OK TRT

SCOUR ANALYSIS AND REPORTING FORM

Bridge Structure No. 23479180 Date 7/13/12 Initials RaT Region (A B C D)

Site _____ Location 11 mi W of Warner on 142nd St

Q_{100} = Q_{25} 3540 by: drainage area ratio____ flood freq. anal. ____ regional regression eq. X

Bridge discharge (Q_2) = 3540 (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

Bridge Width = 132 ft. Flow angle at bridge = 10 ° Abut. Skew = 0 ° Effective Skew = 10 °

Width (W_2) iteration = _____ _____ _____ _____

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

Corrected channel width at bridge Section = W_2 times cos of flow angle = 129.99 ft* $q_2 = Q_2/W_2$ = 27.2 ft²/s

Bridge Vel, V_2 = 2.6 ft/s Final $y_2 = q_2/V_2$ = 10.4 ft Δh = 0.1 ft

Average main channel depth at approach section, $y_1 = \Delta h + y_2$ = 10.5 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.

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

Water Surface Elev. = 0-0.5 ft

Low Steel Elev. = 11.5 ft

n (Channel) = 0.035

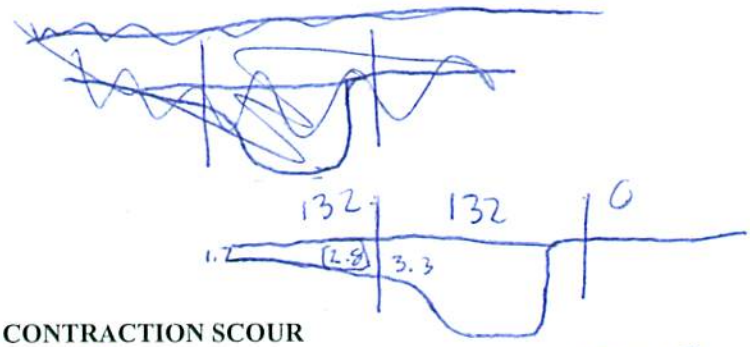
n (LOB) = 0.033

n (ROB) = 0.030

Pier Width = 2.03 ft

Pier Length = 2.03 ft

Piers for 100 yr = 2 ft



CONTRACTION SCOUR

PGRM: Contract

Width of main channel at approach section W_1 = 132 ft 3.3 - 1.7

Width of left overbank flow at approach, W_{lob} = 132 ft Average left overbank flow depth, y_{lob} = 2.8 ft

Width of right overbank flow at approach, W_{rob} = 0 ft Average right overbank flow depth, y_{rob} = 0 ft

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

PGRM: CWCSNEW

x = ~~1.8~~ 1.73 From Figure 9 W_2 (effective) = 125.9 ft y_{cs} = ~~2.3~~ 2.2 ft

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 = 1 Correction factor for flow angle of attack (from Table 1), K2 = 1

Froude # at bridge = 0.14 Using pier width a on Figure 11, ξ = 6.1 Pier scour y_{ps} = 6.1 ft

ABUTMENT SCOUR CALCULATIONS

PGRM: Abutment

Average flow depth blocked by: left abutment, y_{aLT} = 2.8 ft right abutment, y_{aRT} = 0 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} = 11.2 and ψ_{RT} = 0

Left abutment scour, $y_{as} = \psi_{LT}(K_1/0.55)$ = 11.2 ft Right abutment scour $y_{as} = \psi_{RT}(K_1/0.55)$ = 0 ft

SCOUR ANALYSIS AND REPORTING FORM

Bridge Structure No. 23479180 Date 7/13/12 Initials RJT Region (A B C D)

Site _____ Location 11 mi W of Warner on 142 St

Q_{500} = Q_{50} 5600 by: drainage area ratio____ flood freq. anal. ____ regional regression eq. ✓

Bridge discharge (Q_2) = 4276 (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

Bridge Width = 132 ft. Flow angle at bridge = 10 ° Abut. Skew = 0 ° Effective Skew = 10 °

Width (W_2) iteration = _____ _____ _____ _____

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

Corrected channel width at bridge Section = W_2 times cos of flow angle = 129.99 ft* $q_2 = Q_2/W_2$ = 32.9 ft^2/s

Bridge Vel, V_2 = 2.9 ft/s Final $y_2 = q_2/V_2$ = 11.5 ft Δh = 0.2 ft

Average main channel depth at approach section, $y_1 = \Delta h + y_2$ = 11.7 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,

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

Water Surface Elev. = 0-0.5 ft

Low Steel Elev. = 11.5 ft

n (Channel) = 0.035

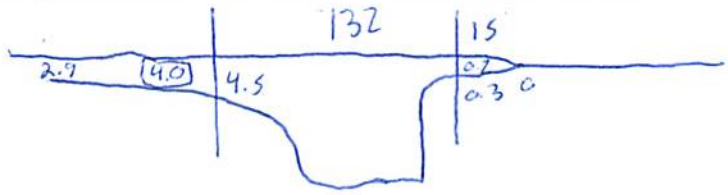
n (LOB) = 0.033

n (ROB) = 0.030

Pier Width = 2.05 ft

Pier Length = 2.06 ft

Piers for 500 yr = 2 ft



CONTRACTION SCOUR

PGRM: Contract

Width of main channel at approach section W_1 = 132 ft 4.5-2.9

Width of left overbank flow at approach, W_{lob} = 132 ft Average left overbank flow depth, y_{lob} = 4.0 ft

Width of right overbank flow at approach, W_{rob} = 15 ft Average right overbank flow depth, y_{rob} = 0.2 ft

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

x = ~~2.74~~ 2.62 From Figure 9 W_2 (effective) = 125.9 ft y_{cs} = ~~3.5~~ 3.2 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

PIER SCOUR CALCULATIONS

PGRM: Pier

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

Froude # at bridge = 0.15 Using pier width a on Figure 11, ξ = 6.1 Pier scour y_{ps} = 6.1 ft

ABUTMENT SCOUR CALCULATIONS

PGRM: Abutment

Average flow depth blocked by: left abutment, y_{aLT} = 4.0 ft right abutment, y_{aRT} = 0.2 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} = 13.3 and ψ_{RT} = 1

Left abutment scour, $y_{as} = \psi_{LT}(K_1/0.55)$ = 13.3 ft Right abutment scour $y_{as} = \psi_{RT}(K_1/0.55)$ = 1 ft

98.7247°
45.3306°

98° 43' 29.208"
45° 19' 50.484"

Route 142 St Stream Snake Ck MRM _____ Date 7/13/2012 Initials RaT

Bridge Structure No. 23479180 Location 11mi W of Warner on 142 St

GPS coordinates: N 45° 19' 50.61" W 98° 43' 29.21" taken from: USL abutment X centerline of ⇑ MRM end _____

Datum of coordinates: WGS84 X NAD27 _____

Drainage area = 306.90 sq. mi.

The average bottom of the main channel was 16.8 ft below top of guardrail at a point 39 ft from left abutment.

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

MISCELLANEOUS CONSIDERATIONS

Flows	~~Q_{100}~~ = Q_{25} 3540			~~Q_{500}~~ = Q_{50} 5600		
Estimated flow passing through bridge	3540			~~5600~~ 4276		
Estimated road overflow & overtopping	0			1324		
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	

7/2

2	164
5	790
10	1660
25	3540
50	5600
100	8310
500	17500

Riprap at abutments? ____Yes ____No ∧ Marginal

Evidence of past Scour? X Yes ____No ____Don't know ~~Scour~~ minor pier/ centroclin significant abutment (pic 12)

Debris Potential? ____High ____Med X Low

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

Riprap	____Yes	X No	____Don't know	____NA
Spur Dike	____Yes	X No	____Don't know	____NA
Other _____	____Yes	X 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

1). Left OB
2). main channel
3). right OB
4) pier
5) pier scour
6-8) right abutment
9-11). left abutment
12). left abutment scour
13). main channel

Summary of Results

	~~Q100~~ Q_{25}	~~Q500~~ Q_{50}
Bridge flow evaluated	3540	4276
Flow depth at left abutment (yaLT), in feet	2.5	4.0
Flow depth at right abutment (yaRT), in feet	0	0.2
Contraction scour depth (ycs), in feet	~~2.7~~ 2.2	~~3.7~~ 3.2
Pier scour depth (yps), in feet	6.1	6.9
Left abutment scour depth (yas), in feet	11.2	13.3
Right abutment scour depth (yas), in feet	0	1
1Flow angle of attack	10	10

See Comments/Diagram for justification where required