OK by RFT

SCOUR ANALYSIS AND REPORTING FORM

Bridge Structure No. 52480282 Date 8/31/12 Initials RaT Region (A B C D)

Site _____ Location Radar Hill Rd & Box Elder Ck in RC

Q_{100} = 4650 by: drainage area ratio____ flood freq. anal. ____ regional regression eq. X

Bridge discharge (Q_2) = 4650 (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 = 81 ft. Flow angle at bridge = 25 ° Abut. Skew = 15 ° Effective Skew = 10 ° see notes

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 = 79.77 ft* $q_2 = Q_2/W_2$ = 58.3 ft²/s

Bridge Vel, V_2 = 8.7 ft/s Final $y_2 = q_2/V_2$ = 6.7 ft Δh = 1.6 ft

Average main channel depth at approach section, $y_1 = \Delta h + y_2$ = 8.2 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. = dry ft

Low Steel Elev. = 7.1 ft

n (Channel) = 0.035

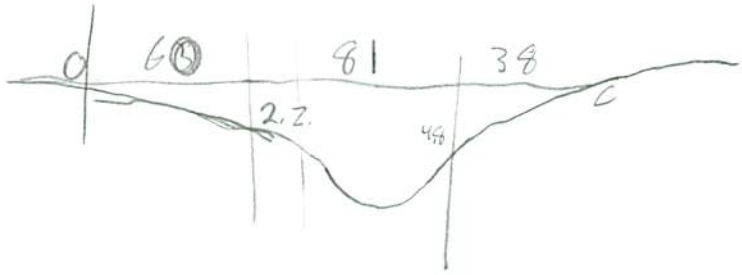
n (LOB) = 0.030

n (ROB) = 0.030

Pier Width = 0.85 ft

Pier Length = 1.25 ft

Piers for 100 yr = 2 ft



CONTRACTION SCOUR

PGRM: Contract

Width of main channel at approach section W_1 = 81 ft 2.2·2/3 = 4.4/3 = 1.5

Width of left overbank flow at approach, W_{lob} = 60 ft Average left overbank flow depth, y_{lob} = 1.5 ft

Width of right overbank flow at approach, W_{rob} = 38 ft Average right overbank flow depth, y_{rob} = 2.4 ft

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

x = 1.34 From Figure 9 W_2 (effective) = 78.1 ft y_{cs} = 1.8 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, $Vc = 11.17y_1^{1/6}D_{50}^{1/3}$ = _____ 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

PGRM: Pier

PIER SCOUR CALCULATIONS

L/a ratio = 1.47 Correction factor for flow angle of attack (from Table 1), K2 = ~~2.0~~ 1.05

Froude # at bridge = 0.59 Using pier width a on Figure 11, ξ = 4.1 Pier scour y_{ps} = ~~7.5~~ 4 ft

PGRM: Abutment

ABUTMENT SCOUR CALCULATIONS

Average flow depth blocked by: left abutment, y_{aLT} = 1.5 ft right abutment, y_{aRT} = 2.4 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} = 6.3 and ψ_{RT} = 9.8

Left abutment scour, $y_{as} = \psi_{LT}(K_1/0.55)$ = 6.3 ft Right abutment scour $y_{as} = \psi_{RT}(K_1/0.55)$ = 9.6 ft

SCOUR ANALYSIS AND REPORTING FORM

Bridge Structure No. 52450282 Date 8/31/12 Initials RaJ Region (A B C D)

Site _____ Location Radar Hill Rd & Boxelder ck in RC

Q_{500} = 10200 by: drainage area ratio____ flood freq. anal. ____ regional regression eq. X

Bridge discharge (Q_2) = 5209 (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 = 81 ft. Flow angle at bridge = 25 ° Abut. Skew = 15 ° 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 = 79.77 ft* $q_2 = Q_2/W_2$ = 65.3 ft^2/s

Bridge Vel, V_2 = 9.2 ft/s Final $y_2 = q_2/V_2$ = 7.1 ft Δh = 1.7 ft

Average main channel depth at approach section, $y_1 = \Delta h + y_2$ = 8.8 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,

Water Surface Elev. = 6.14 ft

Low Steel Elev. = 7.1 ft

n (Channel) = 0.035

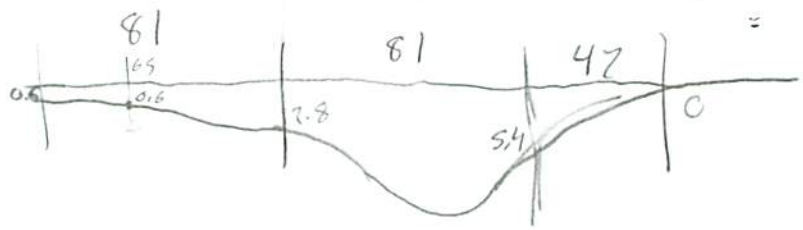
n (LOB) = 0.030

n (ROB) = 0.030

Pier Width = 0.055 ft

Pier Length = 1.25 ft

Piers for 500 yr = 2 ft



CONTRACTION SCOUR

PGRM: Contract

2.8 − 0.6 = 2.2 × 2/3 = 1.5 + 0.6 = 2.1

Width of main channel at approach section W_1 = 81 ft

Width of left overbank flow at approach, W_{lob} = 8.1 ft Average left overbank flow depth, y_{lob} = 2.1 ft

Width of right overbank flow at approach, W_{rob} = 47 ft Average right overbank flow depth, y_{rob} = 2.7 ft (5.4)

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

x = 2.08 From Figure 9 W_2 (effective) = 78.1 ft y_{cs} = 2.6 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 = 51.47 Correction factor for flow angle of attack (from Table 1), K2 = 1.05

Froude # at bridge = 0.61 Using pier width a on Figure 11, ξ = 4.1 Pier scour y_{ps} = 4 ft

PGRM: Abutment

ABUTMENT SCOUR CALCULATIONS

Average flow depth blocked by: left abutment, y_{aLT} = 2.1 ft right abutment, y_{aRT} = 2.7 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} = 11.0

Left abutment scour, $y_{as} = \psi_{LT}(K_1/0.55)$ = 8.6 ft Right abutment scour $y_{as} = \psi_{RT}(K_1/0.55)$ = 11.0 ft

- Exit 63
- right on Cobbly Rock Hill road.

44° 6' 34.164
103° 5' 26.916

103.09081
44.10949

Route Radar Hill Rd Stream Box Elder Ck MRM _____ Date 8/31/12 Initials RAT

Bridge Structure No. 52480282 Location Boxelder Ck & Radar Hill Rd in RC

GPS coordinates: N 41° 06' 34.1" taken from: USL abutment X centerline of ⇑ MRM end _____

W 103° 05' 27.1" Datum of coordinates: WGS84 X NAD27 _____

Drainage area = 187.58 sq. mi.

The average bottom of the main channel was 11.4 ft below top of guardrail at a point 44 ft from left abutment.

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

7/3

2	159
5	414
10	935
25	1870
50	3040
100	4650
500	10200

MISCELLANEOUS CONSIDERATIONS

Flows	Q_{100} = 4650			Q_{500} = 10200		
Estimated flow passing through bridge	4650			5209		
Estimated road overflow & overtopping	0			4991		
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	

Riprap at abutments? X Yes ____No ____Marginal

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

Debris Potential? ____High ____Med X Low - boulder/cobble sized rose quartz

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

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

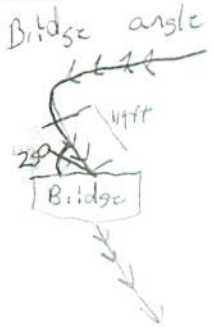
Bed Material Classification Based on Median Particle Size (D_{50})

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

1), left OB
2), main channel
3), right OB
4), pier
5-7), right abutment
8-10). left abutment

11), main channel



Summary of Results

	Q100	Q500
Bridge flow evaluated	4650	5209
Flow depth at left abutment (yaLT), in feet	1.5	2.1
Flow depth at right abutment (yaRT), in feet	2.4	2.7
Contraction scour depth (ycs), in feet	1.8	2.6
Pier scour depth (yps), in feet	4.0	4.0
Left abutment scour depth (yas), in feet	6.3	8.6
Right abutment scour depth (yas), in feet	9.5	11.0
1Flow angle of attack	10	10

See Comments/Diagram for justification where required