OK RJ

SCOUR ANALYSIS AND REPORTING FORM

Bridge Structure No. 49069017 Date 7/24/12 Initials RGJ Region (A B (C) D)

Site ________ Location NE corner of Carthage on 425 Ave

Q_{100} = 5350 by: drainage area ratio ____ flood freq. anal. ____ regional regression eq. X

Bridge discharge (Q_2) = 5350 (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 = 132 ft. Flow angle at bridge = 35 ° Abut. Skew = 30 ° Effective Skew = 5 °

Width (W_2) iteration = 132 111 ~~119~~ 119 114

Avg. flow depth at bridge, y_2 iteration = 9 9.8 9.5 9.7

Corrected channel width at bridge Section = W_2 times cos of flow angle = ~~130.5~~ 113.57 ft* $q_2 = Q_2/W_2$ = ~~40.7~~ 47.1 ft^2/s

Bridge Vel, V_2 = ~~4.55~~ 4.9 ft/s Final $y_2 = q_2/V_2$ = 9.7 ft Δh = ~~0.59~~ 0.5 ft

Average main channel depth at approach section, $y_1 = \Delta h + y_2$ = ~~9.9~~ 10.2 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.

17.6
5.2
12.4
= 5.2 − 3.8 / 32
100

Water Surface Elev. = 0-3 ft 20.3

Low Steel Elev. = 16.2 ft ~4.1

n (Channel) = ~~0.035~~ 0.045

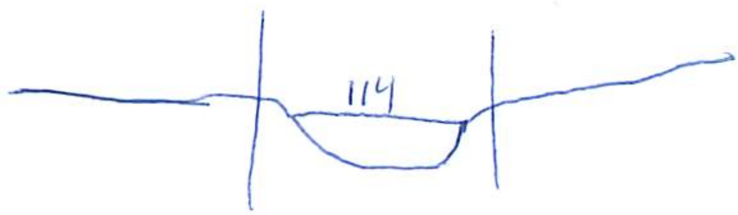
n (LOB) = 0.030

n (ROB) = ~~0.035~~ ~~0.030~~ 0.09

Pier Width = 2.8 ft

Pier Length = 2.8 ft

Piers for 100 yr = 2 ft



CONTRACTION SCOUR

PGRM: Contract

Width of main channel at approach section W_1 = ~~132~~ 114 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} = 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 = 0.57 From Figure 9 W_2 (effective) = 108 ft y_{cs} = 0.9 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 = 0.28 Using pier width a on Figure 11, ξ = 10.2 Pier scour y_{ps} = 8.4 ft

ABUTMENT SCOUR CALCULATIONS

PGRM: Abutment

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

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

SCOUR ANALYSIS AND REPORTING FORM

Bridge Structure No. 49069017 Date 7/24/12 Initials RGJ Region (A B (C) D)

Site ______ Location NE corner of Carthage on 425 Ave

Q_{500} = 10400 by: drainage area ratio ____ flood freq. anal. ____ regional regression eq. X

Bridge discharge (Q_2) = 10400 (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 = 132 ft. 132 Flow angle at bridge = 35 ° Abut. Skew = 30 ° Effective Skew = 5 °

Width (W_2) iteration = ~~130~~ 128

Avg. flow depth at bridge, y_2 iteration = 12.5 12.7

Corrected channel width at bridge Section = W_2 times cos of flow angle = ~~130.5~~ 127.51 ft* $q_2 = Q_2/W_2$ = ~~79.7~~ 81.6 ft^2/s

Bridge Vel, V_2 = 6.4 ft/s Final $y_2 = q_2/V_2$ = ~~12.5~~ 12.7 ft Δh = 0.5 ft

Average main channel depth at approach section, $y_1 = \Delta h + y_2$ = 13.2 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.

Water Surface Elev. = 0-3 ft

Low Steel Elev. = 16.2 ft

n (Channel) = ~~0.035~~ 0.045

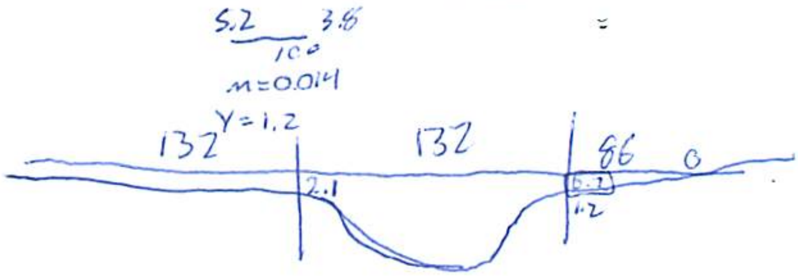
n (LOB) = 0.030

n (ROB) = ~~0.030~~ 0.035

Pier Width = 2.8 ft

Pier Length = 2.8 ft

\# Piers for 500 yr = 2 ft



CONTRACTION SCOUR

PGRM: Contract

Width of main channel at approach section W_1 = 132 ft

Width of left overbank flow at approach, W_{lob} = 132 ft Average left overbank flow depth, y_{lob} = ~~1.9~~ 2.1 ft

Width of right overbank flow at approach, W_{rob} = 86 ft Average right overbank flow depth, y_{rob} = 0.7 ft

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

x = 2.2 From Figure 9 W_2 (effective) = 121.9 ft y_{cs} = 2.7 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

PIER SCOUR CALCULATIONS

PGRM: Pier

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

Froude # at bridge = 0.32 Using pier width a on Figure 11, ξ = 10.2 Pier scour y_{ps} = 8.6 ft

ABUTMENT SCOUR CALCULATIONS

PGRM: Abutment

Average flow depth blocked by: left abutment, y_{aLT} = 2.1 ft right abutment, y_{aRT} = 0.7 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} = 3.1

Left abutment scour, $y_{as} = \psi_{LT}(K_1/0.55)$ = 8.6 ft Right abutment scour $y_{as} = \psi_{RT}(K_1/0.55)$ = 3.1 ft

4244
1.7467
44 6
10.8802
6
64.0812

44° 10' 28.9''
97° 42' 47.2''

97.71311
44.17467

Route 425 Ave Stream Redstone Ck MRM ______ Date 7/24/12 Initials RaT

Bridge Structure No. 49069017 Location NE corner of Carthage on 425 Ave

GPS coordinates: N 44° 10' 27.5" W 97° 42' 45.8" taken from: USL abutment X centerline of ⇑ MRM end ______

Datum of coordinates: WGS84 X NAD27 ______

Drainage area = 143.03 sq. mi. 28.3

The average bottom of the main channel was 28.3 ft below top of guardrail at a point 85 ft from left abutment.

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

MISCELLANEOUS CONSIDERATIONS

Flows	Q_{100} =	5350		Q_{500} =	10400	
Estimated flow passing through bridge		5350			10400	
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	

8/24 (crossed out)

2	475
5	1530
10	2750
25	5030
50	7320
100	10200
500	19200

6/18

2	212
5	725
10	1340
25	2550
50	3750
100	5350
500	10400

Riprap at abutments? ____ Yes X No ____ Marginal

Evidence of past Scour? X Yes ____ No ____ Don't know some pier/contraction

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~~
4). pier
5-6). right abutment
7). pier scour
8-9). left abutment
10). main channel

Summary of Results

	Q100	Q500
Bridge flow evaluated	5350	10400
Flow depth at left abutment (yaLT), in feet	0	2.1
Flow depth at right abutment (yaRT), in feet	0	0.7
Contraction scour depth (ycs), in feet	0.4	2.7
Pier scour depth (yps), in feet	8.4	8.6
Left abutment scour depth (yas), in feet	0	8.6
Right abutment scour depth (yas), in feet	0	3.1
1Flow angle of attack	5	5

See Comments/Diagram for justification where required