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## SCOUR ANALYSIS AND REPORTING FORM

Bridge Structure No. 52313265 Date 9/16/10 Initials CMW Region (A B C D)

Site _____ Location 0.9 NW from intersection Nemo Rd + Norris Peak Rd

$Q_{100}$ = 3180 by: drainage area ratio ✓ flood freq. anal. ____ regional regression eq. ____

Bridge discharge ($Q_2$) = ~~3180~~ 3180 (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

Bridge Width = 110 ft. Flow angle at bridge = 50 ° Abut. Skew = 40 ° Effective Skew = 10 °

Width ($W_2$) iteration = 110 61 78 65 6.1 66.1 (66)

Avg. flow depth at bridge, $y_2$ iteration = 4.6 6.3 5.5 ~~6.1~~

Corrected channel width at bridge Section = $W_2$ times cos of flow angle = 65 ft* $q_2 = Q_2/W_2$ = 48.9 $ft^2/s$

Bridge Vel, $V_2$ = 8.1 ft/s Final $y_2 = q_2/V_2$ = 6.1 ft $\Delta h$ = 1.3 ft

Average main channel depth at approach section, $y_1 = \Delta h + y_2$ = 7.4 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,*

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

Water Surface Elev. = _____ ft

Low Steel Elev. = 11.3 ft

n (Channel) = 0.037

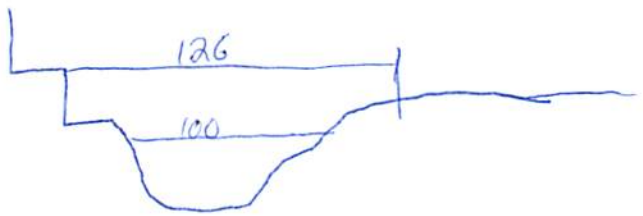
n (LOB) = 0.060

n (ROB) = 0.045

Pier Width = 1.9 ft

Pier Length = 1.9 ft

# Piers for 100 yr = 2 ft




### CONTRACTION SCOUR

PGRM: Contract

Width of main channel at approach section $W_1$ = 110 ft

Width of left overbank flow at approach, $W_{lob}$ = 0 ft Average left overbank flow depth, $y_{lob}$ = 0 ft

Width of right overbank flow at approach, $W_{rob}$ = 0 ft Average right overbank flow depth, $y_{rob}$ = 0 ft

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

$x$ = _____ From Figure 9 $W_2$ (effective) = _____ ft $y_{cs}$ = _____ ft

PGRM: CWCSNEW

Clear Water Contraction Scour (use if bed material is larger than small cobbles) Z=0

Estimated bed material $D_{50}$ = ~~0.25~~ 0.30 ft Average approach velocity, $V_1 = Q_{100}/(y_1 W_1)$ = 3.91 ft/s

Critical approach velocity, $Vc = 11.52 y_1^{1/6} D_{50}^{1/3}$ = 10.44 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.

$D_{c50} = 0.0006(q_2/y_1^{7/6})^3$ = 0.0636 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, $y_{cs}$ = 0.0 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 = 0.58 Using pier width a on Figure 11, $\xi$ = 7.7 Pier scour $y_{ps}$ = 7.1 ft

### ABUTMENT SCOUR CALCULATIONS

PGRM: Abutment

Average flow depth blocked by: left abutment, $y_{aLT}$ = 0 ft right abutment, $y_{aRT}$ = 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, $\psi_{LT}$ = 0 and $\psi_{RT}$ = 0

Left abutment scour, $y_{as} = \psi_{LT}(K_1/0.55)$ = 0 ft Right abutment scour $y_{as} = \psi_{RT}(K_1/0.55)$ = 0 ft

## SCOUR ANALYSIS AND REPORTING FORM

Bridge Structure No. 523132605 Date 9/16/10 Initials CMW Region (A B C D)

Site _____ Location 0.9 NW from intersection Nemo Rd + Norris Peak Rd

$Q_{500}$ = 17600 by: drainage area ratio ✓ flood freq. anal. _____ regional regression eq. ____

Bridge discharge ($Q_2$) = ~~17600~~ 16512 (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 = 110 ft. Flow angle at bridge = 50 ° Abut. Skew = 40 ° Effective Skew = 10 °

Width ($W_2$) iteration = 110

Avg. flow depth at bridge, $y_2$ iteration = 11.7 RD Overflow $W = 111 \cos 10° = 106.329$

Corrected channel width at bridge Section = $W_2$ times cos of flow angle = ~~106.66~~ ft 108.33 $q_2 = Q_2/W_2$ = ~~154.8~~ $ft^2/s$ 152.4

Bridge Vel, $V_2$ = ~~13.6~~ ft/s 13.5 Final $y_2 = q_2/V_2$ = ~~11.4~~ ft 11.3 Δh = 3.8 ft

Average main channel depth at approach section, $y_1 = \Delta h + y_2$ = ~~15.2~~ ft 15.1

** 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. = 11.3 ft

n (Channel) = 0.039

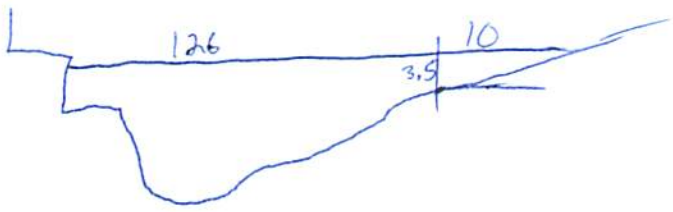
n (LOB) = 0.060

n (ROB) = ~~0.055~~ 0.045

Pier Width = 1.9 ft

Pier Length = 1.9 ft

# Piers for 500 yr = 2 ft




### CONTRACTION SCOUR

PGRM: Contract

Width of main channel at approach section $W_1$ = 110 ft

Width of left overbank flow at approach, $W_{lob}$ = 0 ft Average left overbank flow depth, $y_{lob}$ = 0 ft

Width of right overbank flow at approach, $W_{rob}$ = 10 ft Average right overbank flow depth, $y_{rob}$ = ~~1.85~~ ft 1.75

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

$x$ = _____ From Figure 9 $W_2$ (effective) = _____ ft $y_{cs}$ = _____ ft

PGRM: CWCSNEW

Clear Water Contraction Scour (use if bed material is larger than small cobbles) $z = 0$

Estimated bed material $D_{50}$ = 0.30 ft Average approach velocity, $V_1 = Q_{500}/(y_1 W_1)$ = ~~9.94~~ ~~9.64~~ 9.11 ft/s

Critical approach velocity, $Vc = 11.52 y_1^{1/6} D_{50}^{1/3}$ = ~~11.77~~ ft/s 11.76

If $V_1 < V_c$ and $D_{50} >= 0.2$ ft, use clear water equation below, otherwise use live bed scour equation above.

$D_{c50} = 0.0006(q_2/y_1^{7/6})^3$ = ~~0.1626~~ ft 0.159 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, $y_{cs}$ = 0.0 ft

PGRM: Pier

### PIER SCOUR CALCULATIONS

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

Froude # at bridge = 0.71 Using pier width a on Figure 11, ξ = 7.7 Pier scour $y_{ps}$ = 7.3 ft

PGRM: Abutment

### ABUTMENT SCOUR CALCULATIONS

Average flow depth blocked by: left abutment, $y_{aLT}$ = 0 ft right abutment, $y_{aRT}$ = 1.75 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, $\psi_{LT}$ = 0 and $\psi_{RT}$ = 7.2

Left abutment scour, $y_{as} = \psi_{LT}(K_1/0.55)$ = 0 ft Right abutment scour $y_{as} = \psi_{RT}(K_1/0.55)$ = 7.2 ft

Route Nemo Rd Stream Boxelder Creek MRM _____ Date 9/16/10 Initials CMW

Bridge Structure No. 52313265 Location 0.9 NW from intersection Nemo Rd + Norris Peak Rd

GPS coordinates: N 44° 07 59.4" W 103° 25' 31.4" taken from: USL abutment X centerline of ↑ MRM end _____

Datum of coordinates: WGS84 X NAD27 ____

Drainage area = 97.44 sq. mi.

The average bottom of the main channel was 16.0 ft below top of guardrail at a point 43 ft from left abutment.

Method used to determine flood flows: ____Freq. Anal. ✓drainage area ratio ____regional regression equations.

**MISCELLANEOUS CONSIDERATIONS**

| Flows | $Q_{100}$ = 3180 | | | $Q_{500}$ = 17600 | | |
|---|---|---|---|---|---|---|
| Estimated flow passing through bridge | 3180 | | | 16512 | | |
| Estimated road overflow & overtopping | | | | 1088 | | |
| Consideration | Yes | No | Possibly | Yes | No | Possibly |
| Chance of overtopping | | X | | X | | |
| Chance of Pressure flow | | X | | X | | ~~X~~ |
| Armored appearance to channel | | X | | | X | |
| Lateral instability of channel | | X | | | X | |

Riprap at abutments? X Yes ____No ____Marginal Gabions

Evidence of past Scour? ____Yes X 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 Gabions |
| Spur Dike | ____Yes | ____No | ____Don't know | X NA |
| Other _____ | ____Yes | ____No | ____Don't know | X NA |

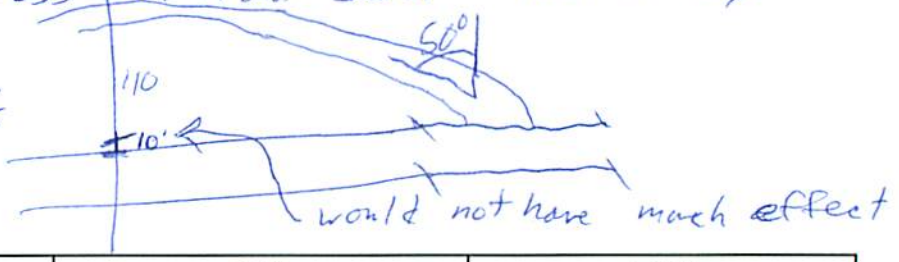
Bed Material Classification Based on Median Particle Size ($D_{50}$)

| Material | Silt/Clay____ | Sand____ | Gravel____ | Cobbles X | Boulders____ |
|---|---|---|---|---|---|
| Size range, in mm | <0.062 | 0.062-2.00 | 2.00-64 | 64-250 | >250 |

Comments, Diagrams & orientation of digital photos

There may be less R. Abut scour than it say

121- Bridge ID
12 - US
13 - RB US
14 - LB US
15 - R. Abut
16 - L. Abut
17 - US face of bridge




Summary of Results

| | Q100 | Q500 |
|---|---|---|
| Bridge flow evaluated | 3180 | 16512 |
| Flow depth at left abutment (yaLT), in feet | 0.0 | 0.0 |
| Flow depth at right abutment (yaRT), in feet | 0.0 | 1.75 |
| Contraction scour depth (ycs), in feet | 0.0 | 0.0 |
| Pier scour depth (yps), in feet | 7.1 | 7.3 |
| Left abutment scour depth (yas), in feet | 0.0 | 0.0 |
| Right abutment scour depth (yas), in feet | 0.0 | 7.2 |
| 1Flow angle of attack | 10° | 10° |

See Comments/Diagram for justification where required