OK TCT

SCOUR ANALYSIS AND REPORTING FORM

Bridge Structure No. 523173 14 Date 9/30/10 Initials CW Region (A B C D)

Site _____ Location Just downstream from Powerhouse Gulch

Q_{100} = 862 by: drainage area ratio ✓ flood freq. anal. _____ regional regression eq. ____

Bridge discharge (Q_2) = 862 (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 = 50 ft. Flow angle at bridge = 45 ° Abut. Skew = 45 ° Effective Skew = 0 °

Width (W_2) iteration = 50 Vert Abut

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

Corrected channel width at bridge Section = W_2 times cos of flow angle = 50 ft* $q_2 = Q_2/W_2$ = 17.2 ft^2/s

Bridge Vel, V_2 = 5 ft/s Final $y_2 = q_2/V_2$ = 3.4 ft Δh = 0.5 ft

Average main channel depth at approach section, $y_1 = \Delta h + y_2$ = 3.9 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. = — ft

n (Channel) = 0.035

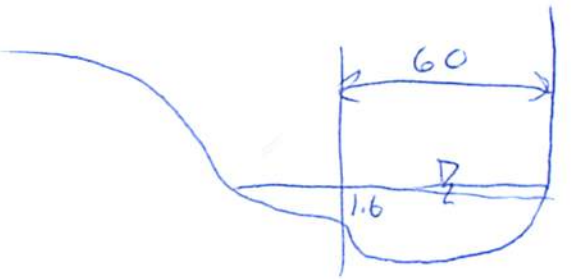
n (LOB) = 0.070

n (ROB) = ~~0.050~~ 0.045

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 = 60 ft

Width of left overbank flow at approach, W_{lob} = 15 ft Average left overbank flow depth, y_{lob} = 0.8 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 ~~2.95~~

Estimated bed material D_{50} = 0.30 ft Average approach velocity, $V_1 = Q_{100}/(y_1 W_1)$ = ~~3.66~~ ft/s

Critical approach velocity, $Vc = 11.52 y_1^{1/6} D_{50}^{1/3}$ = 9.34 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.

$D_{c50} = 0.0006(q_2/y_1^{7/6})^3$ = 0.026 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 = _____ 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} = 0.80 ft right abutment, y_{aRT} = 0 ft

Shape coefficient K_1= ~~1.00~~ CW 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} = 3.5 and ψ_{RT} = 0

Left abutment scour, $y_{as} = \psi_{LT}(K_1/0.55)$ = ~~5.1~~ ~~6.3~~ CW 5.2 ft Right abutment scour $y_{as} = \psi_{RT}(K_1/0.55)$ = ~~0~~ CW 0 ft

SCOUR ANALYSIS AND REPORTING FORM

Bridge Structure No. 52317314 Date 9/30/10 Initials CW Region (A B C D)

Site _____ Location Just Downstream from powerhouse Gulch

Q_{500} = 1280 by: drainage area ratio ✓ flood freq. anal. ____ regional regression eq. ____

Bridge discharge (Q_2) = 1280 (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 = 50 ft. Flow angle at bridge = 45 ° Abut. Skew = 45 ° Effective Skew = 0 °

Width (W_2) iteration = Vert Abut _____ _____

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

Corrected channel width at bridge Section = W_2 times cos of flow angle = 50 ft* $q_2 = Q_2/W_2$ = 25.6 ft^2/s

Bridge Vel, V_2 = 6.0 ft/s Final $y_2 = q_2/V_2$ = 4.2 ft Δh = 0.7 ft

Average main channel depth at approach section, $y_1 = \Delta h + y_2$ = 5.0 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. = — ft

n (Channel) = 0.035

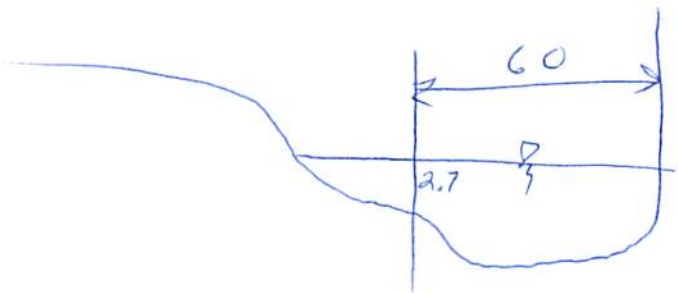
n (LOB) = 0.070

n (ROB) = 0.045

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 = 60 ft

Width of left overbank flow at approach, W_{lob} = 20 ft Average left overbank flow depth, y_{lob} = 1.35 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) 2=0 3.2

Estimated bed material D_{50} = 0.30 ft Average approach velocity, $V_1 = Q_{500}/(y_1W_1)$ = 4.27 ft/s

Critical approach velocity, $Vc = 11.52 y_1^{1/6} D_{50}^{1/3}$ = 9.78 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.

$D_{c50} = 0.0006(q_2/y_1^{7/6})^3$ = 0.0360 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 = _____ 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

PGRM: Abutment

ABUTMENT SCOUR CALCULATIONS

Average flow depth blocked by: left abutment, y_{aLT} = 1.35 ft right abutment, y_{aRT} = 0.0 ft

Shape coefficient K_1= ~~1.00~~ CW 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} = 5.7 and ψ_{RT} = 0

Left abutment scour, $y_{as} = \psi_{LT}(K_1/0.55)$ = ~~10.3~~ 8.4 ft Right abutment scour $y_{as} = \psi_{RT}(K_1/0.55)$ = 0 ft

Thunderhead

Route Falls Rd Stream Rapid Creek MRM _____ Date 9/30/10 Initials CM

Bridge Structure No. 52317314 Location Just Downstream from Powerhouse Gulch

GPS coordinates: N 44°03'40.0" W103°25'03.2" taken from: USL abutment X centerline of ⇑ MRM end _____

Datum of coordinates: WGS84 X NAD27 _____

Drainage area = 338.91 sq. mi.

The average bottom of the main channel was 11.2 ft below top of guardrail at a point 15 ft from left abutment.

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

MISCELLANEOUS CONSIDERATIONS

Flows	Q_{100} = 862			Q_{500} = 1280		
Estimated flow passing through bridge	862			1280		
Estimated road overflow & overtopping						
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 ____No X Don't know R Abut higher rocks than left

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 Very long W.ng Wall X Yes ____No ____Don't know ____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

Not sure about D50 estim.

US- from bridge is pool & fines

At bridge is cobbles ~ 0.30 or larger

Not much for erosion so went w/ 0.30

1293 - Bridge ID

94 - US

95 - US LB

96 - US RB

97 - US Face of Bridge

98 - L. Abut

L. Wall

99 ~~L. Abut~~

1300 - R. Abut

01 - L. Abut

Summary of Results

	Q100	Q500
Bridge flow evaluated	~~862~~	1280
Flow depth at left abutment (yaLT), in feet	0.8	1.35
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	~~0.0~~ NA	~~0.3~~ ~~0.0~~ NA
Left abutment scour depth (yas), in feet	~~CM 6.3~~ 5.2	~~0.0~~ ~~CM 0.3~~ 8.4
Right abutment scour depth (yas), in feet	0.0	0.0
1Flow angle of attack	0°	0°

See Comments/Diagram for justification where required