

# Cheyenne River

## SCOUR ANALYSIS AND REPORTING FORM

Bridge Structure No. 24347040 Date 4/10/12 Initials CW Region (A B C D) B

Site 53300 Location 1.5 mi NW of Oral

Q<sub>100</sub> 53300 by: drainage area ratio      flood freq. anal.      regional regression eq.

Bridge discharge (Q<sub>2</sub>) = 53300 (should be Q<sub>100</sub> unless there is a relief bridge, road overflow, or bridge overtopping)

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

Bridge Width = 293 ft. Flow angle at bridge = 5 ° Abut. Skew = 0 ° Effective Skew = 5 °

Width (W<sub>2</sub>) iteration = 293 ~~2035~~ ~~2035~~ At Vert Abut.

Avg. flow depth at bridge, y<sub>2</sub> iteration = ~~11.0~~ ~~11.0~~ ~~11.0~~ But not over bridge

Corrected channel width at bridge Section = W<sub>2</sub> times cos of flow angle = 291.9 ft\* q<sub>2</sub> = Q<sub>2</sub>/W<sub>2</sub> = 182.6 ft<sup>2</sup>/s

Bridge Vel, V<sub>2</sub> = 11 ft/s Final y<sub>2</sub> = q<sub>2</sub>/V<sub>2</sub> = 16.6 ft Δh = 2.5 ft

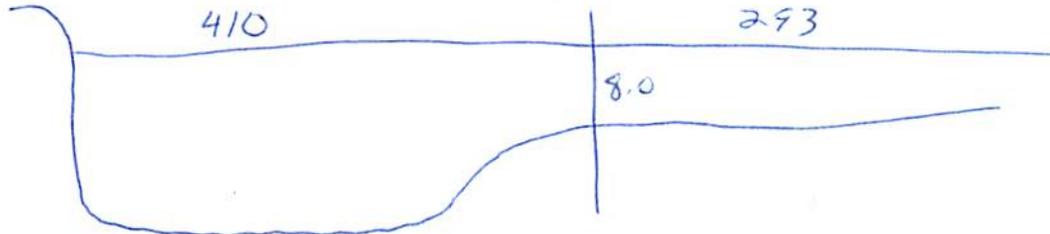
Average main channel depth at approach section, y<sub>1</sub> = Δh + y<sub>2</sub> = 19.1 ft

\* NOTE: repeat above calculations until y<sub>2</sub> changes by less than 0.2 Effective pier width = L sin(q) + a cos(q)

If y<sub>2</sub> is above LS, then account for Road Overflow using PRGM: RDOVREGA, RDOVREGB, RDOVREGC, or RDOVREGD.

May flow over road to South of bridge

Water Surface Elev. =      ft  
 Low Steel Elev. = 17.4 ft  
 n (Channel) = 0.055  
 n (LOB) = 0.050  
 n (ROB) = 0.035  
 Pier Width = 2.1 ft  
 Pier Length = 19 ft  
 # Piers for 100 yr = 2 ft



### CONTRACTION SCOUR

Width of main channel at approach section W<sub>1</sub> = 410 ft

Width of left overbank flow at approach, W<sub>lob</sub> = 0.0 ft Average left overbank flow depth, y<sub>lob</sub> = 0.0 ft

Width of right overbank flow at approach, W<sub>rob</sub> = 293 ft Average right overbank flow depth, y<sub>rob</sub> = 8.0 ft

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

x = 15.72 From Figure 9 W<sub>2</sub> (effective) = 247.7 ft y<sub>cs</sub> = 15.4 ft

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

Estimated bed material D<sub>50</sub> =      ft Average approach velocity, V<sub>1</sub> = Q<sub>100</sub>/(y<sub>1</sub>W<sub>1</sub>) =      ft/s

Critical approach velocity, V<sub>c</sub> = 11.17y<sub>1</sub><sup>1/6</sup>D<sub>50</sub><sup>1/3</sup> =      ft/s

If V<sub>1</sub> < V<sub>c</sub> and D<sub>50</sub> >= 0.2 ft, use clear water equation below, otherwise use live bed scour equation above.

D<sub>c50</sub> = 0.0006(q<sub>2</sub>/y<sub>1</sub><sup>7/6</sup>)<sup>3</sup> =      ft If D<sub>50</sub> >= D<sub>c50</sub>, χ = 0.0

Otherwise, χ = 0.122y<sub>1</sub>[q<sub>2</sub>/(D<sub>50</sub><sup>1/3</sup>y<sub>1</sub><sup>7/6</sup>)<sup>6/7</sup> - y<sub>1</sub>] =      From Figure 10, y<sub>cs</sub> =      ft

### PIER SCOUR CALCULATIONS

L/a ratio = 9.0 Correction factor for flow angle of attack (from Table 1), K<sub>2</sub> = 1.35

Froude # at bridge = 0.48 Using pier width a on Figure 11, ξ = 8.3 Pier scour y<sub>ps</sub> = 10.0 ft

### ABUTMENT SCOUR CALCULATIONS

Average flow depth blocked by: left abutment, y<sub>aLT</sub> = 0.0 ft right abutment, y<sub>aRT</sub> = 8.0 ft

Shape coefficient K<sub>1</sub> = 1.00 for vertical-wall, 0.82 for vertical-wall with wingwalls, 0.55 for spill-through

Using values for y<sub>aLT</sub> and y<sub>aRT</sub> on figure 12, ψ<sub>LT</sub> = 0.0 and ψ<sub>RT</sub> = 19.8

Left abutment scour, y<sub>as</sub> = ψ<sub>LT</sub>(K<sub>1</sub>/0.55) = 0.0 ft Right abutment scour y<sub>as</sub> = ψ<sub>RT</sub>(K<sub>1</sub>/0.55) = 19.8 ft

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

PGRM: Contract

PGRM: CWCNEW

PGRM: Pier

PGRM: Abutment



Route County Rd Stream Cheyenne River MRM \_\_\_\_\_ Date 4/10/12 Initials CM

Bridge Structure No. 24387040 Location 1.5 mi NW of Oral

GPS coordinates: N 43° 25' 07.6" taken from: USL abutment  centerline of  $\uparrow$  MRM end \_\_\_\_\_  
W 103° 17' 19.5" Datum of coordinates: WGS84  NAD27 \_\_\_\_\_

Drainage area = 9338.7 sq. mi.

The average bottom of the main channel was 23.5 ft below top of guardrail at a point 115 ft from left abutment.

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

**MISCELLANEOUS CONSIDERATIONS**

Flows	Q <sub>100</sub> = <u>69200</u>			Q <sub>50</sub> = <u>53300</u>		
Estimated flow passing through bridge	<u>58334</u>			<u>53300</u>		
Estimated road overflow & overtopping	<u>10866</u>					
Consideration	Yes	No	Possibly	Yes	No	Possibly
Chance of overtopping		<input checked="" type="checkbox"/>			<input checked="" type="checkbox"/>	
Chance of Pressure flow	<input checked="" type="checkbox"/>			<input checked="" type="checkbox"/>		
Armored appearance to channel		<input checked="" type="checkbox"/>			<input checked="" type="checkbox"/>	
Lateral instability of channel		<input checked="" type="checkbox"/>			<input checked="" type="checkbox"/>	

Riprap at abutments? \_\_\_ Yes \_\_\_ No  Marginal  
 Evidence of past Scour? \_\_\_ Yes  No \_\_\_ Don't know  
 Debris Potential?  High \_\_\_ Med \_\_\_ Low

Does scour countermeasure(s) appear to have been designed?  
 Riprap \_\_\_ Yes \_\_\_ No  Don't know \_\_\_ NA  
 Spur Dike \_\_\_ Yes \_\_\_ No \_\_\_ Don't know  NA  
 Other \_\_\_ Yes \_\_\_ No \_\_\_ Don't know  NA

**Bed Material Classification Based on Median Particle Size (D<sub>50</sub>)**

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

10/4/11  
 2 | 7910 | 4470  
 5 | 32100 | 14100  
 10 | 24000 | 24700  
 25 | 191000 | 39100  
 50 | 360000 | 53300  
 100 | 630000 | 64200  
 500 | 2030000 | 117000

Photos  
 2190 - 1D  
 91 - L. Abut  
 92 - L. Abut  
 93 - US Face  
 94 - Piers/R. Abut

95 - US Face  
 96 - US  
 97 - US ~~LB~~ LB  
 98 - US RB

**Summary of Results**

	Q100	<del>Q50</del> Q50
Bridge flow evaluated	<u>58334</u>	<u>53300</u>
Flow depth at left abutment (yaLT), in feet	<u>0.0</u>	<u>0.0</u>
Flow depth at right abutment (yaRT), in feet	<u>9.0</u>	<u>8.0</u>
Contraction scour depth (yca), in feet	<u>16.3</u>	<u>15.4</u>
Pier scour depth (yps), in feet	<u>10.0</u>	<u>10.0</u>
Left abutment scour depth (yas), in feet	<u>0.0</u>	<u>0.0</u>
Right abutment scour depth (yas), in feet	<u>20.6</u>	<u>19.8</u>
Flow angle of attack	<u>5°</u>	<u>5°</u>

See Comments/Diagram for justification where required

123.5  
6.1  
17.4

3.2  
2.9  
6.1