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SCOUR ANALYSIS AND REPORTING FORM

Bridge Structure No. 34140101 Date 7/7/11 Initials CW Region (A B C D)

Site 06478280 Location 27810 418 Ave, S. Branch Dry Creek

Q_{100} = 1940 by: drainage area ratio ____ flood freq. anal. ✓ regional regression eq. ____

Bridge discharge (Q_2) = 1940 (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 = 53 ft. Flow angle at bridge = 20 ° Abut. Skew = 0 ° Effective Skew = 20 °

Width (W_2) iteration = 53 45 46

Avg. flow depth at bridge, y_2 iteration = 5.5 4.6 4.5

Corrected channel width at bridge Section = W_2 times cos of flow angle = 43.23 ft* $q_2 = Q_2/W_2$ = 44.9 ft²/s

Bridge Vel, V_2 = 4.7 ft/s Final $y_2 = q_2/V_2$ = 9.5 ft Δh = 0.5 ft

Average main channel depth at approach section, $y_1 = \Delta h + y_2$ = 9.9 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. = 14 ft

n (Channel) = 0.040

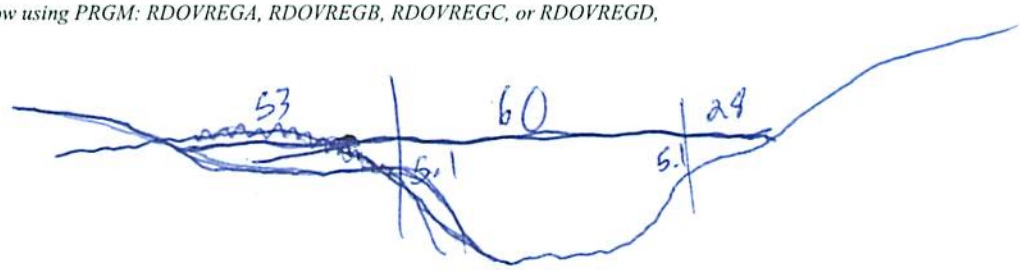
n (LOB) = 0.050

n (ROB) = 0.050

Pier Width = 1.7 ft

Pier Length = 3.5 ft

Piers for 100 yr = 1 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} = 53 ft Average left overbank flow depth, y_{lob} = 2.5 ft

Width of right overbank flow at approach, W_{rob} = 24 ft Average right overbank flow depth, y_{rob} = 2.5 ft

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

x = 5.96 From Figure 9 W_2 (effective) = 91.5 ft y_{cs} = 6.7 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, $V_1 = Q_{100}/(y_1W_1)$ = ____ ft/s

Critical approach velocity, $Vc = 11.52y_1^{1/6}D_{50}^{1/3}$ = ____ 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, $\chi = 0.122y_1[q_2/(D_{50}^{1/3}y_1^{7/6})]^{6/7} - y_1$ = ____ From Figure 10, y_{cs} = ____ ft

PIER SCOUR CALCULATIONS

PGRM: Pier

L/a ratio = 2 Correction factor for flow angle of attack (from Table 1), K2 = 1.2

Froude # at bridge = 0.27 Using pier width a on Figure 11, ξ = 7.0 Pier scour y_{ps} = 6.9 ft

ABUTMENT SCOUR CALCULATIONS

PGRM: Abutment

Average flow depth blocked by: left abutment, y_{aLT} = 2.5 ft right abutment, y_{aRT} = 2.5 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} = 10.2 and ψ_{RT} = 10.2

Left abutment scour, $y_{as} = \psi_{LT}(K_1/0.55)$ = 10.2 ft Right abutment scour $y_{as} = \psi_{RT}(K_1/0.55)$ = 10.2 ft

10.1

SCOUR ANALYSIS AND REPORTING FORM

Bridge Structure No. 34140101 Date 7/7/11 Initials CW Region (A B (C) D)

Site 06478280 Location 27810 418 Ave

Q_{500} = 4810 by: drainage area ratio ____ flood freq. anal. ✓ regional regression eq. ____

Bridge discharge (Q_2) = 4810 (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 = 53 ft, Flow angle at bridge = 20 ° Abut. Skew = 0 ° Effective Skew = 20 °

Width (W_2) iteration = 53 53

Avg. flow depth at bridge, y_2 iteration = 13.9 13.9

Corrected channel width at bridge Section = W_2 times cos of flow angle = 49.8 ft* $q_2 = Q_2/W_2$ = 96.6 ft^2/s

Bridge Vel, V_2 = 7.0 ft/s Final $y_2 = q_2/V_2$ = 13.9 ft Δh = 1.0 ft

Average main channel depth at approach section, $y_1 = \Delta h + y_2$ = 14.9 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. = 14.0 ft

n (Channel) = 0.040

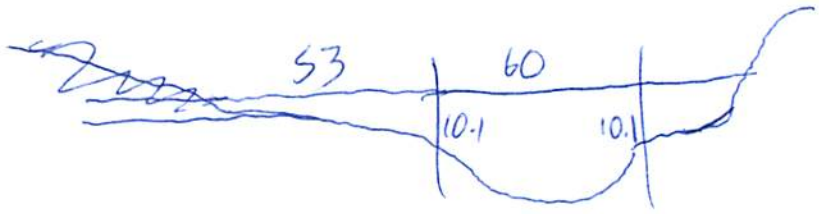
n (LOB) = 0.050

n (ROB) = 0.050

Pier Width = 1.7 ft

Pier Length = 3.5 ft

Piers for 500 yr = 1 ft



CONTRACTION SCOUR

PGRM: Contract

Width of main channel at approach section W_1 = 60 ft $10.1 \times 2/3$

Width of left overbank flow at approach, W_{lob} = 53 ft Average left overbank flow depth, y_{lob} = 6.6 ft

Width of right overbank flow at approach, W_{rob} = 53 ft Average right overbank flow depth, y_{rob} = ~~6.6~~ ft 5.5

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

x = 9.56 From Figure 9 W_2 (effective) = 48.1 ft y_{cs} = 10.5 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

PGRM: Pier

PIER SCOUR CALCULATIONS

L/a ratio = 2 Correction factor for flow angle of attack (from Table 1), K2 = 1.7

Froude # at bridge = 0.33 Using pier width a on Figure 11, ξ = 7.0 Pier scour y_{ps} = 7.2 ft

PGRM: Abutment

ABUTMENT SCOUR CALCULATIONS

Average flow depth blocked by: left abutment, y_{aLT} = 6.6 ft right abutment, y_{aRT} = 5.5 ft

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

Using values for y_{aLT} and y_{aRT} on figure 12, ψ_{LT} = 17.9 and ψ_{RT} = 15.9

Left abutment scour, $y_{as} = \psi_{LT}(K_1/0.55)$ = 17.9 ft Right abutment scour $y_{as} = \psi_{RT}(K_1/0.55)$ = 15.9 ft

Route 418 Ave Stream S. Branch Dry Creek MRM _____ Date 7/7/11 Initials CH

Bridge Structure No. 34140101 Location 27810 418 Ave

GPS coordinates: N 43° 21' 15.8" taken from: USL abutment X centerline of ⇑ MRM end _____

W 097° 50' 12.5" Datum of coordinates: WGS84 X NAD27 _____

Drainage area = 25.76 sq. mi.

The average bottom of the main channel was 16.8 ft below top of guardrail at a point 18 ft from left abutment.

Method used to determine flood flows: ✓ Freq. Anal. ____ drainage area ratio ____ regional regression equations.

MISCELLANEOUS CONSIDERATIONS

Flows	Q_{100} = 1940			Q_{500} = 4810		
Estimated flow passing through bridge	1940			4810		
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? X Yes ____ 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	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

Photos

1722 - ID

23 - US

24 - US RB

25 - US LB

26 - R. Abut

27 - L. Abut

28 - Piers

29 - US Face

30 - " "

31 - "

Summary of Results

	Q100	Q500
Bridge flow evaluated	1940	4810
Flow depth at left abutment (yaLT), in feet	2.5	6.6
Flow depth at right abutment (yaRT), in feet	2.5	5.5
Contraction scour depth (ycs), in feet	6.7	10.5
Pier scour depth (yps), in feet	6.4	7.2
Left abutment scour depth (yas), in feet	10.2	17.9
Right abutment scour depth (yas), in feet	10.2	15.9
1Flow angle of attack	20	20

See Comments/Diagram for justification where required