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SCOUR ANALYSIS AND REPORTING FORM

Bridge Structure No. 52490346 Date 9/7/12 Initials RAL Region (A B C D)

Site _____ Location S Airport Rd + Rapid Ck in RC

Q_{100} = 6410 by: drainage area ratio ____ flood freq. anal. ____ regional regression eq. X

Bridge discharge (Q_2) = 6410 (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 = 115 ft. Flow angle at bridge = 15 ° Abut. Skew = 0 ° Effective Skew = 15 °

Width (W_2) iteration = 115 93 95 ____

Avg. flow depth at bridge, y_2 iteration = 6.6 7.5 7.4 ____

Corrected channel width at bridge Section = W_2 times cos of flow angle = 91.73 ft* $q_2 = Q_2/W_2$ = 69.9 ft^2/s

Bridge Vel, V_2 = 9.5 ft/s Final $y_2 = q_2/V_2$ = 7.4 ft Δh = 1.8 ft

Average main channel depth at approach section, $y_1 = \Delta h + y_2$ = 9.2 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,

11 12.8 5.4 6.4

Water Surface Elev. = 0.5 ft

Low Steel Elev. = 12.4 ft

n (Channel) = 0.040

n (LOB) = 0.030

n (ROB) = 0.030

Pier Width = 1.9 ft

Pier Length = 1.9 ft

Piers for 100 yr = 2 ft

CONTRACTION SCOUR

PGRM: Contract

Width of main channel at approach section W_1 = 145 ft

Width of left overbank flow at approach, W_{lob} = 115 ft Average left overbank flow depth, y_{lob} = 2.8 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 = 0.17 From Figure 9 W_2 (effective) = 88 ft y_{cs} = 9 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 = 0.62 Using pier width a on Figure 11, ξ = 7.7 Pier scour y_{ps} = 7.1 ft

ABUTMENT SCOUR CALCULATIONS

PGRM: Abutment

Average flow depth blocked by: left abutment, y_{aLT} = 2.8 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} = 11.2 and ψ_{RT} = 0

Left abutment scour, $y_{as} = \psi_{LT}(K_1/0.55)$ = 11.2 ft Right abutment scour $y_{as} = \psi_{RT}(K_1/0.55)$ = 0 ft

SCOUR ANALYSIS AND REPORTING FORM

Bridge Structure No. 52490346 Date 9/7/12 Initials KAL Region (A B C D)

Site _____ Location S Airport Rd & Rapid Ck

Q_{500} = 15700 by: drainage area ratio ____ flood freq. anal. ____ regional regression eq. X

Bridge discharge (Q_2) = 15700 (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 = 115 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 = 111.09 ft* $q_2 = Q_2/W_2$ = 141.3 ft^2/s

Bridge Vel, V_2 = 13 ft/s Final $y_2 = q_2/V_2$ = 10.9 ft Δh = 14.8-3.5 ft

Average main channel depth at approach section, $y_1 = \Delta h + y_2$ = 14.3 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. = 0.5 ft

Low Steel Elev. = 12.0 ft

n (Channel) = 0.046

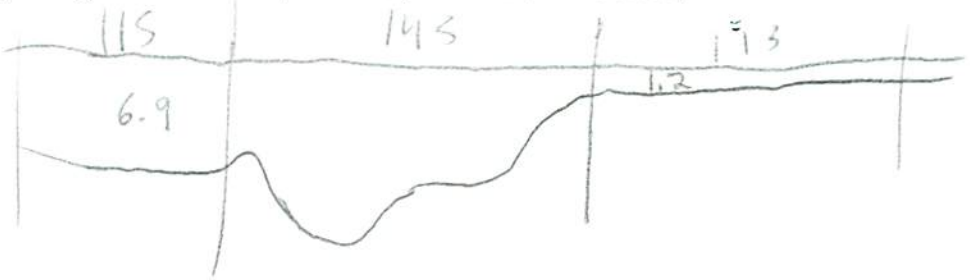
n (LOB) = 0.035

n (ROB) = 0.035

Pier Width = 1.9 ft

Pier Length = 1.9 ft

Piers for 500 yr = 2 ft



CONTRACTION SCOUR

PGRM: Contract

Width of main channel at approach section W_1 = 145 ft

Width of left overbank flow at approach, W_{lob} = 115 ft Average left overbank flow depth, y_{lob} = 6.9 ft

Width of right overbank flow at approach, W_{rob} = 115 ft Average right overbank flow depth, y_{rob} = 1.2 ft

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

x = 11.42 From Figure 9 W_2 (effective) = 107.3 ft y_{cs} = 12.5 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, $V_1 = Q_{500}/(y_1W_1)$ = _____ 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

PGRM: Pier

PIER SCOUR CALCULATIONS

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

Froude # at bridge = 0.7 Using pier width a on Figure 11, ξ = 7.7 Pier scour y_{ps} = 7.3 ft

PGRM: Abutment

ABUTMENT SCOUR CALCULATIONS

Average flow depth blocked by: left abutment, y_{aLT} = 6.9 ft right abutment, y_{aRT} = 1.2 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} = 18.4 and ψ_{RT} = 5.1

Left abutment scour, $y_{as} = \psi_{LT}(K_1/0.55)$ = 18.4 ft Right abutment scour $y_{as} = \psi_{RT}(K_1/0.55)$ = 5.1 ft

Route S. Airport Rd Stream Rapid Ck MRM _____ Date 9/7/12 Initials RAL

Bridge Structure No. 52490346 Location S. Airport Rd & Rapid Ck

GPS coordinates: N 44° 00' 55.91" W 103° 41' 15.01" taken from: USL abutment X centerline of ⇑ MRM end _____

Datum of coordinates: WGS84 X NAD27 _____

Drainage area = 464.54 sq. mi.

The average bottom of the main channel was 17.4 ft below top of guardrail at a point 57 ft from left abutment.

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

MISCELLANEOUS CONSIDERATIONS

Flows	Q_{100} = 6410			Q_{500} = 15700		
Estimated flow passing through bridge	6410			15700		
Estimated road overflow & overtopping	0			0		
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	

7/13

2	233
5	678
10	1260
25	2520
50	4130
100	6410
500	15700

Riprap at abutments? ____Yes X No ____Marginal some contracting pier/right abutment

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

Comments, Diagrams & orientation of digital photos

1). left OB
2). main channel
3). right OB
4). left abutment
5). pier
6-7). right abutment

8). left abutment
~~9). main channel~~
9). pier scour
10). main channel

Summary of Results

	Q100	Q500
Bridge flow evaluated	6410	15700
Flow depth at left abutment (yaLT), in feet	2.8	6.9
Flow depth at right abutment (yaRT), in feet	0	1.2
Contraction scour depth (ycs), in feet	9	12.5
Pier scour depth (yps), in feet	7.1	7.3
Left abutment scour depth (yas), in feet	11.2	15.4
Right abutment scour depth (yas), in feet	0	5.1
1Flow angle of attack	15	15

See Comments/Diagram for justification where required

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