Big Buffalo Creek

SCOUR ANALYSIS AND REPORTING FORM

Bridge Structure No. 36100136 Date 10/14/11 Initials Cw Region (A (B) C D)

Site ________ Location ~2 mi W + ~2.5 mi S of Cactus Flatts on 207 Ave

Q_{100} = 704 by: drainage area ratio____ flood freq. anal. ____ regional regression eq. ____

Bridge discharge (Q_2) = 704 (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 = 22 ft. Flow angle at bridge = 3 ° Abut. Skew = 0 ° Effective Skew = 3 °

Width (W_2) iteration = 22

Avg. flow depth at bridge, y_2 iteration = 6.6 → Vert Wall

Corrected channel width at bridge Section = W_2 times cos of flow angle = 21.97 ft* $q_2 = Q_2/W_2$ = 32 ft²/s

Bridge Vel, V_2 = 4.8 ft/s Final $y_2 = q_2/V_2$ = 6.6 ft Δh = 0.5 ft

Average main channel depth at approach section, $y_1 = \Delta h + y_2$ = 7.1 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. = 6.6 ft

n (Channel) = 0.035

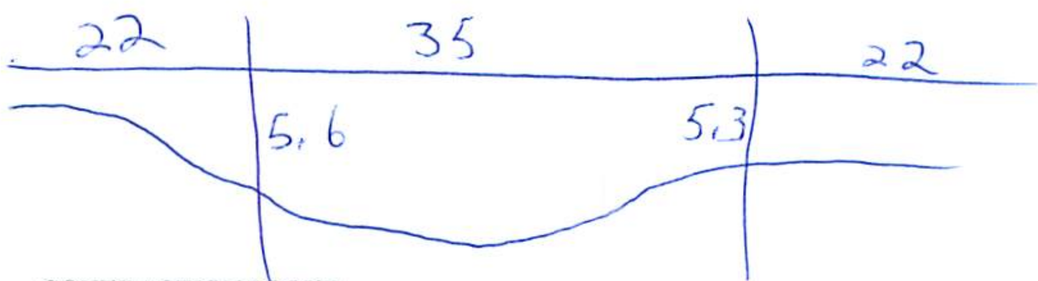
n (LOB) = ~~0.050~~ 0.050

n (ROB) = ~~0.06~~ 0.050

Pier Width = 0.85 ft

Pier Length = 27.0 ft

\# Piers for 100 yr = 1.0 ft



CONTRACTION SCOUR

PGRM: Contract

Width of main channel at approach section W_1 = 35 ft

Width of left overbank flow at approach, W_{lob} = 22 ft Average left overbank flow depth, y_{lob} = 5.6 ft

Width of right overbank flow at approach, W_{rob} = 22 ft Average right overbank flow depth, y_{rob} = 5.3 ft

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

x = 11.33 From Figure 9 W_2 (effective) = 21.1 ft y_{cs} = 12.4 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, $Vc = 11.17 y_1^{1/6} D_{50}^{1/3}$ = ____ 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}, 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} = ____ ft

PIER SCOUR CALCULATIONS

PGRM: Pier

L/a ratio = 31.8 Correction factor for flow angle of attack (from Table 1), K2 = 1.3

Froude # at bridge = 0.33 Using pier width a on Figure 11, ξ = 4.1 Pier scour y_{ps} = 4.6 ft

ABUTMENT SCOUR CALCULATIONS

PGRM: Abutment

Average flow depth blocked by: left abutment, y_{aLT} = 5.6 ft right abutment, y_{aRT} = 5.3 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} = 16.1 and ψ_{RT} = 15.6

Left abutment scour, $y_{as} = \psi_{LT}(K_1/0.55)$ = 24.0 ft Right abutment scour $y_{as} = \psi_{RT}(K_1/0.55)$ = 23.2 ft

SCOUR ANALYSIS AND REPORTING FORM

Bridge Structure No. 36100136 Date 10/14/11 Initials [illegible] Region (A (B) C D)

Site ________ Location ~2.5 mi S & 2 mi W of Cactus Flatts on 207 Ave

Q_{500} = 1220 by: drainage area ratio____ flood freq. anal. ____ regional regression eq. ____

Bridge discharge (Q_2) = 696 (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 = 22 ft. Flow angle at bridge = 3 ° Abut. Skew = 0 ° Effective Skew = 3 °

Width (W_2) iteration = 22 ____ ____ ____

Avg. flow depth at bridge, y_2 iteration = 8.9 > 6.6 ____ ____

Corrected channel width at bridge Section = W_2 times cos of flow angle = 21.97 ft* $q_2 = Q_2/W_2$ = 31.7 ft²/s

Bridge Vel, V_2 = 4.8 ft/s Final $y_2 = q_2/V_2$ = 6.6 ft Δh = 0.5 ft

Average main channel depth at approach section, $y_1 = \Delta h + y_2$ = 7.1 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. = 6.6 ft

n (Channel) = 0.035

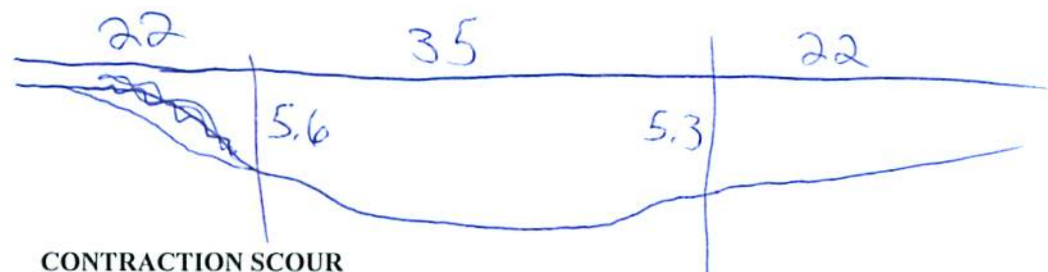
n (LOB) = 0.050

n (ROB) = 0.050

Pier Width = 0.85 ft

Pier Length = 27 ft

\# Piers for 500 yr = 1 ft



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PGRM: CWCSNEW

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

Critical approach velocity, $V_c = 11.17 y_1^{1/6} D_{50}^{1/3}$ = ________ 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: Pie

L/a ratio = 31.8 Correction factor for flow angle of attack (from Table 1), K2 = 1.3

Froude # at bridge = 0.33 Using pier width a on Figure 11, ξ = 4.1 Pier scour y_{ps} = 4.6 ft

ABUTMENT SCOUR CALCULATIONS

PGRM: Abutment

Average flow depth blocked by: left abutment, y_{aLT} = 5.6 ft right abutment, y_{aRT} = 5.3 ft

Shape coefficient K_1= 1.00 for vertical-wall, (0.82 for vertical-wall with wingwalls,) 0.55 for spill-through

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Left abutment scour, $y_{as} = \psi_{LT}(K_1/0.55)$ = 24.0 ft Right abutment scour $y_{as} = \psi_{RT}(K_1/0.55)$ = 23.2 ft

Route 207 Ave Stream Big Buffalo Ck MRM ______ Date 10/14/11 Initials [illegible]
Bridge Structure No. 36100136 Location ~ 2mi W + 2.5 mi S of Cactus Flats on 207 Ave
GPS coordinates: N43° 48' 40.0" W101° 56' 23.0" taken from: USL abutment X centerline of ⇑ MRM end ____
Datum of coordinates: WGS84 X NAD27 ____
Drainage area = 3.00 sq. mi.
The average bottom of the main channel was 10.5 ft below top of guardrail at a point 5.0 ft from left abutment.
Method used to determine flood flows: ____Freq. Anal. ____drainage area ratio ____regional regression equations.

MISCELLANEOUS CONSIDERATIONS

Flows	Q_{100} = 704			Q_{500} = 1220		
Estimated flow passing through bridge	704			696		
Estimated road overflow & overtopping	—			524		
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? ____High X 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 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

10/4/11

2	46.6
5	137
10	236
25	388
50	534
100	704
500	1220

Photos
2109- ID
10- US
11- USRB
12- USLB
13- L. Abut
14- R. Abut
15- US Face
16- Woody debris

Summary of Results

	Q100	Q500
Bridge flow evaluated	704	696
Flow depth at left abutment (yaLT), in feet	5.6	5.6
Flow depth at right abutment (yaRT), in feet	5.3	5.3
Contraction scour depth (ycs), in feet	12.4	12.4
Pier scour depth (yps), in feet	4.6	4.6
Left abutment scour depth (yas), in feet	24.0	24.0
Right abutment scour depth (yas), in feet	23.2	23.2
1Flow angle of attack	3°	3°

See Comments/Diagram for justification where required