DUP OK-RAT

SCOUR ANALYSIS AND REPORTING FORM

Bridge Structure No. 5012480 Date 10-15-12 Initials RFT Region (A B (C) D)

Site _____ Location 0.5mi N + 0.5mi W of Lyons on 252 St

Q_{100} = 2980 by: drainage area ratio____ flood freq. anal. ____ regional regression eq. X

Bridge discharge (Q_2) = 2980 (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 = 142 ft. Flow angle at bridge = 0 ° Abut. Skew = 0 ° Effective Skew = 0 °

Width (W_2) iteration = 142 _____ _____ _____

Avg. flow depth at bridge, y_2 iteration = 6.5 _____ _____ _____

Corrected channel width at bridge Section = W_2 times cos of flow angle = 142 ft* $q_2 = Q_2/W_2$ = 21 ft^2/s

Bridge Vel, V_2 = 3.2 ft/s Final $y_2 = q_2/V_2$ = 6.5 ft Δh = 0.2 ft

Average main channel depth at approach section, $y_1 = \Delta h + y_2$ = 6.7 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. = _____ ft

Low Steel Elev. = 8.0 ft

n (Channel) = .045 } tall ungrazed vegetation

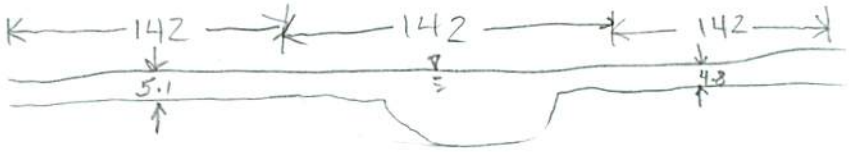
n (LOB) = .040

n (ROB) = .040

Pier Width = 1.84 ft

Pier Length = 1.84 ft

Piers for 100 yr = 4 ft



CONTRACTION SCOUR

PGRM: Contract

Width of main channel at approach section W_1 = 142 ft

Width of left overbank flow at approach, W_{lob} = 142 ft Average left overbank flow depth, y_{lob} = 5.1 ft

Width of right overbank flow at approach, W_{rob} = 142 ft Average right overbank flow depth, y_{rob} = 4.8 ft

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

x = 9.97 From Figure 9 W_2 (effective) = 134.6 ft y_{cs} = 10.9 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, $Vc = 11.52 y_1^{1/6} D_{50}^{1/3}$ = _____ 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

PIER SCOUR CALCULATIONS

PGRM: Pier

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

Froude # at bridge = 0.22 Using pier width a on Figure 11, ξ = 7.5 Pier scour y_{ps} = 6.0 ft

ABUTMENT SCOUR CALCULATIONS

PGRM: Abutment

Average flow depth blocked by: left abutment, y_{aLT} = 5.1 ft right abutment, y_{aRT} = 4.8 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} = 15.2 and ψ_{RT} = 14.7

Left abutment scour, $y_{as} = \psi_{LT}(K_1/0.55)$ = 15.2 ft Right abutment scour $y_{as} = \psi_{RT}(K_1/0.55)$ = 14.7 ft

SCOUR ANALYSIS AND REPORTING FORM

Bridge Structure No. 50124080 Date _____ Initials _____ Region (A B C D)

Site _____ Location _____

Q_{500} = 4620 by: drainage area ratio ____ flood freq. anal. ____ regional regression eq. X

Bridge discharge (Q_2) = 4620 (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 = 142 ft. Flow angle at bridge = 0 ° Abut. Skew = 0 ° Effective Skew = 0 °

Width (W_2) iteration = 142 _____ _____ _____

Avg. flow depth at bridge, y_2 iteration = 8.1 _____ _____ _____

Corrected channel width at bridge Section = W_2 times cos of flow angle = 142 ft* $q_2 = Q_2/W_2$ = 32.5 ft^2/s

Bridge Vel, V_2 = 4.0 ft/s Final $y_2 = q_2/V_2$ = 8.1 ft Δh = 0.3 ft

Average main channel depth at approach section, $y_1 = \Delta h + y_2$ = 8.4 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. = 8.0 ft

n (Channel) = .045

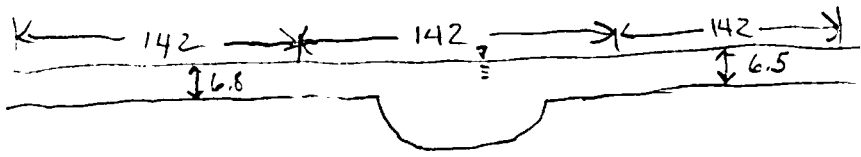
n (LOB) = .040

n (ROB) = .040

Pier Width = 1.84 ft

Pier Length = 1.84 ft

Piers for 500 yr = 4 ft



CONTRACTION SCOUR

PGRM: Contract

Width of main channel at approach section W_1 = 142 ft

Width of left overbank flow at approach, W_{lob} = 142 ft Average left overbank flow depth, y_{lob} = 6.8 ft

Width of right overbank flow at approach, W_{rob} = 142 ft Average right overbank flow depth, y_{rob} = 6.5 ft

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

x = 13.97 From Figure 9 W_2 (effective) = 134.6 ft y_{cs} = 14.4 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, $V_1 = Q_{500}/(y_1 W_1)$ = _____ 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

PIER SCOUR CALCULATIONS

PGRM: Pier

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

Froude # at bridge = 0.25 Using pier width a on Figure 11, ξ = 7.5 Pier scour y_{ps} = 6.1 ft

ABUTMENT SCOUR CALCULATIONS

PGRM: Abutment

Average flow depth blocked by: left abutment, y_{aLT} = 6.8 ft right abutment, y_{aRT} = 6.5 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} = 18.2 and ψ_{RT} = 17.7

Left abutment scour, $y_{as} = \psi_{LT}(K_1/0.55)$ = 18.2 ft Right abutment scour $y_{as} = \psi_{RT}(K_1/0.55)$ = 17.7 ft

Route 252 St Stream Skunk Creek MRM _____ Date _____ Initials _____

Bridge Structure No. 50124080 Location 0.5 mi N + 0.5 mi W of Lyons on 252 St

GPS coordinates: N 43° 43.932' taken from: USL abutment ✓ centerline of ⇑ MRM end _____

W96° 52.942' Datum of coordinates: WGS84 ✓ NAD27 _____

Drainage area = 290.15 sq. mi.

The average bottom of the main channel was 11.7 ft below top of guardrail at a point 33 ft from left abutment.

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

MISCELLANEOUS CONSIDERATIONS

Flows	Q_{100}^{5} = 2980			Q_{500}^{10} = 4620		
Estimated flow passing through bridge	2980			4620		
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 pier scour hole visible

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. on bridge
approach from bridge
LOB from bridge
ROB from bridge
bridge from approach
left abut.
rt. abut.
old pier scour hole

Summary of Results

	Q100 5	Q500 10
Bridge flow evaluated	2980	4620
Flow depth at left abutment (yaLT), in feet	5.1	6.8
Flow depth at right abutment (yaRT), in feet	4.8	6.5
Contraction scour depth (ycs), in feet	10.9	14.4
Pier scour depth (yps), in feet	6.0	6.1
Left abutment scour depth (yas), in feet	15.2	18.2
Right abutment scour depth (yas), in feet	14.7	17.7
Flow angle of attack	0°	0°

See Comments/Diagram for justification where required