Stanley Co.

OK RJ

## SCOUR ANALYSIS AND REPORTING FORM

Bridge Structure No. 59327339 Date 7/11/12 Initials RaJ Region ( A (B) C D )

Site ______ Location approx 0.1 SW Teton on Bad River Road, Bad River

$Q_{100}$ = 60200 ~~6~~50 6660 by: drainage area ~~X~~ flood frequency anal. ____ regional regression eq. X

Bridge discharge ($Q_2$) = 66600 (should be $Q_{100}$ unless there is a relief bridge, road overflow, or bridge overtopping)

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

### Analytical Procedure for Estimating Hydraulic Variables Needed to Apply Method

Bridge Width = 398 ft. Flow angle at bridge = 20 ° Abut. Skew = 20 ° Effective Skew = 20 °

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 = 398 ft* $q_2 = Q_2/W_2$ = 167.8 $ft^2/s$

Bridge Vel, $V_2$ = 10.6 ft/s Final $y_2 = q_2/V_2$ = 15.9 ft $\Delta h$ = 2.3 ft

Average main channel depth at approach section, $y_1 = \Delta h + y_2$ = 18.2 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. = 0-0.8 ft 27.7

Low Steel Elev. = 19.6 ft 7.3

n (Channel) = 0.040

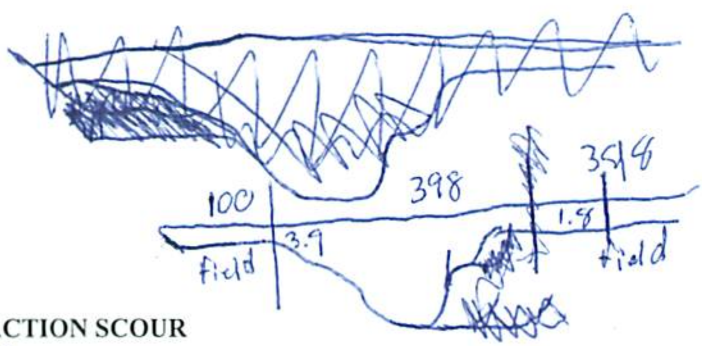
n (LOB) = 0.030

n (ROB) = 0.030

Pier Width = 4 ft 18

Pier Length = 26 ft

\# Piers for 100 yr = 4 ft




PGRM: Contract

### CONTRACTION SCOUR

Width of main channel at approach section $W_1$ = 398 ft

Width of left overbank flow at approach, $W_{lob}$ = 100 ft Average left overbank flow depth, $y_{lob}$ = 3.9 ft

Width of right overbank flow at approach, $W_{rob}$ = 398 ft Average right overbank flow depth, $y_{rob}$ = 1.8 ft

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

$x$ = 1.78 From Figure 9 $W_2$ (effective) = 382 ft $y_{cs}$ = 2.3 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, $V_c = 11.52 y_1^{1/6} D_{50}^{1/3}$ = ______ 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: Pier

### PIER SCOUR CALCULATIONS

L/a ratio = 6.5 Correction factor for flow angle of attack (from Table 1), K2 = 1

Froude # at bridge = 0.47 Using pier width a on Figure 11, $\xi$ = 13.1 Pier scour $y_{ps}$ = 11.7 ft

PGRM: Abutment

### ABUTMENT SCOUR CALCULATIONS

Average flow depth blocked by: left abutment, $y_{aLT}$ = 3.9 ft right abutment, $y_{aRT}$ = 1.8 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, $\psi_{LT}$ = 13.1 and $\psi_{RT}$ = 7.4

Left abutment scour, $y_{as} = \psi_{LT}(K_1/0.55)$ = 13.1 ft Right abutment scour $y_{as} = \psi_{RT}(K_1/0.55)$ = 7.4 ft

## SCOUR ANALYSIS AND REPORTING FORM

Bridge Structure No. 59327339 Date 7/11/12 Initials [illegible] Region ( A B C D ) (B circled)

Site 111000 Location approx 0.1 SW Teton on Bad River Rd

$Q_{500}$ = $Q_{100}$ = ~~103000~~ ~~102000~~ by: drainage area [illegible] flood frequency anal. _____ regional regression eq. X

Bridge discharge ($Q_2$) = 99724 (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 = 398 ft. Flow angle at bridge = 20 ° Abut. Skew = 20 ° 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 = 398 ft* $q_2 = Q_2/W_2$ = 250.6 $ft^2/s$

Bridge Vel, $V_2$ = 12.8 ft/s Final $y_2 = q_2/V_2$ = 19.6 ft $\Delta h$ = 3.4 ft

Average main channel depth at approach section, $y_1 = \Delta h + y_2$ = 23 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. = 0-0.8 ft

Low Steel Elev. = 19.6 ft

n (Channel) = 0.040

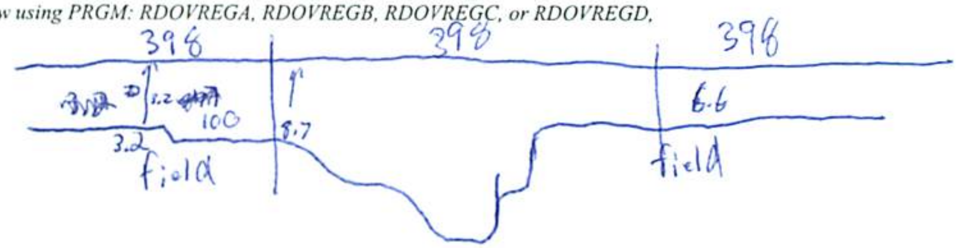
n (LOB) = 0.030

n (ROB) = 0.030

Pier Width = 4 ft

Pier Length = 26 ft

# Piers for 500 yr = 4 ft




### CONTRACTION SCOUR

PGRM: Contract

100 / 3.9+4.8 | +3.2 $\frac{3.2+8.7}{2}$ = 6.0

Width of main channel at approach section $W_1$ = 398 ft

Width of left overbank flow at approach, $W_{lob}$ = 398 ft Average left overbank flow depth, $y_{lob}$ = 6.0 ft

Width of right overbank flow at approach, $W_{rob}$ = 398 ft Average right overbank flow depth, $y_{rob}$ = 6.6 ft

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

$x$ = 8.36 From Figure 9 $W_2$ (effective) = 382 ft $y_{cs}$ = 9.2 ft

PGRM: CWCSNEW

Clear Water Contraction Scour (use if bed material is larger than small cobbles) (section crossed out)

Estimated bed material $D_{50}$ = ________ ft Average approach velocity, $V_1 = Q_{500}/(y_1W_1)$ = ________ 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: Pie

L/a ratio = 6.5 Correction factor for flow angle of attack (from Table 1), K2 = 1

Froude # at bridge = 0.51 Using pier width a on Figure 11, $\xi$ = 13.1 Pier scour $y_{ps}$ = 11.8 ft

### ABUTMENT SCOUR CALCULATIONS

PGRM: Abutment

Average flow depth blocked by: left abutment, $y_{aLT}$ = 6.0 ft right abutment, $y_{aRT}$ = 6.6 ft

Shape coefficient $K_1$= 1.00 for vertical-wall, 0.82 for vertical-wall with wingwalls, 0.55 for spill-through (circled)

Using values for $y_{aLT}$ and $y_{aRT}$ on figure 12, $\psi_{LT}$ = 16.8 and $\psi_{RT}$ = 17.9

Left abutment scour, $y_{as} = \psi_{LT}(K_1/0.55)$ = 16.8 ft Right abutment scour $y_{as} = \psi_{RT}(K_1/0.55)$ = 17.9 ft

Route Bad River Road Stream Bad River MRM ______ Date 7/11/12 Initials RaT

Bridge Structure No. 59327339 Location approx 0.1 SW Teton on Bad River Rd

GPS coordinates: N ~~4~~ 44° 17' 8.4" / W 100° 30' 39.0" taken from: USL abutment X centerline of ⇑ MRM end ______

Datum of coordinates: WGS84 X NAD27 ______

Drainage area = ~~2962.89~~ 2963 sq. mi.

The average bottom of the main channel was 27.7 ft below top of guardrail at a point 265 ft from left abutment.

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

| 7/2 | |
|---|---|
| 2 | 2020 |
| 5 | 7840 |
| 10 | 16700 |
| 25 | 38300 |
| 50 | 66800 |
| 100 | 111000 |
| 500 | 343000 |

**MISCELLANEOUS CONSIDERATIONS** $Q_{100}$ 111000

| | | | | | | |
|---|---|---|---|---|---|---|
| Flows | $Q_{100}$ = ~~60200~~ $Q_{50}$ 66800 | | | $Q_{500}$ = ~~103000~~ 102000 | | |
| Estimated flow passing through bridge | 66800 | | | ~~[illegible]~~ 99724 | | |
| Estimated road overflow & overtopping | 0 | | | 11276 | | |
| Consideration | Yes | No | Possibly | Yes | No | Possibly |
| Chance of overtopping | | X | | X | | |
| Chance of Pressure flow | | X | | X | | |
| Armored appearance to channel | | ~~X~~ | X | | | X |
| Lateral instability of channel | | X | | | X | |

Riprap at abutments? X Yes ____ No ____ Marginal

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

Debris Potential? ____ High X Med ~~X~~ Low

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

| | | | | |
|---|---|---|---|---|
| Riprap | X Yes | ____ No | ____ Don't know | ____ NA - packed evenly |
| 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 X | Cobbles ____ | Boulders ____ |
| Size range, in mm | <0.062 | 0.062-2.00 | 2.00-64 | 64-250 | >250 |

Comments, Diagrams & orientation of digital photos

(1-2). left abutment
3). pier 1
4). pier 2
5). pier scour
6). right abutment
7). left overbank
8). main channel
9). right OB
10). right abutment
11). main channel

Note flow speed taken at depth location.

Summary of Results

| | ~~Q100~~ $Q_{50}$ | ~~Q500~~ $Q_{100}$ |
|---|---|---|
| Bridge flow evaluated | 66800 | 99724 |
| Flow depth at left abutment (yaLT), in feet | 3.9 | 6.0 |
| Flow depth at right abutment (yaRT), in feet | 1.8 | 6.6 |
| Contraction scour depth (ycs), in feet | 2.3 | 9.2 |
| Pier scour depth (yps), in feet | 11.7 | 11.8 |
| Left abutment scour depth (yas), in feet | ~~3.9~~ 13.1 | ~~6.0~~ 16.8 |
| Right abutment scour depth (yas), in feet | ~~1.8~~ 7.4 | ~~6.6~~ 17.9 |
| 1Flow angle of attack | 30 | 30 |

See Comments/Diagram for justification where required