OK RT

SCOUR ANALYSIS AND REPORTING FORM

Bridge Structure No. 52384316 Date 11/13/10 Initials CW Region ((A) B C D)

Site ____________ Location Park Dr over Rapid Cr

Q_{100} = 4630 by: drainage area ratio ✓ flood freq. anal. ____ regional regression eq. ____

Bridge discharge (Q_2) = 4630 (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 = 114 ft. Flow angle at bridge = 0 ° Abut. Skew = 0 ° Effective Skew = 0 °

Width (W_2) iteration = 114 ______ ______

Avg. flow depth at bridge, y_2 iteration = 5.5 On vert Abut

Corrected channel width at bridge Section = W_2 times cos of flow angle = 114 ft* $q_2 = Q_2/W_2$ = 40.6 ft^2/s

Bridge Vel, V_2 = 7.4 ft/s Final $y_2 = q_2/V_2$ = 5.5 ft Δh = 1.1 ft

Average main channel depth at approach section, $y_1 = \Delta h + y_2$ = 6.6 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. = 6.0 ft

n (Channel) = 0.080

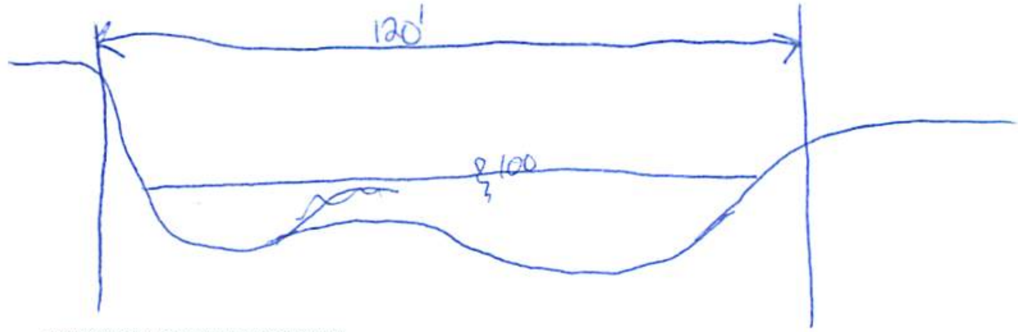
n (LOB) = 0.035

n (ROB) = 0.035

Pier Width = 2.0 ft

Pier Length = 2.0 ft

\# Piers for 100 yr = 2 ft



CONTRACTION SCOUR

PGRM: Contract

Width of main channel at approach section W_1 = 120 ft

Width of left overbank flow at approach, W_{lob} = 0 ft Average left overbank flow depth, y_{lob} = 0 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) Z=0

Estimated bed material D_{50} = 0.30 ft Average approach velocity, $V_1 = Q_{100}/(y_1W_1)$ = 5.85 ft/s

Critical approach velocity, $Vc = 11.52y_1^{1/6}D_{50}^{1/3}$ = 10.24 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.

$D_{c50} = 0.0006(q_2/y_1^{7/6})^3$ = 0.054 ft If $D_{50} >= D_{c50}$, $\chi = 0.0$ (circled)

Otherwise, $\chi = 0.122y_1[q_2/(D_{50}^{1/3}y_1^{7/6})]^{6/7} - y_1$ = — 0 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 = 8 Pier scour y_{ps} = 7.3 ft

ABUTMENT SCOUR CALCULATIONS

PGRM: Abutment

Average flow depth blocked by: left abutment, y_{aLT} = 0 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 (circled)

Using values for y_{aLT} and y_{aRT} on figure 12, ψ_{LT} = 0 and ψ_{RT} = 0

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

6.6
+7.3

SCOUR ANALYSIS AND REPORTING FORM

Bridge Structure No. 52384316 Date 11/13/10 Initials CW Region (A B C D) [A circled]

Site ______ Location Park Dr over Rapid Cr

Q_{500} = 17400 by: drainage area ratio ✓ flood freq. anal. ____ regional regression eq. ____

Bridge discharge (Q_2) = 5476 (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 = 114 ft. Flow angle at bridge = 0 ° Abut. Skew = 0 ° Effective Skew = 0 °

Width (W_2) iteration = 114 [crossed out] ______ ______

Avg. flow depth at bridge, y_2 iteration = 11.3 RD Overflow ______

Corrected channel width at bridge Section = W_2 times cos of flow angle = 114 ft* $q_2 = Q_2/W_2$ = 48 ft²/s

Bridge Vel, V_2 = 8.0 ft/s Final $y_2 = q_2/V_2$ = 6.0 ft Δh = 1.3 ft

Average main channel depth at approach section, $y_1 = \Delta h + y_2$ = 7.3 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,

Water Surface Elev. = — ft

Low Steel Elev. = 6.0 ft

n (Channel) = 0.080

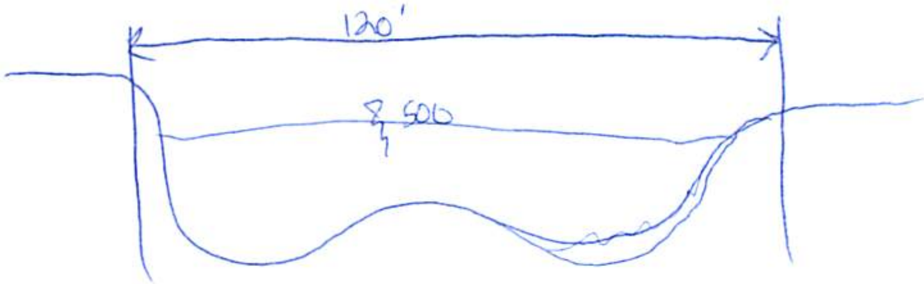
n (LOB) = ~~0.040~~ 0.035

n (ROB) = ~~0.040~~ 0.035

Pier Width = 2.0 ft

Pier Length = 2.0 ft

\# Piers for 500 yr = 2 ft



CONTRACTION SCOUR

PGRM: Contract

Width of main channel at approach section W_1 = 120 ft

Width of left overbank flow at approach, W_{lob} = 0 ft Average left overbank flow depth, y_{lob} = 0 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) Z=0

Estimated bed material D_{50} = 0.30 ft Average approach velocity, $V_1 = Q_{500}/(y_1 W_1)$ = 6.25 ft/s

Critical approach velocity, $V_c = 11.52 y_1^{1/6} D_{50}^{1/3}$ = 10.41 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.

$D_{c50} = 0.0006(q_2/y_1^{7/6})^3$ = 0.063 ft If $D_{50} >= D_{c50}$, $\chi = 0.0$ [circled]

Otherwise, $\chi = 0.122 y_1[q_2/(D_{50}^{1/3} y_1^{7/6})]^{6/7} - y_1$ = 0.0 From Figure 10, y_{cs} = 0.0 ft

PIER SCOUR CALCULATIONS

PGRM: Pie

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

Froude # at bridge = 0.58 Using pier width a on Figure 11, ξ = 8.0 Pier scour y_{ps} = 7.3 ft

ABUTMENT SCOUR CALCULATIONS

PGRM: Abutment

Average flow depth blocked by: left abutment, y_{aLT} = 0 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 [circled]

Using values for y_{aLT} and y_{aRT} on figure 12, ψ_{LT} = 0 and ψ_{RT} = 0

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

Route Park Dr. Stream Rapid Creek MRM ________ Date ____________ Initials ________

Bridge Structure No. 52384316 Location Park Dr over Rapid Creek

GPS coordinates: N 44°03'32.2" W 103°17'03.8 taken from: USL abutment X centerline of ⇑ MRM end ______

Datum of coordinates: WGS84 X NAD27 ______

Drainage area = 397.33 sq. mi.

The average bottom of the main channel was 10.7 ft below top of guardrail at a point 29 ft from left abutment.

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

17400
5476
11924

MISCELLANEOUS CONSIDERATIONS

Flows	Q_{100} = 4630			Q_{500} = 17400		
Estimated flow passing through bridge	4630			5476		
Estimated road overflow & overtopping	—			11924		
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 X No ____Marginal

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 ____No ____Don't know X 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

Constructed channel comin in on L. side above bridge

Photos - 1477 - 1D
78 - US
79 - US RB
80 - US, LB
81 - other channel entering
82 - L. Abut
83 - Pier
84 - R. Abut
85 - US Face bridge

Summary of Results

	Q100	Q500
Bridge flow evaluated	4630	5476
Flow depth at left abutment (yaLT), in feet	0.0	0.0
Flow depth at right abutment (yaRT), in feet	0.0	0.0
Contraction scour depth (ycs), in feet	0.0	0.0
Pier scour depth (yps), in feet	7.3	7.3
Left abutment scour depth (yas), in feet	0.0	0.0
Right abutment scour depth (yas), in feet	0.0	0.0
1Flow angle of attack	0°	0°

See Comments/Diagram for justification where required