OK RT

SCOUR ANALYSIS AND REPORTING FORM

Boulder Hill?

Bridge Structure No. 52325364 Date 10/15/10 Initials CW Region (A B C D)

Site _____ Location First bridge upstream from Baker Park Road

Q_{100} = 3030 by: drainage area ratio ✓ flood freq. anal. ____ regional regression eq. ____

Bridge discharge (Q_2) = 3030 (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 = 96 ft. Flow angle at bridge = 45 ° Abut. Skew = 45 ° Effective Skew = 0 °

Width (W_2) iteration = 96 59 67 68

Avg. flow depth at bridge, y_2 iteration = 4.6 6.2 5.8 5.6

Corrected channel width at bridge Section = W_2 times cos of flow angle = 68 ft* $q_2 = Q_2/W_2$ = 44.6 ft²/s

Bridge Vel, V_2 = 7.7 ft/s Final $y_2 = q_2/V_2$ = 5.8 ft Δh = 1.2 ft

Average main channel depth at approach section, $y_1 = \Delta h + y_2$ = 7.0 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. = 12.7 ft

n (Channel) = ~~0.040~~ 0.045

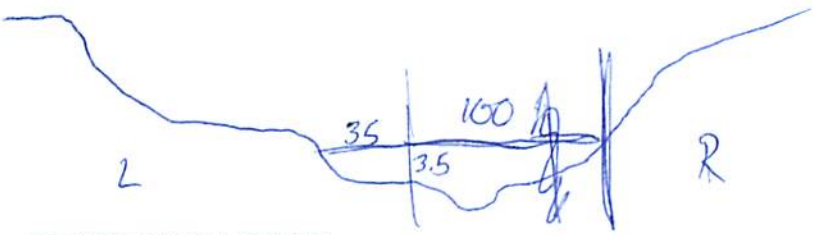
n (LOB) = 0.050

n (ROB) = 0.050

Pier Width = 1.6 ft

Pier Length = 1.6 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} = 35 ft Average left overbank flow depth, y_{lob} = 1.75 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) 230

Estimated bed material D_{50} = 0.3 ft Average approach velocity, $V_1 = Q_{100}/(y_1 W_1)$ = ~~4.33~~ 3.21 ft/s

Critical approach velocity, $Vc = 11.52 y_1^{1/6} D_{50}^{1/3}$ = 10.34 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.

$D_{c50} = 0.0006(q_2/y_1^{7/6})^3$ = 0.05865 ft If $D_{50} >= D_{c50}$, χ = 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

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 = 0.56 Using pier width a on Figure 11, ξ = 7.4 Pier scour y_{ps} = 6.8 ft

ABUTMENT SCOUR CALCULATIONS

PGRM: Abutment

Average flow depth blocked by: left abutment, y_{aLT} = 1.75 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} = 7.2 and ψ_{RT} = 0

Left abutment scour, $y_{as} = \psi_{LT}(K_1/0.55)$ = 7.2 ft Right abutment scour $y_{as} = \psi_{RT}(K_1/0.55)$ = 0 ft

8.17 1.82 9.5

SCOUR ANALYSIS AND REPORTING FORM

Bridge Structure No. 52325364 Date 10/15/10 Initials CW Region (A B C D)

Site _____ Location First bridge upstream from Baker Park Road

Q_{500} = 22600 by: drainage area ratio ✓ flood freq. anal. ____ regional regression eq. ____

Bridge discharge (Q_2) = 16107 (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 = 96 ft. Flow angle at bridge = 45 ° Abut. Skew = 45 ° Effective Skew = 0 °

Width (W_2) iteration = 96

Avg. flow depth at bridge, y_2 iteration = 14.3 RD Overflow

Corrected channel width at bridge Section = W_2 times cos of flow angle = 96 ft* $q_2 = Q_2/W_2$ = 168.6 ft^2/s

Bridge Vel, V_2 = 14.9 ft/s Final $y_2 = q_2/V_2$ = 12.7 ft Δh = 4.5 ft

Average main channel depth at approach section, $y_1 = \Delta h + y_2$ = 17.2 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. = 12.7 ft

n (Channel) = 0.045

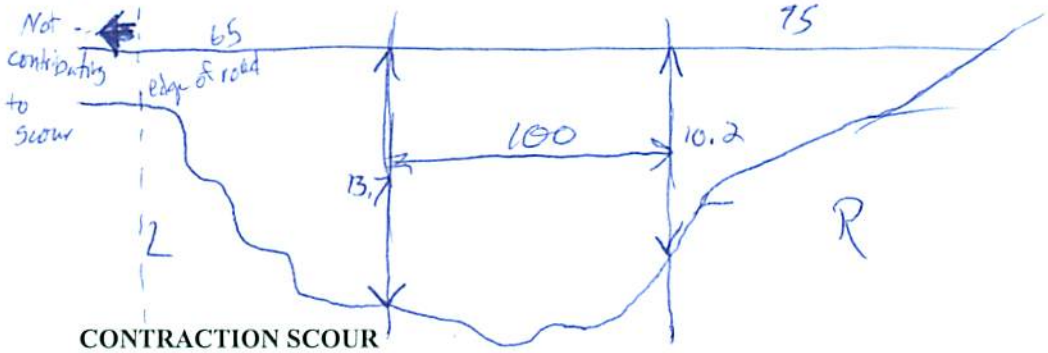
n (LOB) = 0.050

n (ROB) = 0.050

Pier Width = 1.8 ft

Pier Length = 1.8 ft

Piers for 500 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} = 65 ft Average left overbank flow depth, y_{lob} = 6.95 ft

Width of right overbank flow at approach, W_{rob} = 95 ft Average right overbank flow depth, y_{rob} = 5.1 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 = 0

Estimated bed material D_{50} = 0.3 ft Average approach velocity, $V_1 = Q_{500}/(y_1 W_1)$ = ~~10.55~~ 4.05 ft/s

Critical approach velocity, $Vc = 11.52 y_1^{1/6} D_{50}^{1/3}$ = 12.01 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.

$D_{c50} = 0.0006(q_2/y_1^{7/6})^3$ = 0.191 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 = 1.0 Correction factor for flow angle of attack (from Table 1), K2 = 1.0

Froude # at bridge = 0.74 Using pier width a on Figure 11, ξ = 7.4 Pier scour y_{ps} = 7.0 ft

PGRM: Abutment

ABUTMENT SCOUR CALCULATIONS

Average flow depth blocked by: left abutment, y_{aLT} = 6.95 ft right abutment, y_{aRT} = 5.1 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} = 18.3 and ψ_{RT} = 15.2

Left abutment scour, $y_{as} = \psi_{LT}(K_1/0.55)$ = 18.3 ft Right abutment scour $y_{as} = \psi_{RT}(K_1/0.55)$ = 15.2 ft

Route Sheridan Lake Rd Stream Spring Creek MRM _____ Date 10/15/10 Initials CV

Bridge Structure No. 52325364 Location First bridge upstream from Baker Park Road

GPS coordinates: N43°59'20.1" W105°24'34.8" taken from: USL abutment X centerline of ⇑ MRM end _____

Datum of coordinates: WGS84 X NAD27 _____

Drainage area = 152.82 sq. mi.

The average bottom of the main channel was 16.9 ft below top of guardrail at a point 31 ft from left abutment.

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

MISCELLANEOUS CONSIDERATIONS

Flows	Q_{100} = 3030			Q_{500} = 22600		
Estimated flow passing through bridge	3030			18107		
Estimated road overflow & overtopping				4493		
Consideration	Yes	No	Possibly	Yes	No	Possibly
Chance of overtopping		X		X		
Chance of Pressure flow		X		X		X
Armored appearance to channel		X			X	
Lateral instability of channel		X			X	

Riprap at abutments? ____Yes ____No X Marginal

Evidence of past Scour? ____Yes ____No X Don't know Looks like rock that was used for rip rap washed away

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	____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____	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

1349 - 1D
50 - US
51 - USRB
52 - USLB
53 - RB @ App. XS
54 - LB @ App. XS
55 - US Face of bridge
56 - R. Abut
57 - L. Abut

Summary of Results

	Q100	Q500
Bridge flow evaluated	3030	18107
Flow depth at left abutment (yaLT), in feet	1.75	6.85
Flow depth at right abutment (yaRT), in feet	0.0	5.1
Contraction scour depth (ycs), in feet	0.0	0.0
Pier scour depth (yps), in feet	6.8	7.0
Left abutment scour depth (yas), in feet	7.2	18.3
Right abutment scour depth (yas), in feet	0.0	15.2
1Flow angle of attack	0°	0°

See Comments/Diagram for justification where required