Split Rock Creek

SCOUR ANALYSIS AND REPORTING FORM

Bridge Structure No. 50290129 Date 10/9/11 Initials CW Region (A B C D) [D circled]

Site ______ Location 3 mi N + 1 mi E of Carson on 257St

Q_{100} = 16700 by: drainage area ratio____ flood freq. anal. ____ regional regression eq. ✓

Bridge discharge (Q_2) = 16700 (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 = 262 ft. Flow angle at bridge = 25 ° Abut. Skew = 30 ° Effective Skew = 5 °

Width (W_2) iteration = 262 244 247 ____

Avg. flow depth at bridge, y_2 iteration = 11.3 11.7 11.6 ____

Corrected channel width at bridge Section = W_2 times cos of flow angle = 246.06 ft* $q_2 = Q_2/W_2$ = 67.9 ft^2/s

Bridge Vel, V_2 = 5.8 ft/s Final $y_2 = q_2/V_2$ = 11.6 ft Δh = 0.7 ft

Average main channel depth at approach section, $y_1 = \Delta h + y_2$ = 12.3 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. = 14.8 ft

n (Channel) = ~~0.04~~ 0.050

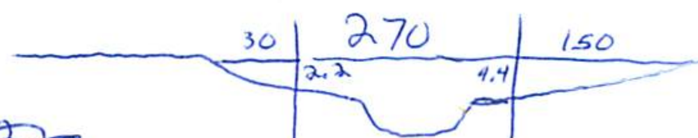
n (LOB) = 0.040

n (ROB) = 0.040

Pier Width = 3.0 ft

Pier Length = 3.0 ft

\# Piers for 100 yr = 3 ft



CONTRACTION SCOUR

PGRM: Contract

Width of main channel at approach section W_1 = 270 ft

Width of left overbank flow at approach, W_{lob} = 30 ft Average left overbank flow depth, y_{lob} = 1.1 ft

Width of right overbank flow at approach, W_{rob} = 150 ft Average right overbank flow depth, y_{rob} = 2.2 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)

Estimated bed material D_{50} = 0.4 ft Average approach velocity, $V_1 = Q_{100}/(y_1W_1)$ = 3.02 ft/s

Critical approach velocity, $Vc = 11.17y_1^{1/6}D_{50}^{1/3}$ = 12.5 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.

$D_{c50} = 0.0006(q_2/y_1^{7/6})^3$ = 0.029 ft If $D_{50} >= D_{c50}$, $\chi = 0.0$

Otherwise, $\chi = 0.122y_1[q_2/(D_{50}^{1/3}y_1^{7/6})]^{6/7} - y_1$ = 0.0 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 = ~~0.29~~ 0.30 Using pier width a on Figure 11, ξ = 10.7 Pier scour y_{ps} = 8.9 ft

ABUTMENT SCOUR CALCULATIONS

PGRM: Abutment

Average flow depth blocked by: left abutment, y_{aLT} = 1.1 ft right abutment, y_{aRT} = 2.2 ft

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

Using values for y_{aLT} and y_{aRT} on figure 12, ψ_{LT} = 4.7 and ψ_{RT} = 9.0

Left abutment scour, $y_{as} = \psi_{LT}(K_1/0.55)$ = 4.7 ft Right abutment scour $y_{as} = \psi_{RT}(K_1/0.55)$ = 9.0 ft

10
8.0
7.2
14.6

SCOUR ANALYSIS AND REPORTING FORM

Bridge Structure No. 50290129 Date 10/9/11 Initials CL Region (A B (C) D)

Site ______ Location 3 mi N & 1mi E of Carson on 257 St

Q_{500} = 26000 by: drainage area ratio____ flood freq. anal. ____ regional regression eq. ____

Bridge discharge (Q_2) = 26,000 (should be Q_{500} unless there is a relief bridge, road overflow, or bridge overtopping)

PGRM: "RegionA", "RegionB", "RegionC", or "RegionD"

Analytical Procedure for Estimating Hydraulic Variables Needed to Apply Method

Bridge Width = 262 ft. Flow angle at bridge = 25 ° Abut. Skew = 30 ° Effective Skew = 5 °

Width (W_2) iteration = 262 ______ ______ ______

Avg. flow depth at bridge, y_2 iteration = 14.1 → Vert Wall ______

Corrected channel width at bridge Section = W_2 times cos of flow angle = 261 ft* $q_2 = Q_2/W_2$ = 99.6 ft²/s

Bridge Vel, V_2 = 7.1 ft/s Final $y_2 = q_2/V_2$ = 14.1 ft Δh = 1.0 ft

Average main channel depth at approach section, $y_1 = \Delta h + y_2$ = 15.1 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. = 14.3 ft

n (Channel) = 0.050

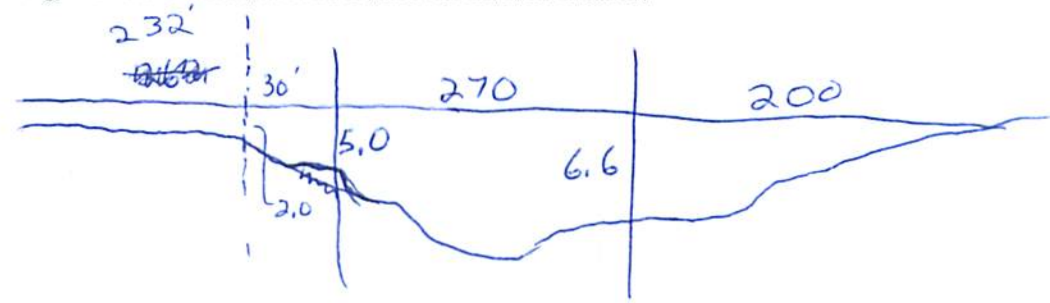
n (LOB) = 0.040

n (ROB) = 0.040

Pier Width = 3.0 ft

Pier Length = 3.0 ft

\# Piers for 500 yr = 3 ft



PGRM: Contract

CONTRACTION SCOUR

Width of main channel at approach section W_1 = 270 ft

Width of left overbank flow at approach, W_{lob} = 262 ft Average left overbank flow depth, y_{lob} = ~~5.0~~ 2.9 ft

Width of right overbank flow at approach, W_{rob} = 200 ft Average right overbank flow depth, y_{rob} = 3.3 ft

732

~~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)

Estimated bed material D_{50} = 0.4 ft Average approach velocity, $V_1 = Q_{500}/(y_1W_1)$ = 2.35 ft/s

Critical approach velocity, $Vc = 11.17y_1^{1/6}D_{50}^{1/3}$ = 12.94 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.

$D_{c50} = 0.0006(q_2/y_1^{7/6})^3$ = 0.044 ft If $D_{50} >= D_{c50}$, $\chi = 0.0$

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

PGRM: Pie

PIER SCOUR CALCULATIONS

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

Froude # at bridge = 0.33 Using pier width a on Figure 11, ξ = 10.7 Pier scour y_{ps} = 9.1 ft

PGRM: Abutment

ABUTMENT SCOUR CALCULATIONS

Average flow depth blocked by: left abutment, y_{aLT} = 2.9 ft right abutment, y_{aRT} = 3.3 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} = 11.3 and ψ_{RT} = 12.0

Left abutment scour, $y_{as} = \psi_{LT}(K_1/0.55)$ = 11.3 ft Right abutment scour $y_{as} = \psi_{RT}(K_1/0.55)$ = 12.0 ft

12.3
2.6
15.1

4 5.0 10
2.4
2.7

Route 257 St Stream Split Rock Ck MRM ________ Date 10/9/11 Initials Cy

Bridge Structure No. 50290129 Location 3mi N & 1 mi E of Corson on 257 St

GPS coordinates: N 43°39'39.1" W 96°33'03.9" taken from: USL abutment X centerline of ⇑ MRM end ____

Datum of coordinates: WGS84 X NAD27 ____

Drainage area = 377.05 sq. mi.

The average bottom of the main channel was 22.0 ft below top of guardrail at a point 55 ft from left abutment.

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

MISCELLANEOUS CONSIDERATIONS

Flows	Q_{100} = 16700			Q_{500} = 26000		
Estimated flow passing through bridge	16700			26000		
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~~		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 ____	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

10/4/11

2	1790
5	4320
10	6590
25	10100
50	13200
100	16700
500	26,000

2049 - ID
2050 - US
2051 - US RB
2052 - US LB
53 - L. Abut
56 - US Face
57 - R. Abut

Summary of Results

	Q100	Q500
Bridge flow evaluated	16,700	26,000
Flow depth at left abutment (yaLT), in feet	1.1	2.9
Flow depth at right abutment (yaRT), in feet	2.2	3.3
Contraction scour depth (ycs), in feet	0.0	0.0
Pier scour depth (yps), in feet	8.9	9.1
Left abutment scour depth (yas), in feet	4.7	11.3
Right abutment scour depth (yas), in feet	9.0	12.0
1Flow angle of attack	5°	5°

See Comments/Diagram for justification where required