NW Lawrence Co OK RT

SCOUR ANALYSIS AND REPORTING FORM

Bridge Structure No. 41015040 Date 7/12/10 Initials CW Region (A B C D)

Site _____ Location 0.6 W I-90 Exit 2 on Service Road, Beaver Creek

Q_{100} = 1180 by: drainage area ratio ✓ flood freq. anal. _____ regional regression eq. ____

Bridge discharge (Q_2) = 1150 (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 = 54 ft. Flow angle at bridge = 0 ° Abut. Skew = 0 ° Effective Skew = 0 °

Width (W_2) iteration = 54

Avg. flow depth at bridge, y_2 iteration = 3.7 Vert wall

Corrected channel width at bridge Section = W_2 times cos of flow angle = 54 ft* $q_2 = Q_2/W_2$ = 20.3 ft^2/s

Bridge Vel, V_2 = 5.4 ft/s Final $y_2 = q_2/V_2$ = 3.7 ft Δh = 0.6 ft

Average main channel depth at approach section, $y_1 = \Delta h + y_2$ = 4.3 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,

Water Surface Elev. = _____ ft

Low Steel Elev. = 6.5 ft

n (Channel) = 0.035

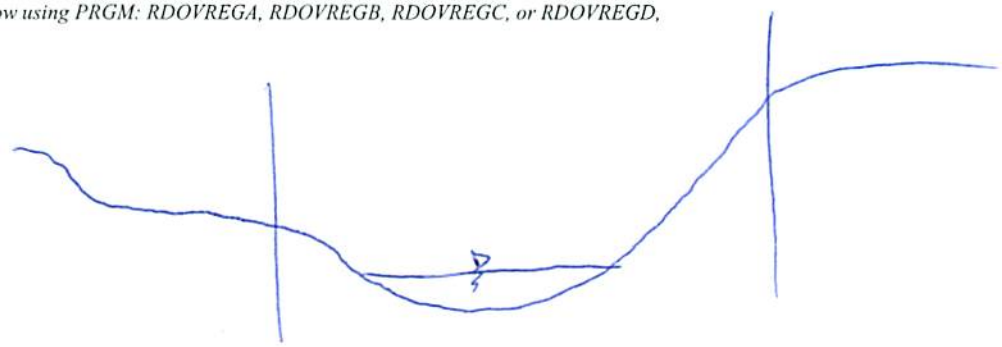
n (LOB) = 0.033

n (ROB) = 0.033

Pier Width = 0 ft

Pier Length = 0 ft

Piers for 100 yr = 0 ft



CONTRACTION SCOUR

PGRM: Contract

Width of main channel at approach section W_1 = 70 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} = 0 ft Average right overbank flow depth, y_{rob} = 0 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) $x = 0$

Estimated bed material D_{50} = 0.2 ft Average approach velocity, $V_1 = Q_{100}/(y_1 W_1)$ = 3.92 ft/s

Critical approach velocity, $Vc = 11.52 y_1^{1/6} D_{50}^{1/3}$ = 4.33 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.

$D_{c50} = 0.0006(q_2/y_1^{7/6})^3$ = 0.031 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

PGRM: Pier

PIER SCOUR CALCULATIONS

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

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

PGRM: Abutment

ABUTMENT SCOUR CALCULATIONS

Average flow depth blocked by: left abutment, y_{aLT} = 0 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} = 0 and ψ_{RT} = 0

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

SCOUR ANALYSIS AND REPORTING FORM

Bridge Structure No. 41015040 Date 7/12/11 Initials CM Region (A B C D)

Site _____ Location 0.6 W I-90 Exit 2 on Service Road

Q_{500} = 9810 by: drainage area ratio ✓ flood freq. anal. ____ regional regression eq. ____

Bridge discharge (Q_2) = 5259 (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 = 54 ft. Flow angle at bridge = 0 ° Abut. Skew = 0 ° Effective Skew = 0 °

Width (W_2) iteration = 54

Avg. flow depth at bridge, y_2 iteration = 12 > 8.5 RD Overflow

Corrected channel width at bridge Section = W_2 times cos of flow angle = 54 ft* $q_2 = Q_2/W_2$ = 90.7 ft²/s

Bridge Vel, V_2 = 10.7 ft/s Final $y_2 = q_2/V_2$ = 8.5 ft Δh = 2.3 ft

Average main channel depth at approach section, $y_1 = \Delta h + y_2$ = 10.8 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. = 46.5 ft

n (Channel) = 0.035

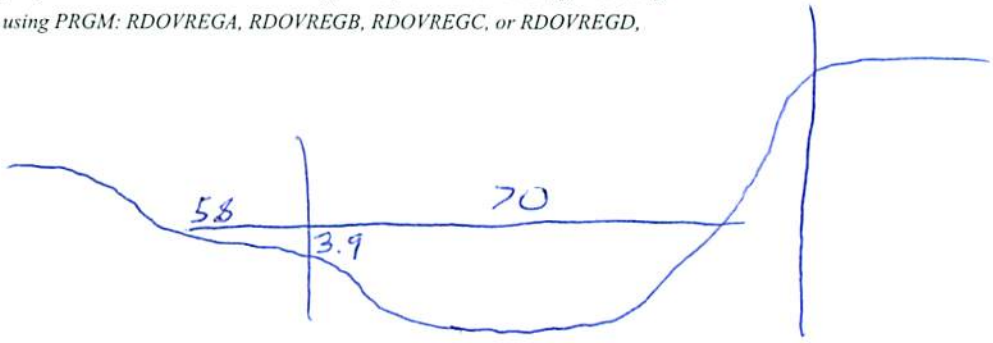
n (LOB) = 0.033

n (ROB) = 0.033

Pier Width = 0 ft

Pier Length = 0 ft

Piers for 500 yr = 0 ft



CONTRACTION SCOUR

PGRM: Contract

Width of main channel at approach section W_1 = 70 ft

Width of left overbank flow at approach, W_{lob} = 54 ft Average left overbank flow depth, y_{lob} = 2.0 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)

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

Estimated bed material D_{50} = 0.2 ft Average approach velocity, $V_1 = Q_{500}/(y_1 W_1)$ = 3.8 ft/s

Critical approach velocity, $Vc = 11.52 y_1^{1/6} D_{50}^{1/3}$ = 9.71 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.

$D_{c50} = 0.0006(q_2/y_1^{7/6})^3$ = 0.104 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 = _____ Correction factor for flow angle of attack (from Table 1), K2 = _____

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

ABUTMENT SCOUR CALCULATIONS

PGRM: Abutment

Average flow depth blocked by: left abutment, y_{aLT} = 2.0 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} = 8.2 and ψ_{RT} = 0

Left abutment scour, $y_{as} = \psi_{LT}(K_1/0.55)$ = 12.3 ft Right abutment scour $y_{as} = \psi_{RT}(K_1/0.55)$ = 0 ft

Route I-90 Service Rd Stream Crow Creek MRM _____ Date 7/12/10 Initials Cw

Bridge Structure No. 41015040 Location 0.6 W I-90 Exit 2 on Service Road

GPS coordinates: N 44° 32' 45.2" W 104° 01' 21.3" taken from: USL abutment X centerline of ⇑ MRM end _____

Datum of coordinates: WGS84 X NAD27 _____

Drainage area = 37.93 sq. mi.

The average bottom of the main channel was 15.2 ft below top of guardrail at a point 32 ft from left abutment.

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

MISCELLANEOUS CONSIDERATIONS

Flows	Q_{100} = 1180			Q_{500} = 9810		
Estimated flow passing through bridge		1180			5259	
Estimated road overflow & overtopping					4551	
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? ____Yes X No ____Don't know

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____	Cobbles X	Boulders____
Size range, in mm	<0.062	0.062-2.00	2.00-64	64-250	>250

Comments, Diagrams & orientation of digital photos

2 Interstate bridges US → Did not calc → App XS down I-90 & service Road Bridge

Photos
1744-ID
45-US
46-US RB
47-US LB
48-US Face
49-App. XS RB
90-App XS LB
91-R. Abut
92-L. Abut

Summary of Results

	Q100	Q500
Bridge flow evaluated	1180	5259
Flow depth at left abutment (yaLT), in feet	0.0	2.0
Flow depth at right abutment (yaRT), in feet	0.0	0.0
Contraction scour depth (ycs), in feet	0.0	0.0
Pier scour depth (yps), in feet	0.0	_____
Left abutment scour depth (yas), in feet	0.0	12.3
Right abutment scour depth (yas), in feet	0.0	0.0
1Flow angle of attack	0	0

See Comments/Diagram for justification where required