OK-RaT

SCOUR ANALYSIS AND REPORTING FORM

Bridge Structure No. 10240390 Date 9-19-12 Initials RFT Region ([✓ A] B C D)

Site ______ Location 1.5 mi S & 1 mi W of Nisland - Butte Co

Q~~100~~ 500 = ~~486~~ 886 by: drainage area ratio ____ flood freq. anal. ____ regional regression eq. ✓

Bridge discharge (Q_2) = 886 (should be Q_{100} unless there is a relief bridge, road overflow, or bridge overtopping)

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

Analytical Procedure for Estimating Hydraulic Variables Needed to Apply Method

Bridge Width = 86.86 ft. Flow angle at bridge = 6 ° Abut. Skew = 0 ° Effective Skew = 6 °

Width (W_2) iteration = ~~52~~ 62 ~~50~~ 52 55

Avg. flow depth at bridge, y_2 iteration* = ~~2.54~~ 3.1 ~~2.5~~ 3.9 3.8 54.7

Corrected channel width at bridge Section = W_2 times cos of flow angle = ~~49.73~~ ~~62.16~~ ft* $q_2 = Q_2/W_2$ = ~~9.8~~ 16.2 ft²/s

Bridge Vel, V_2 = ~~3.9~~ 4.9 ft/s Final $y_2 = q_2/V_2$ = ~~2.5~~ 3.3 ft Δh = ~~0.3~~ 0.5 ft

Average main channel depth at approach section, $y_1 = \Delta h + y_2$ = ~~2.8~~ 3.8 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.

Very incised

Q values seem to be too low for this site? do Q_{500} and Qmax scour

Water Surface Elev. = ____ ft no flow
Low Steel Elev. = 12.5 ft
n (Channel) = .045
n (LOB) = .030
n (ROB) = .030
Pier Width = 2.0 ft
Pier Length = 2.0 ft
\# Piers for 100 yr = 2 ft

PGRM: Contract

CONTRACTION SCOUR

Width of main channel at approach section W_1 = 56 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 = 0.4 From Figure 9 W_2 (effective) = 50.7 ft y_{cs} = 0.7 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

PGRM: Pier

PIER SCOUR CALCULATIONS

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

Froude # at bridge = 0.48 Using pier width a on Figure 11, ξ = 8 Pier scour y_{ps} = 7.1 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. 10240390 Date ______ Initials ______ Region ([✓ A] B C D)

Site ______ Location 1.5 mi S & 1mi W of Nisland

Q_{500}= max scour ~~886~~ 18279 by: drainage area ratio ____ flood freq. anal. ____ regional regression eq. ____

Bridge discharge (Q_2) = 18279 (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 = 86 ft. Flow angle at bridge = 6 ° Abut. Skew = 0 ° Effective Skew = 6 °

Width (W_2) iteration = 86 ____ ____ ____

Avg. flow depth at bridge, y_2 iteration = 13.6 ____ ____ ____

Corrected channel width at bridge Section = W_2 times cos of flow angle = 85.53 ft* $q_2 = Q_2/W_2$ = 213.7 ft²/s

Bridge Vel, V_2 = 15.7 ft/s Final $y_2 = q_2/V_2$ = 13.6 ft Δh = 5.1 ft

Average main channel depth at approach section, $y_1 = \Delta h + y_2$ = 18.7 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.

road overflow will occur at ~ 13.6

Water Surface Elev. = ____ ft

Low Steel Elev. = 12.5 ft

n (Channel) = .045

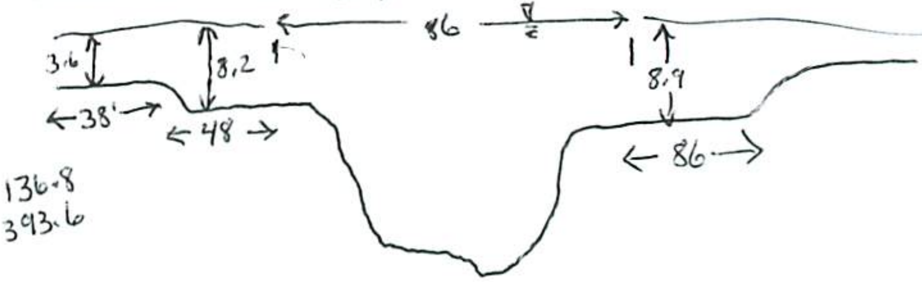
n (LOB) = .030

n (ROB) = .030

Pier Width = 2.0 ft

Pier Length = 2.0 ft

\# Piers for 500 yr = 2 ft



136.8
393.6

CONTRACTION SCOUR

PGRM: Contract

Width of main channel at approach section W_1 = 86 ft

Width of left overbank flow at approach, W_{lob} = 86 ft Average left overbank flow depth, y_{lob} = 6.17 ft

Width of right overbank flow at approach, W_{rob} = 86 ft Average right overbank flow depth, y_{rob} = 8.9 ft

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

x= 14.27 From Figure 9 W_2 (effective) = 81.5 ft y_{cs} = 14.6 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, $V_1 = Q_{500}/(y_1 W_1)$ = ____ 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: Pie

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

Froude # at bridge = 0.75 Using pier width a on Figure 11, ξ = 8 Pier scour y_{ps} = 7.6 ft

ABUTMENT SCOUR CALCULATIONS

PGRM: Abutment

Average flow depth blocked by: left abutment, y_{aLT} = 6.17 ft right abutment, y_{aRT} = 8.9 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} = 17.1 and ψ_{RT} = 20.5

Left abutment scour, $y_{as} = \psi_{LT}(K_1/0.55)$ = 17.1 ft Right abutment scour $y_{as} = \psi_{RT}(K_1/0.55)$ = 20.5 ft

Route Snoma Rd Stream Stinkingwater Ck MRM ________ Date ________ Initials ________

Bridge Structure No. 10240390 Location 1.5 mi S + 1 mi W of Nisland

GPS coordinates N44° 38.368' W103° 34.043' taken from: USL abutment ✓ centerline of ⇑ MRM end ____

Datum of coordinates: WGS84 ✓ NAD27 ____

Drainage area = 29.44 sq. mi.

The average bottom of the main channel was 16.2 ft below top of guardrail at a point 36 ft from left abutment.

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

MISCELLANEOUS CONSIDERATIONS

Flows	Q~~100~~ 500? ~~486~~ 886			Q~~500~~ max scour ~~886~~ 18279		
Estimated flow passing through bridge	886			18279		
Estimated road overflow & overtopping	0			0		
Consideration	Yes	No	Possibly	Yes	No	Possibly
Chance of overtopping		✓				✓
Chance of Pressure flow		✓		X		
Armored appearance to channel		✓			✓	
Lateral instability of channel			✓			✓

	7/2
2	35.3
5	88.5
10	141
25	240
50	351
100	486
500	886

Riprap at abutments? ____Yes ✓ No ____Marginal

Evidence of past Scour? X Yes ____No ____Don't know contraction scour pool under bridge

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____	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

Str. no.
approach from bridge
LOB from bridge
ROB from bridge
Bridge from approach

rt abut. under bridge
left abut. under bridge
scour pool under bridge (ds side of bridge)

Summary of Results

	Q~~100~~ 500 ?	~~Q500~~ Q max scour
Bridge flow evaluated	886	18279
Flow depth at left abutment (yaLT), in feet	0	6.17
Flow depth at right abutment (yaRT), in feet	0	8.9
Contraction scour depth (ycs), in feet	0.7	14.6
Pier scour depth (yps), in feet	7.1	7.6
Left abutment scour depth (yas), in feet	0	17.1
Right abutment scour depth (yas), in feet	0	20.5
1Flow angle of attack	6°	6°

See Comments/Diagram for justification where required