Sand Creek

SCOUR ANALYSIS AND REPORTING FORM

Bridge Structure No. 62070457 Date 10/14/11 Initials CW Region (A B C D)

Site _____ Location ~1.5mi E & ~0.4 mi N of Keyapaha on 303 Ave

Q_{100} = 1520 by: drainage area ratio____ flood freq. anal. ____ regional regression eq. ✓

Bridge discharge (Q_2) = 1520 (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 = 106 ft. Flow angle at bridge = 25 ° Abut. Skew = 0 ° Effective Skew = 25 °

Width (W_2) iteration = 106

Avg. flow depth at bridge, y_2 iteration = 4.6 Vert Wall

Corrected channel width at bridge Section = W_2 times cos of flow angle = 96.07 ft* $q_2 = Q_2/W_2$ = 15.8 ft^2/s

Bridge Vel, V_2 = 3.5 ft/s Final $y_2 = q_2/V_2$ = 4.6 ft Δh = 0.2 ft

Average main channel depth at approach section, $y_1 = \Delta h + y_2$ = 4.8 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. = 8.7 ft

n (Channel) = 0.040

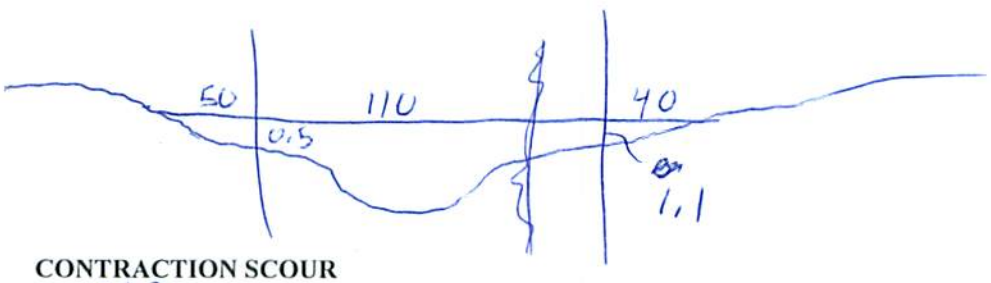
n (LOB) = 0.045

n (ROB) = 0.045

Pier Width = 0.3 ft

Pier Length = 22 ft

Piers for 100 yr = 3 ft



CONTRACTION SCOUR

PGRM: Contract

Width of main channel at approach section W_1 = 110 ft

Width of left overbank flow at approach, W_{lob} = 50 ft Average left overbank flow depth, y_{lob} = 0.5 ft

Width of right overbank flow at approach, W_{rob} = 40 ft Average right overbank flow depth, y_{rob} = 1.1 ft

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

x = 1.05 From Figure 9 W_2 (effective) = 93.7 ft y_{cs} = 1.5 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, $V_1 = Q_{100}/(y_1 W_1)$ = _____ 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 $D_{50} >= D_{c50}$, $\chi = 0.0$

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: Pier

L/a ratio = 27.5 Correction factor for flow angle of attack (from Table 1), K2 = 3.1

Froude # at bridge = 0.29 Using pier width a on Figure 11, ξ = 3.9 Pier scour y_{ps} = 10 ft

ABUTMENT SCOUR CALCULATIONS

PGRM: Abutment

Average flow depth blocked by: left abutment, y_{aLT} = 0.5 ft right abutment, y_{aRT} = 1.1 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} = 2.3 and ψ_{RT} = 4.7

Left abutment scour, $y_{as} = \psi_{LT}(K_1/0.55)$ = 2.3 ft Right abutment scour $y_{as} = \psi_{RT}(K_1/0.55)$ = 4.7 ft

SCOUR ANALYSIS AND REPORTING FORM

Bridge Structure No. 62070457 Date _____ Initials _____ Region (A (B) C D)

Site _____ Location ~1.6 mi E + 0.4 mi N of Keyapaha on 303 Ave

Q_{500} = 2670 by: drainage area ratio ____ flood freq. anal. ____ regional regression eq. ✓

Bridge discharge (Q_2) = 2670 (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 = 106 ft. Flow angle at bridge = 25 ° Abut. Skew = 0 ° Effective Skew = 25 °

Width (W_2) iteration = 106

Avg. flow depth at bridge, y_2 iteration = 6.2 → Vert Wall

Corrected channel width at bridge Section = W_2 times cos of flow angle = 96.07 ft* $q_2 = Q_2/W_2$ = 27.8 ft^2/s

Bridge Vel, V_2 = 4.5 ft/s Final $y_2 = q_2/V_2$ = 6.2 ft Δh = 0.4 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. = 8.7 ft

n (Channel) = 0.040

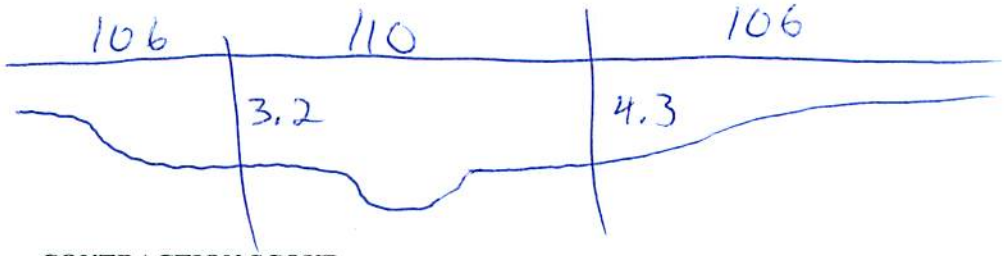
n (LOB) = 0.045

n (ROB) = 0.045

Pier Width = 0.8 ft

Pier Length = 22 ft

Piers for 500 yr = 3 ft



CONTRACTION SCOUR

PGRM: Contract

Width of main channel at approach section W_1 = 110 ft

Width of left overbank flow at approach, W_{lob} = 106 ft Average left overbank flow depth, y_{lob} = 3.2 ft

Width of right overbank flow at approach, W_{rob} = 106 ft Average right overbank flow depth, y_{rob} = 4.3 ft

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

x = 6.39 From Figure 9 W_2 (effective) = 93.7 ft y_{cs} = 7.2 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, $Vc = 11.17 y_1^{1/6} D_{50}^{1/3}$ = _____ 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

PGRM: Pier

PIER SCOUR CALCULATIONS

L/a ratio = 27.5 Correction factor for flow angle of attack (from Table 1), K2 = 3.1

Froude # at bridge = 0.32 Using pier width a on Figure 11, ξ = 3.9 Pier scour y_{ps} = 10.2 ft

PGRM: Abutment

ABUTMENT SCOUR CALCULATIONS

Average flow depth blocked by: left abutment, y_{aLT} = 3.2 ft right abutment, y_{aRT} = 4.3 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} = 11.9 and ψ_{RT} = 13.8

Left abutment scour, $y_{as} = \psi_{LT}(K_1/0.55)$ = 11.9 ft Right abutment scour $y_{as} = \psi_{RT}(K_1/0.55)$ = 13.8 ft

Route 303 Ave Stream Sand Ck MRM _____ Date _____ Initials _____

Bridge Structure No. 62070457 Location ~1.5 mi E & ~0.4 mi N of Kayapaha on 303 Ave

GPS coordinates: N 43° 07' 00.1" W 100°06' 26.1" taken from: USL abutment X centerline of ⇑ MRM end _____

Datum of coordinates: WGS84 X NAD27 _____

Drainage area = 142.58 sq. mi.

The average bottom of the main channel was 11.4 ft below top of guardrail at a point 70 ft from left abutment.

Method used to determine flood flows: ____Freq. Anal. ____drainage area ratio ✓ regional regression equations.

MISCELLANEOUS CONSIDERATIONS

Flows	Q_{100} = 1520			Q_{500} = 2670		
Estimated flow passing through bridge	1520			2670		
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 ____No X Marginal

Evidence of past Scour? ____Yes X No ____Don't know

Debris Potential? ____High ____Med X Low

Does scour countermeasure(s) appear to have been designed?

Riprap ____Yes ____No X 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 X	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	190
5	391
10	576
25	877
50	1170
100	1520
500	2670

Photos

2126-1D

27 - US

28 - US RB

29 - US LB

30 - L. Abut.

31 - Pier config & R. Abut

32 - marginal Rip Rap

33 - US Face

Summary of Results

	Q100	Q500
Bridge flow evaluated	1520	2670
Flow depth at left abutment (yaLT), in feet	0.5	3.2
Flow depth at right abutment (yaRT), in feet	1.1	4.3
Contraction scour depth (ycs), in feet	1.5	7.2
Pier scour depth (yps), in feet	10.0	10.2
Left abutment scour depth (yas), in feet	2.3	11.9
Right abutment scour depth (yas), in feet	4.7	13.8
1Flow angle of attack	25	25

See Comments/Diagram for justification where required