Chateau Creek

SCOUR ANALYSIS AND REPORTING FORM

Bridge Structure No. 22211160 Date 10/10/11 Initials CW Region (A B C D)

Site _____ Location 5.9 mi W of Delmont on 284 St

Q50 ~~Q_{100}~~ = 4700 by: drainage area ratio____ flood freq. anal. ____ regional regression eq. ____

Bridge discharge (Q_2) = 3298 (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 = 120 ft. Flow angle at bridge = 0 ° Abut. Skew = 0 ° Effective Skew = 0 °

Width (W_2) iteration = 120 _____ _____ _____

Avg. flow depth at bridge, y_2 iteration = 8.3 > 7.4 → RD Overflow

Corrected channel width at bridge Section = W_2 times cos of flow angle = 120 ft* $q_2 = Q_2/W_2$ = 27.5 ft^2/s

Bridge Vel, V_2 = 3.7 ft/s Final $y_2 = q_2/V_2$ = 7.4 ft Δh = 0.3 ft

Average main channel depth at approach section, $y_1 = \Delta h + y_2$ = 7.7 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,

Water Surface Elev. = _____ ft

Low Steel Elev. = 7.4 ft

n (Channel) = 0.040

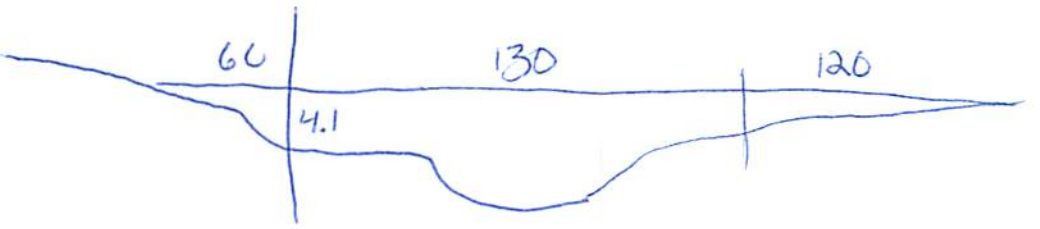
n (LOB) = 0.035

n (ROB) = 0.033

Pier Width = 1.65 ft

Pier Length = 3.6/22 ft

Piers for 100 yr = 3 ft



CONTRACTION SCOUR

PGRM: Contract

Width of main channel at approach section W_1 = 130 ft

Width of left overbank flow at approach, W_{lob} = 60 ft Average left overbank flow depth, y_{lob} = ~~2.05~~ ft 2.1

Width of right overbank flow at approach, W_{rob} = 120 ft Average right overbank flow depth, y_{rob} = 1.0 ft

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

x = 1.85 From Figure 9 W_2 (effective) = 115.1 ft y_{cs} = 2.4 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.

$D_{c50} = 0.0006(q_2/y_1^{7/6})^3$ = _____ 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 = 2.14 Correction factor for flow angle of attack (from Table 1), K2 = 1.0

Froude # at bridge = 0.24 Using pier width a on Figure 11, ξ = 6.9 Pier scour y_{ps} = 5.6 ft

ABUTMENT SCOUR CALCULATIONS

PGRM: Abutment

Average flow depth blocked by: left abutment, y_{aLT} = 2.1 ft right abutment, y_{aRT} = 1.0 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} = 8.6 and ψ_{RT} = 4.3

Left abutment scour, $y_{as} = \psi_{LT}(K_1/0.55)$ = 8.6 ft Right abutment scour $y_{as} = \psi_{RT}(K_1/0.55)$ = 4.3 ft

SCOUR ANALYSIS AND REPORTING FORM

Bridge Structure No. 22211160 Date 10/10/11 Initials CW Region (A B C D)

Site _____ Location 5.9 mi W of Delmont on 284 St

Q_{25} ~~Q_{500}~~ = 3010 by: drainage area ratio____ flood freq. anal. _____ regional regression eq. ____

Bridge discharge (Q_2) = 3010 (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 = 120 ft. Flow angle at bridge = 0 ° Abut. Skew = 0 ° Effective Skew = 0 °

Width (W_2) iteration = 120 _____ _____ _____

Avg. flow depth at bridge, y_2 iteration = 7.1 → Vert Wall _____

Corrected channel width at bridge Section = W_2 times cos of flow angle = 120 ft* $q_2 = Q_2/W_2$ = 25.1 ft^2/s

Bridge Vel, V_2 = 3.5 ft/s Final $y_2 = q_2/V_2$ = 7.1 ft Δh = 0.2 ft

Average main channel depth at approach section, $y_1 = \Delta h + y_2$ = 7.3 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. = 7.4 ft

n (Channel) = 0.040

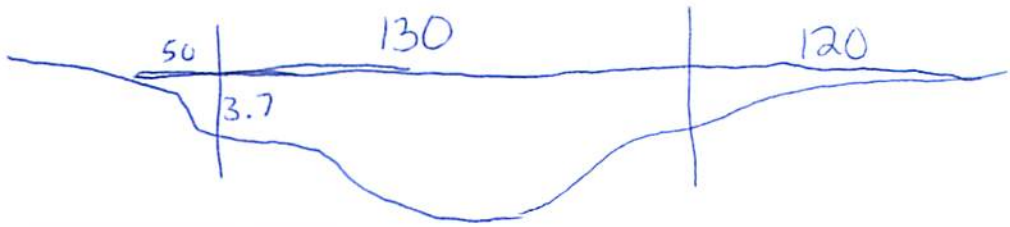
n (LOB) = 0.035

n (ROB) = 0.033

Pier Width = 1.65 ft

Pier Length = 3.6/22 ft

Piers for 500 yr = 3 ft



CONTRACTION SCOUR

PGRM: Contract

Width of main channel at approach section W_1 = 130 ft

Width of left overbank flow at approach, W_{lob} = 50 ft Average left overbank flow depth, y_{lob} = 1.9 ft

Width of right overbank flow at approach, W_{rob} = 120 ft Average right overbank flow depth, y_{rob} = 0.6 ft

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

x = 1.48 From Figure 9 W_2 (effective) = 115.1 ft y_{cs} = 2.0 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, $V_1 = Q_{500}/(y_1 W_1)$ = _____ 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 = 2.14 Correction factor for flow angle of attack (from Table 1), K2 = 1.0

Froude # at bridge = 0.23 Using pier width a on Figure 11, ξ = 6.9 Pier scour y_{ps} = 5.5 ft

ABUTMENT SCOUR CALCULATIONS

PGRM: Abutment

Average flow depth blocked by: left abutment, y_{aLT} = 1.9 ft right abutment, y_{aRT} = 0.6 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} = 7.4 and ψ_{RT} = 2.7

Left abutment scour, $y_{as} = \psi_{LT}(K_1/0.55)$ = 7.4 ft Right abutment scour $y_{as} = \psi_{RT}(K_1/0.55)$ = 2.7 ft

1.9
2 | 3.7
2
1.7

Route 284 St Stream Choteau Ck MRM _____ Date 10/10/11 Initials CL

Bridge Structure No. 22211160 Location 5.9 mi W of Delmont on 284 St

GPS coordinates: N 43°16'05.9" taken from: USL abutment X centerline of ⇑ MRM end _____

W 098°16'58.2" Datum of coordinates: WGS84 X NAD27 _____

Drainage area = 178.64 sq. mi.

The average bottom of the main channel was 12.3 ft below top of guardrail at a point 55 ft from left abutment.

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

8/23

2	165
5	706
10	1450
25	3010
50	4700
100	6920
500	14500

MISCELLANEOUS CONSIDERATIONS

Flows	~~Q100~~ Q50 = 4700			~~Q500~~ Q25 = 3010		
Estimated flow passing through bridge	3298			3010		
Estimated road overflow & overtopping	1402					
Consideration	Yes	No	Possibly	Yes	No	Possibly
Chance of overtopping	X				X	
Chance of Pressure flow	~~X~~		X		X	~~X~~
Armored appearance to channel		X			X	
Lateral instability of channel		X			X	

Riprap at abutments? ____Yes ____No X Marginal Looks like most has washed away

Evidence of past Scour? X Yes ____No ____Don't know Abutment

Debris Potential? ____High ____Med X Low

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

Riprap	____Yes	X No	____Don't know	____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 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

* Cattle in stream → bank erosion

Photos

2082 - ID
83 - US
84 - US RB
85 - US LB
86 - L. Abut
87 - Pier config
88 - L. Abut
89 - US Face
90 - R. Abut
91 - R. Abut

Summary of Results

	~~Q100~~ 50	~~Q500~~ 25
Bridge flow evaluated	3298	3010
Flow depth at left abutment (yaLT), in feet	2.1	1.9
Flow depth at right abutment (yaRT), in feet	1.0	0.6
Contraction scour depth (ycs), in feet	2.4	2.0
Pier scour depth (yps), in feet	5.6	5.5
Left abutment scour depth (yas), in feet	8.6	7.8
Right abutment scour depth (yas), in feet	4.3	2.7
1Flow angle of attack	0°	0°

See Comments/Diagram for justification where required