Dup OK-Rat

SCOUR ANALYSIS AND REPORTING FORM

Bridge Structure No. 42020156 Date 10-16-12 Initials RFT Region (A B (C) D)

Site ______ Location 4.7 mi S Lennox on 466 Ave

Q_{100} = 5600 by: drainage area ratio____ flood freq. anal. ____ regional regression eq. X

Bridge discharge (Q_2) = 5600 (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 = 92 ft. Flow angle at bridge = 18 ° Abut. Skew = 0 ° Effective Skew = 18 °

Width (W_2) iteration = 92 ______ ______ ______

Avg. flow depth at bridge, y_2 iteration = 11.3 ______ ______ ______

Corrected channel width at bridge Section = W_2 times cos of flow angle = 87.5 ft* $q_2 = Q_2/W_2$ = 64.0 ft^2/s

Bridge Vel, V_2 = 5.7 ft/s Final $y_2 = q_2/V_2$ = 11.3 ft Δh = 0.7 ft

Average main channel depth at approach section, $y_1 = \Delta h + y_2$ = 11.9 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. = no flow ft

Low Steel Elev. = 14.0 ft

n (Channel) = .030

n (LOB) = .027

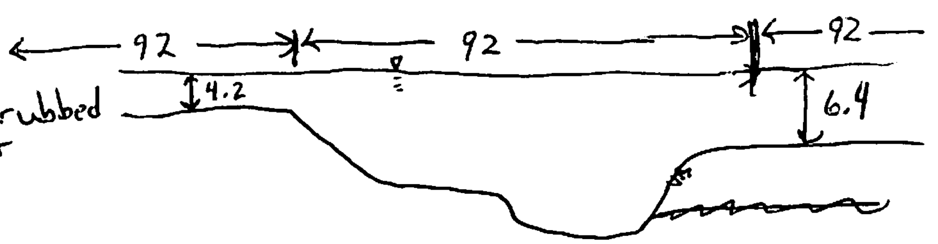
n (ROB) = .027

} pasture grubbed short

Pier Width = 1.67 ft

Pier Length = 1.67 ft

Piers for 100 yr = 3 ft



CONTRACTION SCOUR

PGRM: Contract

Width of main channel at approach section W_1 = 92 ft

Width of left overbank flow at approach, W_{lob} = 92 ft Average left overbank flow depth, y_{lob} = 4.2 ft

Width of right overbank flow at approach, W_{rob} = 92 ft Average right overbank flow depth, y_{rob} = 6.4 ft

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

x = 9.22 From Figure 9 W_2 (effective) = 82.5 ft y_{cs} = 10.1 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

PIER SCOUR CALCULATIONS

PGRM: Pier

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

Froude # at bridge = 0.30 Using pier width a on Figure 11, ξ = 7 Pier scour y_{ps} = 5.8 ft

ABUTMENT SCOUR CALCULATIONS

PGRM: Abutment

Average flow depth blocked by: left abutment, y_{aLT} = 4.2 ft right abutment, y_{aRT} = 6.4 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} = 13.6 and ψ_{RT} = 17.5

Left abutment scour, $y_{as} = \psi_{LT}(K_1/0.55)$ = 13.6 ft Right abutment scour $y_{as} = \psi_{RT}(K_1/0.55)$ = 17.5 ft

SCOUR ANALYSIS AND REPORTING FORM

Bridge Structure No. 42020156 Date ________ Initials ________ Region (A B (C) D)

Site ________ Location ________

Q_{500} = 10100 by: drainage area ratio ____ flood freq. anal. ____ regional regression eq. X

Bridge discharge (Q_2) = ________ (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 = 92 ft. Flow angle at bridge = 18 ° Abut. Skew = 0 ° Effective Skew = 18 °

Width (W_2) iteration = 92 ____ ____ ____

Avg. flow depth at bridge, y_2 iteration = 15.2 ____ ____ ____

Corrected channel width at bridge Section = W_2 times cos of flow angle = 87.5 ft* $q_2 = Q_2/W_2$ = 115.4 ft^2/s

Bridge Vel, V_2 = 7.6 ft/s Final $y_2 = q_2/V_2$ = 15.2 ft Δh = 1.2 ft

Average main channel depth at approach section, $y_1 = \Delta h + y_2$ = 16.3 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.

y_2 for Q500 is approximately at the verge of road overflow

Water Surface Elev. = no flow ft

Low Steel Elev. = 14.0 ft

n (Channel) = .030

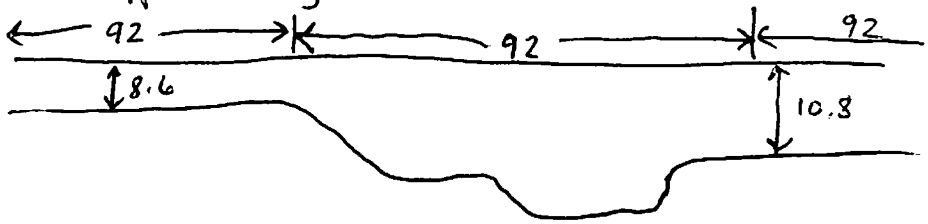
n (LOB) = .027

n (ROB) = .027

Pier Width = 1.67 ft

Pier Length = 1.67 ft

Piers for 500 yr = 3 ft



CONTRACTION SCOUR

PGRM: Contract

Width of main channel at approach section W_1 = 92 ft

Width of left overbank flow at approach, W_{lob} = 92 ft Average left overbank flow depth, y_{lob} = 8.6 ft

Width of right overbank flow at approach, W_{rob} = 92 ft Average right overbank flow depth, y_{rob} = 10.8 ft

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

x = 19.01 From Figure 9 W_2 (effective) = 82.5 ft y_{cs} = 17.2 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, $V_1 = Q_{500}/(y_1W_1)$ = ________ ft/s

Critical approach velocity, $V_c = 11.17y_1^{1/6}D_{50}^{1/3}$ = ________ 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: Pie

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

Froude # at bridge = 0.34 Using pier width a on Figure 11, ξ = 7 Pier scour y_{ps} = 5.9 ft

ABUTMENT SCOUR CALCULATIONS

PGRM: Abutment

Average flow depth blocked by: left abutment, y_{aLT} = 8.6 ft right abutment, y_{aRT} = 10.8 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} = 20.2 and ψ_{RT} = 22.0

Left abutment scour, $y_{as} = \psi_{LT}(K_1/0.55)$ = 20.2 ft Right abutment scour $y_{as} = \psi_{RT}(K_1/0.55)$ = 22.0 ft

Route 466 Ave Stream Long Creek MRM____ Date ____ Initials ____

Bridge Structure No. 42020156 Location 4.7 mi S Lenox on 466 Ave

GPS coordinates: N 43° 16.599' W 96° 53.161' taken from: USL abutment ✓ centerline of ⇑ MRM end ____

Datum of coordinates: WGS84 ✓ NAD27____

Drainage area = 75.39 sq. mi.

The average bottom of the main channel was 17.9 ft below top of guardrail at a point 34 ft from left abutment.

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

MISCELLANEOUS CONSIDERATIONS

Flows	Q_{100} = 5600			Q_{500} = 10100		
Estimated flow passing through bridge	5600			? 10100		
Estimated road overflow & overtopping				? 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 some contraction; a small amount of pier scour at center pier

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.
str. no. on bridge
approach from bridge
LOB from ditch
ROB from ditch
bridge from upstream

left abut.
rt. abut.
old pier scour hole

Summary of Results

	Q100	Q500
Bridge flow evaluated	5600	10100
Flow depth at left abutment (yaLT), in feet	4.2	8.6
Flow depth at right abutment (yaRT), in feet	6.4	10.8
Contraction scour depth (ycs), in feet	10.1	17.2
Pier scour depth (yps), in feet	5.8	5.9
Left abutment scour depth (yas), in feet	13.6	20.2
Right abutment scour depth (yas), in feet	17.5	22.0
1Flow angle of attack	18°	18°

See Comments/Diagram for justification where required