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SCOUR ANALYSIS AND REPORTING FORM

Bridge Structure No. 12510206 Date 10-12-12 Initials RFT Region (A B [✓ C] D)

Site ______ Location 8.1 mi N Wagner on 395 Ave

Q_{100}^{50} = 6100 by: drainage area ratio ____ flood freq. anal. ____ regional regression eq. X

Bridge discharge (Q_2) = 6100 (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 = 140 ft. Flow angle at bridge = 25 ° Abut. Skew = 30 ° Effective Skew = 5 °

Width (W_2) iteration = 140 ____ ____ ____

Avg. flow depth at bridge, y_2 iteration = 9.3 ____ ____ ____

Corrected channel width at bridge Section = W_2 times cos of flow angle = 139.47 ft* $q_2 = Q_2/W_2$ = 43.7 ft^2/s

Bridge Vel, V_2 = 4.7 ft/s Final $y_2 = q_2/V_2$ = 9.3 ft Δh = 0.4 ft

Average main channel depth at approach section, $y_1 = \Delta h + y_2$ = 9.8 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.

$y_2 \geq 7$ft is abut. to abut. flow

Water Surface Elev. = dry ft

Low Steel Elev. = 10.3 ft

n (Channel) = .030

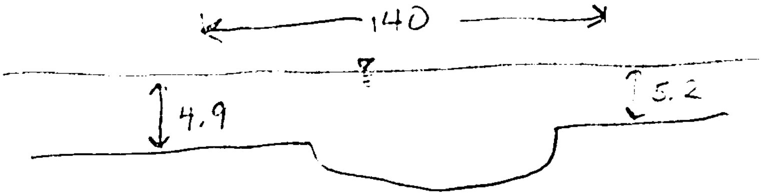
n (LOB) = .030 } pasture

n (ROB) = .030 }

Pier Width = 1.67 ft

Pier Length = 1.67 ft

\# Piers for 100 yr = 4 ft



CONTRACTION SCOUR

PGRM: Contract

Width of main channel at approach section W_1 = 140 ft

Width of left overbank flow at approach, W_{lob} = 140 ft Average left overbank flow depth, y_{lob} = 4.9 ft

Width of right overbank flow at approach, W_{rob} = 140 ft Average right overbank flow depth, y_{rob} = 5.2 ft

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

x = 7.38 From Figure 9 W_2 (effective) = 132.8 ft y_{cs} = 8.2 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, $V_c = 11.17 y_1^{1/6} D_{50}^{1/3}$ = ______ 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 = 1 Correction factor for flow angle of attack (from Table 1), K2 = 1

Froude # at bridge = 0.27 Using pier width a on Figure 11, ξ = 7 Pier scour y_{ps} = 5.7 ft

ABUTMENT SCOUR CALCULATIONS

PGRM: Abutment

Average flow depth blocked by: left abutment, y_{aLT} = 4.9 ft right abutment, y_{aRT} = 5.2 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} = 14.8 and ψ_{RT} = 15.4

Left abutment scour, $y_{as} = \psi_{LT}(K_1/0.55)$ = 14.8 ft Right abutment scour $y_{as} = \psi_{RT}(K_1/0.55)$ = 15.4 ft

SCOUR ANALYSIS AND REPORTING FORM

Bridge Structure No. 12510206 Date ________ Initials ________ Region (A B [✓ C] D)

Site ________ Location ________

Q_{500}^{100}= 9060 by: drainage area ratio ____ flood freq. anal. ____ regional regression eq. X

Bridge discharge (Q_2) = 8949 (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 = 140 ft. Flow angle at bridge = 25 ° Abut. Skew = 30 ° Effective Skew = 5 °

Width (W_2) iteration = 140 ____ ____ ____

Avg. flow depth at bridge, y_2 iteration = 11.3 ____ ____ ____

Corrected channel width at bridge Section = W_2 times cos of flow angle = 139.47 ft* $q_2 = Q_2/W_2$ = 64.2 ft^2/s

Bridge Vel, V_2 = 5.7 ft/s Final $y_2 = q_2/V_2$ = 11.3 ft Δh = 0.7 ft

Average main channel depth at approach section, $y_1 = \Delta h + y_2$ = 12.0 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 begins at $y_2 \approx 11.3$ ft

Water Surface Elev. = dry ft

Low Steel Elev. = 10.3 ft

n (Channel) = .030

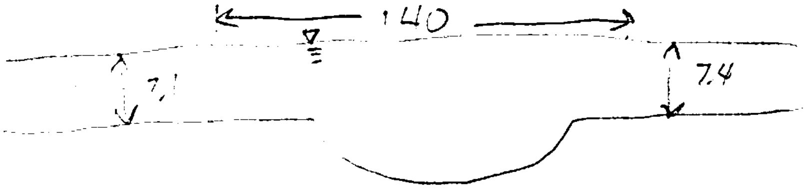
n (LOB) = .030

n (ROB) = .030

Pier Width = 1.67 ft

Pier Length = 1.67 ft

Piers for 500 yr = 4 ft



CONTRACTION SCOUR

PGRM: Contract

Width of main channel at approach section W_1 = 140 ft

Width of left overbank flow at approach, W_{lob} = 140 ft Average left overbank flow depth, y_{lob} = 7.1 ft

Width of right overbank flow at approach, W_{rob} = 140 ft Average right overbank flow depth, y_{rob} = 7.4 ft

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

x = 0.52 From Figure 9 W_2 (effective) = 132.8 ft y_{cs} = 12.6 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, $V_1 = Q_{500}/(y_1W_1)$ = ________ 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: Pie

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

Froude # at bridge = 0.3 Using pier width a on Figure 11, ξ = 7 Pier scour y_{ps} = 5.8 ft

ABUTMENT SCOUR CALCULATIONS

PGRM: Abutment

Average flow depth blocked by: left abutment, y_{aLT} = 7.1 ft right abutment, y_{aRT} = 7.4 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} = 18.8 and ψ_{RT} = 19.3

Left abutment scour, $y_{as} = \psi_{LT}(K_1/0.55)$ = 18.8 ft Right abutment scour $y_{as} = \psi_{RT}(K_1/0.55)$ = 19.3 ft

Route 395 Ave Stream Choteau Creek MRM________ Date ____________ Initials________

Bridge Structure No. 12510206 Location 8.1 mi N Wagner on 395 ave

GPS coordinates: N 43° 12.116' taken from: USL abutment [✓] centerline of ⇑ MRM end ______

W 98° 17.253' Datum of coordinates: WGS84 [✓] NAD27_____

Drainage area = 271.66 sq. mi.

The average bottom of the main channel was 14.0 ft below top of guardrail at a point 85 ft from left abutment.

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

MISCELLANEOUS CONSIDERATIONS

Flows	Q~~100~~50= 6100			Q~~500~~100= 9060		
Estimated flow passing through bridge						
Estimated road overflow & overtopping						
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 abutment

Debris Potential? ____High ____Med [✓ Low]

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 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

Str. no.

bridge from approach

LOB

ROB

left abut.

rt. abut.

approach from bridge

Summary of Results

	Q100	Q500 max scour
Bridge flow evaluated	6100	2949
Flow depth at left abutment (yaLT), in feet	4.9	7.1
Flow depth at right abutment (yaRT), in feet	5.2	7.4
Contraction scour depth (ycs), in feet	2.2	12.6
Pier scour depth (yps), in feet	5.7	5.8
Left abutment scour depth (yas), in feet	14.8	12.8
Right abutment scour depth (yas), in feet	15.4	19.3
1Flow angle of attack	25° (5° eff.)	25° (5° eff.)

See Comments/Diagram for justification where required