OK RT

SCOUR ANALYSIS AND REPORTING FORM

Bridge Structure No. 18160084 Date 7/7/11 Initials CG Region (A B (C) D)

Site ______ Location NE edge Mitchell, Firesteel Creek, 410th Ave

Q_{100} = 12500* by: drainage area ratio ✓ flood freq. anal. ____ regional regression eq. ____

Bridge discharge (Q_2) = ~~13996~~ (should be Q_{100} unless there is a relief bridge, road overflow, or bridge overtopping)

* see note p.3 → 12312 cfs from most contracted XS thru bridge 146'

Analytical Procedure for Estimating Hydraulic Variables Needed to Apply Method

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

Bridge Width = 166 ft. Flow angle at bridge = 52 ° Abut. Skew = 0 ° Effective Skew = 52 °

Width (W_2) iteration = ~~166~~ 166 146

Avg. flow depth at bridge, y_2 iteration = ~~16~~ 15.6 16.6 → RD Overflow ~~[illegible]~~ 102.2

Corrected channel width at bridge Section = W_2 times cos of flow angle = ~~102.2~~ ft* 88.59 $q_2 = Q_2/W_2$ = 136.9 ft²/s

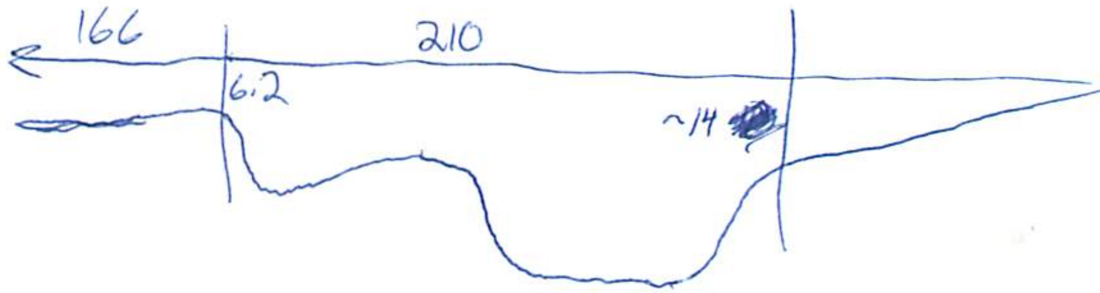
Bridge Vel, V_2 = 6.3 ft/s Final $y_2 = q_2/V_2$ = 16.5 ft Δh = 1.4 ft

Average main channel depth at approach section, $y_1 = \Delta h + y_2$ = 17.9 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. = ____ ft
Low Steel Elev. = 16.5 ft
n (Channel) = 0.040
n (LOB) = 0.100
n (ROB) = 0.100
Pier Width = 2.3 ft
Pier Length = 2.3 ft
\# Piers for 100 yr = 2 ft



CONTRACTION SCOUR

PGRM: Contract

Width of main channel at approach section W_1 = 210 ft

Width of left overbank flow at approach, W_{lob} = 166 ft Average left overbank flow depth, y_{lob} = 6.2 ft

Width of right overbank flow at approach, W_{rob} = 60 ft Average right overbank flow depth, y_{rob} = 7.0 ft

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

x = ~~23.62~~ 29.61 From Figure 9 W_2 (effective) = ~~97.6~~ 85.3 ft y_{cs} = ~~19.6~~ 22.9 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, $Vc = 11.52y_1^{1/6}D_{50}^{1/3}$ = ____ 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 = 1.0 Correction factor for flow angle of attack (from Table 1), K2 = 1.0

Froude # at bridge = 0.36 Using pier width a on Figure 11, ξ = 8.9 Pier scour y_{ps} = 7.6 ft

ABUTMENT SCOUR CALCULATIONS

PGRM: Abutment

Average flow depth blocked by: left abutment, y_{aLT} = 6.2 ft right abutment, y_{aRT} = 7.0 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} = 17.2 and ψ_{RT} = 18.6

Left abutment scour, $y_{as} = \psi_{LT}(K_1/0.55)$ = 17.2 ft Right abutment scour $y_{as} = \psi_{RT}(K_1/0.55)$ = 18.6 ft

SCOUR ANALYSIS AND REPORTING FORM

Bridge Structure No. 18160084 Date 7/7/11 Initials [illegible] Region (A B (C) D)

Site ______ Location NE edge Mitchell

Q_{500} = 18 800 * by: drainage area ratio ✓ flood freq. anal. ____ regional regression eq. ____

Bridge discharge (Q_2) = 13976 *** (should be Q_{500} unless there is a relief bridge, road overflow, or bridge overtopping)

* see note p. 3 ↳** see p. 1 12312 cfs

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

Analytical Procedure for Estimating Hydraulic Variables Needed to Apply Method

Bridge Width = 166 ft. Flow angle at bridge = 52 ° Abut. Skew = 0 ° Effective Skew = 52 °

Width (W_2) iteration = RD Overflow 146' is most contracted

Avg. flow depth at bridge, y_2 iteration = ______ ______ ______ ______

Corrected channel width at bridge Section = W_2 times cos of flow angle = ~~102.2~~ 89.89 ft* $q_2 = Q_2/W_2$ = 136.9 ft²/s

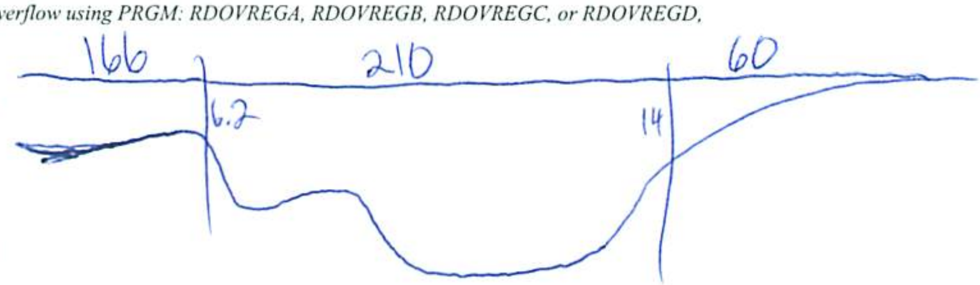
Bridge Vel, V_2 = 8.3 ft/s Final $y_2 = q_2/V_2$ = 16.5 ft Δh = 1.4 ft

Average main channel depth at approach section, $y_1 = \Delta h + y_2$ = 17.9 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. = ______ ft
Low Steel Elev. = 16.5 ft
n (Channel) = 0.040
n (LOB) = 0.100
n (ROB) = 0.100
Pier Width = 2.3 ft
Pier Length = 2.3 ft
\# Piers for 500 yr = 2 ft



PGRM: Contract

CONTRACTION SCOUR

Width of main channel at approach section W_1 = 210 ft

Width of left overbank flow at approach, W_{lob} = 166 ft Average left overbank flow depth, y_{lob} = 6.2 ft

Width of right overbank flow at approach, W_{rob} = 60 ft Average right overbank flow depth, y_{rob} = 7.0 ft

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

x = ~~23.62~~ 29.61 From Figure 9 W_2 (effective) = ~~97.6~~ 85.3 ft y_{cs} = ~~19.6~~ 22.9 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, $V_1 = Q_{500}/(y_1 W_1)$ = ______ ft/s

Critical approach velocity, $Vc = 11.52 y_1^{1/6} D_{50}^{1/3}$ = ______ 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

PGRM: Pie

PIER SCOUR CALCULATIONS

L/a ratio = 1.0 Correction factor for flow angle of attack (from Table 1), K2 = 1.0

Froude # at bridge = 0.36 Using pier width a on Figure 11, ξ = 8.9 Pier scour y_{ps} = 7.6 ft

PGRM: Abutment

ABUTMENT SCOUR CALCULATIONS

Average flow depth blocked by: left abutment, y_{aLT} = 6.2 ft right abutment, y_{aRT} = 7.0 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} = 17.2 and ψ_{RT} = 18.6

Left abutment scour, $y_{as} = \psi_{LT}(K_1/0.55)$ = 17.2 ft Right abutment scour $y_{as} = \psi_{RT}(K_1/0.55)$ = 18.6 ft

Route 410 Ave Stream Firesteel Creek MRM ________ Date 7/7/11 Initials CL

Bridge Structure No. 18160084 Location NE edge Mitchell

GPS coordinates: N43° 43' 31.4" W 98° 00' 27.7" taken from: USL abutment X centerline of ⇑ MRM end ____

Datum of coordinates: WGS84 X NAD27 ____

Drainage area = 647.96 sq. mi.

The average bottom of the main channel was 21.8 ft below top of guardrail at a point 38 ft from left abutment.

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

MISCELLANEOUS CONSIDERATIONS

Flows	Q_{100} =	12500 *		Q_{500} =	18800 *	
Estimated flow passing through bridge		~~13996~~ 12312		12312 ~~13996~~		
Estimated road overflow & overtopping		188		6488 ~~4804~~		
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	

* peaks are probably overestimated - Lk will probably attenuate peak flows

Riprap at abutments? ____ Yes ____ No X Marginal

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

Debris Potential? X High ____ Med ____ Low

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

Riprap X Yes ____ No ____ Don't know ____ NA

Spur Dike ____ Yes ____ No X Don't know ____ NA

Other ________ ____ Yes ____ No ____ Don't know X 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

For 100 yr → geometry maks calcs funny 12500 cfs < 13996 cfs

4.1 146' → 12312 cfs

Photos

1714 - 1D

15 - US

16 - USRB

17 - USLB

18 - L, Abut

19 - R-Abut

20 - Looking at LB US AppXS

21 - RB US AppXS

Summary of Results

	Q100	Q500
Bridge flow evaluated	12312	12312
Flow depth at left abutment (yaLT), in feet	6.2	6.2
Flow depth at right abutment (yaRT), in feet	7.0	7.0
Contraction scour depth (ycs), in feet	22.9	22.9
Pier scour depth (yps), in feet	7.6	7.6
Left abutment scour depth (yas), in feet	17.2	17.2
Right abutment scour depth (yas), in feet	18.6	18.6
1Flow angle of attack	52	52

See Comments/Diagram for justification where required