OK RT

SCOUR ANALYSIS AND REPORTING FORM

Bridge Structure No. 52423419 Date 8/11/16 Initials CW Region (A (B) C D)

Site _____ Location 7.75 mi S & 11 mi W of Wall on Sage Ck Rd

Q_{500} = 13,600 by: drainage area ratio____ flood freq. anal. ____ regional regression eq. ✓

Q50 Bridge discharge (Q_2) = 12,914 (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 = 112 ft. Flow angle at bridge = 35 ° Abut. Skew = 13 ° Effective Skew = 22 °

Width (W_2) iteration = 112

Avg. flow depth at bridge, y_2 iteration = 13.9 ?RD overflow

Corrected channel width at bridge Section = W_2 times cos of flow angle = 103.84 ft* $q_2 = Q_2/W_2$ = 123.4 ft^2/s

Bridge Vel, V_2 = 9.1 ft/s Final $y_2 = q_2/V_2$ = 13.5 ft Δh = 1.7 ft

Average main channel depth at approach section, $y_1 = \Delta h + y_2$ = 15.2 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. = 13.5 ft

n (Channel) = 0.022

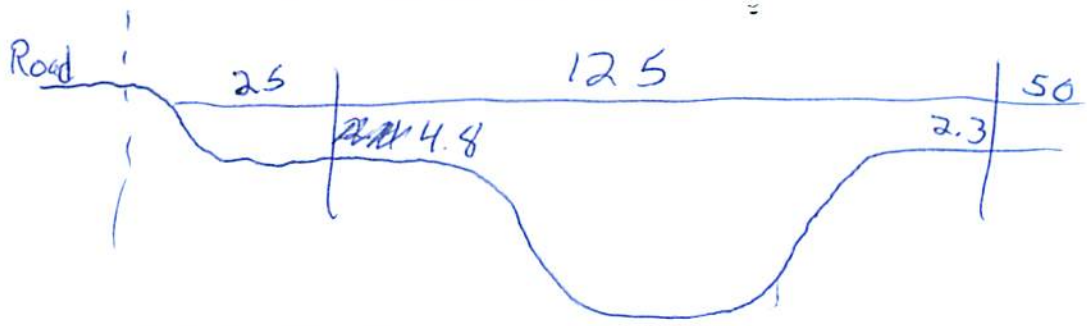
n (LOB) = 0.035

n (ROB) = 0.035

Pier Width = 2.0 ft

Pier Length = 2.0 ft

Piers for 100 yr = 2 ft



CONTRACTION SCOUR

PGRM: Contract

Width of main channel at approach section W_1 = 125 ft

Width of left overbank flow at approach, W_{lob} = 25 ft Average left overbank flow depth, y_{lob} = 2.4 ft (4.8/2 =)

Width of right overbank flow at approach, W_{rob} = ~~50~~ 50 ft Average right overbank flow depth, y_{rob} = ~~4.8~~ 2.3 ft (1.2)

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

x = ~~2.56~~ 4.01 From Figure 9 W_2 (effective) = ~~104~~ 99.8 ft y_{cs} = ~~3.1~~ 4.6 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, $V_1 = Q_{100}/(y_1W_1)$ = _____ ft/s

Critical approach velocity, $Vc = 11.17y_1^{1/6}D_{50}^{1/3}$ = _____ 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: Pier

L/a ratio = 1.0 Correction factor for flow angle of attack (from Table 1), K2 = 1.0

Froude # at bridge = 0.44 Using pier width a on Figure 11, ξ = 8.0 Pier scour y_{ps} = 7.0 ft

ABUTMENT SCOUR CALCULATIONS

PGRM: Abutment

Average flow depth blocked by: left abutment, y_{aLT} = 2.4 ft right abutment, y_{aRT} = 1.2 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} = 9.8 and ψ_{RT} = 5.1

Left abutment scour, $y_{as} = \psi_{LT}(K_1/0.55)$ = 9.8 ft Right abutment scour $y_{as} = \psi_{RT}(K_1/0.55)$ = 5.1 ft

112 / 15.2 / 12.9 / 2.3 35 / 13 / 22 2.3

SCOUR ANALYSIS AND REPORTING FORM

Bridge Structure No. 52823419 Date 8/11/11 Initials CW Region (A (B) C D)

Site _____ Location 7.75 mi S & 11.0 mi W of Wall on Sage Ck Rd

~~Q_{500}~~ Q25 = 8150 by: drainage area ratio ____ flood freq. anal. ____ regional regression eq. ✓

Bridge discharge (Q_2) = 8150 (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 = 112 ft. Flow angle at bridge = 35 ° Abut. Skew = 13 ° Effective Skew = 22 °

Width (W_2) iteration = 112 94 95 ____

Avg. flow depth at bridge, y_2 iteration = 10.6 11.7 11.6 ____

Corrected channel width at bridge Section = W_2 times cos of flow angle = 98.08 ft* $q_2 = Q_2/W_2$ = 92.5 ft^2/s

Bridge Vel, V_2 = 8.0 ft/s Final $y_2 = q_2/V_2$ = 11.6 ft Δh = 1.3 ft

Average main channel depth at approach section, $y_1 = \Delta h + y_2$ = 12.9 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. = ____ ft

Low Steel Elev. = ____ ft

n (Channel) = 0.022

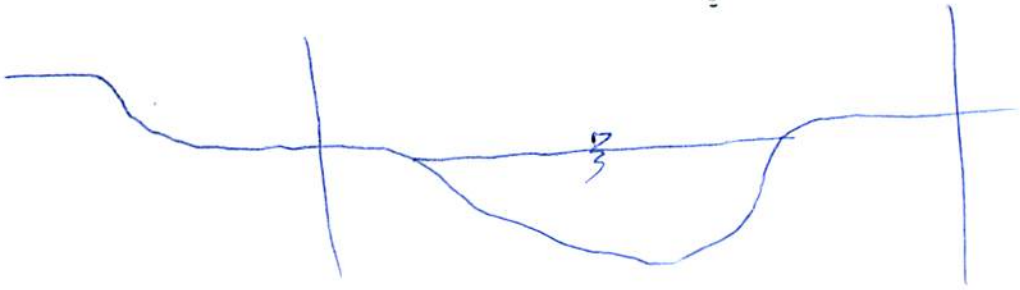
n (LOB) = 0.035

n (ROB) = 0.035

Pier Width = 2.0 ft

Pier Length = 2.0 ft

Piers for 500 yr = 2 ft



CONTRACTION SCOUR

PGRM: Contract

Width of main channel at approach section W_1 = 125 ft

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

Width of right overbank flow at approach, W_{rob} = ~~330~~ ft 0 Average right overbank flow depth, y_{rob} = ~~12.7~~ ft 0.0

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

x = 6.23 From Figure 9 W_2 (effective) = 94.1 ft y_{cs} = 7.0 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 = 1.0 Correction factor for flow angle of attack (from Table 1), K2 = 1.0

Froude # at bridge = 0.41 Using pier width a on Figure 11, ξ = 8.0 Pier scour y_{ps} = 7.0 ft

PGRM: Abutment

ABUTMENT SCOUR CALCULATIONS

Average flow depth blocked by: left abutment, y_{aLT} = 0.0 ft right abutment, y_{aRT} = 0.0 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} = 0.0 and ψ_{RT} = 0.0

Left abutment scour, $y_{as} = \psi_{LT}(K_1/0.55)$ = 0.0 ft Right abutment scour $y_{as} = \psi_{RT}(K_1/0.55)$ = 0.0 ft

Route Sage Ck Rd Stream Sage Ck MRM _____ Date 8/11/11 Initials CW

Bridge Structure No. 52823419 Location 7.75 mi S & 11.0 mi W of Wall on Sage Ck Rd

GPS coordinates: N 43°54'35.0" W 102°24'47.9" taken from: USL abutment X centerline of ⇑ MRM end _____

Datum of coordinates: WGS84 X NAD27 _____

Drainage area = 78.97 sq. mi.

The average bottom of the main channel was 14.0 ft below top of guardrail at a point 45 ft from left abutment.

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

Peak calc'd 8/16

Pk2	367
5	1610
10	3550
25	8150
50	13600
100	21300
500	51900

MISCELLANEOUS CONSIDERATIONS

Flows	~~Q100~~ = Q_{25} = 8150			~~Q200~~ Q_{50} = 13600		
Estimated flow passing through bridge	8150			12814		
Estimated road overflow & overtopping				786		
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? X Yes ____No ____Marginal

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

Debris Potential? ____High ____Med X Low

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

Riprap	X Yes	____No	____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____	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

1915-US
16-USRB
17-USLB
18-L. Abut
19-RAbut
20-Sparrows
21-US Face
22-ID

Summary of Results

	~~Q100~~ Q50	~~Q500~~ Q25
Bridge flow evaluated	12814	8150
Flow depth at left abutment (yaLT), in feet	2.4	0.0
Flow depth at right abutment (yaRT), in feet	1.2	0.0
Contraction scour depth (ycs), in feet	4.6	7.0
Pier scour depth (yps), in feet	7.0	7.0
Left abutment scour depth (yas), in feet	9.8	0.0
Right abutment scour depth (yas), in feet	5.1	0.0
1Flow angle of attack	22	22

See Comments/Diagram for justification where required

13600
12814
786