OK RT

SCOUR ANALYSIS AND REPORTING FORM

Bridge Structure No. 31040141 Date 6/5/12 Initials DRL Region (A B (C) D)

Site ______ Location 25 810 416 Ave, James River

Q_{25} (printed Q_{100} struck out) = ~~29700~~ 43300 by: drainage area ratio NA flood freq. anal. ____ regional regression eq. X

Bridge discharge (Q_2) = 43300 (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 = 383 ft. Flow angle at bridge = 10 ° Abut. Skew = 0 ° Effective Skew = 10 °

Width (W_2) iteration = 377.18 | 332 326.96 | 353 347.64 | 350 344.08

Avg. flow depth at bridge, y_2 iteration = 15.1 | 16.2 | 15.7 | 15.8 (W_2 = 344.60)

Corrected channel width at bridge Section = W_2 times cos of flow angle = ~~[illegible]~~ 344.60 ft* $q_2 = Q_2/W_2$ = 125.6 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, $y_1 = \Delta h + y_2$ = 17.1 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. = 4.5 ft

Low Steel Elev. = 19.5 ft 5.5

n (Channel) = 0.030

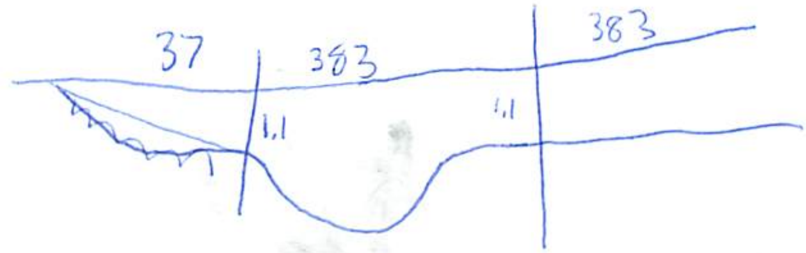
n (LOB) = 0.035

n (ROB) = 0.045

Pier Width = ~~[illegible]~~ 2.4 ft

Pier Length = 2.4 ft

Piers for 100 yr = 4 ft



CONTRACTION SCOUR

PGRM: Contract

Width of main channel at approach section W_1 = 383 ft

$1.7 \cdot 2/3 = .34$

Width of left overbank flow at approach, W_{lob} = 35 ft Average left overbank flow depth, y_{lob} = 1.1 ft

Width of right overbank flow at approach, W_{rob} = 383 ft Average right overbank flow depth, y_{rob} = 1.1 ft

<u>Live Bed Contraction Scour</u> (use if bed material is small cobbles or finer)

x = 2.6 From Figure 9 W_2 (effective) = 335.1 ft y_{cs} = 3.2 ft

PGRM: CWCSNEW

<u>Clear Water Contraction Scour</u> (use if bed material is larger than small cobbles) [section crossed out]

Estimated bed material D_{50} = ______ ft Average approach velocity, $V_1 = Q_{100}/(y_1W_1)$ = ______ ft/s

Critical approach velocity, $V_c = 11.52y_1^{1/6}D_{50}^{1/3}$ = ______ 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 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 = 9.2 Pier scour y_{ps} = 7.9 ft

ABUTMENT SCOUR CALCULATIONS

PGRM: Abutment

Average flow depth blocked by: left abutment, y_{aLT} = 1.1 ft right abutment, y_{aRT} = 1.1 ft

Shape coefficient K_1= 1.00 for vertical-wall, 0.82 for vertical-wall with wingwalls, (0.55 for spill-through) [circled]

Using values for y_{aLT} and y_{aRT} on figure 12, ψ_{LT} = 4.7 and ψ_{RT} = 4.7

Left abutment scour, $y_{as} = \psi_{LT}(K_1/0.55)$ = 4.7 ft Right abutment scour $y_{as} = \psi_{RT}(K_1/0.55)$ = 4.7 ft

SCOUR ANALYSIS AND REPORTING FORM

Bridge Structure No. 31040141 Date 6/5/12 Initials RAL Region (A B (C) D)

Site ________ Location 25810 416 Ave

Q_{500} (50) = 5790 7390 by: drainage area ratio ~~___~~ flood freq. anal. ____ regional regression eq. X

Bridge discharge (Q_2) = 72176 (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 = 383 ft. Flow angle at bridge = 10 ° Abut. Skew = 0 ° Effective Skew = 10 °

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 = 377.18 ft* $q_2 = Q_2/W_2$ = 191.4 ft^2/s

Bridge Vel, V_2 = 9.68 ft/s Final $y_2 = q_2/V_2$ = 19.5 ft Δh = 2 ft

Average main channel depth at approach section, $y_1 = \Delta h + y_2$ = 21.5 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. = 11.5 ft

Low Steel Elev. = 19.5 ft

n (Channel) = 0.030

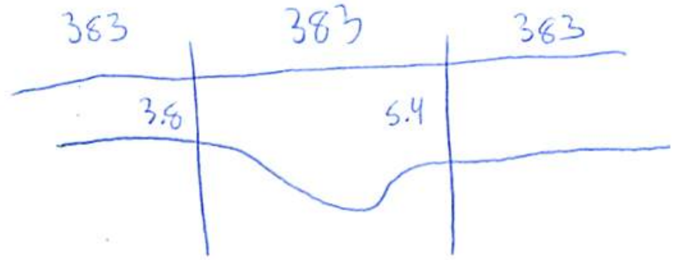
n (LOB) = 0.035

n (ROB) = 0.045

Pier Width = 2.4 ft

Pier Length = 2.4 ft

\# Piers for 500 yr = 4 ft



CONTRACTION SCOUR

PGRM: Contract

Width of main channel at approach section W_1 = 383 ft

Width of left overbank flow at approach, W_{lob} = 383 ft Average left overbank flow depth, y_{lob} = 3.8 ft

Width of right overbank flow at approach, W_{rob} = 383 ft Average right overbank flow depth, y_{rob} = 5.4 ft

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

x = 3.46 From Figure 9 W_2 (effective) = 367.6 ft y_{cs} = 4.1 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, $V_1 = Q_{500}/(y_1 W_1)$ = ____ ft/s

Critical approach velocity, $V_c = 11.52 y_1^{1/6} D_{50}^{1/3}$ = ____ 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 Correction factor for flow angle of attack (from Table 1), K2 = 1

Froude # at bridge = 0.39 Using pier width a on Figure 11, ξ = 9.2 Pier scour y_{ps} = 8 ft

ABUTMENT SCOUR CALCULATIONS

PGRM: Abutment

Average flow depth blocked by: left abutment, y_{aLT} = 3.8 ft right abutment, y_{aRT} = 5.4 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} = 12.9 and ψ_{RT} = 15.7

Left abutment scour, $y_{as} = \psi_{LT}(K_1/0.55)$ = 12.9 ft Right abutment scour $y_{as} = \psi_{RT}(K_1/0.55)$ = 15.7 ft

97,88684
43,64387

Route 416 Ave Stream James River MRM ________ Date 6/5/12 Initials R…T

Bridge Structure No. 3104 0141 Location 25810 416 Ave

GPS coordinates: N 43° 38' 37.9" W 97° 53' 12.8" taken from: USL abutment X centerline of ⇑ MRM end ______

Datum of coordinates: WGS84 X NAD27 _____

Drainage area = ~~17220.31~~ sq. mi. 17221.22

The average bottom of the main channel was 25 ft below top of guardrail at a point 158 ft from left abutment.

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

MISCELLANEOUS CONSIDERATIONS

Flows	~~Q100~~ Q25 = ~~29700~~ 43300			~~Q500~~ Q50 = ~~57900~~ 73900		
Estimated flow passing through bridge	43300			72178		
Estimated road overflow & overtopping	0			1722		
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	

5/30

2	14IO
5	7660
10	18,000
25	43300
50	73900
100	118000
500	289000

Riprap at abutments? _____Yes X No _____Marginal

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

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_____	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). left abutment
4). right abutment
5). left abutment
6). right abutment.
7). left CB
8). right CB
9). main channel

Summary of Results

	~~Q100~~ Q25	~~Q500~~ Q50
Bridge flow evaluated	43300	72178
Flow depth at left abutment (yaLT), in feet	1.1	3.8
Flow depth at right abutment (yaRT), in feet	1.1	5.4
Contraction scour depth (ycs), in feet	3.2	4.1
Pier scour depth (yps), in feet	7.9	8
Left abutment scour depth (yas), in feet	4.7	12.9
Right abutment scour depth (yas), in feet	4.7	15.7
1Flow angle of attack	10	10

See Comments/Diagram for justification where required