ok RT

## SCOUR ANALYSIS AND REPORTING FORM

Bridge Structure No. 63146640 Date 5/23/12 Initials RT Region ( A B C D )

Site _____ Location 0.6 mi E of HWY 19 on 272 St

$Q_{100}$ = $Q_{100}$ 10500 by: drainage area ratio____ flood freq. anal. ____ regional regression eq. X

Bridge discharge ($Q_2$) = 10800 (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 = 117 ft. Flow angle at bridge = 0 ° 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 = 117 ft* $q_2 = Q_2/W_2$ = 92.3 $ft^2/s$

Bridge Vel, $V_2$ = 6.8 ft/s Final $y_2 = q_2/V_2$ = 13.6 ft $\Delta h$ = 0.9 ft

Average main channel depth at approach section, $y_1 = \Delta h + y_2$ = 14.5 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. = 1.0-0 ft

Low Steel Elev. = 14.5 ft 18.9-4.4

n (Channel) = 0.035

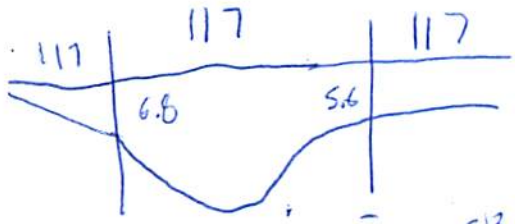
n (LOB) = 0.040

n (ROB) = 0.040

Pier Width = 2.1 ft

Pier Length = 2.1 ft

# Piers for 100 yr = 2 ft




5.3 − 1.6 = 3.7 ; 5.3 + 3.0 = 8.3 ; 8.3 − 3.7 = 4.6 ; $4.6^{2/3}$ ; $9.2^{1/3}$ = 3.1 ; 3.7 + 3.1 = 6.8

### CONTRACTION SCOUR

PGRM: Contract

Width of main channel at approach section $W_1$ = 117 ft

Width of left overbank flow at approach, $W_{lob}$ = 117 ft Average left overbank flow depth, $y_{lob}$ = 6.8 ft

Width of right overbank flow at approach, $W_{rob}$ = 117 ft Average right overbank flow depth, $y_{rob}$ = 5.6 ft

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

$x$ = 6.96 From Figure 9 $W_2$ (effective) = 112.8 ft $y_{cs}$ = 7.8 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, $V_1 = Q_{100}/(y_1 W_1)$ = _____ 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: Pier

### PIER SCOUR CALCULATIONS

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, $\xi$ = ~~8.7~~ 8.3 Pier scour $y_{ps}$ = 7 ft

PGRM: Abutment

### ABUTMENT SCOUR CALCULATIONS

Average flow depth blocked by: left abutment, $y_{aLT}$ = 6.8 ft right abutment, $y_{aRT}$ = 5.6 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, $\psi_{LT}$ = 18.2 and $\psi_{RT}$ = 16.1

Left abutment scour, $y_{as} = \psi_{LT}(K_1/0.55)$ = 18.2 ft Right abutment scour $y_{as} = \psi_{RT}(K_1/0.55)$ = 16.1 ft

## SCOUR ANALYSIS AND REPORTING FORM

Bridge Structure No. 63146640 Date 5/23/12 Initials [illegible] Region ( A B C D )

Site _____ Location 0.6 mi E of HWY 19 on 272 St

~~$Q_{500}$~~ = $Q_{100}$ 14500 by: drainage area ratio____ flood freq. anal. ____ regional regression eq. X

Bridge discharge ($Q_2$) = 12369 (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 = 117 ft. Flow angle at bridge = 0 ° 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 = 117 ft* $q_2 = Q_2/W_2$ = 105.7 $ft^2/s$

Bridge Vel, $V_2$ = 7.3 ft/s Final $y_2 = q_2/V_2$ = 14.5 ft $\Delta h$ = 1.1 ft

Average main channel depth at approach section, $y_1 = \Delta h + y_2$ = 15.6 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. = 0-1.0 ft

Low Steel Elev. = 14.5 ft

n (Channel) = 0.035

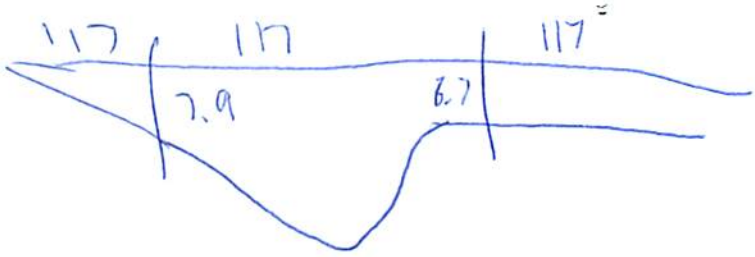
n (LOB) = 0.040

n (ROB) = 0.040

Pier Width = 2.1 ft

Pier Length = 2.1 ft

# Piers for 500 yr = 2 ft




### CONTRACTION SCOUR

PGRM: Contract

Width of main channel at approach section $W_1$ = 117 ft

Width of left overbank flow at approach, $W_{lob}$ = 117 ft Average left overbank flow depth, $y_{lob}$ = 7.9 ft

Width of right overbank flow at approach, $W_{rob}$ = 117 ft Average right overbank flow depth, $y_{rob}$ = 6.7 ft

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

$x$ = 8.6 From Figure 9 $W_2$ (effective) = 112.8 ft $y_{cs}$ = 9.5 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 = ~~0.33~~ 0.34 Using pier width a on Figure 11, $\xi$ = 8.3 Pier scour $y_{ps}$ = 7 ft

PGRM: Abutment

### ABUTMENT SCOUR CALCULATIONS

Average flow depth blocked by: left abutment, $y_{aLT}$ = 7.9 ft right abutment, $y_{aRT}$ = 6.7 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, $\psi_{LT}$ = 19.7 and $\psi_{RT}$ = 18.1

Left abutment scour, $y_{as} = \psi_{LT}(K_1/0.55)$ = 19.7 ft Right abutment scour $y_{as} = \psi_{RT}(K_1/0.55)$ = 18.1 ft

Route 272 St Stream E. Fk. Vermillion River MRM _____ Date 5/23/12 Initials RaT

Bridge Structure No. 63146640 Location 0.6 mi E of Hwy 19 on 272 St

GPS coordinates: 430 26' 43.3" taken from: USL abutment X centerline of ⇑ MRM end _____

47° 03' 35.4" Datum of coordinates: WGS84 X NAD27 _____

Drainage area = 4924.4 sq. mi.

The average bottom of the main channel was 18.9 ft below top of guardrail at a point 410 ft from left abutment.

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

## MISCELLANEOUS CONSIDERATIONS

| Flows | $Q_{100}$ = Q50 | | | $Q_{500}$ = Q100 14500 | | |
|---|---|---|---|---|---|---|
| Estimated flow passing through bridge | 10800 | | | 12369 | | |
| Estimated road overflow & overtopping | 0 | | | 2131 | | |
| 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 | |

5/22

| | |
|---|---|
| 2 | 1050 |
| 5 | 2810 |
| 10 | 4610 |
| 25 | 7760 |
| 50 | 10300 |
| 100 | 14500 |
| 500 | 26000 |

Riprap at abutments? X Yes ____No ____Marginal

Evidence of past Scour? X Yes ____No ____Don't know - contraction - pier

Debris Potential? ____High ____Med X Low

Does scour countermeasure(s) appear to have been designed? - 10% quartz

| | | | | |
|---|---|---|---|---|
| Riprap | X Yes | ____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 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. Main channel.
2. R.A
3. Piers.
4. BLA
5. drain
6. L OB
7. main channel
8. R OB

Summary of Results

| | ~~Q100~~ Q50 | Q500 Q100 |
|---|---|---|
| Bridge flow evaluated | 10800 | 12369 |
| Flow depth at left abutment (yaLT), in feet | 6.8 | 7.9 |
| Flow depth at right abutment (yaRT), in feet | 5.6 | 6.7 |
| Contraction scour depth (ycs), in feet | 7.8 | 9.5 |
| Pier scour depth (yps), in feet | 7 | 7 |
| Left abutment scour depth (yas), in feet | 18.2 | 19.7 |
| Right abutment scour depth (yas), in feet | 16.1 | 18.1 |
| Flow angle of attack | 0 | 0 |

See Comments/Diagram for justification where required