SW Meade Co.
OK RJ

SCOUR ANALYSIS AND REPORTING FORM

Bridge Structure No. 47065619 Date 9/17/10 Initials CMW Region ((A) B C D)

Site _____ Location on Nemo Rd, between Chipmunk Pl + Pine Rd

Q_{100} = 3150 by: drainage area ratio ✓ flood freq. anal. ____ regional regression eq. ____

Bridge discharge (Q_2) = 3150 (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 = ~~102~~ 100 ft. Flow angle at bridge = 75 ° Abut. Skew = 35 ° Effective Skew = 40 °

Width (W_2) iteration = 100 ~~88~~ 87 ____

Avg. flow depth at bridge, y_2 iteration = 5.5 5.9 5.9 ____

Corrected channel width at bridge Section = W_2 times cos of flow angle = 66.65 ft* $q_2 = Q_2/W_2$ = 47.3 ft^2/s

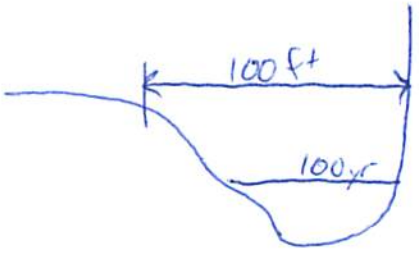
Bridge Vel, V_2 = 7.9 ft/s Final $y_2 = q_2/V_2$ = 5.9 ft Δh = 1.3 ft

Average main channel depth at approach section, $y_1 = \Delta h + y_2$ = 7.2 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. = ____ ft
Low Steel Elev. = 10.1 ft
n (Channel) = 0.037
n (LOB) = 0.037
n (ROB) = 0.050
Pier Width = 1.27 ft
Pier Length = 23.0 ft
Piers for 100 yr = 2 ft



CONTRACTION SCOUR

PGRM: Contract

Width of main channel at approach section W_1 = 100 ft

Width of left overbank flow at approach, W_{lob} = 0 ft Average left overbank flow depth, y_{lob} = ~~100~~ 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) ~~2=3.11523~~

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=3.11523~~ ~~1.2158~~ 0

Estimated bed material D_{50} = 0.2 ft Average approach velocity, $V_1 = Q_{100}/(y_1W_1)$ = 4.38 ft/s

Critical approach velocity, $Vc = 11.52y_1^{1/6}D_{50}^{1/3}$ = 9.08 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.

$D_{c50} = 0.0006(q_2/y_1^{7/6})^3$ = 0.0634 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} = 0.0 ft

PGRM: Pier

PIER SCOUR CALCULATIONS

L/a ratio = 22 Correction factor for flow angle of attack (from Table 1), K2 = 4.0

Froude # at bridge = 0.57 Using pier width a on Figure 11, ξ = 5.7 Pier scour y_{ps} = 21.0 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, ~~Right~~ 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

CM 0.78

One wall vert, One wall spill-thru

SCOUR ANALYSIS AND REPORTING FORM

Bridge Structure No. 47065619 Date 9/17/10 Initials CMW Region (A B C D)

Site _____ Location on Nemo Rd, between Chipmunk Pl + Pine Rd

Q_{500} = 17400 by: drainage area ratio ✓ flood freq. anal. ____ regional regression eq. ____

Bridge discharge (Q_2) = 9513 (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 = ~~102~~ ft. 100 Flow angle at bridge = 75 ° Abut. Skew = 35 ° Effective Skew = 40 °

Width (W_2) iteration = 100 RD Overflow 100 cos 40° = 76.60 = W

Avg. flow depth at bridge, y_2 iteration = 14.1

Corrected channel width at bridge Section = W_2 times cos of flow angle = 76.6 ft* $q_2 = Q_2/W_2$ = 124.2 ft^2/s

Bridge Vel, V_2 = 12.3 ft/s Final $y_2 = q_2/V_2$ = 10.1 ft Δh = 3.1 ft

Average main channel depth at approach section, $y_1 = \Delta h + y_2$ = 13.2 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. = ____ ft

Low Steel Elev. = 10.1 ft

n (Channel) = 0.037

n (LOB) = 0.037

n (ROB) = 0.050

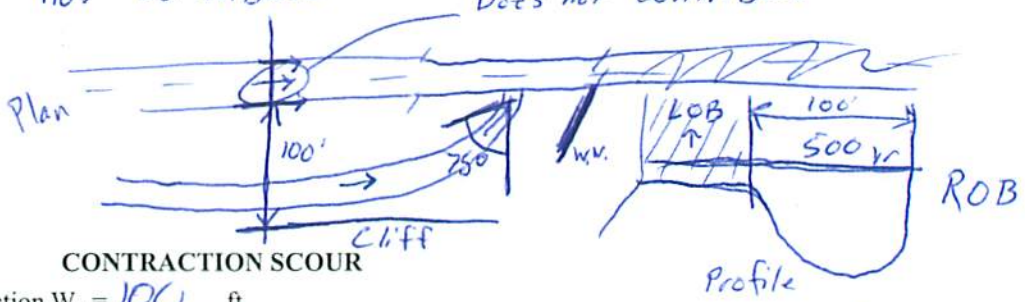
Pier Width = 1.27 ft

Pier Length = 26.0 ft

Piers for 500 yr = 2 ft

LOB Flow would be ~~to~~ going laterally & would not contribute

Does not contribute



CONTRACTION SCOUR

PGRM: Contract

Width of main channel at approach section W_1 = 100 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 = 3.115926~~ 0

Estimated bed material D_{50} = 0.2 ft Average approach velocity, $V_1 = Q_{500}/(y_1W_1)$ = 7.21 ft/s

Critical approach velocity, $Vc = 11.52 y_1^{1/6} D_{50}^{1/3}$ = 10.04 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.

$D_{c50} = 0.0006(q_2/y_1^{7/6})^3$ = 0.13756 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 = 22 Correction factor for flow angle of attack (from Table 1), K2 = 4.0

Froude # at bridge = 0.68 Using pier width a on Figure 11, ξ = 5.7 Pier scour y_{ps} = 21.6 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

CW 0.78

Route Nemo Rd Stream Boxelder Creek MRM _____ Date 9/17/10 Initials CMW

Bridge Structure No. 47065619 Location Extreme SW Meade County between Chipmunk Place and Pine Rd

GPS coordinates: N 44°08'29.3" W103°26'41.9" taken from: USL abutment X centerline of ↑ MRM end _____

Datum of coordinates: WGS84 X NAD27 _____

Drainage area = 95.83 sq. mi.

The average bottom of the main channel was 14.0 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} = 3150			Q_{500} = 17400		
Estimated flow passing through bridge	3150			9513		
Estimated road overflow & overtopping				7887		
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	

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?

Riprap ____Yes ____No X Don't know ____NA Huge Concrete Chunks

Spur Dike ____Yes ____No ____Don't know X NA

Other XL - Wing Wall on R. Abut X Yes ____No ____Don't know ____NA
See Photos

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

I don't think Q500 LOB w/ contribute to scour, already over road

1218 - Bridge ID
19 - US from Bridge
20 - US RB
21 - US LB
22 - US face of bridge
23 - US face of bridge
24 - L. Abut
25 - R. Abut
26 - XL wing wall

Summary of Results

	Q100	Q500
Bridge flow evaluated	3150	9513
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	21.0	21.6
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	40°	40°

See Comments/Diagram for justification where required