OK RJ

SCOUR ANALYSIS AND REPORTING FORM

Bridge Structure No. 52321266 Date 9/16/10 Initials CMW Region (A B C D)

Site _____ Location on Nemo Rd between Pine Cone Ave & Norris Peak Rd

Q_{100} = 3410 by: drainage area ratio ✓ flood freq. anal. ____ regional regression eq. ____

Bridge discharge (Q_2) = 3410 (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 = 126 ft. Flow angle at bridge = 50 ° Abut. Skew = 40 ° Effective Skew = 10 °

Width (W_2) iteration = 126 78 80 ____

Avg. flow depth at bridge, y_2 iteration = 4.4 5.7 5.7 ____

Corrected channel width at bridge Section = W_2 times cos of flow angle = 78.78 ft* $q_2 = Q_2/W_2$ = 43.3 ft^2/s

Bridge Vel, V_2 = 7.6 ft/s Final $y_2 = q_2/V_2$ = 5.7 ft Δh = 1.2 ft

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

Low Steel Elev. = 11.0 ft

n (Channel) = 0.035

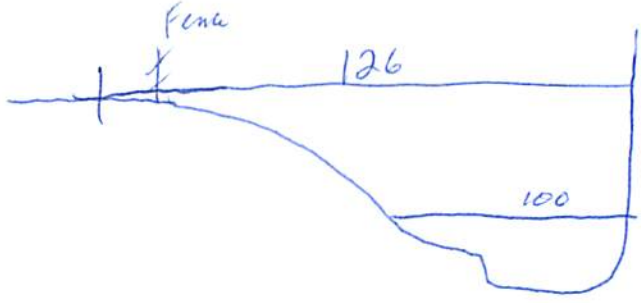
n (LOB) = 0.042

n (ROB) = 0.060

Pier Width = 2.0 ft } Round Part of Piers

Pier Length = 1.9 ft

Piers for 100 yr = 2 ft



CONTRACTION SCOUR

PGRM: Contract

Width of main channel at approach section W_1 = 126 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) 2=0

Estimated bed material D_{50} = 0.25 ft Average approach velocity, $V_1 = Q_{100}/(y_1 W_1)$ = 3.52 ft/s

Critical approach velocity, $Vc = 11.52 y_1^{1/6} D_{50}^{1/3}$ = 9.71 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.

$D_{c50} = 0.0006(q_2/y_1^{7/6})^3$ = 0.05645 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

PGRM: Pier

PIER SCOUR CALCULATIONS

L/a ratio = 1.0

Froude # at bridge = 0.56

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

Using pier width a on Figure 11, ξ = 4 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} = 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, ψ_{LT} = 0 and ψ_{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. 52321264 Date 9/16/10 Initials CMW Region (A B C D)

Site _____ Location on Nemo Rd between Pine Cone Ave + Norriss Peak Rd

Q_{500} = 18800 by: drainage area ratio ✓ flood freq. anal. ____ regional regression eq. ____

Bridge discharge (Q_2) = 14008 (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 = 126 ft. Flow angle at bridge = 50 ° Abut. Skew = 40 ° Effective Skew = 10 °

Width (W_2) iteration = 126

Avg. flow depth at bridge, y_2 iteration = 11.3 → RD Overflow W = 126 cos 10° = 124.09

Corrected channel width at bridge Section = W_2 times cos of flow angle = 124.09 ft* $q_2 = Q_2/W_2$ = ~~117.4~~ ft^2/s 145.1

Bridge Vel, V_2 = ~~13.3~~ ft/s 13.2 Final $y_2 = q_2/V_2$ = ~~11.1~~ ft 11.0 Δh = 3.6 ft

Average main channel depth at approach section, $y_1 = \Delta h + y_2$ = ~~14.7~~ ft 14.6

* *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,

126 ft puts channel edge on road & 50° skew so no contraction scour

Water Surface Elev. = _____ ft

Low Steel Elev. = 11.0 ft

n (Channel) = 0.035

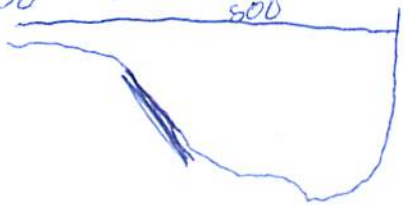
n (LOB) = 0.042

n (ROB) = 0.060

Pier Width = 2.0 ft

Pier Length = 1.9 ft

Piers for 500 yr = 2 ft



See Plan View

CONTRACTION SCOUR

PGRM: Contract

Width of main channel at approach section W_1 = 126 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) 2=0 9.79

Estimated bed material D_{50} = 0.25 ft Average approach velocity, $V_1 = Q_{500}/(y_1 W_1)$ = ~~9.72~~ ft/s

Critical approach velocity, $Vc = 11.52 y_1^{1/6} D_{50}^{1/3}$ = ~~11.01~~ ft/s 11.0

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

$D_{c50} = 0.0006(q_2/y_1^{7/6})^3$ = ~~0.1577~~ ft 0.154 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 = 0.7 Using pier width a on Figure 11, ξ = 8 Pier scour y_{ps} = ~~7.2~~ 7.6 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, ψ_{LT} = 0 and ψ_{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

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

Bridge Structure No. 523212666 Location on Nemo Rd between Pine Cone Ave & Norris Park Rd

GPS coordinates: N44°07'51.4" W103°24'45.2" taken from: USL abutment X centerline of ⇑ MRM end _____

Datum of coordinates: WGS84 X NAD27 _____

Drainage area = 108.11 sq. mi.

The average bottom of the main channel was 15.6 ft below top of guardrail at a point 50 ft from left abutment.

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

MISCELLANEOUS CONSIDERATIONS

Flows	Q_{100} = 3410			Q_{500} = 18800		
Estimated flow passing through bridge	3410			18008		
Estimated road overflow & overtopping	—			792		
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

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? Gabion Baskets

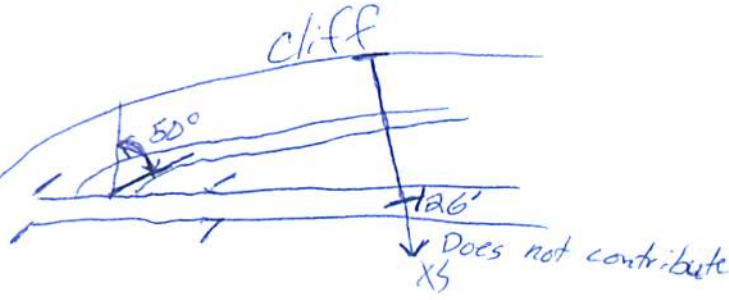
Riprap	X Yes	____No	____Don't know	____NA
Spur Dike	____Yes	____No	____Don't know	X NA
Other _____	____Yes	____No	____Don't know	X NA

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

1203- Bridge #
04- Upstream from bridge
05- US RB
06- US LB
07- L. Abut
08- R. Abut
09- L. Abut
10- U.S. Face of Bridge



Summary of Results

	Q100	Q500
Bridge flow evaluated	3410	18008
Flow depth at left abutment (yaLT), in feet	0.0	0.0
Flow depth at right abutment (yaRT), in feet	0.0	0.0
Contraction scour depth (ycs), in feet	0.0	0.0
Pier scour depth (yps), in feet	7.3	7.6
Left abutment scour depth (yas), in feet	0.0	0.0
Right abutment scour depth (yas), in feet	0.0	0.0
1Flow angle of attack	10°	10°

See Comments/Diagram for justification where required