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SCOUR ANALYSIS AND REPORTING FORM

Bridge Structure No. 07120230 Date ~~7/26/12~~ 7/23/12 Initials RaT Region (A B C [✓ D])

Site ______ Location from Westport, 3S, 1E, Elm River

Q_{100} = ~~Qd [illegible]~~ 12700 by: drainage area ratio ~~wex~~ flood freq. anal. ____ regional regression eq. X

Bridge discharge (Q_2) = 12700 (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

"RegionC", or "RegionD"

Bridge Width = ~~N~~241 ft. Flow angle at bridge = 10 ° Abut. Skew = 0 ° Effective Skew = 10 °

Width (W_2) iteration = 237.34 ~~221.28~~ 226 235 23.13 ____

Avg. flow depth at bridge, y_2 iteration = ~~19~~14.9 15.4 15.3 ____

Corrected channel width at bridge Section = W_2 times cos of flow angle = 231.43 ft* $q_2 = Q_2/W_2$ = 54.9 ft^2/s

Bridge Vel, V_2 = 3.6 ft/s Final $y_2 = q_2/V_2$ = 15.1 ft Δh = 0.3 ft

Average main channel depth at approach section, $y_1 = \Delta h + y_2$ = 15.3 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,

5.4
-3.6

~~3.6~~ 1.8

46 → 90

5.1

1.8 at depth

Water Surface Elev. = 0.9-3.2 ft

Low Steel Elev. = 19.6 ft 23.7 5.1

n (Channel) = 0.035

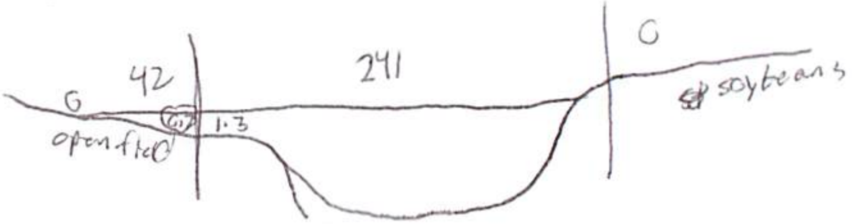
n (LOB) = 0.040

n (ROB) = 0.035

Pier Width = 2.0 ft

Pier Length = 2.0 ft

\# Piers for 100 yr = 3 ft



CONTRACTION SCOUR

PGRM: Contract

Width of main channel at approach section W_1 = 241 ft

Width of left overbank flow at approach, W_{lob} = 42 ft Average left overbank flow depth, y_{lob} = 0.7 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 = 1.07 From Figure 9 W_2 (effective) = 225.4 ft y_{cs} = 1.5 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, $Vc = 11.52y_1^{1/6}D_{50}^{1/3}$ = ______ 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

PIER SCOUR CALCULATIONS

PGRM: Pier

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

Froude # at bridge = 0.16 Using pier width a on Figure 11, ξ = 8 Pier scour y_{ps} = 6.1 ft

ABUTMENT SCOUR CALCULATIONS

PGRM: Abutment

Average flow depth blocked by: left abutment, y_{aLT} = 0.7 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} = 3.1 and ψ_{RT} = 0

Left abutment scour, $y_{as} = \psi_{LT}(K_1/0.55)$ = 3.1 ft Right abutment scour $y_{as} = \psi_{RT}(K_1/0.55)$ = 0 ft

SCOUR ANALYSIS AND REPORTING FORM

Bridge Structure No. 07120230 Date 7/23/12 Initials DnT Region (A B C [✓ D])

Site 19400 Location from Westport, 3S, 1E

Q_{500} = Q_{100} 23800 by: drainage area ratio ✓ flood freq. anal. ____ regional regression eq. ☒

Bridge discharge (Q_2) = 19330 (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 = 241 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 = 237.34 ft* $q_2 = Q_2/W_2$ = 81.4 ft^2/s

Bridge Vel, V_2 = 4.4 ft/s Final $y_2 = q_2/V_2$ = 18.6 ft Δh = 0.4 ft

Average main channel depth at approach section, $y_1 = \Delta h + y_2$ = 19 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. = 0.9-3.2 ft

Low Steel Elev. = 18.6 ft

n (Channel) = 0.035

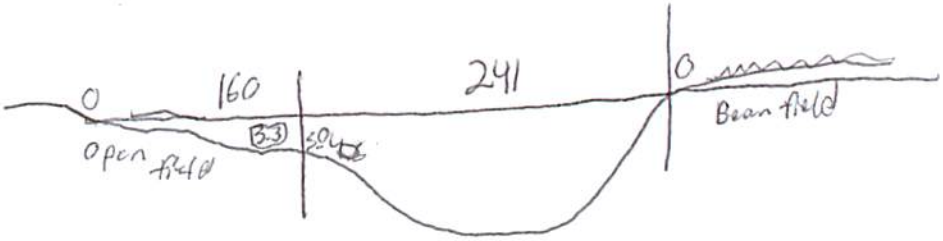
n (LOB) = 0.040

n (ROB) = 0.035

Pier Width = 2.0 ft

Pier Length = 2.0 ft

Piers for 500 yr = 3 ft



CONTRACTION SCOUR

PGRM: Contract

Width of main channel at approach section W_1 = 241 ft

Width of left overbank flow at approach, W_{lob} = 160 ft Average left overbank flow depth, y_{lob} = 3.3 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 = 1.42 From Figure 9 W_2 (effective) = 231.3 ft y_{cs} = 1.9 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, $V_1 = Q_{500}/(y_1W_1)$ = ________ ft/s

Critical approach velocity, $V_c = 11.52y_1^{1/6}D_{50}^{1/3}$ = ________ 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

PIER SCOUR CALCULATIONS

PGRM: Pie

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

Froude # at bridge = 0.19 Using pier width a on Figure 11, ξ = 8 Pier scour y_{ps} = 6.2 ft

ABUTMENT SCOUR CALCULATIONS

PGRM: Abutment

Average flow depth blocked by: left abutment, y_{aLT} = 3.3 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} = 12 and ψ_{RT} = 0

Left abutment scour, $y_{as} = \psi_{LT}(K_1/0.55)$ = 12 ft Right abutment scour $y_{as} = \psi_{RT}(K_1/0.55)$ = 0 ft

98.47757
45.60449

98° 28' 39.252"
45° 36' 16.144"

oute 123 St Stream Elm River MRM ______ Date 7/23/12 Initials RaT

ridge Structure No. 07120230 Location from Westport, 3S, 1E

PS coordinates: N 45° 36' 16.2" taken from: USL abutment _X_ centerline of ⥣ MRM end ______

W 98° 29' 39.3" Datum of coordinates: WGS84 _X_ NAD27 ______

rainage area = 1236.86 sq. mi. 1217.55

he average bottom of the main channel was 23.7 ft below top of guardrail at a point 131 ft from left abutment.

ethod used to determine flood flows: ___Freq. Anal. _✓_ drainage area ratio _X_ regional regression equations.

MISCELLANEOUS CONSIDERATIONS Q100

lows	Q_{100} = ~~[illegible]~~ 12700			Q_{500} = ~~[illegible]~~ 19400		
stimated flow passing through bridge				19330		
stimated road overflow & overtopping				70		
onsideration	Yes	No	Possibly	Yes	No	Possibly
hance of overtopping		X				X
hance of Pressure flow		X		X		
rmored appearance to channel		X			X	
ateral instability of channel		X			X	

7/2

2	290
5	1550
10	3470
25	7820
50	12700
100	19400
500	43000

iprap at abutments? ___Yes _X_ No ___Marginal

vidence of past Scour? _X_ Yes ___No ___Don't know minor pier/contraction and some abutment mostly right side.

ebris Potential? ___High ___Med _X_ Low

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

iprap ___Yes _X_ No ___Don't know ___NA

pur Dike ___Yes _X_ No ___Don't know ___NA

ther ____________ ___Yes _X_ No ___Don't know ___NA

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

aterial	Silt/Clay _X_	Sand___	Gravel___	Cobbles___	Boulders___
ize range, in mm	<0.062	0.062-2.00	2.00-64	64-250	>250

omments, Diagrams & orientation of digital photos

1). left OB
2). main channel
3). right OB
4). lo pier
5). pier scour
~~6). left abu~~

6-8). left abutment
9-11). right abutment
12). main channel

ummary of Results

	~~Q100~~ Q50	~~Q500~~ Q100
ridge flow evaluated	12700	19330
ow depth at left abutment (yaLT), in feet	0.7	3.3
ow depth at right abutment (yaRT), in feet	0	0
ntraction scour depth (ycs), in feet	1.5	1.9
er scour depth (yps), in feet	6.1	6.2
ft abutment scour depth (yas), in feet	3.1	12
ght abutment scour depth (yas), in feet	0	0
low angle of attack	10	10

e Comments/Diagram for justification where required