SCOUR ANALYSIS AND REPORTING FORM

Bridge Structure No. 06131130 Date 10-12-11 Initials JZT Region (A B (C) D)

Site ______ Location from Volga, 3E, 2N, 0.2E

Q_{100} = 5240 by: drainage area ratio ____ flood freq. anal. ____ regional regression eq. ✓

Bridge discharge (Q_2) = 5240 (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 = 110 ft. Flow angle at bridge = 0 ° Abut. Skew = 0 ° Effective Skew = 0 °

Width (W_2) iteration = 110 ____ ____ ____

Avg. flow depth at bridge, y_2 iteration = 9.7 ____ ____ ____

Corrected channel width at bridge Section = W_2 times cos of flow angle = 110 ft* $q_2 = Q_2/W_2$ = 47.6 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. = 0.4 ft

Low Steel Elev. = 9.1 ft

n (Channel) = .029

n (LOB) = .028

n (ROB) = .028

Pier Width = 2.0 ft

Pier Length = 2.0 ft

Piers for 100 yr = 2 ft

channel has been cleaned out recently on up- and down-stream sides of bridge. Spoil piles are still present

bridge will probably pass Q_{100} with pressure flow

Road overflow may happen for $Q > Q_{100}$

assume $Q_{100} = Q$ max scour

CONTRACTION SCOUR

PGRM: Contract

Width of main channel at approach section W_1 = 110 ft

Width of left overbank flow at approach, W_{lob} = 1 ft* Average left overbank flow depth, y_{lob} = 1 ft

Width of right overbank flow at approach, W_{rob} = 1 ft* Average right overbank flow depth, y_{rob} = 1 ft

* past spoil piles block overbank on both sides at approach

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

x = 0.39 From Figure 9 W_2 (effective) = 106 ft y_{cs} = 0.6 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, $V_1 = Q_{100}/(y_1 W_1)$ = ____ ft/s

Critical approach velocity, $V_c = 11.17 y_1^{1/6} D_{50}^{1/3}$ = ____ 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

N/A

PIER SCOUR CALCULATIONS

PGRM: Pier

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

Froude # at bridge = 0.28 Using pier width a on Figure 11, ξ = 8 Pier scour y_{ps} = 6.6 ft

ABUTMENT SCOUR CALCULATIONS

PGRM: Abutment

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

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

N/A

In present condition, equations will not predict any abutment scour because of spoil piles at approach section

SCOUR ANALYSIS AND REPORTING FORM

Bridge Structure No. 06131130 Date ________ Initials ________ Region (A B C D)

Site ________ Location ________

Q_{500} = 8290 by: drainage area ratio ____ flood freq. anal. ____ regional regression eq. ✓

Bridge discharge (Q_2) = ________ (should be Q_{500} unless there is a relief bridge, road overflow, or bridge overtopping)

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

Analytical Procedure for Estimating Hydraulic Variables Needed to Apply Method

Bridge Width = 110 ft. Flow angle at bridge = ____ ° Abut. Skew = ____ ° Effective Skew = ____ °

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 = ____ ft* $q_2 = Q_2/W_2$ = ____ ft^2/s

Bridge Vel, V_2 = ____ ft/s Final $y_2 = q_2/V_2$ = ____ ft Δh = ____ ft

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

Low Steel Elev. = ____ ft

n (Channel) = ____

n (LOB) = ____

n (ROB) = ____

Pier Width = ____ ft

Pier Length = ____ ft

Piers for 500 yr = ____ ft

$Q_{max\ scour} \approx Q_{100}$

see top sheet

PGRM: Contract

CONTRACTION SCOUR

Width of main channel at approach section W_1 = ____ ft

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

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

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

x = ____ From Figure 9 W_2 (effective) = ____ ft y_{cs} = ____ 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 = ____ 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} = ____ ft right abutment, y_{aRT} = ____ 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} = ____ and ψ_{RT} = ____

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

Route 209th St Stream N. Deer Creek MRM ______ Date ______ Initials ______

Bridge Structure No. 06131130 Location from Volga, 3W, 2N, 0.2E

GPS coordinates: N 44° 21.328' taken from: USL abutment ✓ centerline of ⇑ MRM end ______

W 96° 51.885' Datum of coordinates: WGS84 ✓ NAD27 ______

Drainage area = 111.25 sq. mi.

The average bottom of the main channel was 13.0 ft below top of guardrail at a point 36 ft from left abutment.

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

MISCELLANEOUS CONSIDERATIONS

Flows	Q_{100} = 5240			Q_{500} = 8290		
Estimated flow passing through bridge	5240					
Estimated road overflow & overtopping						
Consideration	Yes	No	Possibly	Yes	No	Possibly
Chance of overtopping			✓			
Chance of Pressure flow	✓					
Armored appearance to channel		✓				
Lateral instability of channel			✓			

Riprap at abutments? ____Yes ____No ✓ Marginal

Evidence of past Scour? ____Yes ____No ✓ Don't know

Debris Potential? ____High ____Med ✓ Low

rubble + riprap (some silted under?) on right abutment. It appears that deposition occurs at this site?

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

Riprap ____Yes ✓ No ____Don't know ____NA

Spur Dike ____Yes ~~✓~~ No ____Don't know ✓ NA

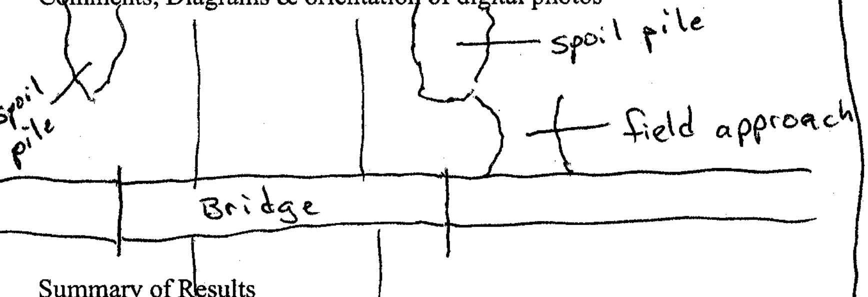
Other guide bank? ____Yes ____No ____Don't know ~~✓~~ NA

spoil pile at upstream left may act as guide bank until it gets eroded away

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

Material	Silt/Clay____	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



photos
structure number
approach from bridge
left approach from bridge
ROB from LOB
Bridge from approach

Summary of Results

	Q100	Q500
Bridge flow evaluated	5240	
Flow depth at left abutment (yaLT), in feet	—	
Flow depth at right abutment (yaRT), in feet	—	
Contraction scour depth (ycs), in feet	0.6	
Pier scour depth (yps), in feet	6.6	
Left abutment scour depth (yas), in feet	—	
Right abutment scour depth (yas), in feet	—	
1Flow angle of attack	0°	

See Comments/Diagram for justification where required

Basin characteristics from Provisional Stream Stats 10-7-11

Cont. D.A. = 111.25 mi^2

PII = 1.05

100% Subregion A

Manually Calculated Peaks

Q_{100} = 5240 cfs

Q_{500} = 8290 cfs