North Fork Moreau River

SCOUR ANALYSIS AND REPORTING FORM

Bridge Structure No. 53018532 Date 8/10/11 Initials CW Region (A B C D)

Site _____ Location 0.4 mi S of Zeona on 157 Ave.

Q_{100} = 10200 by: drainage area ratio ____ flood freq. anal. ____ regional regression eq. ✓

Bridge discharge (Q_2) = 10200 (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 = 134 ft. Flow angle at bridge = 20 ° Abut. Skew = 15 ° Effective Skew = 5 °

Width (W_2) iteration = 134 125 126 ____

Avg. flow depth at bridge, y_2 iteration = 10.5 10.9 10.8 ____

Corrected channel width at bridge Section = W_2 times cos of flow angle = 126.52 ft* $q_2 = Q_2/W_2$ = 81.3 ft^2/s

Bridge Vel, V_2 = 7.5 ft/s Final $y_2 = q_2/V_2$ = 10.8 ft Δh = 1.2 ft

Average main channel depth at approach section, $y_1 = \Delta h + y_2$ = 12.0 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. = 12.2 ft

n (Channel) = 0.033

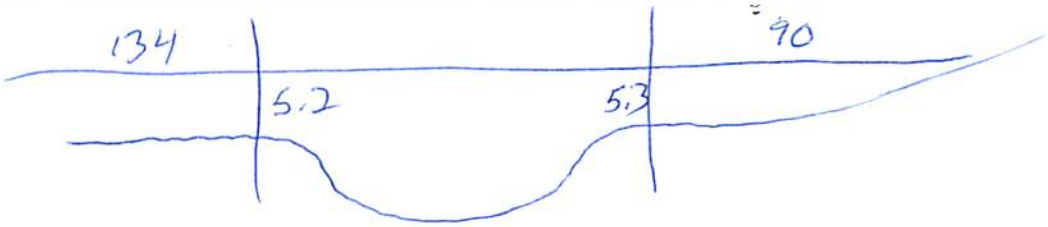
n (LOB) = 0.037

n (ROB) = 0.034

Pier Width = 0.85 ft

Pier Length = 0.83 ft

Piers for 100 yr = 2 ft



CONTRACTION SCOUR

PGRM: Contract

Width of main channel at approach section W_1 = 140 ft

Width of left overbank flow at approach, W_{lob} = 134 ft Average left overbank flow depth, y_{lob} = 5.2 ft

Width of right overbank flow at approach, W_{rob} = 70 ft Average right overbank flow depth, y_{rob} = ~~5.3~~ 2.65 ft

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

x = ~~4.44~~ 5.07 From Figure 9 W_2 (effective) = 123.8 ft y_{cs} = ~~5.1~~ 5.8 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, $V_1 = Q_{100}/(y_1W_1)$ = ____ ft/s

Critical approach velocity, $Vc = 11.17y_1^{1/6}D_{50}^{1/3}$ = ____ 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: Pier

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

Froude # at bridge = 0.4 Using pier width a on Figure 11, ξ = 4.1 Pier scour y_{ps} = 3.6 ft

ABUTMENT SCOUR CALCULATIONS

PGRM: Abutment

Average flow depth blocked by: left abutment, y_{aLT} = 5.2 ft right abutment, y_{aRT} = 2.65 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} = 15.4 and ψ_{RT} = 10.8

Left abutment scour, $y_{as} = \psi_{LT}(K_1/0.55)$ = 15.4 ft Right abutment scour $y_{as} = \psi_{RT}(K_1/0.55)$ = 10.8 ft

2.25
1.95
4.20

16.4
4.2
12.2

SCOUR ANALYSIS AND REPORTING FORM

Bridge Structure No. 53018532 Date 8/10/11 Initials CM Region (A (B) C D)

Site _____ Location 0.4 mi S of Zeona on 167 Ave

Q_{500} = 16900 by: drainage area ratio ____ flood freq. anal. ____ regional regression eq. ✓

Bridge discharge (Q_2) = 13591 (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 = 134 ft. Flow angle at bridge = 20 ° Abut. Skew = 15 ° Effective Skew = 5 °

Width (W_2) iteration = 134

Avg. flow depth at bridge, y_2 iteration = 13.7 ? Low chord RD Overflow

Corrected channel width at bridge Section = W_2 times cos of flow angle = 133.5 ft* $q_2 = Q_2/W_2$ = 101.8 ft^2/s

Bridge Vel, V_2 = 8.3 ft/s Final $y_2 = q_2/V_2$ = 12.2 ft Δh = 1.4 ft

Average main channel depth at approach section, $y_1 = \Delta h + y_2$ = 13.6 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. = 12.2 ft

n (Channel) = 0.033

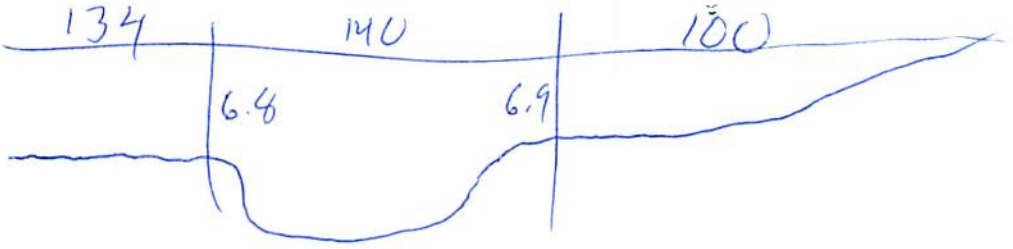
n (LOB) = 0.037

n (ROB) = 0.037

Pier Width = 0.85 ft

Pier Length = 0.85 ft

Piers for 500 yr = 2 ft



CONTRACTION SCOUR

PGRM: Contract

Width of main channel at approach section W_1 = 140 ft

Width of left overbank flow at approach, W_{lob} = 134 ft Average left overbank flow depth, y_{lob} = 6.4 ft

Width of right overbank flow at approach, W_{rob} = 100 ft Average right overbank flow depth, y_{rob} = 3.5 ft

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

x = 5.69 From Figure 9 W_2 (effective) = 131.8 ft y_{cs} = 6.4 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, $V_1 = Q_{500}/(y_1 W_1)$ = ____ ft/s

Critical approach velocity, $Vc = 11.17 y_1^{1/6} D_{50}^{1/3}$ = ____ 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 = 1.0 Correction factor for flow angle of attack (from Table 1), K2 = 1.0

Froude # at bridge = 0.42 Using pier width a on Figure 11, ξ = 4.1 Pier scour y_{ps} = 3.6 ft

PGRM: Abutment

ABUTMENT SCOUR CALCULATIONS

Average flow depth blocked by: left abutment, y_{aLT} = 6.4 ft right abutment, y_{aRT} = 3.5 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} = 18.2 and ψ_{RT} = 12.4

Left abutment scour, $y_{as} = \psi_{LT}(K_1/0.55)$ = 18.2 ft Right abutment scour $y_{as} = \psi_{RT}(K_1/0.55)$ = 12.4 ft

6.9 3.45 2|6.9

Route 157 Ave Stream North Fork Maple River MRM _____ Date 3/10/11 Initials CM

Bridge Structure No. 53018532 Location 0.4 mi S of Zeona on 157 Ave

GPS coordinates: N 45° 11' 06.7" taken from: USL abutment X centerline of ⇑ MRM end _____

W 102° 55' 04.6" Datum of coordinates: WGS84 X NAD27 _____

Drainage area = 336.59 sq. mi.

The average bottom of the main channel was 16.4 ft below top of guardrail at a point 60. ft from left abutment.

Method used to determine flood flows: ____Freq. Anal. ____drainage area ratio ✓regional regression equations.

Pks calc'd on 8/8

Pk2	646
5	2100
10	3630
25	5810
50	7490
100	10200
500	16900

MISCELLANEOUS CONSIDERATIONS

Flows	Q_{100} = 10200			Q_{500} = 16900		
Estimated flow passing through bridge		10200			13591	
Estimated road overflow & overtopping					3309	
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? X Yes ____No ____Don't know Pier

Debris Potential? ____High ____Med X Low

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

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 X	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

1453 - ID
54 - us
55 - usRB
56 - usLB
57 - R. Abut
58 - L Abut
59 - us face
60 - Pier scour hole

Summary of Results

	Q100	Q500
Bridge flow evaluated	10200	13591
Flow depth at left abutment (yaLT), in feet	5.2	6.8
Flow depth at right abutment (yaRT), in feet	2.65	3.5
Contraction scour depth (ycs), in feet	~~5.1~~ 5.8	6.4
Pier scour depth (yps), in feet	3.6	3.6
Left abutment scour depth (yas), in feet	15.4	18.2
Right abutment scour depth (yas), in feet	10.8	12.4
1Flow angle of attack	5	5

See Comments/Diagram for justification where required

5910
16900
13591
3309