OK by RFT

SCOUR ANALYSIS AND REPORTING FORM

Bridge Structure No. 5242312 Date 9/21/12 Initials RaT Region (A B C D)

Site _____ Location Meade St Ditch & HWY 79 in RC

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

Bridge discharge (Q_2) = 1262.6 (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 = 71 ft. Flow angle at bridge = 10 ° Abut. Skew = 0 ° Effective Skew = 10 °

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 = 69.92 ft* $q_2 = Q_2/W_2$ = 18.0 ft^2/s

Bridge Vel, V_2 = 14.16 ft/s Final $y_2 = q_2/V_2$ = 12.4 ft Δh = 4.4 ft

Average main channel depth at approach section, $y_1 = \Delta h + y_2$ = 16.8 ft 9.3 9.8

* *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. = 0.5 ft

Low Steel Elev. = 12.4 ft

n (Channel) = 0.035

n (LOB) = 0.040

n (ROB) = 0.016

Pier Width = 1.75 ft

Pier Length = 1.75 ft

Piers for 100 yr = 2 ft

CONTRACTION SCOUR

PGRM: Contract

Width of main channel at approach section W_1 = 71 ft

Width of left overbank flow at approach, W_{lob} = 71 ft Average left overbank flow depth, y_{lob} = 9.3 ft

Width of right overbank flow at approach, W_{rob} = 5.4 71 ft Average right overbank flow depth, y_{rob} = 71 5.4 ft

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

x = ~~12.95~~ From Figure 9 W_2 (effective) = 66.4 ft y_{cs} = ~~12.3~~ 13.9 ft

PGRM: CWCSNEW

Clear Water Contraction Scour (use if bed material is larger than small cobbles)

Estimated bed material D_{50} = 0.3 ft Average approach velocity, $V_1 = Q_{100}/(y_1 W_1)$ = 3.53 ft/s

Critical approach velocity, $Vc = 11.17 y_1^{1/6} D_{50}^{1/3}$ = 11.97 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.

$D_{c50} = 0.0006(q_2/y_1^{7/6})^3$ = 0.182 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} = 0 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 = 0.73 Using pier width a on Figure 11, ξ = 7.2 Pier scour y_{ps} = 6.9 ft

ABUTMENT SCOUR CALCULATIONS

PGRM: Abutment

Average flow depth blocked by: left abutment, y_{aLT} = 9.3 ft right abutment, y_{aRT} = 5.4 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} = 20.8 and ψ_{RT} = 15.7

Left abutment scour, $y_{as} = \psi_{LT}(K_1/0.55)$ = 20.8 ft Right abutment scour $y_{as} = \psi_{RT}(K_1/0.55)$ = 15.7 ft

SCOUR ANALYSIS AND REPORTING FORM

Bridge Structure No. 52429312 Date 9/21/17 Initials RAT Region ((A) B C D)

Site _____ Location Meade St Ditch + HWY 79

Q_{500} = 576 by: drainage area ratio ____ flood freq. anal. ____ regional regression eq. X

Bridge discharge (Q_2) = 576 (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

Bridge Width = 71 ft. Flow angle at bridge = 5|0 ° Abut. Skew = 0 ° Effective Skew = 5|0 °

Width (W_2) iteration = 69.92 42.65 36.421 34.417

Avg. flow depth at bridge, y_2 iteration = 2.3 4.2 3.3 3.41

Corrected channel width at bridge Section = W_2 times cos of flow angle = 69.88 ft* 34.417 $q_2 = Q_2/W_2$ = 16.8 ft²/s

Bridge Vel, V_2 = 5 ft/s Final $y_2 = q_2/V_2$ = 3.43 ft Δh = 0.5 ft

Average main channel depth at approach section, $y_1 = \Delta h + y_2$ = 3.9 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,

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

Water Surface Elev. = 0.5 ft

Low Steel Elev. = 12.4 ft

n (Channel) = 0.035

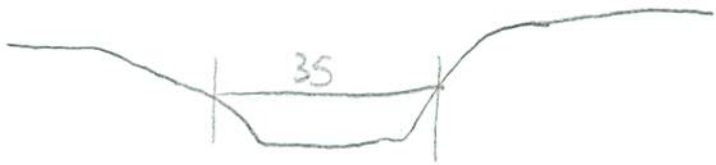
n (LOB) = 0.040

n (ROB) = 0.016

Pier Width = 1.75 ft

Pier Length = 1.75 ft

Piers for 500 yr = 2 ft



CONTRACTION SCOUR

PGRM: Contract

Width of main channel at approach section W_1 = 35 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 = 0.51 From Figure 9 W_2 (effective) = 31 ft y_{cs} = 0.8 ft

PGRM: CWCSNEW

Clear Water Contraction Scour (use if bed material is larger than small cobbles)

Estimated bed material D_{50} = 0.3 ft Average approach velocity, $V_1 = Q_{500}/(y_1W_1)$ = 4.23 ft/s

Critical approach velocity, $Vc = 11.17y_1^{1/6}D_{50}^{1/3}$ = 9.38 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.

$D_{c50} = 0.0006(q_2/y_1^{7/6})^3$ = 0.023 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} = 0 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 = 7.2 Pier scour y_{ps} = 6.4 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

103.19327
44.06427

44° 3' 51.372"
103° 11' 35.772"

Route SD 79 Stream Meade St Drainage MRM _____ Date 9/21/12 Initials LaN

Bridge Structure No. 52429312 Location Meade St Ditch & HWY 79

GPS coordinates: N44° 3 52.1" taken from: USL abutment X centerline of ⇑ MRM end _____

W103° 11' 36.1" Datum of coordinates: WGS84 X NAD27 _____

Drainage area = 3.13 sq. mi.

The average bottom of the main channel was 16.7 ft below top of guardrail at a point 29 ft from left abutment.

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

713

2	15
5	40.5
10	70.9
25	129
50	195
100	285
500	579

MISCELLANEOUS CONSIDERATIONS

Flows	Q_{100} = Qlow steel 12626			Q_{500} = 578		
Estimated flow passing through bridge	12626			578		
Estimated road overflow & overtopping	0			0		
Consideration	Yes	No	Possibly	Yes	No	Possibly
Chance of overtopping	X					
Chance of Pressure flow	X					
Armored appearance to channel		X			X	
Lateral instability of channel		X			X	

Riprap at abutments? X Yes ____No ____Marginal contraction

Evidence of past Scour? X Yes ____No ____Don't know several trees on banks - alive

Debris Potential? ____High X Med ____Low small cobbles in wire mesh

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

Riprap	X Yes	____No	____Don't know	____NA
Spur Dike	____Yes	X No	____Don't know	____NA
Other _____	____Yes	X No	____Don't know	____NA

Notes: Flow values much lower than bridge design. Evaluated @ Q_{500} and low steel unit height.

Bed Material Classification Based on Median Particle Size (D_{50})

Material	Silt/Clay X	Sand	Gravel X	Cobbles X	Boulders
Size range, in mm	<0.062	0.062-2.00	2.00-64	64-250	>250

about 25% silt 75% small cobbles

Comments, Diagrams & orientation of digital photos

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

Summary of Results

	Q100 Qlowsteel	Q500
Bridge flow evaluated	12626	578
Flow depth at left abutment (yaLT), in feet	9.3	0
Flow depth at right abutment (yaRT), in feet	5.4	0
Contraction scour depth (ycs), in feet	12.3 13.9	0.8
Pier scour depth (yps), in feet	6.9	6.4
Left abutment scour depth (yas), in feet	20.8	0
Right abutment scour depth (yas), in feet	15.7	0
1Flow angle of attack	10	10

See Comments/Diagram for justification where required