ok RT

SCOUR ANALYSIS AND REPORTING FORM

Bridge Structure No. 63194120 Date 5/23/17 Initials Kal Region (A B C D)

Site _____ Location 3 mi N + 3.2 mi E of Hurley on 280 St

Q_{100} = Qo 6240 by: drainage area ratio____ flood freq. anal. ____ regional regression eq. X

Bridge discharge (Q_2) = 6240 (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 = 190 ft. Flow angle at bridge = 40 ° Abut. Skew = 0 ° Effective Skew = 40 °

Width (W_2) iteration = _____ _____ _____ _____

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

Corrected channel width at bridge Section = W_2 times cos of flow angle = 145.65 ft* $q_2 = Q_2/W_2$ = 42.9 ft^2/s

Bridge Vel, V_2 = 4.6 ft/s Final $y_2 = q_2/V_2$ = 9.2 ft Δh = 0.4 ft

Average main channel depth at approach section, $y_1 = \Delta h + y_2$ = 9.7 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. = 0-3.0 ft

Low Steel Elev. = 11.4 ft

n (Channel) = 0.040

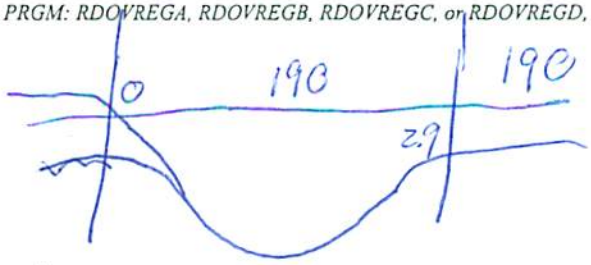
n (LOB) = 0.035

n (ROB) = 0.035

Pier Width = 2.1 ft

Pier Length = 4.2 ft

Piers for 100 yr = 6 ft - counted old abutben piers. larger scour from them too.



CONTRACTION SCOUR

PGRM: Contract

Width of main channel at approach section W_1 = 190 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} = 190 ft Average right overbank flow depth, y_{rob} = 2.9 ft

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

x = 6.28 From Figure 9 W_2 (effective) = 132.9 ft y_{cs} = 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, $V_1 = Q_{100}/(y_1 W_1)$ = _____ 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

PGRM: Pier

PIER SCOUR CALCULATIONS

L/a ratio = 2 Correction factor for flow angle of attack (from Table 1), K2 = 1.4

Froude # at bridge = 0.27 Using pier width a on Figure 11, ξ = 8.3 Pier scour y_{ps} = 9.5 ft

PGRM: Abutment

ABUTMENT SCOUR CALCULATIONS

Average flow depth blocked by: left abutment, y_{aLT} = 0 ft right abutment, y_{aRT} = 2.9 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} = 0 and ψ_{RT} = 11.3

Left abutment scour, $y_{as} = \psi_{LT}(K_1/0.55)$ = 0 ft Right abutment scour $y_{as} = \psi_{RT}(K_1/0.55)$ = 20.6 ft

SCOUR ANALYSIS AND REPORTING FORM

Bridge Structure No. 63194120 Date 5/23/12 Initials rat Region (A B (C) D)

Site _____ Location 3 mi N & 3.2 mi E of Hurley on 280 St

Q_{500} = ~~Q25~~ 11200 by: drainage area ratio____ flood freq. anal. ____ regional regression eq. ____

Bridge discharge (Q_2) = ~~10013~~ 9505 (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 = 190 ft. Flow angle at bridge = 40 ° Abut. Skew = 0 ° Effective Skew = 40 °

Width (W_2) iteration = _____ _____ _____ _____

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

Corrected channel width at bridge Section = W_2 times cos of flow angle = 145.55 ft* $q_2 = Q_2/W_2$ = 66.3 ft^2/s

Bridge Vel, V_2 = 5.7 ft/s Final $y_2 = q_2/V_2$ = 11.4 ft Δh = 0.7 ft

Average main channel depth at approach section, $y_1 = \Delta h + y_2$ = 12.1 ft

** NOTE: repeat above calculations until y_2 changes by less than 0.2* *Effective pier width = L sin(a) + a cos(a)*

If y_2 is above LS, then account for Road Overflow using PRGM: RDOVREGA, RDOVREGB, RDOVREGC, or RDOVREGD,

Water Surface Elev. = 0.-3.0 ft

Low Steel Elev. = 41.4 ft

n (Channel) = 0.040

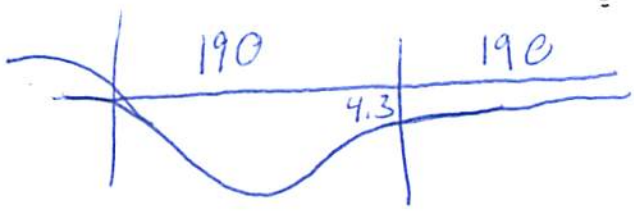
n (LOB) = 0.035

n (ROB) = 0.035

Pier Width = 2.1 ft

Pier Length = 4.2 ft

Piers for 500 yr = 6 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} = 0 ft Average left overbank flow depth, y_{lob} = 0 ft

Width of right overbank flow at approach, W_{rob} = 190 ft Average right overbank flow depth, y_{rob} = 4.3 ft

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

x = 8.72 From Figure 9 W_2 (effective) = ~~133~~ 133 ft y_{cs} = 9.6 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

PGRM: Pier

PIER SCOUR CALCULATIONS

L/a ratio = 2 Correction factor for flow angle of attack (from Table 1), K2 = 1.4

Froude # at bridge = 0.3 Using pier width a on Figure 11, ξ = 8.3 Pier scour y_{ps} = 9.7 ft

PGRM: Abutment

ABUTMENT SCOUR CALCULATIONS

Average flow depth blocked by: left abutment, y_{aLT} = 0 ft right abutment, y_{aRT} = 4.3 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} = 13.8

Left abutment scour, $y_{as} = \psi_{LT}(K_1/0.55)$ = 0 ft Right abutment scour $y_{as} = \psi_{RT}(K_1/0.55)$ = 25.1 ft

Route 280 St Stream Vermillion River MRM _____ Date ~~5/22~~ 5/23/12 Initials RAT

Bridge Structure No. 63/94120 Location 3 mi N & 3.2 mi E of Farley on 280 St

GPS coordinates: N 43° 41' 47.5" taken from: USL abutment _____ centerline of ↑ MRM end _____

W 97° 01' 06.3" Datum of coordinates: WGS84 _____ NAD27 _____

Drainage area = 929 sq. mi.

The average bottom of the main channel was 16.2 ft below top of guardrail at a point 120 ft from left abutment.

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

MISCELLANEOUS CONSIDERATIONS

Flows	~~Q_{100}~~ Q_{10} 6240			~~Q_{500}~~ Q_{25} 11200		
Estimated flow passing through bridge	6240			9505		
Estimated road overflow & overtopping	0			1695		
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	

5/22	
2	1270
5	3620
10	6240
25	11200
50	16200
100	22700
500	44200

Riprap at abutments? ____Yes X No ____Marginal

Evidence of past Scour? X Yes ____No ____Don't know pier contract.

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 X	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

1). damage 5). right A. 10). scour 14. main channel.
2). L. A 6). R. A 11). scour pier 16. main channel
3). Pier 7). scour 12). abut. scour 17. R. OB
4). Pier 8). debris 13. L. OB
9). old pier 14. L. OB

Summary of Results

	~~Q100~~ Q_{10}	~~Q500~~ Q_{25}
Bridge flow evaluated	6240	9505
Flow depth at left abutment (yaLT), in feet	0	0
Flow depth at right abutment (yaRT), in feet	2.9	4.3
Contraction scour depth (ycs), in feet	7	~~9.7~~ 9.6
Pier scour depth (yps), in feet	9.5	9.7
Left abutment scour depth (yas), in feet	0	0
Right abutment scour depth (yas), in feet	20.6	25.1
1Flow angle of attack	40	40

See Comments/Diagram for justification where required