OK RT

SCOUR ANALYSIS AND REPORTING FORM

Bridge Structure No. 29256060 Date 8/17/10 Initials CW Region (A B C D)

Site _____ Location 2.5 mi E. of Castlewood on 184th St

Q_{100} = 10400 by: drainage area ✓ flood frequency anal. ____ regional regression eq. ____

Bridge discharge (Q_2) = 6586 (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 = 91 ft. Flow angle at bridge = 30 ° Abut. Skew = 0 ° Effective Skew = 30 °

Width (W_2) iteration = 91 _____ _____ _____

Avg. flow depth at bridge, y_2 iteration = 16.2 _____ _____ _____

Corrected channel width at bridge Section = W_2 times cos of flow angle = 78.81 ft* $q_2 = Q_2/W_2$ = 83.6 ft^2/s

Bridge Vel, V_2 = 6.5 ft/s Final $y_2 = q_2/V_2$ = 12.9 ft Δh = 0.9 ft

Average main channel depth at approach section, $y_1 = \Delta h + y_2$ = 13.7 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,

$y_2 = 16.2 > LS = 12.0 \Rightarrow$ RD over flow $Q = 6586$

Water Surface Elev. = _____ ft

Low Steel Elev. = 12.0 ft

n (Channel) = 0.033

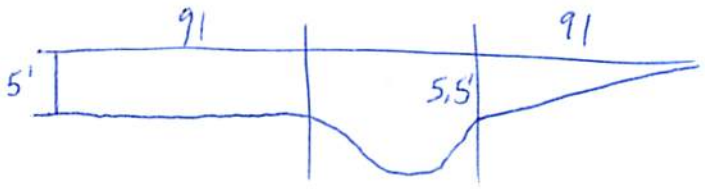
n (LOB) = ~~0.033~~ 0.040

n (ROB) = ~~0.033~~ 0.040

Pier Width = — ft

Pier Length = — ft

Piers for 100 yr = 0 ft



CONTRACTION SCOUR

PGRM: Contract

Width of main channel at approach section W_1 = 130 ft

Width of left overbank flow at approach, W_{lob} = 91 ft Average left overbank flow depth, y_{lob} = 5.0 ft

Width of right overbank flow at approach, W_{rob} = 91 ft Average right overbank flow depth, y_{rob} = 2.75 ft

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

x = 12.23 From Figure 9 W_2 (effective) = 74.8 ft y_{cs} = 13.3 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 = _____ Correction factor for flow angle of attack (from Table 1), K2 = _____

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

No Piers

PGRM: Abutment

ABUTMENT SCOUR CALCULATIONS

Average flow depth blocked by: left abutment, y_{aLT} = 5.0 ft right abutment, y_{aRT} = 2.75 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} = 15 and ψ_{RT} = 11.1

Left abutment scour, $y_{as} = \psi_{LT}(K_1/0.55)$ = 15 ft Right abutment scour $y_{as} = \psi_{RT}(K_1/0.55)$ = 11.1 ft

SCOUR ANALYSIS AND REPORTING FORM

Bridge Structure No. 29256060 Date 8/17/10 Initials CW Region (A B C D)

Site _____ Location 2.5 mi E of Castlewood on 184th St.

Q_{500} = 18400 by: drainage area ✓ flood frequency anal. ____ regional regression eq. ____

Bridge discharge (Q_2) = 6586 (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 = 91 ft. Flow angle at bridge = 30 ° Abut. Skew = 0 ° Effective Skew = 30 °

Width (W_2) iteration = 91 _____ _____ _____

Avg. flow depth at bridge, y_2 iteration = 21.5 _____ _____ _____

Corrected channel width at bridge Section = W_2 times cos of flow angle = 78.81 ft* $q_2 = Q_2/W_2$ = 83.6 ft^2/s

Bridge Vel, V_2 = 6.5 ft/s Final $y_2 = q_2/V_2$ = 12.9 ft Δh = 0.9 ft

Average main channel depth at approach section, $y_1 = \Delta h + y_2$ = 13.7 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,

$Y_2 = 21.5 > LS = 12.0 \rightarrow$ RD overflow Q = 6586

Water Surface Elev. = _____ ft

Low Steel Elev. = 12.0 ft

n (Channel) = 0.033

n (LOB) = 0.040

n (ROB) = 0.040

Pier Width = — ft

Pier Length = — ft

Piers for 500 yr = 0 ft

CONTRACTION SCOUR

PGRM: Contract

Width of main channel at approach section W_1 = 130 ft

Width of left overbank flow at approach, W_{lob} = 91 ft Average left overbank flow depth, y_{lob} = 5.0 ft

Width of right overbank flow at approach, W_{rob} = 91 ft Average right overbank flow depth, y_{rob} = 2.75 ft

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

x = 12.23 From Figure 9 W_2 (effective) = 78.8 ft y_{cs} = 13.3 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

PIER SCOUR CALCULATIONS

PGRM: Pier

NO PIERS

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

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

ABUTMENT SCOUR CALCULATIONS

PGRM: Abutment

Average flow depth blocked by: left abutment, y_{aLT} = 5.0 ft right abutment, y_{aRT} = 2.75 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} = 15 and ψ_{RT} = 11.1

Left abutment scour, $y_{as} = \psi_{LT}(K_1/0.55)$ = 15 ft Right abutment scour $y_{as} = \psi_{RT}(K_1/0.55)$ = 11.1 ft

Route 184th St Stream Stray Horse Creek MRM _____ Date 8/17/10 Initials CW

Bridge Structure No. 29256060 Location 2.5 mi. E of Castlewood on 184th St

GPS coordinates: N44°43'02.6" W096°58'24.5" taken from: USL abutment X centerline of ⇑ MRM end _____

Datum of coordinates: WGS84 X NAD27 _____

Drainage area = 79.69 sq. mi.

The average bottom of the main channel was 20 ft below top of guardrail at a point 28 ft from left abutment.

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

MISCELLANEOUS CONSIDERATIONS

Flows	Q_{100} = 10400			Q_{500} = 18400		
Estimated flow passing through bridge	6586			6586		
Estimated road overflow & overtopping	3814			11814		
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 Left Abut → Pink Quartz, Right → Field stone

Evidence of past Scour? X Yes ____No ____Don't know ~~Left~~ Right Abut. dif, riprap

Debris Potential? ____High X Med ____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

1101 - Bridge #
02 - Upstream
03 - US RB
04 - US LB
05 - US Face of bridge
1106 - Right abut.
1107 - Left Abut.

Summary of Results

	Q100	Q500
Bridge flow evaluated	6586	6586
Flow depth at left abutment (yaLT), in feet	5.0	5.0
Flow depth at right abutment (yaRT), in feet	2.75	2.75
Contraction scour depth (ycs), in feet	13.3	13.3
Pier scour depth (yps), in feet	———	———
Left abutment scour depth (yas), in feet	15.0	15.0
Right abutment scour depth (yas), in feet	11.1	11.1
1Flow angle of attack	30	30

See Comments/Diagram for justification where required