OK RT

East to West Flow

SCOUR ANALYSIS AND REPORTING FORM

Bridge Structure No. 34200064 Date 6/7/12 Initials RCT Region (A B (C) D)

Site ________ Location 0.3 mi S of int of 424 Ave & CR11

Q_{100} = 3321 by: drainage area ratio____ flood freq. anal. ____ regional regression eq. X

Bridge discharge (Q_2) = 1221 (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 = 106 ft. Flow angle at bridge = 180 ° Abut. Skew = 0 ° Effective Skew = 0 °

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 = 74.95 ft* $q_2 = Q_2/W_2$ = 16.3 ft^2/s

Bridge Vel, V_2 = 2.9 ft/s Final $y_2 = q_2/V_2$ = 5.7 ft Δh = 0.2 ft

Average main channel depth at approach section, $y_1 = \Delta h + y_2$ = 5.9 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. = 6.5 ft

Low Steel Elev. = 5.7 ft

n (Channel) = 0.050

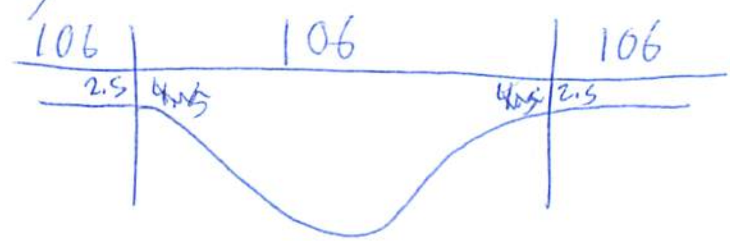
n (LOB) = 0.035

n (ROB) = 0.035

Pier Width = 1.35 ft

Pier Length = 1.35 ft

Piers for 100 yr = 5 ft



CONTRACTION SCOUR

PGRM: Contract

Width of main channel at approach section W_1 = 106 ft

Width of left overbank flow at approach, W_{lob} = 106 ft Average left overbank flow depth, y_{lob} = 2.5 ft

Width of right overbank flow at approach, W_{rob} = 106 ft Average right overbank flow depth, y_{rob} = 2.5 ft

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

x = 9.53 From Figure 9 W_2 (effective) = 68.2 ft y_{cs} = 10.5 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 = 0.21 Using pier width a on Figure 11, ξ = 6 Pier scour y_{ps} = 4.7 ft

ABUTMENT SCOUR CALCULATIONS

PGRM: Abutment

Average flow depth blocked by: left abutment, y_{aLT} = 2.5 ft right abutment, y_{aRT} = 2.5 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} = 10.2 and ψ_{RT} = 10.2

Left abutment scour, $y_{as} = \psi_{LT}(K_1/0.55)$ = 18.6 ft Right abutment scour $y_{as} = \psi_{RT}(K_1/0.55)$ = 18.6 ft

West to East Flow

SCOUR ANALYSIS AND REPORTING FORM

Bridge Structure No. 34200064 Date 6/7/12 Initials RaT Region (A B (C) D)

Site ____________ Location 0.3 mi S of 424 Ave & CR11

Q_{500} = 2200 by: drainage area ratio ____ flood freq. anal. ____ regional regression eq. X

Bridge discharge (Q_2) = 1221 (should be Q_{500} unless there is a relief bridge, road overflow, or bridge overtopping)

PGRM: "RegionA", "RegionB", "RegionC", or "RegionD"

Analytical Procedure for Estimating Hydraulic Variables Needed to Apply Method

Bridge Width = 106 ft. Flow angle at bridge = 45 ° Abut. Skew = 0 ° Effective Skew = 45 °

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 = 74.95 ft* $q_2 = Q_2/W_2$ = 16.3 ft^2/s

Bridge Vel, V_2 = 2.9 ft/s Final $y_2 = q_2/V_2$ = 5.7 ft Δh = 0.2 ft

Average main channel depth at approach section, $y_1 = \Delta h + y_2$ = 5.9 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. = 6.5 ft

Low Steel Elev. = 5.7 ft

n (Channel) = 0.050

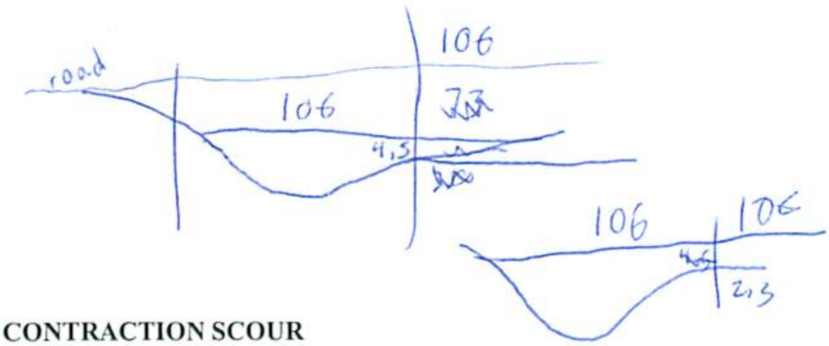
n (LOB) = 0.035

n (ROB) = 0.035

Pier Width = 1.35 ft

Pier Length = 1.35 ft

\# Piers for 500 yr = 5 ft



PGRM: Contract

CONTRACTION SCOUR

Width of main channel at approach section W_1 = 106 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} = 106 ft Average right overbank flow depth, y_{rob} = 2.5 ft

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

x = 6.4 From Figure 9 W_2 (effective) = 68.2 ft y_{cs} = 7.2 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, $Vc = 11.17 y_1^{1/6} D_{50}^{1/3}$ = ________ 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

PGRM: Pie

PIER SCOUR CALCULATIONS

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

Froude # at bridge = 0.21 Using pier width a on Figure 11, ξ = 6 Pier scour y_{ps} = 4.7 ft

PGRM: Abutment

ABUTMENT SCOUR CALCULATIONS

Average flow depth blocked by: left abutment, y_{aLT} = 1.5 ft right abutment, y_{aRT} = 2.5 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} = 6.3 and ψ_{RT} = 10.2

Left abutment scour, $y_{as} = \psi_{LT}(K_1/0.55)$ = 11.4 ft Right abutment scour $y_{as} = \psi_{RT}(K_1/0.55)$ = 18.6 ft

97.71847
43.40934

97.

60.43

97° 43' 6.412"

43° 24' 33.624

Route 424 Ave Stream ______ MRM ______ Date 6/7/12 Initials RaT

Bridge Structure No. 34200064 Location 0.3 mi S of 424 Ave & CR11

GPS coordinates: N 43° 24' 33.0" W 97° 43' 6.60" taken from: USL abutment X centerline of ⇑ MRM end ______

Datum of coordinates: WGS84 X NAD27 ______

Drainage area = 0.07 sq. mi. ← from Stream Stats

The average bottom of the main channel was 10.0 ft below top of guardrail at a point 50 ft from left abutment.

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

MISCELLANEOUS CONSIDERATIONS

Flows	Q100 = West-East			Q500 = East-Flow		
Estimated flow passing through bridge	1221			1221		
Estimated road overflow & overtopping	0			0		
Consideration	Yes	No	Possibly	Yes	No	Possibly
Chance of overtopping	X		X			X
Chance of Pressure flow	X			X		
Armored appearance to channel		X			X	
Lateral instability of channel		X			X	

5/24	
2	4.7
5	11.1
10	17.1
25	26.6
50	34.9
100	44.2
500	69.1

or

5/24	
2	1560
5	8230
10	19200
25	46000
50	75500
100	125000
500	308000

Riprap at abutments? ____ Yes ____ No X Marginal

Evidence of past Scour? X Yes ____ No ____ Don't know

Debris Potential? X High ____ Med ____ Low — depending if James River floods otherwise low

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

Riprap X Yes ____ No ____ Don't know ____ NA — rose quartz along left abutment

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____	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

1-2). left abutment
3). piers
4-5). right abutment
~~debris.~~
6-9) debris

Note channel is dry and road map not high enough resolution to determine upstream/downstream. ~~Assumed flow towards James River~~ Stream stats also showed two cells crossing the road at this point. Used lower flows. It is likely this bridge would recieve some flow from James River in the event of a flood, which would explain the debris and possibly change flow direction. Ran calculations at low steel road N(?) And calculated for both directions, West→East & East→West

Summary of Results

	Q100 West→East	Q500 East→West
Bridge flow evaluated	1221	1221
Flow depth at left abutment (yaLT), in feet	2.5	0
Flow depth at right abutment (yaRT), in feet	2.5	2.5
Contraction scour depth (ycs), in feet	10.5	7.2
Pier scour depth (yps), in feet	4.7	~~7.2~~ 4.7
Left abutment scour depth (yas), in feet	18.6	11.4
Right abutment scour depth (yas), in feet	18.6	18.6
1Flow angle of attack	0	45

See Comments/Diagram for justification where required