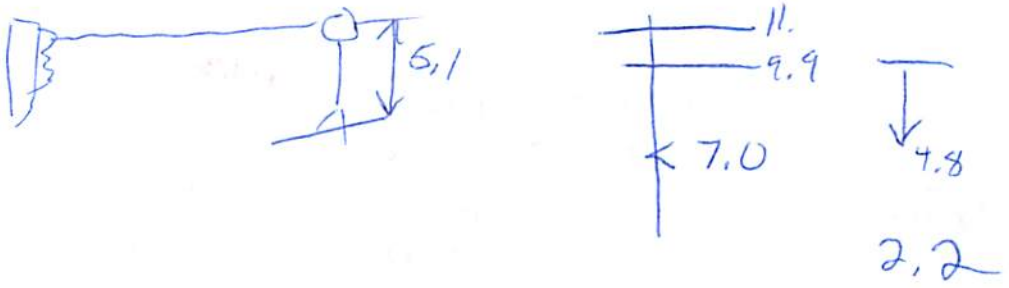

5,1
11.
9.9
7.0
4.8
2,2

ok RT

## SCOUR ANALYSIS AND REPORTING FORM

Bridge Structure No. 0612053 Date 5-17-12 Initials CW/RaT Region ( A B C D )

Site _____ Location 466th St, 1.8 mi N of Bruce

$Q_{\frac{5}{100}}$ = 4220 by: drainage area ratio____ flood freq. anal. _____ regional regression eq. ✓

Bridge discharge ($Q_2$) = _____ (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 = 260 ft. Flow angle at bridge = 5 ° Abut. Skew = 0 ° Effective Skew = 5 °

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 = 278.93 ft* $q_2 = Q_2/W_2$ = 5.1 $ft^2/s$

Bridge Vel, $V_2$ = 2.8 ft/s Final $y_2 = q_2/V_2$ = 5.3 ft $\Delta h$ = 0.1 ft

Average main channel depth at approach section, $y_1 = \Delta h + y_2$ = 5.6 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. = 6 ft

Low Steel Elev. = 6.6 ft

n (Channel) = ~~0.040~~ 0.055

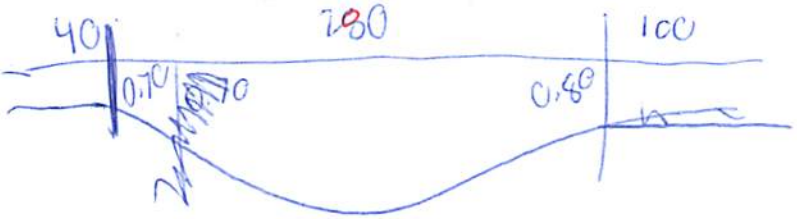
n (LOB) = 0.070

n (ROB) = 0.060

Pier Width = 1.3 ft

Pier Length = 1.3 ft

# Piers for 100 yr = 7 ft




### CONTRACTION SCOUR

PGRM: Contract

Width of main channel at approach section $W_1$ = 280 ft

Width of left overbank flow at approach, $W_{lob}$ = 40 ft Average left overbank flow depth, $y_{lob}$ = 0.70 ft

Width of right overbank flow at approach, $W_{rob}$ = 100 ft Average right overbank flow depth, $y_{rob}$ = 0.80 ft

Live Bed Contraction Scour (use if bed material is small cobbles or finer) 0.5

$x$ = ~~0.33~~ 0.31 From Figure 9 $W_2$ (effective) = 269.8 ft $y_{cs}$ = ~~0.6~~ 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, $y_{cs}$ = 1 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 = 0.21 Using pier width a on Figure 11, $\xi$ = 5.8 Pier scour $y_{ps}$ = 4.6 ft

### ABUTMENT SCOUR CALCULATIONS

PGRM: Abutment

Average flow depth blocked by: 10 ft left abutment, $y_{aLT}$ = 0.70 ft right abutment, $y_{aRT}$ = 0.80 ft 1.5 1.4

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, $\psi_{LT}$ = 3.1 and $\psi_{RT}$ = ~~3.5~~ 3.5

Left abutment scour, $y_{as} = \psi_{LT}(K_1/0.55)$ = ~~3.5.6~~ ~~3.7~~ 5.6 ft Right abutment scour $y_{as} = \psi_{RT}(K_1/0.55)$ = 3.5 ft

## SCOUR ANALYSIS AND REPORTING FORM

Bridge Structure No. 06120053 Date _____ Initials _____ Region ( A B C D )

Site _____ Location 466 St, 1.8 mi N of Bruce

$Q_{500}$= 6750 by: drainage area ratio _____ flood freq. anal. _____ regional regression eq. ✓

Bridge discharge ($Q_2$) = 6472 (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 = 280 ft. Flow angle at bridge = 5 ° Abut. Skew = 0 ° Effective Skew = 5 °

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 = 278.93 ft* $q_2 = Q_2/W_2$ = 23.3 $ft^2/s$

Bridge Vel, $V_2$ = 3.4 ft/s Final $y_2 = q_2/V_2$ = 6.90 ft $\Delta h$ = 0.2 ft

Average main channel depth at approach section, $y_1 = \Delta h + y_2$ = 7 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. = 6.9 ft

Low Steel Elev. = 6.6 ft

n (Channel) = 0.055

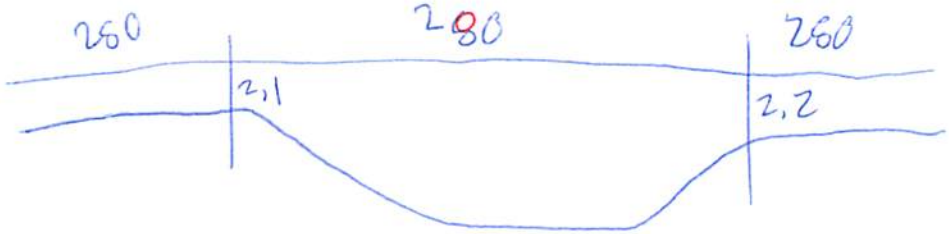
n (LOB) = 0.070

n (ROB) = 0.060

Pier Width = 1.3 ft

Pier Length = 1.3 ft

# Piers for 500 yr = 7 ft




### CONTRACTION SCOUR

PGRM: Contract

Width of main channel at approach section $W_1$ = 280 ft

Width of left overbank flow at approach, $W_{lob}$ = 260 ft Average left overbank flow depth, $y_{lob}$ = 2.1 ft

Width of right overbank flow at approach, $W_{rob}$ = 240 ft Average right overbank flow depth, $y_{rob}$ = 2.2 ft

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

$x$ = 2 From Figure 9 $W_2$ (effective) = 279.8 ft $y_{cs}$ = 2.5 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, $V_1 = Q_{500}/(y_1 W_1)$ = _____ 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 = 0.23 Using pier width a on Figure 11, $\xi$ = 5.8 Pier scour $y_{ps}$ = 4.7 ft

PGRM: Abutment

### ABUTMENT SCOUR CALCULATIONS

Average flow depth blocked by: left abutment, $y_{aLT}$ = 2.1 ft right abutment, $y_{aRT}$ = 2.2 ft right

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, $\psi_{LT}$ = 8.6 and $\psi_{RT}$ = 9

Left abutment scour, $y_{as} = \psi_{LT}(K_1/0.55)$ = 15.7 ft Right abutment scour $y_{as} = \psi_{RT}(K_1/0.55)$ = 9 ft

Route 466th St Stream Big Sioux River MRM _____ Date _____ Initials _____

Bridge Structure No. 06120053 Location 466th St, 1.8 mi N of Brice

GPS coordinates: N 44° 26' 1.1" taken from: USL abutment X centerline of ⇑ MRM end _____

W 96° 53' 14.61" Datum of coordinates: WGS84 X NAD27 _____

Drainage area = 1548.8 sq. mi.

The average bottom of the main channel was 11 ft below top of guardrail at a point 156 ft from left abutment.

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

## MISCELLANEOUS CONSIDERATIONS

| Flows | $Q_{100}$ = 4220 | | | $Q_{500}$ = 6750 | | |
|---|---|---|---|---|---|---|
| Estimated flow passing through bridge | 4220 | | | 6471 | | |
| Estimated road overflow & overtopping | 0 | | | 279 | | |
| 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 | |

5/15

| | |
|---|---|
| 2 | 1600 |
| 5 | 4220 |
| 10 | 6750 |
| 25 | 10900 |
| 50 | 14700 |
| 100 | 19000 |
| 500 | 31000 |

Riprap at abutments? ____Yes X No ____Marginal

Evidence of past Scour? X Yes ____No ____Don't know pier 1

Debris Potential? ____High X Med ____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 + | 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

2279 Str. no
2280 upstream from bridge
2281 ROB from bridge
2282 LOB from bridge
2283 under bridge from rt abut.
2284 under bridge from left abut.
2285 junk under bridge
2286 left abut.
2287 re-bar exposed on pier
2288 spalling on pier cap
2290 right abutment
2291 right abutment?
2292 bridge section from right ditch

Summary of Results

| | ~~Q100~~ 5 | ~~Q500~~ 10 |
|---|---|---|
| Bridge flow evaluated | 4220 | 6471 |
| Flow depth at left abutment (yaLT), in feet | 0.70 | 2.1 |
| Flow depth at right abutment (yaRT), in feet | 0.80 | 2.2 |
| Contraction scour depth (ycs), in feet | ~~0.6~~ 0.5 | 2.5 |
| Pier scour depth (yps), in feet | 4.6 | 4.7 |
| Left abutment scour depth (yas), in feet | 5.6 | 15.7 |
| Right abutment scour depth (yas), in feet | 3.5 | 9 |
| 1Flow angle of attack | 5° | 5° |

See Comments/Diagram for justification where required