	0			25224		
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? X Yes ____No ____Marginal

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

Debris Potential? ____High ____Med X Low

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

Riprap	X Yes	____No	____Don't know	____NA rose quartz arranged
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 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

1). main channel
2). piers
3). right abutment
4). left abutment
5). ~~pier~~ abutment scour (left)
6). left abutment
7). right abutment
8). left OB
9). main channel
10. right OB
11. left OB

Summary of Results

	~~Q100~~ Q25	~~Q500~~ Q50
Bridge flow evaluated	~~3[illegible]~~ 40700	44176
Flow depth at left abutment (yaLT), in feet	~~16.8~~ 3.5	4.2
Flow depth at right abutment (yaRT), in feet	~~13~~ 10.6	11.3
Contraction scour depth (ycs), in feet	~~9.4~~ 12	13
Pier scour depth (yps), in feet	7.4	7.4
Left abutment scour depth (yas), in feet	12.4	13.6
Right abutment scour depth (yas), in feet	~~21.8~~ 22.4	22.4
1Flow angle of attack	15	15

See Comments/Diagram for justification where required