OK-RAT

SCOUR ANALYSIS AND REPORTING FORM

Bridge Structure No. 20156220 Date 10-11-12 Initials RFT Region (A B Ⓒ D)

Site ______ Location 2.6 mi E Brandt on 188 St

Q_{100} = 2460 by: drainage area ratio____ flood freq. anal. ____ regional regression eq. X

Bridge discharge (Q_2) = 2460 (should be Q_{100} unless there is a relief bridge, road overflow, or bridge overtopping)

lowflow channel has larger angle, but the lowflow channel is very shallow

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

Analytical Procedure for Estimating Hydraulic Variables Needed to Apply Method

Bridge Width = 94 ft. Flow angle at bridge = 18 ° Abut. Skew = 0 ° Effective Skew = 18 °

Width (W_2) iteration = 94

Avg. flow depth at bridge, y_2 iteration = 7.4

Corrected channel width at bridge Section = W_2 times cos of flow angle = 89.4 ft* $q_2 = Q_2/W_2$ = 27.5 ft^2/s

Bridge Vel, V_2 = 3.7 ft/s Final $y_2 = q_2/V_2$ = 7.4 ft Δh = 0.3 ft

Average main channel depth at approach section, $y_1 = \Delta h + y_2$ = 7.7 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. = [illegible] ft

Low Steel Elev. = 8.0 ft

n (Channel) = .035

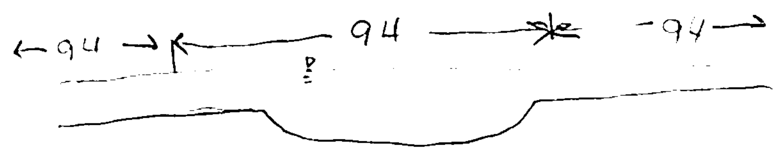
n (LOB) = .035

n (ROB) = .035 } ungrazed pasture

Pier Width = 1.1 ft

Pier Length = 1.1 ft

Piers for 100 yr = 2 ft



PGRM: Contract

CONTRACTION SCOUR

Width of main channel at approach section W_1 = 94 ft

Width of left overbank flow at approach, W_{lob} = 94 ft Average left overbank flow depth, y_{lob} = 6.0 ft

Width of right overbank flow at approach, W_{rob} = 94 ft Average right overbank flow depth, y_{rob} = 5.6 ft

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

x = 10.96 From Figure 9 W_2 (effective) = 87.2 ft y_{cs} = 12 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, $V_c = 11.17 y_1^{1/6} D_{50}^{1/3}$ = ______ 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

PGRM: Pier

PIER SCOUR CALCULATIONS

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

Froude # at bridge = 0.24 Using pier width a on Figure 11, ξ = 5.2 Pier scour y_{ps} = 4.2 ft

PGRM: Abutment

ABUTMENT SCOUR CALCULATIONS

Average flow depth blocked by: left abutment, y_{aLT} = 6.0 ft right abutment, y_{aRT} = 5.6 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} = 16.8 and ψ_{RT} = 16.1

Left abutment scour, $y_{as} = \psi_{LT}(K_1/0.55)$ = 25.1 ft Right abutment scour $y_{as} = \psi_{RT}(K_1/0.55)$ = 24 ft

SCOUR ANALYSIS AND REPORTING FORM

Bridge Structure No. 20156220 Date ______ Initials ______ Region (A B (C) D)

Site ______ Location ______

Q_{500} = 3850 by: drainage area ratio ____ flood freq. anal. ____ regional regression eq. ✓

Bridge discharge (Q_2) = 3850 (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 = 94 ft. Flow angle at bridge = 18 ° Abut. Skew = 0 ° Effective Skew = 18 °

Width (W_2) iteration = 94 ____ ____ ____

Avg. flow depth at bridge, y_2 iteration = 9.3 ____ ____ ____

Corrected channel width at bridge Section = W_2 times cos of flow angle = 89.4 ft* $q_2 = Q_2/W_2$ = 43.1 ft^2/s

Bridge Vel, V_2 = 4.7 ft/s Final $y_2 = q_2/V_2$ = 9.3 ft Δh = 0.4 ft

Average main channel depth at approach section, $y_1 = \Delta h + y_2$ = 9.7 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.

road overflow will begin at $y_2 \approx 9.5$ ft

Water Surface Elev. = dry ft

Low Steel Elev. = 8.0 ft

n (Channel) = .035

n (LOB) = .035

n (ROB) = .035

Pier Width = 1.1 ft

Pier Length = 1.1 ft

Piers for 500 yr = 2 ft

CONTRACTION SCOUR

PGRM: Contract

Width of main channel at approach section W_1 = 94 ft

Width of left overbank flow at approach, W_{lob} = 94 ft Average left overbank flow depth, y_{lob} = 8.0 ft

Width of right overbank flow at approach, W_{rob} = 94 ft Average right overbank flow depth, y_{rob} = 7.6 ft

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

x = 15.3 From Figure 9 W_2 (effective) = 87.2 ft y_{cs} = 15.2 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, $V_c = 11.17 y_1^{1/6} D_{50}^{1/3}$ = ______ 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: Pier

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

Froude # at bridge = 0.27 Using pier width a on Figure 11, ξ = 5.2 Pier scour y_{ps} = 4.3 ft

ABUTMENT SCOUR CALCULATIONS

PGRM: Abutment

Average flow depth blocked by: left abutment, y_{aLT} = 8.0 ft right abutment, y_{aRT} = 7.6 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} = 19.8 and ψ_{RT} = 19.5

Left abutment scour, $y_{as} = \psi_{LT}(K_1/0.55)$ = 29.5 ft Right abutment scour $y_{as} = \psi_{RT}(K_1/0.55)$ = 29 ft

Route 188 St Stream Cobb Creek MRM ______ Date ______ Initials ______

Bridge Structure No. 20156220 Location 2.6 mi E Brandt on 188 St

GPS coordinates: N 44° 39.585' taken from: USL abutment ✓ centerline of ⇑ MRM end ______

W 96° 34.151' Datum of coordinates: WGS84 ✓ NAD27 ______

Drainage area = 28.53 sq. mi.

The average bottom of the main channel was 11.7 ft below top of guardrail at a point 30 ft from left abutment.

Method used to determine flood flows: ___Freq. Anal. ___drainage area ratio ✓ regional regression equations.

8-23-12

Pk	Q
2	219
5	581
10	922
25	1460
50	1940
100	2460
500	3850

MISCELLANEOUS CONSIDERATIONS

Flows	Q_{100} = 2460			Q_{500} = 3850		
Estimated flow passing through bridge	2460			3850		
Estimated road overflow & overtopping	0			0		
Consideration	Yes	No	Possibly	Yes	No	Possibly
Chance of overtopping		✓				✓
Chance of Pressure flow		✓		✓		
Armored appearance to channel		✓			✓	
Lateral instability of channel		✓			✓	

Riprap at abutments? ___Yes ✓ No ___Marginal

Evidence of past Scour? ✓ Yes ___No ___Don't know possibly minor contraction scour

Debris Potential? ___High ___Med ✓ Low

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

Riprap ___Yes ___No ___Don't know ✓ NA

Spur Dike ___Yes ___No ___Don't know ✓ NA

Other ______ ___Yes ___No ___Don't know ✓ 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

str. no.
approach from bridge
LOB from bridge
ROB from bridge
bridge from approach

left abut. under bridge
rt. abut. under bridge

Summary of Results

	Q100	Q500
Bridge flow evaluated	2460	3850
Flow depth at left abutment (yaLT), in feet	6.0	8.0
Flow depth at right abutment (yaRT), in feet	5.6	7.6
Contraction scour depth (ycs), in feet	12.0	15.2
Pier scour depth (yps), in feet	4.2	4.3
Left abutment scour depth (yas), in feet	25.1	29.5
Right abutment scour depth (yas), in feet	24	29.0
1Flow angle of attack	* 18°	* 18°

* low flow channel approaches bridge at a larger angle, but may have little effect at high flows

See Comments/Diagram for justification where required