OK RT

SCOUR ANALYSIS AND REPORTING FORM

Bridge Structure No. 29230144 Date 7/3/12 Initials RaT Region (A B (C) D)

Site _____ Location 3.6 mi W, 2.4 mi S of Dempster on 459 Av

Q_{100} = Q5 2100 by: drainage area ratio ____ flood freq. anal. ____ regional regression eq. X

Bridge discharge (Q_2) = 2100 (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 = 52 ft. Flow angle at bridge = 0 ° Abut. Skew = 0 ° Effective Skew = 0 °

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 = 52 ft* $q_2 = Q_2/W_2$ = 40 ft^2/s

Bridge Vel, V_2 = 4.5 ft/s Final $y_2 = q_2/V_2$ = 9 ft Δh = 0.4 ft

Average main channel depth at approach section, $y_1 = \Delta h + y_2$ = 9.4 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. = 3.9 ft 15.9 −11.4

Low Steel Elev. = 9.7 ft

n (Channel) = 0.040

n (LOB) = 0.035

n (ROB) = 0.035

Pier Width = 0 ft

Pier Length = 0 ft

Piers for 100 yr = 0 ft

5.1

CONTRACTION SCOUR

PGRM: Contract

Width of main channel at approach section W_1 = 526 ft

Width of left overbank flow at approach, W_{lob} = 52 ft Average left overbank flow depth, y_{lob} = 3.7 ft

Width of right overbank flow at approach, W_{rob} = 27 ft Average right overbank flow depth, y_{rob} = 2.2 ft

Live Bed Contraction Scour (use if bed material is small cobbles or finer) 16.1

x = 68.45 From Figure 9 W_2 (effective) = ~~52~~ 52 ft y_{cs} = ~~5.4~~ 5.1 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, $V_1 = Q_{100}/(y_1W_1)$ = _____ 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 = _____ 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

PGRM: Abutment

ABUTMENT SCOUR CALCULATIONS

Average flow depth blocked by: left abutment, y_{aLT} = 3.7 ft right abutment, y_{aRT} = 2.2 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} = 12.7 and ψ_{RT} = 9

Left abutment scour, $y_{as} = \psi_{LT}(K_1/0.55)$ = 19 ft Right abutment scour $y_{as} = \psi_{RT}(K_1/0.55)$ = 13.5 ft

SCOUR ANALYSIS AND REPORTING FORM

Bridge Structure No. 29230144 Date 7/3/17 Initials RaT Region (A B C D)

Site _____ Location 3.6 mi W, 2.4 mi S of Dempster on 459 Ave

Q_{500} = Q_{10} 3390 by: drainage area ratio ____ flood freq. anal. ____ regional regression eq. X

Bridge discharge (Q_2) = 2457 (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 = 52 ft. Flow angle at bridge = 0 ° Abut. Skew = 0 ° Effective Skew = 0 °

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 = 52 ft* $q_2 = Q_2/W_2$ = 47.3 ft^2/s

Bridge Vel, V_2 = 4.9 ft/s Final $y_2 = q_2/V_2$ = 9.7 ft Δh = 0.5 ft

Average main channel depth at approach section, $y_1 = \Delta h + y_2$ = 10.2 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. = 3.4 ft

Low Steel Elev. = 97 ft

n (Channel) = 0.040

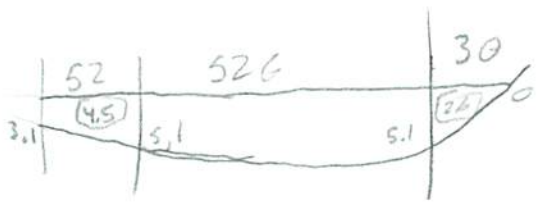
n (LOB) = 0.035

n (ROB) = 0.035

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 = 526 ft 5.1 > 3.1 $2\frac{2}{3} + 3.1$ = 4.5

Width of left overbank flow at approach, W_{lob} = 52 ft Average left overbank flow depth, y_{lob} = 4.5 ft

Width of right overbank flow at approach, W_{rob} = 30 ft Average right overbank flow depth, y_{rob} = 2.6 ft

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

x = 96.65 From Figure 9 W_2 (effective) = 52 ft y_{cs} = ~~3.4~~ 16.1 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} = 4.5 ft right abutment, y_{aRT} = 2.6 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} = 14.1 and ψ_{RT} = 10.6

Left abutment scour, $y_{as} = \psi_{LT}(K_1/0.55)$ = 21.1 ft Right abutment scour $y_{as} = \psi_{RT}(K_1/0.55)$ = 15.8 ft

44° 35' 45.226"
97° 1' 39.072"

97.02752
44.59591

Route 459 Ave Stream Lake Pomsett Outlet MRM _____ Date 7/31/12 Initials RAT

Bridge Structure No. 29230144 Location 3.6 mi W + 2.4 mi S of Dempster on 459 Ave

GPS coordinates: N 44° 35' 45.6" W 97° 1' 39.2" taken from: USL abutment X centerline of ⇑ MRM end _____

Datum of coordinates: WGS84 X NAD27 _____

Drainage area = 540.89 sq. mi.

The average bottom of the main channel was 15.2 ft below top of guardrail at a point 20 ft from left abutment.

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

MISCELLANEOUS CONSIDERATIONS

Flows	Q_{100} = Q_5 2100			Q_{500} = Q_{10} 3390		
Estimated flow passing through bridge	2100			2457		
Estimated road overflow & overtopping	0			933		
Consideration	Yes	No	Possibly	Yes	No	Possibly
Chance of overtopping				X		
Chance of Pressure flow				X		
Armored appearance to channel					X	
Lateral instability of channel					X	

7/3

2	780
5	2102
10	3390
25	5300
50	7430
100	9610
500	15600

Riprap at abutments? X Yes ____No X Marginal rose quartz on outside abutments

Evidence of past Scour? X Yes ____No ____Don't know significant abutment/ contraction

Debris Potential? ____High ____Med X Low

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

Riprap X Yes ____No ____Don't know ____NA

Spur Dike ____Yes X No ____Don't know ____NA

Other _____ ____Yes ____No X Don't know ____NA old bridge abutment is protecting abutments.

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

1). left OB
2). main channel
3). right OB
4-5). right abutment
6-7). left abutment
8). main channel

Summary of Results

	Q100 Q_5	Q500 Q_{10}
Bridge flow evaluated	2100	~~2457~~ 2457
Flow depth at left abutment (yaLT), in feet	3.7	4.5
Flow depth at right abutment (yaRT), in feet	2.2	2.6
Contraction scour depth (ycs), in feet	~~3.4~~ 16.1	~~3.4~~ 16.1
Pier scour depth (yps), in feet	N/A	N/A
Left abutment scour depth (yas), in feet	19	21.1
Right abutment scour depth (yas), in feet	13.5	15.8
1Flow angle of attack	0	0

See Comments/Diagram for justification where required