97.95156
43.1509

Route 292 St Stream Emanuel Ck MRM _____ Date 6/8/12 Initials RJS

Bridge Structure No. 05109010 Location 3.8mi S & 1mi E of HWY 37 fork on 292 St

GPS coordinates: N 43° 9' 19.8" W 97° 57' 5.6" taken from: USL abutment X centerline of ⇑ MRM end _____

Datum of coordinates: WGS84 X NAD27 _____

Drainage area = 29.12 sq. mi.

The average bottom of the main channel was 14.5 ft below top of guardrail at a point 8 & 40. ft from left abutment.

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

8/22

2	80.6
5	293
10	560
25	1080
50	1620
100	2310
500	4570

MISCELLANEOUS CONSIDERATIONS

Flows	Q_{100} = 1920			Q_{500} = 3720		
Estimated flow passing through bridge	1920			2155		
Estimated road overflow & overtopping	0			1565		
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	

6/4

2	61
5	237
10	461
25	901
50	1350
100	1920
500	3720

Riprap at abutments? ____Yes ____No __X__Marginal

Evidence of past Scour? ____Yes __X__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). main channel
2). right abutment
3). left abutment
4-3). guardian of the channel
6). damage downstream left abut.
7). left OB
8). right OB
9). main channel

Summary of Results

	Q100	Q500
Bridge flow evaluated	1920	2155
Flow depth at left abutment (yaLT), in feet	1.9	2.5
Flow depth at right abutment (yaRT), in feet	2.6	3.2
Contraction scour depth (ycs), in feet	14.9	15.9
Pier scour depth (yps), in feet	4.9	4.9
Left abutment scour depth (yas), in feet	14.2	18.6
Right abutment scour depth (yas), in feet	19.3	21.6
1Flow angle of attack	40	40

See Comments/Diagram for justification where required

SCOUR ANALYSIS AND REPORTING FORM

Bridge Structure No. 05109010 Date 6/9/17 Initials RAT Region (A B C D)

Site _____ Location 3.8 mi S & 1 mi E of Hwy 37 fork, on 292 St

Q_{500} = 3720 by: drainage area ratio ____ flood freq. anal. ____ regional regression eq. X

Bridge discharge (Q_2) = 2155 (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 = 56 ft. Flow angle at bridge = 40 ° Abut. Skew = 0 ° Effective Skew = 40 °

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 = 42.9 ft* $q_2 = Q_2/W_2$ = 50.2 ft^2/s

Bridge Vel, V_2 = 5 ft/s Final $y_2 = q_2/V_2$ = 10 ft Δh = 0.5 ft

Average main channel depth at approach section, $y_1 = \Delta h + y_2$ = 10.5 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. = 0.5 ft

Low Steel Elev. = 10.0 ft

n (Channel) = 0.035

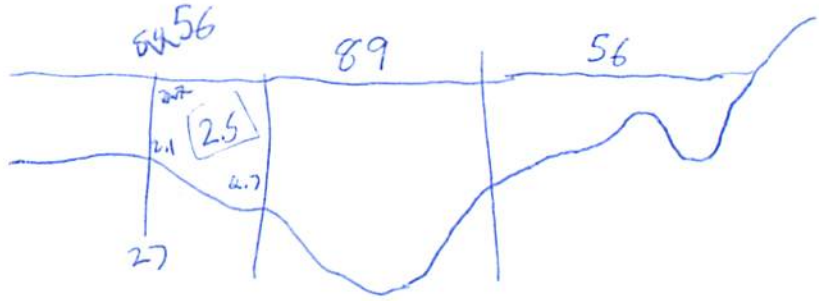
n (LOB) = 0.030

n (ROB) = 0.030

Pier Width = 1.35 ft

Pier Length = 1.35 ft

Piers for 500 yr = 2 ft



CONTRACTION SCOUR

PGRM: Contract

Width of main channel at approach section W_1 = 89 ft

Width of left overbank flow at approach, W_{lob} = 56 ft Average left overbank flow depth, y_{lob} = 2.5 ft

Width of right overbank flow at approach, W_{rob} = 56 ft Average right overbank flow depth, y_{rob} = 3.2 ft

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

x = 16.66 From Figure 9 W_2 (effective) = 40.2 ft y_{cs} = 15.9 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, $V_1 = Q_{500}/(y_1W_1)$ = _____ 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

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 = 6 Pier scour y_{ps} = 4.9 ft

ABUTMENT SCOUR CALCULATIONS

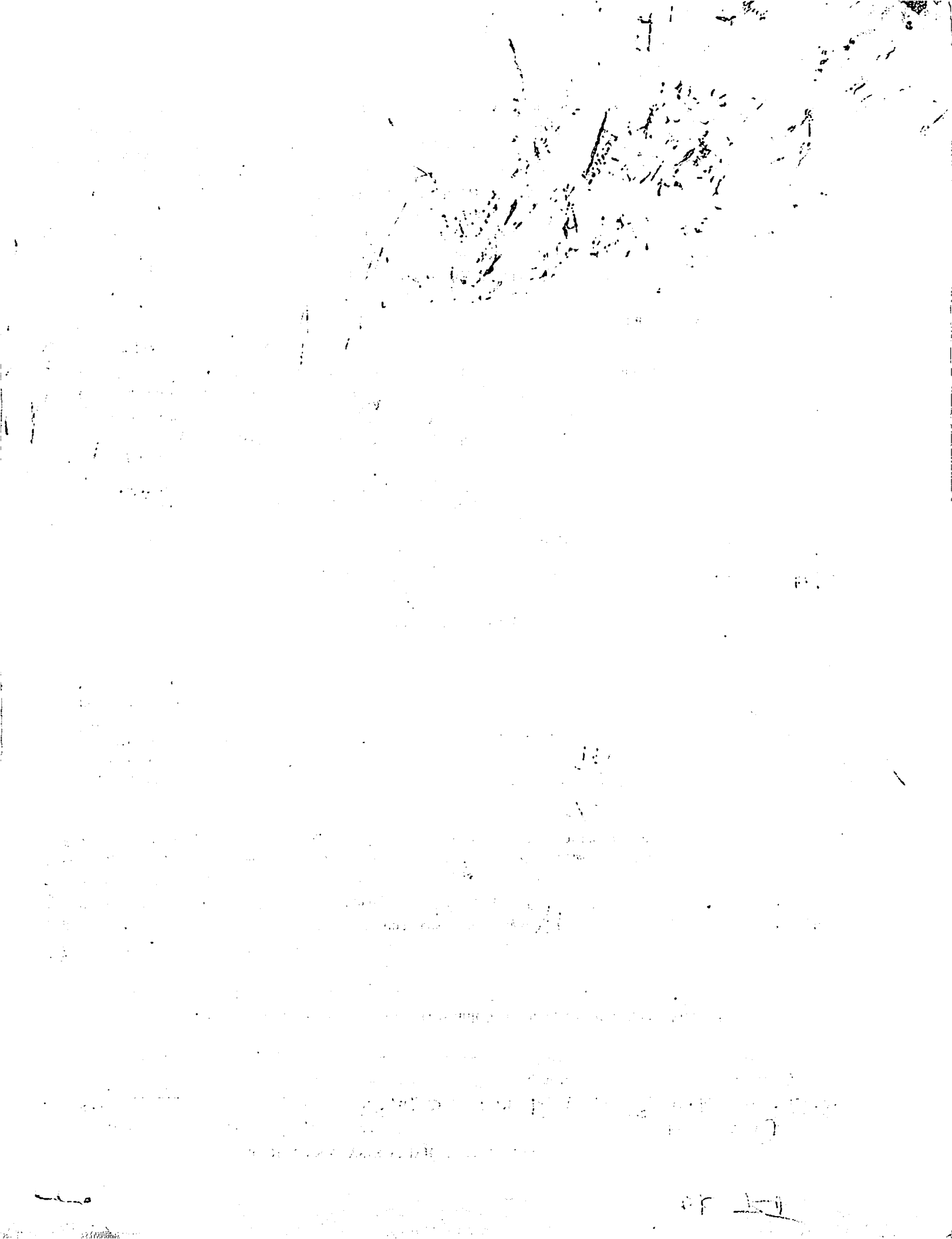
PGRM: Abutment

Average flow depth blocked by: left abutment, y_{aLT} = 2.5 ft right abutment, y_{aRT} = 3.2 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} = 10.2 and ψ_{RT} = 11.9

Left abutment scour, $y_{as} = \psi_{LT}(K_1/0.55)$ = 18.6 ft Right abutment scour $y_{as} = \psi_{RT}(K_1/0.55)$ = 21.6 ft



ok RJ

SCOUR ANALYSIS AND REPORTING FORM

Bridge Structure No. 05109010 Date 6/9/12 Initials RaJ Region (A B C D)

Site _____ Location 3.8 mi S & 1 mi E of HWY 37 fork on 292 St

Q_{100} = 1920 by: drainage area ratio____ flood freq. anal. ____ regional regression eq. X

Bridge discharge (Q_2) = 1920 (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 = 56 ft. Flow angle at bridge = 40 ° Abut. Skew = 0 ° Effective Skew = 46 °

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 = 42.9 ft* $q_2 = Q_2/W_2$ = 44.8 ft^2/s

Bridge Vel, V_2 = 4.7 ft/s Final $y_2 = q_2/V_2$ = 9.4 ft Δh = 0.5 ft

Average main channel depth at approach section, $y_1 = \Delta h + y_2$ = 9.9 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. = 0.5 ft

Low Steel Elev. = 10.0 ft

n (Channel) = 0.030 0.035

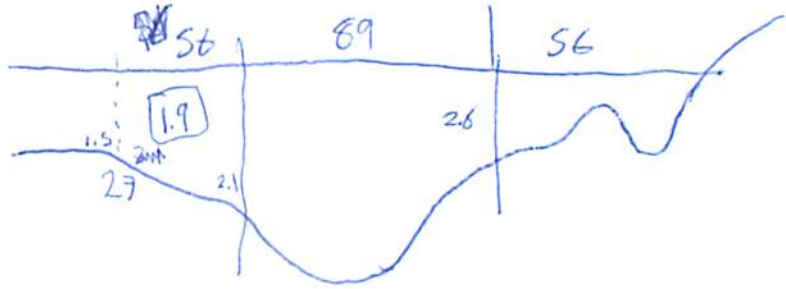
n (LOB) = 0.035 0.030

n (ROB) = 0.035 0.030

Pier Width = 1.35 ft

Pier Length = 1.35 ft

Piers for 100 yr = 2 ft



27-6in

2

CONTRACTION SCOUR

PGRM: Contract

Width of main channel at approach section W_1 = 89 ft

Width of left overbank flow at approach, W_{lob} = 56 ft Average left overbank flow depth, y_{lob} = 1.9 ft

Width of right overbank flow at approach, W_{rob} = 36 ft Average right overbank flow depth, y_{rob} = 2.6 ft

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

x = 14.75 From Figure 9 W_2 (effective) = 40.2 ft y_{cs} = 14.9 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 = 0.27 Using pier width a on Figure 11, ξ = 6 Pier scour y_{ps} = 4.9 ft

ABUTMENT SCOUR CALCULATIONS

PGRM: Abutment

Average flow depth blocked by: left abutment, y_{aLT} = 1.9 ft right abutment, y_{aRT} = 2.6 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} = 7.8 and ψ_{RT} = 10.6

Left abutment scour, $y_{as} = \psi_{LT}(K_1/0.55)$ = 14.2 ft Right abutment scour $y_{as} = \psi_{RT}(K_1/0.55)$ = 19.3 ft