ok TRT

SCOUR ANALYSIS AND REPORTING FORM

Bridge Structure No. 14117214 Date 5/27/12 Initials cat Region (A B (C) D)

Site _____ Location in Vermillion, 700 S. Dakota Ave Vermillion River

Q_{100} = ~~20300~~ 40700 by: drainage area ratio ~~✓~~ flood freq. anal. ____ regional regression eq. ✓

Bridge discharge (Q_2) = 40700 (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 = ~~291~~ ft. Flow angle at bridge = 20 ° Abut. Skew = 0 ° Effective Skew = 20 °

Width (W_2) iteration = 273.45 ~~[illegible]~~ 245.16 252.76 249.07

Avg. flow depth at bridge, y_2 iteration = 17.2 ~~16.9~~ 18.2 17.9 18

Corrected channel width at bridge Section = W_2 times cos of flow angle = ~~[illegible]~~ ft* 249.07 $q_2 = Q_2/W_2$ = 163.4 ft^2/s

Bridge Vel, V_2 = 9.1 ft/s Final $y_2 = q_2/V_2$ = 18 ft Δh = 1.7 ft

Average main channel depth at approach section, $y_1 = \Delta h + y_2$ = 19.7 ft

261
269

** 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. = NA ft

Low Steel Elev. = 25 ft

n (Channel) = 0.060

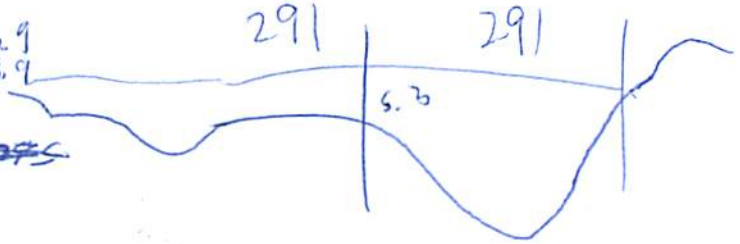
n (LOB) = ~~[illegible]~~ 0.090

n (ROB) = 0.075 ~~0.060~~

Pier Width = 2.5 ft

Pier Length = 14.35 ft

Piers for 100 yr = 1 ft



CONTRACTION SCOUR

PGRM: Contract

Width of main channel at approach section W_1 = 291 ft

Width of left overbank flow at approach, W_{lob} = 291 ft Average left overbank flow depth, y_{lob} = 5.3 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 = 5.29 From Figure 9 W_2 (effective) = 246.5 ft y_{cs} = 6 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, $V_1 = Q_{100}/(y_1 W_1)$ = _____ ft/s

Critical approach velocity, $Vc = 11.52 y_1^{1/6} D_{50}^{1/3}$ = _____ 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 = ~~6.74~~ 5.74 Correction factor for flow angle of attack (from Table 1), K2 = 1.85

Froude # at bridge = 0.38 Using pier width a on Figure 11, ξ = 9.5 Pier scour y_{ps} = 15.2 ft

PGRM: Abutment

ABUTMENT SCOUR CALCULATIONS

Average flow depth blocked by: left abutment, y_{aLT} = 5.3 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} = 15.6 and ψ_{RT} = 0

Left abutment scour, $y_{as} = \psi_{LT}(K_1/0.55)$ = 15.6 ft Right abutment scour $y_{as} = \psi_{RT}(K_1/0.55)$ = 0 ft

SCOUR ANALYSIS AND REPORTING FORM

Bridge Structure No. 14117214 Date 5/27/12 Initials RAJ Region (A B C D)

Site _____ Location in Vermillion, 700 S. Dakota Ave.

Q_{500} = 356900 85100 by: drainage area ratio ✓ flood freq. anal. ____ regional regression eq. X

Bridge discharge (Q_2) = 85100 (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 = 291 ft. Flow angle at bridge = 20 ° Abut. Skew = 0 ° Effective Skew = 20 °

Width (W_2) iteration = _____ _____ _____ _____

Avg. flow depth at bridge, y_2 iteration = _____ _____ _____ _____

Corrected channel width at bridge Section = W_2 times cos of flow angle = 273.45 ft* $q_2 = Q_2/W_2$ = 311.2 ft^2/s

Bridge Vel, V_2 = 12.2 ft/s Final $y_2 = q_2/V_2$ = 24.9 ft Δh = 3.2 ft

Average main channel depth at approach section, $y_1 = \Delta h + y_2$ = 28.1 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. = 25 ft

n (Channel) = 0.060

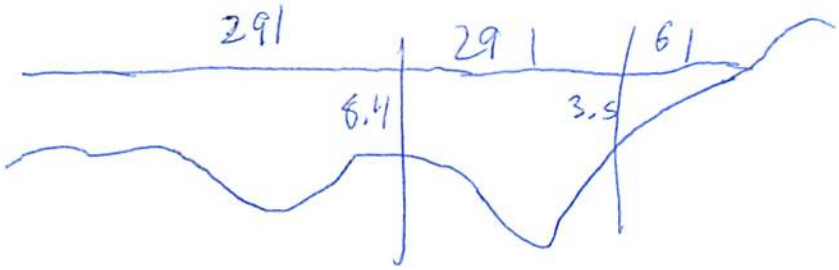
n (LOB) = 0.090

n (ROB) = 0.075

Pier Width = 2.5 ft

Pier Length = 14.35 ft

Piers for 500 yr = 1 ft



CONTRACTION SCOUR

PGRM: Contract

Width of main channel at approach section W_1 = 291 ft

Width of left overbank flow at approach, W_{lob} = 291 ft Average left overbank flow depth, y_{lob} = 6.4 ft

Width of right overbank flow at approach, W_{rob} = 61 ft Average right overbank flow depth, y_{rob} = 3.5 ft

$5.33_3 = 10.6$

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

x = 4.93 From Figure 9 W_2 (effective) = 271 ft y_{cs} = 5.6 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, $Vc = 11.52 y_1^{1/6} D_{50}^{1/3}$ = _____ 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 = 5.71 Correction factor for flow angle of attack (from Table 1), K2 = 1.83

Froude # at bridge = 0.43 Using pier width a on Figure 11, ξ = 9.3 Pier scour y_{ps} = ~~15.6~~ 15.5 ft

PGRM: Abutment

ABUTMENT SCOUR CALCULATIONS

Average flow depth blocked by: left abutment, y_{aLT} = 8.4 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} = 20.1 and ψ_{RT} = 12.4

Left abutment scour, $y_{as} = \psi_{LT}(K_1/0.55)$ = 20.1 ft Right abutment scour $y_{as} = \psi_{RT}(K_1/0.55)$ = 12.4 ft

Route S. Dak. Ave Stream Vermillion River MRM _____ Date 5/27/12 Initials RaT

Bridge Structure No. 14117214 Location in Vermillion, 700 S. Dakota Ave

GPS coordinates: N 42° 46' 34.61" W 96° 55' 51.01" taken from: USL abutment X centerline of ⇑ MRM end _____

Datum of coordinates: WGS84 X NAD27 _____

Drainage area = 2115.53 sq. mi.

The average bottom of the main channel was ~~33~~ 33.9 ft below top of guardrail at a point 136 ft from left abutment.

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

MISCELLANEOUS CONSIDERATIONS

Flows	Q_{100} = 20300 40700			Q_{500} = ~~31,800~~ 85100		
Estimated flow passing through bridge			40700			85100
Estimated road overflow & overtopping			0			0
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	

5/22	
2	1590
5	5570
10	9950
25	18700
50	25200
100	40700
500	85100

Riprap at abutments? X Yes ____No ____Marginal riprip lines the right bank but is absent of the left side

Evidence of past Scour? X Yes ____No ____Don't know contraction

Debris Potential? ____High X Med ____Low

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

Riprap	X Yes	____No	____Don't know	____NA
Spur Dike	____Yes	X No	____Don't know	____NA
Other _____	X Yes	____No	____Don't know	____NA

riprap along right bank, ~~Rip~~ lines on bank.

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

1). main channel
2). right ab
3). right ab
4). piers.
5). river
6) left ab
7). left ab
8). left OB
9). left OB
10). main channel
11). right OB
12). right OB
13). main channel

Note: the Q values used are from StreamStats, and are higher than the Q_{100} and Q_{500} values produced by a drainage area ratio from a nearby gage.

Summary of Results

	Q100	Q500
Bridge flow evaluated	40700	85100
Flow depth at left abutment (yaLT), in feet	5.3	8.4
Flow depth at right abutment (yaRT), in feet	0	3.5
Contraction scour depth (ycs), in feet	6	5.6
Pier scour depth (yps), in feet	15.2	~~15.6~~ 15.5
Left abutment scour depth (yas), in feet	15.6	20.1
Right abutment scour depth (yas), in feet	0	12.4
1Flow angle of attack	20	20

See Comments/Diagram for justification where required