OK RT

SCOUR ANALYSIS AND REPORTING FORM

Bridge Structure No. 151811175 Date 4/16/10 Initials CW Region (A B (C) D)

Site _____ Location Big Sioux River on 4th Ave S in Wakefield

Q_{100} = 5940 by: drainage area V flood frequency anal. ____ regional regression eq. ____

Bridge discharge (Q_2) = 5940 (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 = 146 ft. Flow angle at bridge = 15 ° Abut. Skew = 0 ° Effective Skew = 15 °

Width (W_2) iteration = 146 _____ _____ _____

Avg. flow depth at bridge, y_2 iteration = 9.2 _____ _____ _____

Corrected channel width at bridge Section = W_2 times cos of flow angle = 141.03 ft* $q_2 = Q_2/W_2$ = 42.1 ft^2/s

Bridge Vel, V_2 = 4.6 ft/s Final $y_2 = q_2/V_2$ = 9.2 ft Δh = 0.4 ft

Average main channel depth at approach section, $y_1 = \Delta h + y_2$ = 9.6 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,

Vertical wall → no iteration @ water surface

Water Surface Elev. = _____ ft

Low Steel Elev. = 4.6 ft

n (Channel) = .037

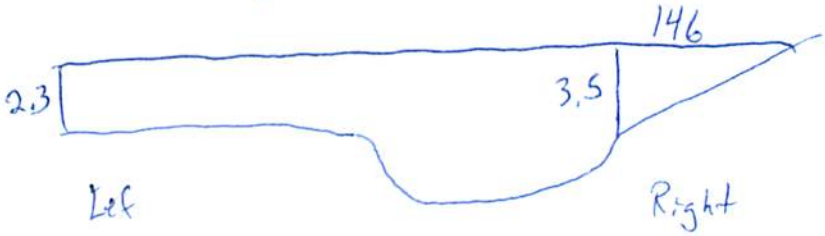
n (LOB) = .033

n (ROB) = .035

Pier Width = 2.2 ft

Pier Length = 2.2 ft

Piers for 100 yr = 4 ft



CONTRACTION SCOUR

PGRM: Contract

Width of main channel at approach section W_1 = 150 ft

Width of left overbank flow at approach, W_{lob} = 146 ft Average left overbank flow depth, y_{lob} = ~~1.75~~ 2.3 ft

Width of right overbank flow at approach, W_{rob} = 146 ft Average right overbank flow depth, y_{rob} = ~~2.3~~ 1.75 ft

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

x = 3.05 From Figure 9 W_2 (effective) = ~~141~~ 132.2 ft y_{cs} = 3.6 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, $V_1 = Q_{100}/(y_1W_1)$ = _____ ft/s

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

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 = 0.27 Using pier width a on Figure 11, ξ = 8.6 Pier scour y_{ps} = 7.1 ft

PGRM: Abutment

ABUTMENT SCOUR CALCULATIONS

Average flow depth blocked by: left abutment, y_{aLT} = 2.3 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, ψ_{LT} = 9.4 and ψ_{RT} = 7.2

Left abutment scour, $y_{as} = \psi_{LT}(K_1/0.55)$ = 9.4 ft Right abutment scour $y_{as} = \psi_{RT}(K_1/0.55)$ = 7.2 ft

SCOUR ANALYSIS AND REPORTING FORM

Bridge Structure No. 15181175 Date 8/16/10 Initials CW Region (A B C D)

Site _____ Location Big Sioux River on 4th Ave. S in Watertown

Q_{500} = ~~9560~~ 9720 by: drainage area V flood frequency anal. ____ regional regression eq. ____

Bridge discharge (Q_2) = 6758 (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 = 146 ft. Flow angle at bridge = 15 ° Abut. Skew = 0 ° Effective Skew = 15 °

Width (W_2) iteration = 146 _____ _____ _____

Avg. flow depth at bridge, y_2 iteration = 11.7 _____ _____ _____

Corrected channel width at bridge Section = W_2 times cos of flow angle = 141.03 ft* $q_2 = Q_2/W_2$ = 47.9 ft^2/s

Bridge Vel, V_2 = 4.9 ft/s Final $y_2 = q_2/V_2$ = 9.8 ft Δh = 0.5 ft

Average main channel depth at approach section, $y_1 = \Delta h + y_2$ = 10.3 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.

$y_2 = 11.7 \rightarrow$ RD Overflow $\rightarrow$ ~~Q=~~ Q = 6758

Water Surface Elev. = _____ ft

Low Steel Elev. = 9.6 ft

n (Channel) = 0.037

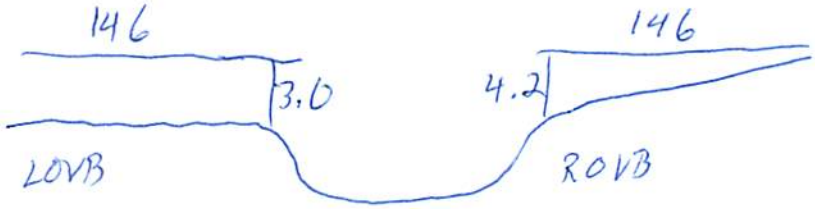
n (LOB) = 0.033

n (ROB) = 0.035

Pier Width = 2.2 ft

Pier Length = 2.2 ft

Piers for 500 yr = 4 ft



CONTRACTION SCOUR

PGRM: Contract

Width of main channel at approach section W_1 = 150 ft

Width of left overbank flow at approach, W_{lob} = 146 ft Average left overbank flow depth, y_{lob} = ~~2.1~~ ft 3.0

Width of right overbank flow at approach, W_{rob} = 146 ft Average right overbank flow depth, y_{rob} = ~~3.0~~ ft 2.1

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

x = 3.87 From Figure 9 W_2 (effective) = 132.2 ft y_{cs} = 4.5 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, $V_1 = Q_{500}/(y_1W_1)$ = _____ ft/s

Critical approach velocity, $Vc = 11.52y_1^{1/6}D_{50}^{1/3}$ = _____ 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 = ~~0.27~~ 0.24 Using pier width a on Figure 11, ξ = 8.6 Pier scour y_{ps} = 7.1 ft

ABUTMENT SCOUR CALCULATIONS

PGRM: Abutment

Average flow depth blocked by: left abutment, y_{aLT} = 3.0 ft right abutment, y_{aRT} = ~~2.1~~ 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} = 11.5 and ψ_{RT} = 8.6

Left abutment scour, $y_{as} = \psi_{LT}(K_1/0.55)$ = 11.5 ft Right abutment scour $y_{as} = \psi_{RT}(K_1/0.55)$ = 8.6 ft

Route 4th Ave S Stream Big Sioux River MRM _____ Date _____ Initials _____

Bridge Structure No. 151811175 Location in Watertown

GPS coordinates: N44°53'51.0" W097°07'32.2" taken from: USL abutment X centerline of ⇑ MRM end _____

Datum of coordinates: WGS84 X NAD27 _____

Drainage area = 363.2 sq. mi.

The average bottom of the main channel was 14.7 ft below top of guardrail at a point 37 ft from left abutment.

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

MISCELLANEOUS CONSIDERATIONS

Flows	Q_{100} = 5940			Q_{500} = ~~9560~~ 9720		
Estimated flow passing through bridge	5940			6758		
Estimated road overflow & overtopping				2962		
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? ____Yes ____No X Marginal Some @ left abut, but for sewer, not abut.

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	X No	____Don't know	____NA
Spur Dike	____Yes	X No	____Don't know	____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

1094- Bridge ID
95- US bridge face
96- US bridge face
97- US
98- US RB
99- US LB
100- US LB

Summary of Results

	Q100	Q500
Bridge flow evaluated	5940	6758
Flow depth at left abutment (yaLT), in feet	2.3	3.0
Flow depth at right abutment (yaRT), in feet	1.75	2.1
Contraction scour depth (ycs), in feet	3.6	4.5
Pier scour depth (yps), in feet	7.1	7.1
Left abutment scour depth (yas), in feet	9.4	11.5
Right abutment scour depth (yas), in feet	7.2	8.6
1Flow angle of attack	15	15

See Comments/Diagram for justification where required