DUP OK-RAT

SCOUR ANALYSIS AND REPORTING FORM

Bridge Structure No. 41015040 Date 9-18-12 Initials RET Region (A B C D)

Site _____ Location 0.6 W I-90 Exit 2 on Service Rd, Beaver Ck

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

Bridge discharge (Q_2) = 1180 (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 = 60 ft. Flow angle at bridge = 0 ° Abut. Skew = 0 ° Effective Skew = 0 °

Width (W_2) iteration = 60 _____ _____ _____

Avg. flow depth at bridge, y_2 iteration = 3.7 _____ _____ _____

Corrected channel width at bridge Section = W_2 times cos of flow angle = 60 ft* $q_2 = Q_2/W_2$ = 19.7 ft^2/s

Bridge Vel, V_2 = 5.3 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,

Interstate median acts as smoothly transitioned approach section. flow is already partially constricted from US bridges

Water Surface Elev. = _____ ft

Low Steel Elev. = 8.10 ft

n (Channel) = 0.035

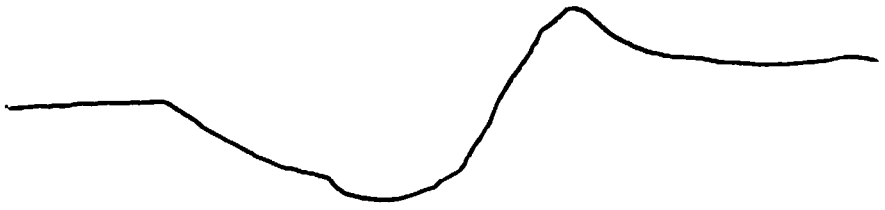
n (LOB) = 0.030

n (ROB) = 0.030

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 = 60 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 = 0 From Figure 9 W_2 (effective) = 60 ft y_{cs} = 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, $V_1 = Q_{100}/(y_1 W_1)$ = _____ 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.

$D_{c50} = 0.0006(q_2/y_1^{7/6})^2$ = _____ 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

N/A

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} = 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 _____ Initials _____ Region (A B C D)

Site _____ Location _____

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

Bridge discharge (Q_2) = 9443 (should be Q_{500} unless there is a relief bridge, road overflow, or bridge overtopping)

← Q max scour

Analytical Procedure for Estimating Hydraulic Variables Needed to Apply Method

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

Bridge Width = 60 ft. Flow angle at bridge = 0 ° Abut. Skew = 0 ° Effective Skew = 0 °

Width (W_2) iteration = 60 _____ _____ _____

Avg. flow depth at bridge, y_2 iteration = 11.5 _____ _____ _____

Corrected channel width at bridge Section = W_2 times cos of flow angle = 60 ft* $q_2 = Q_2/W_2$ = 157.4 ft²/s

Bridge Vel, V_2 = 13.7 ft/s Final $y_2 = q_2/V_2$ = 11.5 ft Δh = 3.9 ft ← flow is already mostly constricted use $\Sigma h = 1$

Average main channel depth at approach section, $y_1 = \Delta h + y_2$ = 15.4 ft $y_1 = 12.5$ ←

* 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.

Road overflow will begin at approx 11.5 ft ≈ 9443 cfs

Water Surface Elev. = _____ ft

Low Steel Elev. = 8.0 ft

n (Channel) = .035

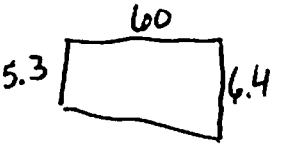
n (LOB) = .030

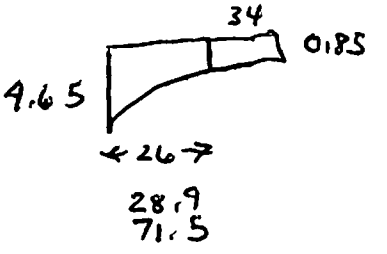
n (ROB) = .030

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 = 60 ft

Width of left overbank flow at approach, W_{lob} = 60 ft Average left overbank flow depth, y_{lob} = 4.85 ft

Width of right overbank flow at approach, W_{rob} = 60 ft Average right overbank flow depth, y_{rob} = 1.67 ft

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

x = 3.52 From Figure 9 W_2 (effective) = 60 ft y_{cs} = 4.1 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, $V_1 = Q_{500}/(y_1 W_1)$ = _____ 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 = _____ 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} = 4.85 ft right abutment, y_{aRT} = 1.67 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} = 14.8 and ψ_{RT} = 6.9

Left abutment scour, $y_{as} = \psi_{LT}(K_1/0.55)$ = 22 ft Right abutment scour $y_{as} = \psi_{RT}(K_1/0.55)$ = 10.3 ft

I-90

Route Serv. Road Stream Crow Creek MRM _____ Date _____ Initials _____

Bridge Structure No. 410150400 Location 0.6 W I-90 Exit 2 on Service Rd

GPS coordinates: N 44° 32.814' taken from: USL abutment ✓ centerline of ⇑ MRM end _____

W 104° 01.333' Datum of coordinates: WGS84 ✓ NAD27 _____

Drainage area = 37.93 sq. mi.

The average bottom of the main channel was 14.6 ft below top of guardrail at a point 30 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			9443		
Estimated road overflow & overtopping	0			367		
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 small amount of contraction scour

Debris Potential? ____High ✓Med ____Low trees upstream

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____	Sand X	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

Str. no.
approach from bridge
LOB
ROB
Bridge from approach
L abut.
R abut

Summary of Results

	Q100	Q500
Bridge flow evaluated	1180	9443
Flow depth at left abutment (yaLT), in feet	0	4.85
Flow depth at right abutment (yaRT), in feet	0	1.67
Contraction scour depth (ycs), in feet	0	4.1
Pier scour depth (yps), in feet	NA	NA
Left abutment scour depth (yas), in feet	0	22
Right abutment scour depth (yas), in feet	0	10.3
Flow angle of attack	0°	0°

See Comments/Diagram for justification where required