Spring Creek

SCOUR ANALYSIS AND REPORTING FORM

Bridge Structure No. 52399370 Date 11/4/10 Initials CW Region (A B C D)

Site _____ Location 0.4 E intersection Neck Yoke Rd + Spring Creek Rd

Q_{100} = 3330 by: drainage area ratio ✓ flood freq. anal. _____ regional regression eq. ____

Bridge discharge (Q_2) = 2121 (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 = 70 ft. Flow angle at bridge = 10 ° Abut. Skew = 0 ° Effective Skew = 10 °

Width (W_2) iteration = Vert. Abut

Avg. flow depth at bridge, y_2 iteration = RDOverflow! W_2 = 68.94 68.94

Corrected channel width at bridge Section = W_2 times cos of flow angle = ~~68.94~~ ft* $q_2 = Q_2/W_2$ = ~~49.3~~ 30.8 ft^2/s

Bridge Vel, V_2 = ~~5.0~~ 6.5 ft/s Final $y_2 = q_2/V_2$ = ~~6.0~~ 4.7 ft Δh = ~~1.3~~ 0.9 ft

Average main channel depth at approach section, $y_1 = \Delta h + y_2$ = ~~7.0~~ 5.6 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. = 4.7 ft

n (Channel) = 0.045

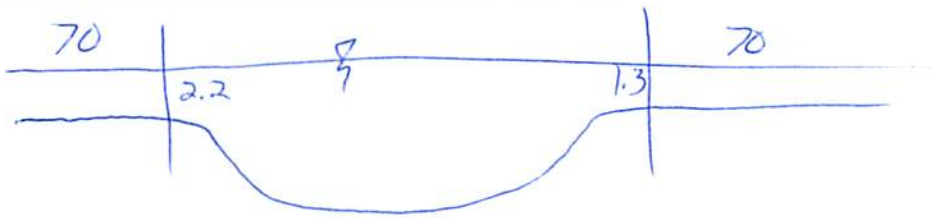
n (LOB) = 0.035

n (ROB) = 0.035

Pier Width = 0.9 ft

Pier Length = 29 ft

Piers for 100 yr = 1 ft



CONTRACTION SCOUR

PGRM: Contract

Width of main channel at approach section W_1 = 75 ft

Width of left overbank flow at approach, W_{lob} = 70 ft Average left overbank flow depth, y_{lob} = 2.2 ft

Width of right overbank flow at approach, W_{rob} = 70 ft Average right overbank flow depth, y_{rob} = 1.3 ft

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

x = _____ From Figure 9 W_2 (effective) = _____ ft y_{cs} = _____ ft

PGRM: CWCSNEW

Clear Water Contraction Scour (use if bed material is larger than small cobbles) ~~z = 0.676~~ z = 0 ~~5.0~~ 1.46

Estimated bed material D_{50} = 0.20 ft Average approach velocity, $V_1 = Q_{100}/(y_1 W_1)$ = ~~5.05~~ ft/s

Critical approach velocity, $Vc = 11.52 y_1^{1/6} D_{50}^{1/3}$ = 4.7 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.

$D_{c50} = 0.0006(q_2/y_1^{7/6})^3$ = 0.042 ft If $D_{50} >= D_{c50}$, $\chi = 0.0$

Otherwise, $\chi = 0.122 y_1 [q_2/(D_{50}^{1/3} y_1^{7/6})]^{6/7} - y_1$ = — 0 From Figure 10, y_{cs} = 0.0 ft

PIER SCOUR CALCULATIONS

PGRM: Pier

L/a ratio = 32.2 Correction factor for flow angle of attack (from Table 1), K2 = 2.0

Froude # at bridge = 0.53 Using pier width a on Figure 11, ξ = 4.4 Pier scour y_{ps} = 8.0 ft

ABUTMENT SCOUR CALCULATIONS

PGRM: Abutment

Average flow depth blocked by: left abutment, y_{aLT} = 2.2 ft right abutment, y_{aRT} = 1.3 ft

Shape coefficient K_1= ~~1.00~~ CW 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} = 9.0 and ψ_{RT} = 5.5

Left abutment scour, $y_{as} = \psi_{LT}(K_1/0.55)$ = ~~16.4~~ CW 13.5 ft Right abutment scour $y_{as} = \psi_{RT}(K_1/0.55)$ = ~~9.9~~ CW 8.1 ft

SCOUR ANALYSIS AND REPORTING FORM

Bridge Structure No. 52399370 Date 11/4/10 Initials CW Region (A B C D)

Site _____ Location 0.4 E intersection Nick Yoke Rd + Spring Creek Rd

Q_{500} = 24800 by: drainage area ratio ✓ flood freq. anal. _____ regional regression eq. _____

Bridge discharge (Q_2) = 2121 (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 = 70 ft. Flow angle at bridge = 10 ° Abut. Skew = 0 ° Effective Skew = 10 °

Width (W_2) iteration = Vert. Abut.

Avg. flow depth at bridge, y_2 iteration = RD over flow $W_2 = 68.94$

Corrected channel width at bridge Section = W_2 times cos of flow angle = 68.94 ft* $q_2 = Q_2/W_2$ = 30.8 ft^2/s

Bridge Vel, V_2 = 6.5 ft/s Final $y_2 = q_2/V_2$ = 4.7 ft Δh = 0.9 ft

Average main channel depth at approach section, $y_1 = \Delta h + y_2$ = 5.6 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. = 4.7 ft

n (Channel) = 0.045

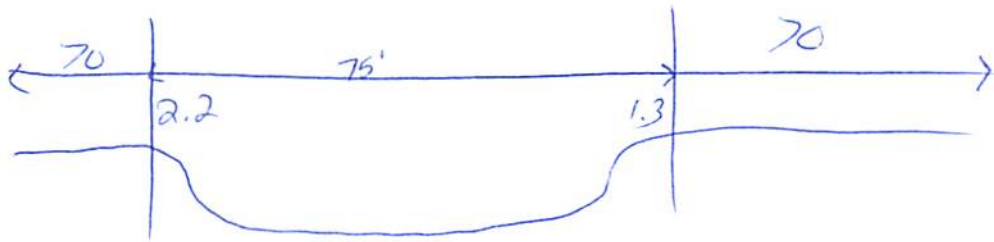
n (LOB) = 0.055

n (ROB) = 0.035

Pier Width = 0.9 ft

Pier Length = 20 ft

Piers for 500 yr = 1 ft



CONTRACTION SCOUR

PGRM: Contract

Width of main channel at approach section W_1 = 75 ft

Width of left overbank flow at approach, W_{lob} = 70 ft Average left overbank flow depth, y_{lob} = 2.2 ft

Width of right overbank flow at approach, W_{rob} = 70 ft Average right overbank flow depth, y_{rob} = 1.3 ft

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

x = _____ From Figure 9 W_2 (effective) = _____ ft y_{cs} = _____ ft

PGRM: CWCSNEW

Clear Water Contraction Scour (use if bed material is larger than small cobbles) ~~$x = 0.576$~~ $x = 0$ ~~1.76~~ 1.46

Estimated bed material D_{50} = 0.20 ft Average approach velocity, $V_1 = Q_{500}/(y_1W_1)$ = ~~5.05~~ ft/s

Critical approach velocity, $Vc = 11.52y_1^{1/6}D_{50}^{1/3}$ = 4.7 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.

$D_{c50} = 0.0006(q_2/y_1^{7/6})^3$ = 0.042 ft If $D_{50} >= D_{c50}$, ~~$x = 0.0$~~

Otherwise, $\chi = 0.122y_1[q_2/(D_{50}^{1/3}y_1^{7/6})]^{6/7} - y_1$ = — 0 From Figure 10, y_{cs} = 0.0 ft

PIER SCOUR CALCULATIONS

PGRM: Pier

L/a ratio = 32.2 Correction factor for flow angle of attack (from Table 1), K2 = 2.0

Froude # at bridge = 0.53 Using pier width a on Figure 11, ξ = 4.4 Pier scour y_{ps} = 5.0 ft

ABUTMENT SCOUR CALCULATIONS

PGRM: Abutment

Average flow depth blocked by: left abutment, y_{aLT} = 2.2 ft right abutment, y_{aRT} = 1.3 ft

Shape coefficient K_1= ~~1.00~~ for vertical-wall, CW 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} = 9.0 and ψ_{RT} = 5.5

Left abutment scour, $y_{as} = \psi_{LT}(K_1/0.55)$ = ~~16.4~~ ft CW 13.5 Right abutment scour $y_{as} = \psi_{RT}(K_1/0.55)$ = ~~9.9~~ CW 8.1 ft

Route Spring Creek Road Stream Spring Creek MRM _____ Date 11/4/10 Initials CW

Bridge Structure No. 52399370 Location 0.4 E intersection Nat Yoke Rd + Spring Creek Rd

GPS coordinates: N 43°59'05.3" W 103°15'41.5" taken from: USL abutment X centerline of ⇑ MRM end _____

Datum of coordinates: WGS84 X NAD27 _____

Drainage area = 175.18 sq. mi.

The average bottom of the main channel was 9.2 ft below top of guardrail at a point 24 ft from left abutment.

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

MISCELLANEOUS CONSIDERATIONS

Flows	Q_{100} = 3330			Q_{500} = 24800		
Estimated flow passing through bridge	2121			2121		
Estimated road overflow & overtopping	1209			22679		
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? ____Yes X No ____Marginal

Evidence of past Scour? X Yes ____No ____Don't know Scour hole ~100' US from bridge

Debris Potential? X High ____Med ____Low

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

Riprap ____Yes ____No ____Don't know X 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____	Sand____	Gravel X	Cobbles____	Boulders____
Size range, in mm	<0.062	0.062-2.00	2.00-64	64-250	>250

Comments, Diagrams & orientation of digital photos

Lots of Corrosion ~~B&B~~ under bridge deck

B/C both flows top → same values

Level 2 site

Photos

1436-ID

37-US

36-USRB

39-USLB

40-US Face Bridge

41-App. XS looking @ LB

42-App. XS looking @ RB

43-R. Abut

44-L. Abut

Summary of Results

	Q100	Q500
Bridge flow evaluated	2121	2121
Flow depth at left abutment (yaLT), in feet	2.2	2.2
Flow depth at right abutment (yaRT), in feet	1.3	1.3
Contraction scour depth (ycs), in feet	0.0	0.0
Pier scour depth (yps), in feet	8.0	8.0
Left abutment scour depth (yas), in feet	CW ~~16.4~~ 13.5	CW ~~16.4~~ 13.5
Right abutment scour depth (yas), in feet	CW ~~9.9~~ 8.1	CW ~~9.9~~ 8.1
1Flow angle of attack	10°	10°

See Comments/Diagram for justification where required