

APPENDIX A: TERRAIN SURFACES WITH CROSS-SECTION LOCATIONS

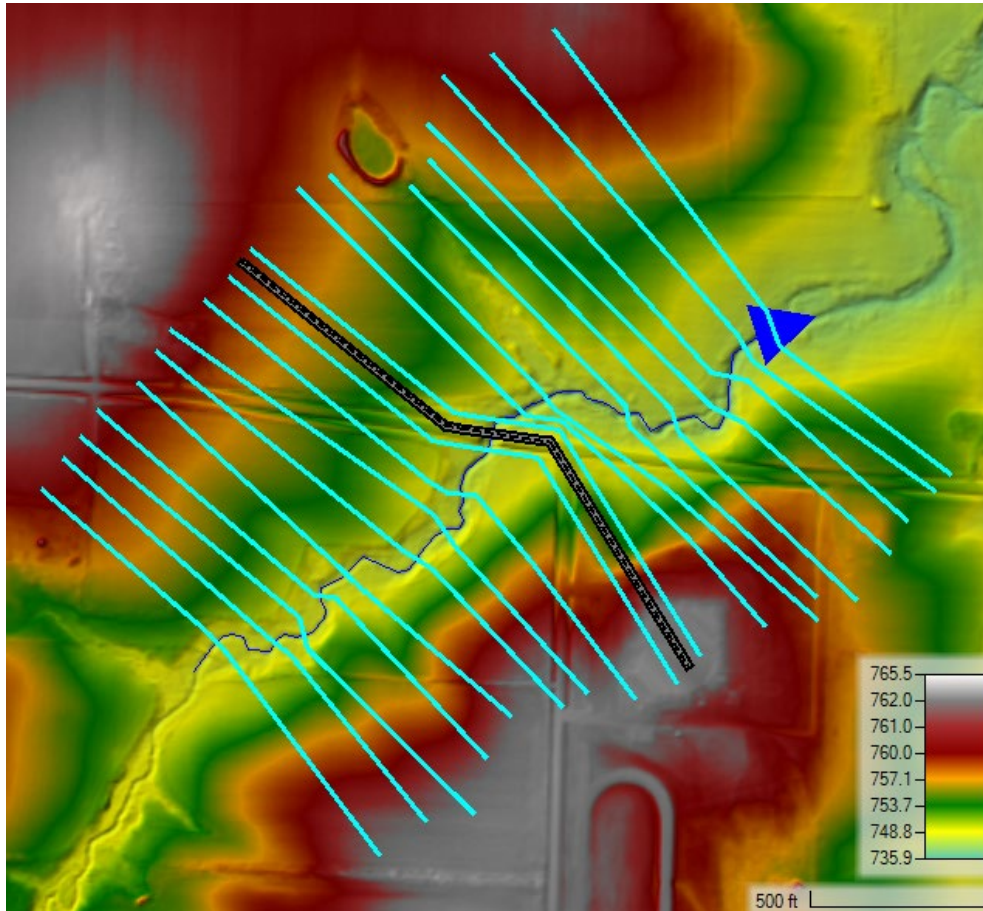


Figure A-1. Creek (H-0024) – HEC-RAS plan view of cross sections and elevations.

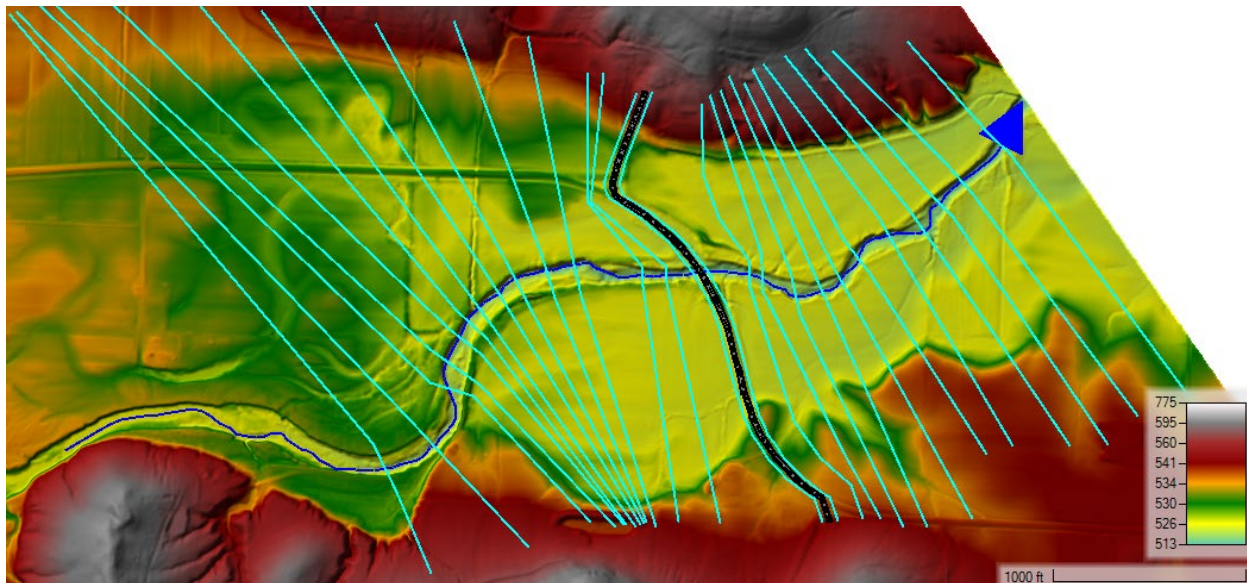


Figure A-2. Dry Fork Creek (L-0564) – HEC-RAS plan view of cross sections and elevations.

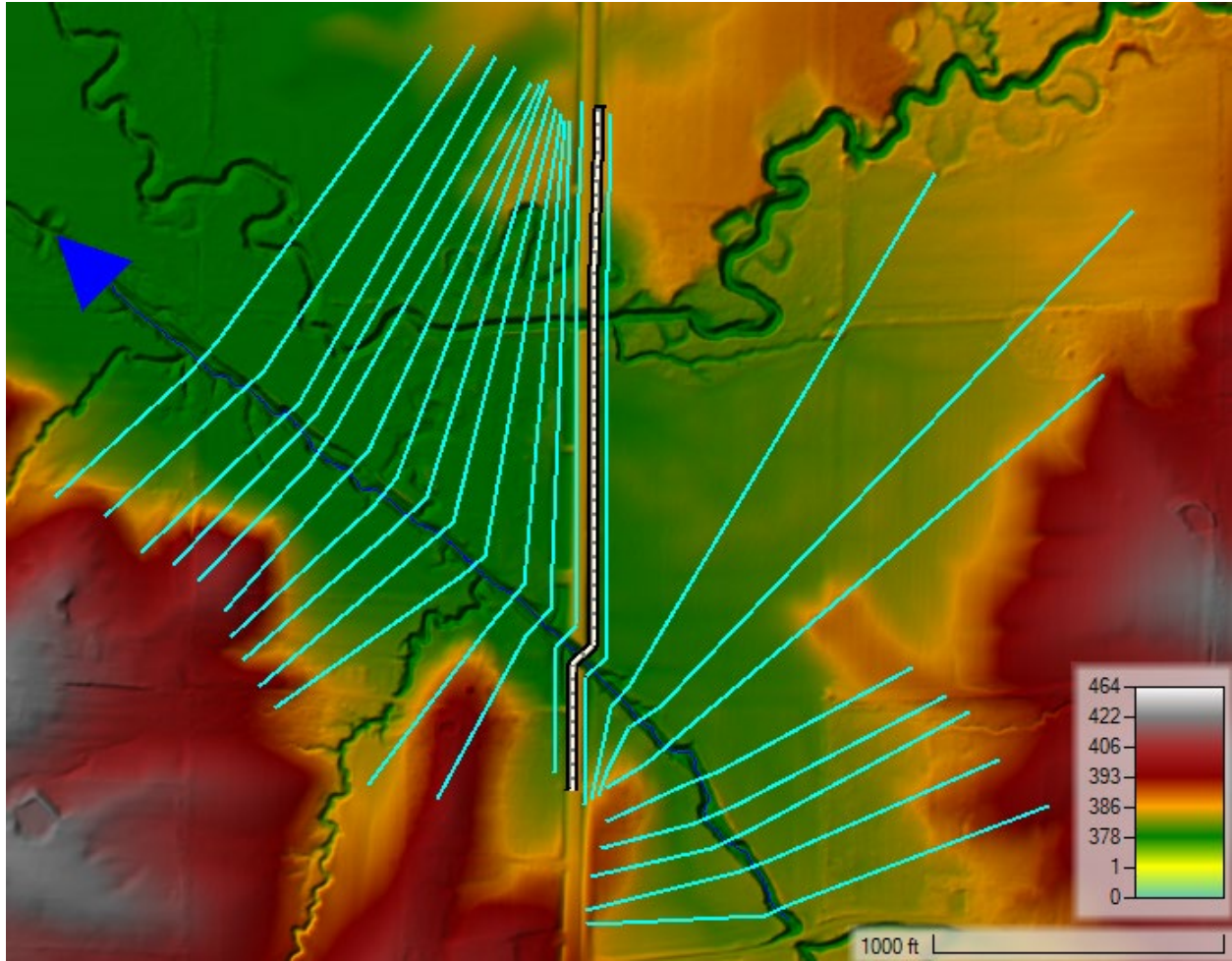


Figure A-3. Wolf Creek (L-0022) – HEC-RAS plan view of cross sections and elevations.

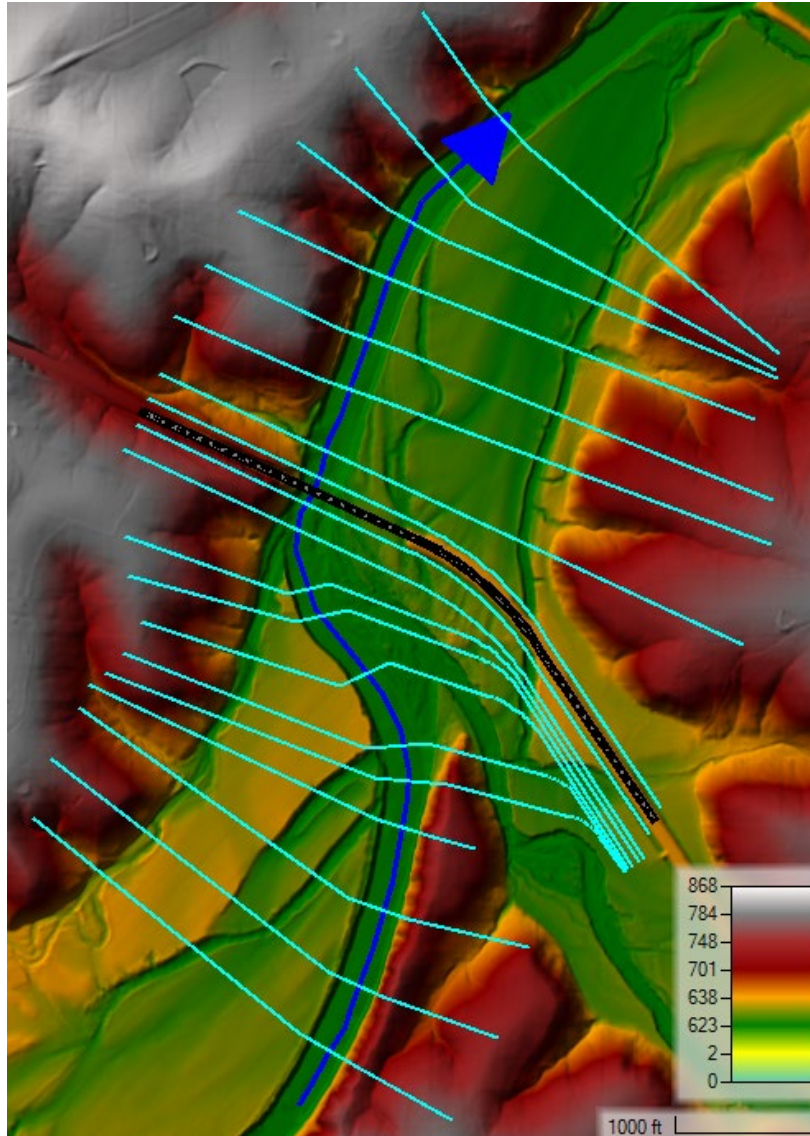


Figure A-4. Gasconade River (A-3760) – HEC-RAS plan view of cross sections and elevations.

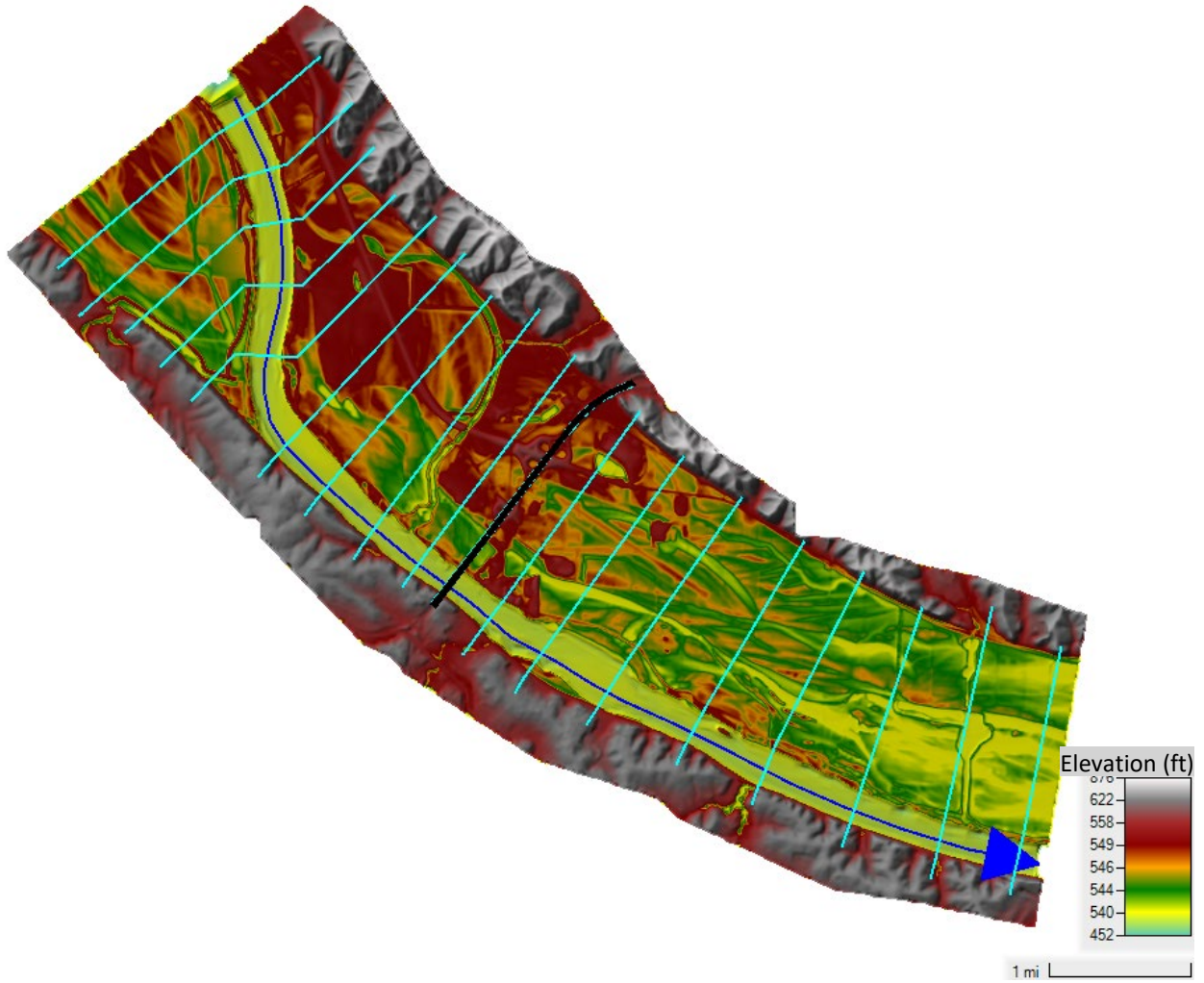


Figure A-5. Missouri River (A-3760)– HEC-RAS plan view of cross sections and elevations.

APPENDIX B: 2-D HYDRAULIC MODELING MESHES

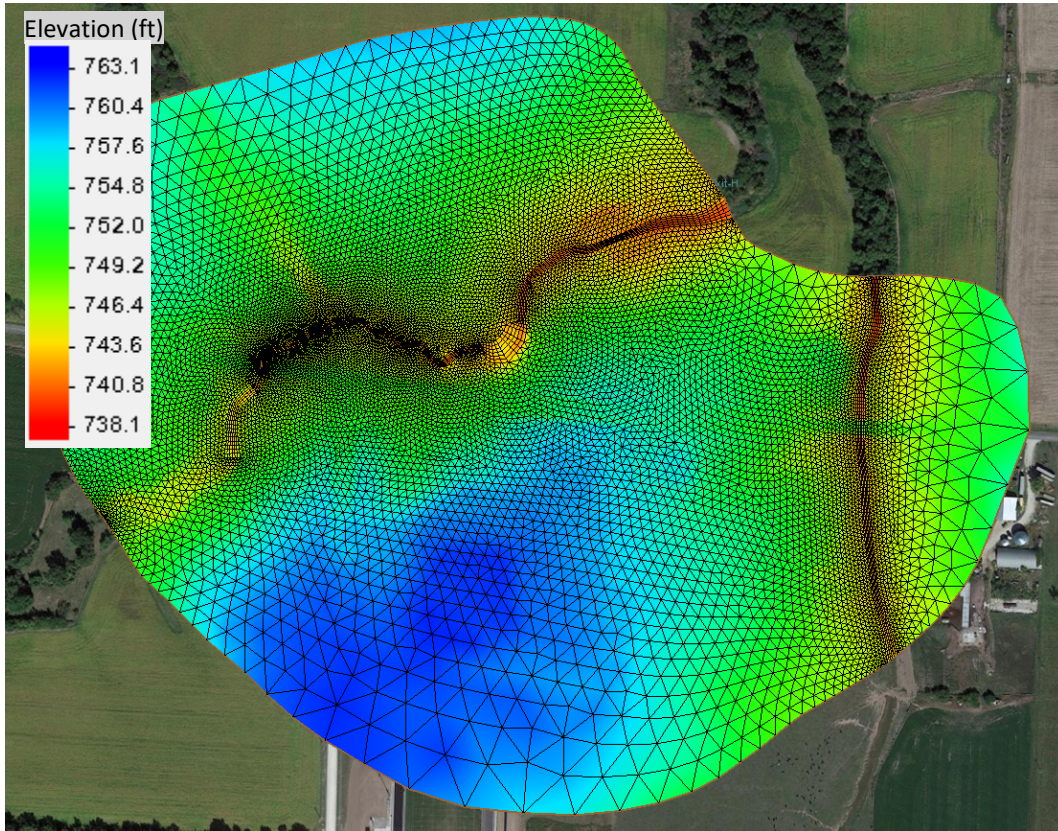


Figure B-1. Creek (H-0024) – SRH-2D mesh with bed elevations and boundary arcs.

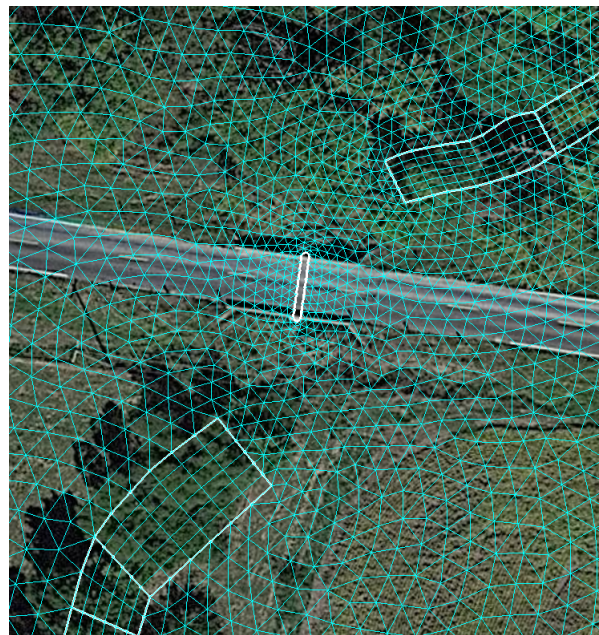


Figure B-2. Creek (H-0024) – SRH-2D Mesh with pier at the bridge section.

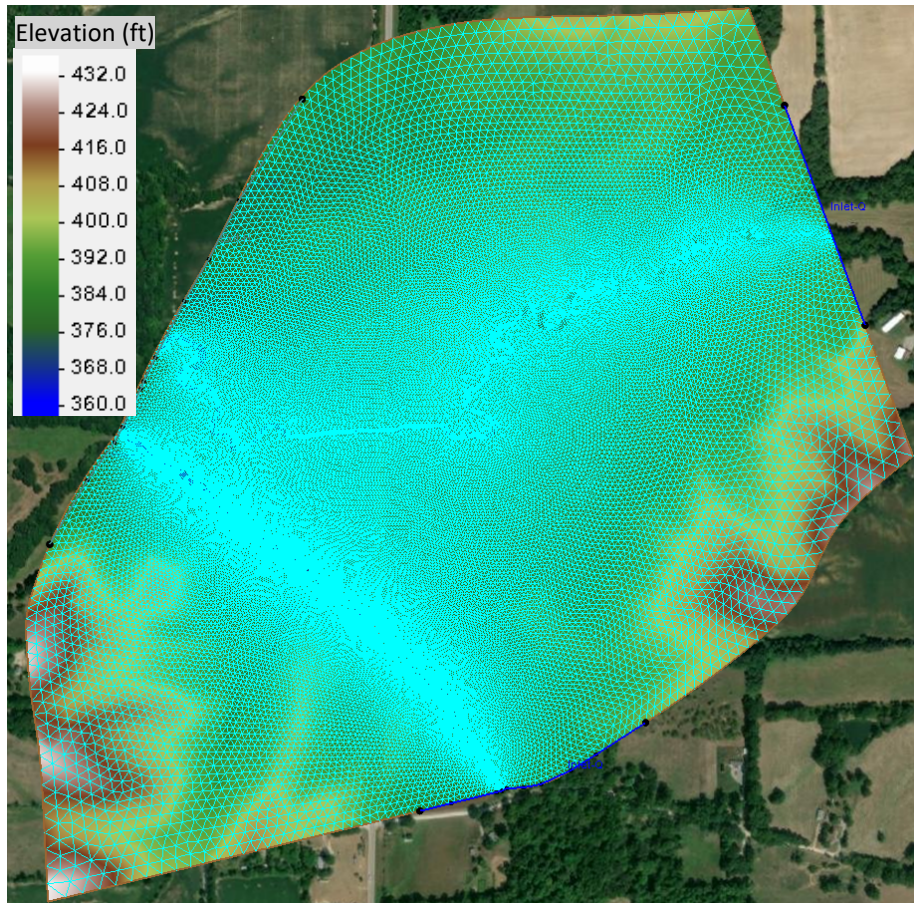


Figure B-3. Wolf Creek (L-0022) – SRH-2D mesh with bed elevations and boundary arcs.

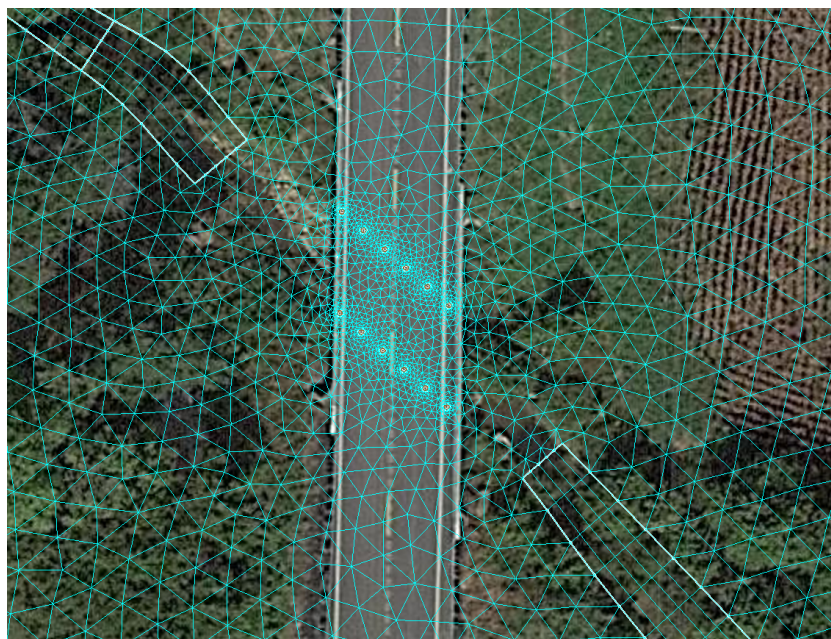


Figure B-4. Wolf Creek (L-0022) – SRH-2D mesh at the bridge section.

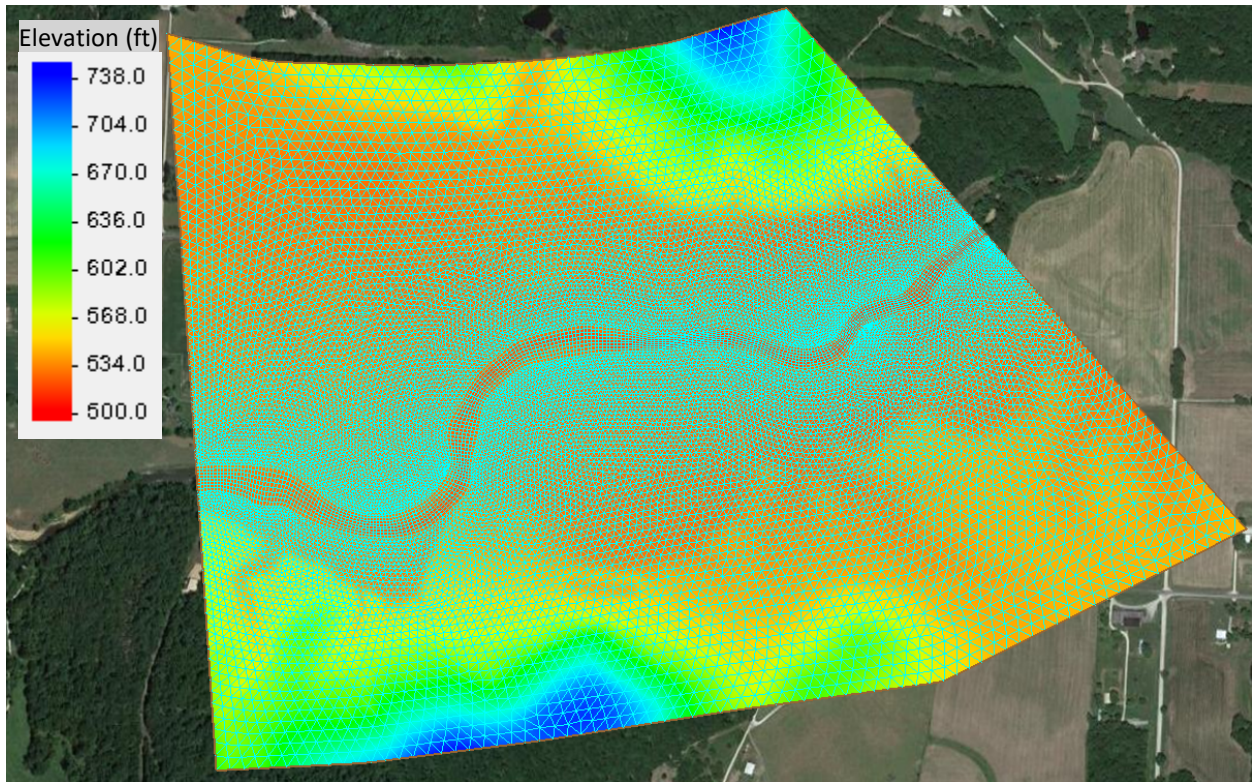


Figure B-5. Dry Fork Creek (L-0564) – SRH-2D mesh with bed elevations and boundary arcs.

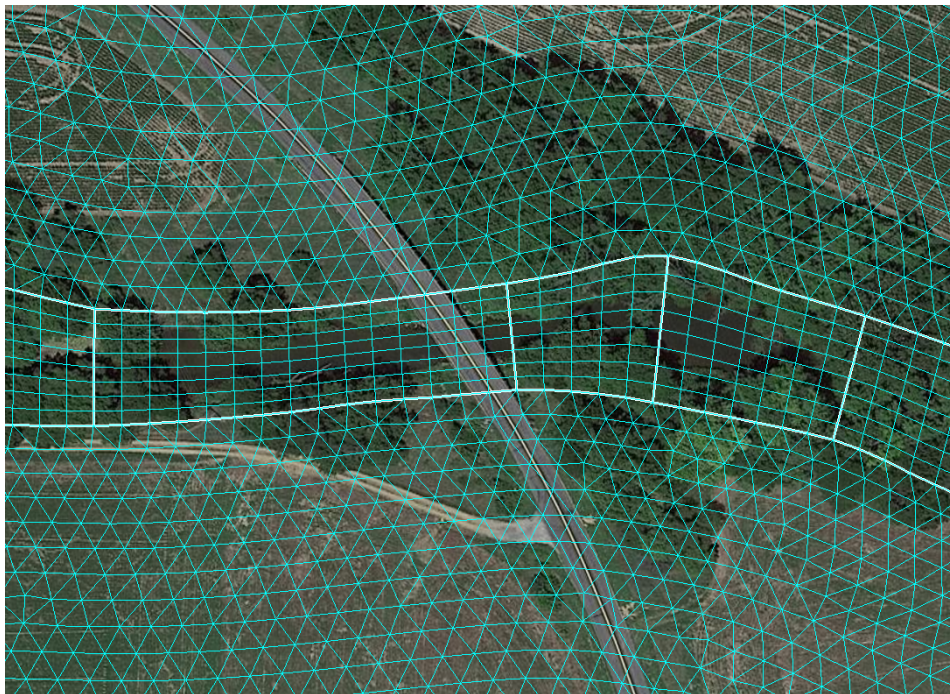


Figure B-6. Dry Fork Creek (L-0564) – SRH-2D mesh at the bridge section.

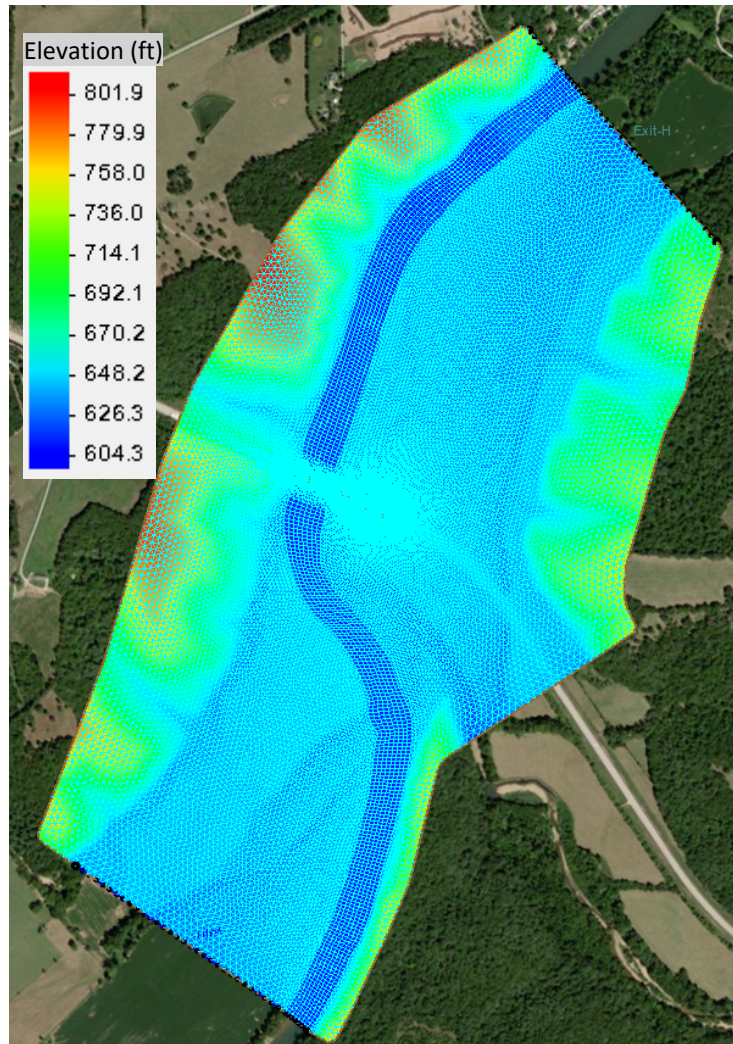


Figure B-7. Gasconade River (A-3760) – SRH-2D mesh with bed elevations and boundary arcs.

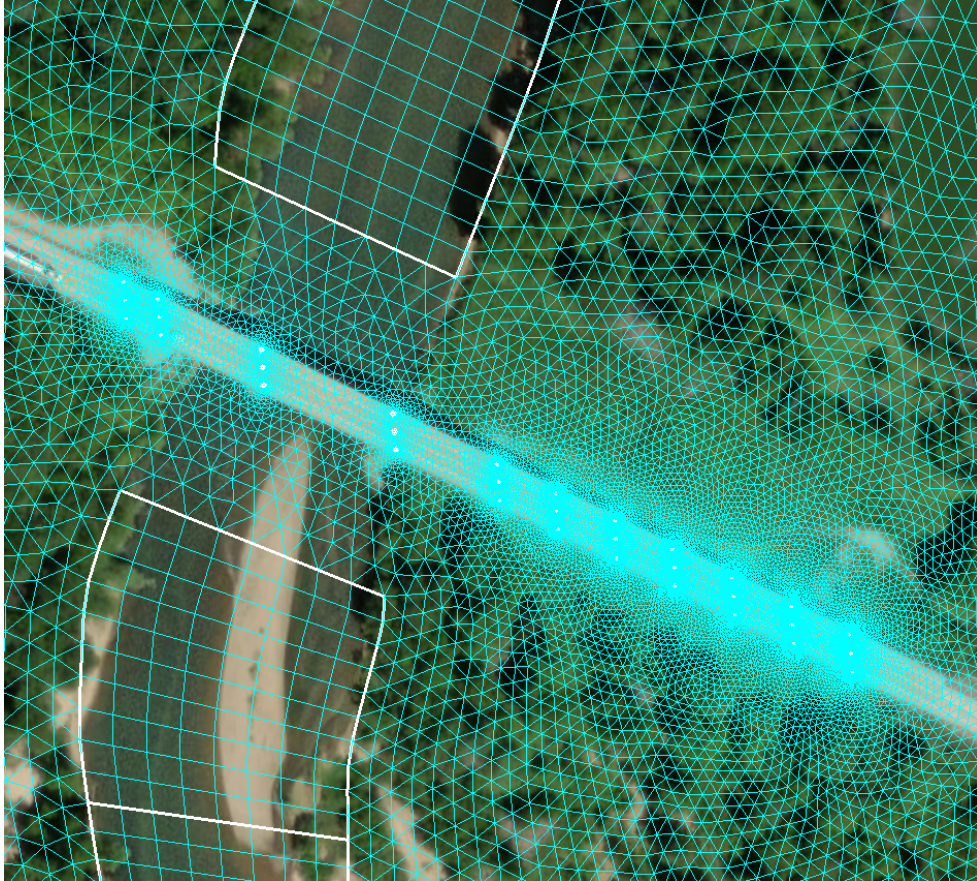


Figure B-8. Gasconade River (A-3760) – SRH-2D mesh with piers at the bridge section.

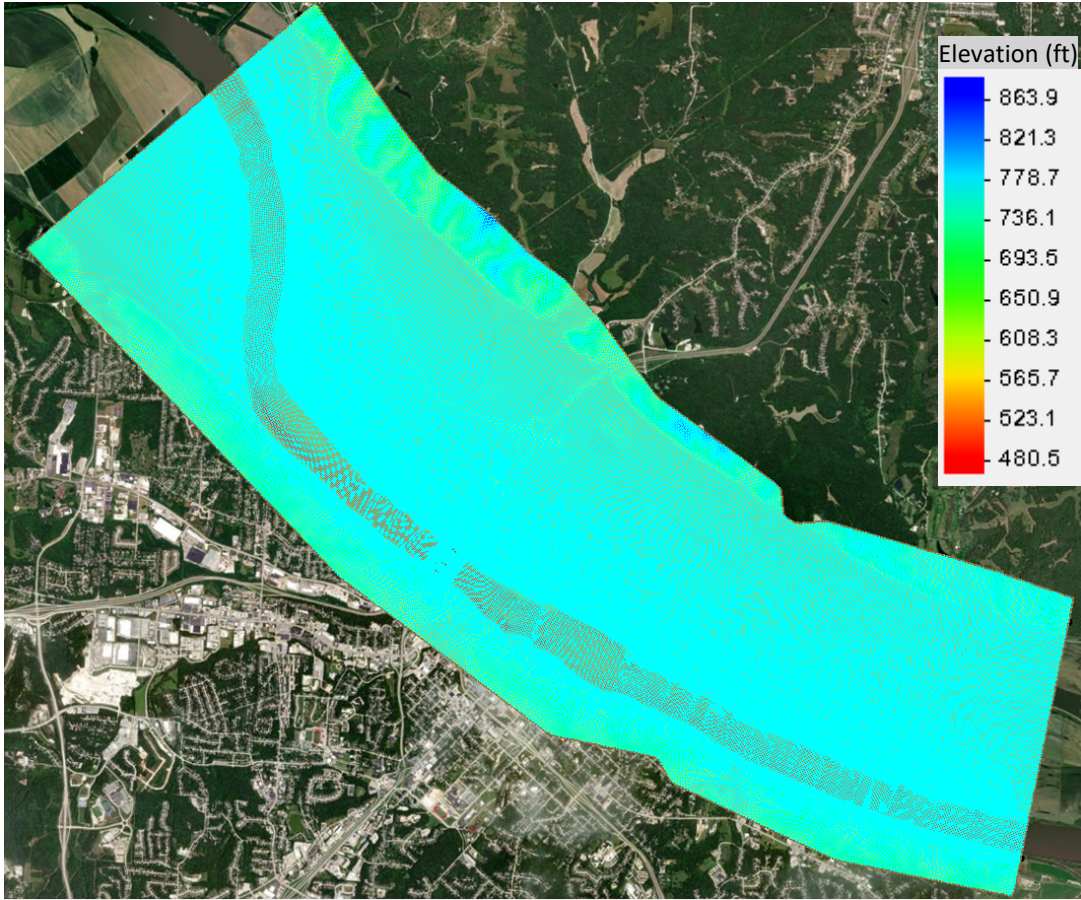


Figure B-9. Missouri River (L0550) – SRH-2D mesh with bed elevations and boundary arcs.

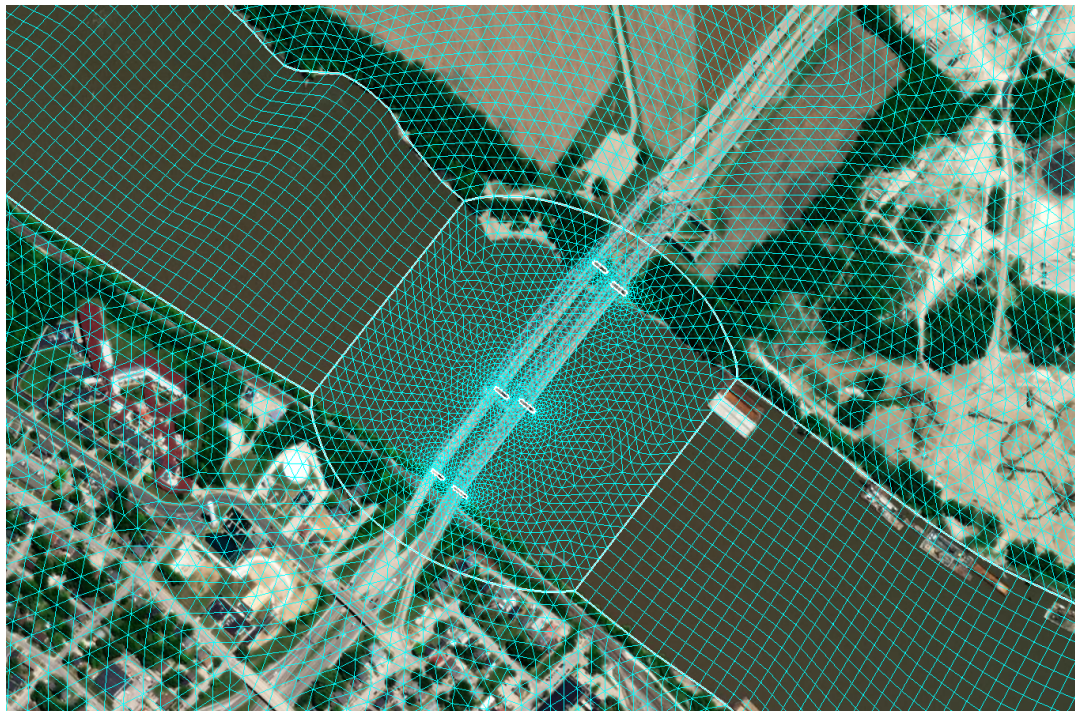


Figure B-10. Missouri River (L0550) – SRH-2D Mesh with piers at the bridge section.

APPENDIX C: SOIL/SEDIMENT SAMPLING LOCATIONS AND ANALYSIS RESULTS

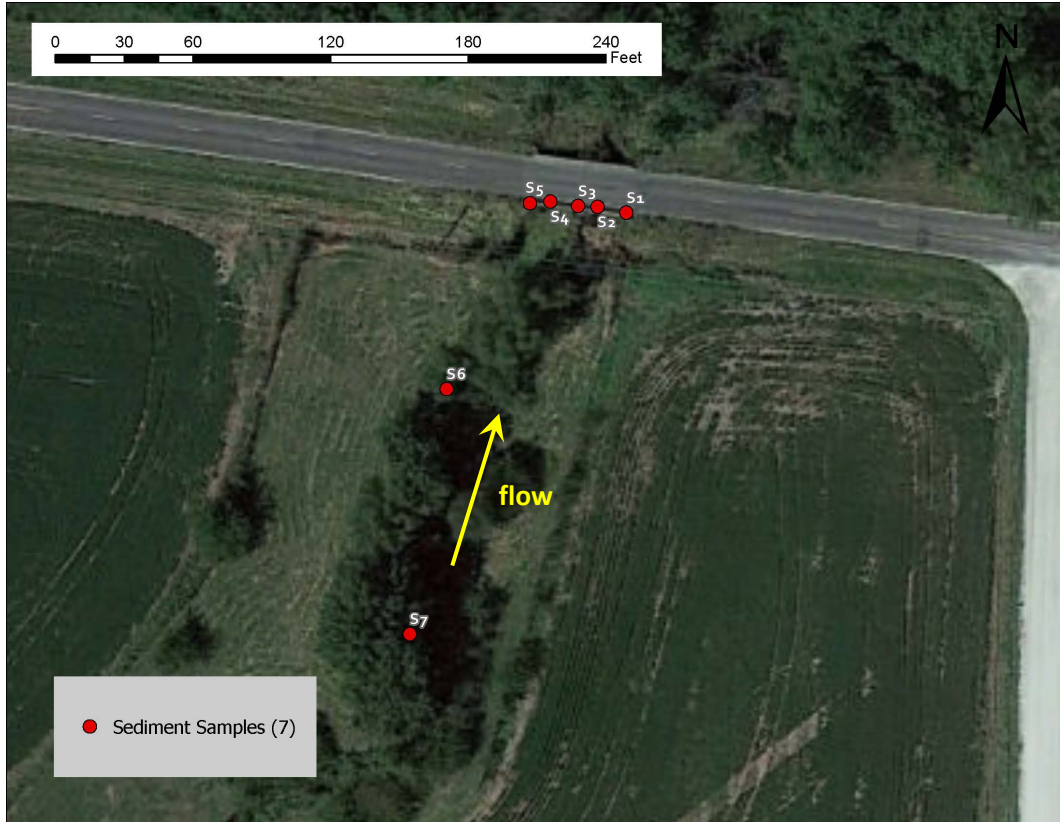


Figure C-1. Creek (H-0024) – Soil/sediment sample locations.

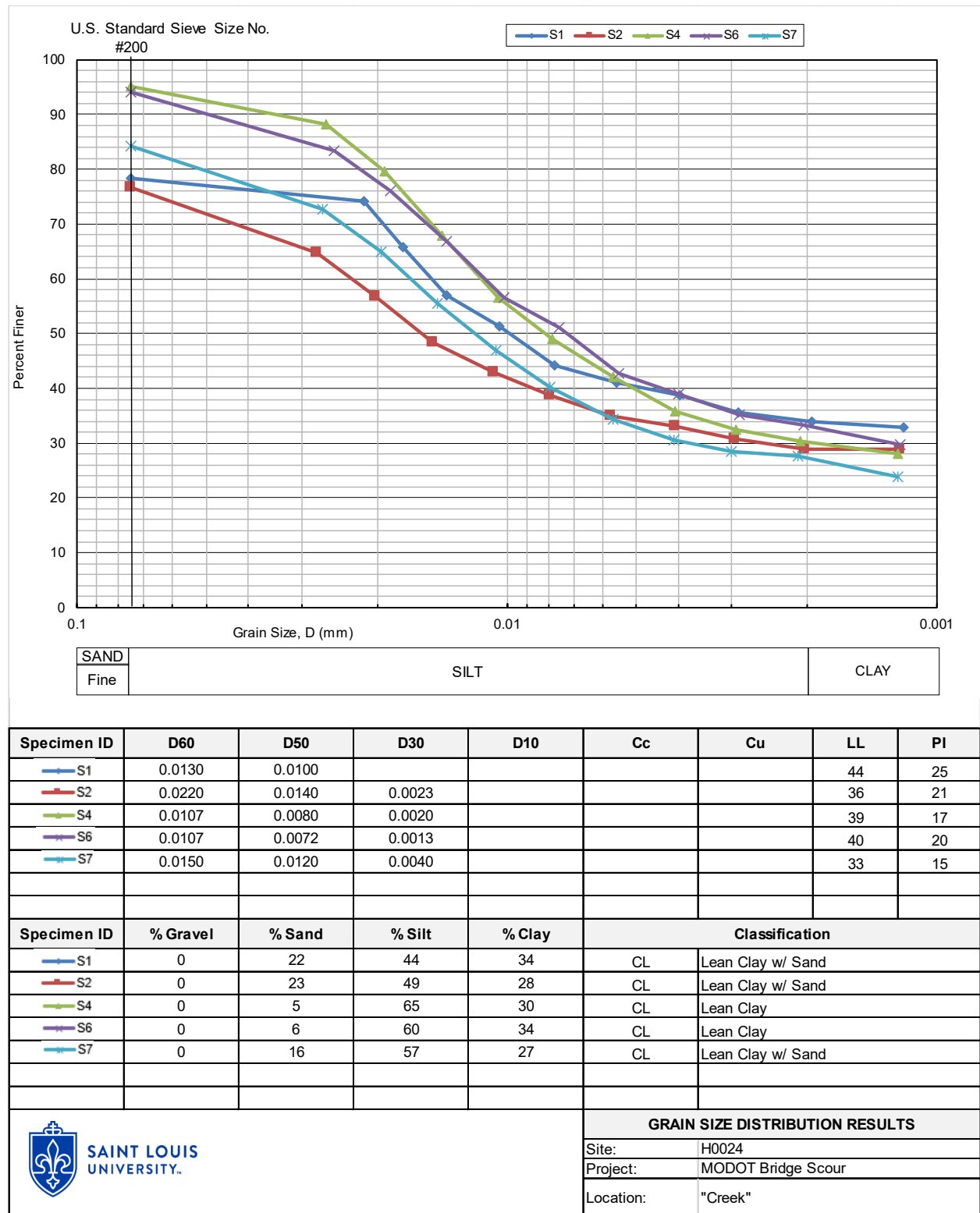
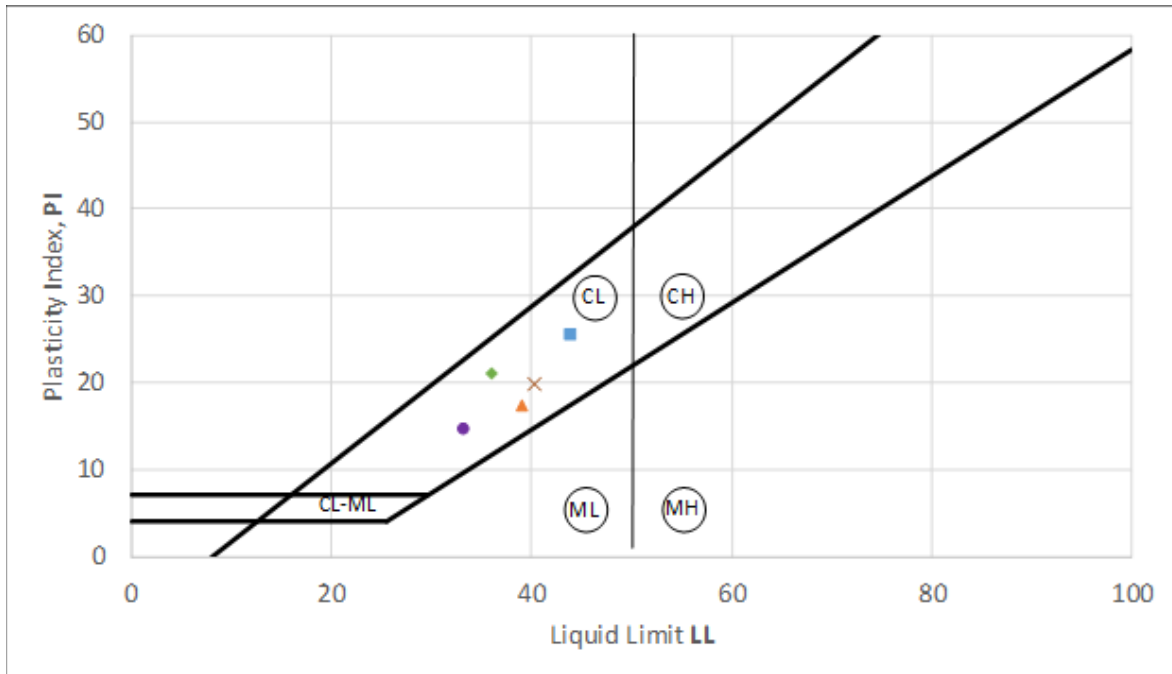


Figure C-2. Creek (H-0024) – Soil/sediment grain size distribution.



Legend	Borehole	Sample	Depth	LL	PL	PI	% Fines	Description
■	S1	1	0'-1'	44	18	25	78%	CL - w/ sand
◆	S2	2	0'-1'	36	15	21	77%	CL - w/ sand
▲	S4	4	0'-1'	39	22	17	95%	CL
×	S6	6	0'-1'	40	20	20	94%	CL
●	S7	7	0'-1'	33	19	15	84%	CL - w/ sand
							(#200 Wash)	



ATTERBERG LIMIT RESULTS	
Site:	H0024
Project:	MODOT Bridge Scour Analysis
Location:	Vandalia, MO

Figure C-3. Creek (H-0024) – Soil/sediment Atterberg limits.

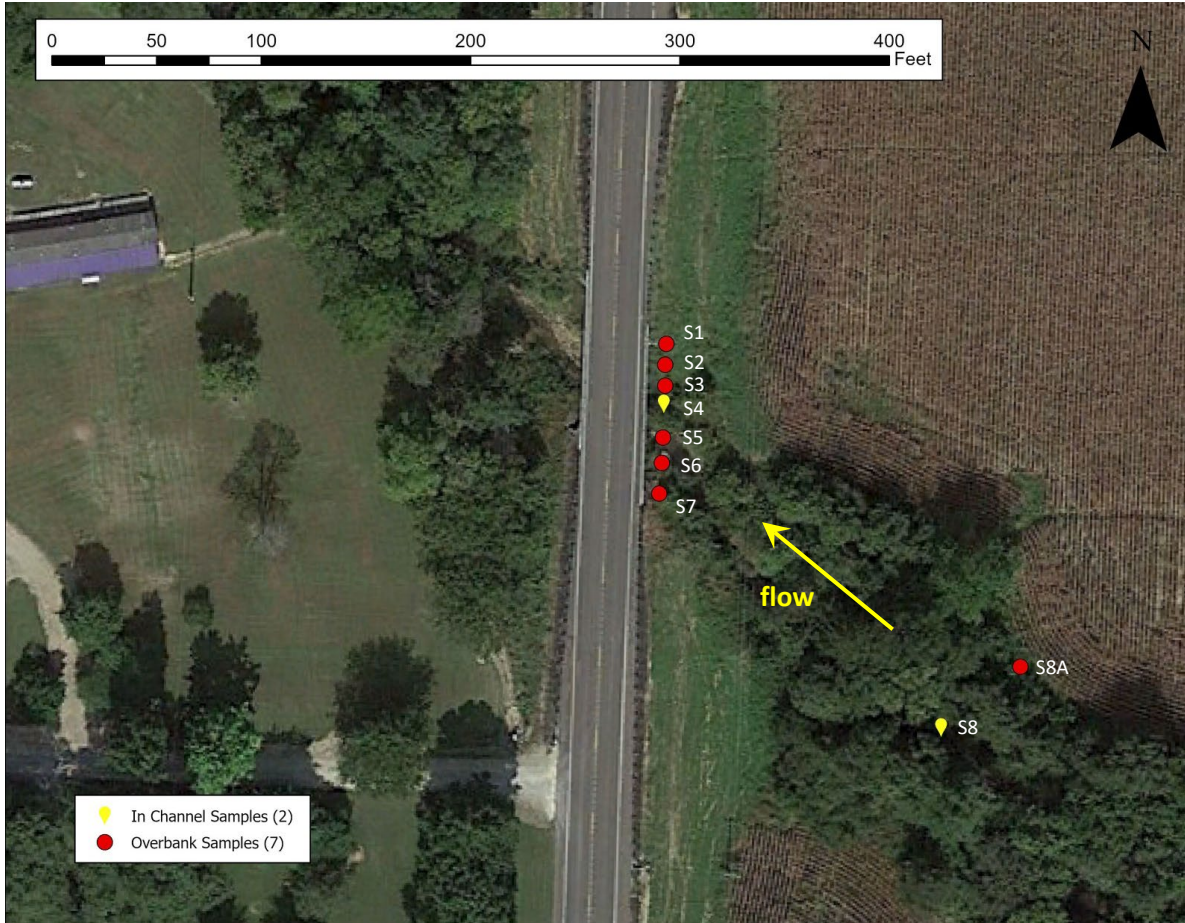
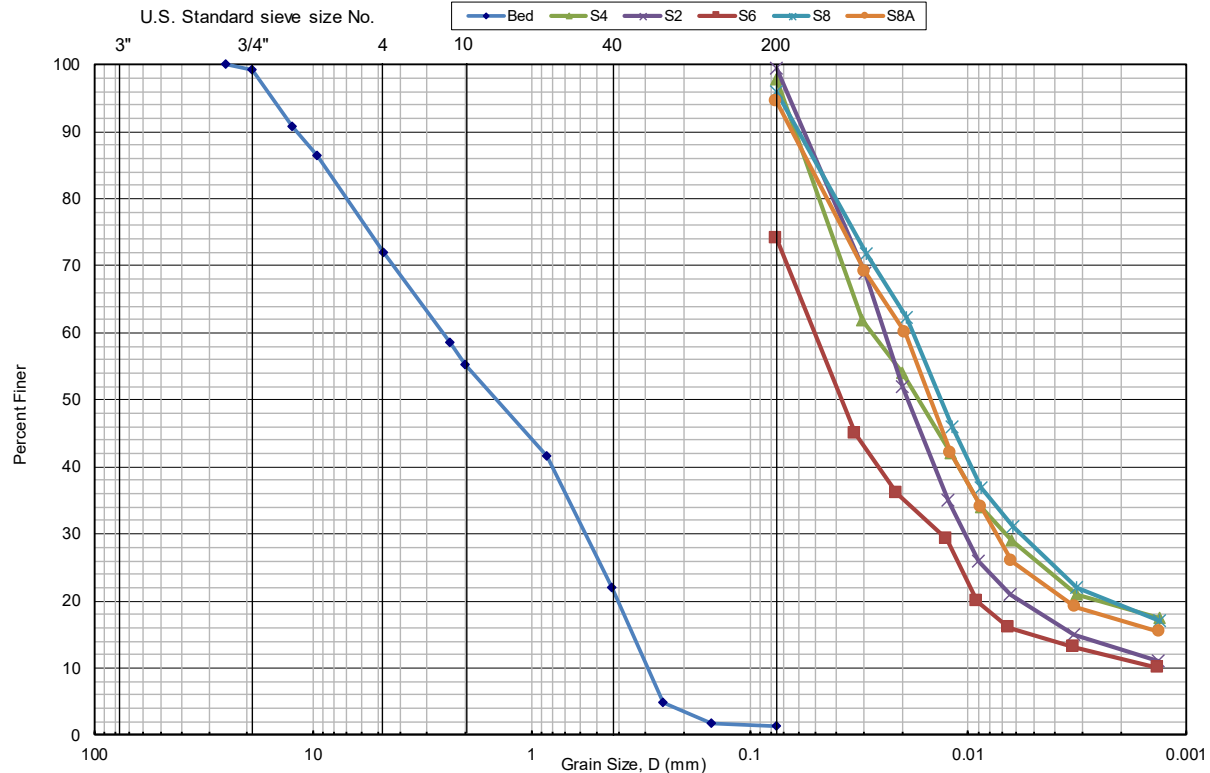


Figure C-4. Wolf Creek (L-0022) – Soil/sediment sampling locations.



COBBLES	GRAVEL		SAND			SILT	CLAY
	Coarse	Fine	Coarse	Medium	Fine		


Specimen ID	D60	D50	D30	D10	Cc	Cu	LL	PI
Bed	2.50	1.30	0.58	0.30	0.45	8.33		
S2	0.025	0.019	0.011	0.0002	N/A	N/A	31	7
S4	0.028	0.017	0.0064		N/A	N/A	35	14
S6	0.050	0.038	0.013	0.001	N/A	N/A	32	8
S8	0.0018	0.011	0.0006		N/A	N/A	31	10
S8A	0.02	0.04	0.0078		N/A	N/A	28	7
Specimen ID	% Gravel	% Sand	% Silt	% Clay	Classification			
Bed	28.1	70.5	1.4		SW	Well Graded Sand w/ Gravel		
S2	0.0	0.6	86.4	13.0	ML	Silt		
S4	0.0	2.3	78.7	19.0	CL	Lean Clay		
S6	0.0	25.9	63.1	11.0	ML	Silt		
S8	0.0	4.1	76.9	19.0	CL	Lean Clay		
S8A	0.0	5.6	77.4	17.0	CL	Lean Clay		
					GRAIN SIZE DISTRIBUTION RESULTS			
					Site	L0022		
					Project	MODOT Bridge Scour		
					Location	Wolf Creek		

Figure C-5. Wolf Creek (L-0022) – Soil/sediment grain size distribution.

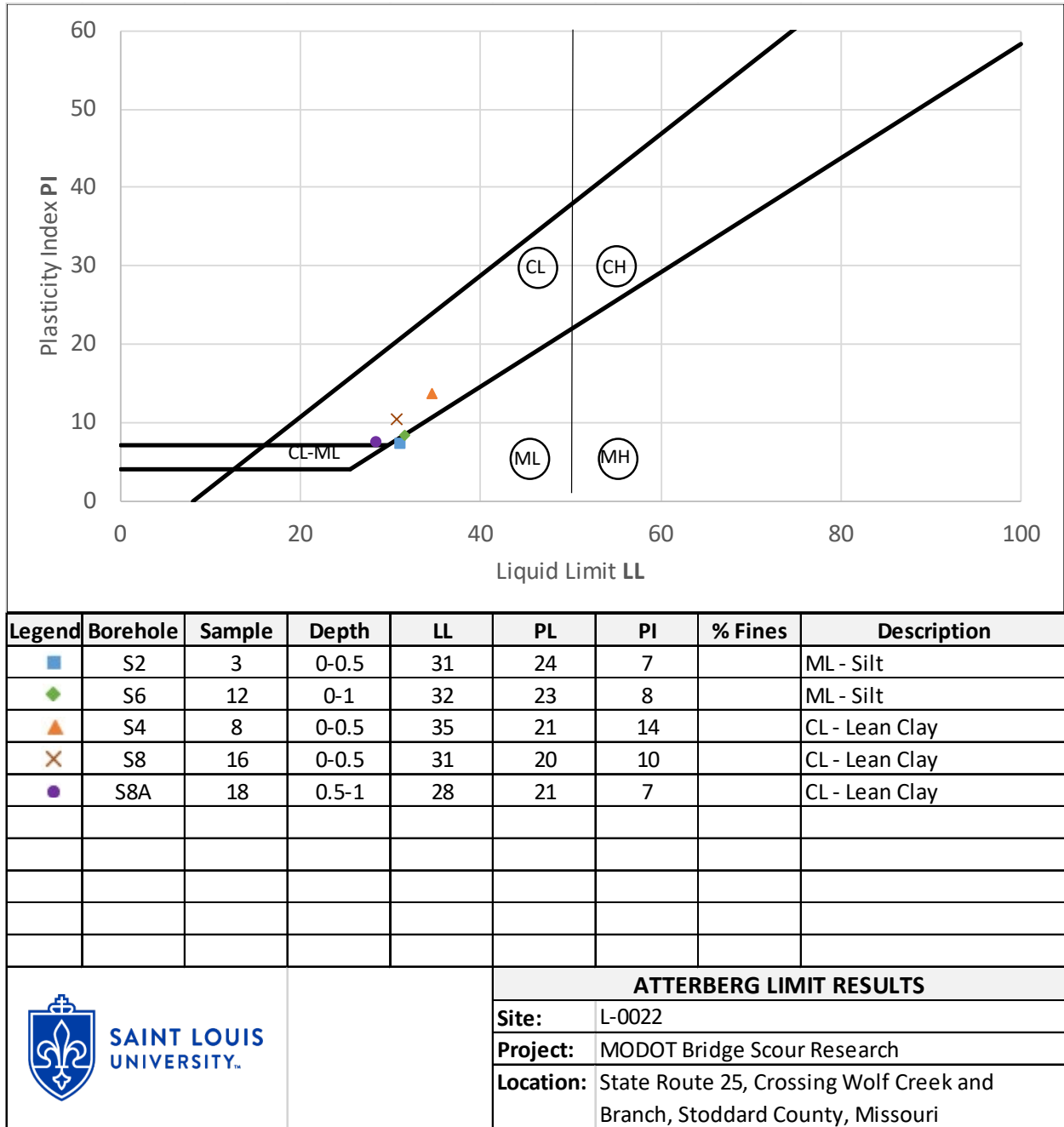
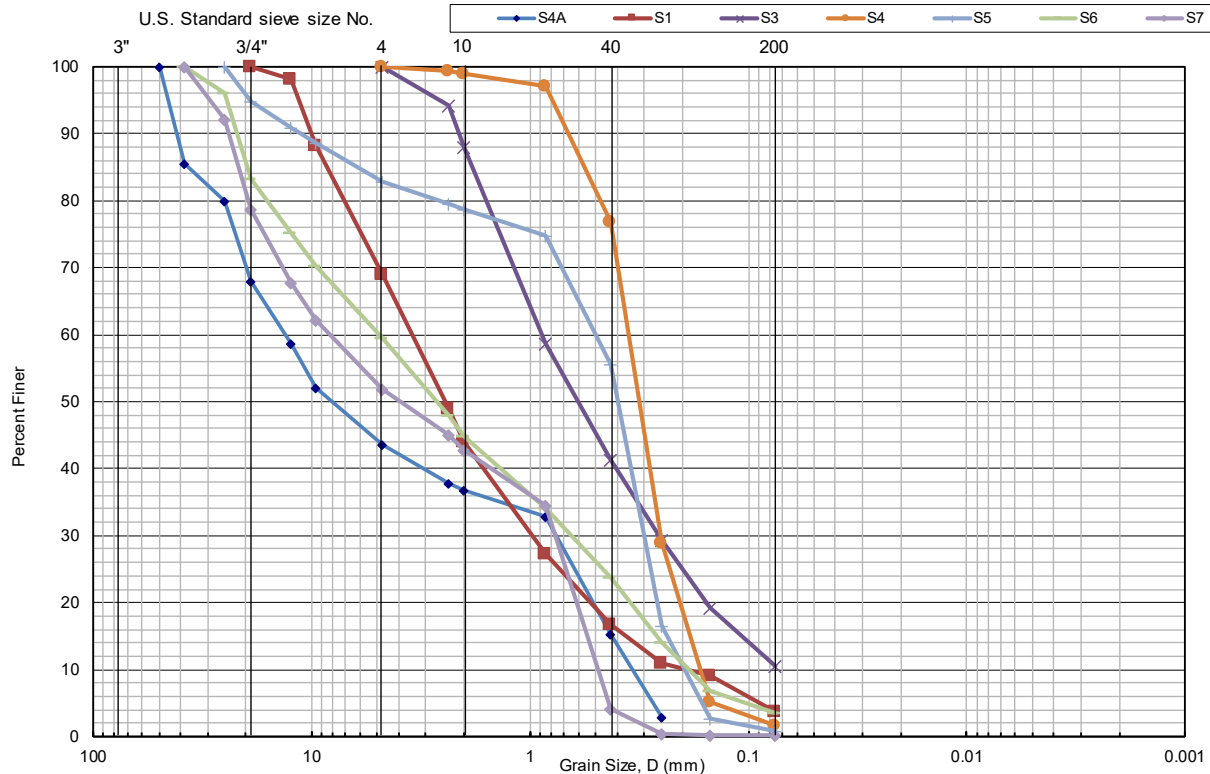


Figure C-6. Wolf Creek (L-0022) – Soil/sediment Atterberg limits.



Figure C-7. Dry Fork Creek (L-0564) – Soil/sediment sampling locations.

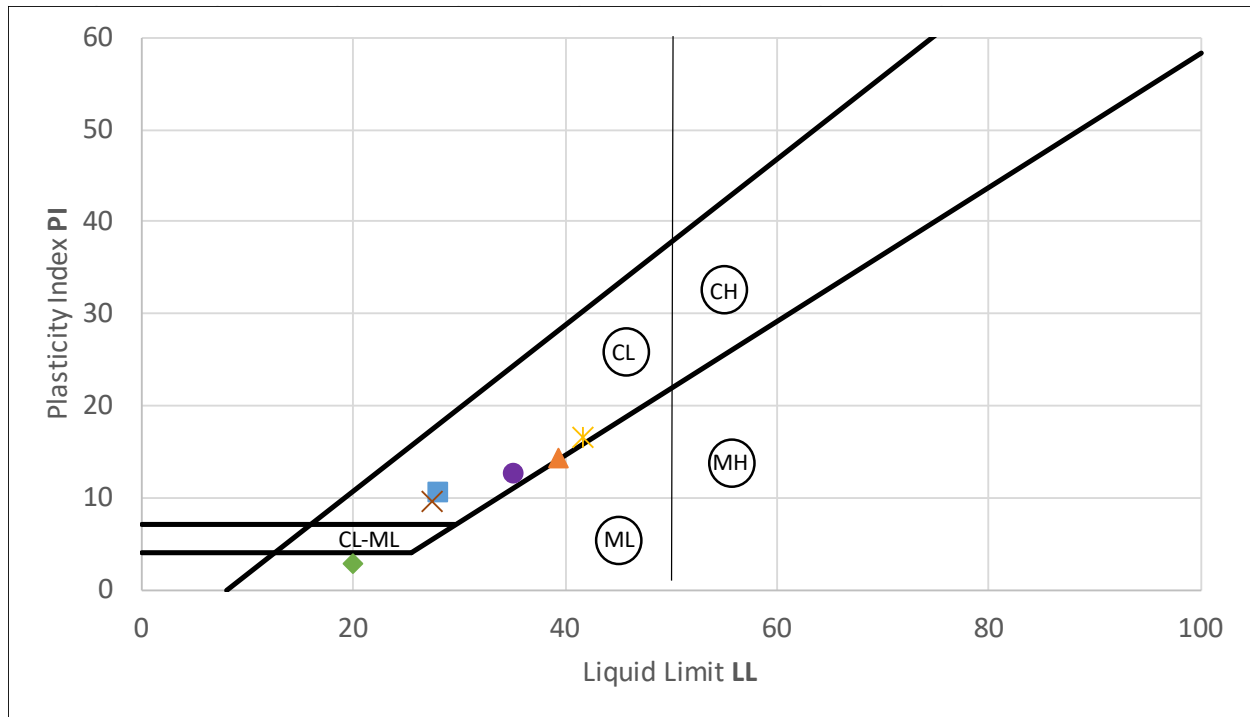


COBBLES	GRAVEL		SAND			SILT	CLAY
	Coarse	Fine	Coarse	Medium	Fine		

Specimen ID	D60	D50	D30	D10	Cc	Cu	LL	PI
S4A	13.00	8.00	0.75	0.32	0.14	40.63		
S1	3.20	2.20	1.00	0.20	1.56	16.00		
S3	0.90	0.60	0.24	0.07	0.91	12.86	42	16
S4	0.33	0.31	0.25	0.17	1.11	1.94		
S5	0.50	0.40	0.30	0.20	0.90	2.50		
S6	5.00	2.70	0.63	0.20	0.40	25.00		
S7	8.20	4.00	0.79	0.50	0.15	16.40		
Specimen ID	% Gravel	% Sand	% Silt	% Clay	Classification			
S4A	56.5	43.5		0.0	GP	Poorly Graded Gravel w/ Sand		
S1	31.0	65.2		3.8	SP	Poorly Graded Sand w/ Gravel		
S3	0.0	89.4		11.0	SC	Clayey Sand		
S4	0.0	98.4		1.6	SP	Poorly Graded Sand w/ Gravel		
S5	17.2	81.9		0.9	SP	Poorly Graded Sand w/ Gravel		
S6	40.5	56.0		3.5	SP	Poorly Graded Sand w/ Gravel		
S7	48.1	51.7		0.2	SP	Poorly Graded Sand w/ Gravel		

 SAINT LOUIS UNIVERSITY.	GRAIN SIZE DISTRIBUTION RESULTS	
	Site:	L0564
	Project:	MODOT Bridge Scour
Location:	Dry Fork Creek	

Figure C-8. Dry Fork Creek (L-0564) – Soil/sediment grain size distribution.




Legend	Borehole	Sample	Depth	LL	PL	PI	% Fines	Description
■	S2A	0	6"	28	17	11		CL
◆	S5A	0	6"	20	17	3		ML
▲	S3A	0	6"	39	25	14		ML
×	S1A	0	1'	27	18	10		CL
●	S2	0	1'	35	22	13		CL
*	S3	0	1'	42	25	16		CL
 SAINT LOUIS UNIVERSITY.				ATTERBERG LIMIT RESULTS				
				Site: L0564				
				Project: MODOT Bridge Scour				
				Location: Dry Fork Creek				

Figure C-9. Dry Fork Creek (L-0564) – Soil/sediment Atterberg limits.



Figure C-10. Gasconade River (A-3760) – Soil sampling locations.

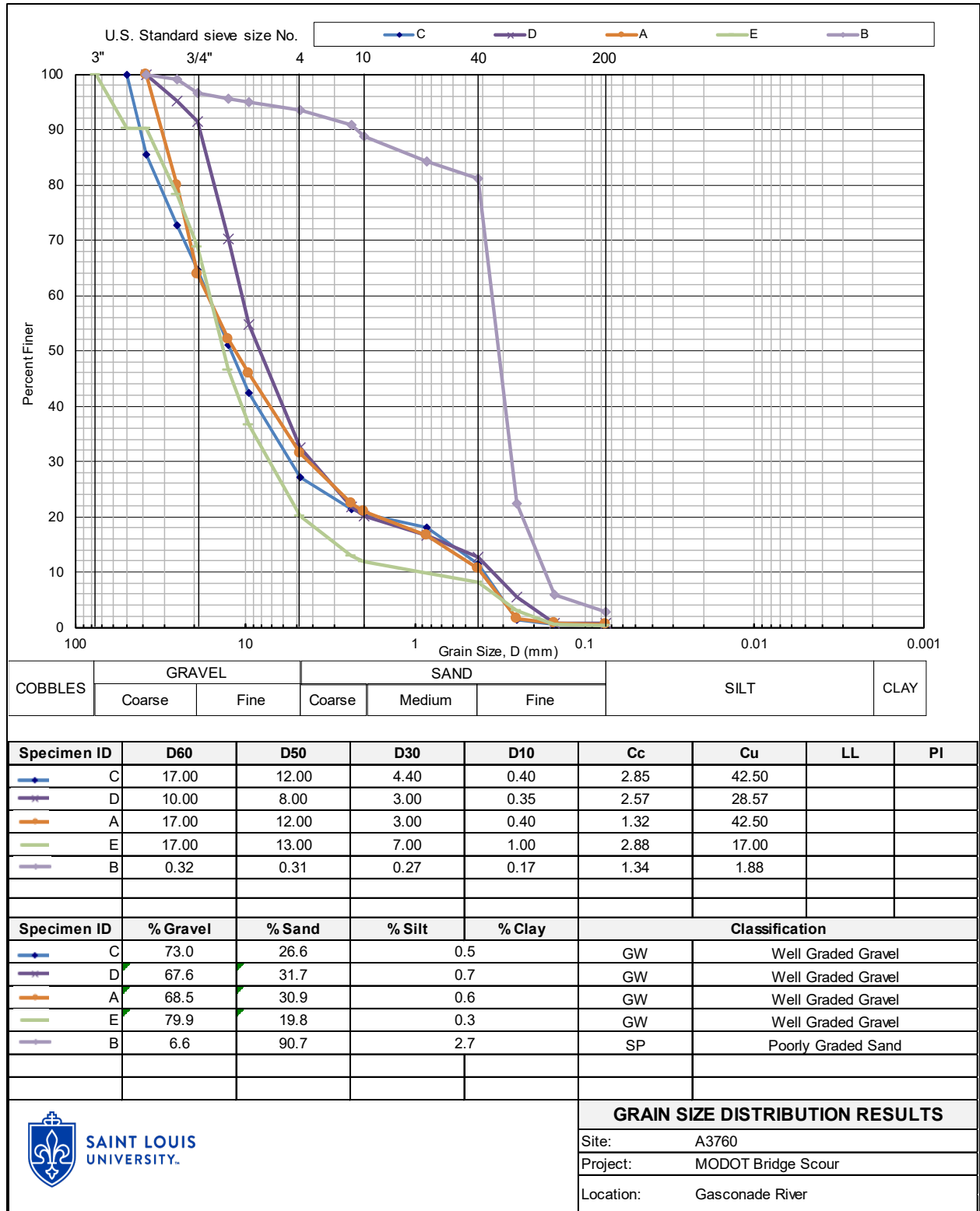


Figure C-11. Gasconade River (A-3760) – Soil/sediment grain size distribution in channel.

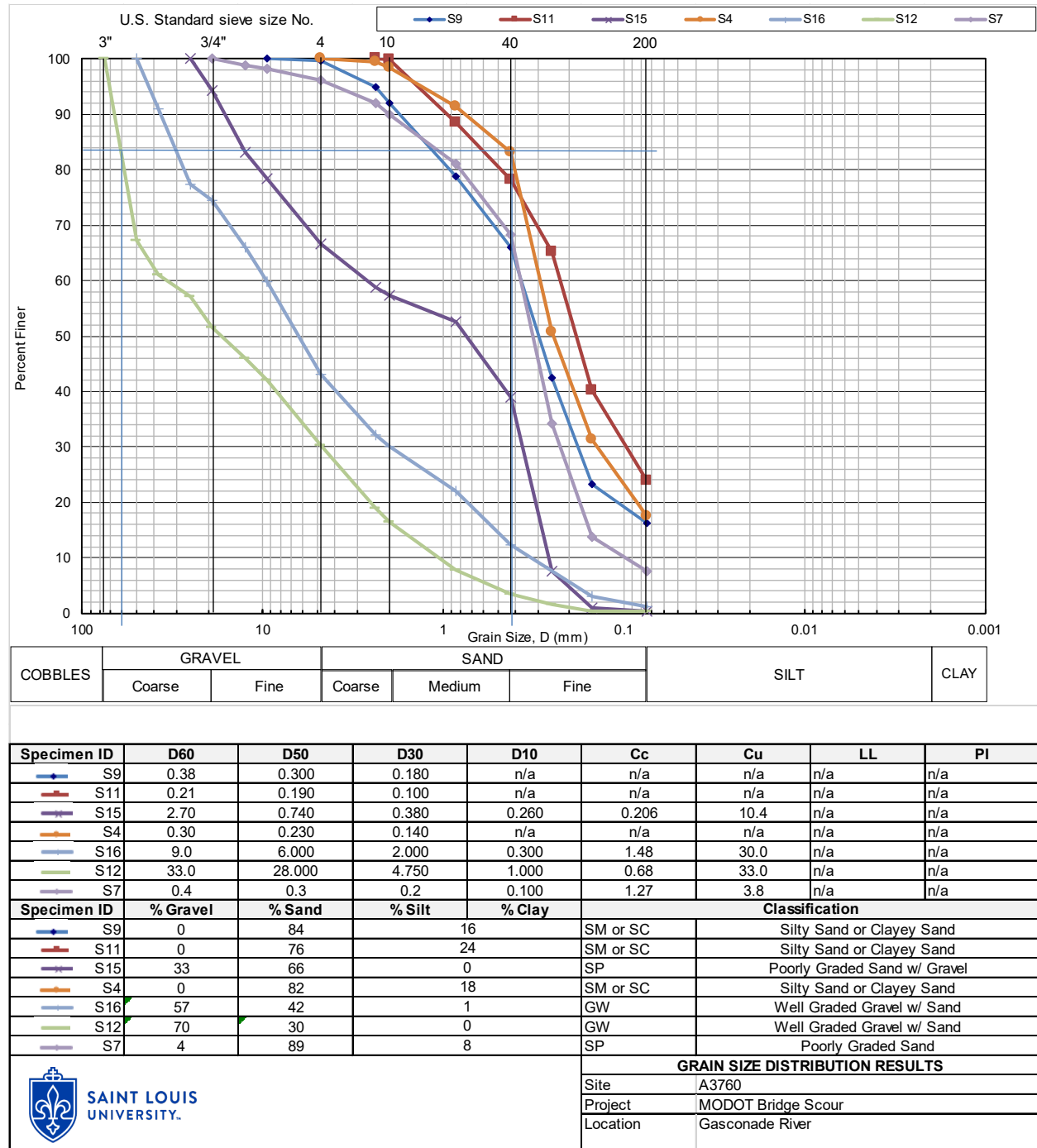
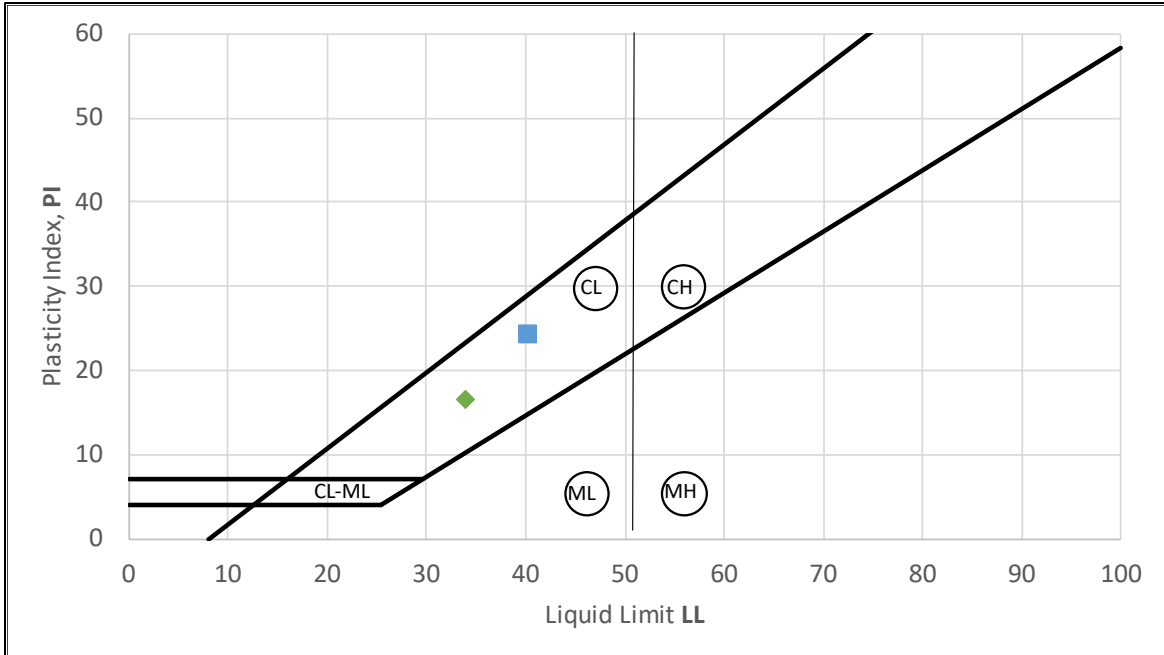


Figure C-12. Gasconade River (A-3760) – Soil/sediment grain size distribution in overbanks.



Legend	Borehole	Sample	Depth	LL	PL	PI	% Fines	Description
■	S0	1	6"-12"	40	16	24		CL
◆	S2	5	0"-6"	34	17	17		CL
▲	S3	6	6"-12"	NP	NP	NA		
#200 Wash	Borehole	Sample	Depth	w.c.	Dry	Retained	% Fines	Description
	S5	8	6"-12"	19%	123.91	57.09	54%	
	S6	9	6"-12"	26%	153.01	103.33	32%	
	S10	13	6"-12"	24%	113.07	40.22	64%	
	S13	16	6"-12"	20%	123.36	58.65	52%	



SAINT LOUIS
 UNIVERSITY.

ATTERBERG LIMIT and #200 WASH RESULTS

Site: A3760
 Project: MODOT Bridge Scour
 Location: Gasconade River

Figure C-13. Gasconade River (A-3760) – Soil/sediment Atterberg limits.

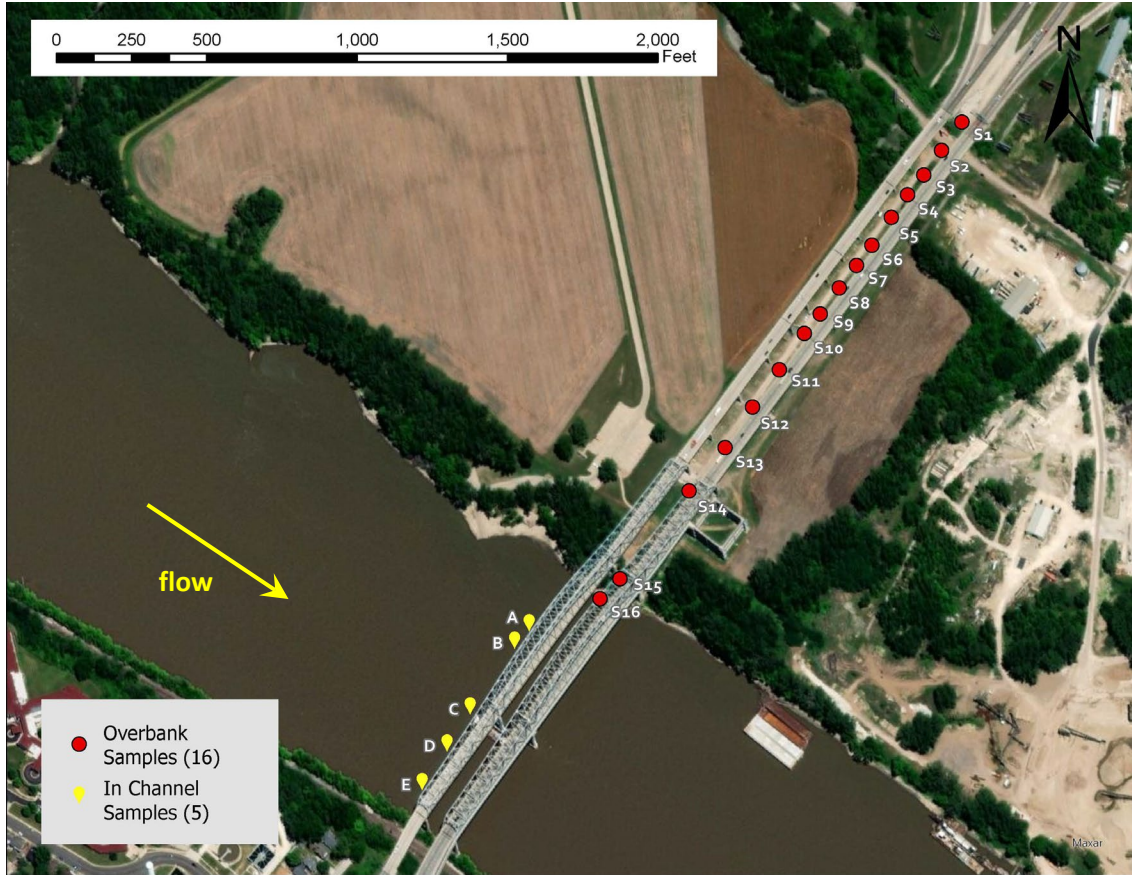


Figure C-14. Missouri River (L-0550) – Soil sampling locations.

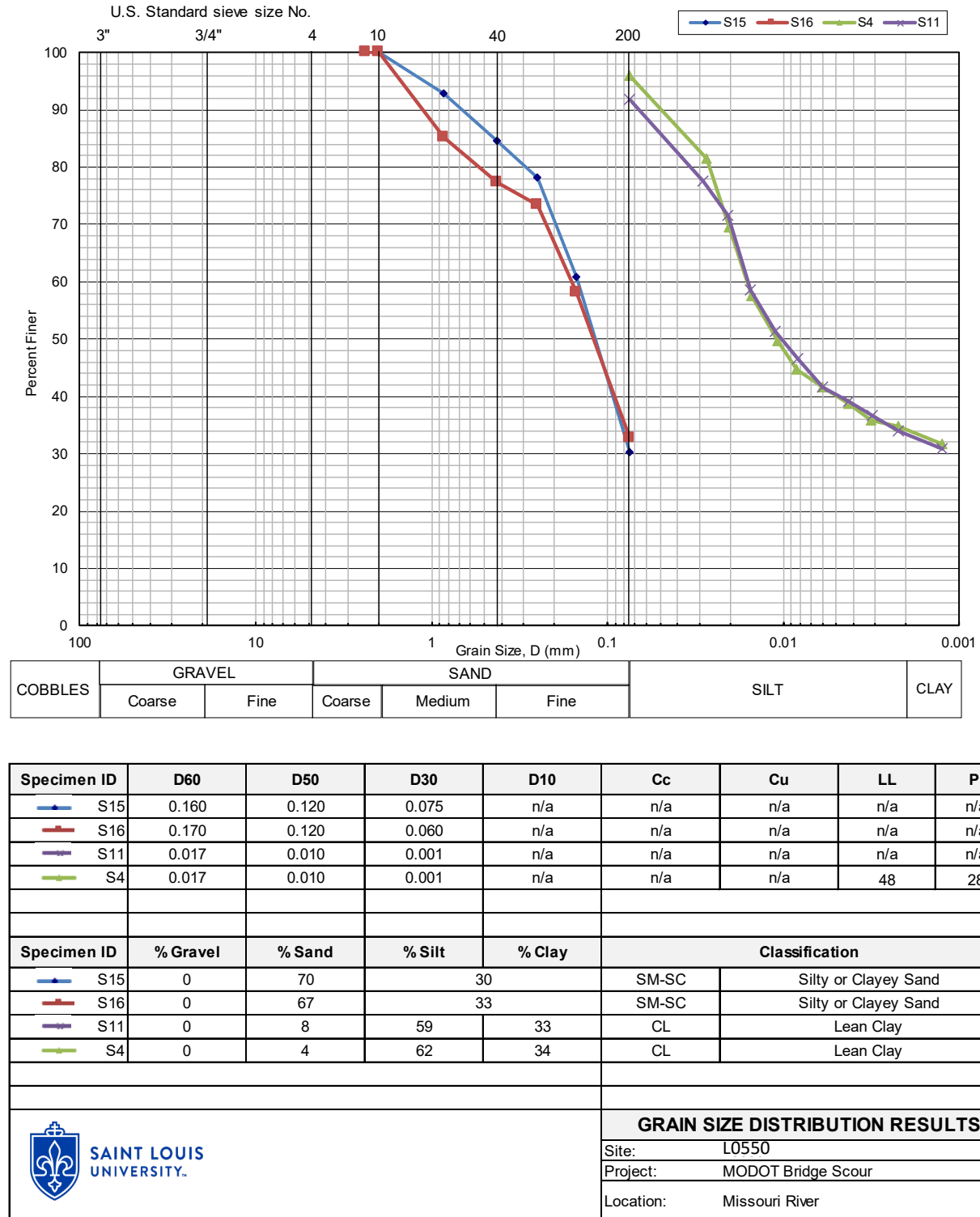


Figure C-15. Missouri River (L-0550) – Soil/sediment grain size distributions for floodplain samples.

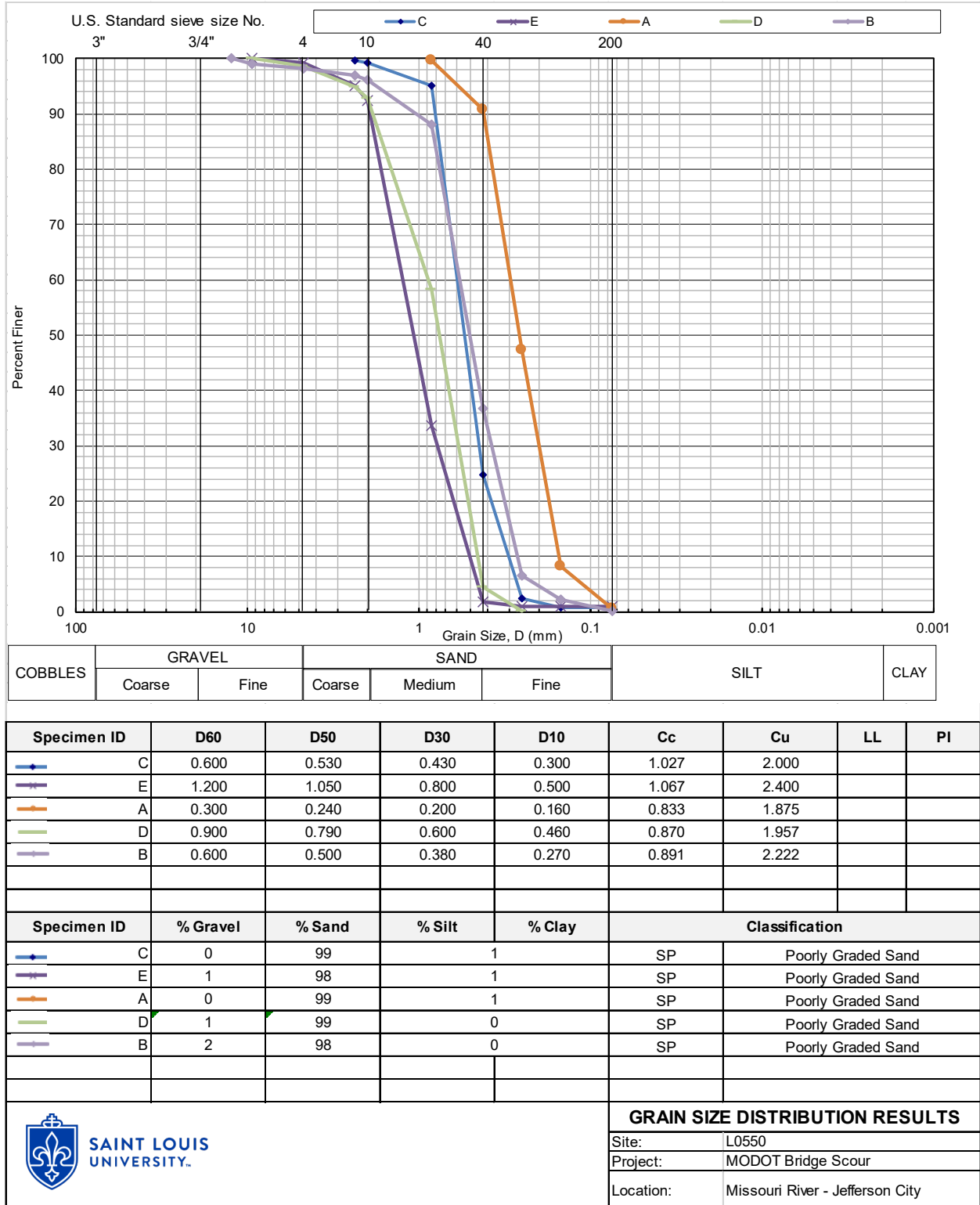


Figure C-16. Missouri River (L-0550) – Soil/sediment grain size distributions for channel samples.

APPENDIX D: 1-D HYDRAULIC MODELING VELOCITY DISTRIBUTIONS

Remainder of page intentionally left blank.



Figure D-1. Creek (H-0024) – HEC-RAS 100-yr flow velocity distribution.

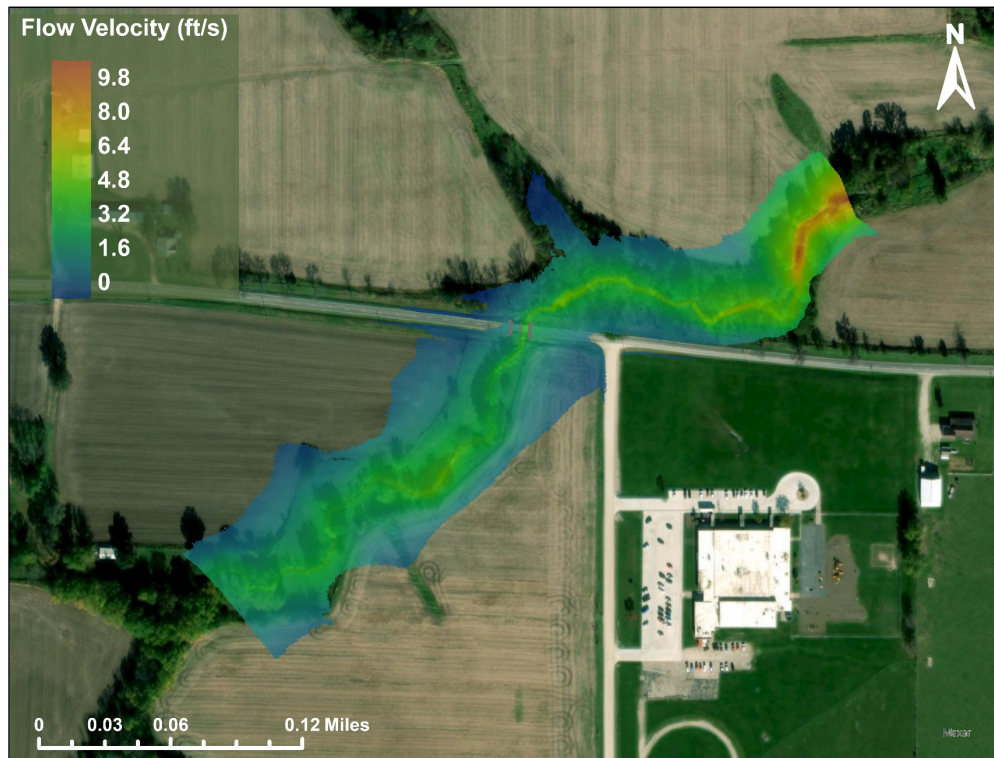


Figure D-2. Creek (H-0024) – HEC-RAS 500-yr flow velocity distribution.

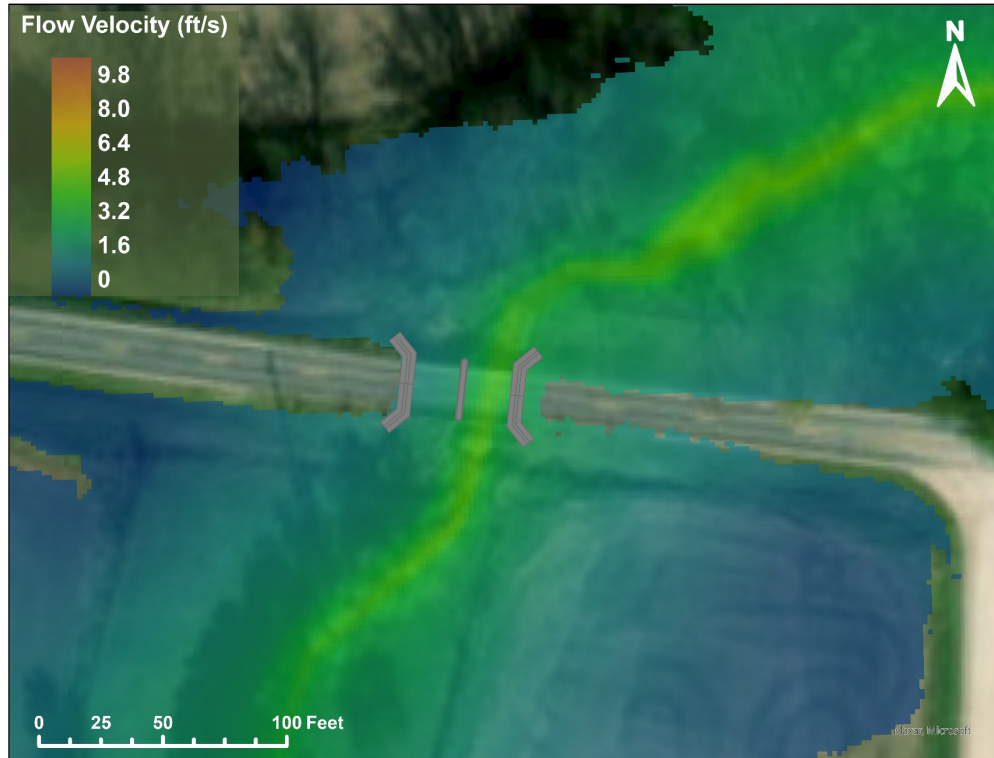


Figure D-3. Creek (H-0024) – HEC-RAS 100-yr flow velocity distribution near the bridge section.

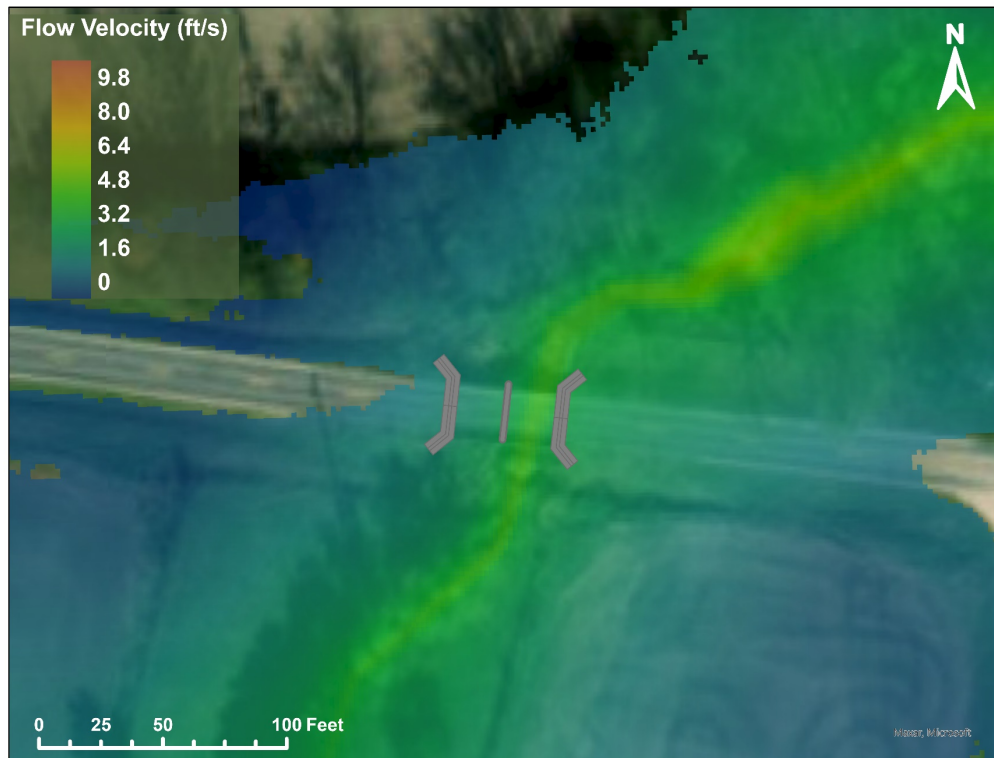


Figure D-4. Creek (H-0024) – HEC-RAS 500-yr flow velocity distribution near the bridge section.

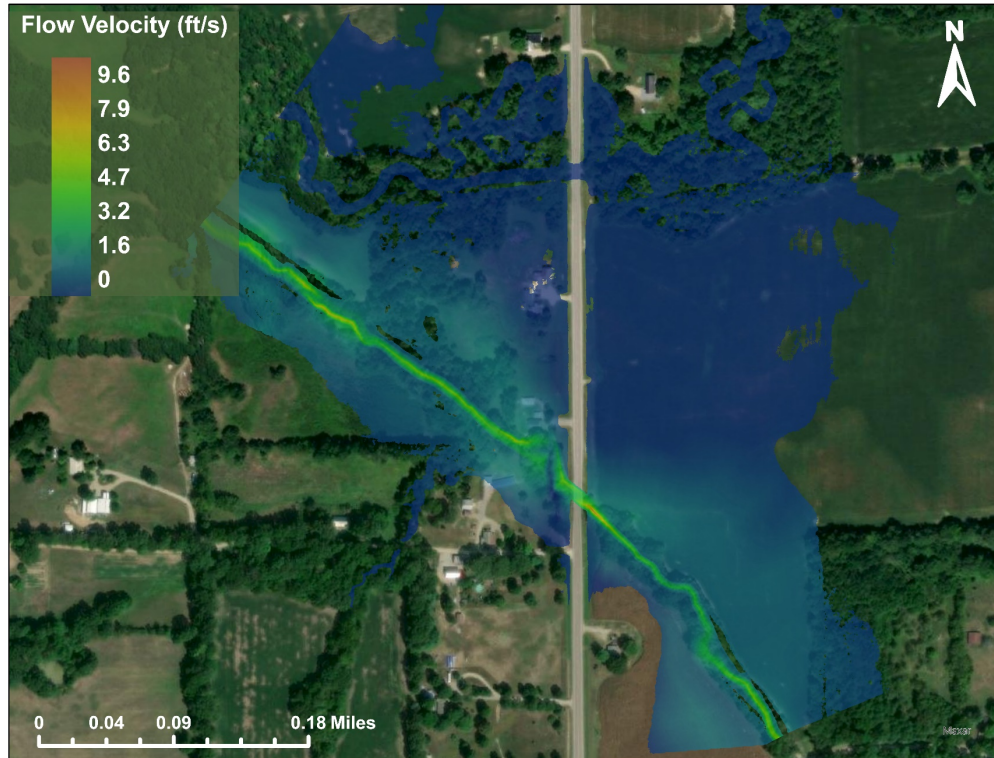


Figure D-5. Wolf Creek (L-0022) – HEC-RAS 100-yr flow velocity distribution.

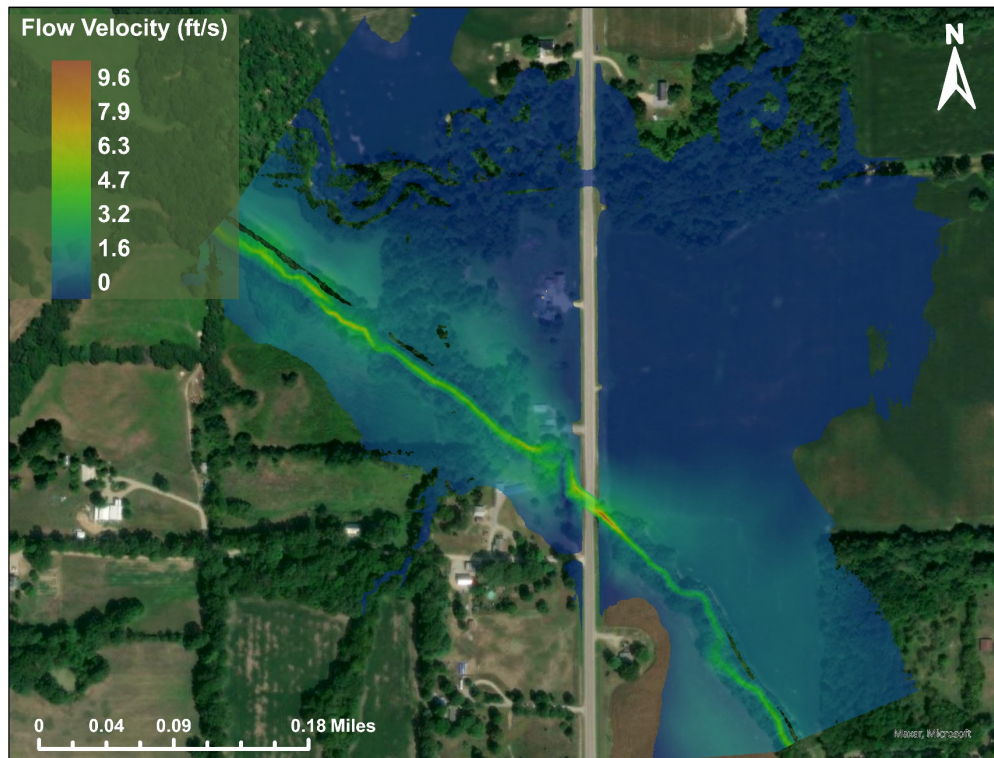


Figure D-6. Wolf Creek (L-0022) – HEC-RAS 500-yr flow velocity distribution.

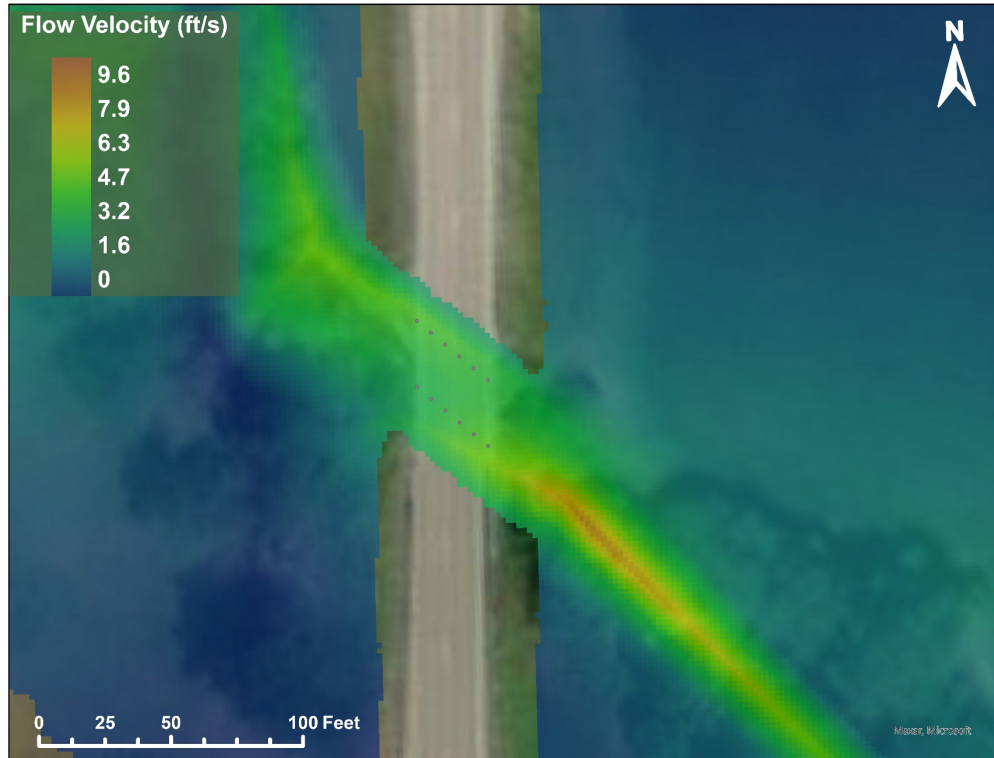


Figure D-7. Wolf Creek (L-0022) – HEC-RAS 100-yr flow velocity distribution near the bridge section.

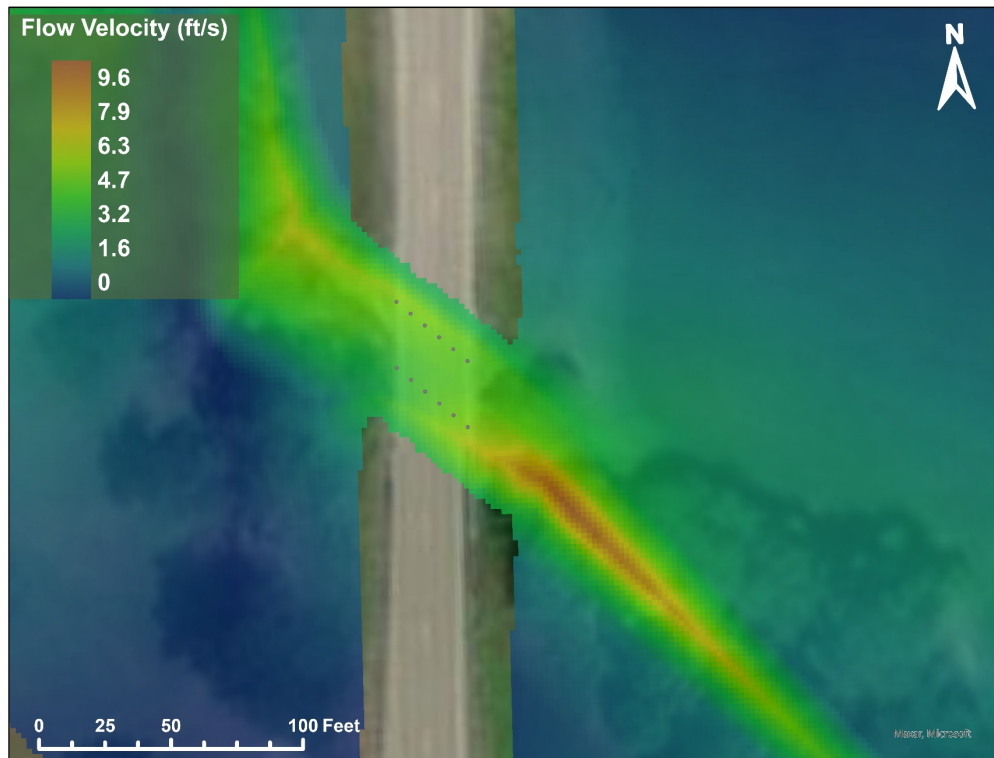


Figure D-8. Wolf Creek (L-0022) – HEC-RAS 500-yr flow velocity distribution near the bridge section.

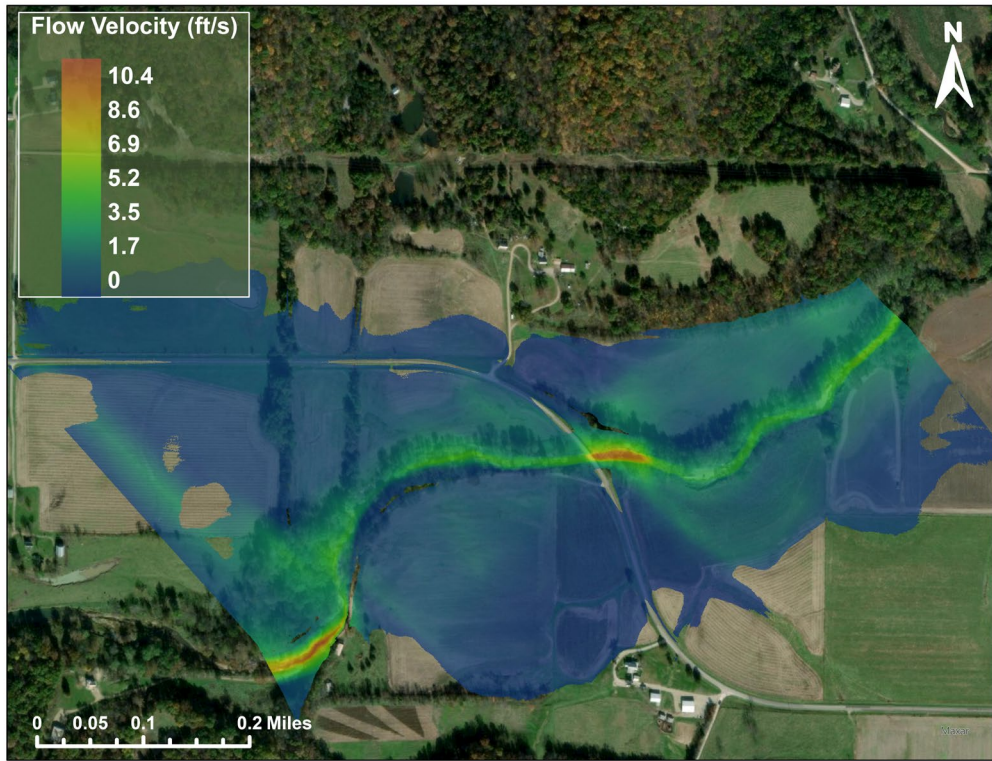


Figure D-9. Dry Fork Creek (L0564) – HEC-RAS 100-yr flow velocity distribution.

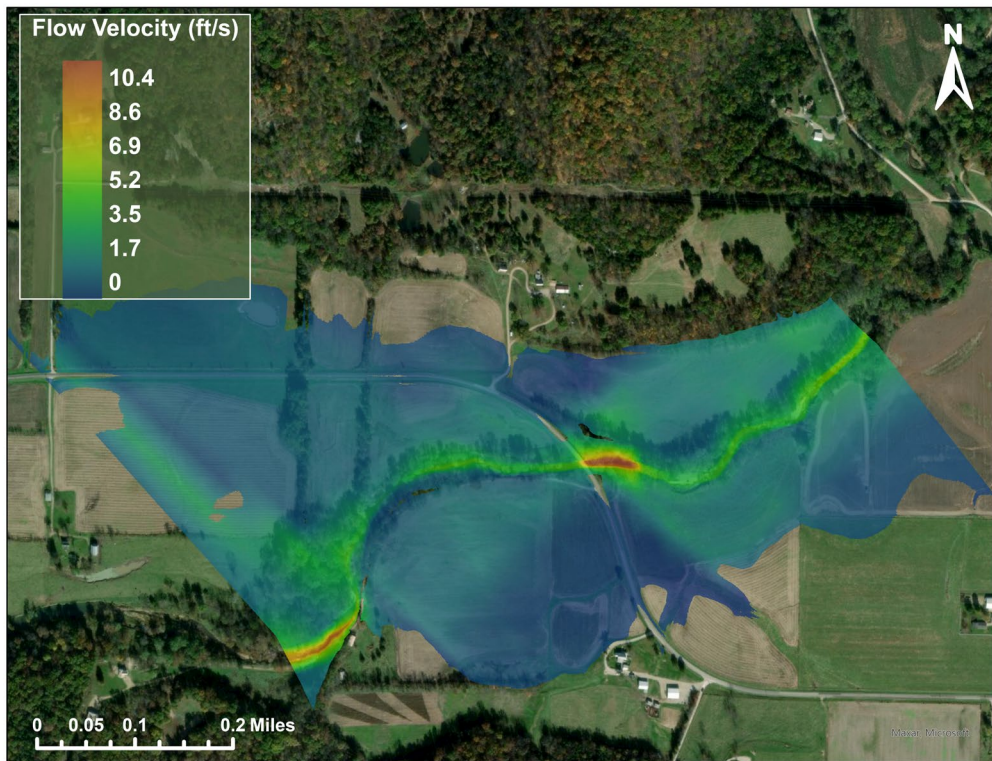


Figure D-10. Dry Fork Creek (L0564) – HEC-RAS 500-yr flow velocity distribution.

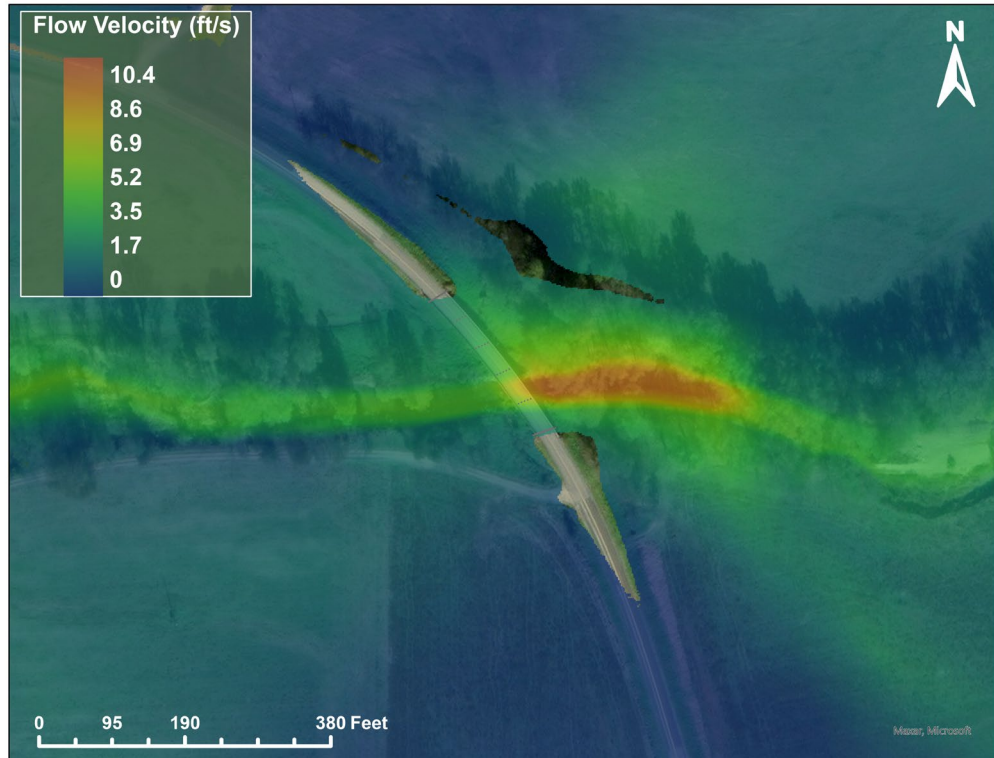


Figure D-11. Dry Fork Creek (L0564) – HEC-RAS 100-yr flow velocity distribution near the bridge section.

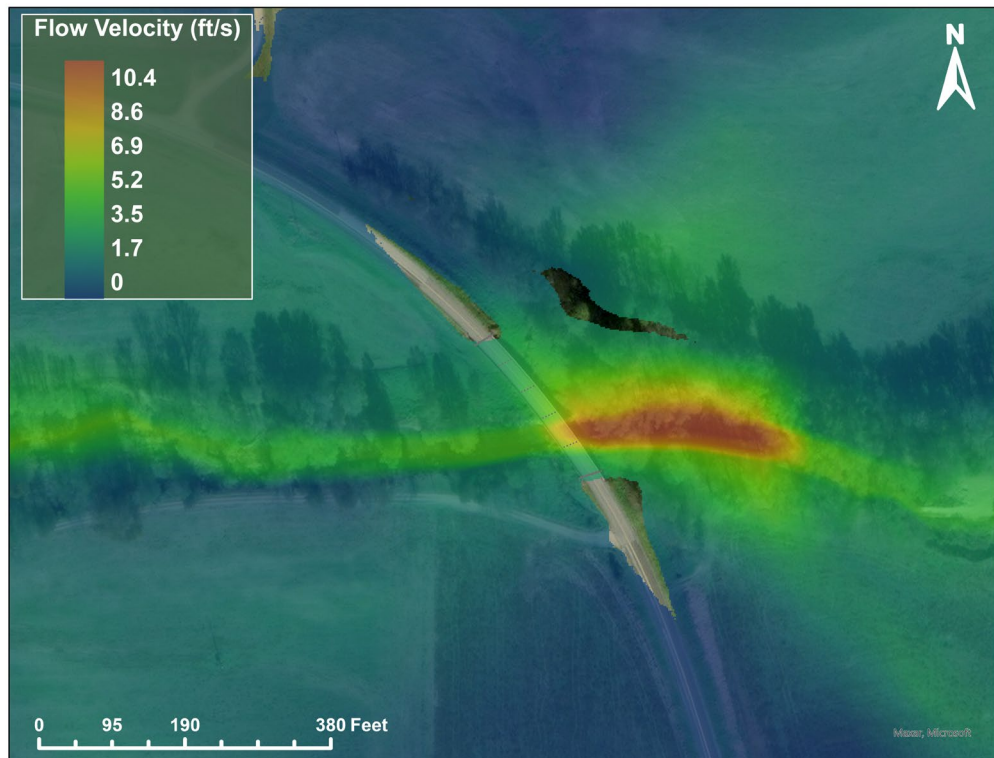


Figure D-12. Dry Fork Creek (L0564) – HEC-RAS 500-yr flow velocity distribution near the bridge section.

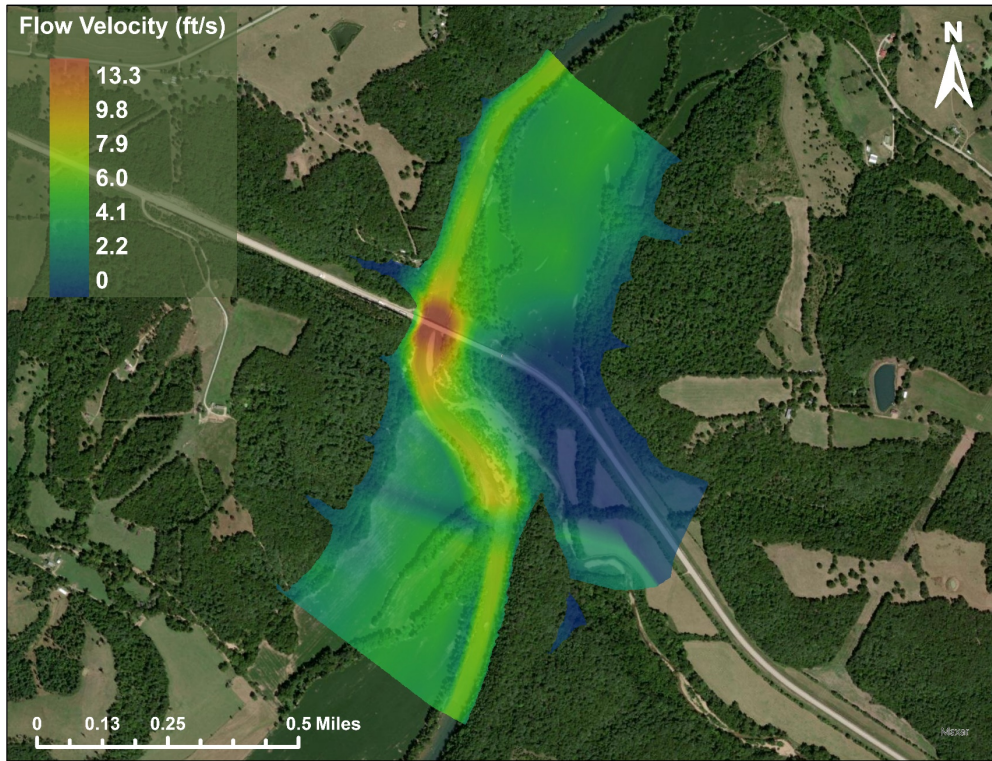


Figure D-13. Gasconade River (A3760) – HEC-RAS 100-yr flow velocity distribution.

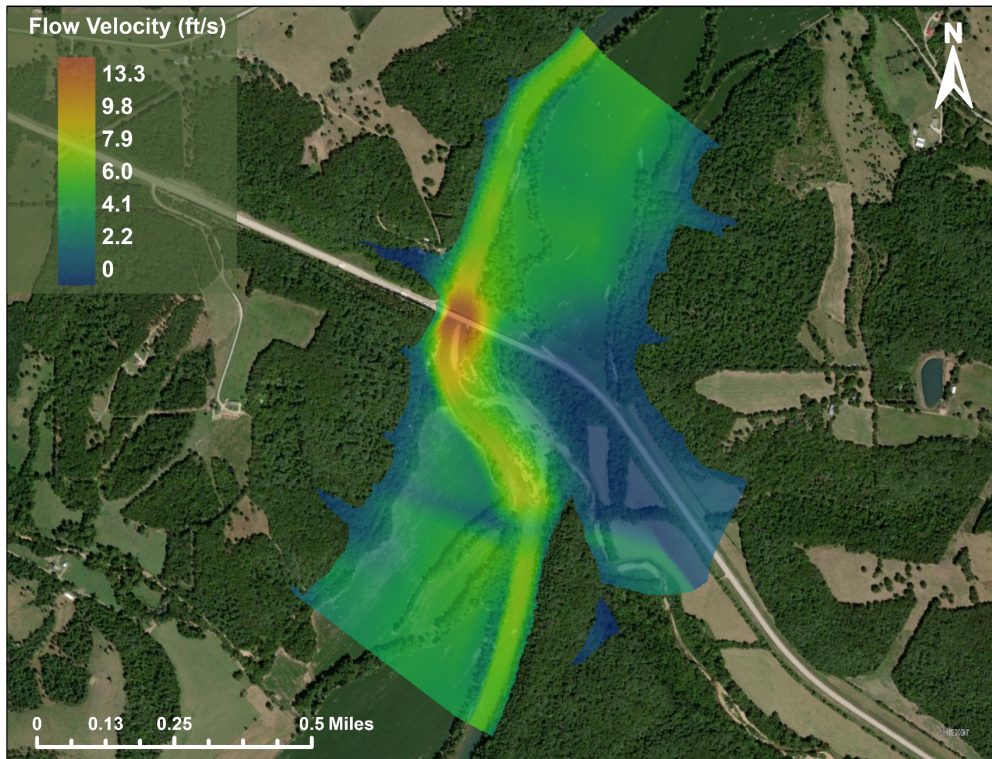


Figure D-14. Gasconade River (A3760) – HEC-RAS 500-yr flow velocity distribution.

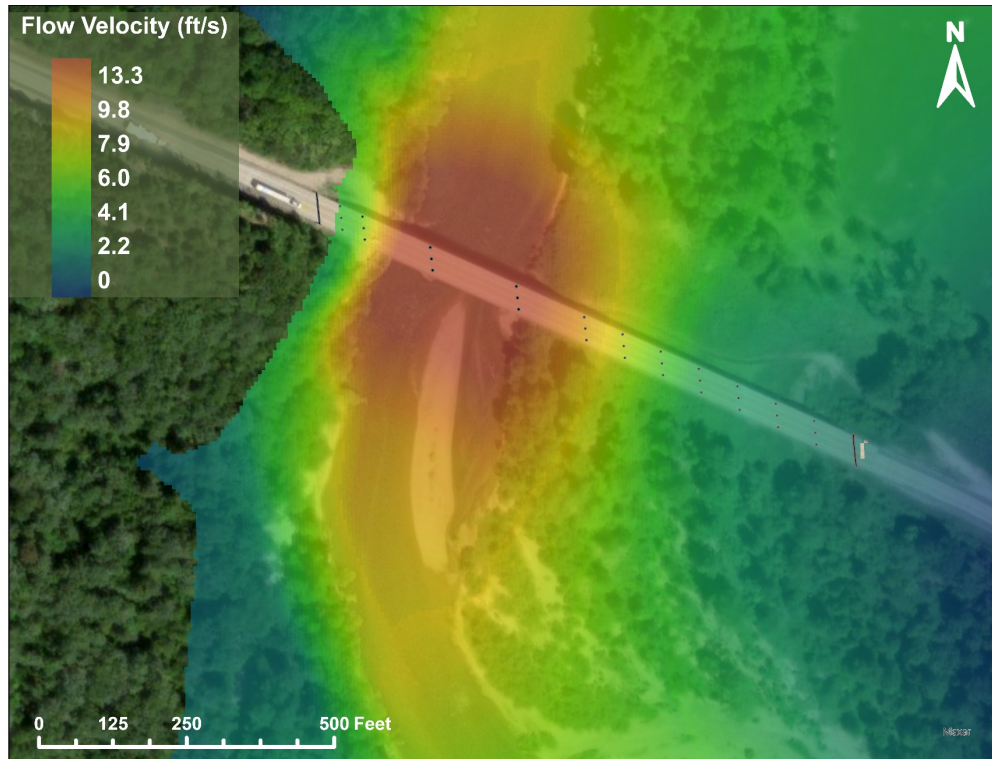


Figure D-15. Gasconade River (A3760) – HEC-RAS 100-yr flow velocity distribution near the bridge section.

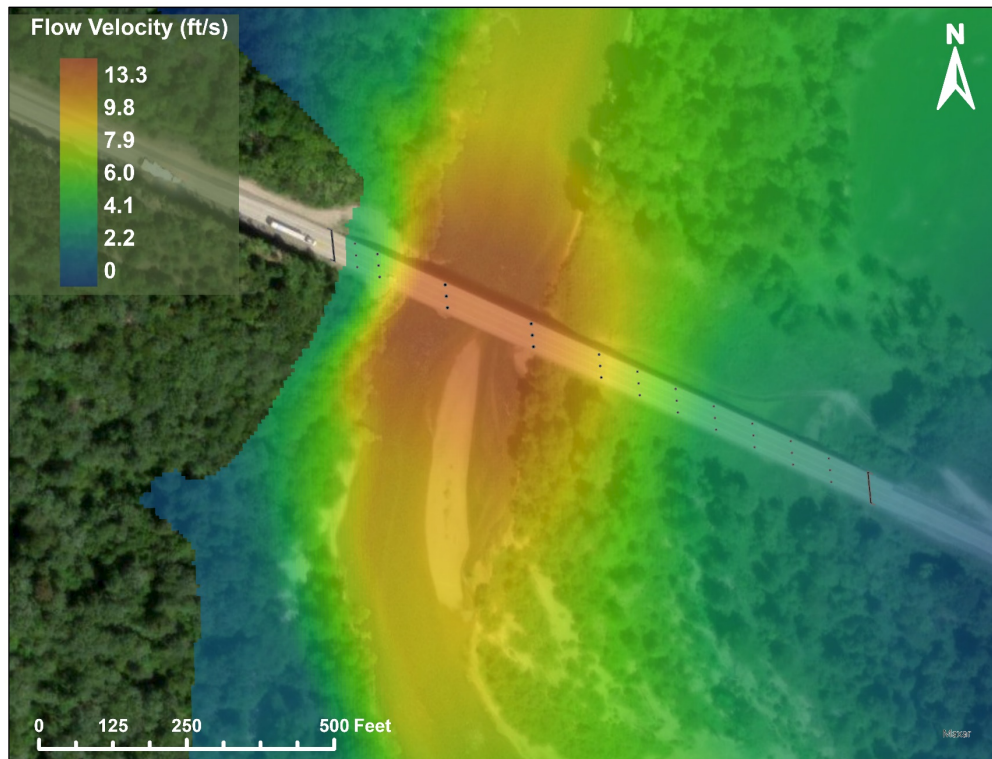


Figure D-16. Gasconade River (A3760) – HEC-RAS 500-yr flow velocity distribution near the bridge section.

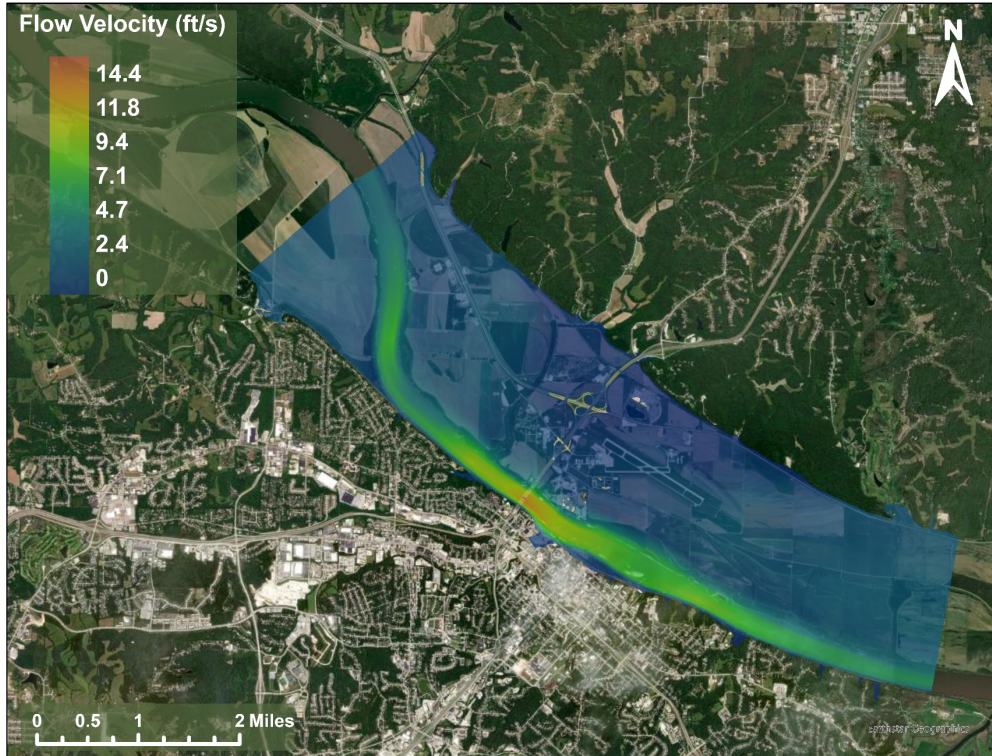


Figure D-17. Missouri River (L0550) – HEC-RAS 100-yr flow velocity distribution.

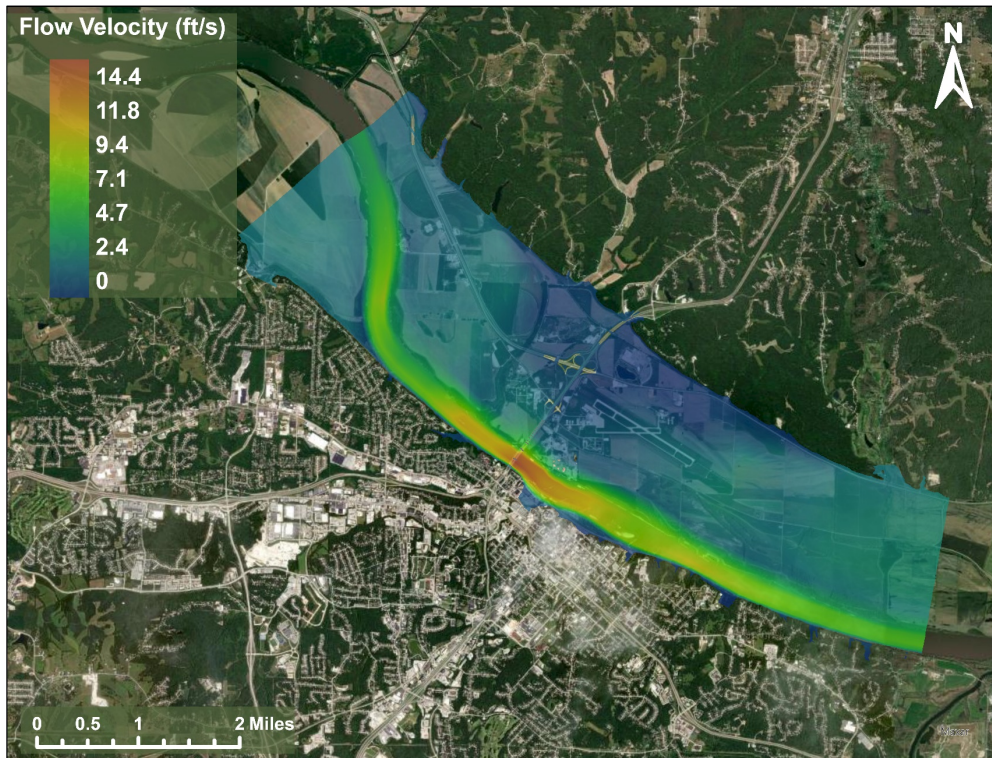


Figure D-18. Missouri River (L0550) – HEC-RAS 500-yr flow velocity distribution.

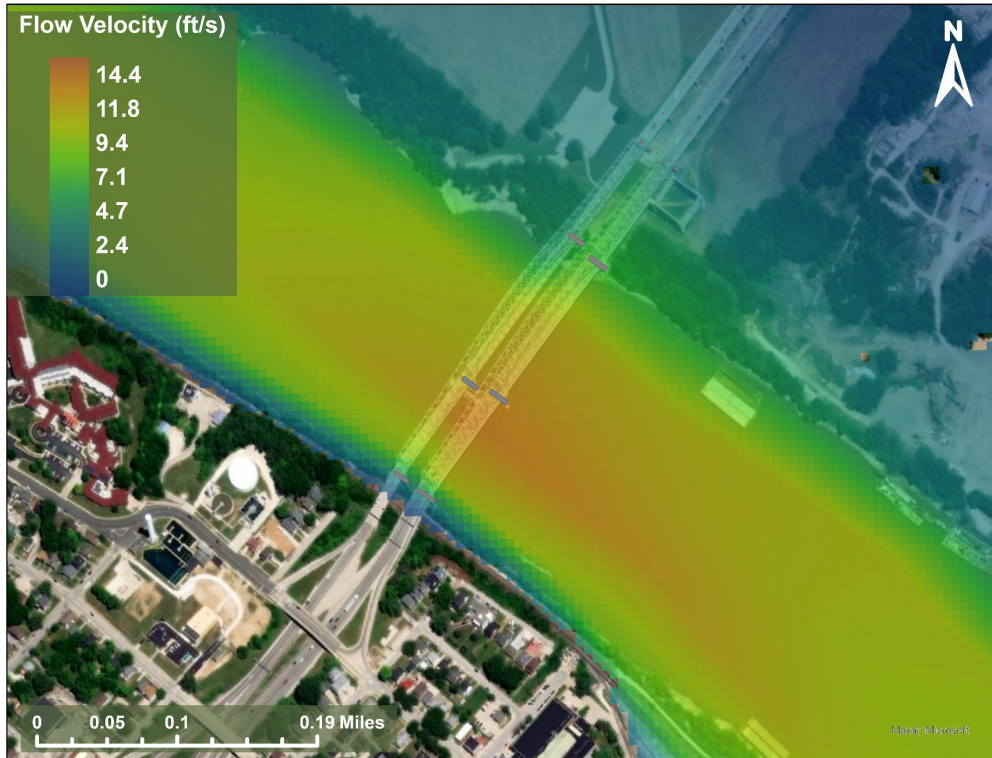


Figure D-19. Missouri River (L0550) – HEC-RAS 100-yr flow velocity distribution - Inset.

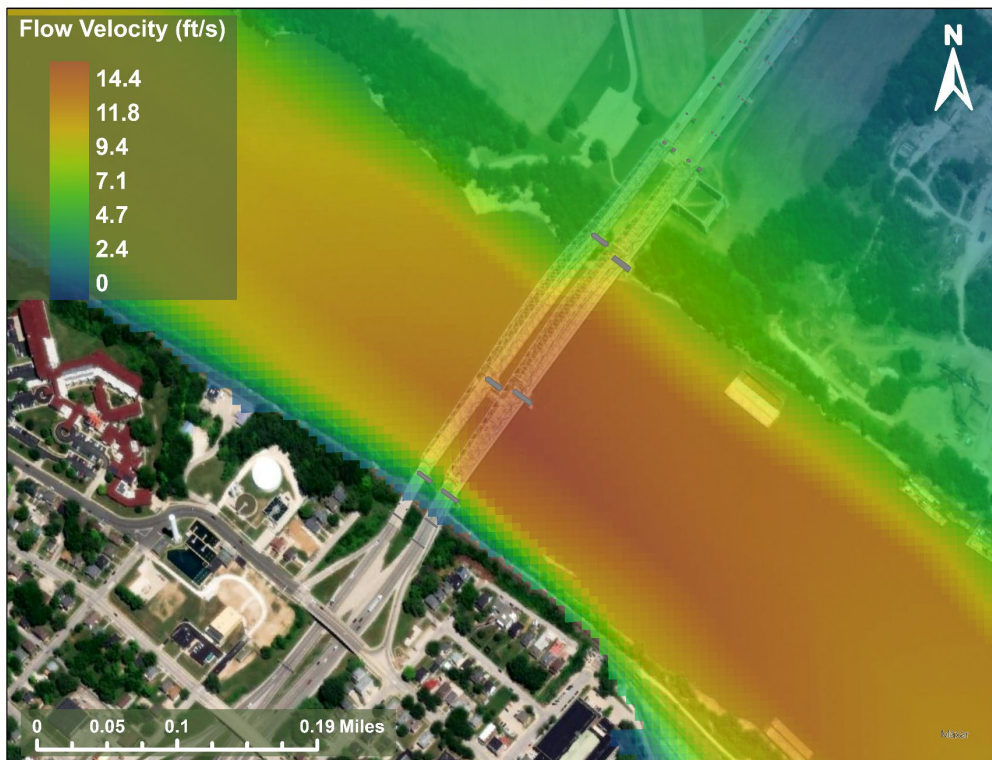


Figure D-20. Missouri River (L0550) – HEC-RAS 500-yr flow velocity distribution - Inset.

APPENDIX E: 2-D HYDRUALIC MODELING VELOCITY DISTRIBITONS

Remainder of page intentionally left blank.

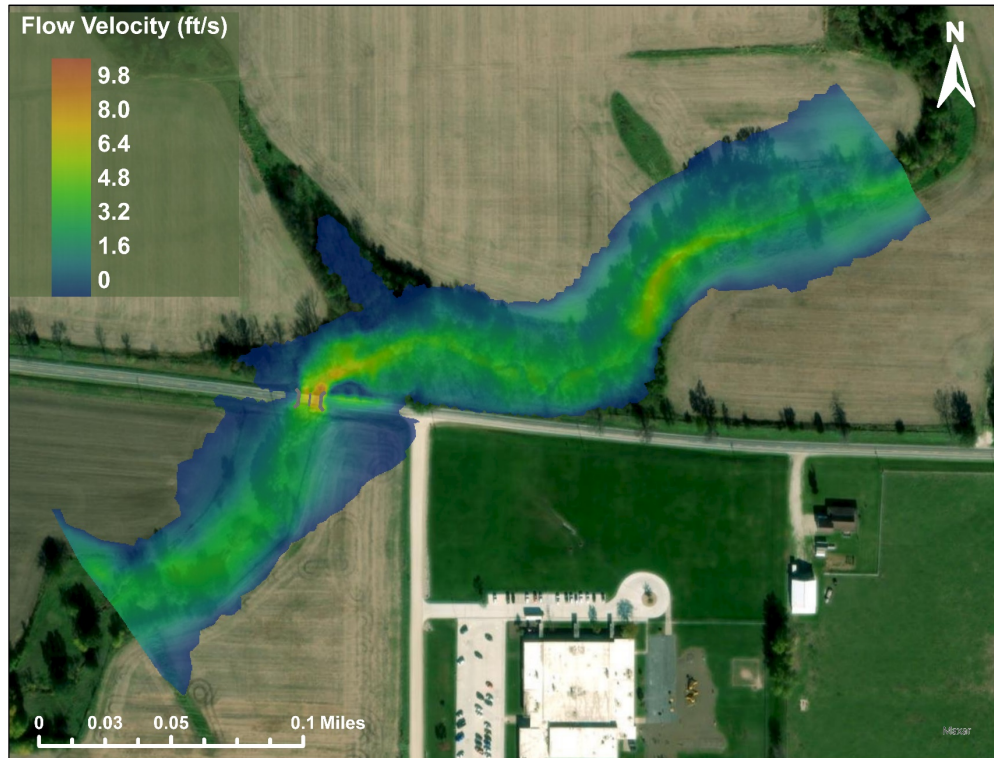


Figure E-1. Creek (H-0024) – SRH-2D 100-yr flow velocity distribution.

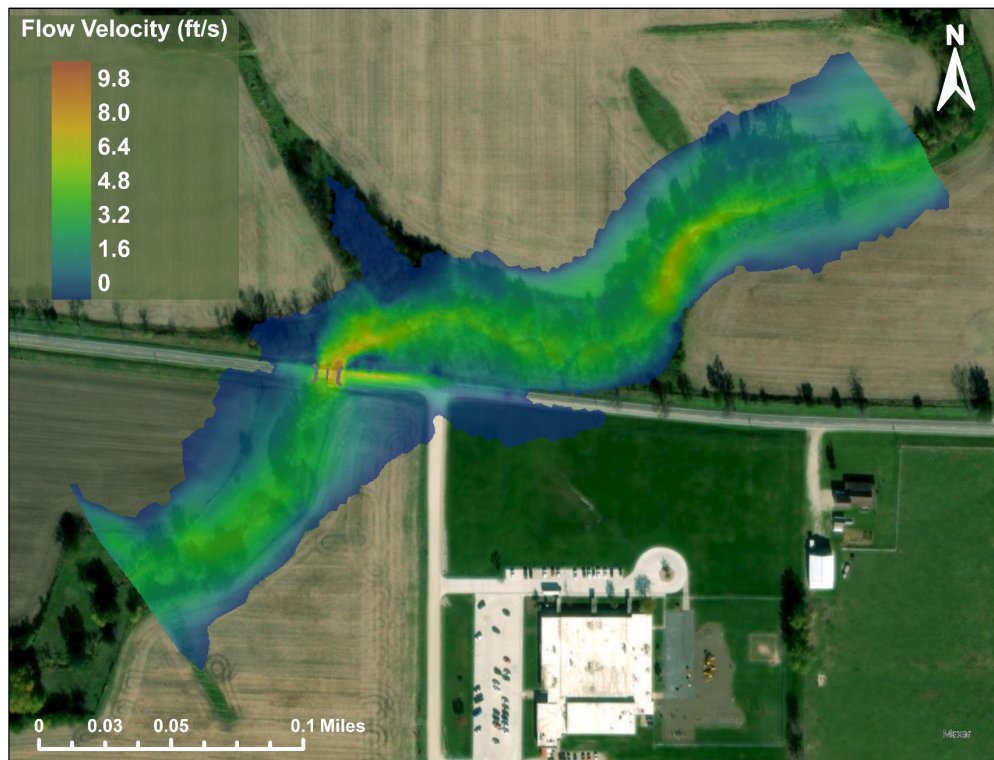


Figure E-2. Creek (H-0024) – SRH-2D 500-yr flow velocity distribution.

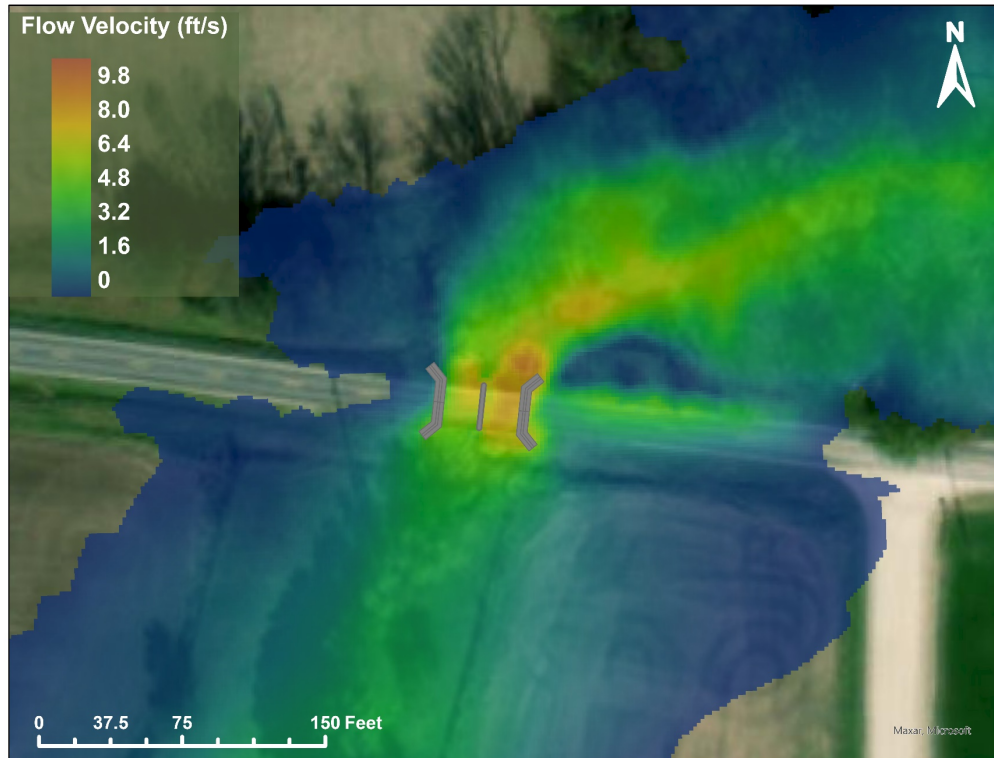


Figure E-3. Creek (H-0024) – SRH-2D 100-yr flow velocity distribution near the bridge section.

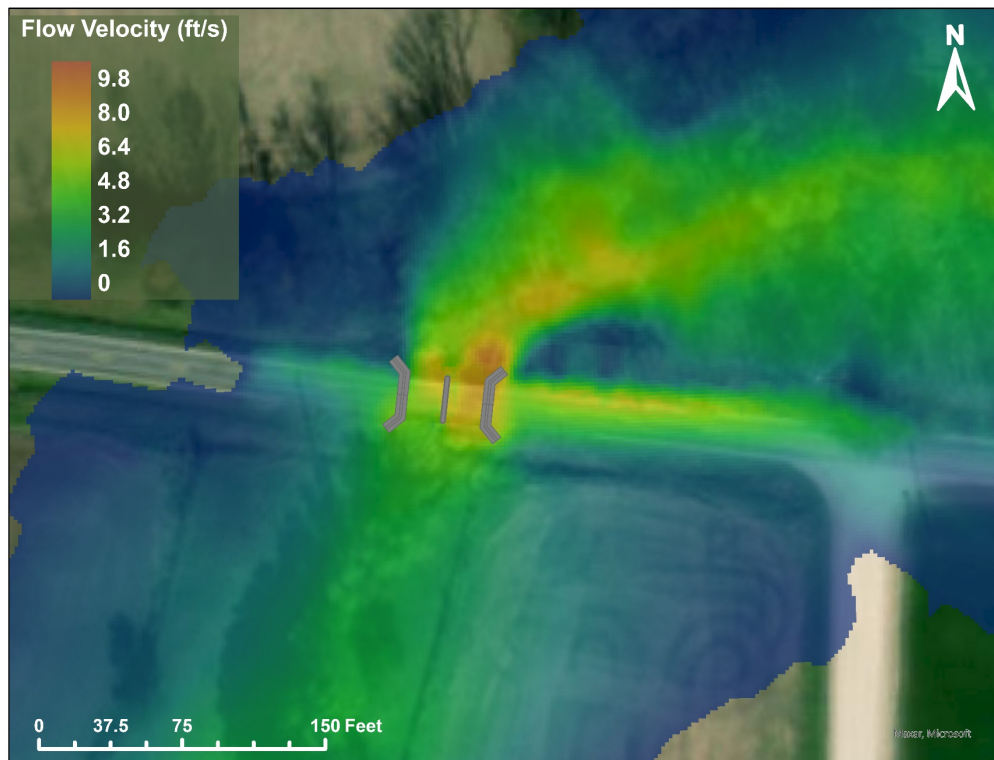


Figure E-4. Creek (H-0024) – SRH-2D 500-yr flow velocity distribution near the bridge section.

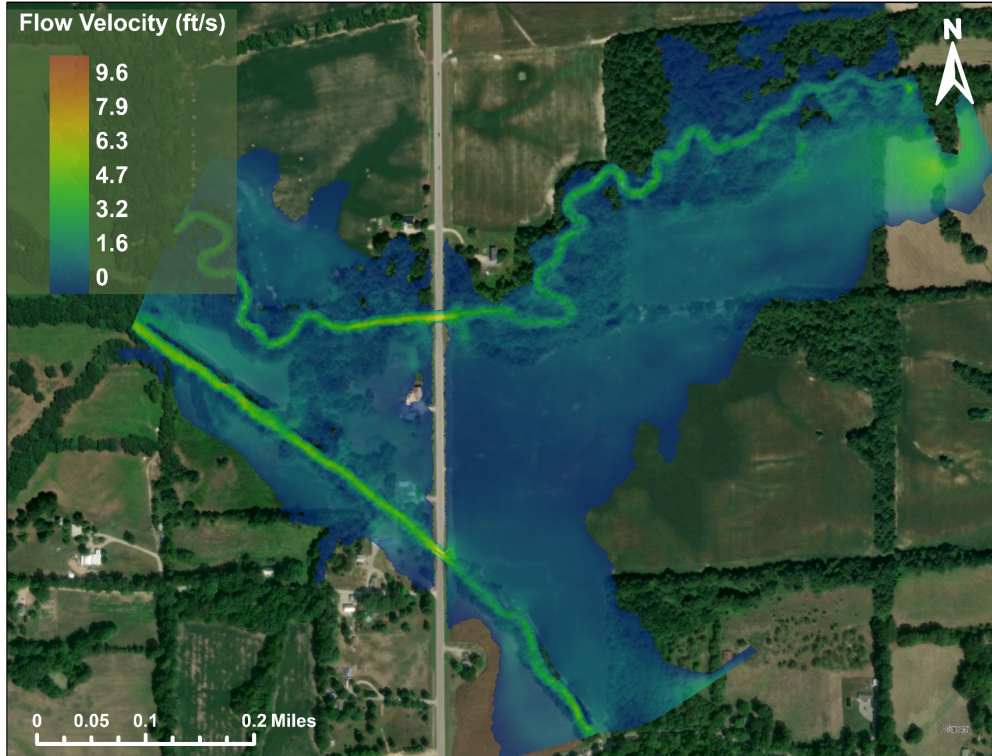


Figure E-5. Wolf Creek (L-0022) – SRH-2D 100-yr flow velocity distribution.

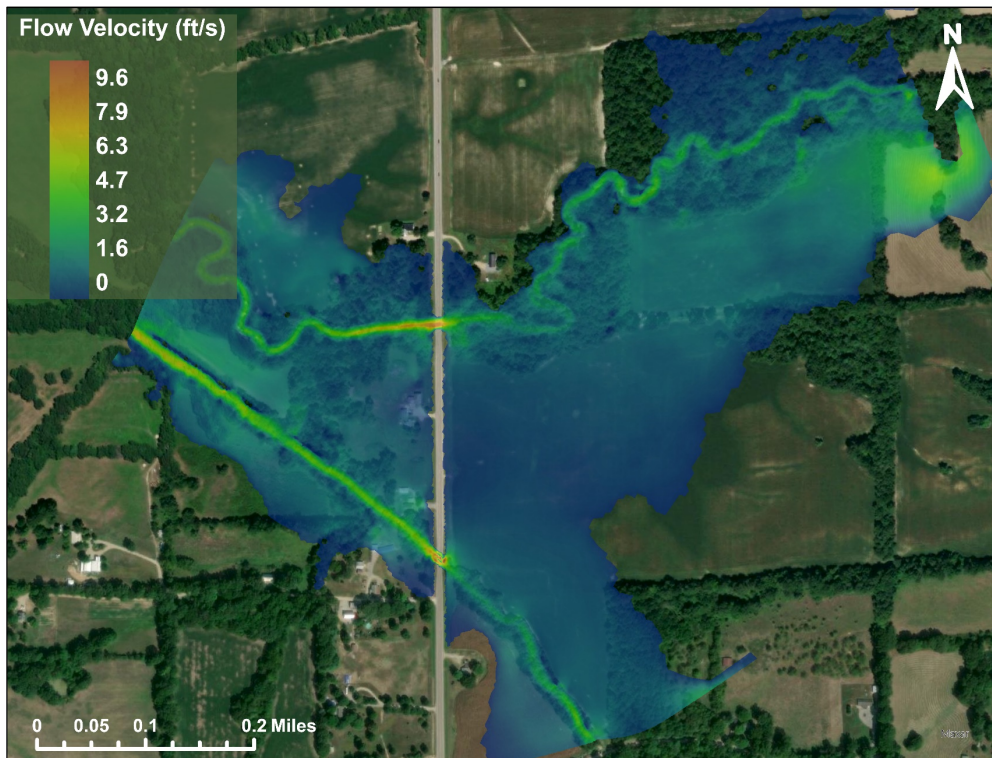


Figure E-6. Wolf Creek (L-0022) – SRH-2D 500-yr flow velocity distribution.

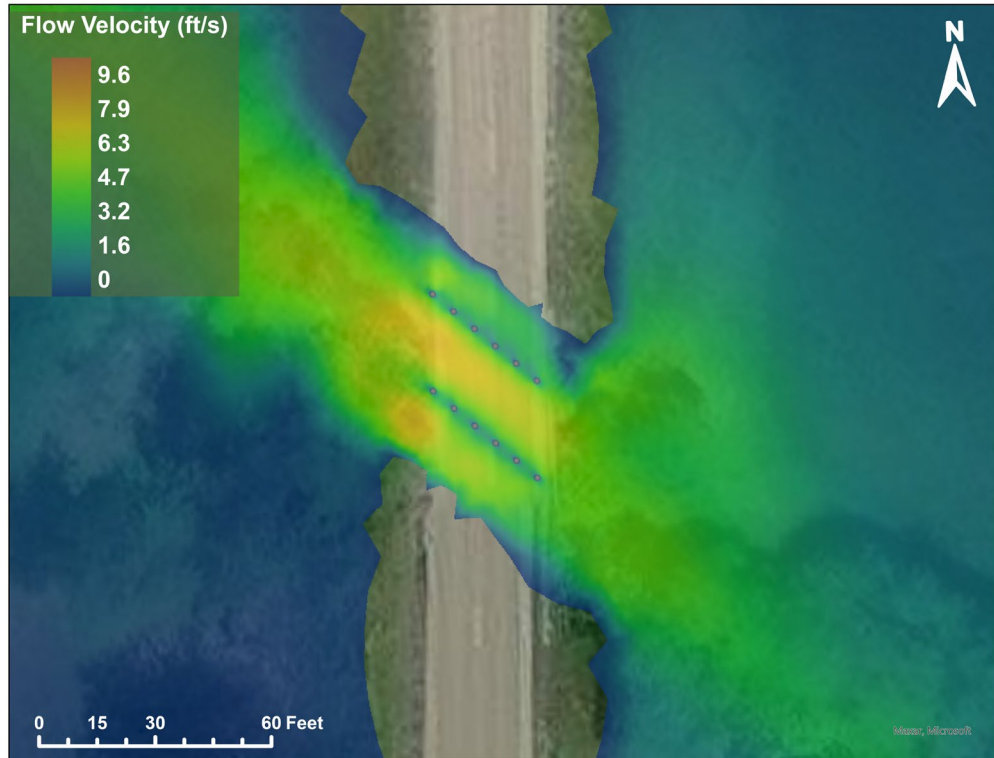


Figure E-7. Wolf Creek (L-0022) – SRH-2D 100-yr flow velocity distribution near the bridge section.

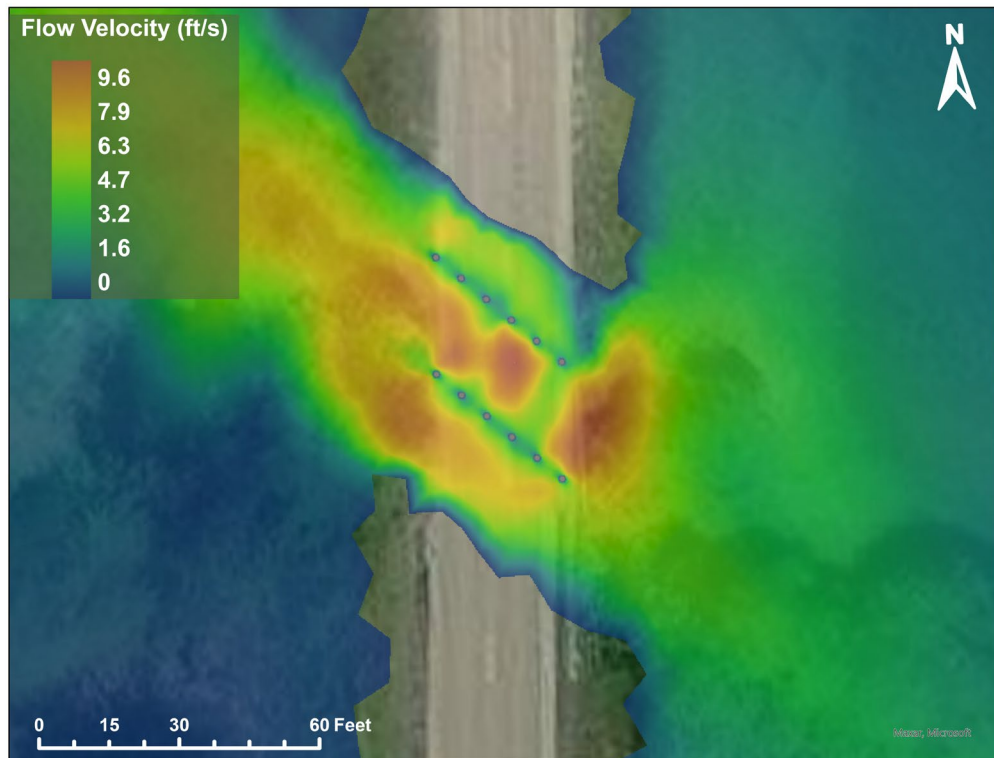


Figure E-8. Wolf Creek (L-0022) – SRH-2D 500-yr flow velocity distribution near the bridge section.

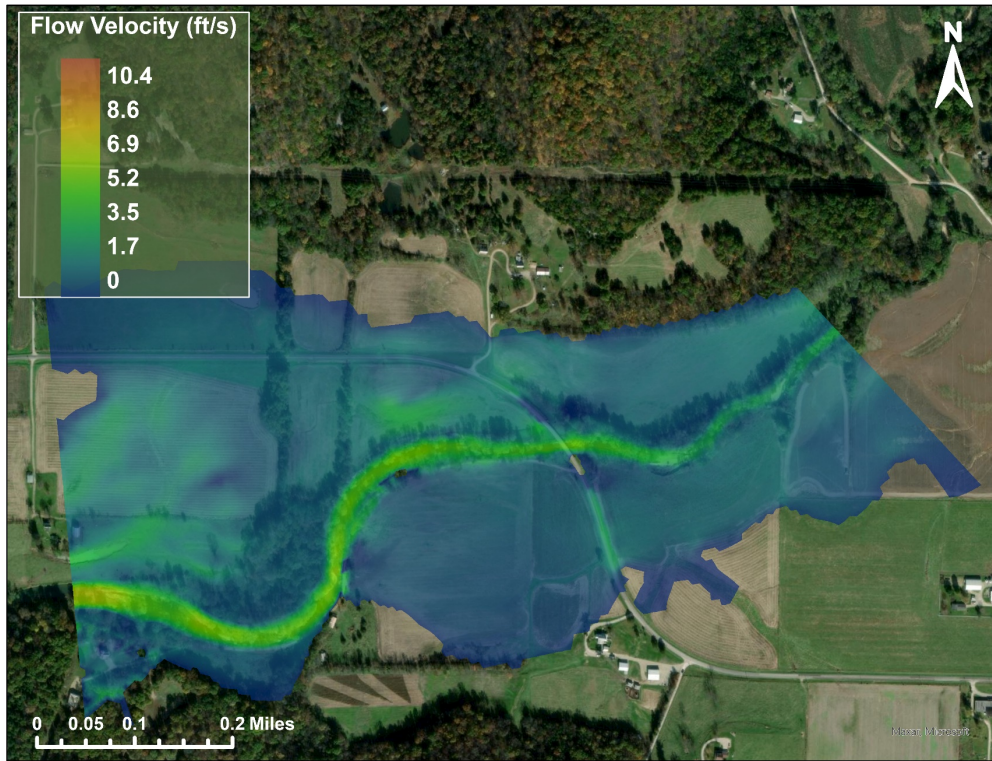


Figure E-9. Dry Fork Creek (L0564) – SRH-2D 100-yr flow velocity distribution.

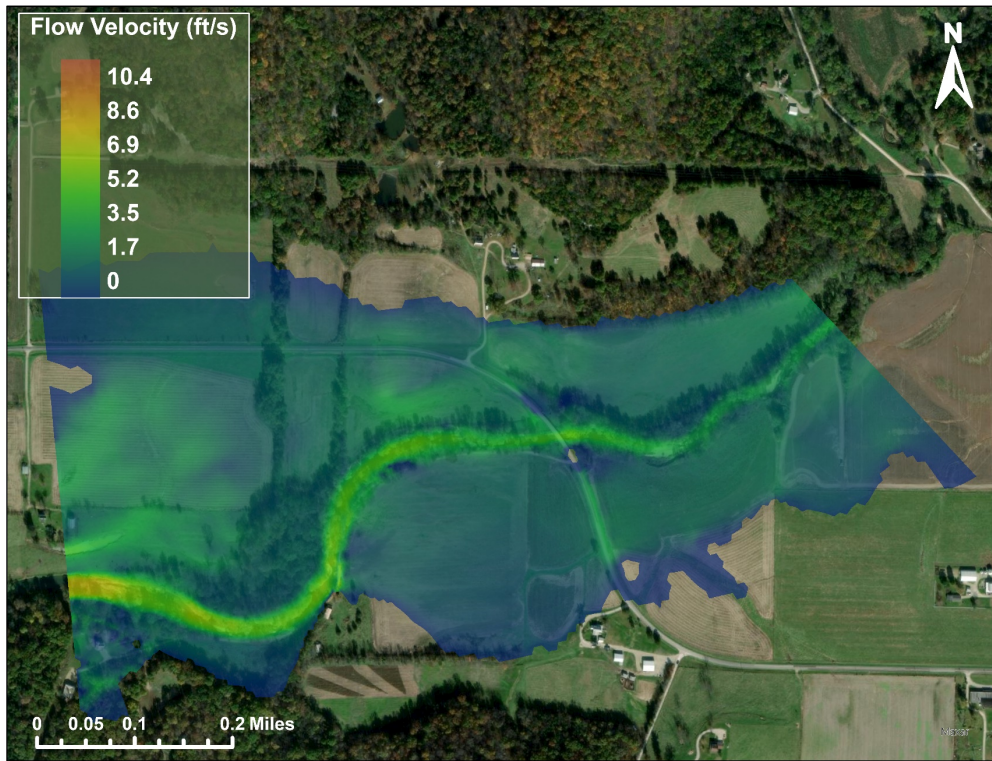


Figure E-10. Dry Fork Creek (L0564) – SRH-2D 500-yr flow velocity distribution.

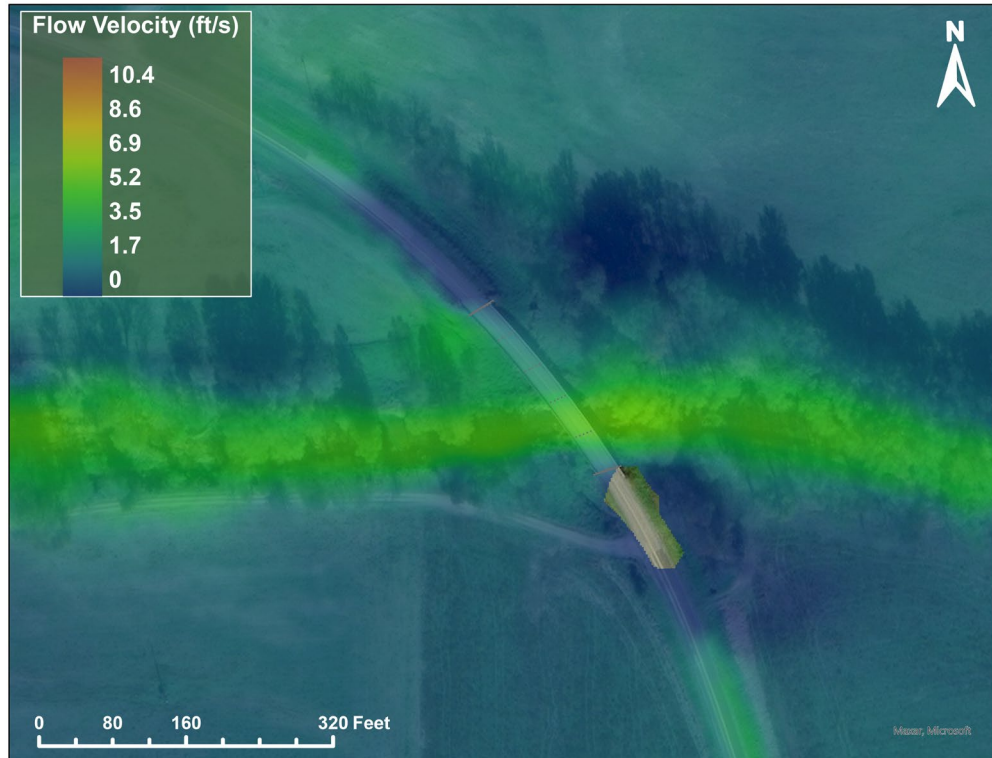


Figure E-11. Dry Fork Creek (L0564) – SRH-2D 100-yr flow velocity distribution near the bridge section.

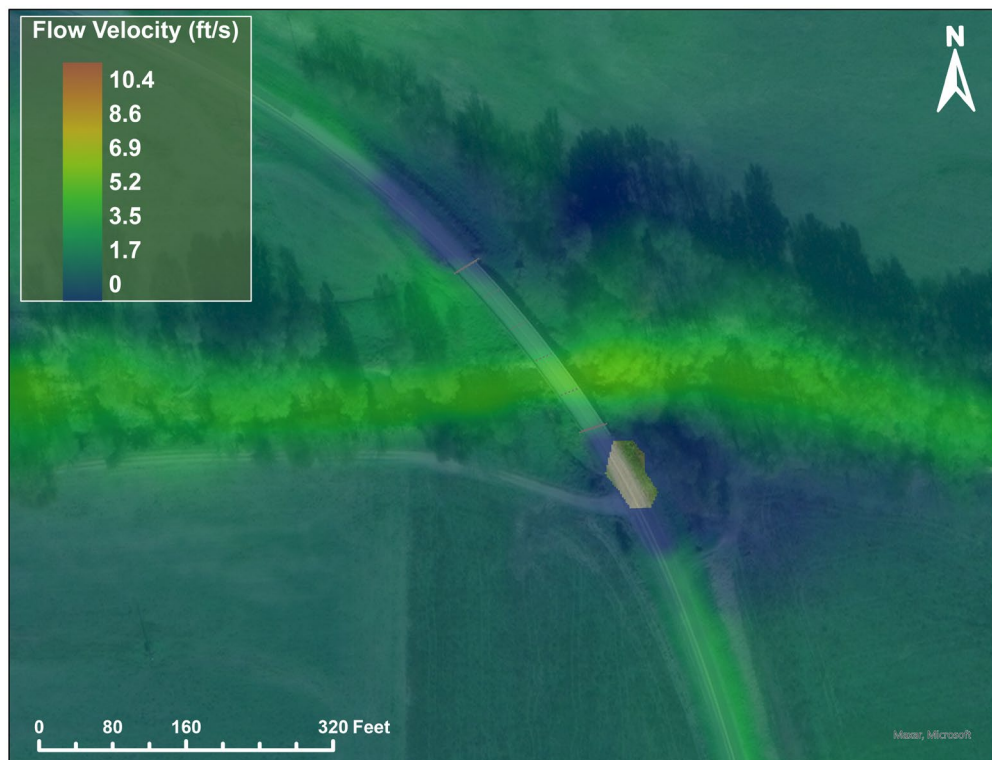


Figure E-12. Dry Fork Creek (L0564) – SRH-2D 500-yr flow velocity distribution near the bridge section.

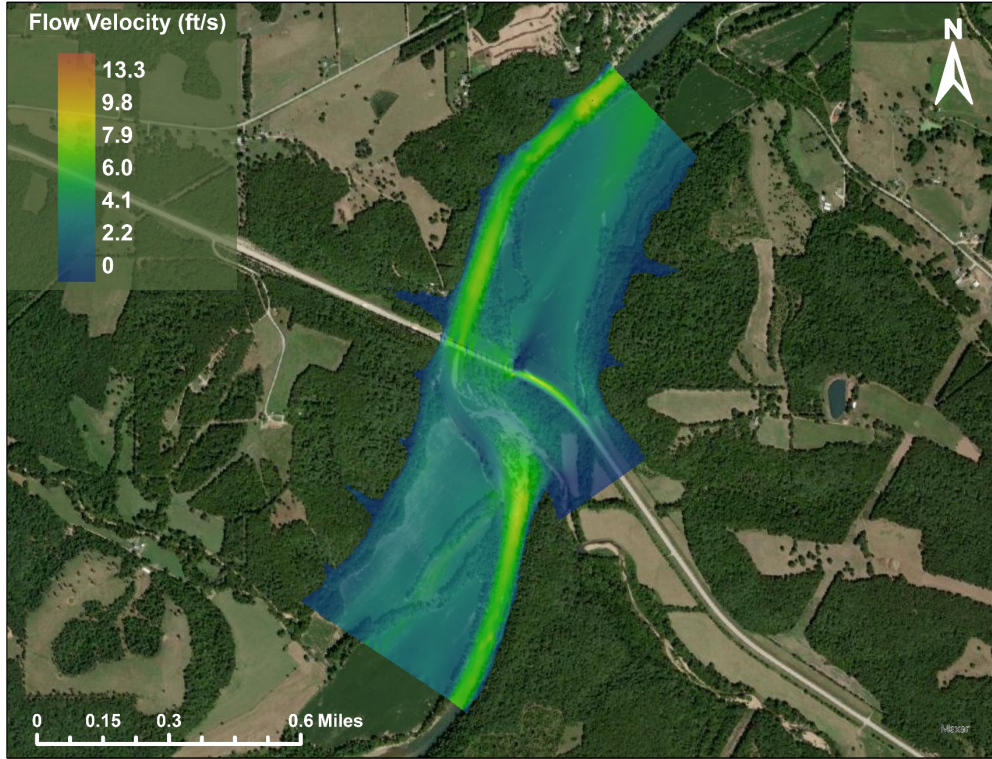


Figure E-13. Gasconade River (A3760) – SRH-2D 100-yr flow velocity distribution.

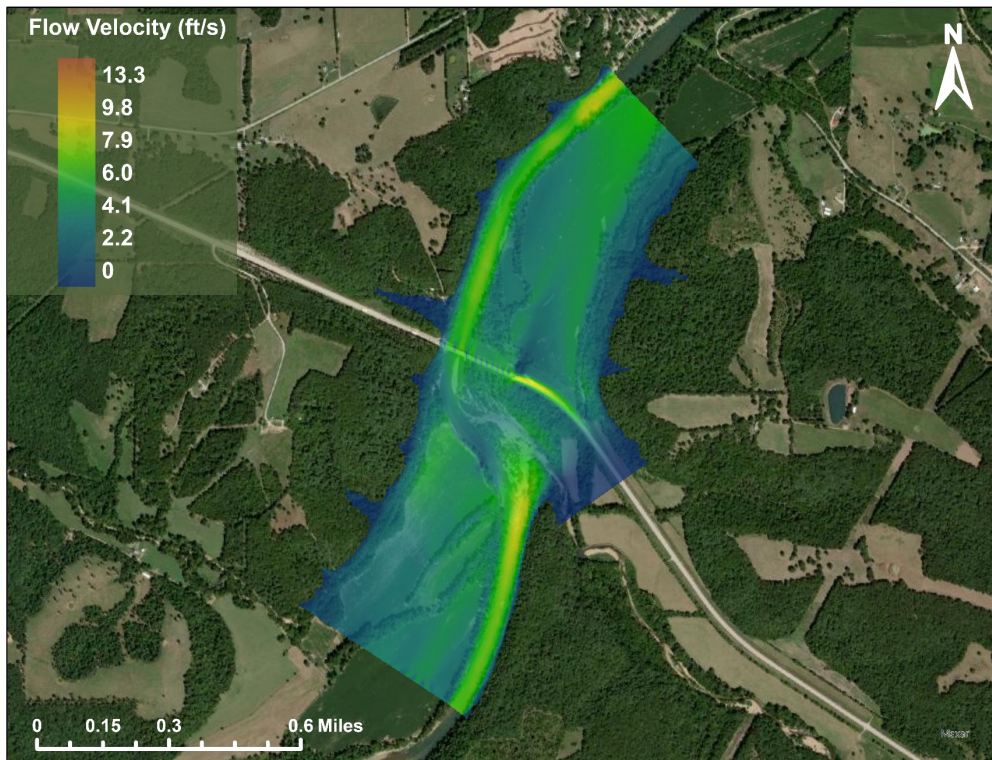


Figure E-14. Gasconade River (A3760) – SRH-2D 500-yr flow velocity distribution.

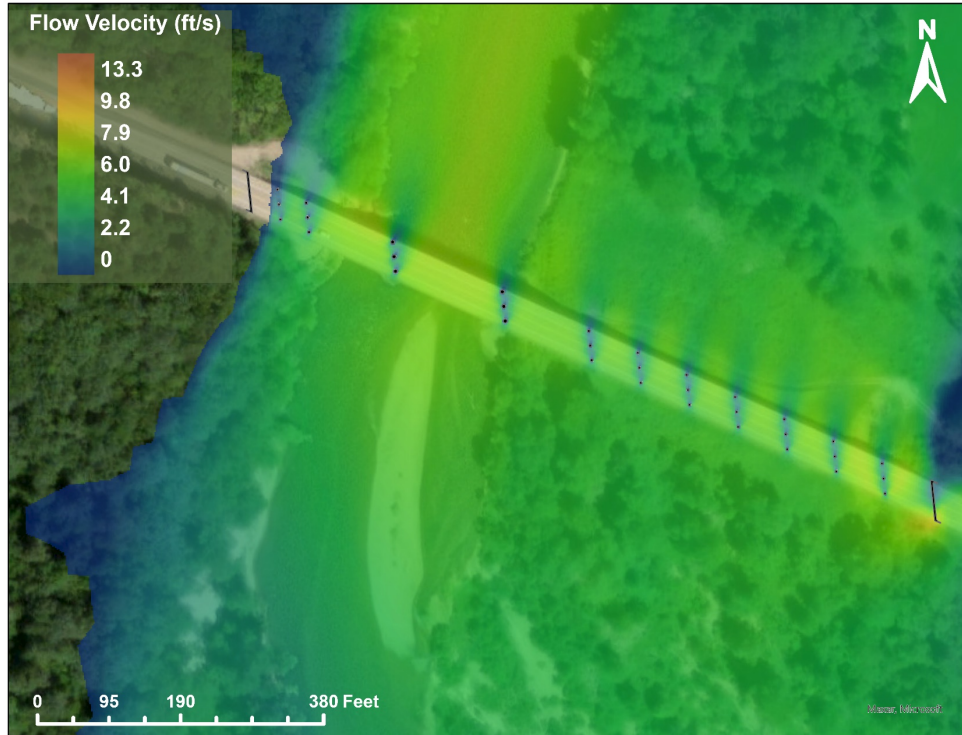


Figure E-15. Gasconade River (A3760) – SRH-2D 100-yr flow velocity distribution near the bridge section.

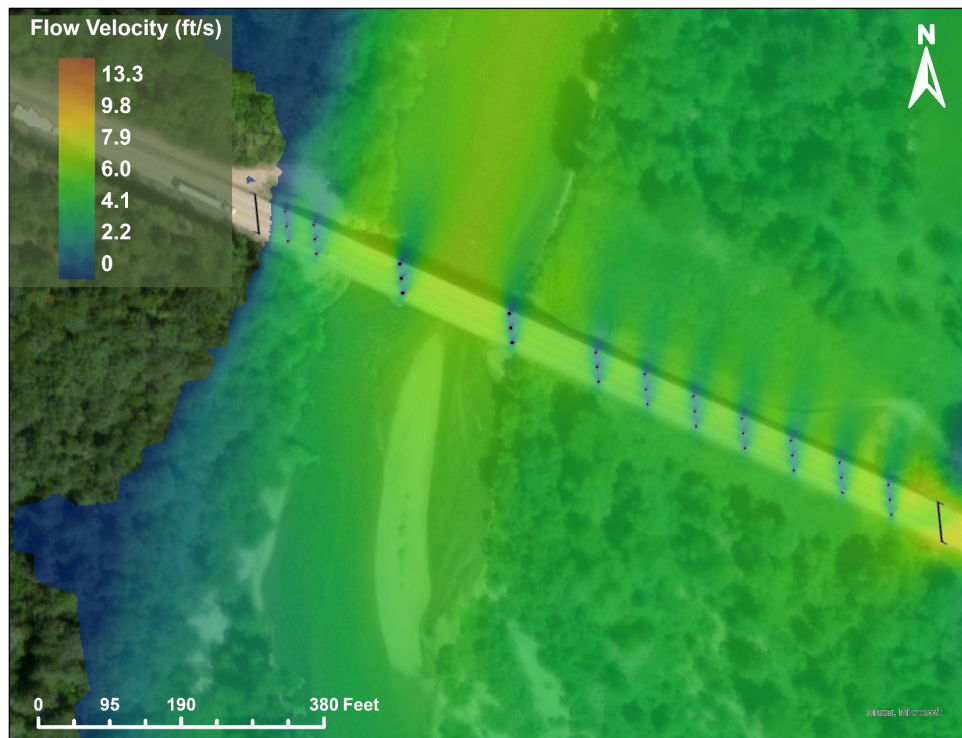


Figure E-16. Gasconade River (A3760) – SRH-2D 500-yr flow velocity distribution near the bridge section.

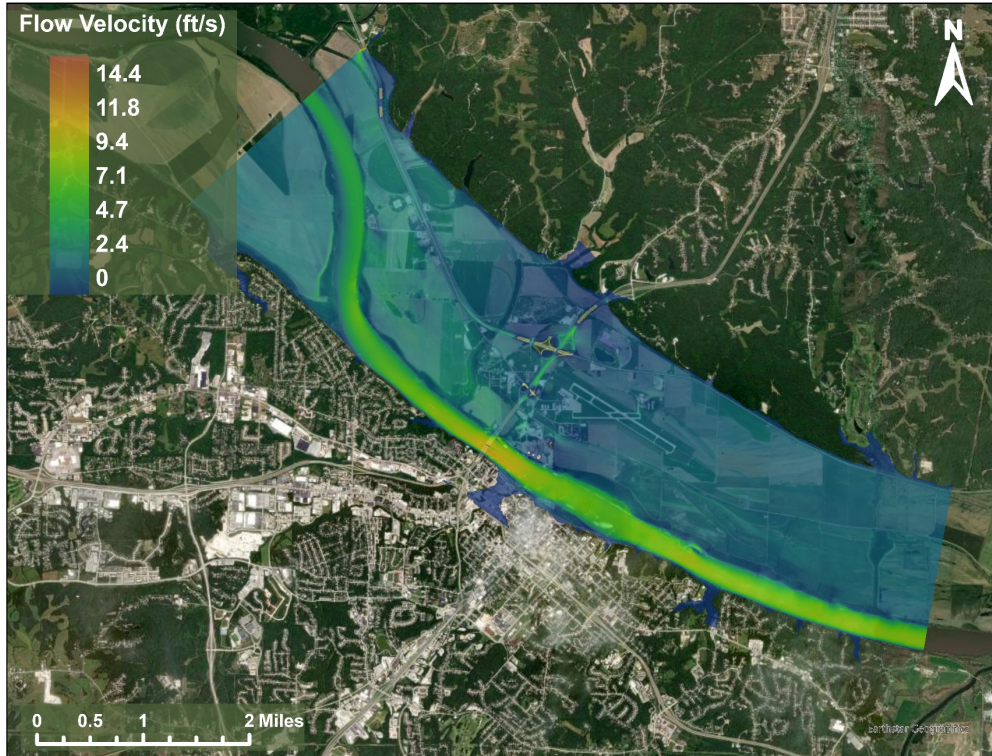


Figure E-17. Missouri River (L0550) – SRH-2D 100-yr flow velocity distribution.

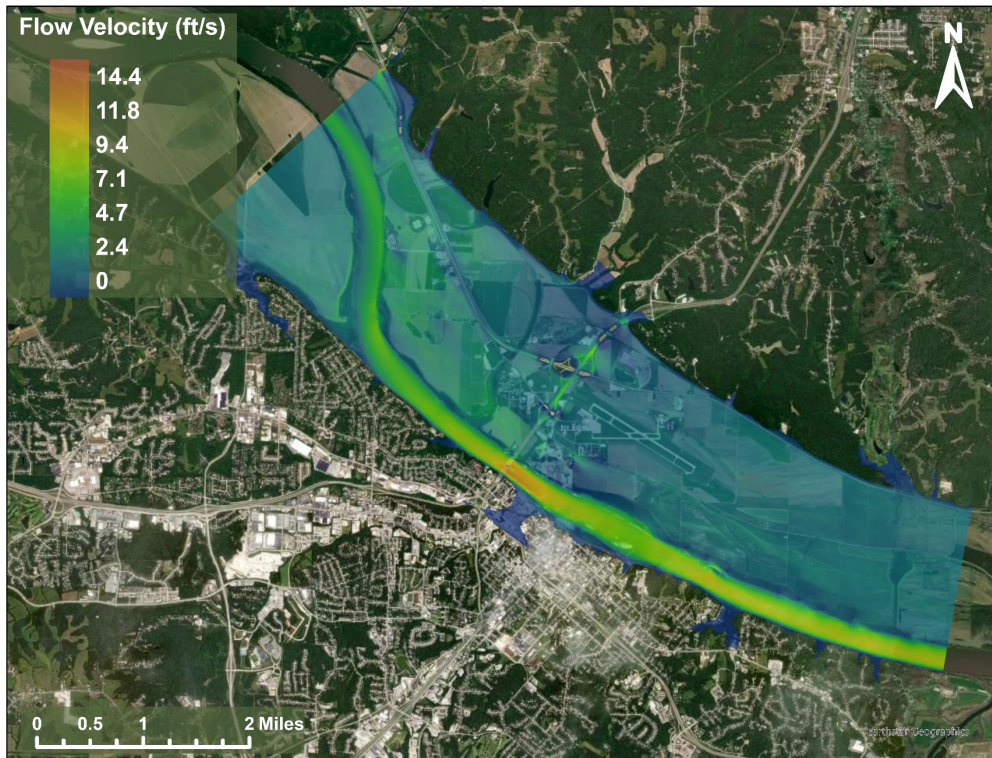


Figure E-18. Missouri River (L0550) – SRH-2D 500-yr flow velocity distribution.

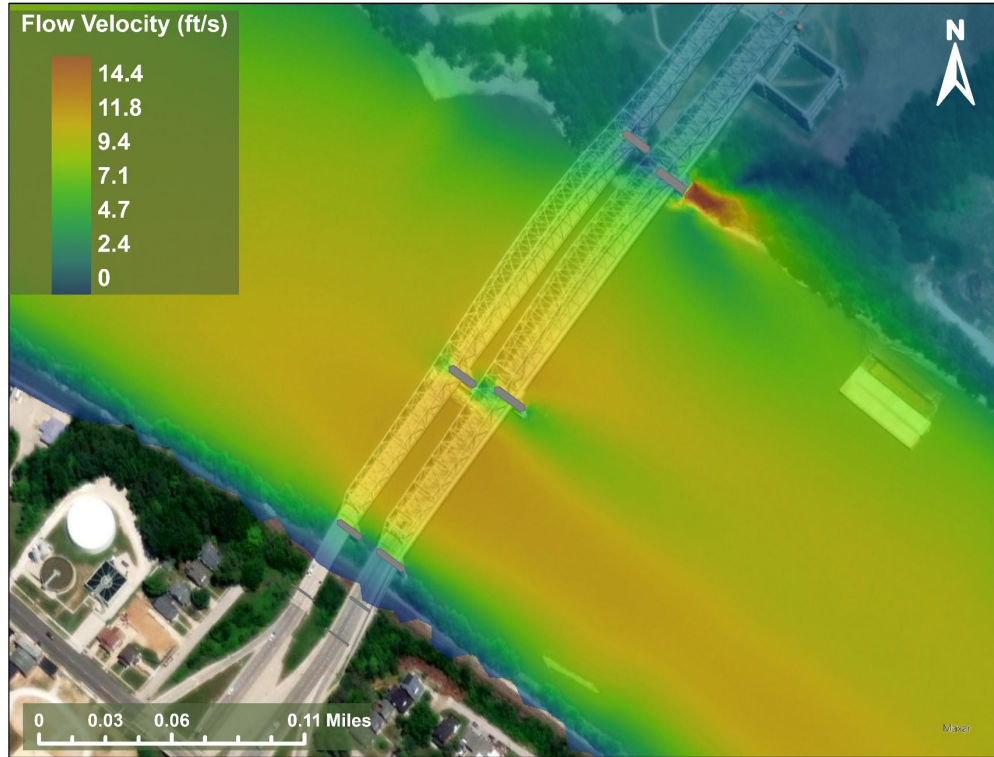


Figure E-19. Missouri River (L0550) – SRH-2D 100-yr flow velocity distribution near the bridge section.

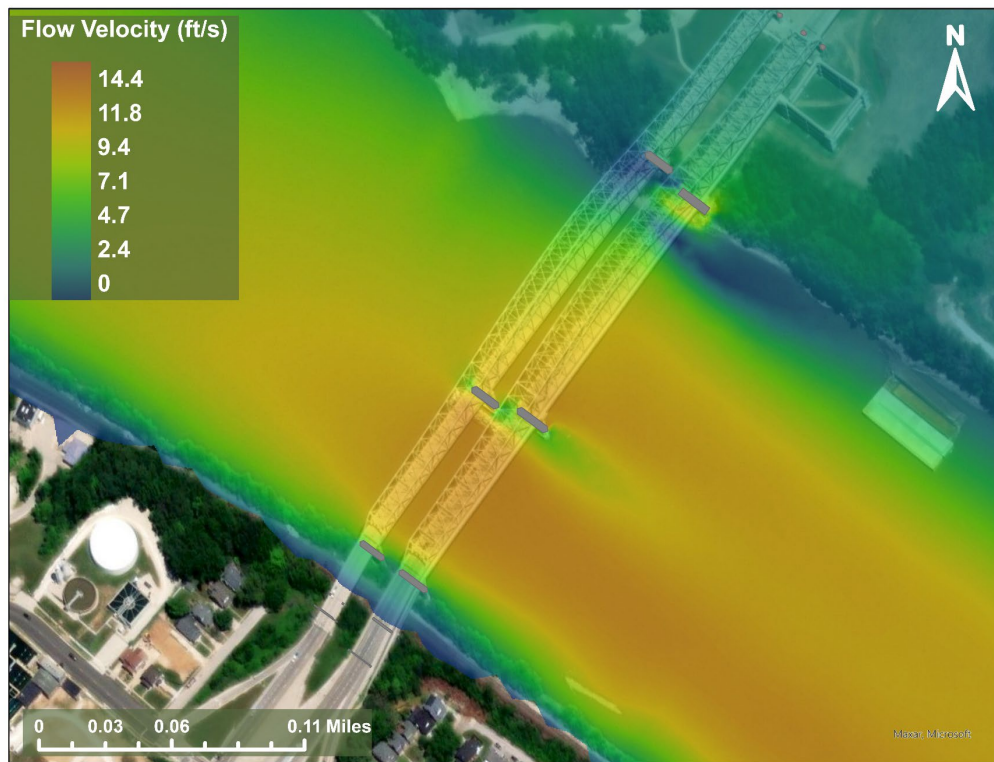


Figure E-20. Missouri River (L0550) – SRH-2D 500-yr flow velocity distribution near the bridge section.

APPENDIX F: BRIDGE SCOUR ANALYSIS RESULTS FOR 1-D HYDRAULIC MODELING

Remainder of page intentionally left blank.

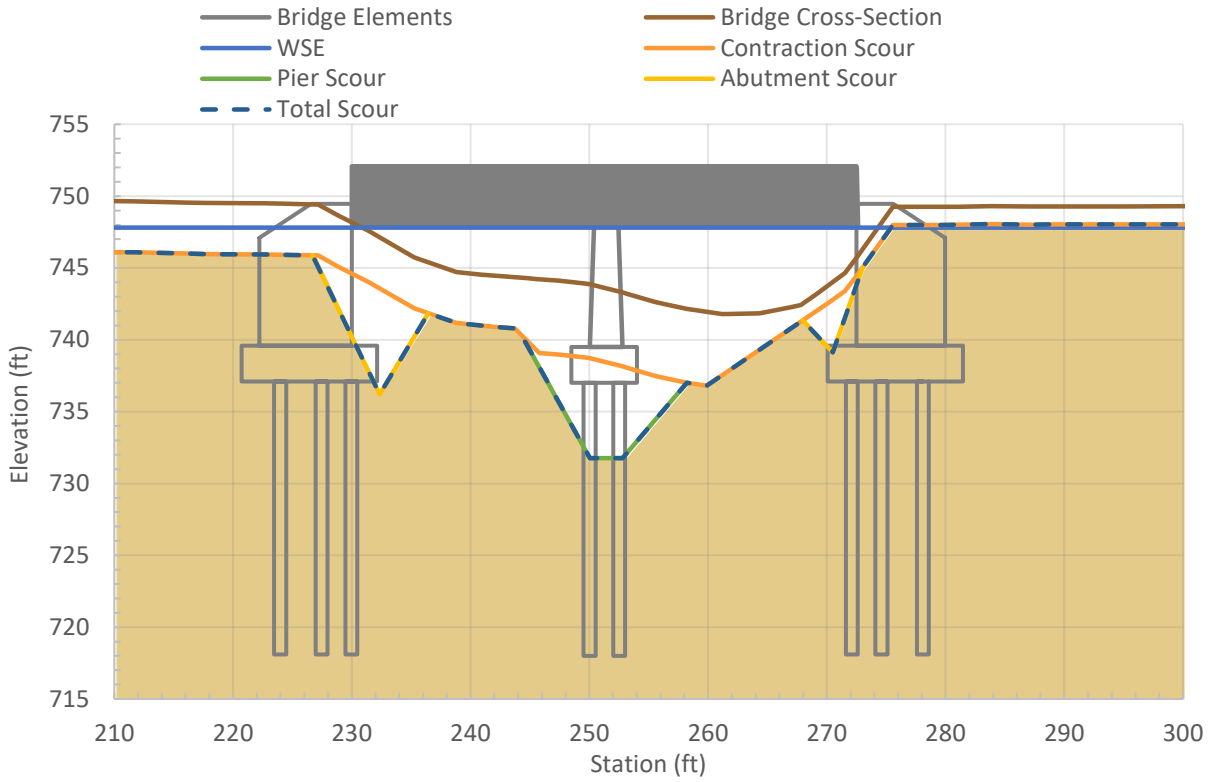
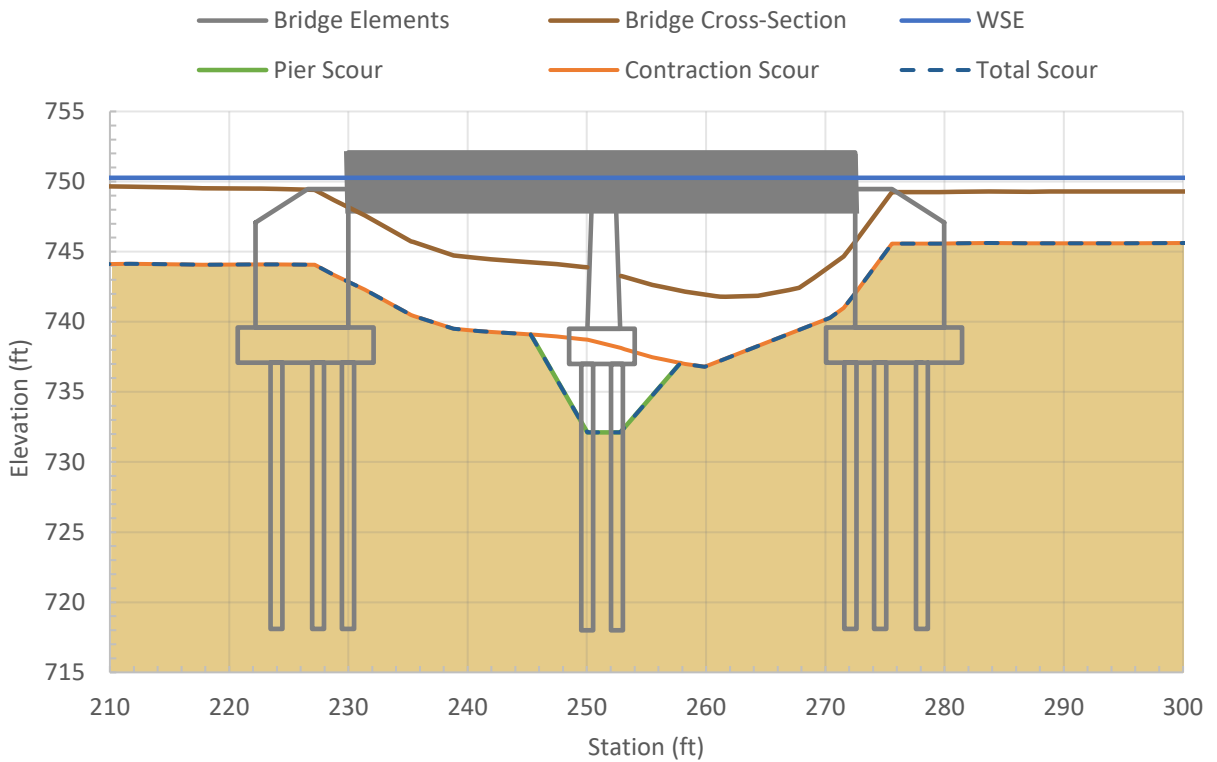


Figure F-1. Creek (H-0024) – HEC-RAS 100-yr scour plot.



Note: Pressure flow contraction scour elevation on the left and right overbank areas is lower than the abutment scour elevation. Thus, abutment scour is not illustrated here for the total scour analysis.

Figure F-2. Creek (H-0024) – HEC-RAS 500-yr scour plot.

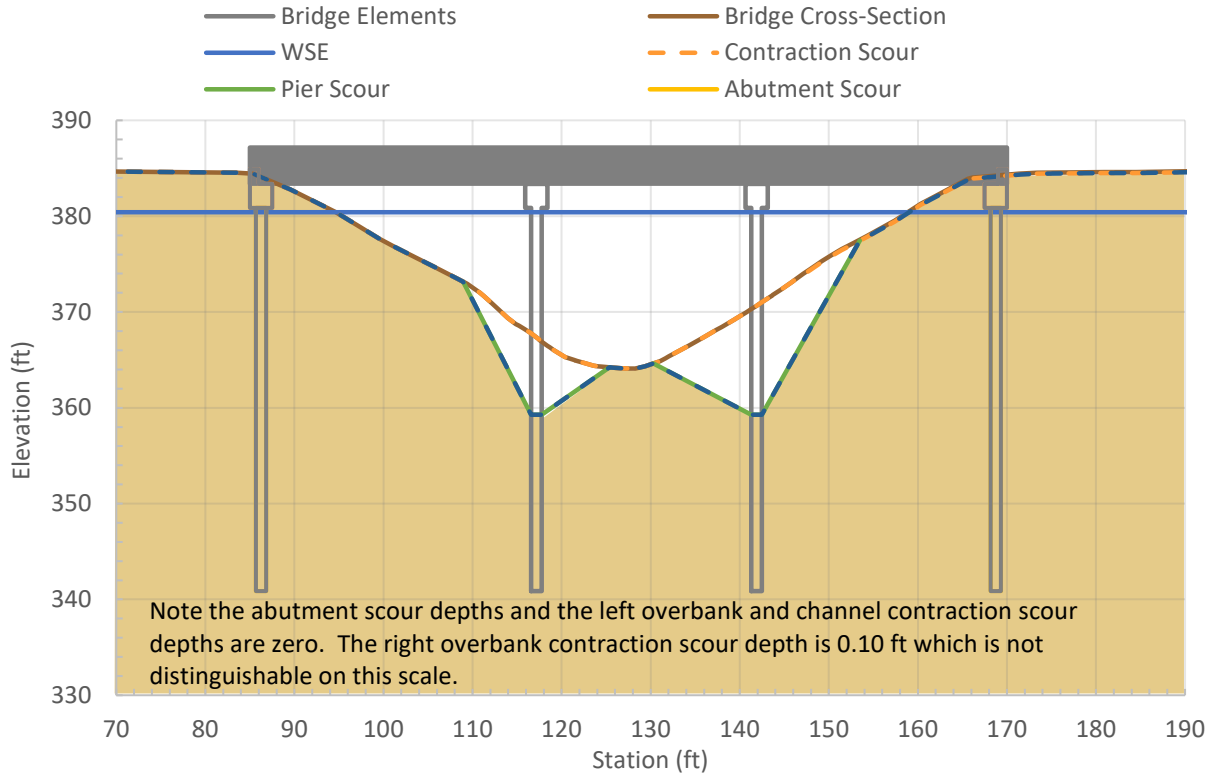


Figure F-3. Wolf Creek (L-0022) – HEC-RAS 100-yr scour plot.

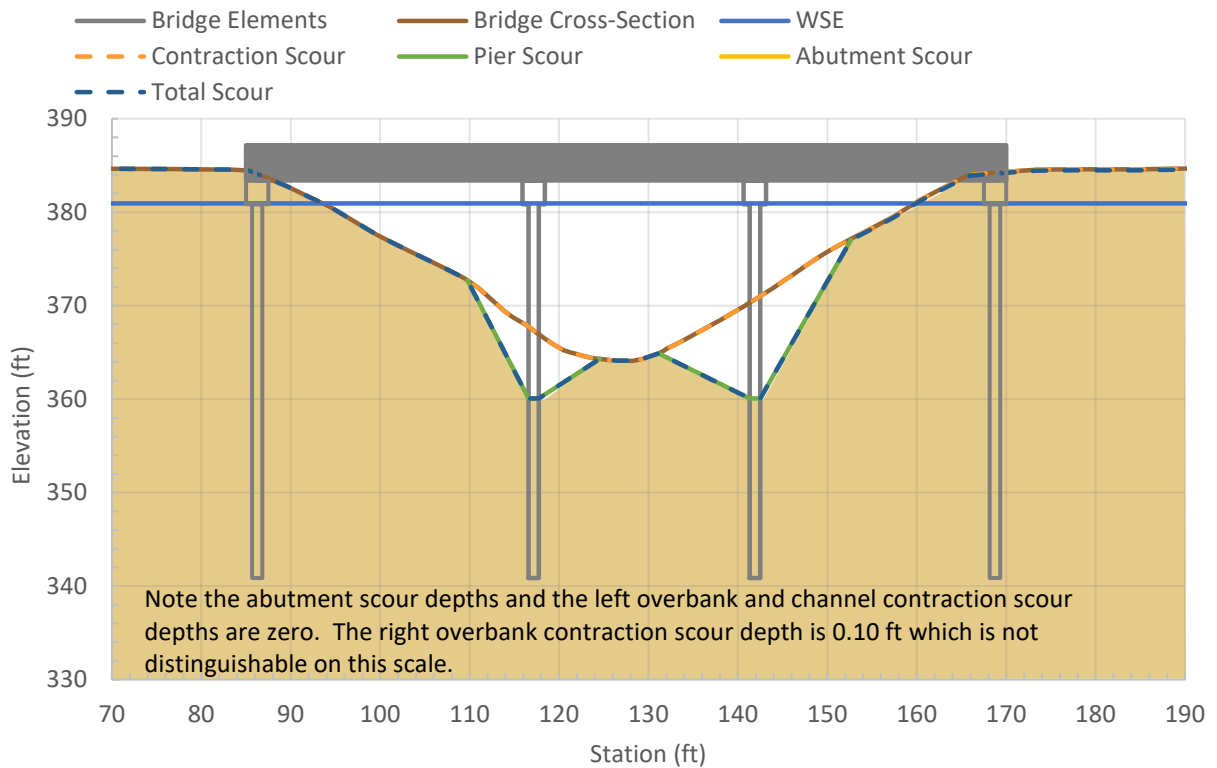


Figure F-4. Wolf Creek (L-0022) – HEC-RAS 500-yr scour plot.

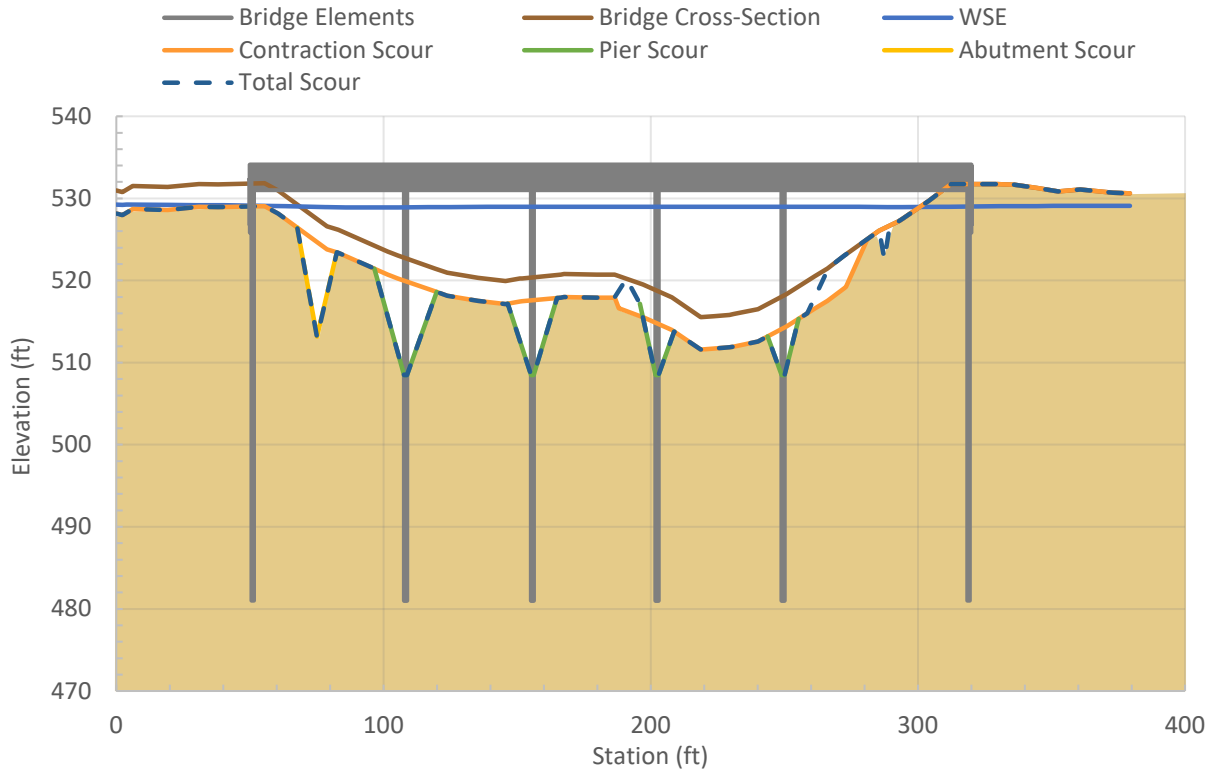


Figure F-5. Dry Fork Creek (L0564) – HEC-RAS 100-yr scour plot.

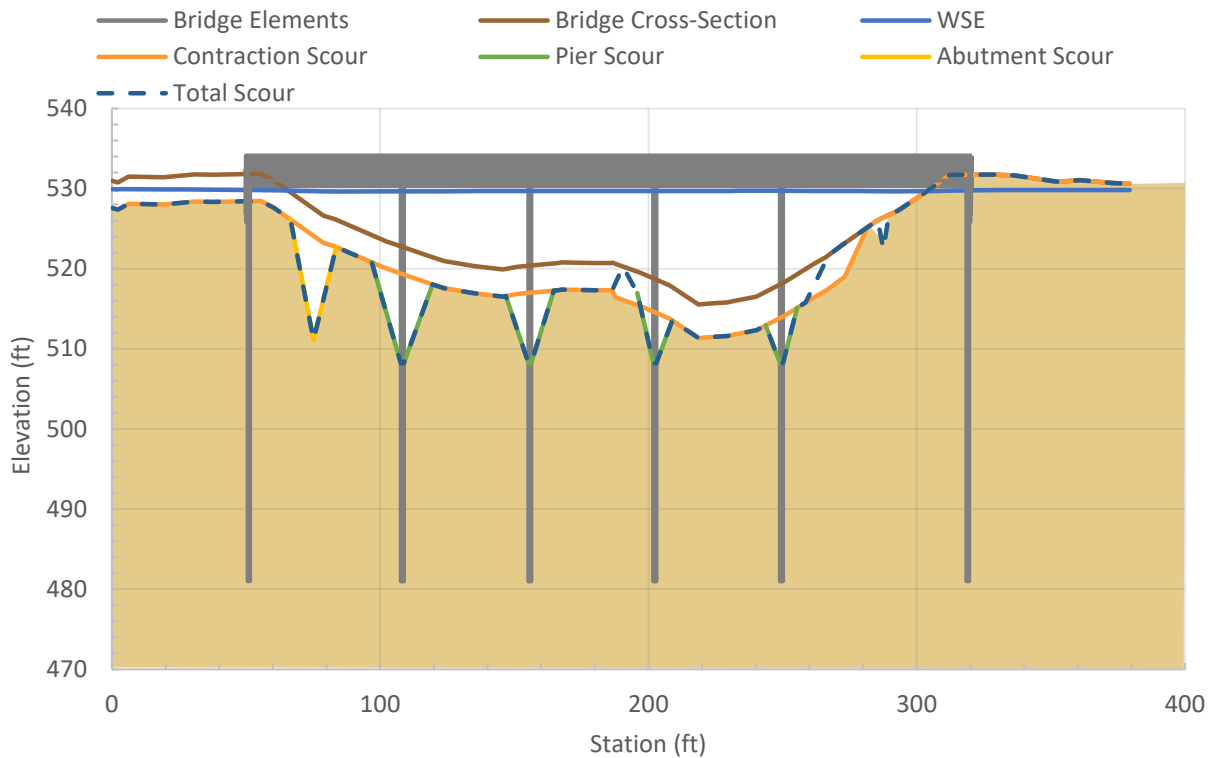


Figure F-6. Dry Fork Creek (L0564) – HEC-RAS 500-yr scour plot.

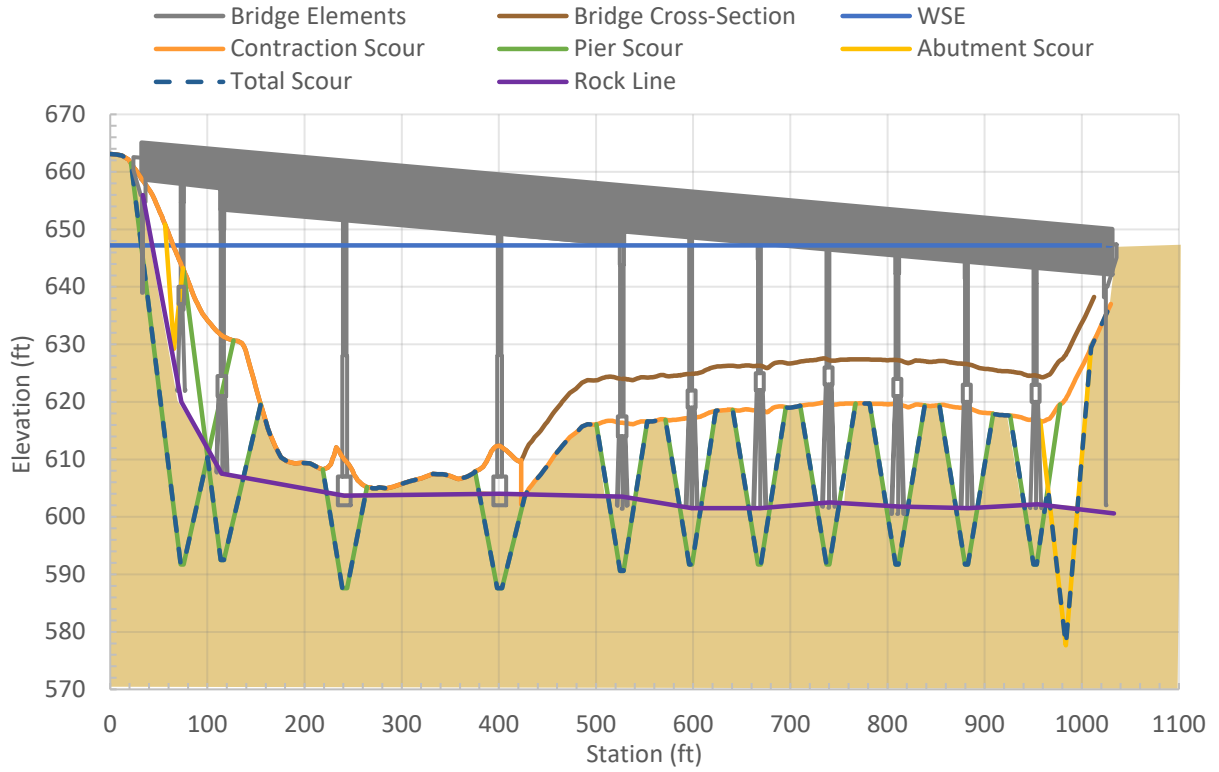


Figure F-7. Gasconade River (A3760) – HEC-RAS 100-yr scour plot.

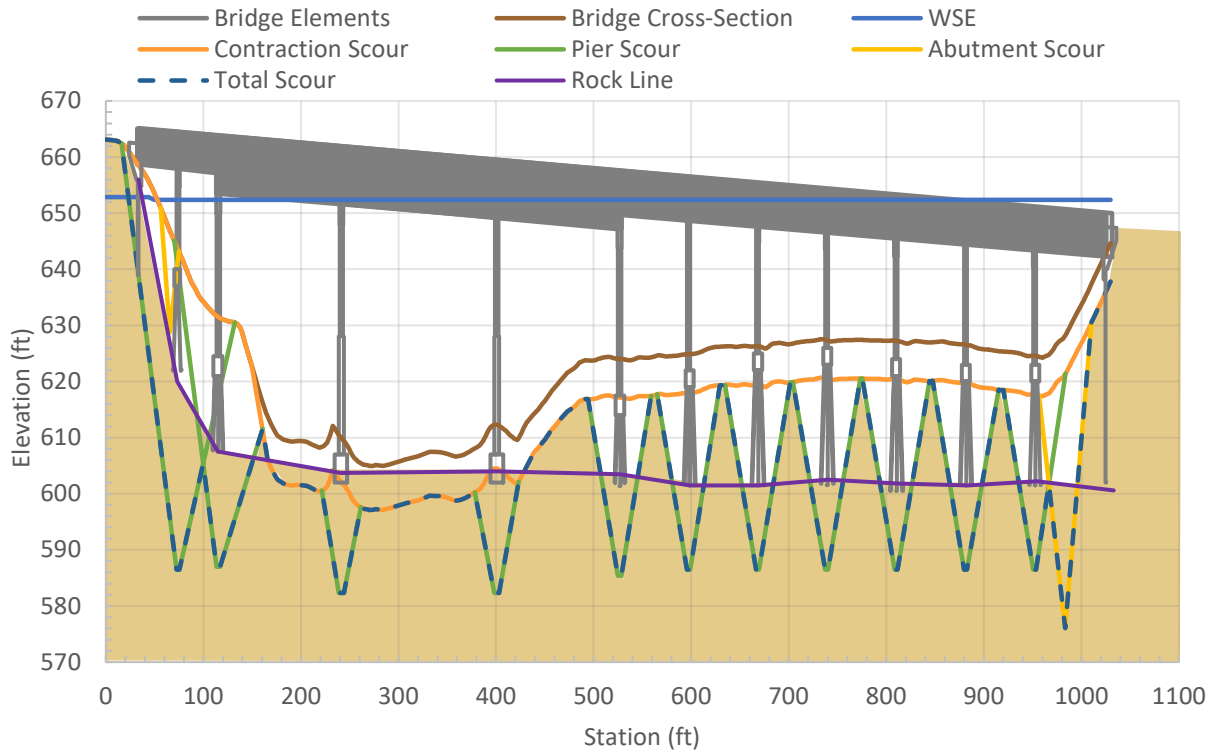


Figure F-8. Gasconade River (A3760) – HEC-RAS 500-yr scour plot.

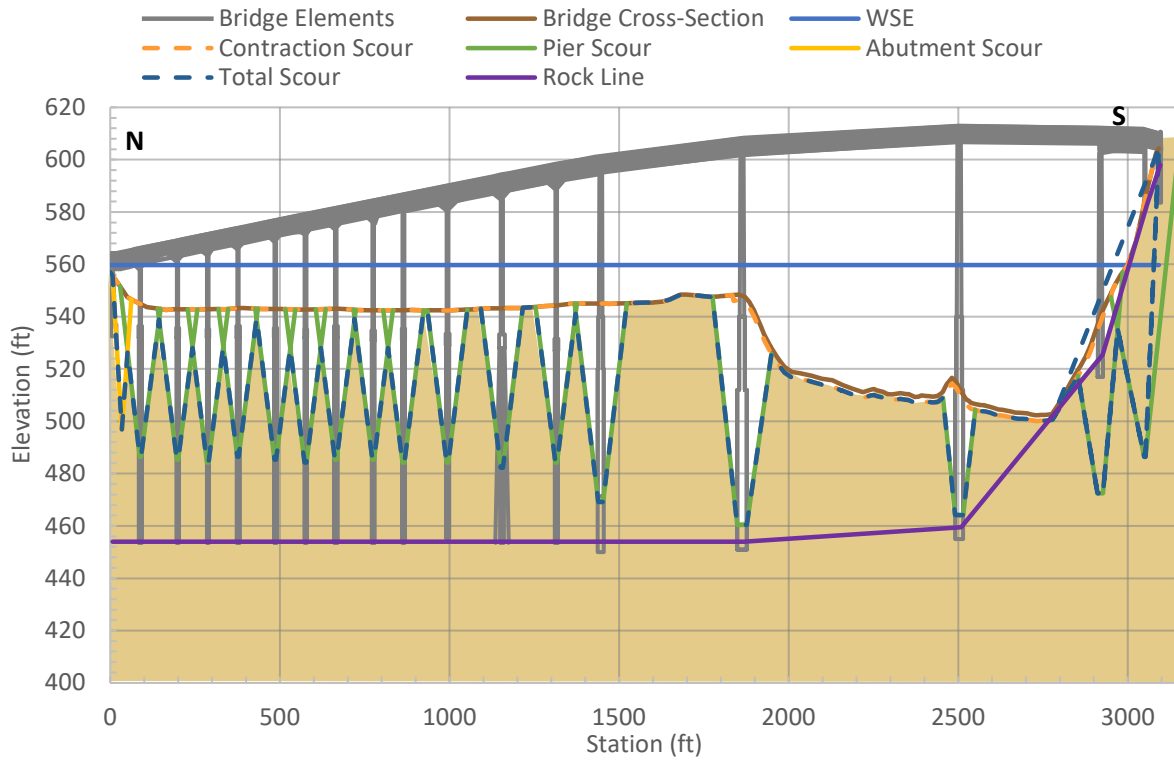


Figure F-9. Missouri River (A4497-L0550) – HEC-RAS 100-yr scour plot.

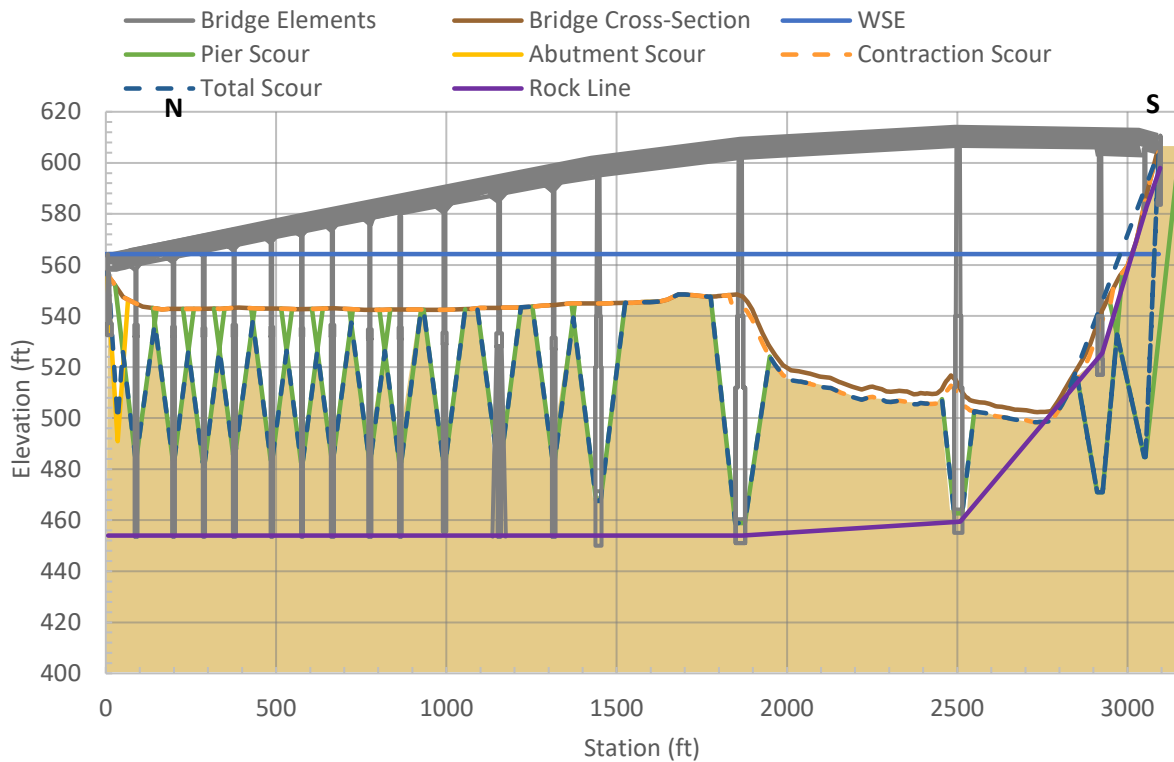


Figure F-10. Missouri River (A4497-L0550) – HEC-RAS 500-yr scour plot.

APPENDIX G: BRIDGE SCOUR ANALYSIS RESULTS FOR 2-D HYDRAULIC MODELING

Remainder of page intentionally left blank.

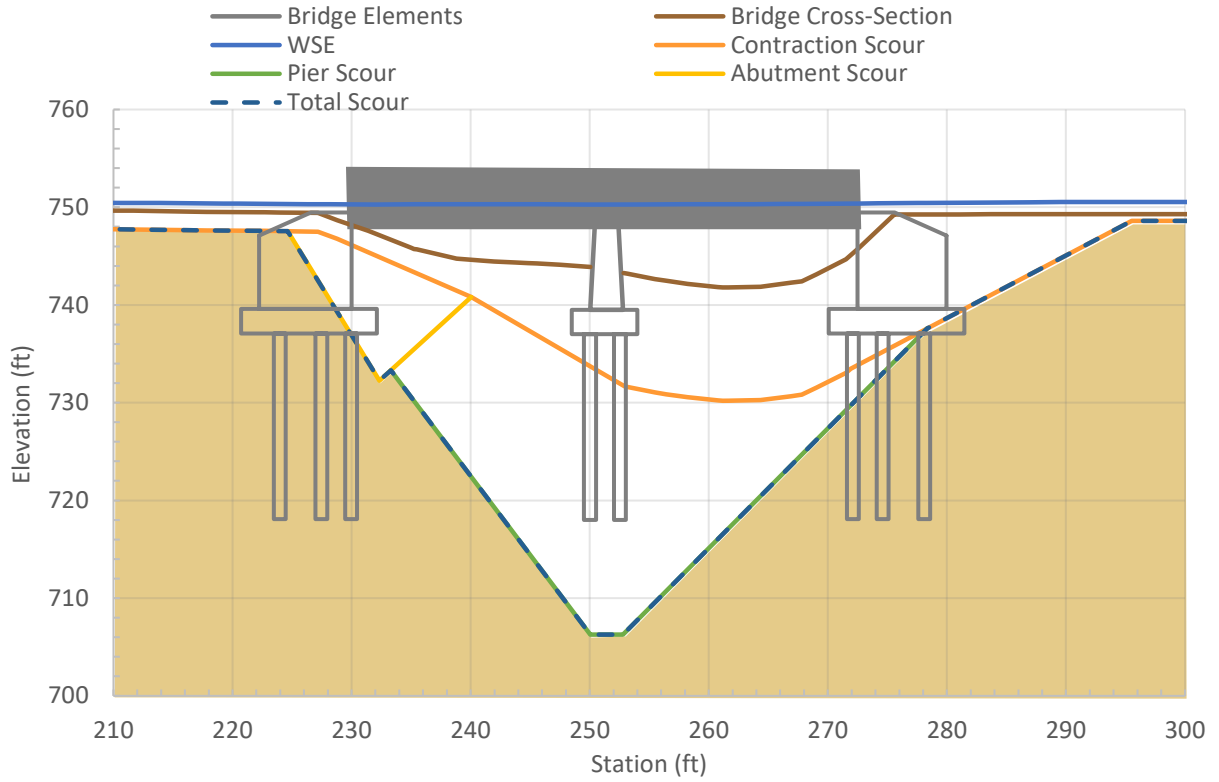
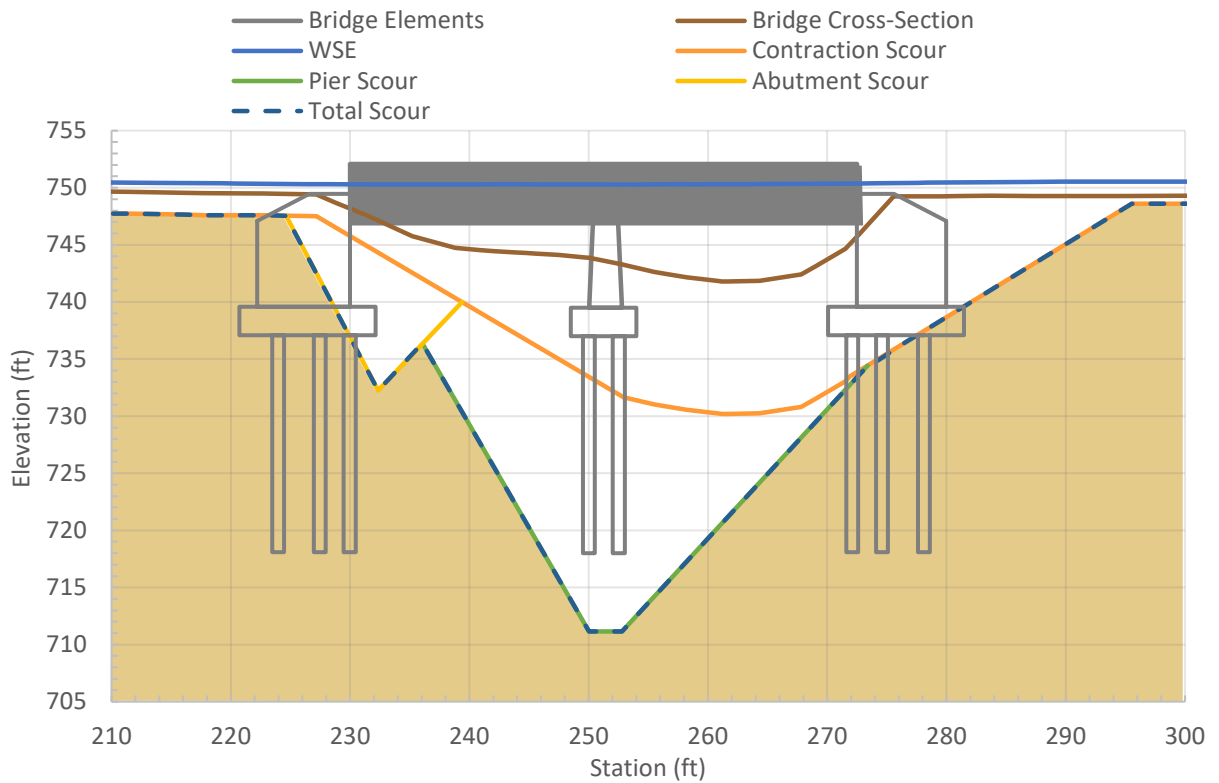


Figure G-1. Creek (H-0024) – SRH-2D 100-yr scour plot.



Note: Pressure flow contraction scour elevation on the right overbank area is lower than the right abutment scour elevation. Thus, the right abutment scour is not illustrated here for the total scour analysis.

Figure G-2. Creek (H-0024) – SRH-2D 500-yr scour plot.

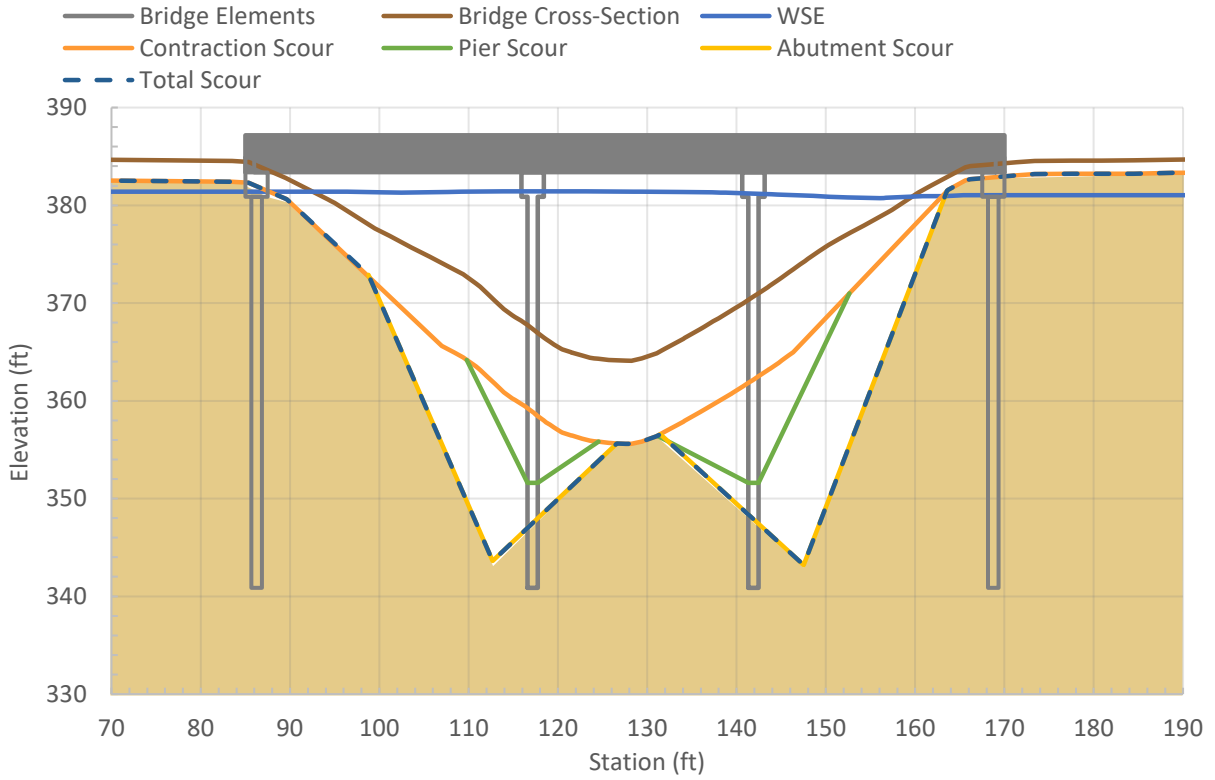


Figure G-3. Wolf Creek (L-0022) – SRH-2D 100-yr scour plot.

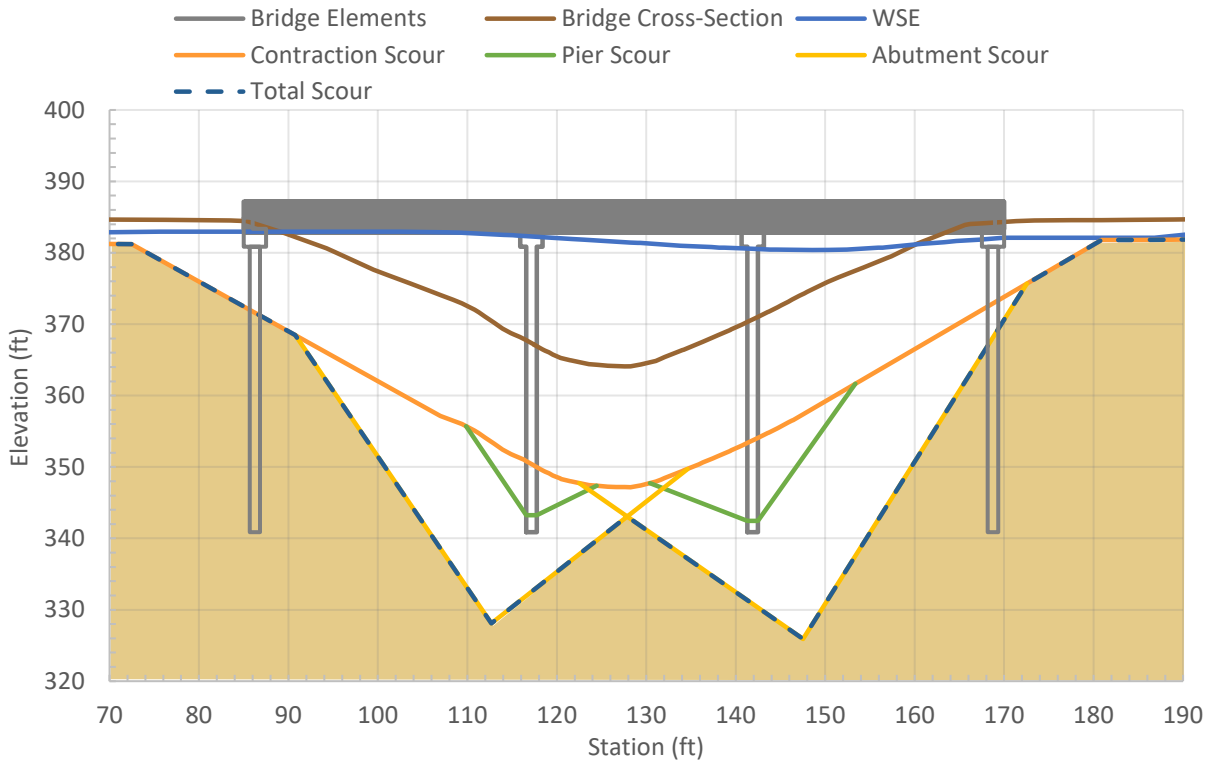


Figure G-4. Wolf Creek (L-0022) – SRH-2D 500-yr scour plot.

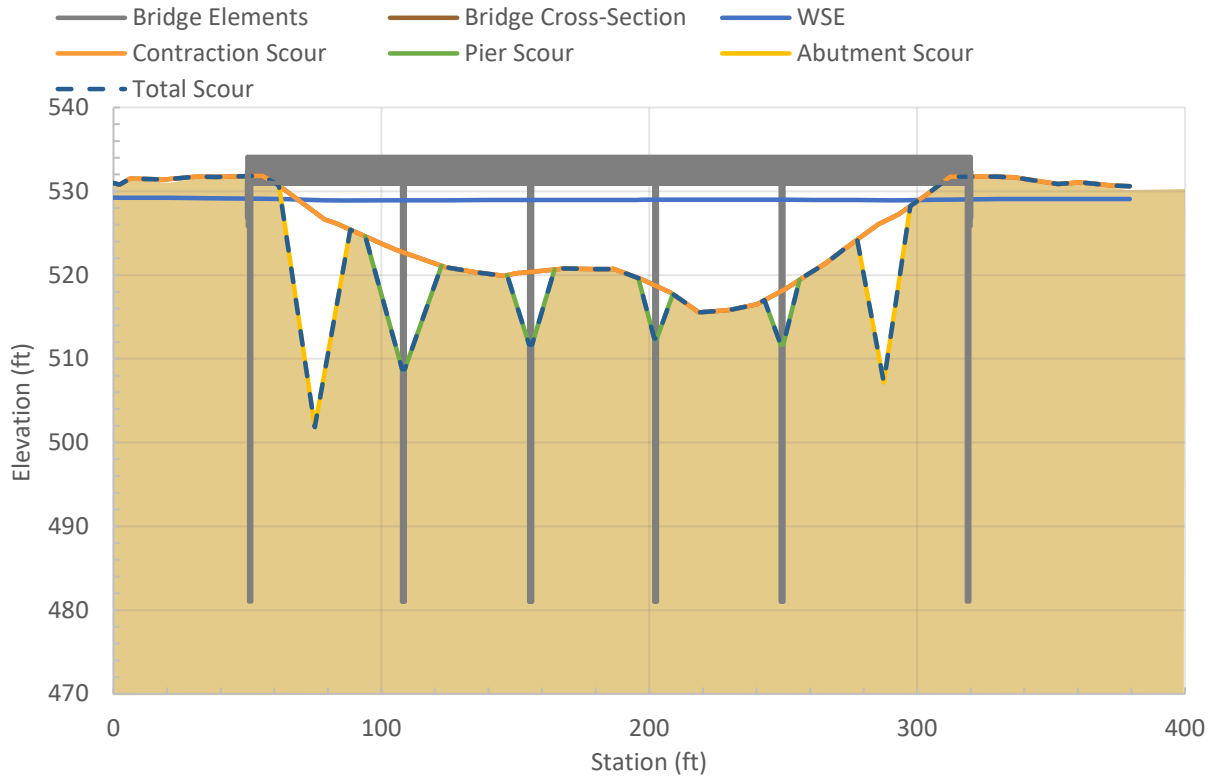


Figure G-5. Dry Fork Creek (L0564) – SRH-2D 100-yr scour plot.

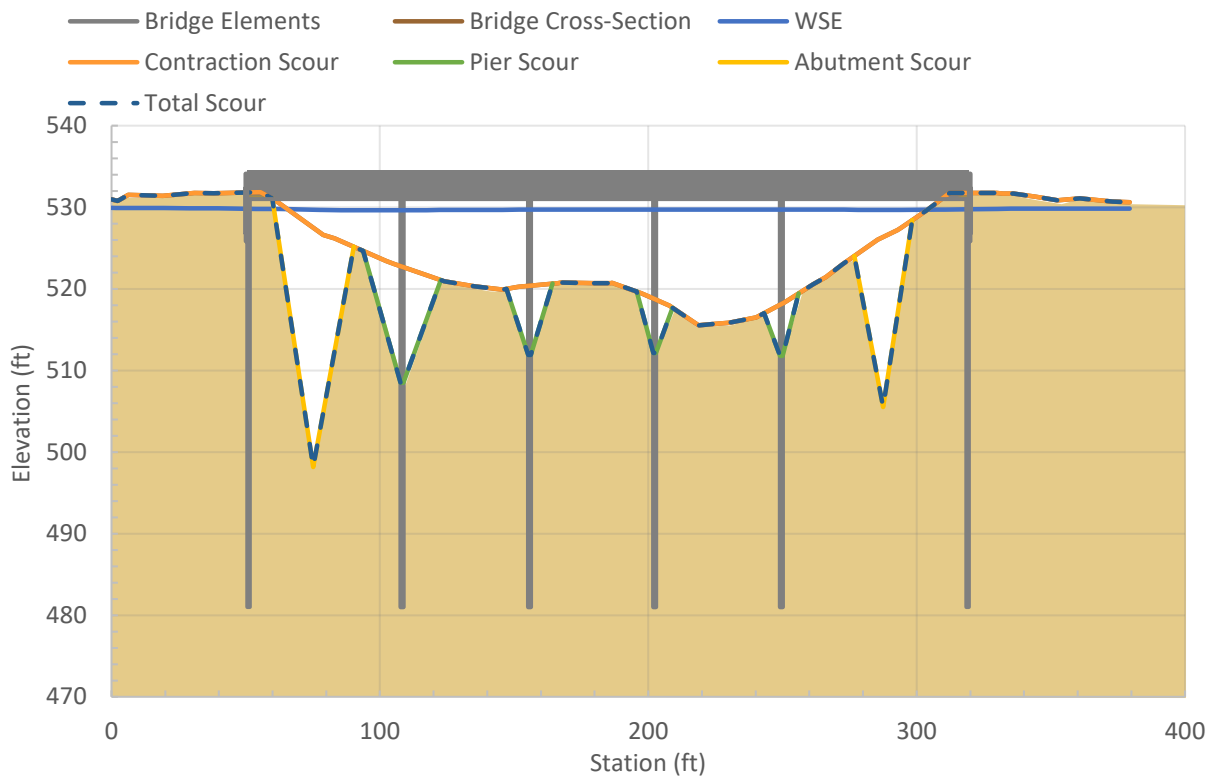


Figure G-6. Dry Fork Creek (L0564) – SRH-2D 500-yr scour plot.

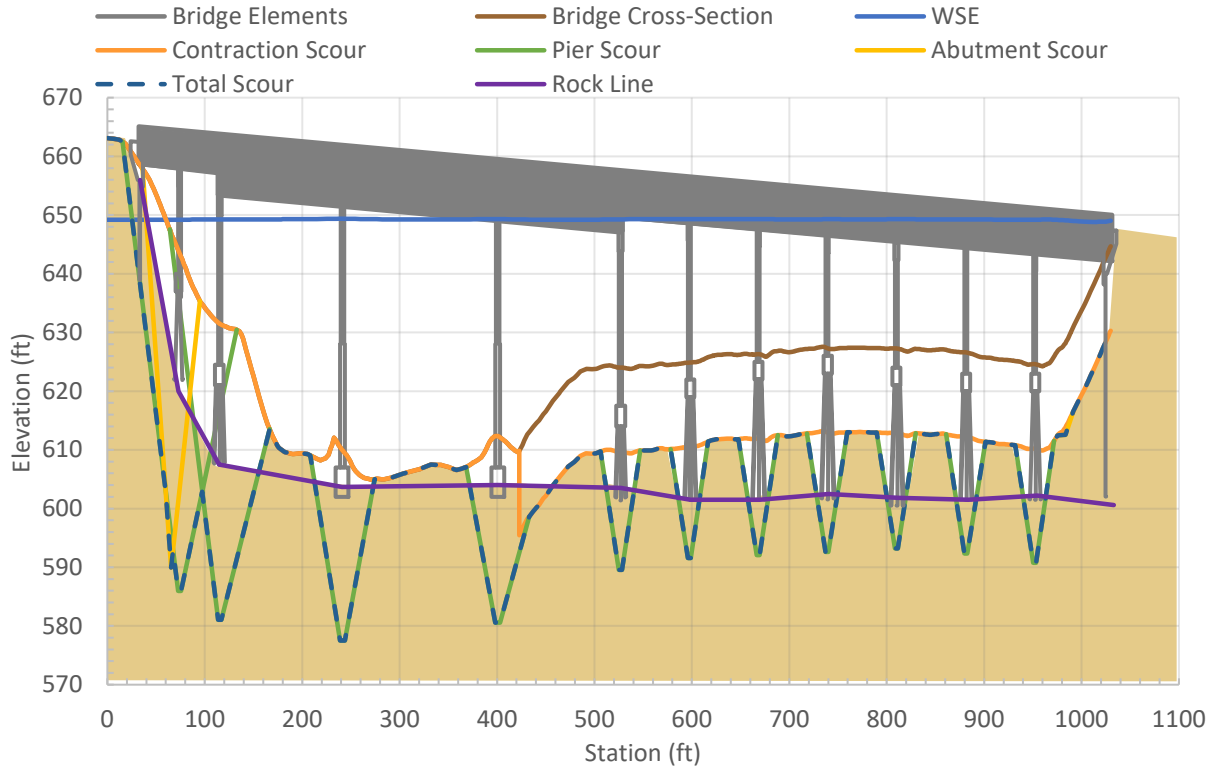


Figure G-7. Gasconade River (A3760) – SRH-2D 100-yr scour plot.

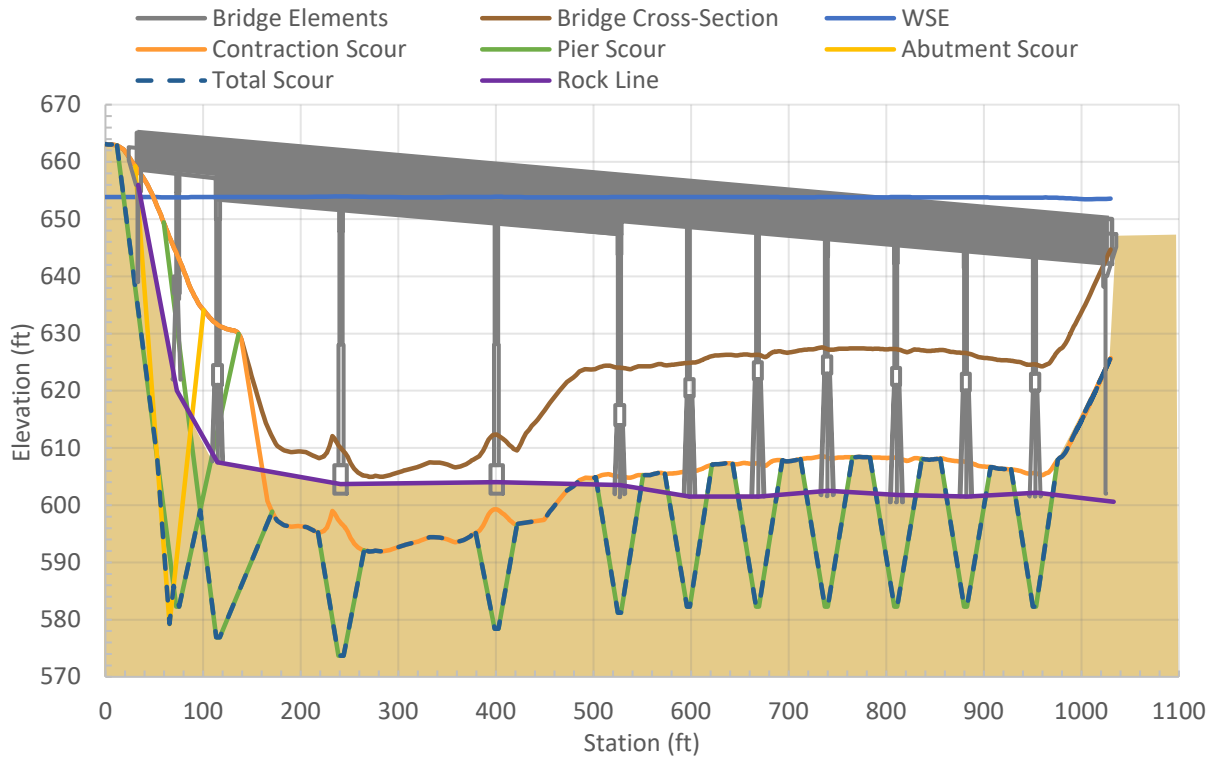


Figure G-8. Gasconade River (A3760) – SRH-2D 500-yr scour plot.

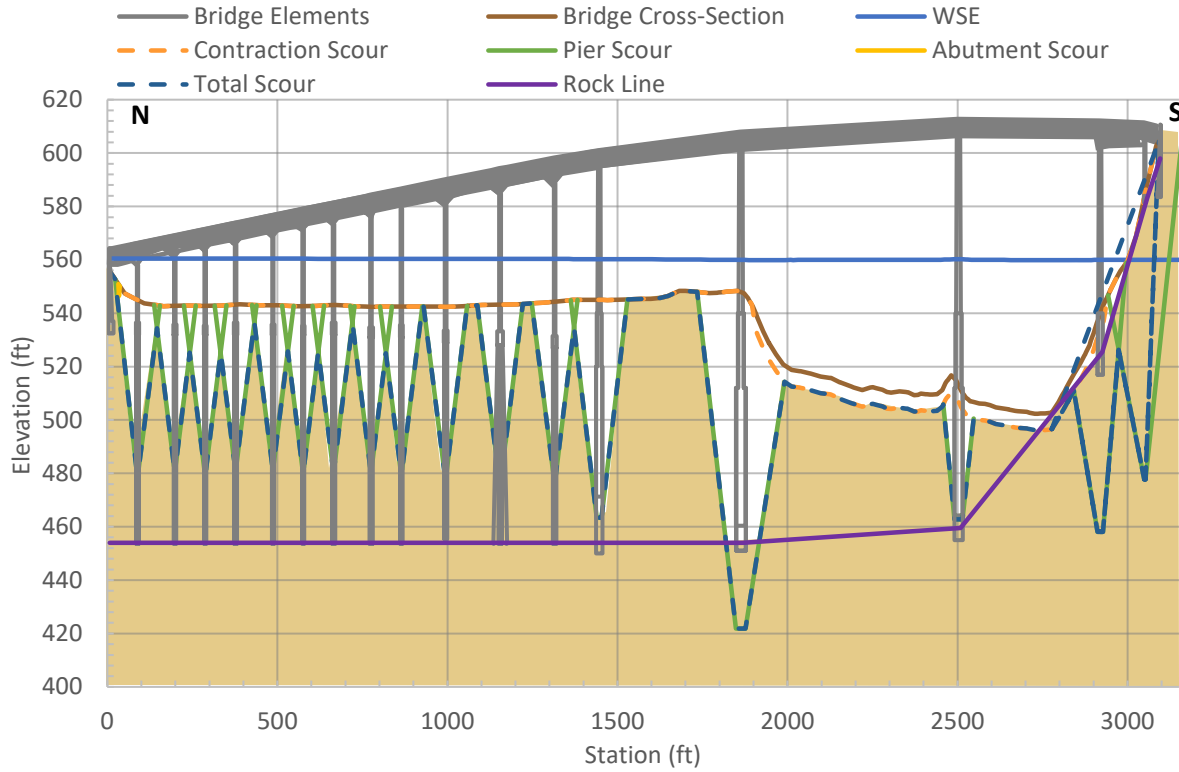


Figure G-9. Missouri River (A4497-L0550) – SRH-2D 100-yr scour plot.

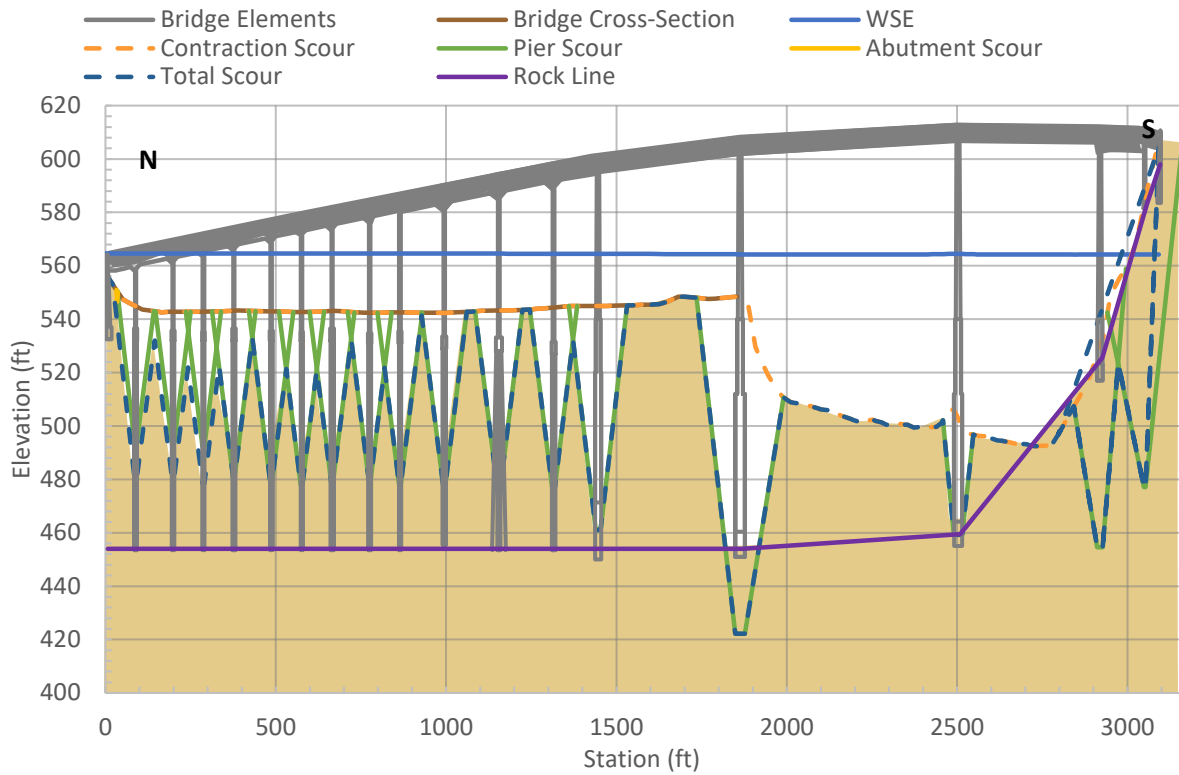


Figure G-10. Missouri River (A4497-L0550) – SRH-2D 500-yr scour plot.

APPENDIX H: HYDRAULIC TOOLBOX SCOUR ANALYSIS REPORTS

BRIDGE SCOUR ANALYSIS: CREEK H-0024

Project Title: H0024

Designer:

Project Date: Monday, May 22, 2023

Project Units: U.S. Customary Units

Notes:

H-0024 SRH-2D

Notes:

SCENARIO: 100-YR

CONTRACTION SCOUR SUMMARY

Pressure Flow

Applied Contraction Scour Depth 11.84 ft

Contraction and Long Term Degradation do NOT apply

Contraction Scour Depth and Long Term Degradation (LTD) 9.49 ft

Clear Water Contraction Scour Depth 45.81 ft

Live Bed Contraction Scour Depth 9.49 ft

Applied Contraction Scour Elevation with LTD 9.49 ft

LOCAL SCOUR AT PIERS SUMMARY

PIER NAME: PIER 1

Computation Method: Complex Piers

Pier Scour Depth 23.05 ft

Total Scour at Pier 34.89 ft

Total Scour Elevation at Pier 706.90 ft

LOCAL SCOUR AT ABUTMENTS SUMMARY

LEFT ABUTMENT

Abutment Scour Method: NCHRP Method

Abutment Scour Depth 17.10 ft

Total Scour at Abutment 0.00 ft

Total Scour Elevation at Abutment 731.64 ft

RIGHT ABUTMENT

Abutment Scour Method: NCHRP Method

Abutment Scour Depth 15.12 ft

Total Scour at Abutment 0.00 ft

Total Scour Elevation at Abutment 731.69 ft

MAIN CHANNEL CONTRACTION SCOUR

Computation Type:

INPUT PARAMETERS

Average Depth Upstream of Contraction: 7.14 ft

D50: 0.014021 mm

Average Velocity Upstream: 2.40 ft/s

RESULTS OF SCOUR CONDITION

Critical velocity above which bed material of size

D and smaller will be transported: 0.56 ft/s

Contraction Scour Condition: Live-Bed

Live Bed and/or Clear Water Input Parameters

Temperature of Water: 60.00 °F

Slope of Energy Grade Line at Approach Section: 0.0141 ft/ft

Flow in Contracted Section: 843.24 cfs

Flow Upstream that is Transporting Sediment: 359.85 cfs

Width in Contracted Section: 18.99 ft

Width Upstream that is Transporting Sediment: 21.03 ft

Depth Prior to Scour in Contracted Section: 6.42 ft

Unit Weight of Water: 62.40 lb/ft³

Unit Weight of Sediment: 165.00 lb/ft³

RESULTS OF LIVE BED METHOD

Shear Velocity: 1.80 ft/s

Fall Velocity: 0.00 ft/s

Average Depth in Contracted Section after Scour: 15.90 ft

Scour Depth for Live Bed: 9.49 ft

Scour may be limited by armoring. Compute all methods to check.

Upstream Channel Flow Depth: 7.14 ft

Average Velocity Upstream: 2.40 ft/s

D50: 0.014021 mm

RESULTS OF SCOUR CONDITION

Critical velocity above which bed material of size D and smaller will be transported: 0.56 ft/s

Contraction Scour Condition: Live Bed

INPUT PARAMETERS FOR BRIDGE SCOUR

Width of the Contracted Section: 18.99 ft

Flow through bridge opening: 843.24 cfs

Width of the Upstream Section: 21.03 ft

Flow in Upstream Section: 359.85 cfs

Slope of Energy Grade Line at Approach Section: 0.0141 ft/ft

Vertical Size of Bridge Opening Prior to Scour: 6.11 ft

Deck Thickness: 3.95 ft

RESULT PARAMETERS

K1: 0.69

Diameter of Smallest Non-moving Particle:
0.017526 mm

Average Depth In Contracted Section: 15.90 ft

Flow Separation Thickness: 2.05 ft

Scour Depth: 11.84 ft

LEFT BANK CONTRACTION SCOUR

Computation Type: Clear-Water or Live-Bed
Scour

INPUT PARAMETERS

Average Depth Upstream of Contraction: 2.08 ft

D50: 0.007925 mm

Average Velocity Upstream: 1.20 ft/s

RESULTS OF SCOUR CONDITION

Critical velocity above which bed material of size
D and smaller will be transported: 0.37 ft/s

Contraction Scour Condition: Live-Bed

Live Bed and/or Clear Water Input Parameters

Temperature of Water: 60.00 °F

Slope of Energy Grade Line at Approach Section:
0.0141 ft/ft

Flow in Contracted Section: 454.11 cfs

Flow Upstream that is Transporting Sediment:
379.90 cfs

Width in Contracted Section: 81.33 ft

Width Upstream that is Transporting Sediment:
151.60 ft

Depth Prior to Scour in Contracted Section: 1.08
ft

Unit Weight of Water: 62.40 lb/ft³

Unit Weight of Sediment: 165.00 lb/ft³

RESULTS OF LIVE BED METHOD

Shear Velocity: 0.97 ft/s

Fall Velocity: 0.00 ft/s

Average Depth in Contracted Section after
Scour: 3.73 ft

Scour Depth for Live Bed: 2.65 ft

Scour may be limited by armoring. Compute all
methods to check.

RIGHT BANK CONTRACTION SCOUR

Computation Type: Clear-Water or Live-Bed
Scour

INPUT PARAMETERS

Average Depth Upstream of Contraction: 2.76 ft

D50: 0.010058 mm

Average Velocity Upstream: 1.45 ft/s

RESULTS OF SCOUR CONDITION

Critical velocity above which bed material of size
D and smaller will be transported: 0.42 ft/s

Contraction Scour Condition: Live-Bed

Live Bed and/or Clear Water Input Parameters

Temperature of Water: 60.00 °F

Slope of Energy Grade Line at Approach Section:
0.0141 ft/ft

Flow in Contracted Section: 203.10 cfs

Flow Upstream that is Transporting Sediment:
872.16 cfs

Width in Contracted Section: 222.61 ft

Width Upstream that is Transporting Sediment:
218.23 ft

Depth Prior to Scour in Contracted Section: 0.29
ft

Unit Weight of Water: 62.40 lb/ft³

Unit Weight of Sediment: 165.00 lb/ft³

RESULTS OF LIVE BED METHOD

Shear Velocity: 1.12 ft/s

Fall Velocity: 0.00 ft/s

Average Depth in Contracted Section after
Scour: 0.78 ft

Scour Depth for Live Bed: 0.49 ft

Scour may be limited by armoring. Compute all
methods to check.

PIER DETAILS

Pier Name: Pier 1

PIER SCOUR

Computation Type: Complex Piers

INPUT PARAMETERS

Pier Shape: Round Nose

Bed Condition: Clear-Water Scour

Angle of Attack: 19.40 Degrees

Depth Upstream of Pier: 7.16 ft

Velocity Upstream of Pier: 4.42 ft/s

PIER INPUT PARAMETERS

Distance between Front Edge of Pile Cap or
Footing and Pier: 1.38 ft

Pier Width: 2.75 ft

Pier Length: 25.25 ft

PILE CAP (FOOTING) INPUT PARAMETERS

Initial Height of the Pile Cap Bottom Above the
Bed: 7.05 ft

Thickness of Pile Cap: 2.50 ft

Pile Cap Width: 5.50 ft

PILE GROUP PARAMETERS

Individual Pile Width: 1.00 ft

Spacing between Piles: 2.50 ft

Number of Rows of Piles: 13

Number of Columns of Piles: 2

Rows are staggered
Total width of non-overlapping Piles: 15.00 ft
BED MATERIAL PARAMETERS
D50: 0.014021 mm
RESULT PARAMETERS
PIER PARAMETERS
Correction Factor for Pier Nose Shape (K1): 1.00
Correction Factor for Angle of Attack (K2): 2.46
Correction Factor for Bed Condition (K3): 1.10
Coefficient for Pier Stem Height Above Bed (Kh): 0.00
Scour Component for Pier Stem: 0.00 ft
PILE CAP (FOOTING) RESULT PARAMETERS
Froude Number: 0.29
Effective Pile Cap Width: 0.03 ft
Distance from Bed to Top of Footing: 9.55 ft
Scour Component for Pier Cap or Footing: 0.70 ft
PILE GROUP RESULT PARAMETERS
Coefficient for Pile Spacing (Ksp): 1.00
Scour Component for Pile Group: 22.35 ft
TOTAL SCOUR
Scour Depth: 23.05 ft
LEFT ABUTMENT DETAILS
ABUTMENT SCOUR
Computation Type: NCHRP
Input Parameters
NCHRP METHOD
Abutment Type: Vertical-wall abutment with wing wall
Angle of Embankment to Flow: 91.65 Degrees
Centerline Length of Embankment: 0.00 ft
Projected Length of Embankment: 0.00 ft
Width of Flood Plain: 0.00 ft
Unit Discharge, Upstream in Main Channel (q1): 17.11 cfs
Unit Discharge in the Constricted Area (q2): 44.41 cfs/ft
D50: 0.007925 mm
Upstream Flow Depth: 7.14 ft
Flow Depth Prior to Scour: 1.04 ft
RESULT PARAMETERS
q2/q1: 2.60
Average Velocity Upstream: 2.40 ft/s
Critical Velocity above which Bed Material of Size D and Smaller will be Transported: 0.46 ft/s
Scour Condition: Live Bed
Embankment Length/Floodplain Width Ratio: 0.00

Scour Condition: a (Main Channel)
Amplification Factor: 1.12
Flow Depth including Contraction Scour: 16.18 ft
Maximum Flow Depth including Abutment Scour: 18.14 ft
Scour Hole Depth from NCHRP Method: 17.10 ft
RIGHT ABUTMENT DETAILS
ABUTMENT SCOUR
Computation Type: NCHRP
Input Parameters
NCHRP METHOD
Abutment Type: Vertical-wall abutment with wing wall
Angle of Embankment to Flow: 88.35 Degrees
Centerline Length of Embankment: 0.00 ft
Projected Length of Embankment: 0.00 ft
Width of Flood Plain: 0.00 ft
Unit Discharge, Upstream in Main Channel (q1): 17.11 cfs
Unit Discharge in the Constricted Area (q2): 44.41 cfs/ft
D50: 0.014021 mm
Upstream Flow Depth: 7.14 ft
Flow Depth Prior to Scour: 3.02 ft
RESULT PARAMETERS
q2/q1: 2.60
Average Velocity Upstream: 2.40 ft/s
Critical Velocity above which Bed Material of Size D and Smaller will be Transported: 0.56 ft/s
Scour Condition: Live Bed
Embankment Length/Floodplain Width Ratio: 0.00
Scour Condition: a (Main Channel)
Amplification Factor: 1.12
Flow Depth including Contraction Scour: 16.18 ft
Maximum Flow Depth including Abutment Scour: 18.14 ft
Scour Hole Depth from NCHRP Method: 15.12 ft
SCENARIO: 500-YR
CONTRACTION SCOUR SUMMARY
Pressure Flow
Applied Contraction Scour Depth 11.84 ft
Contraction and Long Term Degradation do NOT apply
Contraction Scour Depth and Long Term Degradation (LTD) 9.49 ft
Clear Water Contraction Scour Depth 45.81 ft
Live Bed Contraction Scour Depth 9.49 ft

Applied Contraction Scour Elevation with LTD
9.49 ft

LOCAL SCOUR AT PIERS SUMMARY

PIER NAME: PIER 1

Computation Method: Complex Piers

Pier Scour Depth 23.05 ft

Total Scour at Pier 34.89 ft

Total Scour Elevation at Pier 706.90 ft

LOCAL SCOUR AT ABUTMENTS SUMMARY

LEFT ABUTMENT

Abutment Scour Method: NCHRP Method

Abutment Scour Depth 17.10 ft

Total Scour at Abutment 0.00 ft

Total Scour Elevation at Abutment 731.64 ft

RIGHT ABUTMENT

Abutment Scour Method: NCHRP Method

Abutment Scour Depth 15.12 ft

Total Scour at Abutment 0.00 ft

Total Scour Elevation at Abutment 731.69 ft

MAIN CHANNEL CONTRACTION SCOUR

Computation Type:

INPUT PARAMETERS

Average Depth Upstream of Contraction: 7.14 ft

D50: 0.014021 mm

Average Velocity Upstream: 2.40 ft/s

RESULTS OF SCOUR CONDITION

Critical velocity above which bed material of size

D and smaller will be transported: 0.56 ft/s

Contraction Scour Condition: Live-Bed

Live Bed and/or Clear Water Input Parameters

Temperature of Water: 60.00 °F

Slope of Energy Grade Line at Approach Section:

0.0141 ft/ft

Flow in Contracted Section: 843.24 cfs

Flow Upstream that is Transporting Sediment:

359.85 cfs

Width in Contracted Section: 18.99 ft

Width Upstream that is Transporting Sediment:

21.03 ft

Depth Prior to Scour in Contracted Section: 6.42

ft

Unit Weight of Water: 62.40 lb/ft³

Unit Weight of Sediment: 165.00 lb/ft³

RESULTS OF LIVE BED METHOD

Shear Velocity: 1.80 ft/s

Fall Velocity: 0.00 ft/s

Average Depth in Contracted Section after

Scour: 15.90 ft

Scour Depth for Live Bed: 9.49 ft

Scour may be limited by armoring. Compute all
methods to check.

Upstream Channel Flow Depth: 7.14 ft

Average Velocity Upstream: 2.40 ft/s

D50: 0.014021 mm

RESULTS OF SCOUR CONDITION

Critical velocity above which bed material of size

D and smaller will be transported: 0.56 ft/s

Contraction Scour Condition: Live Bed

INPUT PARAMETERS FOR BRIDGE SCOUR

Width of the Contracted Section: 18.99 ft

Flow through bridge opening: 843.24 cfs

Width of the Upstream Section: 21.03 ft

Flow in Upstream Section: 359.85 cfs

Slope of Energy Grade Line at Approach Section:

0.0141 ft/ft

Vertical Size of Bridge Opening Prior to Scour:

6.11 ft

Deck Thickness: 3.95 ft

RESULT PARAMETERS

K1: 0.69

Diameter of Smallest Non-moving Particle:

0.017526 mm

Average Depth In Contracted Section: 15.90 ft

Flow Separation Thickness: 2.05 ft

Scour Depth: 11.84 ft

LEFT BANK CONTRACTION SCOUR

Computation Type: Clear-Water or Live-Bed

Scour

INPUT PARAMETERS

Average Depth Upstream of Contraction: 2.08 ft

D50: 0.007925 mm

Average Velocity Upstream: 1.20 ft/s

RESULTS OF SCOUR CONDITION

Critical velocity above which bed material of size

D and smaller will be transported: 0.37 ft/s

Contraction Scour Condition: Live-Bed

Live Bed and/or Clear Water Input Parameters

Temperature of Water: 60.00 °F

Slope of Energy Grade Line at Approach Section:

0.0141 ft/ft

Flow in Contracted Section: 454.11 cfs

Flow Upstream that is Transporting Sediment:

379.90 cfs

Width in Contracted Section: 81.33 ft

Width Upstream that is Transporting Sediment:

151.60 ft

Depth Prior to Scour in Contracted Section: 1.08 ft

Unit Weight of Water: 62.40 lb/ft³

Unit Weight of Sediment: 165.00 lb/ft³

RESULTS OF LIVE BED METHOD

Shear Velocity: 0.97 ft/s

Fall Velocity: 0.00 ft/s

Average Depth in Contracted Section after Scour: 3.73 ft

Scour Depth for Live Bed: 2.65 ft

Scour may be limited by armoring. Compute all methods to check.

RIGHT BANK CONTRACTION SCOUR

Computation Type: Clear-Water or Live-Bed Scour

INPUT PARAMETERS

Average Depth Upstream of Contraction: 2.76 ft

D50: 0.010058 mm

Average Velocity Upstream: 1.45 ft/s

RESULTS OF SCOUR CONDITION

Critical velocity above which bed material of size D and smaller will be transported: 0.42 ft/s

Contraction Scour Condition: Live-Bed

Live Bed and/or Clear Water Input Parameters

Temperature of Water: 60.00 °F

Slope of Energy Grade Line at Approach Section: 0.0141 ft/ft

Flow in Contracted Section: 203.10 cfs

Flow Upstream that is Transporting Sediment: 872.16 cfs

Width in Contracted Section: 222.61 ft

Width Upstream that is Transporting Sediment: 218.23 ft

Depth Prior to Scour in Contracted Section: 0.29 ft

Unit Weight of Water: 62.40 lb/ft³

Unit Weight of Sediment: 165.00 lb/ft³

RESULTS OF LIVE BED METHOD

Shear Velocity: 1.12 ft/s

Fall Velocity: 0.00 ft/s

Average Depth in Contracted Section after Scour: 0.78 ft

Scour Depth for Live Bed: 0.49 ft

Scour may be limited by armoring. Compute all methods to check.

PIER DETAILS

Pier Name: Pier 1

PIER SCOUR

Computation Type: Complex Piers

INPUT PARAMETERS

Pier Shape: Round Nose

Bed Condition: Clear-Water Scour

Angle of Attack: 19.40 Degrees

Depth Upstream of Pier: 7.16 ft

Velocity Upstream of Pier: 4.42 ft/s

PIER INPUT PARAMETERS

Distance between Front Edge of Pile Cap or Footing and Pier: 1.38 ft

Pier Width: 2.75 ft

Pier Length: 25.25 ft

PILE CAP (FOOTING) INPUT PARAMETERS

Initial Height of the Pile Cap Bottom Above the Bed: 7.05 ft

Thickness of Pile Cap: 2.50 ft

Pile Cap Width: 5.50 ft

PILE GROUP PARAMETERS

Individual Pile Width: 1.00 ft

Spacing between Piles: 2.50 ft

Number of Rows of Piles: 13

Number of Columns of Piles: 2

Rows are staggered

Total width of non-overlapping Piles: 15.00 ft

BED MATERIAL PARAMETERS

D50: 0.014021 mm

RESULT PARAMETERS

PIER PARAMETERS

Correction Factor for Pier Nose Shape (K1): 1.00

Correction Factor for Angle of Attack (K2): 2.46

Correction Factor for Bed Condition (K3): 1.10

Coefficient for Pier Stem Height Above Bed (Kh): 0.00

Scour Component for Pier Stem: 0.00 ft

PILE CAP (FOOTING) RESULT PARAMETERS

Froude Number: 0.29

Effective Pile Cap Width: 0.03 ft

Distance from Bed to Top of Footing: 9.55 ft

Scour Component for Pier Cap or Footing: 0.70 ft

PILE GROUP RESULT PARAMETERS

Coefficient for Pile Spacing (Ksp): 1.00

Scour Component for Pile Group: 22.35 ft

TOTAL SCOUR

Scour Depth: 23.05 ft

LEFT ABUTMENT DETAILS

ABUTMENT SCOUR

Computation Type: NCHRP

Input Parameters

NCHRP METHOD

Abutment Type: Vertical-wall abutment with wing wall

Angle of Embankment to Flow: 91.65 Degrees

Centerline Length of Embankment: 0.00 ft

Projected Length of Embankment: 0.00 ft

Width of Flood Plain: 0.00 ft

Unit Discharge, Upstream in Main Channel (q1): 17.11 cfs

Unit Discharge in the Constricted Area (q2): 44.41 cfs/ft

D50: 0.007925 mm

Upstream Flow Depth: 7.14 ft

Flow Depth Prior to Scour: 1.04 ft

RESULT PARAMETERS

q2/q1: 2.60

Average Velocity Upstream: 2.40 ft/s

Critical Velocity above which Bed Material of Size D and Smaller will be Transported: 0.46 ft/s

Scour Condition: Live Bed

Embankment Length/Floodplain Width Ratio: 0.00

Scour Condition: a (Main Channel)

Amplification Factor: 1.12

Flow Depth including Contraction Scour: 16.18 ft

Maximum Flow Depth including Abutment Scour: 18.14 ft

Scour Hole Depth from NCHRP Method: 17.10 ft

RIGHT ABUTMENT DETAILS

ABUTMENT SCOUR

Computation Type: NCHRP

Input Parameters

NCHRP METHOD

Abutment Type: Vertical-wall abutment with wing wall

Angle of Embankment to Flow: 88.35 Degrees

Centerline Length of Embankment: 0.00 ft

Projected Length of Embankment: 0.00 ft

Width of Flood Plain: 0.00 ft

Unit Discharge, Upstream in Main Channel (q1): 17.11 cfs

Unit Discharge in the Constricted Area (q2): 44.41 cfs/ft

D50: 0.014021 mm

Upstream Flow Depth: 7.14 ft

Flow Depth Prior to Scour: 3.02 ft

RESULT PARAMETERS

q2/q1: 2.60

Average Velocity Upstream: 2.40 ft/s

Critical Velocity above which Bed Material of Size D and Smaller will be Transported: 0.56 ft/s

Scour Condition: Live Bed

Embankment Length/Floodplain Width Ratio: 0.00

Scour Condition: a (Main Channel)

Amplification Factor: 1.12

Flow Depth including Contraction Scour: 16.18 ft

Maximum Flow Depth including Abutment Scour: 18.14 ft

Scour Hole Depth from NCHRP Method: 15.12 ft

H-0024 HEC-RAS

Notes:

SCENARIO: 100-YR

CONTRACTION SCOUR SUMMARY

Contraction & Long Term Scour is applied method due to greater scour.

Applied Contraction Scour Depth 5.14 ft

Contraction & Long Term Scour is applied method due to greater scour.

Pressure Scour Depth 5.14 ft

Live Bed Contraction Scour Depth 5.14 ft

Applied Contraction Scour Elevation with LTD 5.14 ft

LOCAL SCOUR AT PIERS SUMMARY

PIER NAME: PIER 1

Computation Method: Complex Piers

Pier Scour Depth 5.04 ft

Total Scour at Pier 10.19 ft

Total Scour Elevation at Pier 731.76 ft

LOCAL SCOUR AT ABUTMENTS SUMMARY

LEFT ABUTMENT

Abutment Scour Method: NCHRP Method

Abutment Scour Depth 5.31 ft

Total Scour at Abutment 5.31 ft

Total Scour Elevation at Abutment 736.20 ft

RIGHT ABUTMENT

Abutment Scour Method: NCHRP Method

Abutment Scour Depth 5.05 ft

Total Scour at Abutment 5.05 ft

Total Scour Elevation at Abutment 739.14 ft

MAIN CHANNEL CONTRACTION SCOUR

Computation Type: Clear-Water or Live-Bed Scour

INPUT PARAMETERS

Average Depth Upstream of Contraction: 7.50 ft

D50: 0.014021 mm

Average Velocity Upstream: 4.01 ft/s

RESULTS OF SCOUR CONDITION

Critical velocity above which bed material of size D and smaller will be transported: 0.56 ft/s

Contraction Scour Condition: Live-Bed

Live Bed and/or Clear Water Input Parameters

Temperature of Water: 60.00 °F

Slope of Energy Grade Line at Approach Section: 0.0011 ft/ft

Flow in Contracted Section: 605.82 cfs

Flow Upstream that is Transporting Sediment: 428.35 cfs

Width in Contracted Section: 14.10 ft

Width Upstream that is Transporting Sediment: 14.10 ft

Depth Prior to Scour in Contracted Section: 4.95 ft

Unit Weight of Water: 62.40 lb/ft³

Unit Weight of Sediment: 165.00 lb/ft³

RESULTS OF LIVE BED METHOD

Shear Velocity: 0.51 ft/s

Fall Velocity: 0.00 ft/s

Average Depth in Contracted Section after Scour: 10.09 ft

Scour Depth for Live Bed: 5.14 ft

Scour may be limited by armoring. Compute all methods to check.

LEFT BANK CONTRACTION SCOUR

Computation Type: Clear-Water and Live-Bed Scour

INPUT PARAMETERS

Average Depth Upstream of Contraction: 5.46 ft

D50: 0.007925 mm

Average Velocity Upstream: 2.33 ft/s

RESULTS OF SCOUR CONDITION

Critical velocity above which bed material of size D and smaller will be transported: 0.44 ft/s

Contraction Scour Condition: Live-Bed

Live Bed and/or Clear Water Input Parameters

Temperature of Water: 60.00 °F

Slope of Energy Grade Line at Approach Section: 0.0011 ft/ft

Flow in Contracted Section: 695.33 cfs

Flow Upstream that is Transporting Sediment: 487.62 cfs

Width in Contracted Section: 15.44 ft

Width Upstream that is Transporting Sediment: 15.44 ft

Depth Prior to Scour in Contracted Section: 3.85 ft

Unit Weight of Water: 62.40 lb/ft³

Unit Weight of Sediment: 165.00 lb/ft³

RESULTS OF CLEAR WATER METHOD

Diameter of the smallest nontransportable particle in the bed material: 0.009906 mm

Average Depth in Contracted Section after Scour: 62.21 ft

Scour Depth: 58.36 ft

RESULTS OF LIVE BED METHOD

Shear Velocity: 0.44 ft/s

Fall Velocity: 0.00 ft/s

Average Depth in Contracted Section after Scour: 7.40 ft

Scour Depth for Live Bed: 3.55 ft

Shear Applied to Bed by Live-Bed Scour: 0.0698 lb/ft²

Shear Required for Movement of D50 Particle: 0.0001 lb/ft²

Recommendations

Recommended Scour Depth: 3.55 ft

RIGHT BANK CONTRACTION SCOUR

Computation Type: Clear-Water and Live-Bed Scour

INPUT PARAMETERS

Average Depth Upstream of Contraction: 4.08 ft

D50: 0.010058 mm

Average Velocity Upstream: 2.52 ft/s

RESULTS OF SCOUR CONDITION

Critical velocity above which bed material of size D and smaller will be transported: 0.45 ft/s

Contraction Scour Condition: Live-Bed

Live Bed and/or Clear Water Input Parameters

Temperature of Water: 60.00 °F

Slope of Energy Grade Line at Approach Section: 0.0011 ft/ft

Flow in Contracted Section: 313.86 cfs

Flow Upstream that is Transporting Sediment: 361.42 cfs

Width in Contracted Section: 12.96 ft

Width Upstream that is Transporting Sediment: 12.96 ft

Depth Prior to Scour in Contracted Section: 2.36 ft

Unit Weight of Water: 62.40 lb/ft³

Unit Weight of Sediment: 165.00 lb/ft³

RESULTS OF CLEAR WATER METHOD

Diameter of the smallest nontransportable particle in the bed material: 0.012573 mm
Average Depth in Contracted Section after Scour: 34.15 ft

Scour Depth: 31.79 ft

RESULTS OF LIVE BED METHOD

Shear Velocity: 0.38 ft/s

Fall Velocity: 0.00 ft/s

Average Depth in Contracted Section after Scour: 3.62 ft

Scour Depth for Live Bed: 1.26 ft

Shear Applied to Bed by Live-Bed Scour: 0.0722 lb/ft²

Shear Required for Movement of D50 Particle: 0.0001 lb/ft²

Recommendations

Recommended Scour Depth: 1.26 ft

PIER DETAILS

Pier Name: Pier 1

PIER SCOUR

Computation Type: Complex Piers

INPUT PARAMETERS

Pier Shape: Round Nose

Bed Condition: Clear-Water Scour

Angle of Attack: 0.00 Degrees

Depth Upstream of Pier: 8.42 ft

Velocity Upstream of Pier: 4.53 ft/s

PIER INPUT PARAMETERS

Distance between Front Edge of Pile Cap or Footing and Pier: 1.38 ft

Pier Width: 2.75 ft

Pier Length: 25.25 ft

PILE CAP (FOOTING) INPUT PARAMETERS

Initial Height of the Pile Cap Bottom Above the Bed: 0.19 ft

Thickness of Pile Cap: 2.50 ft

Pile Cap Width: 5.50 ft

PILE GROUP PARAMETERS

Individual Pile Width: 1.00 ft

Spacing between Piles: 2.50 ft

Number of Rows of Piles: 13

Number of Columns of Piles: 2

Rows are staggered

Total width of non-overlapping Piles: 2.00 ft

BED MATERIAL PARAMETERS

D50: 0.014021 mm

RESULT PARAMETERS

PIER PARAMETERS

Correction Factor for Pier Nose Shape (K1): 1.00

Correction Factor for Angle of Attack (K2): 1.00

Correction Factor for Bed Condition (K3): 1.10

Coefficient for Pier Stem Height Above Bed (Kh): 0.11

Scour Component for Pier Stem: 0.55 ft

PILE CAP (FOOTING) RESULT PARAMETERS

Froude Number: 0.26

Effective Pile Cap Width: 1.02 ft

Distance from Bed to Top of Footing: 3.24 ft

Scour Component for Pier Cap or Footing: 2.94 ft

PILE GROUP RESULT PARAMETERS

Coefficient for Pile Spacing (Ksp): 1.00

Scour Component for Pile Group: 1.55 ft

TOTAL SCOUR

Scour Depth: 5.04 ft

LEFT ABUTMENT DETAILS

ABUTMENT SCOUR

Computation Type: NCHRP

Input Parameters

NCHRP METHOD

Abutment Type: Vertical-wall abutment with wing wall

Angle of Embankment to Flow: 91.65 Degrees

Centerline Length of Embankment: 0.00 ft

Projected Length of Embankment: 0.00 ft

Width of Flood Plain: 0.00 ft

Unit Discharge, Upstream in Main Channel (q1): 30.38 cfs

Unit Discharge in the Constricted Area (q2): 38.00 cfs/ft

D50: 0.007925 mm

Upstream Flow Depth: 5.46 ft

Flow Depth Prior to Scour: 6.30 ft

RESULT PARAMETERS

q2/q1: 1.25

Average Velocity Upstream: 5.56 ft/s

Critical Velocity above which Bed Material of Size D and Smaller will be Transported: 0.44 ft/s

Scour Condition: Live Bed

Embankment Length/Floodplain Width Ratio: 0.00

Scour Condition: a (Main Channel)

Amplification Factor: 1.76

Flow Depth including Contraction Scour: 6.61 ft

Maximum Flow Depth including Abutment Scour: 11.61 ft

Scour Hole Depth from NCHRP Method: 5.31 ft

RIGHT ABUTMENT DETAILS

ABUTMENT SCOUR

Computation Type: NCHRP

Input Parameters

NCHRP METHOD

Abutment Type: Vertical-wall abutment with wing wall

Angle of Embankment to Flow: 88.35 Degrees

Centerline Length of Embankment: 0.00 ft

Projected Length of Embankment: 0.00 ft

Width of Flood Plain: 0.00 ft

Unit Discharge, Upstream in Main Channel (q1):
30.38 cfs

Unit Discharge in the Constricted Area (q2):
38.00 cfs/ft

D50: 0.014021 mm

Upstream Flow Depth: 4.08 ft

Flow Depth Prior to Scour: 3.62 ft

RESULT PARAMETERS

q2/q1: 1.25

Average Velocity Upstream: 7.45 ft/s

Critical Velocity above which Bed Material of Size D and Smaller will be Transported: 0.51 ft/s

Scour Condition: Live Bed

Embankment Length/Floodplain Width Ratio:
0.00

Scour Condition: a (Main Channel)

Amplification Factor: 1.76

Flow Depth including Contraction Scour: 4.94 ft

Maximum Flow Depth including Abutment Scour: 8.67 ft

Scour Hole Depth from NCHRP Method: 5.05 ft

SCENARIO: 500-YR

CONTRACTION SCOUR SUMMARY

Contraction & Long Term Scour is applied method due to greater scour.

Applied Contraction Scour Depth 5.14 ft

Contraction & Long Term Scour is applied method due to greater scour.

Pressure Scour Depth 5.14 ft

Live Bed Contraction Scour Depth 5.14 ft

Applied Contraction Scour Elevation with LTD
5.14 ft

LOCAL SCOUR AT PIERS SUMMARY

PIER NAME: PIER 1

Computation Method: Complex Piers

Pier Scour Depth 5.04 ft

Total Scour at Pier 10.19 ft

Total Scour Elevation at Pier 731.76 ft

LOCAL SCOUR AT ABUTMENTS SUMMARY

LEFT ABUTMENT

Abutment Scour Method: NCHRP Method

Abutment Scour Depth 5.31 ft

Total Scour at Abutment 5.31 ft

Total Scour Elevation at Abutment 736.20 ft

RIGHT ABUTMENT

Abutment Scour Method: NCHRP Method

Abutment Scour Depth 5.05 ft

Total Scour at Abutment 5.05 ft

Total Scour Elevation at Abutment 739.14 ft

MAIN CHANNEL CONTRACTION SCOUR

Computation Type: Clear-Water or Live-Bed Scour

INPUT PARAMETERS

Average Depth Upstream of Contraction: 7.50 ft

D50: 0.014021 mm

Average Velocity Upstream: 4.01 ft/s

RESULTS OF SCOUR CONDITION

Critical velocity above which bed material of size D and smaller will be transported: 0.56 ft/s

Contraction Scour Condition: Live-Bed

Live Bed and/or Clear Water Input Parameters

Temperature of Water: 60.00 °F

Slope of Energy Grade Line at Approach Section:
0.0011 ft/ft

Flow in Contracted Section: 605.82 cfs

Flow Upstream that is Transporting Sediment:
428.35 cfs

Width in Contracted Section: 14.10 ft

Width Upstream that is Transporting Sediment:
14.10 ft

Depth Prior to Scour in Contracted Section: 4.95 ft

Unit Weight of Water: 62.40 lb/ft³

Unit Weight of Sediment: 165.00 lb/ft³

RESULTS OF LIVE BED METHOD

Shear Velocity: 0.51 ft/s

Fall Velocity: 0.00 ft/s

Average Depth in Contracted Section after Scour: 10.09 ft

Scour Depth for Live Bed: 5.14 ft

Scour may be limited by armoring. Compute all methods to check.

LEFT BANK CONTRACTION SCOUR

Computation Type: Clear-Water and Live-Bed Scour

INPUT PARAMETERS

Average Depth Upstream of Contraction: 5.46 ft
D50: 0.007925 mm

Average Velocity Upstream: 2.33 ft/s

RESULTS OF SCOUR CONDITION

Critical velocity above which bed material of size D and smaller will be transported: 0.44 ft/s

Contraction Scour Condition: Live-Bed

Live Bed and/or Clear Water Input Parameters

Temperature of Water: 60.00 °F

Slope of Energy Grade Line at Approach Section: 0.0011 ft/ft

Flow in Contracted Section: 695.33 cfs

Flow Upstream that is Transporting Sediment: 487.62 cfs

Width in Contracted Section: 15.44 ft

Width Upstream that is Transporting Sediment: 15.44 ft

Depth Prior to Scour in Contracted Section: 3.85 ft

Unit Weight of Water: 62.40 lb/ft³

Unit Weight of Sediment: 165.00 lb/ft³

Results of Clear Water Method

Diameter of the smallest nontransportable particle in the bed material: 0.009906 mm

Average Depth in Contracted Section after Scour: 62.21 ft

Scour Depth: 58.36 ft

RESULTS OF LIVE BED METHOD

Shear Velocity: 0.44 ft/s

Fall Velocity: 0.00 ft/s

Average Depth in Contracted Section after Scour: 7.40 ft

Scour Depth for Live Bed: 3.55 ft

Shear Applied to Bed by Live-Bed Scour: 0.0698 lb/ft²

Shear Required for Movement of D50 Particle: 0.0001 lb/ft²

Recommendations

WolfRecommended Scour Depth: 3.55 ft

RIGHT BANK CONTRACTION SCOUR

Computation Type: Clear-Water and Live-Bed Scour

INPUT PARAMETERS

Average Depth Upstream of Contraction: 4.08 ft
D50: 0.010058 mm

Average Velocity Upstream: 2.52 ft/s

RESULTS OF SCOUR CONDITION

Critical velocity above which bed material of size D and smaller will be transported: 0.45 ft/s

Contraction Scour Condition: Live-Bed

Live Bed and/or Clear Water Input Parameters

Temperature of Water: 60.00 °F

Slope of Energy Grade Line at Approach Section: 0.0011 ft/ft

Flow in Contracted Section: 313.86 cfs

Flow Upstream that is Transporting Sediment: 361.42 cfs

Width in Contracted Section: 12.96 ft

Width Upstream that is Transporting Sediment: 12.96 ft

Depth Prior to Scour in Contracted Section: 2.36 ft

Unit Weight of Water: 62.40 lb/ft³

Unit Weight of Sediment: 165.00 lb/ft³

Results of Clear Water Method

Diameter of the smallest nontransportable particle in the bed material: 0.012573 mm

Average Depth in Contracted Section after Scour: 34.15 ft

Scour Depth: 31.79 ft

RESULTS OF LIVE BED METHOD

Shear Velocity: 0.38 ft/s

Fall Velocity: 0.00 ft/s

Average Depth in Contracted Section after Scour: 3.62 ft

Scour Depth for Live Bed: 1.26 ft

Shear Applied to Bed by Live-Bed Scour: 0.0722 lb/ft²

Shear Required for Movement of D50 Particle: 0.0001 lb/ft²

Recommendations

Recommended Scour Depth: 1.26 ft

PIER DETAILS

Pier Name: Pier 1

PIER SCOUR

Computation Type: Complex Piers

INPUT PARAMETERS

Pier Shape: Round Nose

Bed Condition: Clear-Water Scour

Angle of Attack: 0.00 Degrees

Depth Upstream of Pier: 8.42 ft

Velocity Upstream of Pier: 4.53 ft/s

PIER INPUT PARAMETERS

Distance between Front Edge of Pile Cap or Footing and Pier: 1.38 ft

Pier Width: 2.75 ft
Pier Length: 25.25 ft
PILE CAP (FOOTING) INPUT PARAMETERS
Initial Height of the Pile Cap Bottom Above the Bed: 0.19 ft
Thickness of Pile Cap: 2.50 ft
Pile Cap Width: 5.50 ft
PILE GROUP PARAMETERS
Individual Pile Width: 1.00 ft
Spacing between Piles: 2.50 ft
Number of Rows of Piles: 13
Number of Columns of Piles: 2
Rows are staggered
Total width of non-overlapping Piles: 2.00 ft
BED MATERIAL PARAMETERS
D50: 0.014021 mm
RESULT PARAMETERS
PIER PARAMETERS
Correction Factor for Pier Nose Shape (K1): 1.00
Correction Factor for Angle of Attack (K2): 1.00
Correction Factor for Bed Condition (K3): 1.10
Coefficient for Pier Stem Height Above Bed (Kh): 0.11
Scour Component for Pier Stem: 0.55 ft
PILE CAP (FOOTING) RESULT PARAMETERS
Froude Number: 0.26
Effective Pile Cap Width: 1.02 ft
Distance from Bed to Top of Footing: 3.24 ft
Scour Component for Pier Cap or Footing: 2.94 ft
PILE GROUP RESULT PARAMETERS
Coefficient for Pile Spacing (Ksp): 1.00
Scour Component for Pile Group: 1.55 ft
TOTAL SCOUR
Scour Depth: 5.04 ft
LEFT ABUTMENT DETAILS
ABUTMENT SCOUR
Computation Type: NCHRP
Input Parameters
NCHRP METHOD
Abutment Type: Vertical-wall abutment with wing wall
Angle of Embankment to Flow: 91.65 Degrees
Centerline Length of Embankment: 0.00 ft
Projected Length of Embankment: 0.00 ft
Width of Flood Plain: 0.00 ft
Unit Discharge, Upstream in Main Channel (q1): 30.38 cfs

Unit Discharge in the Constricted Area (q2): 38.00 cfs/ft
D50: 0.007925 mm
Upstream Flow Depth: 5.46 ft
Flow Depth Prior to Scour: 6.30 ft
RESULT PARAMETERS
q2/q1: 1.25
Average Velocity Upstream: 5.56 ft/s
Critical Velocity above which Bed Material of Size D and Smaller will be Transported: 0.44 ft/s
Scour Condition: Live Bed
Embankment Length/Floodplain Width Ratio: 0.00
Scour Condition: a (Main Channel)
Amplification Factor: 1.76
Flow Depth including Contraction Scour: 6.61 ft
Maximum Flow Depth including Abutment Scour: 11.61 ft
Scour Hole Depth from NCHRP Method: 5.31 ft
RIGHT ABUTMENT DETAILS
ABUTMENT SCOUR
Computation Type: NCHRP
Input Parameters
NCHRP METHOD
Abutment Type: Vertical-wall abutment with wing wall
Angle of Embankment to Flow: 88.35 Degrees
Centerline Length of Embankment: 0.00 ft
Projected Length of Embankment: 0.00 ft
Width of Flood Plain: 0.00 ft
Unit Discharge, Upstream in Main Channel (q1): 30.38 cfs
Unit Discharge in the Constricted Area (q2): 38.00 cfs/ft
D50: 0.014021 mm
Upstream Flow Depth: 4.08 ft
Flow Depth Prior to Scour: 3.62 ft
RESULT PARAMETERS
q2/q1: 1.25
Average Velocity Upstream: 7.45 ft/s
Critical Velocity above which Bed Material of Size D and Smaller will be Transported: 0.51 ft/s
Scour Condition: Live Bed
Embankment Length/Floodplain Width Ratio: 0.00
Scour Condition: a (Main Channel)
Amplification Factor: 1.76
Flow Depth including Contraction Scour: 4.94 ft

Maximum Flow Depth including Abutment Scour: 8.67 ft

Scour Hole Depth from NCHRP Method: 5.05 ft

BRIDGE SCOUR ANALYSIS: WOLF CREEK L-0022

Project Title: L0022

Designer:

Project Date: Friday, May 26, 2023

Project Units: U.S. Customary Units

Notes:

L-0022 SRH-2D

Notes:

SCENARIO: 100-YR

CONTRACTION SCOUR SUMMARY

Contraction & Long Term Scour is applied method due to greater scour.

Applied Contraction Scour Depth 8.49 ft

Contraction & Long Term Scour is applied method due to greater scour.

Pressure Scour Depth 8.49 ft

Clear Water Contraction Scour Depth 8.49 ft

Applied Contraction Scour Elevation with LTD 0.00 ft

LOCAL SCOUR AT PIERS SUMMARY

PIER NAME: PIER 1

Computation Method: HEC-18

Pier Scour Depth 4.00 ft

Total Scour at Pier 12.49 ft

Total Scour Elevation at Pier 351.61 ft

PIER NAME: PIER 2

Computation Method: HEC-18

Pier Scour Depth 4.00 ft

Total Scour at Pier 12.49 ft

Total Scour Elevation at Pier 351.61 ft

LOCAL SCOUR AT ABUTMENTS SUMMARY

LEFT ABUTMENT

Abutment Scour Method: NCHRP Method

Abutment Scour Depth 27.32 ft

Total Scour at Abutment 27.32 ft

Total Scour Elevation at Abutment 343.61 ft

RIGHT ABUTMENT

Abutment Scour Method: NCHRP Method

Abutment Scour Depth 31.42 ft

Total Scour at Abutment 31.42 ft

Total Scour Elevation at Abutment 343.20 ft

MAIN CHANNEL CONTRACTION SCOUR

Computation Type: Clear-Water or Live-Bed Scour

INPUT PARAMETERS

Average Depth Upstream of Contraction: 10.83 ft

D50: 1.299972 mm

Average Velocity Upstream: 2.45 ft/s

RESULTS OF SCOUR CONDITION

Critical velocity above which bed material of size D and smaller will be transported: 2.69 ft/s

Contraction Scour Condition: Clear-Water

Live Bed and/or Clear Water Input Parameters

Flow in Contracted Section: 1760.25 cfs

Bottom Width in Contracted Section: 15.80 ft

Depth Prior to Scour in Contracted Section: 23.01 ft

Results of Clear Water Method

Diameter of the smallest nontransportable particle in the bed material: 1.624965 mm

Average Depth in Contracted Section after Scour: 31.50 ft

Scour Depth: 8.49 ft

LEFT BANK CONTRACTION SCOUR

Computation Type: Clear-Water or Live-Bed Scour

INPUT PARAMETERS

Average Depth Upstream of Contraction: 1.45 ft

D50: 1.299972 mm

Average Velocity Upstream: 1.28 ft/s

RESULTS OF SCOUR CONDITION

Critical velocity above which bed material of size D and smaller will be transported: 1.93 ft/s

Contraction Scour Condition: Clear-Water

Live Bed and/or Clear Water Input Parameters

Flow in Contracted Section: 206.33 cfs

Bottom Width in Contracted Section: 12.29 ft

Depth Prior to Scour in Contracted Section: 4.09 ft

Results of Clear Water Method

Diameter of the smallest nontransportable particle in the bed material: 1.624965 mm

Average Depth in Contracted Section after Scour: 6.22 ft

Scour Depth: 2.13 ft

RIGHT BANK CONTRACTION SCOUR

Computation Type: Clear-Water or Live-Bed Scour

INPUT PARAMETERS

Average Depth Upstream of Contraction: 2.64 ft

D50: 1.299972 mm

Average Velocity Upstream: 0.79 ft/s

RESULTS OF SCOUR CONDITION

Critical velocity above which bed material of size D and smaller will be transported: 2.13 ft/s
Contraction Scour Condition: Clear-Water
Live Bed and/or Clear Water Input Parameters
Flow in Contracted Section: 162.54 cfs
Bottom Width in Contracted Section: 13.93 ft
Depth Prior to Scour in Contracted Section: 3.21 ft

Results of Clear Water Method

Diameter of the smallest nontransportable particle in the bed material: 1.624965 mm
Average Depth in Contracted Section after Scour: 4.55 ft
Scour Depth: 1.35 ft

PIER DETAILS

Pier Name: Pier 1

PIER SCOUR

Computation Type: HEC-18

INPUT PARAMETERS

Pier Shape: Group of Cylinders
Bed Condition: Clear-Water Scour
Depth Upstream of Pier: 17.28 ft
Velocity Upstream of Pier: 4.80 ft/s
Width of Pier: 1.17 ft

Length of Pier: 36.20 ft

Angle of Attack: 15.23 Degrees

Spacing between Piers: 7.00 ft

Number of Columns of Piers: 6

RESULT PARAMETERS

Froude Number Upstream: 0.20

Correction Factor for Pier Nose Shape (K1): 1.00

Correction Factor of Angle of Attack (K2): 1.00

Spacing to Pier Width (s/a): 5.98

Correction Factor for Bed Condition (K3): 1.10

Scour Depth: 4.00 ft

Pier Name: Pier 2

PIER SCOUR

Computation Type: HEC-18

INPUT PARAMETERS

Pier Shape: Group of Cylinders
Bed Condition: Clear-Water Scour
Depth Upstream of Pier: 17.28 ft
Velocity Upstream of Pier: 4.80 ft/s
Width of Pier: 1.17 ft

Length of Pier: 36.20 ft

Angle of Attack: 1.29 Degrees

Spacing between Piers: 7.00 ft

Number of Columns of Piers: 6

RESULT PARAMETERS

Froude Number Upstream: 0.20

Correction Factor for Pier Nose Shape (K1): 1.00

Correction Factor of Angle of Attack (K2): 1.00

Spacing to Pier Width (s/a): 5.98

Correction Factor for Bed Condition (K3): 1.10

Scour Depth: 4.00 ft

LEFT ABUTMENT DETAILS

ABUTMENT SCOUR

Computation Type: NCHRP

Input Parameters

NCHRP METHOD

Abutment Type: Spill-through abutment

Angle of Embankment to Flow: 46.03 Degrees

Centerline Length of Embankment: 0.00 ft

Projected Length of Embankment: 0.00 ft

Width of Flood Plain: 0.00 ft

Unit Discharge, Upstream in Main Channel (q1): 26.54 cfs

Unit Discharge in the Constricted Area (q2): 111.44 cfs/ft

D50: 1.280160 mm

Upstream Flow Depth: 10.83 ft

Flow Depth Prior to Scour: 10.48 ft

RESULT PARAMETERS

q2/q1: 4.20

Average Velocity Upstream: 2.45 ft/s

Critical Velocity above which Bed Material of Size D and Smaller will be Transported: 2.68 ft/s

Scour Condition: Clear Water

Embankment Length/Floodplain Width Ratio: 0.00

Scour Condition: a (Main Channel)

Amplification Factor: 1.10

Flow Depth including Contraction Scour: 34.30 ft

Maximum Flow Depth including Abutment Scour: 37.80 ft

Scour Hole Depth from NCHRP Method: 27.32 ft

RIGHT ABUTMENT DETAILS

ABUTMENT SCOUR

Computation Type: NCHRP

Input Parameters

NCHRP METHOD

Abutment Type: Spill-through abutment

Angle of Embankment to Flow: 133.97 Degrees

Centerline Length of Embankment: 0.00 ft

Projected Length of Embankment: 0.00 ft

Width of Flood Plain: 0.00 ft
Unit Discharge, Upstream in Main Channel (q1):
26.54 cfs
Unit Discharge in the Constricted Area (q2):
111.44 cfs/ft
D50: 1.280160 mm
Upstream Flow Depth: 10.83 ft
Flow Depth Prior to Scour: 6.38 ft
RESULT PARAMETERS
q2/q1: 4.20
Average Velocity Upstream: 2.45 ft/s
Critical Velocity above which Bed Material of Size
D and Smaller will be Transported: 2.68 ft/s
Scour Condition: Clear Water
Embankment Length/Floodplain Width Ratio:
0.00
Scour Condition: a (Main Channel)
Amplification Factor: 1.10
Flow Depth including Contraction Scour: 34.30 ft
Maximum Flow Depth including Abutment
Scour: 37.80 ft
Scour Hole Depth from NCHRP Method: 31.42 ft
SCENARIO: 500-YR
CONTRACTION SCOUR SUMMARY
Contraction & Long Term Scour is applied
method due to greater scour.
Applied Contraction Scour Depth 8.49 ft
Contraction & Long Term Scour is applied
method due to greater scour.
Pressure Scour Depth 8.49 ft
Clear Water Contraction Scour Depth 8.49 ft
Applied Contraction Scour Elevation with LTD
0.00 ft
LOCAL SCOUR AT PIERS SUMMARY
PIER NAME: PIER 1
Computation Method: HEC-18
Pier Scour Depth 4.00 ft
Total Scour at Pier 12.49 ft
Total Scour Elevation at Pier 351.61 ft
PIER NAME: PIER 2
Computation Method: HEC-18
Pier Scour Depth 4.00 ft
Total Scour at Pier 12.49 ft
Total Scour Elevation at Pier 351.61 ft
LOCAL SCOUR AT ABUTMENTS SUMMARY
LEFT ABUTMENT
Abutment Scour Method: NCHRP Method
Abutment Scour Depth 27.32 ft

Total Scour at Abutment 27.32 ft
Total Scour Elevation at Abutment 343.61 ft
RIGHT ABUTMENT
Abutment Scour Method: NCHRP Method
Abutment Scour Depth 31.42 ft
Total Scour at Abutment 31.42 ft
Total Scour Elevation at Abutment 343.20 ft
MAIN CHANNEL CONTRACTION SCOUR
Computation Type: Clear-Water or Live-Bed
Scour
INPUT PARAMETERS
Average Depth Upstream of Contraction: 10.83
ft
D50: 1.299972 mm
Average Velocity Upstream: 2.45 ft/s
RESULTS OF SCOUR CONDITION
Critical velocity above which bed material of size
D and smaller will be transported: 2.69 ft/s
Contraction Scour Condition: Clear-Water
Live Bed and/or Clear Water Input Parameters
Flow in Contracted Section: 1760.25 cfs
Bottom Width in Contracted Section: 15.80 ft
Depth Prior to Scour in Contracted Section: 23.01
ft
Results of Clear Water Method
Diameter of the smallest nontransportable
particle in the bed material: 1.624965 mm
Average Depth in Contracted Section after
Scour: 31.50 ft
Scour Depth: 8.49 ft
LEFT BANK CONTRACTION SCOUR
Computation Type: Clear-Water or Live-Bed
Scour
INPUT PARAMETERS
Average Depth Upstream of Contraction: 1.45 ft
D50: 1.299972 mm
Average Velocity Upstream: 1.28 ft/s
RESULTS OF SCOUR CONDITION
Critical velocity above which bed material of size
D and smaller will be transported: 1.93 ft/s
Contraction Scour Condition: Clear-Water
Live Bed and/or Clear Water Input Parameters
Flow in Contracted Section: 206.33 cfs
Bottom Width in Contracted Section: 12.29 ft
Depth Prior to Scour in Contracted Section: 4.09
ft
Results of Clear Water Method

Diameter of the smallest nontransportable particle in the bed material: 1.624965 mm

Average Depth in Contracted Section after Scour: 6.22 ft

Scour Depth: 2.13 ft

RIGHT BANK CONTRACTION SCOUR

Computation Type: Clear-Water or Live-Bed Scour

INPUT PARAMETERS

Average Depth Upstream of Contraction: 2.64 ft
D50: 1.299972 mm

Average Velocity Upstream: 0.79 ft/s

RESULTS OF SCOUR CONDITION

Critical velocity above which bed material of size D and smaller will be transported: 2.13 ft/s

Contraction Scour Condition: Clear-Water

Live Bed and/or Clear Water Input Parameters

Flow in Contracted Section: 162.54 cfs

Bottom Width in Contracted Section: 13.93 ft

Depth Prior to Scour in Contracted Section: 3.21 ft

Results of Clear Water Method

Diameter of the smallest nontransportable particle in the bed material: 1.624965 mm

Average Depth in Contracted Section after Scour: 4.55 ft

Scour Depth: 1.35 ft

PIER DETAILS

Pier Name: Pier 1

PIER SCOUR

Computation Type: HEC-18

INPUT PARAMETERS

Pier Shape: Group of Cylinders

Bed Condition: Clear-Water Scour

Depth Upstream of Pier: 17.28 ft

Velocity Upstream of Pier: 4.80 ft/s

Width of Pier: 1.17 ft

Length of Pier: 36.20 ft

Angle of Attack: 15.23 Degrees

Spacing between Piers: 7.00 ft

Number of Columns of Piers: 6

RESULT PARAMETERS

Froude Number Upstream: 0.20

Correction Factor for Pier Nose Shape (K1): 1.00

Correction Factor of Angle of Attack (K2): 1.00

Spacing to Pier Width (s/a): 5.98

Correction Factor for Bed Condition (K3): 1.10

Scour Depth: 4.00 ft

Pier Name: Pier 2

PIER SCOUR

Computation Type: HEC-18

INPUT PARAMETERS

Pier Shape: Group of Cylinders

Bed Condition: Clear-Water Scour

Depth Upstream of Pier: 17.28 ft

Velocity Upstream of Pier: 4.80 ft/s

Width of Pier: 1.17 ft

Length of Pier: 36.20 ft

Angle of Attack: 1.29 Degrees

Spacing between Piers: 7.00 ft

Number of Columns of Piers: 6

RESULT PARAMETERS

Froude Number Upstream: 0.20

Correction Factor for Pier Nose Shape (K1): 1.00

Correction Factor of Angle of Attack (K2): 1.00

Spacing to Pier Width (s/a): 5.98

Correction Factor for Bed Condition (K3): 1.10

Scour Depth: 4.00 ft

LEFT ABUTMENT DETAILS

ABUTMENT SCOUR

Computation Type: NCHRP

Input Parameters

NCHRP METHOD

Abutment Type: Spill-through abutment

Angle of Embankment to Flow: 46.03 Degrees

Centerline Length of Embankment: 0.00 ft

Projected Length of Embankment: 0.00 ft

Width of Flood Plain: 0.00 ft

Unit Discharge, Upstream in Main Channel (q1):
26.54 cfs

Unit Discharge in the Constricted Area (q2):
111.44 cfs/ft

D50: 1.280160 mm

Upstream Flow Depth: 10.83 ft

Flow Depth Prior to Scour: 10.48 ft

RESULT PARAMETERS

q2/q1: 4.20

Average Velocity Upstream: 2.45 ft/s

Critical Velocity above which Bed Material of Size D and Smaller will be Transported: 2.68 ft/s

Scour Condition: Clear Water

Embankment Length/Floodplain Width Ratio:
0.00

Scour Condition: a (Main Channel)

Amplification Factor: 1.10

Flow Depth including Contraction Scour: 34.30 ft

Maximum Flow Depth including Abutment Scour: 37.80 ft

Scour Hole Depth from NCHRP Method: 27.32 ft

RIGHT ABUTMENT DETAILS

ABUTMENT SCOUR

Computation Type: NCHRP

Input Parameters

NCHRP METHOD

Abutment Type: Spill-through abutment

Angle of Embankment to Flow: 133.97 Degrees

Centerline Length of Embankment: 0.00 ft

Projected Length of Embankment: 0.00 ft

Width of Flood Plain: 0.00 ft

Unit Discharge, Upstream in Main Channel (q1):
26.54 cfs

Unit Discharge in the Constricted Area (q2):
111.44 cfs/ft

D50: 1.280160 mm

Upstream Flow Depth: 10.83 ft

Flow Depth Prior to Scour: 6.38 ft

RESULT PARAMETERS

q2/q1: 4.20

Average Velocity Upstream: 2.45 ft/s

Critical Velocity above which Bed Material of Size D and Smaller will be Transported: 2.68 ft/s

Scour Condition: Clear Water

Embankment Length/Floodplain Width Ratio:
0.00

Scour Condition: a (Main Channel)

Amplification Factor: 1.10

Flow Depth including Contraction Scour: 34.30 ft

Maximum Flow Depth including Abutment Scour: 37.80 ft

Scour Hole Depth from NCHRP Method: 31.42 ft

L-0022 HEC-RAS

Notes:

SCENARIO: 100-YR

CONTRACTION SCOUR SUMMARY

Contraction & Long Term Scour is applied method due to greater scour.

Applied Contraction Scour Elevation with LTD -
1.51 ft

LOCAL SCOUR AT PIERS SUMMARY

PIER NAME: PIER 1

Computation Method: HEC-18

Pier Scour Depth 4.02 ft

Total Scour at Pier 4.02 ft

Total Scour Elevation at Pier 360.08 ft

PIER NAME: PIER 2

Computation Method: HEC-18

Pier Scour Depth 4.02 ft

Total Scour at Pier 4.02 ft

Total Scour Elevation at Pier 360.08 ft

LOCAL SCOUR AT ABUTMENTS SUMMARY

LEFT ABUTMENT

Abutment Scour Method: NCHRP Method

Abutment Scour Depth -4.26 ft

Total Scour at Abutment 0.00 ft

Total Scour Elevation at Abutment 374.72 ft

RIGHT ABUTMENT

Abutment Scour Method: NCHRP Method

Abutment Scour Depth -2.55 ft

Total Scour at Abutment 0.00 ft

Total Scour Elevation at Abutment 376.78 ft

MAIN CHANNEL CONTRACTION SCOUR

Computation Type: Clear-Water or Live-Bed Scour

INPUT PARAMETERS

Average Depth Upstream of Contraction: 7.56 ft

D50: 1.299972 mm

Average Velocity Upstream: 4.01 ft/s

RESULTS OF SCOUR CONDITION

Critical velocity above which bed material of size D and smaller will be transported: 2.54 ft/s

Contraction Scour Condition: Live-Bed

Live Bed and/or Clear Water Input Parameters

Temperature of Water: 60.00 °F

Slope of Energy Grade Line at Approach Section:
0.0048 ft/ft

Flow in Contracted Section: 1992.01 cfs

Flow Upstream that is Transporting Sediment:
1841.70 cfs

Width in Contracted Section: 47.56 ft

Width Upstream that is Transporting Sediment:
27.67 ft

Depth Prior to Scour in Contracted Section: 7.07 ft

Unit Weight of Water: 62.40 lb/ft³

Unit Weight of Sediment: 165.00 lb/ft³

RESULTS OF LIVE BED METHOD

Shear Velocity: 1.08 ft/s

Fall Velocity: 0.49 ft/s

Average Depth in Contracted Section after Scour: 5.56 ft

Scour Depth for Live Bed: -1.51 ft

Scour may be limited by armoring. Compute all methods to check.

LEFT BANK CONTRACTION SCOUR

Computation Type: Clear-Water or Live-Bed Scour

INPUT PARAMETERS

Average Depth Upstream of Contraction: 0.55 ft
D50: 1.299972 mm

Average Velocity Upstream: 0.96 ft/s

RESULTS OF SCOUR CONDITION

Critical velocity above which bed material of size D and smaller will be transported: 1.64 ft/s

Contraction Scour Condition: Clear-Water

Live Bed and/or Clear Water Input Parameters

Flow in Contracted Section: 0.63 cfs

Bottom Width in Contracted Section: 4.38 ft

Depth Prior to Scour in Contracted Section: 0.31 ft

Results of Clear Water Method

Diameter of the smallest nontransportable particle in the bed material: 1.624965 mm

Average Depth in Contracted Section after Scour: 0.11 ft

Scour Depth: -0.20 ft

RIGHT BANK CONTRACTION SCOUR

Computation Type: Clear-Water or Live-Bed Scour

INPUT PARAMETERS

Average Depth Upstream of Contraction: 1.45 ft
D50: 1.299972 mm

Average Velocity Upstream: 1.89 ft/s

RESULTS OF SCOUR CONDITION

Critical velocity above which bed material of size D and smaller will be transported: 1.93 ft/s

Contraction Scour Condition: Clear-Water

Live Bed and/or Clear Water Input Parameters

Flow in Contracted Section: 58.36 cfs

Bottom Width in Contracted Section: 27.38 ft

Depth Prior to Scour in Contracted Section: 0.96 ft

Results of Clear Water Method

Diameter of the smallest nontransportable particle in the bed material: 1.624965 mm

Average Depth in Contracted Section after Scour: 1.06 ft

Scour Depth: 0.10 ft

PIER DETAILS

Pier Name: Pier 1

PIER SCOUR

Computation Type: HEC-18

INPUT PARAMETERS

Pier Shape: Group of Cylinders

Bed Condition: Clear-Water Scour

Depth Upstream of Pier: 14.89 ft

Velocity Upstream of Pier: 7.77 ft/s

Width of Pier: 1.17 ft

Length of Pier: 36.20 ft

Angle of Attack: 0.00 Degrees

RESULT PARAMETERS

Froude Number Upstream: 0.35

Correction Factor for Pier Nose Shape (K1): 1.00

Correction Factor of Angle of Attack (K2): 1.00

Pier Length to Pier Width (L/a): 12.00

Correction Factor for Bed Condition (K3): 1.10

Scour Depth: 4.02 ft

Pier Name: Pier 2

PIER SCOUR

Computation Type: HEC-18

INPUT PARAMETERS

Pier Shape: Group of Cylinders

Bed Condition: Clear-Water Scour

Depth Upstream of Pier: 14.89 ft

Velocity Upstream of Pier: 7.77 ft/s

Width of Pier: 1.17 ft

Length of Pier: 36.20 ft

Angle of Attack: 0.00 Degrees

RESULT PARAMETERS

Froude Number Upstream: 0.35

Correction Factor for Pier Nose Shape (K1): 1.00

Correction Factor of Angle of Attack (K2): 1.00

Pier Length to Pier Width (L/a): 12.00

Correction Factor for Bed Condition (K3): 1.10

Scour Depth: 4.02 ft

LEFT ABUTMENT DETAILS

ABUTMENT SCOUR

Computation Type: NCHRP

Input Parameters

NCHRP METHOD

Abutment Type: Spill-through abutment

Angle of Embankment to Flow: 46.03 Degrees

Centerline Length of Embankment: 0.00 ft

Projected Length of Embankment: 0.00 ft

Width of Flood Plain: 0.00 ft

Unit Discharge, Upstream in Main Channel (q1):
61.51 cfs

Unit Discharge in the Constricted Area (q2):
24.42 cfs/ft
D50: 1.280160 mm
Upstream Flow Depth: 10.47 ft
Flow Depth Prior to Scour: 9.95 ft
RESULT PARAMETERS
q2/q1: 0.40
Average Velocity Upstream: 5.87 ft/s
Critical Velocity above which Bed Material of Size
D and Smaller will be Transported: 2.67 ft/s
Scour Condition: Live Bed
Embankment Length/Floodplain Width Ratio:
0.00
Scour Condition: a (Main Channel)
Amplification Factor: 1.20
Flow Depth including Contraction Scour: 4.74 ft
Maximum Flow Depth including Abutment
Scour: 5.69 ft
Scour Hole Depth from NCHRP Method: -4.26 ft
RIGHT ABUTMENT DETAILS
ABUTMENT SCOUR
Computation Type: NCHRP
Input Parameters
NCHRP METHOD
Abutment Type: Spill-through abutment
Angle of Embankment to Flow: 133.97 Degrees
Centerline Length of Embankment: 0.00 ft
Projected Length of Embankment: 0.00 ft
Width of Flood Plain: 0.00 ft
Unit Discharge, Upstream in Main Channel (q1):
61.51 cfs
Unit Discharge in the Constricted Area (q2):
24.42 cfs/ft
D50: 1.280160 mm
Upstream Flow Depth: 6.67 ft
Flow Depth Prior to Scour: 6.18 ft
RESULT PARAMETERS
q2/q1: 0.40
Average Velocity Upstream: 9.22 ft/s
Critical Velocity above which Bed Material of Size
D and Smaller will be Transported: 2.47 ft/s
Scour Condition: Live Bed
Embankment Length/Floodplain Width Ratio:
0.00
Scour Condition: a (Main Channel)
Amplification Factor: 1.20
Flow Depth including Contraction Scour: 3.02 ft

Maximum Flow Depth including Abutment
Scour: 3.63 ft
Scour Hole Depth from NCHRP Method: -2.55 ft
SCENARIO: 500-YR
CONTRACTION SCOUR SUMMARY
Contraction & Long Term Scour is applied
method due to greater scour.
Applied Contraction Scour Elevation with LTD -
1.51 ft
LOCAL SCOUR AT PIERS SUMMARY
PIER NAME: PIER 1
Computation Method: HEC-18
Pier Scour Depth 4.02 ft
Total Scour at Pier 4.02 ft
Total Scour Elevation at Pier 360.08 ft
PIER NAME: PIER 2
Computation Method: HEC-18
Pier Scour Depth 4.02 ft
Total Scour at Pier 4.02 ft
Total Scour Elevation at Pier 360.08 ft
LOCAL SCOUR AT ABUTMENTS SUMMARY
LEFT ABUTMENT
Abutment Scour Method: NCHRP Method
Abutment Scour Depth -4.26 ft
Total Scour at Abutment 0.00 ft
Total Scour Elevation at Abutment 374.72 ft
RIGHT ABUTMENT
Abutment Scour Method: NCHRP Method
Abutment Scour Depth -2.55 ft
Total Scour at Abutment 0.00 ft
Total Scour Elevation at Abutment 376.78 ft
MAIN CHANNEL CONTRACTION SCOUR
Computation Type: Clear-Water or Live-Bed
Scour
INPUT PARAMETERS
Average Depth Upstream of Contraction: 7.56 ft
D50: 1.299972 mm
Average Velocity Upstream: 4.01 ft/s
RESULTS OF SCOUR CONDITION
Critical velocity above which bed material of size
D and smaller will be transported: 2.54 ft/s
Contraction Scour Condition: Live-Bed
Live Bed and/or Clear Water Input Parameters
Temperature of Water: 60.00 °F
Slope of Energy Grade Line at Approach Section:
0.0048 ft/ft
Flow in Contracted Section: 1992.01 cfs

Flow Upstream that is Transporting Sediment:
1841.70 cfs

Width in Contracted Section: 47.56 ft

Width Upstream that is Transporting Sediment:
27.67 ft

Depth Prior to Scour in Contracted Section: 7.07
ft

Unit Weight of Water: 62.40 lb/ft³

Unit Weight of Sediment: 165.00 lb/ft³

RESULTS OF LIVE BED METHOD

Shear Velocity: 1.08 ft/s

Fall Velocity: 0.49 ft/s

Average Depth in Contracted Section after
Scour: 5.56 ft

Scour Depth for Live Bed: -1.51 ft

Scour may be limited by armoring. Compute all
methods to check.

LEFT BANK CONTRACTION SCOUR

Computation Type: Clear-Water or Live-Bed
Scour

INPUT PARAMETERS

Average Depth Upstream of Contraction: 0.55 ft
D50: 1.299972 mm

Average Velocity Upstream: 0.96 ft/s

RESULTS OF SCOUR CONDITION

Critical velocity above which bed material of size
D and smaller will be transported: 1.64 ft/s

Contraction Scour Condition: Clear-Water

Live Bed and/or Clear Water Input Parameters

Flow in Contracted Section: 0.63 cfs

Bottom Width in Contracted Section: 4.38 ft

Depth Prior to Scour in Contracted Section: 0.31
ft

Results of Clear Water Method

Diameter of the smallest nontransportable
particle in the bed material: 1.624965 mm

Average Depth in Contracted Section after
Scour: 0.11 ft

Scour Depth: -0.20 ft

RIGHT BANK CONTRACTION SCOUR

Computation Type: Clear-Water or Live-Bed
Scour

INPUT PARAMETERS

Average Depth Upstream of Contraction: 1.45 ft
D50: 1.299972 mm

Average Velocity Upstream: 1.89 ft/s

RESULTS OF SCOUR CONDITION

Critical velocity above which bed material of size
D and smaller will be transported: 1.93 ft/s

Contraction Scour Condition: Clear-Water

Live Bed and/or Clear Water Input Parameters

Flow in Contracted Section: 58.36 cfs

Bottom Width in Contracted Section: 27.38 ft

Depth Prior to Scour in Contracted Section: 0.96
ft

Results of Clear Water Method

Diameter of the smallest nontransportable
particle in the bed material: 1.624965 mm

Average Depth in Contracted Section after
Scour: 1.06 ft

Scour Depth: 0.10 ft

PIER DETAILS

Pier Name: Pier 1

PIER SCOUR

Computation Type: HEC-18

INPUT PARAMETERS

Pier Shape: Group of Cylinders

Bed Condition: Clear-Water Scour

Depth Upstream of Pier: 14.89 ft

Velocity Upstream of Pier: 7.77 ft/s

Width of Pier: 1.17 ft

Length of Pier: 36.20 ft

Angle of Attack: 0.00 Degrees

RESULT PARAMETERS

Froude Number Upstream: 0.35

Correction Factor for Pier Nose Shape (K1): 1.00

Correction Factor of Angle of Attack (K2): 1.00

Pier Length to Pier Width (L/a): 12.00

Correction Factor for Bed Condition (K3): 1.10

Scour Depth: 4.02 ft

Pier Name: Pier 2

PIER SCOUR

Computation Type: HEC-18

INPUT PARAMETERS

Pier Shape: Group of Cylinders

Bed Condition: Clear-Water Scour

Depth Upstream of Pier: 14.89 ft

Velocity Upstream of Pier: 7.77 ft/s

Width of Pier: 1.17 ft

Length of Pier: 36.20 ft

Angle of Attack: 0.00 Degrees

RESULT PARAMETERS

Froude Number Upstream: 0.35

Correction Factor for Pier Nose Shape (K1): 1.00

Correction Factor of Angle of Attack (K2): 1.00

Pier Length to Pier Width (L/a): 12.00
Correction Factor for Bed Condition (K3): 1.10
Scour Depth: 4.02 ft
LEFT ABUTMENT DETAILS
ABUTMENT SCOUR
Computation Type: NCHRP
Input Parameters
NCHRP METHOD
Abutment Type: Spill-through abutment
Angle of Embankment to Flow: 46.03 Degrees
Centerline Length of Embankment: 0.00 ft
Projected Length of Embankment: 0.00 ft
Width of Flood Plain: 0.00 ft
Unit Discharge, Upstream in Main Channel (q1):
61.51 cfs
Unit Discharge in the Constricted Area (q2):
24.42 cfs/ft
D50: 1.280160 mm
Upstream Flow Depth: 10.47 ft
Flow Depth Prior to Scour: 9.95 ft
RESULT PARAMETERS
q2/q1: 0.40
Average Velocity Upstream: 5.87 ft/s
Critical Velocity above which Bed Material of Size
D and Smaller will be Transported: 2.67 ft/s
Scour Condition: Live Bed
Embankment Length/Floodplain Width Ratio:
0.00
Scour Condition: a (Main Channel)
Amplification Factor: 1.20
Flow Depth including Contraction Scour: 4.74 ft
Maximum Flow Depth including Abutment
Scour: 5.69 ft
Scour Hole Depth from NCHRP Method: -4.26 ft
RIGHT ABUTMENT DETAILS
ABUTMENT SCOUR
Computation Type: NCHRP
Input Parameters
NCHRP METHOD
Abutment Type: Spill-through abutment
Angle of Embankment to Flow: 133.97 Degrees
Centerline Length of Embankment: 0.00 ft
Projected Length of Embankment: 0.00 ft
Width of Flood Plain: 0.00 ft
Unit Discharge, Upstream in Main Channel (q1):
61.51 cfs
Unit Discharge in the Constricted Area (q2):
24.42 cfs/ft

D50: 1.280160 mm
Upstream Flow Depth: 6.67 ft
Flow Depth Prior to Scour: 6.18 ft
RESULT PARAMETERS
q2/q1: 0.40
Average Velocity Upstream: 9.22 ft/s
Critical Velocity above which Bed Material of Size
D and Smaller will be Transported: 2.47 ft/s
Scour Condition: Live Bed
Embankment Length/Floodplain Width Ratio:
0.00
Scour Condition: a (Main Channel)
Amplification Factor: 1.20
Flow Depth including Contraction Scour: 3.02 ft
Maximum Flow Depth including Abutment
Scour: 3.63 ft
Scour Hole Depth from NCHRP Method: -2.55 ft

BRIDGE SCOUR ANALYSIS: DRY FORK CREEK L-0564

Project Title: L0564
Designer:
Project Date: Tuesday, May 23, 2023
Project Units: U.S. Customary Units
Notes:

L-0564 SRH-2D

Notes:

SCENARIO: 100-YR

CONTRACTION SCOUR SUMMARY
Contraction & Long Term Scour is applied
method due to greater scour.
Applied Contraction Scour Elevation with LTD -
0.39 ft
LOCAL SCOUR AT PIERS SUMMARY
PIER NAME: PIER 1
Computation Method: HEC-18
Pier Scour Depth 6.79 ft
Total Scour at Pier 6.79 ft
Total Scour Elevation at Pier 508.74 ft
PIER NAME: PIER 2
Computation Method: HEC-18
Pier Scour Depth 3.85 ft
Total Scour at Pier 3.85 ft
Total Scour Elevation at Pier 511.69 ft
PIER NAME: PIER 3
Computation Method: HEC-18
Pier Scour Depth 3.11 ft
Total Scour at Pier 3.11 ft

Total Scour Elevation at Pier 512.42 ft
PIER NAME: PIER 4
Computation Method: HEC-18
Pier Scour Depth 3.83 ft
Total Scour at Pier 3.83 ft
Total Scour Elevation at Pier 511.71 ft
LOCAL SCOUR AT ABUTMENTS SUMMARY
LEFT ABUTMENT
Abutment Scour Method: NCHRP Method
Abutment Scour Depth 23.55 ft
Total Scour at Abutment 23.55 ft
Total Scour Elevation at Abutment 501.84 ft
RIGHT ABUTMENT
Abutment Scour Method: NCHRP Method
Abutment Scour Depth 19.31 ft
Total Scour at Abutment 19.31 ft
Total Scour Elevation at Abutment 507.17 ft
MAIN CHANNEL CONTRACTION SCOUR
Computation Type: Clear-Water or Live-Bed Scour
INPUT PARAMETERS
Average Depth Upstream of Contraction: 10.63 ft
D50: 4.200144 mm
Average Velocity Upstream: 4.13 ft/s
RESULTS OF SCOUR CONDITION
Critical velocity above which bed material of size D and smaller will be transported: 3.97 ft/s
Contraction Scour Condition: Live-Bed
Live Bed and/or Clear Water Input Parameters
Temperature of Water: 60.00 °F
Slope of Energy Grade Line at Approach Section: 0.0017 ft/ft
Flow in Contracted Section: 2682.43 cfs
Flow Upstream that is Transporting Sediment: 2681.38 cfs
Width in Contracted Section: 48.26 ft
Width Upstream that is Transporting Sediment: 61.04 ft
Depth Prior to Scour in Contracted Section: 12.74 ft
Unit Weight of Water: 62.40 lb/ft³
Unit Weight of Sediment: 165.00 lb/ft³
RESULTS OF LIVE BED METHOD
Shear Velocity: 0.76 ft/s
Fall Velocity: 1.00 ft/s
Average Depth in Contracted Section after Scour: 12.35 ft

Scour Depth for Live Bed: -0.39 ft
Scour may be limited by armoring. Compute all methods to check.
LEFT BANK CONTRACTION SCOUR
Computation Type: Clear-Water or Live-Bed Scour
INPUT PARAMETERS
Average Depth Upstream of Contraction: 4.55 ft
D50: 1.039978 mm
Average Velocity Upstream: 2.08 ft/s
RESULTS OF SCOUR CONDITION
Critical velocity above which bed material of size D and smaller will be transported: 2.16 ft/s
Contraction Scour Condition: Clear-Water
Live Bed and/or Clear Water Input Parameters
Flow in Contracted Section: 1984.63 cfs
Bottom Width in Contracted Section: 199.02 ft
Depth Prior to Scour in Contracted Section: 13.72 ft
Results of Clear Water Method
Diameter of the smallest nontransportable particle in the bed material: 1.299972 mm
Average Depth in Contracted Section after Scour: 4.24 ft
Scour Depth: -9.48 ft
RIGHT BANK CONTRACTION SCOUR
Computation Type: Clear-Water or Live-Bed Scour
INPUT PARAMETERS
Average Depth Upstream of Contraction: 2.79 ft
D50: 2.699918 mm
Average Velocity Upstream: 1.37 ft/s
RESULTS OF SCOUR CONDITION
Critical velocity above which bed material of size D and smaller will be transported: 2.74 ft/s
Contraction Scour Condition: Clear-Water
Live Bed and/or Clear Water Input Parameters
Flow in Contracted Section: 727.45 cfs
Bottom Width in Contracted Section: 45.30 ft
Depth Prior to Scour in Contracted Section: 5.69 ft
Results of Clear Water Method
Diameter of the smallest nontransportable particle in the bed material: 3.374898 mm
Average Depth in Contracted Section after Scour: 4.86 ft
Scour Depth: -0.84 ft
PIER DETAILS

Pier Name: Pier 1
PIER SCOUR
Computation Type: HEC-18
INPUT PARAMETERS
Pier Shape: Square Nose
Bed Condition: Clear-Water Scour
Depth Upstream of Pier: 13.16 ft
Velocity Upstream of Pier: 4.54 ft/s
Width of Pier: 1.00 ft
Length of Pier: 5.00 ft
Angle of Attack: 37.69 Degrees
RESULT PARAMETERS
Froude Number Upstream: 0.22
Correction Factor for Pier Nose Shape (K1): 1.00
Correction Factor of Angle of Attack (K2): 2.40
Pier Length to Pier Width (L/a): 5.00
Correction Factor for Bed Condition (K3): 1.10
Scour Depth: 6.79 ft
Pier Name: Pier 2
PIER SCOUR
Computation Type: HEC-18
INPUT PARAMETERS
Pier Shape: Square Nose
Bed Condition: Clear-Water Scour
Depth Upstream of Pier: 13.16 ft
Velocity Upstream of Pier: 4.54 ft/s
Width of Pier: 1.00 ft
Length of Pier: 5.00 ft
Angle of Attack: 7.03 Degrees
RESULT PARAMETERS
Froude Number Upstream: 0.22
Correction Factor for Pier Nose Shape (K1): 1.00
Correction Factor of Angle of Attack (K2): 1.36
Pier Length to Pier Width (L/a): 5.00
Correction Factor for Bed Condition (K3): 1.10
Scour Depth: 3.85 ft
Pier Name: Pier 3
PIER SCOUR
Computation Type: HEC-18
INPUT PARAMETERS
Pier Shape: Square Nose
Bed Condition: Clear-Water Scour
Depth Upstream of Pier: 13.16 ft
Velocity Upstream of Pier: 4.54 ft/s
Width of Pier: 1.00 ft
Length of Pier: 5.00 ft
Angle of Attack: 0.00 Degrees
RESULT PARAMETERS

Froude Number Upstream: 0.22
Correction Factor for Pier Nose Shape (K1): 1.10
Correction Factor of Angle of Attack (K2): 1.00
Pier Length to Pier Width (L/a): 5.00
Correction Factor for Bed Condition (K3): 1.10
Scour Depth: 3.11 ft
Pier Name: Pier 4
PIER SCOUR
Computation Type: HEC-18
INPUT PARAMETERS
Pier Shape: Square Nose
Bed Condition: Clear-Water Scour
Depth Upstream of Pier: 13.16 ft
Velocity Upstream of Pier: 4.54 ft/s
Width of Pier: 1.00 ft
Length of Pier: 5.00 ft
Angle of Attack: 4.32 Degrees
RESULT PARAMETERS
Froude Number Upstream: 0.22
Correction Factor for Pier Nose Shape (K1): 1.10
Correction Factor of Angle of Attack (K2): 1.23
Pier Length to Pier Width (L/a): 5.00
Correction Factor for Bed Condition (K3): 1.10
Scour Depth: 3.83 ft
LEFT ABUTMENT DETAILS
ABUTMENT SCOUR
Computation Type: NCHRP
Input Parameters
NCHRP METHOD
Abutment Type: Spill-through abutment
Angle of Embankment to Flow: 54.62 Degrees
Centerline Length of Embankment: 0.00 ft
Projected Length of Embankment: 0.00 ft
Width of Flood Plain: 0.00 ft
Unit Discharge, Upstream in Main Channel (q1):
43.93 cfs
Unit Discharge in the Constricted Area (q2):
55.58 cfs/ft
D50: 2.200046 mm
Upstream Flow Depth: 10.63 ft
Flow Depth Prior to Scour: 3.57 ft
RESULT PARAMETERS
q2/q1: 1.27
Average Velocity Upstream: 4.13 ft/s
Critical Velocity above which Bed Material of Size
D and Smaller will be Transported: 3.20 ft/s
Scour Condition: Live Bed

Embankment Length/Floodplain Width Ratio:
0.00

Scour Condition: b (overbank)

Amplification Factor: 2.09

Flow Depth including Contraction Scour: 13.00 ft

Maximum Flow Depth including Abutment
Scour: 27.12 ft

Scour Hole Depth from NCHRP Method: 23.55 ft

RIGHT ABUTMENT DETAILS

ABUTMENT SCOUR

Computation Type: NCHRP

Input Parameters

NCHRP METHOD

Abutment Type: Spill-through abutment

Angle of Embankment to Flow: 110.37 Degrees

Centerline Length of Embankment: 0.00 ft

Projected Length of Embankment: 0.00 ft

Width of Flood Plain: 0.00 ft

Unit Discharge, Upstream in Main Channel (q1):
43.93 cfs

Unit Discharge in the Constricted Area (q2):
55.58 cfs/ft

D50: 2.699918 mm

Upstream Flow Depth: 10.63 ft

Flow Depth Prior to Scour: 2.47 ft

RESULT PARAMETERS

q2/q1: 1.27

Average Velocity Upstream: 4.13 ft/s

Critical Velocity above which Bed Material of Size
D and Smaller will be Transported: 3.43 ft/s

Scour Condition: Live Bed

Embankment Length/Floodplain Width Ratio:
0.00

Scour Condition: a (Main Channel)

Amplification Factor: 1.67

Flow Depth including Contraction Scour: 13.00 ft

Maximum Flow Depth including Abutment
Scour: 21.77 ft

Scour Hole Depth from NCHRP Method: 19.31 ft

SCENARIO: 500-YR

CONTRACTION SCOUR SUMMARY

Contraction & Long Term Scour is applied
method due to greater scour.

Applied Contraction Scour Elevation with LTD -
0.39 ft

LOCAL SCOUR AT PIERS SUMMARY

PIER NAME: PIER 1

Computation Method: HEC-18

Pier Scour Depth 6.79 ft

Total Scour at Pier 6.79 ft

Total Scour Elevation at Pier 508.74 ft

PIER NAME: PIER 2

Computation Method: HEC-18

Pier Scour Depth 3.85 ft

Total Scour at Pier 3.85 ft

Total Scour Elevation at Pier 511.69 ft

PIER NAME: PIER 3

Computation Method: HEC-18

Pier Scour Depth 3.11 ft

Total Scour at Pier 3.11 ft

Total Scour Elevation at Pier 512.42 ft

PIER NAME: PIER 4

Computation Method: HEC-18

Pier Scour Depth 3.83 ft

Total Scour at Pier 3.83 ft

Total Scour Elevation at Pier 511.71 ft

LOCAL SCOUR AT ABUTMENTS SUMMARY

LEFT ABUTMENT

Abutment Scour Method: NCHRP Method

Abutment Scour Depth 23.55 ft

Total Scour at Abutment 23.55 ft

Total Scour Elevation at Abutment 501.84 ft

RIGHT ABUTMENT

Abutment Scour Method: NCHRP Method

Abutment Scour Depth 19.31 ft

Total Scour at Abutment 19.31 ft

Total Scour Elevation at Abutment 507.17 ft

MAIN CHANNEL CONTRACTION SCOUR

Computation Type: Clear-Water or Live-Bed
Scour

INPUT PARAMETERS

Average Depth Upstream of Contraction: 10.63
ft

D50: 4.200144 mm

Average Velocity Upstream: 4.13 ft/s

RESULTS OF SCOUR CONDITION

Critical velocity above which bed material of size
D and smaller will be transported: 3.97 ft/s

Contraction Scour Condition: Live-Bed

Live Bed and/or Clear Water Input Parameters

Temperature of Water: 60.00 °F

Slope of Energy Grade Line at Approach Section:
0.0017 ft/ft

Flow in Contracted Section: 2682.43 cfs

Flow Upstream that is Transporting Sediment:
2681.38 cfs

Width in Contracted Section: 48.26 ft
Width Upstream that is Transporting Sediment:
61.04 ft
Depth Prior to Scour in Contracted Section: 12.74
ft

Unit Weight of Water: 62.40 lb/ft³
Unit Weight of Sediment: 165.00 lb/ft³

RESULTS OF LIVE BED METHOD

Shear Velocity: 0.76 ft/s
Fall Velocity: 1.00 ft/s
Average Depth in Contracted Section after
Scour: 12.35 ft
Scour Depth for Live Bed: -0.39 ft
Scour may be limited by armoring. Compute all
methods to check.

LEFT BANK CONTRACTION SCOUR

Computation Type: Clear-Water or Live-Bed
Scour

INPUT PARAMETERS

Average Depth Upstream of Contraction: 4.55 ft
D50: 1.039978 mm
Average Velocity Upstream: 2.08 ft/s

RESULTS OF SCOUR CONDITION

Critical velocity above which bed material of size
D and smaller will be transported: 2.16 ft/s
Contraction Scour Condition: Clear-Water
Live Bed and/or Clear Water Input Parameters
Flow in Contracted Section: 1984.63 cfs
Bottom Width in Contracted Section: 199.02 ft
Depth Prior to Scour in Contracted Section: 13.72
ft

Results of Clear Water Method
Diameter of the smallest nontransportable
particle in the bed material: 1.299972 mm
Average Depth in Contracted Section after
Scour: 4.24 ft
Scour Depth: -9.48 ft

RIGHT BANK CONTRACTION SCOUR

Computation Type: Clear-Water or Live-Bed
Scour

INPUT PARAMETERS

Average Depth Upstream of Contraction: 2.79 ft
D50: 2.699918 mm
Average Velocity Upstream: 1.37 ft/s

RESULTS OF SCOUR CONDITION

Critical velocity above which bed material of size
D and smaller will be transported: 2.74 ft/s
Contraction Scour Condition: Clear-Water

Live Bed and/or Clear Water Input Parameters
Flow in Contracted Section: 727.45 cfs
Bottom Width in Contracted Section: 45.30 ft
Depth Prior to Scour in Contracted Section: 5.69
ft

Results of Clear Water Method

Diameter of the smallest nontransportable
particle in the bed material: 3.374898 mm
Average Depth in Contracted Section after
Scour: 4.86 ft
Scour Depth: -0.84 ft

PIER DETAILS

Pier Name: Pier 1

PIER SCOUR

Computation Type: HEC-18

INPUT PARAMETERS

Pier Shape: Square Nose
Bed Condition: Clear-Water Scour
Depth Upstream of Pier: 13.16 ft
Velocity Upstream of Pier: 4.54 ft/s
Width of Pier: 1.00 ft
Length of Pier: 5.00 ft
Angle of Attack: 37.69 Degrees

RESULT PARAMETERS

Froude Number Upstream: 0.22
Correction Factor for Pier Nose Shape (K1): 1.00
Correction Factor of Angle of Attack (K2): 2.40
Pier Length to Pier Width (L/a): 5.00
Correction Factor for Bed Condition (K3): 1.10
Scour Depth: 6.79 ft
Pier Name: Pier 2

PIER SCOUR

Computation Type: HEC-18

INPUT PARAMETERS

Pier Shape: Square Nose
Bed Condition: Clear-Water Scour
Depth Upstream of Pier: 13.16 ft
Velocity Upstream of Pier: 4.54 ft/s
Width of Pier: 1.00 ft
Length of Pier: 5.00 ft
Angle of Attack: 7.03 Degrees

RESULT PARAMETERS

Froude Number Upstream: 0.22
Correction Factor for Pier Nose Shape (K1): 1.00
Correction Factor of Angle of Attack (K2): 1.36
Pier Length to Pier Width (L/a): 5.00
Correction Factor for Bed Condition (K3): 1.10
Scour Depth: 3.85 ft

Pier Name: Pier 3
PIER SCOUR
Computation Type: HEC-18
INPUT PARAMETERS
Pier Shape: Square Nose
Bed Condition: Clear-Water Scour
Depth Upstream of Pier: 13.16 ft
Velocity Upstream of Pier: 4.54 ft/s
Width of Pier: 1.00 ft
Length of Pier: 5.00 ft
Angle of Attack: 0.00 Degrees
RESULT PARAMETERS
Froude Number Upstream: 0.22
Correction Factor for Pier Nose Shape (K1): 1.10
Correction Factor of Angle of Attack (K2): 1.00
Pier Length to Pier Width (L/a): 5.00
Correction Factor for Bed Condition (K3): 1.10
Scour Depth: 3.11 ft
Pier Name: Pier 4
PIER SCOUR
Computation Type: HEC-18
INPUT PARAMETERS
Pier Shape: Square Nose
Bed Condition: Clear-Water Scour
Depth Upstream of Pier: 13.16 ft
Velocity Upstream of Pier: 4.54 ft/s
Width of Pier: 1.00 ft
Length of Pier: 5.00 ft
Angle of Attack: 4.32 Degrees
RESULT PARAMETERS
Froude Number Upstream: 0.22
Correction Factor for Pier Nose Shape (K1): 1.10
Correction Factor of Angle of Attack (K2): 1.23
Pier Length to Pier Width (L/a): 5.00
Correction Factor for Bed Condition (K3): 1.10
Scour Depth: 3.83 ft
LEFT ABUTMENT DETAILS
ABUTMENT SCOUR
Computation Type: NCHRP
Input Parameters
NCHRP METHOD
Abutment Type: Spill-through abutment
Angle of Embankment to Flow: 54.62 Degrees
Centerline Length of Embankment: 0.00 ft
Projected Length of Embankment: 0.00 ft
Width of Flood Plain: 0.00 ft
Unit Discharge, Upstream in Main Channel (q1):
43.93 cfs

Unit Discharge in the Constricted Area (q2):
55.58 cfs/ft
D50: 2.200046 mm
Upstream Flow Depth: 10.63 ft
Flow Depth Prior to Scour: 3.57 ft
RESULT PARAMETERS
q2/q1: 1.27
Average Velocity Upstream: 4.13 ft/s
Critical Velocity above which Bed Material of Size
D and Smaller will be Transported: 3.20 ft/s
Scour Condition: Live Bed
Embankment Length/Floodplain Width Ratio:
0.00
Scour Condition: b (overbank)
Amplification Factor: 2.09
Flow Depth including Contraction Scour: 13.00 ft
Maximum Flow Depth including Abutment
Scour: 27.12 ft
Scour Hole Depth from NCHRP Method: 23.55 ft
RIGHT ABUTMENT DETAILS
ABUTMENT SCOUR
Computation Type: NCHRP
Input Parameters
NCHRP METHOD
Abutment Type: Spill-through abutment
Angle of Embankment to Flow: 110.37 Degrees
Centerline Length of Embankment: 0.00 ft
Projected Length of Embankment: 0.00 ft
Width of Flood Plain: 0.00 ft
Unit Discharge, Upstream in Main Channel (q1):
43.93 cfs
Unit Discharge in the Constricted Area (q2):
55.58 cfs/ft
D50: 2.699918 mm
Upstream Flow Depth: 10.63 ft
Flow Depth Prior to Scour: 2.47 ft
RESULT PARAMETERS
q2/q1: 1.27
Average Velocity Upstream: 4.13 ft/s
Critical Velocity above which Bed Material of Size
D and Smaller will be Transported: 3.43 ft/s
Scour Condition: Live Bed
Embankment Length/Floodplain Width Ratio:
0.00
Scour Condition: a (Main Channel)
Amplification Factor: 1.67
Flow Depth including Contraction Scour: 13.00 ft

Maximum Flow Depth including Abutment Scour: 21.77 ft

Scour Hole Depth from NCHRP Method: 19.31 ft

L-0564 HEC-RAS

Notes

SCENARIO: 100-YR

CONTRACTION SCOUR SUMMARY

Contraction & Long Term Scour is applied method due to greater scour.

Applied Contraction Scour Depth 3.95 ft

Contraction & Long Term Scour is applied method due to greater scour.

Pressure Scour Depth 3.95 ft

Clear Water Contraction Scour Depth 3.95 ft

Applied Contraction Scour Elevation with LTD 0.00 ft

LOCAL SCOUR AT PIERS SUMMARY

PIER NAME: PIER 1

Computation Method: HEC-18

Pier Scour Depth 6.78 ft

Total Scour at Pier 10.73 ft

Total Scour Elevation at Pier 504.80 ft

PIER NAME: PIER 2

Computation Method: HEC-18

Pier Scour Depth 3.84 ft

Total Scour at Pier 7.79 ft

Total Scour Elevation at Pier 507.74 ft

PIER NAME: PIER 3

Computation Method: HEC-18

Pier Scour Depth 3.11 ft

Total Scour at Pier 7.06 ft

Total Scour Elevation at Pier 508.48 ft

PIER NAME: PIER 4

Computation Method: HEC-18

Pier Scour Depth 3.82 ft

Total Scour at Pier 7.77 ft

Total Scour Elevation at Pier 507.76 ft

LOCAL SCOUR AT ABUTMENTS SUMMARY

LEFT ABUTMENT

Abutment Scour Method: NCHRP Method

Abutment Scour Depth 11.15 ft

Total Scour at Abutment 11.15 ft

Total Scour Elevation at Abutment 513.17 ft

RIGHT ABUTMENT

Abutment Scour Method: NCHRP Method

Abutment Scour Depth -1.24 ft

Total Scour at Abutment 0.00 ft

Total Scour Elevation at Abutment 522.65 ft

MAIN CHANNEL CONTRACTION SCOUR

Computation Type: Clear-Water or Live-Bed Scour

INPUT PARAMETERS

Average Depth Upstream of Contraction: 10.98 ft

D50: 4.200144 mm

Average Velocity Upstream: 3.77 ft/s

RESULTS OF SCOUR CONDITION

Critical velocity above which bed material of size D and smaller will be transported: 3.99 ft/s

Contraction Scour Condition: Clear-Water

Live Bed and/or Clear Water Input Parameters

Flow in Contracted Section: 5148.40 cfs

Bottom Width in Contracted Section: 77.00 ft

Depth Prior to Scour in Contracted Section: 10.59 ft

Results of Clear Water Method

Diameter of the smallest nontransportable particle in the bed material: 5.250180 mm

Average Depth in Contracted Section after Scour: 14.54 ft

Scour Depth: 3.95 ft

LEFT BANK CONTRACTION SCOUR

Computation Type: Clear-Water or Live-Bed Scour

INPUT PARAMETERS

Average Depth Upstream of Contraction: 6.11 ft

D50: 1.039978 mm

Average Velocity Upstream: 2.12 ft/s

RESULTS OF SCOUR CONDITION

Critical velocity above which bed material of size D and smaller will be transported: 2.27 ft/s

Contraction Scour Condition: Clear-Water

Live Bed and/or Clear Water Input Parameters

Flow in Contracted Section: 3084.27 cfs

Bottom Width in Contracted Section: 137.23 ft

Depth Prior to Scour in Contracted Section: 5.71 ft

Results of Clear Water Method

Diameter of the smallest nontransportable particle in the bed material: 1.299972 mm

Average Depth in Contracted Section after Scour: 8.51 ft

Scour Depth: 2.80 ft

RIGHT BANK CONTRACTION SCOUR

Computation Type: Clear-Water or Live-Bed Scour

INPUT PARAMETERS

Average Depth Upstream of Contraction: 6.59 ft
D50: 2.699918 mm

Average Velocity Upstream: 0.46 ft/s

RESULTS OF SCOUR CONDITION

Critical velocity above which bed material of size
D and smaller will be transported: 3.16 ft/s

Contraction Scour Condition: Clear-Water

Live Bed and/or Clear Water Input Parameters

Flow in Contracted Section: 155.70 cfs

Bottom Width in Contracted Section: 37.36 ft

Depth Prior to Scour in Contracted Section: 3.49
ft

Results of Clear Water Method

Diameter of the smallest nontransportable
particle in the bed material: 3.374898 mm

Average Depth in Contracted Section after
Scour: 1.53 ft

Scour Depth: -1.96 ft

PIER DETAILS

Pier Name: Pier 1

PIER SCOUR

Computation Type: HEC-18

INPUT PARAMETERS

Pier Shape: Square Nose

Bed Condition: Clear-Water Scour

Depth Upstream of Pier: 12.98 ft

Velocity Upstream of Pier: 4.54 ft/s

Width of Pier: 1.00 ft

Length of Pier: 5.00 ft

Angle of Attack: 37.69 Degrees

RESULT PARAMETERS

Froude Number Upstream: 0.22

Correction Factor for Pier Nose Shape (K1): 1.00

Correction Factor of Angle of Attack (K2): 2.40

Pier Length to Pier Width (L/a): 5.00

Correction Factor for Bed Condition (K3): 1.10

Scour Depth: 6.78 ft

Pier Name: Pier 2

PIER SCOUR

Computation Type: HEC-18

INPUT PARAMETERS

Pier Shape: Square Nose

Bed Condition: Clear-Water Scour

Depth Upstream of Pier: 12.98 ft

Velocity Upstream of Pier: 4.54 ft/s

Width of Pier: 1.00 ft

Length of Pier: 5.00 ft

Angle of Attack: 7.03 Degrees

RESULT PARAMETERS

Froude Number Upstream: 0.22

Correction Factor for Pier Nose Shape (K1): 1.00

Correction Factor of Angle of Attack (K2): 1.36

Pier Length to Pier Width (L/a): 5.00

Correction Factor for Bed Condition (K3): 1.10

Scour Depth: 3.84 ft

Pier Name: Pier 3

PIER SCOUR

Computation Type: HEC-18

INPUT PARAMETERS

Pier Shape: Square Nose

Bed Condition: Clear-Water Scour

Depth Upstream of Pier: 12.98 ft

Velocity Upstream of Pier: 4.54 ft/s

Width of Pier: 1.00 ft

Length of Pier: 5.00 ft

Angle of Attack: 0.00 Degrees

RESULT PARAMETERS

Froude Number Upstream: 0.22

Correction Factor for Pier Nose Shape (K1): 1.10

Correction Factor of Angle of Attack (K2): 1.00

Pier Length to Pier Width (L/a): 5.00

Correction Factor for Bed Condition (K3): 1.10

Scour Depth: 3.11 ft

Pier Name: Pier 4

PIER SCOUR

Computation Type: HEC-18

INPUT PARAMETERS

Pier Shape: Square Nose

Bed Condition: Clear-Water Scour

Depth Upstream of Pier: 12.98 ft

Velocity Upstream of Pier: 4.54 ft/s

Width of Pier: 1.00 ft

Length of Pier: 5.00 ft

Angle of Attack: 4.32 Degrees

RESULT PARAMETERS

Froude Number Upstream: 0.22

Correction Factor for Pier Nose Shape (K1): 1.10

Correction Factor of Angle of Attack (K2): 1.23

Pier Length to Pier Width (L/a): 5.00

Correction Factor for Bed Condition (K3): 1.10

Scour Depth: 3.82 ft

LEFT ABUTMENT DETAILS

ABUTMENT SCOUR

Computation Type: NCHRP

Input Parameters

NCHRP METHOD

Abutment Type: Spill-through abutment
Angle of Embankment to Flow: 54.62 Degrees
Centerline Length of Embankment: 0.00 ft
Projected Length of Embankment: 0.00 ft
Width of Flood Plain: 0.00 ft
Unit Discharge, Upstream in Main Channel (q1):
12.95 cfs
Unit Discharge in the Constricted Area (q2):
33.34 cfs/ft
D50: 2.200046 mm
Upstream Flow Depth: 4.10 ft
Flow Depth Prior to Scour: 4.64 ft

RESULT PARAMETERS

q2/q1: 2.57
Average Velocity Upstream: 3.16 ft/s
Critical Velocity above which Bed Material of Size
D and Smaller will be Transported: 2.73 ft/s
Scour Condition: Live Bed
Embankment Length/Floodplain Width Ratio:
0.00
Scour Condition: b (overbank)
Amplification Factor: 1.71
Flow Depth including Contraction Scour: 9.22 ft
Maximum Flow Depth including Abutment
Scour: 15.79 ft
Scour Hole Depth from NCHRP Method: 11.15 ft

RIGHT ABUTMENT DETAILS

ABUTMENT SCOUR

Computation Type: NCHRP
Input Parameters

NCHRP METHOD

Abutment Type: Spill-through abutment
Angle of Embankment to Flow: 110.37 Degrees
Centerline Length of Embankment: 0.00 ft
Projected Length of Embankment: 0.00 ft
Width of Flood Plain: 0.00 ft
Unit Discharge, Upstream in Main Channel (q1):
43.53 cfs
Unit Discharge in the Constricted Area (q2):
33.34 cfs/ft
D50: 2.699918 mm
Upstream Flow Depth: 6.59 ft
Flow Depth Prior to Scour: 7.53 ft

RESULT PARAMETERS

q2/q1: 0.77
Average Velocity Upstream: 6.61 ft/s

Critical Velocity above which Bed Material of Size
D and Smaller will be Transported: 3.16 ft/s
Scour Condition: Live Bed
Embankment Length/Floodplain Width Ratio:
0.00
Scour Condition: a (Main Channel)
Amplification Factor: 1.20
Flow Depth including Contraction Scour: 5.24 ft
Maximum Flow Depth including Abutment
Scour: 6.29 ft
Scour Hole Depth from NCHRP Method: -1.24 ft

SCENARIO: 500-YR

CONTRACTION SCOUR SUMMARY

Contraction & Long Term Scour is applied
method due to greater scour.
Applied Contraction Scour Depth 3.95 ft
Contraction & Long Term Scour is applied
method due to greater scour.
Pressure Scour Depth 3.95 ft
Clear Water Contraction Scour Depth 3.95 ft
Applied Contraction Scour Elevation with LTD
0.00 ft

LOCAL SCOUR AT PIERS SUMMARY

PIER NAME: PIER 1
Computation Method: HEC-18
Pier Scour Depth 6.78 ft
Total Scour at Pier 10.73 ft
Total Scour Elevation at Pier 504.80 ft
PIER NAME: PIER 2
Computation Method: HEC-18
Pier Scour Depth 3.84 ft
Total Scour at Pier 7.79 ft
Total Scour Elevation at Pier 507.74 ft
PIER NAME: PIER 3
Computation Method: HEC-18
Pier Scour Depth 3.11 ft
Total Scour at Pier 7.06 ft
Total Scour Elevation at Pier 508.48 ft
PIER NAME: PIER 4

Computation Method: HEC-18
Pier Scour Depth 3.82 ft
Total Scour at Pier 7.77 ft
Total Scour Elevation at Pier 507.76 ft

LOCAL SCOUR AT ABUTMENTS SUMMARY

LEFT ABUTMENT

Abutment Scour Method: NCHRP Method
Abutment Scour Depth 11.15 ft
Total Scour at Abutment 11.15 ft

Total Scour Elevation at Abutment 513.17 ft
RIGHT ABUTMENT
Abutment Scour Method: NCHRP Method
Abutment Scour Depth -1.24 ft
Total Scour at Abutment 0.00 ft
Total Scour Elevation at Abutment 522.65 ft
MAIN CHANNEL CONTRACTION SCOUR
Computation Type: Clear-Water or Live-Bed Scour
INPUT PARAMETERS
Average Depth Upstream of Contraction: 10.98 ft
D50: 4.200144 mm
Average Velocity Upstream: 3.77 ft/s
RESULTS OF SCOUR CONDITION
Critical velocity above which bed material of size D and smaller will be transported: 3.99 ft/s
Contraction Scour Condition: Clear-Water Live Bed and/or Clear Water Input Parameters
Flow in Contracted Section: 5148.40 cfs
Bottom Width in Contracted Section: 77.00 ft
Depth Prior to Scour in Contracted Section: 10.59 ft
Results of Clear Water Method
Diameter of the smallest nontransportable particle in the bed material: 5.250180 mm
Average Depth in Contracted Section after Scour: 14.54 ft
Scour Depth: 3.95 ft
LEFT BANK CONTRACTION SCOUR
Computation Type: Clear-Water or Live-Bed Scour
INPUT PARAMETERS
Average Depth Upstream of Contraction: 6.11 ft
D50: 1.039978 mm
Average Velocity Upstream: 2.12 ft/s
RESULTS OF SCOUR CONDITION
Critical velocity above which bed material of size D and smaller will be transported: 2.27 ft/s
Contraction Scour Condition: Clear-Water Live Bed and/or Clear Water Input Parameters
Flow in Contracted Section: 3084.27 cfs
Bottom Width in Contracted Section: 137.23 ft
Depth Prior to Scour in Contracted Section: 5.71 ft
Results of Clear Water Method
Diameter of the smallest nontransportable particle in the bed material: 1.299972 mm

Average Depth in Contracted Section after Scour: 8.51 ft
Scour Depth: 2.80 ft
RIGHT BANK CONTRACTION SCOUR
Computation Type: Clear-Water or Live-Bed Scour
INPUT PARAMETERS
Average Depth Upstream of Contraction: 6.59 ft
D50: 2.699918 mm
Average Velocity Upstream: 0.46 ft/s
RESULTS OF SCOUR CONDITION
Critical velocity above which bed material of size D and smaller will be transported: 3.16 ft/s
Contraction Scour Condition: Clear-Water Live Bed and/or Clear Water Input Parameters
Flow in Contracted Section: 155.70 cfs
Bottom Width in Contracted Section: 37.36 ft
Depth Prior to Scour in Contracted Section: 3.49 ft
Results of Clear Water Method
Diameter of the smallest nontransportable particle in the bed material: 3.374898 mm
Average Depth in Contracted Section after Scour: 1.53 ft
Scour Depth: -1.96 ft
PIER DETAILS
Pier Name: Pier 1
PIER SCOUR
Computation Type: HEC-18
INPUT PARAMETERS
Pier Shape: Square Nose
Bed Condition: Clear-Water Scour
Depth Upstream of Pier: 12.98 ft
Velocity Upstream of Pier: 4.54 ft/s
Width of Pier: 1.00 ft
Length of Pier: 5.00 ft
Angle of Attack: 37.69 Degrees
RESULT PARAMETERS
Froude Number Upstream: 0.22
Correction Factor for Pier Nose Shape (K1): 1.00
Correction Factor of Angle of Attack (K2): 2.40
Pier Length to Pier Width (L/a): 5.00
Correction Factor for Bed Condition (K3): 1.10
Scour Depth: 6.78 ft
Pier Name: Pier 2
PIER SCOUR
Computation Type: HEC-18
INPUT PARAMETERS

Pier Shape: Square Nose
Bed Condition: Clear-Water Scour
Depth Upstream of Pier: 12.98 ft
Velocity Upstream of Pier: 4.54 ft/s
Width of Pier: 1.00 ft
Length of Pier: 5.00 ft
Angle of Attack: 7.03 Degrees
RESULT PARAMETERS
Froude Number Upstream: 0.22
Correction Factor for Pier Nose Shape (K1): 1.00
Correction Factor of Angle of Attack (K2): 1.36
Pier Length to Pier Width (L/a): 5.00
Correction Factor for Bed Condition (K3): 1.10
Scour Depth: 3.84 ft
Pier Name: Pier 3
PIER SCOUR
Computation Type: HEC-18
INPUT PARAMETERS
Pier Shape: Square Nose
Bed Condition: Clear-Water Scour
Depth Upstream of Pier: 12.98 ft
Velocity Upstream of Pier: 4.54 ft/s
Width of Pier: 1.00 ft
Length of Pier: 5.00 ft
Angle of Attack: 0.00 Degrees
RESULT PARAMETERS
Froude Number Upstream: 0.22
Correction Factor for Pier Nose Shape (K1): 1.10
Correction Factor of Angle of Attack (K2): 1.00
Pier Length to Pier Width (L/a): 5.00
Correction Factor for Bed Condition (K3): 1.10
Scour Depth: 3.11 ft
Pier Name: Pier 4
PIER SCOUR
Computation Type: HEC-18
INPUT PARAMETERS
Pier Shape: Square Nose
Bed Condition: Clear-Water Scour
Depth Upstream of Pier: 12.98 ft
Velocity Upstream of Pier: 4.54 ft/s
Width of Pier: 1.00 ft
Length of Pier: 5.00 ft
Angle of Attack: 4.32 Degrees
RESULT PARAMETERS
Froude Number Upstream: 0.22
Correction Factor for Pier Nose Shape (K1): 1.10
Correction Factor of Angle of Attack (K2): 1.23
Pier Length to Pier Width (L/a): 5.00

Correction Factor for Bed Condition (K3): 1.10
Scour Depth: 3.82 ft
LEFT ABUTMENT DETAILS
ABUTMENT SCOUR
Computation Type: NCHRP
Input Parameters
NCHRP METHOD
Abutment Type: Spill-through abutment
Angle of Embankment to Flow: 54.62 Degrees
Centerline Length of Embankment: 0.00 ft
Projected Length of Embankment: 0.00 ft
Width of Flood Plain: 0.00 ft
Unit Discharge, Upstream in Main Channel (q1):
12.95 cfs
Unit Discharge in the Constricted Area (q2):
33.34 cfs/ft
D50: 2.200046 mm
Upstream Flow Depth: 4.10 ft
Flow Depth Prior to Scour: 4.64 ft
RESULT PARAMETERS
q2/q1: 2.57
Average Velocity Upstream: 3.16 ft/s
Critical Velocity above which Bed Material of Size
D and Smaller will be Transported: 2.73 ft/s
Scour Condition: Live Bed
Embankment Length/Floodplain Width Ratio:
0.00
Scour Condition: b (overbank)
Amplification Factor: 1.71
Flow Depth including Contraction Scour: 9.22 ft
Maximum Flow Depth including Abutment
Scour: 15.79 ft
Scour Hole Depth from NCHRP Method: 11.15 ft
RIGHT ABUTMENT DETAILS
ABUTMENT SCOUR
Computation Type: NCHRP
Input Parameters
NCHRP METHOD
Abutment Type: Spill-through abutment
Angle of Embankment to Flow: 110.37 Degrees
Centerline Length of Embankment: 0.00 ft
Projected Length of Embankment: 0.00 ft
Width of Flood Plain: 0.00 ft
Unit Discharge, Upstream in Main Channel (q1):
43.53 cfs
Unit Discharge in the Constricted Area (q2):
33.34 cfs/ft
D50: 2.699918 mm

Upstream Flow Depth: 6.59 ft
Flow Depth Prior to Scour: 7.53 ft
RESULT PARAMETERS
q2/q1: 0.77
Average Velocity Upstream: 6.61 ft/s
Critical Velocity above which Bed Material of Size D and Smaller will be Transported: 3.16 ft/s
Scour Condition: Live Bed
Embankment Length/Floodplain Width Ratio: 0.00
Scour Condition: a (Main Channel)
Amplification Factor: 1.20
Flow Depth including Contraction Scour: 5.24 ft
Maximum Flow Depth including Abutment Scour: 6.29 ft
Scour Hole Depth from NCHRP Method: -1.24 ft
BRIDGE SCOUR ANALYSIS: GASCONADE RIVER A-3760
Project Title: A3760
Designer:
Project Date: Thursday, May 18, 2023
Project Units: U.S. Customary Units
Notes:
A-3760 SRH-2D
Notes:
SCENARIO: 100-YR
CONTRACTION SCOUR SUMMARY
Pressure Flow
Applied Contraction Scour Depth 13.07 ft
Live Bed Contraction Scour Depth 17.21 ft
Applied Contraction Scour Elevation with LTD 17.21 ft
LOCAL SCOUR AT PIERS SUMMARY
PIER NAME: PIER 1
Computation Method: HEC-18
Pier Scour Depth 9.64 ft
Total Scour at Pier 22.71 ft
Total Scour Elevation at Pier 582.23 ft
PIER NAME: PIER 2
Computation Method: Coarse Bed
Pier Scour Depth 15.00 ft
Total Scour at Pier 28.07 ft
Total Scour Elevation at Pier 576.87 ft
PIER NAME: PIER 3
Computation Method: HEC-18
Pier Scour Depth 18.19 ft
Total Scour at Pier 31.26 ft
Total Scour Elevation at Pier 573.68 ft

PIER NAME: PIER 4
Computation Method: HEC-18
Pier Scour Depth 13.47 ft
Total Scour at Pier 26.55 ft
Total Scour Elevation at Pier 578.40 ft
PIER NAME: PIER 5
Computation Method: HEC-18
Pier Scour Depth 10.66 ft
Total Scour at Pier 23.73 ft
Total Scour Elevation at Pier 581.22 ft
PIER NAME: PIER 6
Computation Method: HEC-18
Pier Scour Depth 9.64 ft
Total Scour at Pier 22.71 ft
Total Scour Elevation at Pier 582.23 ft
PIER NAME: PIER 7
Computation Method: HEC-18
Pier Scour Depth 9.64 ft
Total Scour at Pier 22.71 ft
Total Scour Elevation at Pier 582.23 ft
PIER NAME: PIER 8
Computation Method: HEC-18
Pier Scour Depth 9.64 ft
Total Scour at Pier 22.71 ft
Total Scour Elevation at Pier 582.23 ft
PIER NAME: PIER 9
Computation Method: HEC-18
Pier Scour Depth 9.64 ft
Total Scour at Pier 22.71 ft
Total Scour Elevation at Pier 582.23 ft
PIER NAME: PIER 10
Computation Method: HEC-18
Pier Scour Depth 9.64 ft
Total Scour at Pier 22.71 ft
Total Scour Elevation at Pier 582.23 ft
PIER NAME: PIER 11
Computation Method: HEC-18
Pier Scour Depth 9.64 ft
Total Scour at Pier 22.71 ft
Total Scour Elevation at Pier 582.23 ft
LOCAL SCOUR AT ABUTMENTS SUMMARY
LEFT ABUTMENT
Abutment Scour Method: NCHRP Method
Abutment Scour Depth 67.63 ft
Total Scour at Abutment 0.00 ft
RIGHT ABUTMENT
Abutment Scour Method: NCHRP Method
Abutment Scour Depth 11.41 ft

Total Scour at Abutment 0.00 ft
Total Scour Elevation at Abutment 617.00 ft
MAIN CHANNEL CONTRACTION SCOUR
Computation Type:
INPUT PARAMETERS
Average Depth Upstream of Contraction: 44.97 ft
D50: 11.249863 mm
Average Velocity Upstream: 4.52 ft/s
RESULTS OF SCOUR CONDITION
Critical velocity above which bed material of size D and smaller will be transported: 7.01 ft/s
Contraction Scour Condition: Clear-Water Live Bed and/or Clear Water Input Parameters
Flow in Contracted Section: 71620.80 cfs
Bottom Width in Contracted Section: 216.74 ft
Depth Prior to Scour in Contracted Section: 52.67 ft
Results of Clear Water Method
Diameter of the smallest nontransportable particle in the bed material: 14.062329 mm
Average Depth in Contracted Section after Scour: 43.17 ft
Scour Depth: -9.50 ft
Upstream Channel Flow Depth: 44.97 ft
Average Velocity Upstream: 4.52 ft/s
D50: 11.249863 mm
RESULTS OF SCOUR CONDITION
Critical velocity above which bed material of size D and smaller will be transported: 7.01 ft/s
Contraction Scour Condition: Clear Water
INPUT PARAMETERS FOR BRIDGE SCOUR
Width of the Contracted Section: 216.74 ft
Flow through bridge opening: 71620.80 cfs
Vertical Size of Bridge Opening Prior to Scour: 42.00 ft
Deck Thickness: 10.30 ft
RESULT PARAMETERS
Diameter of Smallest Non-moving Particle: 14.062329 mm
Average Depth In Contracted Section: 43.17 ft
Flow Separation Thickness: 11.91 ft
Scour Depth: 13.07 ft
LEFT BANK CONTRACTION SCOUR
Computation Type: Clear-Water or Live-Bed Scour
INPUT PARAMETERS

Average Depth Upstream of Contraction: 28.86 ft
D50: 16.999915 mm
Average Velocity Upstream: 2.49 ft/s
RESULTS OF SCOUR CONDITION
Critical velocity above which bed material of size D and smaller will be transported: 7.47 ft/s
Contraction Scour Condition: Clear-Water Live Bed and/or Clear Water Input Parameters
Flow in Contracted Section: 10994.60 cfs
Bottom Width in Contracted Section: 115.04 ft
Depth Prior to Scour in Contracted Section: 19.60 ft
Results of Clear Water Method
Diameter of the smallest nontransportable particle in the bed material: 21.249894 mm
Average Depth in Contracted Section after Scour: 13.25 ft
Scour Depth: -6.36 ft
RIGHT BANK CONTRACTION SCOUR
Computation Type:
INPUT PARAMETERS
Average Depth Upstream of Contraction: 32.39 ft
D50: 0.259994 mm
Average Velocity Upstream: 4.60 ft/s
RESULTS OF SCOUR CONDITION
Critical velocity above which bed material of size D and smaller will be transported: 1.89 ft/s
Contraction Scour Condition: Live-Bed Live Bed and/or Clear Water Input Parameters
Temperature of Water: 60.00 °F
Slope of Energy Grade Line at Approach Section: 0.0005 ft/ft
Flow in Contracted Section: 91379.90 cfs
Flow Upstream that is Transporting Sediment: 123599.00 cfs
Width in Contracted Section: 607.12 ft
Width Upstream that is Transporting Sediment: 828.84 ft
Depth Prior to Scour in Contracted Section: 27.20 ft
Unit Weight of Water: 62.40 lb/ft³
Unit Weight of Sediment: 165.00 lb/ft³
RESULTS OF LIVE BED METHOD
Shear Velocity: 0.69 ft/s
Fall Velocity: 0.11 ft/s

Average Depth in Contracted Section after Scour: 30.99 ft

Scour Depth for Live Bed: 3.79 ft

Scour may be limited by armoring. Compute all methods to check.

Upstream Channel Flow Depth: 32.39 ft

Average Velocity Upstream: 4.60 ft/s

D50: 0.259994 mm

RESULTS OF SCOUR CONDITION

Critical velocity above which bed material of size D and smaller will be transported: 1.89 ft/s

Contraction Scour Condition: Live Bed

INPUT PARAMETERS FOR BRIDGE SCOUR

Width of the Contracted Section: 607.12 ft

Flow through bridge opening: 91379.90 cfs

Width of the Upstream Section: 828.84 ft

Flow in Upstream Section: 123599.00 cfs

Slope of Energy Grade Line at Approach Section: 0.0005 ft/ft

Vertical Size of Bridge Opening Prior to Scour: 18.91 ft

Deck Thickness: 8.00 ft

RESULT PARAMETERS

K1: 0.69

Diameter of Smallest Non-moving Particle: 0.324993 mm

Average Depth In Contracted Section: 30.99 ft

Flow Separation Thickness: 6.90 ft

Scour Depth: 18.99 ft

PIER DETAILS

Pier Name: Pier 1

PIER SCOUR

Computation Type: HEC-18

INPUT PARAMETERS

Pier Shape: Group of Cylinders

Bed Condition: Clear-Water Scour

Depth Upstream of Pier: 46.42 ft

Velocity Upstream of Pier: 6.57 ft/s

Width of Pier: 3.00 ft

Length of Pier: 43.12 ft

Angle of Attack: 26.49 Degrees

Spacing between Piers: 20.00 ft

Number of Columns of Piers: 3

RESULT PARAMETERS

Froude Number Upstream: 0.17

Correction Factor for Pier Nose Shape (K1): 1.00

Correction Factor of Angle of Attack (K2): 1.00

Spacing to Pier Width (s/a): 6.67

Correction Factor for Bed Condition (K3): 1.10

Scour Depth: 9.64 ft

Pier Name: Pier 2

PIER SCOUR

Computation Type: Coarse Bed

INPUT PARAMETERS

Pier Shape: Group of Cylinders

Angle of Attack: 24.55 Degrees

Upstream Channel Flow Depth: 46.42 ft

Average Velocity Upstream: 6.57 ft/s

D50: 28.000147 mm

D84: 60.999929 mm

Pier Width: 3.50 ft

Pier Length: 10.50 ft

Unit Weight of Sediment: 165.00 lb/ft³

Unit Weight of Water: 62.40 lb/ft³

RESULT PARAMETERS

Sediment Gradation Coefficient (Sigma): 2.18

Specific Gravity of Sediment: 2.64

Densimetric Particle Froude Number: 2.98

Scour Depth: 15.00 ft

Pier Name: Pier 3

PIER SCOUR

Computation Type: HEC-18

INPUT PARAMETERS

Pier Shape: Group of Cylinders

Bed Condition: Clear-Water Scour

Depth Upstream of Pier: 46.42 ft

Velocity Upstream of Pier: 6.57 ft/s

Width of Pier: 5.00 ft

Length of Pier: 44.08 ft

Angle of Attack: 23.41 Degrees

Spacing between Piers: 19.50 ft

Number of Columns of Piers: 3

RESULT PARAMETERS

Froude Number Upstream: 0.17

Correction Factor for Pier Nose Shape (K1): 1.00

Correction Factor of Angle of Attack (K2): 1.62

Spacing to Pier Width (s/a): 3.90

Correction Factor for Bed Condition (K3): 1.10

Scour Depth: 18.19 ft

Pier Name: Pier 4

PIER SCOUR

Computation Type: HEC-18

INPUT PARAMETERS

Pier Shape: Group of Cylinders

Bed Condition: Clear-Water Scour

Depth Upstream of Pier: 46.42 ft

Velocity Upstream of Pier: 6.57 ft/s
Width of Pier: 4.00 ft
Length of Pier: 44.16 ft
Angle of Attack: 13.26 Degrees
Spacing between Piers: 19.50 ft
Number of Columns of Piers: 3
RESULT PARAMETERS
Froude Number Upstream: 0.17
Correction Factor for Pier Nose Shape (K1): 1.00
Correction Factor of Angle of Attack (K2): 1.39
Spacing to Pier Width (s/a): 4.88
Correction Factor for Bed Condition (K3): 1.10
Scour Depth: 13.47 ft
Pier Name: Pier 5
PIER SCOUR
Computation Type: HEC-18
INPUT PARAMETERS
Pier Shape: Group of Cylinders
Bed Condition: Clear-Water Scour
Depth Upstream of Pier: 46.42 ft
Velocity Upstream of Pier: 6.57 ft/s
Width of Pier: 3.50 ft
Length of Pier: 42.84 ft
Angle of Attack: 9.22 Degrees
Spacing between Piers: 20.00 ft
Number of Columns of Piers: 3
RESULT PARAMETERS
Froude Number Upstream: 0.17
Correction Factor for Pier Nose Shape (K1): 1.00
Correction Factor of Angle of Attack (K2): 1.00
Spacing to Pier Width (s/a): 5.71
Correction Factor for Bed Condition (K3): 1.10
Scour Depth: 10.66 ft
Pier Name: Pier 6
PIER SCOUR
Computation Type: HEC-18
INPUT PARAMETERS
Pier Shape: Group of Cylinders
Bed Condition: Clear-Water Scour
Depth Upstream of Pier: 46.42 ft
Velocity Upstream of Pier: 6.57 ft/s
Width of Pier: 3.00 ft
Length of Pier: 43.01 ft
Angle of Attack: 8.15 Degrees
Spacing between Piers: 20.00 ft
Number of Columns of Piers: 3
RESULT PARAMETERS
Froude Number Upstream: 0.17

Correction Factor for Pier Nose Shape (K1): 1.00
Correction Factor of Angle of Attack (K2): 1.00
Spacing to Pier Width (s/a): 6.67
Correction Factor for Bed Condition (K3): 1.10
Scour Depth: 9.64 ft
Pier Name: Pier 7
PIER SCOUR
Computation Type: HEC-18
INPUT PARAMETERS
Pier Shape: Group of Cylinders
Bed Condition: Clear-Water Scour
Depth Upstream of Pier: 46.42 ft
Velocity Upstream of Pier: 6.57 ft/s
Width of Pier: 3.00 ft
Length of Pier: 43.01 ft
Angle of Attack: 10.02 Degrees
Spacing between Piers: 20.00 ft
Number of Columns of Piers: 3
RESULT PARAMETERS
Froude Number Upstream: 0.17
Correction Factor for Pier Nose Shape (K1): 1.00
Correction Factor of Angle of Attack (K2): 1.00
Spacing to Pier Width (s/a): 6.67
Correction Factor for Bed Condition (K3): 1.10
Scour Depth: 9.64 ft
Pier Name: Pier 8
PIER SCOUR
Computation Type: HEC-18
INPUT PARAMETERS
Pier Shape: Group of Cylinders
Bed Condition: Clear-Water Scour
Depth Upstream of Pier: 46.42 ft
Velocity Upstream of Pier: 6.57 ft/s
Width of Pier: 3.00 ft
Length of Pier: 43.01 ft
Angle of Attack: 9.19 Degrees
Spacing between Piers: 20.00 ft
Number of Columns of Piers: 3
RESULT PARAMETERS
Froude Number Upstream: 0.17
Correction Factor for Pier Nose Shape (K1): 1.00
Correction Factor of Angle of Attack (K2): 1.00
Spacing to Pier Width (s/a): 6.67
Correction Factor for Bed Condition (K3): 1.10
Scour Depth: 9.64 ft
Pier Name: Pier 9
PIER SCOUR
Computation Type: HEC-18

INPUT PARAMETERS

Pier Shape: Group of Cylinders
Bed Condition: Clear-Water Scour
Depth Upstream of Pier: 46.42 ft
Velocity Upstream of Pier: 6.57 ft/s
Width of Pier: 3.00 ft
Length of Pier: 43.01 ft
Angle of Attack: 8.18 Degrees
Spacing between Piers: 20.00 ft
Number of Columns of Piers: 3

RESULT PARAMETERS

Froude Number Upstream: 0.17
Correction Factor for Pier Nose Shape (K1): 1.00
Correction Factor of Angle of Attack (K2): 1.00
Spacing to Pier Width (s/a): 6.67
Correction Factor for Bed Condition (K3): 1.10
Scour Depth: 9.64 ft
Pier Name: Pier 10

PIER SCOUR

Computation Type: HEC-18

INPUT PARAMETERS

Pier Shape: Group of Cylinders
Bed Condition: Clear-Water Scour
Depth Upstream of Pier: 46.42 ft
Velocity Upstream of Pier: 6.57 ft/s
Width of Pier: 3.00 ft
Length of Pier: 43.01 ft
Angle of Attack: 4.45 Degrees
Spacing between Piers: 20.00 ft
Number of Columns of Piers: 3

RESULT PARAMETERS

Froude Number Upstream: 0.17
Correction Factor for Pier Nose Shape (K1): 1.00
Correction Factor of Angle of Attack (K2): 1.00
Spacing to Pier Width (s/a): 6.67
Correction Factor for Bed Condition (K3): 1.10
Scour Depth: 9.64 ft
Pier Name: Pier 11

PIER SCOUR

Computation Type: HEC-18

INPUT PARAMETERS

Pier Shape: Group of Cylinders
Bed Condition: Clear-Water Scour
Depth Upstream of Pier: 46.42 ft
Velocity Upstream of Pier: 6.57 ft/s
Width of Pier: 3.00 ft
Length of Pier: 43.01 ft
Angle of Attack: 1.75 Degrees

Spacing between Piers: 20.00 ft

Number of Columns of Piers: 3

RESULT PARAMETERS

Froude Number Upstream: 0.17
Correction Factor for Pier Nose Shape (K1): 1.00
Correction Factor of Angle of Attack (K2): 1.00
Spacing to Pier Width (s/a): 6.67
Correction Factor for Bed Condition (K3): 1.10
Scour Depth: 9.64 ft

LEFT ABUTMENT DETAILS

ABUTMENT SCOUR

Computation Type: NCHRP

Input Parameters

NCHRP METHOD

Abutment Type: Spill-through abutment
Angle of Embankment to Flow: 99.90 Degrees
Centerline Length of Embankment: 0.00 ft
Projected Length of Embankment: 0.00 ft
Width of Flood Plain: 0.00 ft

Unit Discharge, Upstream in Main Channel (q1):
205.81 cfs

Unit Discharge in the Constricted Area (q2):
329.58 cfs/ft

D50: 5.999988 mm

Upstream Flow Depth: 40.69 ft

Flow Depth Prior to Scour: 6.97 ft

RESULT PARAMETERS

q2/q1: 1.60

Average Velocity Upstream: 5.06 ft/s

Critical Velocity above which Bed Material of Size
D and Smaller will be Transported: 5.59 ft/s

Scour Condition: Clear Water

Embankment Length/Floodplain Width Ratio:
0.00

Scour Condition: a (Main Channel)

Amplification Factor: 1.33

Flow Depth including Contraction Scour: 55.89 ft

Maximum Flow Depth including Abutment
Scour: 74.60 ft

Scour Hole Depth from NCHRP Method: 67.63 ft

RIGHT ABUTMENT DETAILS

ABUTMENT SCOUR

Computation Type: NCHRP

Input Parameters

NCHRP METHOD

Abutment Type: Spill-through abutment

Angle of Embankment to Flow: 80.10 Degrees

Centerline Length of Embankment: 0.00 ft

Projected Length of Embankment: 0.00 ft
Width of Flood Plain: 0.00 ft
Unit Discharge, Upstream in Main Channel (q1):
149.12 cfs
Unit Discharge in the Constricted Area (q2):
150.51 cfs/ft
D50: 0.230124 mm
Upstream Flow Depth: 32.39 ft
Flow Depth Prior to Scour: 25.24 ft
RESULT PARAMETERS
q2/q1: 1.01
Average Velocity Upstream: 4.60 ft/s
Critical Velocity above which Bed Material of Size
D and Smaller will be Transported: 1.82 ft/s
Scour Condition: Live Bed
Embankment Length/Floodplain Width Ratio:
0.00
Scour Condition: b (overbank)
Amplification Factor: 1.12
Flow Depth including Contraction Scour: 32.65 ft
Maximum Flow Depth including Abutment
Scour: 36.65 ft
Scour Hole Depth from NCHRP Method: 11.41 ft

SCENARIO: 500-YR

CONTRACTION SCOUR SUMMARY

Pressure Flow

Applied Contraction Scour Depth 13.07 ft
Live Bed Contraction Scour Depth 17.21 ft
Applied Contraction Scour Elevation with LTD
17.21 ft

LOCAL SCOUR AT PIERS SUMMARY

PIER NAME: PIER 1

Computation Method: HEC-18

Pier Scour Depth 9.64 ft

Total Scour at Pier 22.71 ft

Total Scour Elevation at Pier 582.23 ft

PIER NAME: PIER 2

Computation Method: Coarse Bed

Pier Scour Depth 15.00 ft

Total Scour at Pier 28.07 ft

Total Scour Elevation at Pier 576.87 ft

PIER NAME: PIER 3

Computation Method: HEC-18

Pier Scour Depth 18.19 ft

Total Scour at Pier 31.26 ft

Total Scour Elevation at Pier 573.68 ft

PIER NAME: PIER 4

Computation Method: HEC-18

Pier Scour Depth 13.47 ft

Total Scour at Pier 26.55 ft

Total Scour Elevation at Pier 578.40 ft

PIER NAME: PIER 5

Computation Method: HEC-18

Pier Scour Depth 10.66 ft

Total Scour at Pier 23.73 ft

Total Scour Elevation at Pier 581.22 ft

PIER NAME: PIER 6

Computation Method: HEC-18

Pier Scour Depth 9.64 ft

Total Scour at Pier 22.71 ft

Total Scour Elevation at Pier 582.23 ft

PIER NAME: PIER 7

Computation Method: HEC-18

Pier Scour Depth 9.64 ft

Total Scour at Pier 22.71 ft

Total Scour Elevation at Pier 582.23 ft

PIER NAME: PIER 8

Computation Method: HEC-18

Pier Scour Depth 9.64 ft

Total Scour at Pier 22.71 ft

Total Scour Elevation at Pier 582.23 ft

PIER NAME: PIER 9

Computation Method: HEC-18

Pier Scour Depth 9.64 ft

Total Scour at Pier 22.71 ft

Total Scour Elevation at Pier 582.23 ft

PIER NAME: PIER 10

Computation Method: HEC-18

Pier Scour Depth 9.64 ft

Total Scour at Pier 22.71 ft

Total Scour Elevation at Pier 582.23 ft

PIER NAME: PIER 11

Computation Method: HEC-18

Pier Scour Depth 9.64 ft

Total Scour at Pier 22.71 ft

Total Scour Elevation at Pier 582.23 ft

LOCAL SCOUR AT ABUTMENTS SUMMARY

LEFT ABUTMENT

Abutment Scour Method: NCHRP Method

Abutment Scour Depth 67.63 ft

Total Scour at Abutment 0.00 ft

RIGHT ABUTMENT

Abutment Scour Method: NCHRP Method

Abutment Scour Depth 11.41 ft

Total Scour at Abutment 0.00 ft

Total Scour Elevation at Abutment 617.00 ft
MAIN CHANNEL CONTRACTION SCOUR
Computation Type:
INPUT PARAMETERS
Average Depth Upstream of Contraction: 44.97 ft
D50: 11.249863 mm
Average Velocity Upstream: 4.52 ft/s
RESULTS OF SCOUR CONDITION
Critical velocity above which bed material of size D and smaller will be transported: 7.01 ft/s
Contraction Scour Condition: Clear-Water Live Bed and/or Clear Water Input Parameters
Flow in Contracted Section: 71620.80 cfs
Bottom Width in Contracted Section: 216.74 ft
Depth Prior to Scour in Contracted Section: 52.67 ft
Results of Clear Water Method
Diameter of the smallest nontransportable particle in the bed material: 14.062329 mm
Average Depth in Contracted Section after Scour: 43.17 ft
Scour Depth: -9.50 ft
Upstream Channel Flow Depth: 44.97 ft
Average Velocity Upstream: 4.52 ft/s
D50: 11.249863 mm
RESULTS OF SCOUR CONDITION
Critical velocity above which bed material of size D and smaller will be transported: 7.01 ft/s
Contraction Scour Condition: Clear Water
INPUT PARAMETERS FOR BRIDGE SCOUR
Width of the Contracted Section: 216.74 ft
Flow through bridge opening: 71620.80 cfs
Vertical Size of Bridge Opening Prior to Scour: 42.00 ft
Deck Thickness: 10.30 ft
RESULT PARAMETERS
Diameter of Smallest Non-moving Particle: 14.062329 mm
Average Depth In Contracted Section: 43.17 ft
Flow Separation Thickness: 11.91 ft
Scour Depth: 13.07 ft
LEFT BANK CONTRACTION SCOUR
Computation Type: Clear-Water or Live-Bed Scour
INPUT PARAMETERS
Average Depth Upstream of Contraction: 28.86 ft

D50: 16.999915 mm
Average Velocity Upstream: 2.49 ft/s
RESULTS OF SCOUR CONDITION
Critical velocity above which bed material of size D and smaller will be transported: 7.47 ft/s
Contraction Scour Condition: Clear-Water Live Bed and/or Clear Water Input Parameters
Flow in Contracted Section: 10994.60 cfs
Bottom Width in Contracted Section: 115.04 ft
Depth Prior to Scour in Contracted Section: 19.60 ft
Results of Clear Water Method
Diameter of the smallest nontransportable particle in the bed material: 21.249894 mm
Average Depth in Contracted Section after Scour: 13.25 ft
Scour Depth: -6.36 ft
RIGHT BANK CONTRACTION SCOUR
Computation Type:
INPUT PARAMETERS
Average Depth Upstream of Contraction: 32.39 ft
D50: 0.259994 mm
Average Velocity Upstream: 4.60 ft/s
RESULTS OF SCOUR CONDITION
Critical velocity above which bed material of size D and smaller will be transported: 1.89 ft/s
Contraction Scour Condition: Live-Bed
Live Bed and/or Clear Water Input Parameters
Temperature of Water: 60.00 °F
Slope of Energy Grade Line at Approach Section: 0.0005 ft/ft
Flow in Contracted Section: 91379.90 cfs
Flow Upstream that is Transporting Sediment: 123599.00 cfs
Width in Contracted Section: 607.12 ft
Width Upstream that is Transporting Sediment: 828.84 ft
Depth Prior to Scour in Contracted Section: 27.20 ft
Unit Weight of Water: 62.40 lb/ft³
Unit Weight of Sediment: 165.00 lb/ft³
RESULTS OF LIVE BED METHOD
Shear Velocity: 0.69 ft/s
Fall Velocity: 0.11 ft/s
Average Depth in Contracted Section after Scour: 30.99 ft
Scour Depth for Live Bed: 3.79 ft

Scour may be limited by armoring. Compute all methods to check.

Upstream Channel Flow Depth: 32.39 ft

Average Velocity Upstream: 4.60 ft/s

D50: 0.259994 mm

RESULTS OF SCOUR CONDITION

Critical velocity above which bed material of size D and smaller will be transported: 1.89 ft/s

Contraction Scour Condition: Live Bed

INPUT PARAMETERS FOR BRIDGE SCOUR

Width of the Contracted Section: 607.12 ft

Flow through bridge opening: 91379.90 cfs

Width of the Upstream Section: 828.84 ft

Flow in Upstream Section: 123599.00 cfs

Slope of Energy Grade Line at Approach Section: 0.0005 ft/ft

Vertical Size of Bridge Opening Prior to Scour: 18.91 ft

Deck Thickness: 8.00 ft

RESULT PARAMETERS

K1: 0.69

Diameter of Smallest Non-moving Particle: 0.324993 mm

Average Depth In Contracted Section: 30.99 ft

Flow Separation Thickness: 6.90 ft

Scour Depth: 18.99 ft

PIER DETAILS

Pier Name: Pier 1

PIER SCOUR

Computation Type: HEC-18

INPUT PARAMETERS

Pier Shape: Group of Cylinders

Bed Condition: Clear-Water Scour

Depth Upstream of Pier: 46.42 ft

Velocity Upstream of Pier: 6.57 ft/s

Width of Pier: 3.00 ft

Length of Pier: 43.12 ft

Angle of Attack: 26.49 Degrees

Spacing between Piers: 20.00 ft

Number of Columns of Piers: 3

RESULT PARAMETERS

Froude Number Upstream: 0.17

Correction Factor for Pier Nose Shape (K1): 1.00

Correction Factor of Angle of Attack (K2): 1.00

Spacing to Pier Width (s/a): 6.67

Correction Factor for Bed Condition (K3): 1.10

Scour Depth: 9.64 ft

Pier Name: Pier 2

PIER SCOUR

Computation Type: Coarse Bed

INPUT PARAMETERS

Pier Shape: Group of Cylinders

Angle of Attack: 24.55 Degrees

Upstream Channel Flow Depth: 46.42 ft

Average Velocity Upstream: 6.57 ft/s

D50: 28.000147 mm

D84: 60.999929 mm

Pier Width: 3.50 ft

Pier Length: 10.50 ft

Unit Weight of Sediment: 165.00 lb/ft³

Unit Weight of Water: 62.40 lb/ft³

RESULT PARAMETERS

Sediment Gradation Coefficient (Sigma): 2.18

Specific Gravity of Sediment: 2.64

Densimetric Particle Froude Number: 2.98

Scour Depth: 15.00 ft

Pier Name: Pier 3

PIER SCOUR

Computation Type: HEC-18

INPUT PARAMETERS

Pier Shape: Group of Cylinders

Bed Condition: Clear-Water Scour

Depth Upstream of Pier: 46.42 ft

Velocity Upstream of Pier: 6.57 ft/s

Width of Pier: 5.00 ft

Length of Pier: 44.08 ft

Angle of Attack: 23.41 Degrees

Spacing between Piers: 19.50 ft

Number of Columns of Piers: 3

RESULT PARAMETERS

Froude Number Upstream: 0.17

Correction Factor for Pier Nose Shape (K1): 1.00

Correction Factor of Angle of Attack (K2): 1.62

Spacing to Pier Width (s/a): 3.90

Correction Factor for Bed Condition (K3): 1.10

Scour Depth: 18.19 ft

Pier Name: Pier 4

PIER SCOUR

Computation Type: HEC-18

INPUT PARAMETERS

Pier Shape: Group of Cylinders

Bed Condition: Clear-Water Scour

Depth Upstream of Pier: 46.42 ft

Velocity Upstream of Pier: 6.57 ft/s

Width of Pier: 4.00 ft

Length of Pier: 44.16 ft

Angle of Attack: 13.26 Degrees
Spacing between Piers: 19.50 ft
Number of Columns of Piers: 3
RESULT PARAMETERS
Froude Number Upstream: 0.17
Correction Factor for Pier Nose Shape (K1): 1.00
Correction Factor of Angle of Attack (K2): 1.39
Spacing to Pier Width (s/a): 4.88
Correction Factor for Bed Condition (K3): 1.10
Scour Depth: 13.47 ft
Pier Name: Pier 5
PIER SCOUR
Computation Type: HEC-18
INPUT PARAMETERS
Pier Shape: Group of Cylinders
Bed Condition: Clear-Water Scour
Depth Upstream of Pier: 46.42 ft
Velocity Upstream of Pier: 6.57 ft/s
Width of Pier: 3.50 ft
Length of Pier: 42.84 ft
Angle of Attack: 9.22 Degrees
Spacing between Piers: 20.00 ft
Number of Columns of Piers: 3
RESULT PARAMETERS
Froude Number Upstream: 0.17
Correction Factor for Pier Nose Shape (K1): 1.00
Correction Factor of Angle of Attack (K2): 1.00
Spacing to Pier Width (s/a): 5.71
Correction Factor for Bed Condition (K3): 1.10
Scour Depth: 10.66 ft
Pier Name: Pier 6
PIER SCOUR
Computation Type: HEC-18
INPUT PARAMETERS
Pier Shape: Group of Cylinders
Bed Condition: Clear-Water Scour
Depth Upstream of Pier: 46.42 ft
Velocity Upstream of Pier: 6.57 ft/s
Width of Pier: 3.00 ft
Length of Pier: 43.01 ft
Angle of Attack: 8.15 Degrees
Spacing between Piers: 20.00 ft
Number of Columns of Piers: 3
RESULT PARAMETERS
Froude Number Upstream: 0.17
Correction Factor for Pier Nose Shape (K1): 1.00
Correction Factor of Angle of Attack (K2): 1.00
Spacing to Pier Width (s/a): 6.67

Correction Factor for Bed Condition (K3): 1.10
Scour Depth: 9.64 ft
Pier Name: Pier 7
PIER SCOUR
Computation Type: HEC-18
INPUT PARAMETERS
Pier Shape: Group of Cylinders
Bed Condition: Clear-Water Scour
Depth Upstream of Pier: 46.42 ft
Velocity Upstream of Pier: 6.57 ft/s
Width of Pier: 3.00 ft
Length of Pier: 43.01 ft
Angle of Attack: 10.02 Degrees
Spacing between Piers: 20.00 ft
Number of Columns of Piers: 3
RESULT PARAMETERS
Froude Number Upstream: 0.17
Correction Factor for Pier Nose Shape (K1): 1.00
Correction Factor of Angle of Attack (K2): 1.00
Spacing to Pier Width (s/a): 6.67
Correction Factor for Bed Condition (K3): 1.10
Scour Depth: 9.64 ft
Pier Name: Pier 8
PIER SCOUR
Computation Type: HEC-18
INPUT PARAMETERS
Pier Shape: Group of Cylinders
Bed Condition: Clear-Water Scour
Depth Upstream of Pier: 46.42 ft
Velocity Upstream of Pier: 6.57 ft/s
Width of Pier: 3.00 ft
Length of Pier: 43.01 ft
Angle of Attack: 9.19 Degrees
Spacing between Piers: 20.00 ft
Number of Columns of Piers: 3
RESULT PARAMETERS
Froude Number Upstream: 0.17
Correction Factor for Pier Nose Shape (K1): 1.00
Correction Factor of Angle of Attack (K2): 1.00
Spacing to Pier Width (s/a): 6.67
Correction Factor for Bed Condition (K3): 1.10
Scour Depth: 9.64 ft
Pier Name: Pier 9
PIER SCOUR
Computation Type: HEC-18
INPUT PARAMETERS
Pier Shape: Group of Cylinders
Bed Condition: Clear-Water Scour

Depth Upstream of Pier: 46.42 ft
Velocity Upstream of Pier: 6.57 ft/s
Width of Pier: 3.00 ft
Length of Pier: 43.01 ft
Angle of Attack: 8.18 Degrees
Spacing between Piers: 20.00 ft
Number of Columns of Piers: 3
RESULT PARAMETERS
Froude Number Upstream: 0.17
Correction Factor for Pier Nose Shape (K1): 1.00
Correction Factor of Angle of Attack (K2): 1.00
Spacing to Pier Width (s/a): 6.67
Correction Factor for Bed Condition (K3): 1.10
Scour Depth: 9.64 ft

Pier Name: Pier 10

PIER SCOUR

Computation Type: HEC-18

INPUT PARAMETERS

Pier Shape: Group of Cylinders
Bed Condition: Clear-Water Scour
Depth Upstream of Pier: 46.42 ft
Velocity Upstream of Pier: 6.57 ft/s
Width of Pier: 3.00 ft
Length of Pier: 43.01 ft

Angle of Attack: 4.45 Degrees
Spacing between Piers: 20.00 ft
Number of Columns of Piers: 3

RESULT PARAMETERS

Froude Number Upstream: 0.17
Correction Factor for Pier Nose Shape (K1): 1.00
Correction Factor of Angle of Attack (K2): 1.00
Spacing to Pier Width (s/a): 6.67
Correction Factor for Bed Condition (K3): 1.10
Scour Depth: 9.64 ft

Pier Name: Pier 11

PIER SCOUR

Computation Type: HEC-18

INPUT PARAMETERS

Pier Shape: Group of Cylinders
Bed Condition: Clear-Water Scour
Depth Upstream of Pier: 46.42 ft
Velocity Upstream of Pier: 6.57 ft/s
Width of Pier: 3.00 ft
Length of Pier: 43.01 ft

Angle of Attack: 1.75 Degrees
Spacing between Piers: 20.00 ft
Number of Columns of Piers: 3

RESULT PARAMETERS

Froude Number Upstream: 0.17
Correction Factor for Pier Nose Shape (K1): 1.00
Correction Factor of Angle of Attack (K2): 1.00
Spacing to Pier Width (s/a): 6.67
Correction Factor for Bed Condition (K3): 1.10
Scour Depth: 9.64 ft

LEFT ABUTMENT DETAILS

ABUTMENT SCOUR

Computation Type: NCHRP

Input Parameters

NCHRP METHOD

Abutment Type: Spill-through abutment
Angle of Embankment to Flow: 99.90 Degrees
Centerline Length of Embankment: 0.00 ft
Projected Length of Embankment: 0.00 ft
Width of Flood Plain: 0.00 ft
Unit Discharge, Upstream in Main Channel (q1):
205.81 cfs

Unit Discharge in the Constricted Area (q2):
329.58 cfs/ft
D50: 5.999988 mm

Upstream Flow Depth: 40.69 ft
Flow Depth Prior to Scour: 6.97 ft

RESULT PARAMETERS

q2/q1: 1.60
Average Velocity Upstream: 5.06 ft/s
Critical Velocity above which Bed Material of Size
D and Smaller will be Transported: 5.59 ft/s

Scour Condition: Clear Water

Embankment Length/Floodplain Width Ratio:
0.00

Scour Condition: a (Main Channel)

Amplification Factor: 1.33

Flow Depth including Contraction Scour: 55.89 ft
Maximum Flow Depth including Abutment
Scour: 74.60 ft

Scour Hole Depth from NCHRP Method: 67.63 ft

RIGHT ABUTMENT DETAILS

ABUTMENT SCOUR

Computation Type: NCHRP

Input Parameters

NCHRP METHOD

Abutment Type: Spill-through abutment
Angle of Embankment to Flow: 80.10 Degrees
Centerline Length of Embankment: 0.00 ft
Projected Length of Embankment: 0.00 ft
Width of Flood Plain: 0.00 ft

Unit Discharge, Upstream in Main Channel (q1):
149.12 cfs

Unit Discharge in the Constricted Area (q2):
150.51 cfs/ft

D50: 0.230124 mm

Upstream Flow Depth: 32.39 ft

Flow Depth Prior to Scour: 25.24 ft

RESULT PARAMETERS

q2/q1: 1.01

Average Velocity Upstream: 4.60 ft/s

Critical Velocity above which Bed Material of Size
D and Smaller will be Transported: 1.82 ft/s

Scour Condition: Live Bed

Embankment Length/Floodplain Width Ratio:
0.00

Scour Condition: b (overbank)

Amplification Factor: 1.12

Flow Depth including Contraction Scour: 32.65 ft

Maximum Flow Depth including Abutment
Scour: 36.65 ft

Scour Hole Depth from NCHRP Method: 11.41 ft

A-3760 HEC-RAS

Notes:

SCENARIO: 100-YR

CONTRACTION SCOUR SUMMARY

Pressure Flow

Applied Contraction Scour Depth 7.84 ft

Clear Water Contraction Scour Depth 6.44 ft

Applied Contraction Scour Elevation with LTD -
13.21 ft

LOCAL SCOUR AT PIERS SUMMARY

PIER NAME: PIER 1

Computation Method: HEC-18

Pier Scour Depth 12.72 ft

Total Scour at Pier 20.56 ft

Total Scour Elevation at Pier 584.39 ft

PIER NAME: PIER 2

Computation Method: Coarse Bed

Pier Scour Depth 16.62 ft

Total Scour at Pier 24.46 ft

Total Scour Elevation at Pier 580.49 ft

PIER NAME: PIER 3

Computation Method: HEC-18

Pier Scour Depth 24.00 ft

Total Scour at Pier 31.84 ft

Total Scour Elevation at Pier 573.11 ft

PIER NAME: PIER 4

Computation Method: HEC-18

Pier Scour Depth 20.55 ft

Total Scour at Pier 28.39 ft

Total Scour Elevation at Pier 576.56 ft

PIER NAME: PIER 5

Computation Method: HEC-18

Pier Scour Depth 11.72 ft

Total Scour at Pier 19.55 ft

Total Scour Elevation at Pier 585.39 ft

PIER NAME: PIER 6

Computation Method: HEC-18

Pier Scour Depth 10.60 ft

Total Scour at Pier 18.44 ft

Total Scour Elevation at Pier 586.51 ft

PIER NAME: PIER 7

Computation Method: HEC-18

Pier Scour Depth 10.60 ft

Total Scour at Pier 18.44 ft

Total Scour Elevation at Pier 586.51 ft

PIER NAME: PIER 8

Computation Method: HEC-18

Pier Scour Depth 10.60 ft

Total Scour at Pier 18.44 ft

Total Scour Elevation at Pier 586.51 ft

PIER NAME: PIER 9

Computation Method: HEC-18

Pier Scour Depth 10.60 ft

Total Scour at Pier 18.44 ft

Total Scour Elevation at Pier 586.51 ft

PIER NAME: PIER 10

Computation Method: HEC-18

Pier Scour Depth 10.60 ft

Total Scour at Pier 18.44 ft

Total Scour Elevation at Pier 586.51 ft

PIER NAME: PIER 11

Computation Method: HEC-18

Pier Scour Depth 10.60 ft

Total Scour at Pier 18.44 ft

Total Scour Elevation at Pier 586.51 ft

LOCAL SCOUR AT ABUTMENTS SUMMARY

LEFT ABUTMENT

Abutment Scour Method: NCHRP Method

Abutment Scour Depth 21.48 ft

Total Scour at Abutment 0.00 ft

Total Scour Elevation at Abutment 628.79 ft

RIGHT ABUTMENT

Abutment Scour Method: NCHRP Method

Abutment Scour Depth 49.23 ft

Total Scour at Abutment 0.00 ft

Total Scour Elevation at Abutment 576.05 ft
MAIN CHANNEL CONTRACTION SCOUR
Computation Type:
INPUT PARAMETERS
Average Depth Upstream of Contraction: 41.31 ft
D50: 11.249863 mm
Average Velocity Upstream: 9.47 ft/s
RESULTS OF SCOUR CONDITION
Critical velocity above which bed material of size D and smaller will be transported: 6.91 ft/s
Contraction Scour Condition: Live-Bed
Live Bed and/or Clear Water Input Parameters
Temperature of Water: 60.00 °F
Slope of Energy Grade Line at Approach Section: 0.0005 ft/ft
Flow in Contracted Section: 131601.60 cfs
Flow Upstream that is Transporting Sediment: 139262.70 cfs
Width in Contracted Section: 276.57 ft
Width Upstream that is Transporting Sediment: 276.57 ft
Depth Prior to Scour in Contracted Section: 52.56 ft
Unit Weight of Water: 62.40 lb/ft³
Unit Weight of Sediment: 165.00 lb/ft³
RESULTS OF LIVE BED METHOD
Shear Velocity: 0.83 ft/s
Fall Velocity: 1.50 ft/s
Average Depth in Contracted Section after Scour: 39.35 ft
Scour Depth for Live Bed: -13.21 ft
Scour may be limited by armoring. Compute all methods to check.
Upstream Channel Flow Depth: 41.31 ft
Average Velocity Upstream: 9.47 ft/s
D50: 11.249863 mm
RESULTS OF SCOUR CONDITION
Critical velocity above which bed material of size D and smaller will be transported: 6.91 ft/s
Contraction Scour Condition: Live Bed
INPUT PARAMETERS FOR BRIDGE SCOUR
Width of the Contracted Section: 276.57 ft
Flow through bridge opening: 131601.60 cfs
Width of the Upstream Section: 276.57 ft
Flow in Upstream Section: 139262.70 cfs
Slope of Energy Grade Line at Approach Section: 0.0005 ft/ft

Vertical Size of Bridge Opening Prior to Scour: 42.00 ft
Deck Thickness: 10.30 ft
RESULT PARAMETERS
K1: 0.64
Diameter of Smallest Non-moving Particle: 14.062329 mm
Average Depth In Contracted Section: 39.35 ft
Flow Separation Thickness: 10.48 ft
Scour Depth: 7.84 ft
LEFT BANK CONTRACTION SCOUR
Computation Type: Clear-Water and Live-Bed Scour
INPUT PARAMETERS
Average Depth Upstream of Contraction: 21.41 ft
D50: 16.999915 mm
Average Velocity Upstream: 2.84 ft/s
RESULTS OF SCOUR CONDITION
Critical velocity above which bed material of size D and smaller will be transported: 7.11 ft/s
Contraction Scour Condition: Clear-Water
Live Bed and/or Clear Water Input Parameters
Flow in Contracted Section: 11105.91 cfs
Bottom Width in Contracted Section: 88.81 ft
Depth Prior to Scour in Contracted Section: 20.61 ft
Temperature of Water: 60.00 °F
Slope of Energy Grade Line at Approach Section: 0.0005 ft/ft
Flow in Contracted Section: 11105.91 cfs
Flow Upstream that is Transporting Sediment: 7521.77 cfs
Width in Contracted Section: 88.81 ft
Width Upstream that is Transporting Sediment: 125.64 ft
Depth Prior to Scour in Contracted Section: 20.61 ft
Unit Weight of Water: 62.40 lb/ft³
Unit Weight of Sediment: 165.00 lb/ft³
Results of Clear Water Method
Diameter of the smallest nontransportable particle in the bed material: 21.249894 mm
Average Depth in Contracted Section after Scour: 16.68 ft
Scour Depth: -3.93 ft
RESULTS OF LIVE BED METHOD
Shear Velocity: 0.59 ft/s

Fall Velocity: 1.64 ft/s
Average Depth in Contracted Section after Scour: 36.69 ft
Scour Depth for Live Bed: 16.08 ft
Shear Applied to Bed by Live-Bed Scour: 0.4817 lb/ft²
Shear Required for Movement of D50 Particle: 0.2232 lb/ft²
Recommendations
Recommended Scour Depth: -3.93 ft
RIGHT BANK CONTRACTION SCOUR
Computation Type:
INPUT PARAMETERS
Average Depth Upstream of Contraction: 27.26 ft
D50: 0.259994 mm
Average Velocity Upstream: 4.19 ft/s
RESULTS OF SCOUR CONDITION
Critical velocity above which bed material of size D and smaller will be transported: 1.84 ft/s
Contraction Scour Condition: Live-Bed
Live Bed and/or Clear Water Input Parameters
Temperature of Water: 60.00 °F
Slope of Energy Grade Line at Approach Section: 0.0005 ft/ft
Flow in Contracted Section: 45688.48 cfs
Flow Upstream that is Transporting Sediment: 69647.70 cfs
Width in Contracted Section: 609.11 ft
Width Upstream that is Transporting Sediment: 609.11 ft
Depth Prior to Scour in Contracted Section: 19.94 ft
Unit Weight of Water: 62.40 lb/ft³
Unit Weight of Sediment: 165.00 lb/ft³
RESULTS OF LIVE BED METHOD
Shear Velocity: 0.67 ft/s
Fall Velocity: 0.11 ft/s
Average Depth in Contracted Section after Scour: 18.99 ft
Scour Depth for Live Bed: -0.95 ft
Scour may be limited by armoring. Compute all methods to check.
Upstream Channel Flow Depth: 27.26 ft
Average Velocity Upstream: 4.19 ft/s
D50: 0.259994 mm
RESULTS OF SCOUR CONDITION

Critical velocity above which bed material of size D and smaller will be transported: 1.84 ft/s
Contraction Scour Condition: Live Bed
INPUT PARAMETERS FOR BRIDGE SCOUR
Width of the Contracted Section: 609.11 ft
Flow through bridge opening: 45688.48 cfs
Width of the Upstream Section: 609.11 ft
Flow in Upstream Section: 69647.70 cfs
Slope of Energy Grade Line at Approach Section: 0.0005 ft/ft
Vertical Size of Bridge Opening Prior to Scour: 18.91 ft
Deck Thickness: 8.00 ft
RESULT PARAMETERS
K1: 0.69
Diameter of Smallest Non-moving Particle: 0.324993 mm
Average Depth In Contracted Section: 18.99 ft
Flow Separation Thickness: 6.78 ft
Scour Depth: 6.87 ft
PIER DETAILS
Pier Name: Pier 1
PIER SCOUR
Computation Type: HEC-18
INPUT PARAMETERS
Pier Shape: Group of Cylinders
Bed Condition: Clear-Water Scour
Depth Upstream of Pier: 44.17 ft
Velocity Upstream of Pier: 12.71 ft/s
Width of Pier: 3.00 ft
Length of Pier: 43.12 ft
Angle of Attack: 26.49 Degrees
Spacing between Piers: 20.00 ft
Number of Columns of Piers: 3
RESULT PARAMETERS
Froude Number Upstream: 0.34
Correction Factor for Pier Nose Shape (K1): 1.00
Correction Factor of Angle of Attack (K2): 1.00
Spacing to Pier Width (s/a): 6.67
Correction Factor for Bed Condition (K3): 1.10
Scour Depth: 12.72 ft
Pier Name: Pier 2
PIER SCOUR
Computation Type: Coarse Bed
INPUT PARAMETERS
Pier Shape: Group of Cylinders
Angle of Attack: 24.55 Degrees
Upstream Channel Flow Depth: 44.17 ft

Average Velocity Upstream: 12.71 ft/s
D50: 28.000147 mm
D84: 60.999929 mm
Pier Width: 3.50 ft
Pier Length: 10.50 ft
Unit Weight of Sediment: 165.00 lb/ft³
Unit Weight of Water: 62.40 lb/ft³
RESULT PARAMETERS
Sediment Gradation Coefficient (Sigma): 2.18
Specific Gravity of Sediment: 2.64
Densimetric Particle Froude Number: 5.76
Scour Depth: 16.62 ft
Pier Name: Pier 3
PIER SCOUR
Computation Type: HEC-18
INPUT PARAMETERS
Pier Shape: Group of Cylinders
Bed Condition: Clear-Water Scour
Depth Upstream of Pier: 44.17 ft
Velocity Upstream of Pier: 12.71 ft/s
Width of Pier: 5.00 ft
Length of Pier: 44.08 ft
Angle of Attack: 23.41 Degrees
Spacing between Piers: 19.50 ft
Number of Columns of Piers: 3
RESULT PARAMETERS
Froude Number Upstream: 0.34
Correction Factor for Pier Nose Shape (K1): 1.00
Correction Factor of Angle of Attack (K2): 1.62
Spacing to Pier Width (s/a): 3.90
Correction Factor for Bed Condition (K3): 1.10
Scour Depth: 24.00 ft
Pier Name: Pier 4
PIER SCOUR
Computation Type: HEC-18
INPUT PARAMETERS
Pier Shape: Group of Cylinders
Bed Condition: Clear-Water Scour
Depth Upstream of Pier: 44.17 ft
Velocity Upstream of Pier: 12.71 ft/s
Width of Pier: 5.00 ft
Length of Pier: 44.16 ft
Angle of Attack: 13.26 Degrees
Spacing between Piers: 19.50 ft
Number of Columns of Piers: 3
RESULT PARAMETERS
Froude Number Upstream: 0.34
Correction Factor for Pier Nose Shape (K1): 1.00

Correction Factor of Angle of Attack (K2): 1.39
Spacing to Pier Width (s/a): 3.90
Correction Factor for Bed Condition (K3): 1.10
Scour Depth: 20.55 ft
Pier Name: Pier 5
PIER SCOUR
Computation Type: HEC-18
INPUT PARAMETERS
Pier Shape: Group of Cylinders
Bed Condition: Clear-Water Scour
Depth Upstream of Pier: 44.17 ft
Velocity Upstream of Pier: 12.71 ft/s
Width of Pier: 3.50 ft
Length of Pier: 10.50 ft
Angle of Attack: 0.00 Degrees
RESULT PARAMETERS
Froude Number Upstream: 0.34
Correction Factor for Pier Nose Shape (K1): 1.00
Correction Factor of Angle of Attack (K2): 1.00
Pier Length to Pier Width (L/a): 3.00
Correction Factor for Bed Condition (K3): 1.10
Scour Depth: 11.72 ft
Pier Name: Pier 6
PIER SCOUR
Computation Type: HEC-18
INPUT PARAMETERS
Pier Shape: Group of Cylinders
Bed Condition: Clear-Water Scour
Depth Upstream of Pier: 44.17 ft
Velocity Upstream of Pier: 12.71 ft/s
Width of Pier: 3.00 ft
Length of Pier: 9.00 ft
Angle of Attack: 0.00 Degrees
RESULT PARAMETERS
Froude Number Upstream: 0.34
Correction Factor for Pier Nose Shape (K1): 1.00
Correction Factor of Angle of Attack (K2): 1.00
Pier Length to Pier Width (L/a): 3.00
Correction Factor for Bed Condition (K3): 1.10
Scour Depth: 10.60 ft
Pier Name: Pier 7
PIER SCOUR
Computation Type: HEC-18
INPUT PARAMETERS
Pier Shape: Group of Cylinders
Bed Condition: Clear-Water Scour
Depth Upstream of Pier: 44.17 ft
Velocity Upstream of Pier: 12.71 ft/s

Width of Pier: 3.00 ft
Length of Pier: 9.00 ft
Angle of Attack: 0.00 Degrees
RESULT PARAMETERS
Froude Number Upstream: 0.34
Correction Factor for Pier Nose Shape (K1): 1.00
Correction Factor of Angle of Attack (K2): 1.00
Pier Length to Pier Width (L/a): 3.00
Correction Factor for Bed Condition (K3): 1.10
Scour Depth: 10.60 ft
Pier Name: Pier 8

PIER SCOUR

Computation Type: HEC-18
INPUT PARAMETERS
Pier Shape: Group of Cylinders
Bed Condition: Clear-Water Scour
Depth Upstream of Pier: 44.17 ft
Velocity Upstream of Pier: 12.71 ft/s

Width of Pier: 3.00 ft
Length of Pier: 9.00 ft
Angle of Attack: 0.00 Degrees
RESULT PARAMETERS
Froude Number Upstream: 0.34
Correction Factor for Pier Nose Shape (K1): 1.00
Correction Factor of Angle of Attack (K2): 1.00
Pier Length to Pier Width (L/a): 3.00
Correction Factor for Bed Condition (K3): 1.10
Scour Depth: 10.60 ft

Pier Name: Pier 9

PIER SCOUR

Computation Type: HEC-18
INPUT PARAMETERS
Pier Shape: Group of Cylinders
Bed Condition: Clear-Water Scour
Depth Upstream of Pier: 44.17 ft
Velocity Upstream of Pier: 12.71 ft/s

Width of Pier: 3.00 ft
Length of Pier: 9.00 ft
Angle of Attack: 0.00 Degrees
RESULT PARAMETERS
Froude Number Upstream: 0.34
Correction Factor for Pier Nose Shape (K1): 1.00
Correction Factor of Angle of Attack (K2): 1.00
Pier Length to Pier Width (L/a): 3.00
Correction Factor for Bed Condition (K3): 1.10
Scour Depth: 10.60 ft

Pier Name: Pier 10

PIER SCOUR

Computation Type: HEC-18

INPUT PARAMETERS

Pier Shape: Group of Cylinders
Bed Condition: Clear-Water Scour
Depth Upstream of Pier: 44.17 ft
Velocity Upstream of Pier: 12.71 ft/s

Width of Pier: 3.00 ft
Length of Pier: 9.00 ft
Angle of Attack: 0.00 Degrees

RESULT PARAMETERS

Froude Number Upstream: 0.34
Correction Factor for Pier Nose Shape (K1): 1.00
Correction Factor of Angle of Attack (K2): 1.00
Pier Length to Pier Width (L/a): 3.00
Correction Factor for Bed Condition (K3): 1.10

Scour Depth: 10.60 ft

Pier Name: Pier 11

PIER SCOUR

Computation Type: HEC-18

INPUT PARAMETERS

Pier Shape: Group of Cylinders
Bed Condition: Clear-Water Scour
Depth Upstream of Pier: 44.17 ft
Velocity Upstream of Pier: 12.71 ft/s

Width of Pier: 3.00 ft
Length of Pier: 9.00 ft
Angle of Attack: 0.00 Degrees

RESULT PARAMETERS

Froude Number Upstream: 0.34
Correction Factor for Pier Nose Shape (K1): 1.00
Correction Factor of Angle of Attack (K2): 1.00
Pier Length to Pier Width (L/a): 3.00
Correction Factor for Bed Condition (K3): 1.10

Scour Depth: 10.60 ft

LEFT ABUTMENT DETAILS

ABUTMENT SCOUR

Computation Type: NCHRP

Input Parameters

NCHRP METHOD

Abutment Type: Vertical-wall abutment
Angle of Embankment to Flow: 99.90 Degrees
Centerline Length of Embankment: 0.00 ft
Projected Length of Embankment: 0.00 ft

Width of Flood Plain: 0.00 ft

Unit Discharge, Upstream in Main Channel (q1):
448.10 cfs

Unit Discharge in the Constricted Area (q2):
171.13 cfs/ft

D50: 5.999988 mm
Upstream Flow Depth: 44.84 ft
Flow Depth Prior to Scour: 2.10 ft
RESULT PARAMETERS
q2/q1: 0.38
Average Velocity Upstream: 9.99 ft/s
Critical Velocity above which Bed Material of Size D and Smaller will be Transported: 5.68 ft/s
Scour Condition: Live Bed
Embankment Length/Floodplain Width Ratio: 0.00
Scour Condition: a (Main Channel)
Amplification Factor: 1.20
Flow Depth including Contraction Scour: 19.65 ft
Maximum Flow Depth including Abutment Scour: 23.58 ft
Scour Hole Depth from NCHRP Method: 21.48 ft
RIGHT ABUTMENT DETAILS
ABUTMENT SCOUR
Computation Type: NCHRP
Input Parameters
NCHRP METHOD
Abutment Type: Spill-through abutment
Angle of Embankment to Flow: 80.10 Degrees
Centerline Length of Embankment: 0.00 ft
Projected Length of Embankment: 0.00 ft
Width of Flood Plain: 0.00 ft
Unit Discharge, Upstream in Main Channel (q1): 129.61 cfs
Unit Discharge in the Constricted Area (q2): 175.62 cfs/ft
D50: 0.230124 mm
Upstream Flow Depth: 27.26 ft
Flow Depth Prior to Scour: 27.09 ft
RESULT PARAMETERS
q2/q1: 1.35
Average Velocity Upstream: 4.75 ft/s
Critical Velocity above which Bed Material of Size D and Smaller will be Transported: 1.76 ft/s
Scour Condition: Live Bed
Embankment Length/Floodplain Width Ratio: 0.00
Scour Condition: b (overbank)
Amplification Factor: 2.16
Flow Depth including Contraction Scour: 35.37 ft
Maximum Flow Depth including Abutment Scour: 76.32 ft
Scour Hole Depth from NCHRP Method: 49.23 ft

SCENARIO: 500-YR
CONTRACTION SCOUR SUMMARY
Pressure Flow
Applied Contraction Scour Depth 7.84 ft
Clear Water Contraction Scour Depth 6.44 ft
Applied Contraction Scour Elevation with LTD - 13.21 ft
LOCAL SCOUR AT PIERS SUMMARY
PIER NAME: PIER 1
Computation Method: HEC-18
Pier Scour Depth 12.72 ft
Total Scour at Pier 20.56 ft
Total Scour Elevation at Pier 584.39 ft
PIER NAME: PIER 2
Computation Method: Coarse Bed
Pier Scour Depth 16.62 ft
Total Scour at Pier 24.46 ft
Total Scour Elevation at Pier 580.49 ft
PIER NAME: PIER 3
Computation Method: HEC-18
Pier Scour Depth 24.00 ft
Total Scour at Pier 31.84 ft
Total Scour Elevation at Pier 573.11 ft
PIER NAME: PIER 4
Computation Method: HEC-18
Pier Scour Depth 20.55 ft
Total Scour at Pier 28.39 ft
Total Scour Elevation at Pier 576.56 ft
PIER NAME: PIER 5
Computation Method: HEC-18
Pier Scour Depth 11.72 ft
Total Scour at Pier 19.55 ft
Total Scour Elevation at Pier 585.39 ft
PIER NAME: PIER 6
Computation Method: HEC-18
Pier Scour Depth 10.60 ft
Total Scour at Pier 18.44 ft
Total Scour Elevation at Pier 586.51 ft
PIER NAME: PIER 7
Computation Method: HEC-18
Pier Scour Depth 10.60 ft
Total Scour at Pier 18.44 ft
Total Scour Elevation at Pier 586.51 ft
PIER NAME: PIER 8
Computation Method: HEC-18
Pier Scour Depth 10.60 ft
Total Scour at Pier 18.44 ft
Total Scour Elevation at Pier 586.51 ft

PIER NAME: PIER 9
Computation Method: HEC-18
Pier Scour Depth 10.60 ft
Total Scour at Pier 18.44 ft
Total Scour Elevation at Pier 586.51 ft
PIER NAME: PIER 10
Computation Method: HEC-18
Pier Scour Depth 10.60 ft
Total Scour at Pier 18.44 ft
Total Scour Elevation at Pier 586.51 ft
PIER NAME: PIER 11
Computation Method: HEC-18
Pier Scour Depth 10.60 ft
Total Scour at Pier 18.44 ft
Total Scour Elevation at Pier 586.51 ft
LOCAL SCOUR AT ABUTMENTS SUMMARY
LEFT ABUTMENT
Abutment Scour Method: NCHRP Method
Abutment Scour Depth 21.48 ft
Total Scour at Abutment 0.00 ft
Total Scour Elevation at Abutment 628.79 ft
RIGHT ABUTMENT
Abutment Scour Method: NCHRP Method
Abutment Scour Depth 49.23 ft
Total Scour at Abutment 0.00 ft
Total Scour Elevation at Abutment 576.05 ft
MAIN CHANNEL CONTRACTION SCOUR
Computation Type:
INPUT PARAMETERS
Average Depth Upstream of Contraction: 41.31 ft
D50: 11.249863 mm
Average Velocity Upstream: 9.47 ft/s
RESULTS OF SCOUR CONDITION
Critical velocity above which bed material of size D and smaller will be transported: 6.91 ft/s
Contraction Scour Condition: Live-Bed
Live Bed and/or Clear Water Input Parameters
Temperature of Water: 60.00 °F
Slope of Energy Grade Line at Approach Section: 0.0005 ft/ft
Flow in Contracted Section: 131601.60 cfs
Flow Upstream that is Transporting Sediment: 139262.70 cfs
Width in Contracted Section: 276.57 ft
Width Upstream that is Transporting Sediment: 276.57 ft

Depth Prior to Scour in Contracted Section: 52.56 ft
Unit Weight of Water: 62.40 lb/ft³
Unit Weight of Sediment: 165.00 lb/ft³
RESULTS OF LIVE BED METHOD
Shear Velocity: 0.83 ft/s
Fall Velocity: 1.50 ft/s
Average Depth in Contracted Section after Scour: 39.35 ft
Scour Depth for Live Bed: -13.21 ft
Scour may be limited by armoring. Compute all methods to check.
Upstream Channel Flow Depth: 41.31 ft
Average Velocity Upstream: 9.47 ft/s
D50: 11.249863 mm
RESULTS OF SCOUR CONDITION
Critical velocity above which bed material of size D and smaller will be transported: 6.91 ft/s
Contraction Scour Condition: Live Bed
INPUT PARAMETERS FOR BRIDGE SCOUR
Width of the Contracted Section: 276.57 ft
Flow through bridge opening: 131601.60 cfs
Width of the Upstream Section: 276.57 ft
Flow in Upstream Section: 139262.70 cfs
Slope of Energy Grade Line at Approach Section: 0.0005 ft/ft
Vertical Size of Bridge Opening Prior to Scour: 42.00 ft
Deck Thickness: 10.30 ft
RESULT PARAMETERS
K1: 0.64
Diameter of Smallest Non-moving Particle: 14.062329 mm
Average Depth In Contracted Section: 39.35 ft
Flow Separation Thickness: 10.48 ft
Scour Depth: 7.84 ft
LEFT BANK CONTRACTION SCOUR
Computation Type: Clear-Water and Live-Bed Scour
INPUT PARAMETERS
Average Depth Upstream of Contraction: 21.41 ft
D50: 16.999915 mm
Average Velocity Upstream: 2.84 ft/s
RESULTS OF SCOUR CONDITION
Critical velocity above which bed material of size D and smaller will be transported: 7.11 ft/s
Contraction Scour Condition: Clear-Water

Live Bed and/or Clear Water Input Parameters
Flow in Contracted Section: 11105.91 cfs
Bottom Width in Contracted Section: 88.81 ft
Depth Prior to Scour in Contracted Section: 20.61 ft
Temperature of Water: 60.00 °F
Slope of Energy Grade Line at Approach Section: 0.0005 ft/ft
Flow in Contracted Section: 11105.91 cfs
Flow Upstream that is Transporting Sediment: 7521.77 cfs
Width in Contracted Section: 88.81 ft
Width Upstream that is Transporting Sediment: 125.64 ft
Depth Prior to Scour in Contracted Section: 20.61 ft
Unit Weight of Water: 62.40 lb/ft³
Unit Weight of Sediment: 165.00 lb/ft³
Results of Clear Water Method
Diameter of the smallest nontransportable particle in the bed material: 21.249894 mm
Average Depth in Contracted Section after Scour: 16.68 ft
Scour Depth: -3.93 ft
RESULTS OF LIVE BED METHOD
Shear Velocity: 0.59 ft/s
Fall Velocity: 1.64 ft/s
Average Depth in Contracted Section after Scour: 36.69 ft
Scour Depth for Live Bed: 16.08 ft
Shear Applied to Bed by Live-Bed Scour: 0.4817 lb/ft²
Shear Required for Movement of D50 Particle: 0.2232 lb/ft²
Recommendations
Recommended Scour Depth: -3.93 ft
RIGHT BANK CONTRACTION SCOUR
Computation Type:
INPUT PARAMETERS
Average Depth Upstream of Contraction: 27.26 ft
D50: 0.259994 mm
Average Velocity Upstream: 4.19 ft/s
RESULTS OF SCOUR CONDITION
Critical velocity above which bed material of size D and smaller will be transported: 1.84 ft/s
Contraction Scour Condition: Live-Bed
Live Bed and/or Clear Water Input Parameters

Temperature of Water: 60.00 °F
Slope of Energy Grade Line at Approach Section: 0.0005 ft/ft
Flow in Contracted Section: 45688.48 cfs
Flow Upstream that is Transporting Sediment: 69647.70 cfs
Width in Contracted Section: 609.11 ft
Width Upstream that is Transporting Sediment: 609.11 ft
Depth Prior to Scour in Contracted Section: 19.94 ft
Unit Weight of Water: 62.40 lb/ft³
Unit Weight of Sediment: 165.00 lb/ft³
RESULTS OF LIVE BED METHOD
Shear Velocity: 0.67 ft/s
Fall Velocity: 0.11 ft/s
Average Depth in Contracted Section after Scour: 18.99 ft
Scour Depth for Live Bed: -0.95 ft
Scour may be limited by armoring. Compute all methods to check.
Upstream Channel Flow Depth: 27.26 ft
Average Velocity Upstream: 4.19 ft/s
D50: 0.259994 mm
RESULTS OF SCOUR CONDITION
Critical velocity above which bed material of size D and smaller will be transported: 1.84 ft/s
Contraction Scour Condition: Live Bed
INPUT PARAMETERS FOR BRIDGE SCOUR
Width of the Contracted Section: 609.11 ft
Flow through bridge opening: 45688.48 cfs
Width of the Upstream Section: 609.11 ft
Flow in Upstream Section: 69647.70 cfs
Slope of Energy Grade Line at Approach Section: 0.0005 ft/ft
Vertical Size of Bridge Opening Prior to Scour: 18.91 ft
Deck Thickness: 8.00 ft
RESULT PARAMETERS
K1: 0.69
Diameter of Smallest Non-moving Particle: 0.324993 mm
Average Depth In Contracted Section: 18.99 ft
Flow Separation Thickness: 6.78 ft
Scour Depth: 6.87 ft
PIER DETAILS
Pier Name: Pier 1
PIER SCOUR

Computation Type: HEC-18

INPUT PARAMETERS

Pier Shape: Group of Cylinders
Bed Condition: Clear-Water Scour
Depth Upstream of Pier: 44.17 ft
Velocity Upstream of Pier: 12.71 ft/s
Width of Pier: 3.00 ft
Length of Pier: 43.12 ft
Angle of Attack: 26.49 Degrees
Spacing between Piers: 20.00 ft
Number of Columns of Piers: 3

RESULT PARAMETERS

Froude Number Upstream: 0.34
Correction Factor for Pier Nose Shape (K1): 1.00
Correction Factor of Angle of Attack (K2): 1.00
Spacing to Pier Width (s/a): 6.67
Correction Factor for Bed Condition (K3): 1.10
Scour Depth: 12.72 ft
Pier Name: Pier 2

PIER SCOUR

Computation Type: Coarse Bed

INPUT PARAMETERS

Pier Shape: Group of Cylinders
Angle of Attack: 24.55 Degrees
Upstream Channel Flow Depth: 44.17 ft
Average Velocity Upstream: 12.71 ft/s
D50: 28.000147 mm
D84: 60.999929 mm
Pier Width: 3.50 ft
Pier Length: 10.50 ft
Unit Weight of Sediment: 165.00 lb/ft³
Unit Weight of Water: 62.40 lb/ft³

RESULT PARAMETERS

Sediment Gradation Coefficient (Sigma): 2.18
Specific Gravity of Sediment: 2.64
Densimetric Particle Froude Number: 5.76
Scour Depth: 16.62 ft
Pier Name: Pier 3

PIER SCOUR

Computation Type: HEC-18

INPUT PARAMETERS

Pier Shape: Group of Cylinders
Bed Condition: Clear-Water Scour
Depth Upstream of Pier: 44.17 ft
Velocity Upstream of Pier: 12.71 ft/s
Width of Pier: 5.00 ft
Length of Pier: 44.08 ft
Angle of Attack: 23.41 Degrees

Spacing between Piers: 19.50 ft

Number of Columns of Piers: 3

RESULT PARAMETERS

Froude Number Upstream: 0.34
Correction Factor for Pier Nose Shape (K1): 1.00
Correction Factor of Angle of Attack (K2): 1.62
Spacing to Pier Width (s/a): 3.90
Correction Factor for Bed Condition (K3): 1.10
Scour Depth: 24.00 ft
Pier Name: Pier 4

PIER SCOUR

Computation Type: HEC-18

INPUT PARAMETERS

Pier Shape: Group of Cylinders
Bed Condition: Clear-Water Scour
Depth Upstream of Pier: 44.17 ft
Velocity Upstream of Pier: 12.71 ft/s
Width of Pier: 5.00 ft
Length of Pier: 44.16 ft
Angle of Attack: 13.26 Degrees
Spacing between Piers: 19.50 ft
Number of Columns of Piers: 3

RESULT PARAMETERS

Froude Number Upstream: 0.34
Correction Factor for Pier Nose Shape (K1): 1.00
Correction Factor of Angle of Attack (K2): 1.39
Spacing to Pier Width (s/a): 3.90
Correction Factor for Bed Condition (K3): 1.10
Scour Depth: 20.55 ft
Pier Name: Pier 5

PIER SCOUR

Computation Type: HEC-18

INPUT PARAMETERS

Pier Shape: Group of Cylinders
Bed Condition: Clear-Water Scour
Depth Upstream of Pier: 44.17 ft
Velocity Upstream of Pier: 12.71 ft/s
Width of Pier: 3.50 ft
Length of Pier: 10.50 ft
Angle of Attack: 0.00 Degrees

RESULT PARAMETERS

Froude Number Upstream: 0.34
Correction Factor for Pier Nose Shape (K1): 1.00
Correction Factor of Angle of Attack (K2): 1.00
Pier Length to Pier Width (L/a): 3.00
Correction Factor for Bed Condition (K3): 1.10
Scour Depth: 11.72 ft
Pier Name: Pier 6

PIER SCOUR

Computation Type: HEC-18

INPUT PARAMETERS

Pier Shape: Group of Cylinders

Bed Condition: Clear-Water Scour

Depth Upstream of Pier: 44.17 ft

Velocity Upstream of Pier: 12.71 ft/s

Width of Pier: 3.00 ft

Length of Pier: 9.00 ft

Angle of Attack: 0.00 Degrees

RESULT PARAMETERS

Froude Number Upstream: 0.34

Correction Factor for Pier Nose Shape (K1): 1.00

Correction Factor of Angle of Attack (K2): 1.00

Pier Length to Pier Width (L/a): 3.00

Correction Factor for Bed Condition (K3): 1.10

Scour Depth: 10.60 ft

Pier Name: Pier 7

PIER SCOUR

Computation Type: HEC-18

INPUT PARAMETERS

Pier Shape: Group of Cylinders

Bed Condition: Clear-Water Scour

Depth Upstream of Pier: 44.17 ft

Velocity Upstream of Pier: 12.71 ft/s

Width of Pier: 3.00 ft

Length of Pier: 9.00 ft

Angle of Attack: 0.00 Degrees

RESULT PARAMETERS

Froude Number Upstream: 0.34

Correction Factor for Pier Nose Shape (K1): 1.00

Correction Factor of Angle of Attack (K2): 1.00

Pier Length to Pier Width (L/a): 3.00

Correction Factor for Bed Condition (K3): 1.10

Scour Depth: 10.60 ft

Pier Name: Pier 8

PIER SCOUR

Computation Type: HEC-18

INPUT PARAMETERS

Pier Shape: Group of Cylinders

Bed Condition: Clear-Water Scour

Depth Upstream of Pier: 44.17 ft

Velocity Upstream of Pier: 12.71 ft/s

Width of Pier: 3.00 ft

Length of Pier: 9.00 ft

Angle of Attack: 0.00 Degrees

RESULT PARAMETERS

Froude Number Upstream: 0.34

Correction Factor for Pier Nose Shape (K1): 1.00

Correction Factor of Angle of Attack (K2): 1.00

Pier Length to Pier Width (L/a): 3.00

Correction Factor for Bed Condition (K3): 1.10

Scour Depth: 10.60 ft

Pier Name: Pier 9

PIER SCOUR

Computation Type: HEC-18

INPUT PARAMETERS

Pier Shape: Group of Cylinders

Bed Condition: Clear-Water Scour

Depth Upstream of Pier: 44.17 ft

Velocity Upstream of Pier: 12.71 ft/s

Width of Pier: 3.00 ft

Length of Pier: 9.00 ft

Angle of Attack: 0.00 Degrees

RESULT PARAMETERS

Froude Number Upstream: 0.34

Correction Factor for Pier Nose Shape (K1): 1.00

Correction Factor of Angle of Attack (K2): 1.00

Pier Length to Pier Width (L/a): 3.00

Correction Factor for Bed Condition (K3): 1.10

Scour Depth: 10.60 ft

Pier Name: Pier 10

PIER SCOUR

Computation Type: HEC-18

INPUT PARAMETERS

Pier Shape: Group of Cylinders

Bed Condition: Clear-Water Scour

Depth Upstream of Pier: 44.17 ft

Velocity Upstream of Pier: 12.71 ft/s

Width of Pier: 3.00 ft

Length of Pier: 9.00 ft

Angle of Attack: 0.00 Degrees

RESULT PARAMETERS

Froude Number Upstream: 0.34

Correction Factor for Pier Nose Shape (K1): 1.00

Correction Factor of Angle of Attack (K2): 1.00

Pier Length to Pier Width (L/a): 3.00

Correction Factor for Bed Condition (K3): 1.10

Scour Depth: 10.60 ft

Pier Name: Pier 11

PIER SCOUR

Computation Type: HEC-18

INPUT PARAMETERS

Pier Shape: Group of Cylinders

Bed Condition: Clear-Water Scour

Depth Upstream of Pier: 44.17 ft

Velocity Upstream of Pier: 12.71 ft/s
Width of Pier: 3.00 ft
Length of Pier: 9.00 ft
Angle of Attack: 0.00 Degrees
RESULT PARAMETERS
Froude Number Upstream: 0.34
Correction Factor for Pier Nose Shape (K1): 1.00
Correction Factor of Angle of Attack (K2): 1.00
Pier Length to Pier Width (L/a): 3.00
Correction Factor for Bed Condition (K3): 1.10
Scour Depth: 10.60 ft
LEFT ABUTMENT DETAILS
ABUTMENT SCOUR
Computation Type: NCHRP
Input Parameters
NCHRP METHOD
Abutment Type: Vertical-wall abutment
Angle of Embankment to Flow: 99.90 Degrees
Centerline Length of Embankment: 0.00 ft
Projected Length of Embankment: 0.00 ft
Width of Flood Plain: 0.00 ft
Unit Discharge, Upstream in Main Channel (q1):
448.10 cfs
Unit Discharge in the Constricted Area (q2):
171.13 cfs/ft
D50: 5.999988 mm
Upstream Flow Depth: 44.84 ft
Flow Depth Prior to Scour: 2.10 ft
RESULT PARAMETERS
q2/q1: 0.38
Average Velocity Upstream: 9.99 ft/s
Critical Velocity above which Bed Material of Size
D and Smaller will be Transported: 5.68 ft/s
Scour Condition: Live Bed
Embankment Length/Floodplain Width Ratio:
0.00
Scour Condition: a (Main Channel)
Amplification Factor: 1.20
Flow Depth including Contraction Scour: 19.65 ft
Maximum Flow Depth including Abutment
Scour: 23.58 ft
Scour Hole Depth from NCHRP Method: 21.48 ft
RIGHT ABUTMENT DETAILS
ABUTMENT SCOUR
Computation Type: NCHRP
Input Parameters
NCHRP METHOD
Abutment Type: Spill-through abutment

Angle of Embankment to Flow: 80.10 Degrees
Centerline Length of Embankment: 0.00 ft
Projected Length of Embankment: 0.00 ft
Width of Flood Plain: 0.00 ft
Unit Discharge, Upstream in Main Channel (q1):
129.61 cfs
Unit Discharge in the Constricted Area (q2):
175.62 cfs/ft
D50: 0.230124 mm
Upstream Flow Depth: 27.26 ft
Flow Depth Prior to Scour: 27.09 ft
RESULT PARAMETERS
q2/q1: 1.35
Average Velocity Upstream: 4.75 ft/s
Critical Velocity above which Bed Material of Size
D and Smaller will be Transported: 1.76 ft/s
Scour Condition: Live Bed
Embankment Length/Floodplain Width Ratio:
0.00
Scour Condition: b (overbank)
Amplification Factor: 2.16
Flow Depth including Contraction Scour: 35.37 ft
Maximum Flow Depth including Abutment
Scour: 76.32 ft
Scour Hole Depth from NCHRP Method: 49.23 ft
BRIDGE SCOUR ANALYSIS: MISSOURI RIVER L-
0550
Project Title: L0550
Designer:
Project Date: Friday, May 26, 2023
Project Units: U.S. Customary Units
Notes:
L-0550 SRH-2D
Notes:
SCENARIO: 100-YR
CONTRACTION SCOUR SUMMARY
Contraction & Long Term Scour is applied
method due to greater scour.
Applied Contraction Scour Depth 9.94 ft
Contraction & Long Term Scour is applied
method due to greater scour.
Pressure Scour Depth 9.94 ft
Live Bed Contraction Scour Depth 9.94 ft
Applied Contraction Scour Elevation with LTD
9.94 ft
LOCAL SCOUR AT PIERS SUMMARY
PIER NAME: PIER 17
Computation Method: HEC-18

Pier Scour Depth 15.29 ft
Total Scour at Pier 25.23 ft
Total Scour Elevation at Pier 477.10 ft
PIER NAME: PIER 16
Computation Method: HEC-18
Pier Scour Depth 37.89 ft
Total Scour at Pier 47.82 ft
Total Scour Elevation at Pier 454.51 ft
PIER NAME: PIER 15
Computation Method: HEC-18
Pier Scour Depth 33.15 ft
Total Scour at Pier 43.09 ft
Total Scour Elevation at Pier 459.24 ft
PIER NAME: PIER 14
Computation Method: HEC-18
Pier Scour Depth 70.22 ft
Total Scour at Pier 80.15 ft
Total Scour Elevation at Pier 422.18 ft
PIER NAME: PIER 13
Computation Method: HEC-18
Pier Scour Depth 31.32 ft
Total Scour at Pier 41.25 ft
Total Scour Elevation at Pier 461.08 ft
PIER NAME: PIER 12
Computation Method: HEC-18
Pier Scour Depth 16.65 ft
Total Scour at Pier 26.58 ft
Total Scour Elevation at Pier 475.74 ft
PIER NAME: PIER 11
Computation Method: HEC-18
Pier Scour Depth 17.34 ft
Total Scour at Pier 27.28 ft
Total Scour Elevation at Pier 475.05 ft
PIER NAME: PIER 10
Computation Method: HEC-18
Pier Scour Depth 15.55 ft
Total Scour at Pier 25.48 ft
Total Scour Elevation at Pier 476.85 ft
PIER NAME: PIER 9
Computation Method: HEC-18
Pier Scour Depth 14.07 ft
Total Scour at Pier 24.01 ft
Total Scour Elevation at Pier 478.32 ft
PIER NAME: PIER 8
Computation Method: HEC-18
Pier Scour Depth 13.07 ft
Total Scour at Pier 23.01 ft
Total Scour Elevation at Pier 479.32 ft

PIER NAME: PIER 7
Computation Method: HEC-18
Pier Scour Depth 14.27 ft
Total Scour at Pier 24.21 ft
Total Scour Elevation at Pier 478.12 ft
PIER NAME: PIER 6
Computation Method: HEC-18
Pier Scour Depth 14.71 ft
Total Scour at Pier 24.65 ft
Total Scour Elevation at Pier 477.68 ft
PIER NAME: PIER 5
Computation Method: HEC-18
Pier Scour Depth 13.60 ft
Total Scour at Pier 23.53 ft
Total Scour Elevation at Pier 478.80 ft
PIER NAME: PIER 4
Computation Method: HEC-18
Pier Scour Depth 11.98 ft
Total Scour at Pier 21.92 ft
Total Scour Elevation at Pier 480.41 ft
PIER NAME: PIER 3
Computation Method: HEC-18
Pier Scour Depth 13.99 ft
Total Scour at Pier 23.92 ft
Total Scour Elevation at Pier 478.40 ft
PIER NAME: PIER 2
Computation Method: HEC-18
Pier Scour Depth 13.12 ft
Total Scour at Pier 23.05 ft
Total Scour Elevation at Pier 479.28 ft
PIER NAME: PIER 1
Computation Method: HEC-18
Pier Scour Depth 13.48 ft
Total Scour at Pier 23.42 ft
Total Scour Elevation at Pier 478.91 ft
LOCAL SCOUR AT ABUTMENTS SUMMARY
LEFT ABUTMENT
Abutment Scour Method: NCHRP Method
Abutment Scour Depth 0.70 ft
Total Scour at Abutment 0.70 ft
Total Scour Elevation at Abutment 546.48 ft
MAIN CHANNEL CONTRACTION SCOUR
Computation Type: Clear-Water or Live-Bed
Scour
INPUT PARAMETERS
Average Depth Upstream of Contraction: 51.53
ft
D50: 0.621792 mm

Average Velocity Upstream: 6.99 ft/s
RESULTS OF SCOUR CONDITION
Critical velocity above which bed material of size D and smaller will be transported: 2.73 ft/s
Contraction Scour Condition: Live-Bed
Live Bed and/or Clear Water Input Parameters
Temperature of Water: 60.00 °F
Slope of Energy Grade Line at Approach Section: 0.0004 ft/ft
Flow in Contracted Section: 448863.00 cfs
Flow Upstream that is Transporting Sediment: 409694.00 cfs
Width in Contracted Section: 968.30 ft
Width Upstream that is Transporting Sediment: 1137.01 ft
Depth Prior to Scour in Contracted Section: 52.31 ft
Unit Weight of Water: 62.40 lb/ft³
Unit Weight of Sediment: 165.00 lb/ft³
RESULTS OF LIVE BED METHOD
Shear Velocity: 0.86 ft/s
Fall Velocity: 0.27 ft/s
Average Depth in Contracted Section after Scour: 62.25 ft
Scour Depth for Live Bed: 9.94 ft
Scour may be limited by armoring. Compute all methods to check.
LEFT BANK CONTRACTION SCOUR
Computation Type: Clear-Water or Live-Bed Scour
INPUT PARAMETERS
Average Depth Upstream of Contraction: 20.01 ft
D50: 0.000000 mm
Average Velocity Upstream: 2.39 ft/s
RESULTS OF SCOUR CONDITION
Critical velocity above which bed material of size D and smaller will be transported: 0.00 ft/s
Contraction Scour Condition: Live-Bed
Live Bed and/or Clear Water Input Parameters
Temperature of Water: 60.00 °F
Slope of Energy Grade Line at Approach Section: 0.0004 ft/ft
Flow in Contracted Section: 81174.10 cfs
Flow Upstream that is Transporting Sediment: 95868.50 cfs
Width in Contracted Section: 1907.49 ft

Width Upstream that is Transporting Sediment: 2008.49 ft
Depth Prior to Scour in Contracted Section: 20.10 ft
Unit Weight of Water: 62.40 lb/ft³
Unit Weight of Sediment: 165.00 lb/ft³
RIGHT BANK CONTRACTION SCOUR
Computation Type: Clear-Water or Live-Bed Scour
INPUT PARAMETERS
Average Depth Upstream of Contraction: 7.38 ft
D50: 2.000098 mm
Average Velocity Upstream: 1.50 ft/s
RESULTS OF SCOUR CONDITION
Critical velocity above which bed material of size D and smaller will be transported: 2.92 ft/s
Contraction Scour Condition: Clear-Water
Live Bed and/or Clear Water Input Parameters
Flow in Contracted Section: 2440.79 cfs
Bottom Width in Contracted Section: 96.13 ft
Depth Prior to Scour in Contracted Section: 9.42 ft
Results of Clear Water Method
Diameter of the smallest nontransportable particle in the bed material: 2.500122 mm
Average Depth in Contracted Section after Scour: 7.84 ft
Scour Depth: -1.59 ft
PIER DETAILS
Pier Name: Pier 17
PIER SCOUR
Computation Type: HEC-18
INPUT PARAMETERS
Pier Shape: Square Nose
Bed Condition: Clear-Water Scour
Depth Upstream of Pier: 61.16 ft
Velocity Upstream of Pier: 7.92 ft/s
Width of Pier: 4.00 ft
Length of Pier: 8.00 ft
Angle of Attack: 22.33 Degrees
RESULT PARAMETERS
Froude Number Upstream: 0.18
Correction Factor for Pier Nose Shape (K1): 1.00
Correction Factor of Angle of Attack (K2): 1.40
Pier Length to Pier Width (L/a): 2.00
Correction Factor for Bed Condition (K3): 1.10
Scour Depth: 15.29 ft
Pier Name: Pier 16

PIER SCOUR

Computation Type: HEC-18

INPUT PARAMETERS

Pier Shape: Sharp Nose

Bed Condition: Clear-Water Scour

Depth Upstream of Pier: 61.16 ft

Velocity Upstream of Pier: 7.92 ft/s

Width of Pier: 16.00 ft

Length of Pier: 65.35 ft

Angle of Attack: 10.10 Degrees

RESULT PARAMETERS

Froude Number Upstream: 0.18

Correction Factor for Pier Nose Shape (K1): 1.00

Correction Factor of Angle of Attack (K2): 1.41

Pier Length to Pier Width (L/a): 4.08

Correction Factor for Bed Condition (K3): 1.10

Scour Depth: 37.89 ft

Pier Name: Pier 15

PIER SCOUR

Computation Type: HEC-18

INPUT PARAMETERS

Pier Shape: Sharp Nose

Bed Condition: Clear-Water Scour

Depth Upstream of Pier: 61.16 ft

Velocity Upstream of Pier: 7.92 ft/s

Width of Pier: 24.00 ft

Length of Pier: 72.99 ft

Angle of Attack: 1.63 Degrees

RESULT PARAMETERS

Froude Number Upstream: 0.18

Correction Factor for Pier Nose Shape (K1): 0.90

Correction Factor of Angle of Attack (K2): 1.06

Pier Length to Pier Width (L/a): 3.04

Correction Factor for Bed Condition (K3): 1.10

Scour Depth: 33.15 ft

Pier Name: Pier 14

PIER SCOUR

Computation Type: HEC-18

INPUT PARAMETERS

Pier Shape: Sharp Nose

Bed Condition: Clear-Water Scour

Depth Upstream of Pier: 61.16 ft

Velocity Upstream of Pier: 7.92 ft/s

Width of Pier: 28.00 ft

Length of Pier: 73.11 ft

Angle of Attack: 42.95 Degrees

RESULT PARAMETERS

Froude Number Upstream: 0.18

Correction Factor for Pier Nose Shape (K1): 1.00

Correction Factor of Angle of Attack (K2): 1.82

Pier Length to Pier Width (L/a): 2.61

Correction Factor for Bed Condition (K3): 1.10

Scour Depth: 70.22 ft

Pier Name: Pier 13

PIER SCOUR

Computation Type: HEC-18

INPUT PARAMETERS

Pier Shape: Square Nose

Bed Condition: Clear-Water Scour

Depth Upstream of Pier: 61.16 ft

Velocity Upstream of Pier: 7.92 ft/s

Width of Pier: 14.00 ft

Length of Pier: 22.00 ft

Angle of Attack: 18.65 Degrees

RESULT PARAMETERS

Froude Number Upstream: 0.18

Correction Factor for Pier Nose Shape (K1): 1.00

Correction Factor of Angle of Attack (K2): 1.27

Pier Length to Pier Width (L/a): 1.57

Correction Factor for Bed Condition (K3): 1.10

Scour Depth: 31.32 ft

Pier Name: Pier 12

PIER SCOUR

Computation Type: HEC-18

INPUT PARAMETERS

Pier Shape: Square Nose

Bed Condition: Clear-Water Scour

Depth Upstream of Pier: 61.16 ft

Velocity Upstream of Pier: 7.92 ft/s

Width of Pier: 5.00 ft

Length of Pier: 12.00 ft

Angle of Attack: 13.59 Degrees

RESULT PARAMETERS

Froude Number Upstream: 0.18

Correction Factor for Pier Nose Shape (K1): 1.00

Correction Factor of Angle of Attack (K2): 1.32

Pier Length to Pier Width (L/a): 2.40

Correction Factor for Bed Condition (K3): 1.10

Scour Depth: 16.65 ft

Pier Name: Pier 11

PIER SCOUR

Computation Type: HEC-18

INPUT PARAMETERS

Pier Shape: Square Nose

Bed Condition: Clear-Water Scour

Depth Upstream of Pier: 61.16 ft

Velocity Upstream of Pier: 7.92 ft/s
Width of Pier: 6.00 ft
Length of Pier: 12.00 ft
Angle of Attack: 10.98 Degrees
RESULT PARAMETERS
Froude Number Upstream: 0.18
Correction Factor for Pier Nose Shape (K1): 1.00
Correction Factor of Angle of Attack (K2): 1.22
Pier Length to Pier Width (L/a): 2.00
Correction Factor for Bed Condition (K3): 1.10
Scour Depth: 17.34 ft
Pier Name: Pier 10
PIER SCOUR
Computation Type: HEC-18
INPUT PARAMETERS
Pier Shape: Square Nose
Bed Condition: Clear-Water Scour
Depth Upstream of Pier: 61.16 ft
Velocity Upstream of Pier: 7.92 ft/s
Width of Pier: 5.00 ft
Length of Pier: 12.00 ft
Angle of Attack: 9.50 Degrees
RESULT PARAMETERS
Froude Number Upstream: 0.18
Correction Factor for Pier Nose Shape (K1): 1.00
Correction Factor of Angle of Attack (K2): 1.23
Pier Length to Pier Width (L/a): 2.40
Correction Factor for Bed Condition (K3): 1.10
Scour Depth: 15.55 ft
Pier Name: Pier 9
PIER SCOUR
Computation Type: HEC-18
INPUT PARAMETERS
Pier Shape: Square Nose
Bed Condition: Clear-Water Scour
Depth Upstream of Pier: 61.16 ft
Velocity Upstream of Pier: 7.92 ft/s
Width of Pier: 5.00 ft
Length of Pier: 8.00 ft
Angle of Attack: 6.94 Degrees
RESULT PARAMETERS
Froude Number Upstream: 0.18
Correction Factor for Pier Nose Shape (K1): 1.00
Correction Factor of Angle of Attack (K2): 1.12
Pier Length to Pier Width (L/a): 1.60
Correction Factor for Bed Condition (K3): 1.10
Scour Depth: 14.07 ft
Pier Name: Pier 8

PIER SCOUR
Computation Type: HEC-18
INPUT PARAMETERS
Pier Shape: Square Nose
Bed Condition: Clear-Water Scour
Depth Upstream of Pier: 61.16 ft
Velocity Upstream of Pier: 7.92 ft/s
Width of Pier: 4.50 ft
Length of Pier: 9.00 ft
Angle of Attack: 5.18 Degrees
RESULT PARAMETERS
Froude Number Upstream: 0.18
Correction Factor for Pier Nose Shape (K1): 1.00
Correction Factor of Angle of Attack (K2): 1.11
Pier Length to Pier Width (L/a): 2.00
Correction Factor for Bed Condition (K3): 1.10
Scour Depth: 13.07 ft
Pier Name: Pier 7
PIER SCOUR
Computation Type: HEC-18
INPUT PARAMETERS
Pier Shape: Square Nose
Bed Condition: Clear-Water Scour
Depth Upstream of Pier: 61.16 ft
Velocity Upstream of Pier: 7.92 ft/s
Width of Pier: 4.50 ft
Length of Pier: 9.00 ft
Angle of Attack: 4.78 Degrees
RESULT PARAMETERS
Froude Number Upstream: 0.18
Correction Factor for Pier Nose Shape (K1): 1.10
Correction Factor of Angle of Attack (K2): 1.10
Pier Length to Pier Width (L/a): 2.00
Correction Factor for Bed Condition (K3): 1.10
Scour Depth: 14.27 ft
Pier Name: Pier 6
PIER SCOUR
Computation Type: HEC-18
INPUT PARAMETERS
Pier Shape: Square Nose
Bed Condition: Clear-Water Scour
Depth Upstream of Pier: 61.16 ft
Velocity Upstream of Pier: 7.92 ft/s
Width of Pier: 5.00 ft
Length of Pier: 7.00 ft
Angle of Attack: 4.07 Degrees
RESULT PARAMETERS
Froude Number Upstream: 0.18

Correction Factor for Pier Nose Shape (K1): 1.10
Correction Factor of Angle of Attack (K2): 1.06
Pier Length to Pier Width (L/a): 1.40
Correction Factor for Bed Condition (K3): 1.10
Scour Depth: 14.71 ft
Pier Name: Pier 5
PIER SCOUR
Computation Type: HEC-18
INPUT PARAMETERS
Pier Shape: Square Nose
Bed Condition: Clear-Water Scour
Depth Upstream of Pier: 61.16 ft
Velocity Upstream of Pier: 7.92 ft/s
Width of Pier: 4.50 ft
Length of Pier: 9.00 ft
Angle of Attack: 2.30 Degrees
RESULT PARAMETERS
Froude Number Upstream: 0.18
Correction Factor for Pier Nose Shape (K1): 1.10
Correction Factor of Angle of Attack (K2): 1.05
Pier Length to Pier Width (L/a): 2.00
Correction Factor for Bed Condition (K3): 1.10
Scour Depth: 13.60 ft
Pier Name: Pier 4
PIER SCOUR
Computation Type: HEC-18
INPUT PARAMETERS
Pier Shape: Square Nose
Bed Condition: Clear-Water Scour
Depth Upstream of Pier: 61.16 ft
Velocity Upstream of Pier: 7.92 ft/s
Width of Pier: 4.00 ft
Length of Pier: 8.00 ft
Angle of Attack: 0.00 Degrees
RESULT PARAMETERS
Froude Number Upstream: 0.18
Correction Factor for Pier Nose Shape (K1): 1.10
Correction Factor of Angle of Attack (K2): 1.00
Pier Length to Pier Width (L/a): 2.00
Correction Factor for Bed Condition (K3): 1.10
Scour Depth: 11.98 ft
Pier Name: Pier 3
PIER SCOUR
Computation Type: HEC-18
INPUT PARAMETERS
Pier Shape: Square Nose
Bed Condition: Clear-Water Scour
Depth Upstream of Pier: 61.16 ft

Velocity Upstream of Pier: 7.92 ft/s
Width of Pier: 5.00 ft
Length of Pier: 7.00 ft
Angle of Attack: 0.61 Degrees
RESULT PARAMETERS
Froude Number Upstream: 0.18
Correction Factor for Pier Nose Shape (K1): 1.10
Correction Factor of Angle of Attack (K2): 1.01
Pier Length to Pier Width (L/a): 1.40
Correction Factor for Bed Condition (K3): 1.10
Scour Depth: 13.99 ft
Pier Name: Pier 2
PIER SCOUR
Computation Type: HEC-18
INPUT PARAMETERS
Pier Shape: Square Nose
Bed Condition: Clear-Water Scour
Depth Upstream of Pier: 61.16 ft
Velocity Upstream of Pier: 7.92 ft/s
Width of Pier: 4.50 ft
Length of Pier: 9.00 ft
Angle of Attack: 0.61 Degrees
RESULT PARAMETERS
Froude Number Upstream: 0.18
Correction Factor for Pier Nose Shape (K1): 1.10
Correction Factor of Angle of Attack (K2): 1.01
Pier Length to Pier Width (L/a): 2.00
Correction Factor for Bed Condition (K3): 1.10
Scour Depth: 13.12 ft
Pier Name: Pier 1
PIER SCOUR
Computation Type: HEC-18
INPUT PARAMETERS
Pier Shape: Square Nose
Bed Condition: Clear-Water Scour
Depth Upstream of Pier: 61.16 ft
Velocity Upstream of Pier: 7.92 ft/s
Width of Pier: 4.00 ft
Length of Pier: 8.00 ft
Angle of Attack: 11.78 Degrees
RESULT PARAMETERS
Froude Number Upstream: 0.18
Correction Factor for Pier Nose Shape (K1): 1.00
Correction Factor of Angle of Attack (K2): 1.24
Pier Length to Pier Width (L/a): 2.00
Correction Factor for Bed Condition (K3): 1.10
Scour Depth: 13.48 ft
LEFT ABUTMENT DETAILS

ABUTMENT SCOUR

Computation Type: NCHRP

Input Parameters

NCHRP METHOD

Abutment Type: Spill-through abutment

Angle of Embankment to Flow: 90.80 Degrees

Centerline Length of Embankment: 0.00 ft

Projected Length of Embankment: 0.00 ft

Width of Flood Plain: 0.00 ft

Unit Discharge, Upstream in Main Channel (q1):
47.73 cfs

Unit Discharge in the Constricted Area (q2):
42.56 cfs/ft

D50: 0.010058 mm

Upstream Flow Depth: 20.01 ft

Flow Depth Prior to Scour: 17.44 ft

RESULT PARAMETERS

q2/q1: 0.89

Average Velocity Upstream: 2.39 ft/s

Critical Velocity above which Bed Material of Size

D and Smaller will be Transported: 0.59 ft/s

Scour Condition: Live Bed

Embankment Length/Floodplain Width Ratio:
0.00

Scour Condition: b (overbank)

Amplification Factor: 1.00

Flow Depth including Contraction Scour: 18.14 ft

Maximum Flow Depth including Abutment
Scour: 18.14 ft

Scour Hole Depth from NCHRP Method: 0.70 ft

SCENARIO: 500-YR

CONTRACTION SCOUR SUMMARY

Contraction & Long Term Scour is applied
method due to greater scour.

Applied Contraction Scour Depth 9.94 ft

Contraction & Long Term Scour is applied
method due to greater scour.

Pressure Scour Depth 9.94 ft

Live Bed Contraction Scour Depth 9.94 ft

Applied Contraction Scour Elevation with LTD
9.94 ft

LOCAL SCOUR AT PIERS SUMMARY

PIER NAME: PIER 17

Computation Method: HEC-18

Pier Scour Depth 15.29 ft

Total Scour at Pier 25.23 ft

Total Scour Elevation at Pier 477.10 ft

PIER NAME: PIER 16

Computation Method: HEC-18

Pier Scour Depth 37.89 ft

Total Scour at Pier 47.82 ft

Total Scour Elevation at Pier 454.51 ft

PIER NAME: PIER 15

Computation Method: HEC-18

Pier Scour Depth 33.15 ft

Total Scour at Pier 43.09 ft

Total Scour Elevation at Pier 459.24 ft

PIER NAME: PIER 14

Computation Method: HEC-18

Pier Scour Depth 70.22 ft

Total Scour at Pier 80.15 ft

Total Scour Elevation at Pier 422.18 ft

PIER NAME: PIER 13

Computation Method: HEC-18

Pier Scour Depth 31.32 ft

Total Scour at Pier 41.25 ft

Total Scour Elevation at Pier 461.08 ft

PIER NAME: PIER 12

Computation Method: HEC-18

Pier Scour Depth 16.65 ft

Total Scour at Pier 26.58 ft

Total Scour Elevation at Pier 475.74 ft

PIER NAME: PIER 11

Computation Method: HEC-18

Pier Scour Depth 17.34 ft

Total Scour at Pier 27.28 ft

Total Scour Elevation at Pier 475.05 ft

PIER NAME: PIER 10

Computation Method: HEC-18

Pier Scour Depth 15.55 ft

Total Scour at Pier 25.48 ft

Total Scour Elevation at Pier 476.85 ft

PIER NAME: PIER 9

Computation Method: HEC-18

Pier Scour Depth 14.07 ft

Total Scour at Pier 24.01 ft

Total Scour Elevation at Pier 478.32 ft

PIER NAME: PIER 8

Computation Method: HEC-18

Pier Scour Depth 13.07 ft

Total Scour at Pier 23.01 ft

Total Scour Elevation at Pier 479.32 ft

PIER NAME: PIER 7

Computation Method: HEC-18

Pier Scour Depth 14.27 ft

Total Scour at Pier 24.21 ft

Total Scour Elevation at Pier 478.12 ft
PIER NAME: PIER 6
Computation Method: HEC-18
Pier Scour Depth 14.71 ft
Total Scour at Pier 24.65 ft
Total Scour Elevation at Pier 477.68 ft
PIER NAME: PIER 5
Computation Method: HEC-18
Pier Scour Depth 13.60 ft
Total Scour at Pier 23.53 ft
Total Scour Elevation at Pier 478.80 ft
PIER NAME: PIER 4
Computation Method: HEC-18
Pier Scour Depth 11.98 ft
Total Scour at Pier 21.92 ft
Total Scour Elevation at Pier 480.41 ft
PIER NAME: PIER 3
Computation Method: HEC-18
Pier Scour Depth 13.99 ft
Total Scour at Pier 23.92 ft
Total Scour Elevation at Pier 478.40 ft
PIER NAME: PIER 2
Computation Method: HEC-18
Pier Scour Depth 13.12 ft
Total Scour at Pier 23.05 ft
Total Scour Elevation at Pier 479.28 ft
PIER NAME: PIER 1
Computation Method: HEC-18
Pier Scour Depth 13.48 ft
Total Scour at Pier 23.42 ft
Total Scour Elevation at Pier 478.91 ft
LOCAL SCOUR AT ABUTMENTS SUMMARY
LEFT ABUTMENT
Abutment Scour Method: NCHRP Method
Abutment Scour Depth 0.70 ft
Total Scour at Abutment 0.70 ft
Total Scour Elevation at Abutment 546.48 ft
MAIN CHANNEL CONTRACTION SCOUR
Computation Type: Clear-Water or Live-Bed Scour
INPUT PARAMETERS
Average Depth Upstream of Contraction: 51.53 ft
D50: 0.621792 mm
Average Velocity Upstream: 6.99 ft/s
RESULTS OF SCOUR CONDITION
Critical velocity above which bed material of size D and smaller will be transported: 2.73 ft/s

Contraction Scour Condition: Live-Bed
Live Bed and/or Clear Water Input Parameters
Temperature of Water: 60.00 °F
Slope of Energy Grade Line at Approach Section: 0.0004 ft/ft
Flow in Contracted Section: 448863.00 cfs
Flow Upstream that is Transporting Sediment: 409694.00 cfs
Width in Contracted Section: 968.30 ft
Width Upstream that is Transporting Sediment: 1137.01 ft
Depth Prior to Scour in Contracted Section: 52.31 ft
Unit Weight of Water: 62.40 lb/ft³
Unit Weight of Sediment: 165.00 lb/ft³
RESULTS OF LIVE BED METHOD
Shear Velocity: 0.86 ft/s
Fall Velocity: 0.27 ft/s
Average Depth in Contracted Section after Scour: 62.25 ft
Scour Depth for Live Bed: 9.94 ft
Scour may be limited by armoring. Compute all methods to check.
LEFT BANK CONTRACTION SCOUR
Computation Type: Clear-Water or Live-Bed Scour
INPUT PARAMETERS
Average Depth Upstream of Contraction: 20.01 ft
D50: 0.000000 mm
Average Velocity Upstream: 2.39 ft/s
RESULTS OF SCOUR CONDITION
Critical velocity above which bed material of size D and smaller will be transported: 0.00 ft/s
Contraction Scour Condition: Live-Bed
Live Bed and/or Clear Water Input Parameters
Temperature of Water: 60.00 °F
Slope of Energy Grade Line at Approach Section: 0.0004 ft/ft
Flow in Contracted Section: 81174.10 cfs
Flow Upstream that is Transporting Sediment: 95868.50 cfs
Width in Contracted Section: 1907.49 ft
Width Upstream that is Transporting Sediment: 2008.49 ft
Depth Prior to Scour in Contracted Section: 20.10 ft
Unit Weight of Water: 62.40 lb/ft³

Unit Weight of Sediment: 165.00 lb/ft³
RIGHT BANK CONTRACTION SCOUR
Computation Type: Clear-Water or Live-Bed Scour
INPUT PARAMETERS
Average Depth Upstream of Contraction: 7.38 ft
D50: 2.000098 mm
Average Velocity Upstream: 1.50 ft/s
RESULTS OF SCOUR CONDITION
Critical velocity above which bed material of size D and smaller will be transported: 2.92 ft/s
Contraction Scour Condition: Clear-Water Live Bed and/or Clear Water Input Parameters
Flow in Contracted Section: 2440.79 cfs
Bottom Width in Contracted Section: 96.13 ft
Depth Prior to Scour in Contracted Section: 9.42 ft
Results of Clear Water Method
Diameter of the smallest nontransportable particle in the bed material: 2.500122 mm
Average Depth in Contracted Section after Scour: 7.84 ft
Scour Depth: -1.59 ft
PIER DETAILS
Pier Name: Pier 17
PIER SCOUR
Computation Type: HEC-18
INPUT PARAMETERS
Pier Shape: Square Nose
Bed Condition: Clear-Water Scour
Depth Upstream of Pier: 61.16 ft
Velocity Upstream of Pier: 7.92 ft/s
Width of Pier: 4.00 ft
Length of Pier: 8.00 ft
Angle of Attack: 22.33 Degrees
RESULT PARAMETERS
Froude Number Upstream: 0.18
Correction Factor for Pier Nose Shape (K1): 1.00
Correction Factor of Angle of Attack (K2): 1.40
Pier Length to Pier Width (L/a): 2.00
Correction Factor for Bed Condition (K3): 1.10
Scour Depth: 15.29 ft
Pier Name: Pier 16
PIER SCOUR
Computation Type: HEC-18
INPUT PARAMETERS
Pier Shape: Sharp Nose
Bed Condition: Clear-Water Scour

Depth Upstream of Pier: 61.16 ft
Velocity Upstream of Pier: 7.92 ft/s
Width of Pier: 16.00 ft
Length of Pier: 65.35 ft
Angle of Attack: 10.10 Degrees
RESULT PARAMETERS
Froude Number Upstream: 0.18
Correction Factor for Pier Nose Shape (K1): 1.00
Correction Factor of Angle of Attack (K2): 1.41
Pier Length to Pier Width (L/a): 4.08
Correction Factor for Bed Condition (K3): 1.10
Scour Depth: 37.89 ft
Pier Name: Pier 15
PIER SCOUR
Computation Type: HEC-18
INPUT PARAMETERS
Pier Shape: Sharp Nose
Bed Condition: Clear-Water Scour
Depth Upstream of Pier: 61.16 ft
Velocity Upstream of Pier: 7.92 ft/s
Width of Pier: 24.00 ft
Length of Pier: 72.99 ft
Angle of Attack: 1.63 Degrees
RESULT PARAMETERS
Froude Number Upstream: 0.18
Correction Factor for Pier Nose Shape (K1): 0.90
Correction Factor of Angle of Attack (K2): 1.06
Pier Length to Pier Width (L/a): 3.04
Correction Factor for Bed Condition (K3): 1.10
Scour Depth: 33.15 ft
Pier Name: Pier 14
PIER SCOUR
Computation Type: HEC-18
INPUT PARAMETERS
Pier Shape: Sharp Nose
Bed Condition: Clear-Water Scour
Depth Upstream of Pier: 61.16 ft
Velocity Upstream of Pier: 7.92 ft/s
Width of Pier: 28.00 ft
Length of Pier: 73.11 ft
Angle of Attack: 42.95 Degrees
RESULT PARAMETERS
Froude Number Upstream: 0.18
Correction Factor for Pier Nose Shape (K1): 1.00
Correction Factor of Angle of Attack (K2): 1.82
Pier Length to Pier Width (L/a): 2.61
Correction Factor for Bed Condition (K3): 1.10
Scour Depth: 70.22 ft

Pier Name: Pier 13
PIER SCOUR
Computation Type: HEC-18
INPUT PARAMETERS
Pier Shape: Square Nose
Bed Condition: Clear-Water Scour
Depth Upstream of Pier: 61.16 ft
Velocity Upstream of Pier: 7.92 ft/s
Width of Pier: 14.00 ft
Length of Pier: 22.00 ft
Angle of Attack: 18.65 Degrees
RESULT PARAMETERS
Froude Number Upstream: 0.18
Correction Factor for Pier Nose Shape (K1): 1.00
Correction Factor of Angle of Attack (K2): 1.27
Pier Length to Pier Width (L/a): 1.57
Correction Factor for Bed Condition (K3): 1.10
Scour Depth: 31.32 ft
Pier Name: Pier 12
PIER SCOUR
Computation Type: HEC-18
INPUT PARAMETERS
Pier Shape: Square Nose
Bed Condition: Clear-Water Scour
Depth Upstream of Pier: 61.16 ft
Velocity Upstream of Pier: 7.92 ft/s
Width of Pier: 5.00 ft
Length of Pier: 12.00 ft
Angle of Attack: 13.59 Degrees
RESULT PARAMETERS
Froude Number Upstream: 0.18
Correction Factor for Pier Nose Shape (K1): 1.00
Correction Factor of Angle of Attack (K2): 1.32
Pier Length to Pier Width (L/a): 2.40
Correction Factor for Bed Condition (K3): 1.10
Scour Depth: 16.65 ft
Pier Name: Pier 11
PIER SCOUR
Computation Type: HEC-18
INPUT PARAMETERS
Pier Shape: Square Nose
Bed Condition: Clear-Water Scour
Depth Upstream of Pier: 61.16 ft
Velocity Upstream of Pier: 7.92 ft/s
Width of Pier: 6.00 ft
Length of Pier: 12.00 ft
Angle of Attack: 10.98 Degrees
RESULT PARAMETERS

Froude Number Upstream: 0.18
Correction Factor for Pier Nose Shape (K1): 1.00
Correction Factor of Angle of Attack (K2): 1.22
Pier Length to Pier Width (L/a): 2.00
Correction Factor for Bed Condition (K3): 1.10
Scour Depth: 17.34 ft
Pier Name: Pier 10
PIER SCOUR
Computation Type: HEC-18
INPUT PARAMETERS
Pier Shape: Square Nose
Bed Condition: Clear-Water Scour
Depth Upstream of Pier: 61.16 ft
Velocity Upstream of Pier: 7.92 ft/s
Width of Pier: 5.00 ft
Length of Pier: 12.00 ft
Angle of Attack: 9.50 Degrees
RESULT PARAMETERS
Froude Number Upstream: 0.18
Correction Factor for Pier Nose Shape (K1): 1.00
Correction Factor of Angle of Attack (K2): 1.23
Pier Length to Pier Width (L/a): 2.40
Correction Factor for Bed Condition (K3): 1.10
Scour Depth: 15.55 ft
Pier Name: Pier 9
PIER SCOUR
Computation Type: HEC-18
INPUT PARAMETERS
Pier Shape: Square Nose
Bed Condition: Clear-Water Scour
Depth Upstream of Pier: 61.16 ft
Velocity Upstream of Pier: 7.92 ft/s
Width of Pier: 5.00 ft
Length of Pier: 8.00 ft
Angle of Attack: 6.94 Degrees
RESULT PARAMETERS
Froude Number Upstream: 0.18
Correction Factor for Pier Nose Shape (K1): 1.00
Correction Factor of Angle of Attack (K2): 1.12
Pier Length to Pier Width (L/a): 1.60
Correction Factor for Bed Condition (K3): 1.10
Scour Depth: 14.07 ft
Pier Name: Pier 8
PIER SCOUR
Computation Type: HEC-18
INPUT PARAMETERS
Pier Shape: Square Nose
Bed Condition: Clear-Water Scour

Depth Upstream of Pier: 61.16 ft
Velocity Upstream of Pier: 7.92 ft/s
Width of Pier: 4.50 ft
Length of Pier: 9.00 ft
Angle of Attack: 5.18 Degrees
RESULT PARAMETERS
Froude Number Upstream: 0.18
Correction Factor for Pier Nose Shape (K1): 1.00
Correction Factor of Angle of Attack (K2): 1.11
Pier Length to Pier Width (L/a): 2.00
Correction Factor for Bed Condition (K3): 1.10
Scour Depth: 13.07 ft
Pier Name: Pier 7
PIER SCOUR
Computation Type: HEC-18
INPUT PARAMETERS
Pier Shape: Square Nose
Bed Condition: Clear-Water Scour
Depth Upstream of Pier: 61.16 ft
Velocity Upstream of Pier: 7.92 ft/s
Width of Pier: 4.50 ft
Length of Pier: 9.00 ft
Angle of Attack: 4.78 Degrees
RESULT PARAMETERS
Froude Number Upstream: 0.18
Correction Factor for Pier Nose Shape (K1): 1.10
Correction Factor of Angle of Attack (K2): 1.10
Pier Length to Pier Width (L/a): 2.00
Correction Factor for Bed Condition (K3): 1.10
Scour Depth: 14.27 ft
Pier Name: Pier 6
PIER SCOUR
Computation Type: HEC-18
INPUT PARAMETERS
Pier Shape: Square Nose
Bed Condition: Clear-Water Scour
Depth Upstream of Pier: 61.16 ft
Velocity Upstream of Pier: 7.92 ft/s
Width of Pier: 5.00 ft
Length of Pier: 7.00 ft
Angle of Attack: 4.07 Degrees
RESULT PARAMETERS
Froude Number Upstream: 0.18
Correction Factor for Pier Nose Shape (K1): 1.10
Correction Factor of Angle of Attack (K2): 1.06
Pier Length to Pier Width (L/a): 1.40
Correction Factor for Bed Condition (K3): 1.10
Scour Depth: 14.71 ft

Pier Name: Pier 5
PIER SCOUR
Computation Type: HEC-18
INPUT PARAMETERS
Pier Shape: Square Nose
Bed Condition: Clear-Water Scour
Depth Upstream of Pier: 61.16 ft
Velocity Upstream of Pier: 7.92 ft/s
Width of Pier: 4.50 ft
Length of Pier: 9.00 ft
Angle of Attack: 2.30 Degrees
RESULT PARAMETERS
Froude Number Upstream: 0.18
Correction Factor for Pier Nose Shape (K1): 1.10
Correction Factor of Angle of Attack (K2): 1.05
Pier Length to Pier Width (L/a): 2.00
Correction Factor for Bed Condition (K3): 1.10
Scour Depth: 13.60 ft
Pier Name: Pier 4
PIER SCOUR
Computation Type: HEC-18
INPUT PARAMETERS
Pier Shape: Square Nose
Bed Condition: Clear-Water Scour
Depth Upstream of Pier: 61.16 ft
Velocity Upstream of Pier: 7.92 ft/s
Width of Pier: 4.00 ft
Length of Pier: 8.00 ft
Angle of Attack: 0.00 Degrees
RESULT PARAMETERS
Froude Number Upstream: 0.18
Correction Factor for Pier Nose Shape (K1): 1.10
Correction Factor of Angle of Attack (K2): 1.00
Pier Length to Pier Width (L/a): 2.00
Correction Factor for Bed Condition (K3): 1.10
Scour Depth: 11.98 ft
Pier Name: Pier 3
PIER SCOUR
Computation Type: HEC-18
INPUT PARAMETERS
Pier Shape: Square Nose
Bed Condition: Clear-Water Scour
Depth Upstream of Pier: 61.16 ft
Velocity Upstream of Pier: 7.92 ft/s
Width of Pier: 5.00 ft
Length of Pier: 7.00 ft
Angle of Attack: 0.61 Degrees
RESULT PARAMETERS

Froude Number Upstream: 0.18
Correction Factor for Pier Nose Shape (K1): 1.10
Correction Factor of Angle of Attack (K2): 1.01
Pier Length to Pier Width (L/a): 1.40
Correction Factor for Bed Condition (K3): 1.10
Scour Depth: 13.99 ft
Pier Name: Pier 2
PIER SCOUR
Computation Type: HEC-18
INPUT PARAMETERS
Pier Shape: Square Nose
Bed Condition: Clear-Water Scour
Depth Upstream of Pier: 61.16 ft
Velocity Upstream of Pier: 7.92 ft/s
Width of Pier: 4.50 ft
Length of Pier: 9.00 ft
Angle of Attack: 0.61 Degrees
RESULT PARAMETERS
Froude Number Upstream: 0.18
Correction Factor for Pier Nose Shape (K1): 1.10
Correction Factor of Angle of Attack (K2): 1.01
Pier Length to Pier Width (L/a): 2.00
Correction Factor for Bed Condition (K3): 1.10
Scour Depth: 13.12 ft
Pier Name: Pier 1
PIER SCOUR
Computation Type: HEC-18
INPUT PARAMETERS
Pier Shape: Square Nose
Bed Condition: Clear-Water Scour
Depth Upstream of Pier: 61.16 ft
Velocity Upstream of Pier: 7.92 ft/s
Width of Pier: 4.00 ft
Length of Pier: 8.00 ft
Angle of Attack: 11.78 Degrees
RESULT PARAMETERS
Froude Number Upstream: 0.18
Correction Factor for Pier Nose Shape (K1): 1.00
Correction Factor of Angle of Attack (K2): 1.24
Pier Length to Pier Width (L/a): 2.00
Correction Factor for Bed Condition (K3): 1.10
Scour Depth: 13.48 ft
LEFT ABUTMENT DETAILS
ABUTMENT SCOUR
Computation Type: NCHRP
Input Parameters
NCHRP METHOD
Abutment Type: Spill-through abutment

Angle of Embankment to Flow: 90.80 Degrees
Centerline Length of Embankment: 0.00 ft
Projected Length of Embankment: 0.00 ft
Width of Flood Plain: 0.00 ft
Unit Discharge, Upstream in Main Channel (q1):
47.73 cfs
Unit Discharge in the Constricted Area (q2):
42.56 cfs/ft
D50: 0.010058 mm
Upstream Flow Depth: 20.01 ft
Flow Depth Prior to Scour: 17.44 ft
RESULT PARAMETERS
q2/q1: 0.89
Average Velocity Upstream: 2.39 ft/s
Critical Velocity above which Bed Material of Size
D and Smaller will be Transported: 0.59 ft/s
Scour Condition: Live Bed
Embankment Length/Floodplain Width Ratio:
0.00
Scour Condition: b (overbank)
Amplification Factor: 1.00
Flow Depth including Contraction Scour: 18.14 ft
Maximum Flow Depth including Abutment
Scour: 18.14 ft
Scour Hole Depth from NCHRP Method: 0.70 ft
L-0550 HEC-RAS
Notes:
SCENARIO: 100-YR
CONTRACTION SCOUR SUMMARY
Contraction & Long Term Scour is applied
method due to greater scour.
Applied Contraction Scour Depth 2.24 ft
Contraction & Long Term Scour is applied
method due to greater scour.
Pressure Scour Depth 2.24 ft
Live Bed Contraction Scour Depth 2.24 ft
Applied Contraction Scour Elevation with LTD
2.24 ft
LOCAL SCOUR AT PIERS SUMMARY
PIER NAME: PIER 17
Computation Method: HEC-18
Pier Scour Depth 13.69 ft
Total Scour at Pier 15.94 ft
Total Scour Elevation at Pier 486.39 ft
PIER NAME: PIER 16
Computation Method: HEC-18
Pier Scour Depth 27.59 ft
Total Scour at Pier 29.83 ft

Total Scour Elevation at Pier 472.50 ft
PIER NAME: PIER 15
Computation Method: HEC-18
Pier Scour Depth 35.91 ft
Total Scour at Pier 38.15 ft
Total Scour Elevation at Pier 464.18 ft
PIER NAME: PIER 14
Computation Method: HEC-18
Pier Scour Depth 39.69 ft
Total Scour at Pier 41.94 ft
Total Scour Elevation at Pier 460.39 ft
PIER NAME: PIER 13
Computation Method: HEC-18
Pier Scour Depth 30.92 ft
Total Scour at Pier 33.16 ft
Total Scour Elevation at Pier 469.17 ft
PIER NAME: PIER 12
Computation Method: HEC-18
Pier Scour Depth 15.83 ft
Total Scour at Pier 18.08 ft
Total Scour Elevation at Pier 484.25 ft
PIER NAME: PIER 11
Computation Method: HEC-18
Pier Scour Depth 17.82 ft
Total Scour at Pier 20.07 ft
Total Scour Elevation at Pier 482.26 ft
PIER NAME: PIER 10
Computation Method: HEC-18
Pier Scour Depth 15.83 ft
Total Scour at Pier 18.08 ft
Total Scour Elevation at Pier 484.25 ft
PIER NAME: PIER 9
Computation Method: HEC-18
Pier Scour Depth 15.83 ft
Total Scour at Pier 18.08 ft
Total Scour Elevation at Pier 484.25 ft
PIER NAME: PIER 8
Computation Method: HEC-18
Pier Scour Depth 14.78 ft
Total Scour at Pier 17.03 ft
Total Scour Elevation at Pier 485.30 ft
PIER NAME: PIER 7
Computation Method: HEC-18
Pier Scour Depth 14.78 ft
Total Scour at Pier 17.03 ft
Total Scour Elevation at Pier 485.30 ft
PIER NAME: PIER 6
Computation Method: HEC-18

Pier Scour Depth 15.83 ft
Total Scour at Pier 18.08 ft
Total Scour Elevation at Pier 484.25 ft
PIER NAME: PIER 5
Computation Method: HEC-18
Pier Scour Depth 14.78 ft
Total Scour at Pier 17.03 ft
Total Scour Elevation at Pier 485.30 ft
PIER NAME: PIER 4
Computation Method: HEC-18
Pier Scour Depth 13.69 ft
Total Scour at Pier 15.94 ft
Total Scour Elevation at Pier 486.39 ft
PIER NAME: PIER 3
Computation Method: HEC-18
Pier Scour Depth 15.83 ft
Total Scour at Pier 18.08 ft
Total Scour Elevation at Pier 484.25 ft
PIER NAME: PIER 2
Computation Method: HEC-18
Pier Scour Depth 14.78 ft
Total Scour at Pier 17.03 ft
Total Scour Elevation at Pier 485.30 ft
PIER NAME: PIER 1
Computation Method: HEC-18
Pier Scour Depth 13.69 ft
Total Scour at Pier 15.94 ft
Total Scour Elevation at Pier 486.39 ft
LOCAL SCOUR AT ABUTMENTS SUMMARY
LEFT ABUTMENT
Abutment Scour Method: NCHRP Method
Abutment Scour Depth 49.90 ft
Total Scour at Abutment 49.90 ft
Total Scour Elevation at Abutment 496.86 ft
MAIN CHANNEL CONTRACTION SCOUR
Computation Type: Clear-Water or Live-Bed
Scour
INPUT PARAMETERS
Average Depth Upstream of Contraction: 44.48
ft
D50: 0.621792 mm
Average Velocity Upstream: 9.36 ft/s
RESULTS OF SCOUR CONDITION
Critical velocity above which bed material of size
D and smaller will be transported: 2.67 ft/s
Contraction Scour Condition: Live-Bed
Live Bed and/or Clear Water Input Parameters
Temperature of Water: 60.00 °F

Slope of Energy Grade Line at Approach Section:
0.0007 ft/ft

Flow in Contracted Section: 485856.21 cfs

Flow Upstream that is Transporting Sediment:
473572.06 cfs

Width in Contracted Section: 1056.32 ft

Width Upstream that is Transporting Sediment:
1100.60 ft

Depth Prior to Scour in Contracted Section: 44.53
ft

Unit Weight of Water: 62.40 lb/ft³

Unit Weight of Sediment: 165.00 lb/ft³

RESULTS OF LIVE BED METHOD

Shear Velocity: 1.03 ft/s

Fall Velocity: 0.27 ft/s

Average Depth in Contracted Section after
Scour: 46.77 ft

Scour Depth for Live Bed: 2.24 ft

Scour may be limited by armoring. Compute all
methods to check.

LEFT BANK CONTRACTION SCOUR

Computation Type: Clear-Water or Live-Bed
Scour

INPUT PARAMETERS

Average Depth Upstream of Contraction: 16.22
ft

D50: 0.010058 mm

Average Velocity Upstream: 3.62 ft/s

RESULTS OF SCOUR CONDITION

Critical velocity above which bed material of size
D and smaller will be transported: 0.57 ft/s

Contraction Scour Condition: Live-Bed

Live Bed and/or Clear Water Input Parameters

Temperature of Water: 60.00 °F

Slope of Energy Grade Line at Approach Section:
0.0007 ft/ft

Flow in Contracted Section: 98926.37 cfs

Flow Upstream that is Transporting Sediment:
108107.80 cfs

Width in Contracted Section: 1774.12 ft

Width Upstream that is Transporting Sediment:
1841.57 ft

Depth Prior to Scour in Contracted Section: 15.88
ft

Unit Weight of Water: 62.40 lb/ft³

Unit Weight of Sediment: 165.00 lb/ft³

RESULTS OF LIVE BED METHOD

Shear Velocity: 0.62 ft/s

Fall Velocity: 0.00 ft/s

Average Depth in Contracted Section after
Scour: 15.42 ft

Scour Depth for Live Bed: -0.46 ft

Scour may be limited by armoring. Compute all
methods to check.

RIGHT BANK CONTRACTION SCOUR

Computation Type: Clear-Water or Live-Bed
Scour

INPUT PARAMETERS

Average Depth Upstream of Contraction: 4.87 ft

D50: 1.499921 mm

Average Velocity Upstream: 1.27 ft/s

RESULTS OF SCOUR CONDITION

Critical velocity above which bed material of size
D and smaller will be transported: 2.47 ft/s

Contraction Scour Condition: Clear-Water

Live Bed and/or Clear Water Input Parameters

Flow in Contracted Section: 242.42 cfs

Bottom Width in Contracted Section: 107.76 ft

Depth Prior to Scour in Contracted Section: 4.74
ft

Results of Clear Water Method

Diameter of the smallest nontransportable
particle in the bed material: 1.874901 mm

Average Depth in Contracted Section after
Scour: 1.07 ft

Scour Depth: -3.67 ft

PIER DETAILS

Pier Name: Pier 17

PIER SCOUR

Computation Type: HEC-18

INPUT PARAMETERS

Pier Shape: Square Nose

Bed Condition: Clear-Water Scour

Depth Upstream of Pier: 54.97 ft

Velocity Upstream of Pier: 11.17 ft/s

Width of Pier: 4.00 ft

Length of Pier: 8.00 ft

Angle of Attack: 0.00 Degrees

RESULT PARAMETERS

Froude Number Upstream: 0.27

Correction Factor for Pier Nose Shape (K1): 1.10

Correction Factor of Angle of Attack (K2): 1.00

Pier Length to Pier Width (L/a): 2.00

Correction Factor for Bed Condition (K3): 1.10

Scour Depth: 13.69 ft

Pier Name: Pier 16

PIER SCOUR

Computation Type: HEC-18

INPUT PARAMETERS

Pier Shape: Sharp Nose

Bed Condition: Clear-Water Scour

Depth Upstream of Pier: 54.97 ft

Velocity Upstream of Pier: 11.17 ft/s

Width of Pier: 16.00 ft

Length of Pier: 65.35 ft

Angle of Attack: 0.00 Degrees

RESULT PARAMETERS

Froude Number Upstream: 0.27

Correction Factor for Pier Nose Shape (K1): 0.90

Correction Factor of Angle of Attack (K2): 1.00

Pier Length to Pier Width (L/a): 4.08

Correction Factor for Bed Condition (K3): 1.10

Scour Depth: 27.59 ft

Pier Name: Pier 15

PIER SCOUR

Computation Type: HEC-18

INPUT PARAMETERS

Pier Shape: Sharp Nose

Bed Condition: Clear-Water Scour

Depth Upstream of Pier: 54.97 ft

Velocity Upstream of Pier: 11.17 ft/s

Width of Pier: 24.00 ft

Length of Pier: 72.99 ft

Angle of Attack: 0.00 Degrees

RESULT PARAMETERS

Froude Number Upstream: 0.27

Correction Factor for Pier Nose Shape (K1): 0.90

Correction Factor of Angle of Attack (K2): 1.00

Pier Length to Pier Width (L/a): 3.04

Correction Factor for Bed Condition (K3): 1.10

Scour Depth: 35.91 ft

Pier Name: Pier 14

PIER SCOUR

Computation Type: HEC-18

INPUT PARAMETERS

Pier Shape: Sharp Nose

Bed Condition: Clear-Water Scour

Depth Upstream of Pier: 54.97 ft

Velocity Upstream of Pier: 11.17 ft/s

Width of Pier: 28.00 ft

Length of Pier: 73.11 ft

Angle of Attack: 0.00 Degrees

RESULT PARAMETERS

Froude Number Upstream: 0.27

Correction Factor for Pier Nose Shape (K1): 0.90

Correction Factor of Angle of Attack (K2): 1.00

Pier Length to Pier Width (L/a): 2.61

Correction Factor for Bed Condition (K3): 1.10

Scour Depth: 39.69 ft

Pier Name: Pier 13

PIER SCOUR

Computation Type: HEC-18

INPUT PARAMETERS

Pier Shape: Square Nose

Bed Condition: Clear-Water Scour

Depth Upstream of Pier: 54.97 ft

Velocity Upstream of Pier: 11.17 ft/s

Width of Pier: 14.00 ft

Length of Pier: 22.00 ft

Angle of Attack: 0.00 Degrees

RESULT PARAMETERS

Froude Number Upstream: 0.27

Correction Factor for Pier Nose Shape (K1): 1.10

Correction Factor of Angle of Attack (K2): 1.00

Pier Length to Pier Width (L/a): 1.57

Correction Factor for Bed Condition (K3): 1.10

Scour Depth: 30.92 ft

Pier Name: Pier 12

PIER SCOUR

Computation Type: HEC-18

INPUT PARAMETERS

Pier Shape: Square Nose

Bed Condition: Clear-Water Scour

Depth Upstream of Pier: 54.97 ft

Velocity Upstream of Pier: 11.17 ft/s

Width of Pier: 5.00 ft

Length of Pier: 12.00 ft

Angle of Attack: 0.00 Degrees

RESULT PARAMETERS

Froude Number Upstream: 0.27

Correction Factor for Pier Nose Shape (K1): 1.10

Correction Factor of Angle of Attack (K2): 1.00

Pier Length to Pier Width (L/a): 2.40

Correction Factor for Bed Condition (K3): 1.10

Scour Depth: 15.83 ft

Pier Name: Pier 11

PIER SCOUR

Computation Type: HEC-18

INPUT PARAMETERS

Pier Shape: Square Nose

Bed Condition: Clear-Water Scour

Depth Upstream of Pier: 54.97 ft

Velocity Upstream of Pier: 11.17 ft/s
Width of Pier: 6.00 ft
Length of Pier: 12.00 ft
Angle of Attack: 0.00 Degrees
RESULT PARAMETERS
Froude Number Upstream: 0.27
Correction Factor for Pier Nose Shape (K1): 1.10
Correction Factor of Angle of Attack (K2): 1.00
Pier Length to Pier Width (L/a): 2.00
Correction Factor for Bed Condition (K3): 1.10
Scour Depth: 17.82 ft
Pier Name: Pier 10
PIER SCOUR
Computation Type: HEC-18
INPUT PARAMETERS
Pier Shape: Square Nose
Bed Condition: Clear-Water Scour
Depth Upstream of Pier: 54.97 ft
Velocity Upstream of Pier: 11.17 ft/s
Width of Pier: 5.00 ft
Length of Pier: 12.00 ft
Angle of Attack: 0.00 Degrees
RESULT PARAMETERS
Froude Number Upstream: 0.27
Correction Factor for Pier Nose Shape (K1): 1.10
Correction Factor of Angle of Attack (K2): 1.00
Pier Length to Pier Width (L/a): 2.40
Correction Factor for Bed Condition (K3): 1.10
Scour Depth: 15.83 ft
Pier Name: Pier 9
PIER SCOUR
Computation Type: HEC-18
INPUT PARAMETERS
Pier Shape: Square Nose
Bed Condition: Clear-Water Scour
Depth Upstream of Pier: 54.97 ft
Velocity Upstream of Pier: 11.17 ft/s
Width of Pier: 5.00 ft
Length of Pier: 8.00 ft
Angle of Attack: 0.00 Degrees
RESULT PARAMETERS
Froude Number Upstream: 0.27
Correction Factor for Pier Nose Shape (K1): 1.10
Correction Factor of Angle of Attack (K2): 1.00
Pier Length to Pier Width (L/a): 1.60
Correction Factor for Bed Condition (K3): 1.10
Scour Depth: 15.83 ft
Pier Name: Pier 8

PIER SCOUR
Computation Type: HEC-18
INPUT PARAMETERS
Pier Shape: Square Nose
Bed Condition: Clear-Water Scour
Depth Upstream of Pier: 54.97 ft
Velocity Upstream of Pier: 11.17 ft/s
Width of Pier: 4.50 ft
Length of Pier: 9.00 ft
Angle of Attack: 0.00 Degrees
RESULT PARAMETERS
Froude Number Upstream: 0.27
Correction Factor for Pier Nose Shape (K1): 1.10
Correction Factor of Angle of Attack (K2): 1.00
Pier Length to Pier Width (L/a): 2.00
Correction Factor for Bed Condition (K3): 1.10
Scour Depth: 14.78 ft
Pier Name: Pier 7
PIER SCOUR
Computation Type: HEC-18
INPUT PARAMETERS
Pier Shape: Square Nose
Bed Condition: Clear-Water Scour
Depth Upstream of Pier: 54.97 ft
Velocity Upstream of Pier: 11.17 ft/s
Width of Pier: 4.50 ft
Length of Pier: 9.00 ft
Angle of Attack: 0.00 Degrees
RESULT PARAMETERS
Froude Number Upstream: 0.27
Correction Factor for Pier Nose Shape (K1): 1.10
Correction Factor of Angle of Attack (K2): 1.00
Pier Length to Pier Width (L/a): 2.00
Correction Factor for Bed Condition (K3): 1.10
Scour Depth: 14.78 ft
Pier Name: Pier 6
PIER SCOUR
Computation Type: HEC-18
INPUT PARAMETERS
Pier Shape: Square Nose
Bed Condition: Clear-Water Scour
Depth Upstream of Pier: 54.97 ft
Velocity Upstream of Pier: 11.17 ft/s
Width of Pier: 5.00 ft
Length of Pier: 7.00 ft
Angle of Attack: 0.00 Degrees
RESULT PARAMETERS
Froude Number Upstream: 0.27

Correction Factor for Pier Nose Shape (K1): 1.10
Correction Factor of Angle of Attack (K2): 1.00
Pier Length to Pier Width (L/a): 1.40
Correction Factor for Bed Condition (K3): 1.10
Scour Depth: 15.83 ft
Pier Name: Pier 5
PIER SCOUR
Computation Type: HEC-18
INPUT PARAMETERS
Pier Shape: Square Nose
Bed Condition: Clear-Water Scour
Depth Upstream of Pier: 54.97 ft
Velocity Upstream of Pier: 11.17 ft/s
Width of Pier: 4.50 ft
Length of Pier: 9.00 ft
Angle of Attack: 0.00 Degrees
RESULT PARAMETERS
Froude Number Upstream: 0.27
Correction Factor for Pier Nose Shape (K1): 1.10
Correction Factor of Angle of Attack (K2): 1.00
Pier Length to Pier Width (L/a): 2.00
Correction Factor for Bed Condition (K3): 1.10
Scour Depth: 14.78 ft
Pier Name: Pier 4
PIER SCOUR
Computation Type: HEC-18
INPUT PARAMETERS
Pier Shape: Square Nose
Bed Condition: Clear-Water Scour
Depth Upstream of Pier: 54.97 ft
Velocity Upstream of Pier: 11.17 ft/s
Width of Pier: 4.00 ft
Length of Pier: 8.00 ft
Angle of Attack: 0.00 Degrees
RESULT PARAMETERS
Froude Number Upstream: 0.27
Correction Factor for Pier Nose Shape (K1): 1.10
Correction Factor of Angle of Attack (K2): 1.00
Pier Length to Pier Width (L/a): 2.00
Correction Factor for Bed Condition (K3): 1.10
Scour Depth: 13.69 ft
Pier Name: Pier 3
PIER SCOUR
Computation Type: HEC-18
INPUT PARAMETERS
Pier Shape: Square Nose
Bed Condition: Clear-Water Scour
Depth Upstream of Pier: 54.97 ft

Velocity Upstream of Pier: 11.17 ft/s
Width of Pier: 5.00 ft
Length of Pier: 7.00 ft
Angle of Attack: 0.00 Degrees
RESULT PARAMETERS
Froude Number Upstream: 0.27
Correction Factor for Pier Nose Shape (K1): 1.10
Correction Factor of Angle of Attack (K2): 1.00
Pier Length to Pier Width (L/a): 1.40
Correction Factor for Bed Condition (K3): 1.10
Scour Depth: 15.83 ft
Pier Name: Pier 2
PIER SCOUR
Computation Type: HEC-18
INPUT PARAMETERS
Pier Shape: Square Nose
Bed Condition: Clear-Water Scour
Depth Upstream of Pier: 54.97 ft
Velocity Upstream of Pier: 11.17 ft/s
Width of Pier: 4.50 ft
Length of Pier: 9.00 ft
Angle of Attack: 0.00 Degrees
RESULT PARAMETERS
Froude Number Upstream: 0.27
Correction Factor for Pier Nose Shape (K1): 1.10
Correction Factor of Angle of Attack (K2): 1.00
Pier Length to Pier Width (L/a): 2.00
Correction Factor for Bed Condition (K3): 1.10
Scour Depth: 14.78 ft
Pier Name: Pier 1
PIER SCOUR
Computation Type: HEC-18
INPUT PARAMETERS
Pier Shape: Square Nose
Bed Condition: Clear-Water Scour
Depth Upstream of Pier: 54.97 ft
Velocity Upstream of Pier: 11.17 ft/s
Width of Pier: 4.00 ft
Length of Pier: 8.00 ft
Angle of Attack: 0.00 Degrees
RESULT PARAMETERS
Froude Number Upstream: 0.27
Correction Factor for Pier Nose Shape (K1): 1.10
Correction Factor of Angle of Attack (K2): 1.00
Pier Length to Pier Width (L/a): 2.00
Correction Factor for Bed Condition (K3): 1.10
Scour Depth: 13.69 ft
LEFT ABUTMENT DETAILS

ABUTMENT SCOUR

Computation Type: NCHRP

Input Parameters

NCHRP METHOD

Abutment Type: Spill-through abutment

Angle of Embankment to Flow: 91.11 Degrees

Centerline Length of Embankment: 0.00 ft

Projected Length of Embankment: 0.00 ft

Width of Flood Plain: 0.00 ft

Unit Discharge, Upstream in Main Channel (q1):
64.59 cfs

Unit Discharge in the Constricted Area (q2):
199.11 cfs/ft

D50: 0.010058 mm

Upstream Flow Depth: 16.22 ft

Flow Depth Prior to Scour: 12.96 ft

RESULT PARAMETERS

q2/q1: 3.08

Average Velocity Upstream: 3.98 ft/s

Critical Velocity above which Bed Material of Size
D and Smaller will be Transported: 0.57 ft/s

Scour Condition: Live Bed

Embankment Length/Floodplain Width Ratio:
0.00

Scour Condition: b (overbank)

Amplification Factor: 1.48

Flow Depth including Contraction Scour: 42.57 ft

Maximum Flow Depth including Abutment
Scour: 62.86 ft

Scour Hole Depth from NCHRP Method: 49.90 ft

SCENARIO: 500-YR

CONTRACTION SCOUR SUMMARY

Contraction & Long Term Scour is applied
method due to greater scour.

Applied Contraction Scour Depth 2.24 ft

Contraction & Long Term Scour is applied
method due to greater scour.

Pressure Scour Depth 2.24 ft

Live Bed Contraction Scour Depth 2.24 ft

Applied Contraction Scour Elevation with LTD
2.24 ft

LOCAL SCOUR AT PIERS SUMMARY

PIER NAME: PIER 17

Computation Method: HEC-18

Pier Scour Depth 13.69 ft

Total Scour at Pier 15.94 ft

Total Scour Elevation at Pier 486.39 ft

PIER NAME: PIER 16

Computation Method: HEC-18

Pier Scour Depth 27.59 ft

Total Scour at Pier 29.83 ft

Total Scour Elevation at Pier 472.50 ft

PIER NAME: PIER 15

Computation Method: HEC-18

Pier Scour Depth 35.91 ft

Total Scour at Pier 38.15 ft

Total Scour Elevation at Pier 464.18 ft

PIER NAME: PIER 14

Computation Method: HEC-18

Pier Scour Depth 39.69 ft

Total Scour at Pier 41.94 ft

Total Scour Elevation at Pier 460.39 ft

PIER NAME: PIER 13

Computation Method: HEC-18

Pier Scour Depth 30.92 ft

Total Scour at Pier 33.16 ft

Total Scour Elevation at Pier 469.17 ft

PIER NAME: PIER 12

Computation Method: HEC-18

Pier Scour Depth 15.83 ft

Total Scour at Pier 18.08 ft

Total Scour Elevation at Pier 484.25 ft

PIER NAME: PIER 11

Computation Method: HEC-18

Pier Scour Depth 17.82 ft

Total Scour at Pier 20.07 ft

Total Scour Elevation at Pier 482.26 ft

PIER NAME: PIER 10

Computation Method: HEC-18

Pier Scour Depth 15.83 ft

Total Scour at Pier 18.08 ft

Total Scour Elevation at Pier 484.25 ft

PIER NAME: PIER 9

Computation Method: HEC-18

Pier Scour Depth 15.83 ft

Total Scour at Pier 18.08 ft

Total Scour Elevation at Pier 484.25 ft

PIER NAME: PIER 8

Computation Method: HEC-18

Pier Scour Depth 14.78 ft

Total Scour at Pier 17.03 ft

Total Scour Elevation at Pier 485.30 ft

PIER NAME: PIER 7

Computation Method: HEC-18

Pier Scour Depth 14.78 ft

Total Scour at Pier 17.03 ft

Total Scour Elevation at Pier 485.30 ft
PIER NAME: PIER 6
Computation Method: HEC-18
Pier Scour Depth 15.83 ft
Total Scour at Pier 18.08 ft
Total Scour Elevation at Pier 484.25 ft
PIER NAME: PIER 5
Computation Method: HEC-18
Pier Scour Depth 14.78 ft
Total Scour at Pier 17.03 ft
Total Scour Elevation at Pier 485.30 ft
PIER NAME: PIER 4
Computation Method: HEC-18
Pier Scour Depth 13.69 ft
Total Scour at Pier 15.94 ft
Total Scour Elevation at Pier 486.39 ft
PIER NAME: PIER 3
Computation Method: HEC-18
Pier Scour Depth 15.83 ft
Total Scour at Pier 18.08 ft
Total Scour Elevation at Pier 484.25 ft
PIER NAME: PIER 2
Computation Method: HEC-18
Pier Scour Depth 14.78 ft
Total Scour at Pier 17.03 ft
Total Scour Elevation at Pier 485.30 ft
PIER NAME: PIER 1
Computation Method: HEC-18
Pier Scour Depth 13.69 ft
Total Scour at Pier 15.94 ft
Total Scour Elevation at Pier 486.39 ft
LOCAL SCOUR AT ABUTMENTS SUMMARY
LEFT ABUTMENT
Abutment Scour Method: NCHRP Method
Abutment Scour Depth 49.90 ft
Total Scour at Abutment 49.90 ft
Total Scour Elevation at Abutment 496.86 ft
MAIN CHANNEL CONTRACTION SCOUR
Computation Type: Clear-Water or Live-Bed Scour
INPUT PARAMETERS
Average Depth Upstream of Contraction: 44.48 ft
D50: 0.621792 mm
Average Velocity Upstream: 9.36 ft/s
RESULTS OF SCOUR CONDITION
Critical velocity above which bed material of size D and smaller will be transported: 2.67 ft/s

Contraction Scour Condition: Live-Bed
Live Bed and/or Clear Water Input Parameters
Temperature of Water: 60.00 °F
Slope of Energy Grade Line at Approach Section: 0.0007 ft/ft
Flow in Contracted Section: 485856.21 cfs
Flow Upstream that is Transporting Sediment: 473572.06 cfs
Width in Contracted Section: 1056.32 ft
Width Upstream that is Transporting Sediment: 1100.60 ft
Depth Prior to Scour in Contracted Section: 44.53 ft
Unit Weight of Water: 62.40 lb/ft³
Unit Weight of Sediment: 165.00 lb/ft³
RESULTS OF LIVE BED METHOD
Shear Velocity: 1.03 ft/s
Fall Velocity: 0.27 ft/s
Average Depth in Contracted Section after Scour: 46.77 ft
Scour Depth for Live Bed: 2.24 ft
Scour may be limited by armoring. Compute all methods to check.
LEFT BANK CONTRACTION SCOUR
Computation Type: Clear-Water or Live-Bed Scour
INPUT PARAMETERS
Average Depth Upstream of Contraction: 16.22 ft
D50: 0.010058 mm
Average Velocity Upstream: 3.62 ft/s
RESULTS OF SCOUR CONDITION
Critical velocity above which bed material of size D and smaller will be transported: 0.57 ft/s
Contraction Scour Condition: Live-Bed
Live Bed and/or Clear Water Input Parameters
Temperature of Water: 60.00 °F
Slope of Energy Grade Line at Approach Section: 0.0007 ft/ft
Flow in Contracted Section: 98926.37 cfs
Flow Upstream that is Transporting Sediment: 108107.80 cfs
Width in Contracted Section: 1774.12 ft
Width Upstream that is Transporting Sediment: 1841.57 ft
Depth Prior to Scour in Contracted Section: 15.88 ft
Unit Weight of Water: 62.40 lb/ft³

Unit Weight of Sediment: 165.00 lb/ft³

RESULTS OF LIVE BED METHOD

Shear Velocity: 0.62 ft/s

Fall Velocity: 0.00 ft/s

Average Depth in Contracted Section after Scour: 15.42 ft

Scour Depth for Live Bed: -0.46 ft

Scour may be limited by armoring. Compute all methods to check.

RIGHT BANK CONTRACTION SCOUR

Computation Type: Clear-Water or Live-Bed Scour

INPUT PARAMETERS

Average Depth Upstream of Contraction: 4.87 ft

D50: 1.499921 mm

Average Velocity Upstream: 1.27 ft/s

RESULTS OF SCOUR CONDITION

Critical velocity above which bed material of size D and smaller will be transported: 2.47 ft/s

Contraction Scour Condition: Clear-Water

Live Bed and/or Clear Water Input Parameters

Flow in Contracted Section: 242.42 cfs

Bottom Width in Contracted Section: 107.76 ft

Depth Prior to Scour in Contracted Section: 4.74 ft

Results of Clear Water Method

Diameter of the smallest nontransportable particle in the bed material: 1.874901 mm

Average Depth in Contracted Section after Scour: 1.07 ft

Scour Depth: -3.67 ft

PIER DETAILS

Pier Name: Pier 17

PIER SCOUR

Computation Type: HEC-18

INPUT PARAMETERS

Pier Shape: Square Nose

Bed Condition: Clear-Water Scour

Depth Upstream of Pier: 54.97 ft

Velocity Upstream of Pier: 11.17 ft/s

Width of Pier: 4.00 ft

Length of Pier: 8.00 ft

Angle of Attack: 0.00 Degrees

RESULT PARAMETERS

Froude Number Upstream: 0.27

Correction Factor for Pier Nose Shape (K1): 1.10

Correction Factor of Angle of Attack (K2): 1.00

Pier Length to Pier Width (L/a): 2.00

Correction Factor for Bed Condition (K3): 1.10

Scour Depth: 13.69 ft

Pier Name: Pier 16

PIER SCOUR

Computation Type: HEC-18

INPUT PARAMETERS

Pier Shape: Sharp Nose

Bed Condition: Clear-Water Scour

Depth Upstream of Pier: 54.97 ft

Velocity Upstream of Pier: 11.17 ft/s

Width of Pier: 16.00 ft

Length of Pier: 65.35 ft

Angle of Attack: 0.00 Degrees

RESULT PARAMETERS

Froude Number Upstream: 0.27

Correction Factor for Pier Nose Shape (K1): 0.90

Correction Factor of Angle of Attack (K2): 1.00

Pier Length to Pier Width (L/a): 4.08

Correction Factor for Bed Condition (K3): 1.10

Scour Depth: 27.59 ft

Pier Name: Pier 15

PIER SCOUR

Computation Type: HEC-18

INPUT PARAMETERS

Pier Shape: Sharp Nose

Bed Condition: Clear-Water Scour

Depth Upstream of Pier: 54.97 ft

Velocity Upstream of Pier: 11.17 ft/s

Width of Pier: 24.00 ft

Length of Pier: 72.99 ft

Angle of Attack: 0.00 Degrees

RESULT PARAMETERS

Froude Number Upstream: 0.27

Correction Factor for Pier Nose Shape (K1): 0.90

Correction Factor of Angle of Attack (K2): 1.00

Pier Length to Pier Width (L/a): 3.04

Correction Factor for Bed Condition (K3): 1.10

Scour Depth: 35.91 ft

Pier Name: Pier 14

PIER SCOUR

Computation Type: HEC-18

INPUT PARAMETERS

Pier Shape: Sharp Nose

Bed Condition: Clear-Water Scour

Depth Upstream of Pier: 54.97 ft

Velocity Upstream of Pier: 11.17 ft/s

Width of Pier: 28.00 ft

Length of Pier: 73.11 ft

Angle of Attack: 0.00 Degrees

RESULT PARAMETERS

Froude Number Upstream: 0.27

Correction Factor for Pier Nose Shape (K1): 0.90

Correction Factor of Angle of Attack (K2): 1.00

Pier Length to Pier Width (L/a): 2.61

Correction Factor for Bed Condition (K3): 1.10

Scour Depth: 39.69 ft

Pier Name: Pier 13

PIER SCOUR

Computation Type: HEC-18

INPUT PARAMETERS

Pier Shape: Square Nose

Bed Condition: Clear-Water Scour

Depth Upstream of Pier: 54.97 ft

Velocity Upstream of Pier: 11.17 ft/s

Width of Pier: 14.00 ft

Length of Pier: 22.00 ft

Angle of Attack: 0.00 Degrees

RESULT PARAMETERS

Froude Number Upstream: 0.27

Correction Factor for Pier Nose Shape (K1): 1.10

Correction Factor of Angle of Attack (K2): 1.00

Pier Length to Pier Width (L/a): 1.57

Correction Factor for Bed Condition (K3): 1.10

Scour Depth: 30.92 ft

Pier Name: Pier 12

PIER SCOUR

Computation Type: HEC-18

INPUT PARAMETERS

Pier Shape: Square Nose

Bed Condition: Clear-Water Scour

Depth Upstream of Pier: 54.97 ft

Velocity Upstream of Pier: 11.17 ft/s

Width of Pier: 5.00 ft

Length of Pier: 12.00 ft

Angle of Attack: 0.00 Degrees

RESULT PARAMETERS

Froude Number Upstream: 0.27

Correction Factor for Pier Nose Shape (K1): 1.10

Correction Factor of Angle of Attack (K2): 1.00

Pier Length to Pier Width (L/a): 2.40

Correction Factor for Bed Condition (K3): 1.10

Scour Depth: 15.83 ft

Pier Name: Pier 11

PIER SCOUR

Computation Type: HEC-18

INPUT PARAMETERS

Pier Shape: Square Nose

Bed Condition: Clear-Water Scour

Depth Upstream of Pier: 54.97 ft

Velocity Upstream of Pier: 11.17 ft/s

Width of Pier: 6.00 ft

Length of Pier: 12.00 ft

Angle of Attack: 0.00 Degrees

RESULT PARAMETERS

Froude Number Upstream: 0.27

Correction Factor for Pier Nose Shape (K1): 1.10

Correction Factor of Angle of Attack (K2): 1.00

Pier Length to Pier Width (L/a): 2.00

Correction Factor for Bed Condition (K3): 1.10

Scour Depth: 17.82 ft

Pier Name: Pier 10

PIER SCOUR

Computation Type: HEC-18

INPUT PARAMETERS

Pier Shape: Square Nose

Bed Condition: Clear-Water Scour

Depth Upstream of Pier: 54.97 ft

Velocity Upstream of Pier: 11.17 ft/s

Width of Pier: 5.00 ft

Length of Pier: 12.00 ft

Angle of Attack: 0.00 Degrees

RESULT PARAMETERS

Froude Number Upstream: 0.27

Correction Factor for Pier Nose Shape (K1): 1.10

Correction Factor of Angle of Attack (K2): 1.00

Pier Length to Pier Width (L/a): 2.40

Correction Factor for Bed Condition (K3): 1.10

Scour Depth: 15.83 ft

Pier Name: Pier 9

PIER SCOUR

Computation Type: HEC-18

INPUT PARAMETERS

Pier Shape: Square Nose

Bed Condition: Clear-Water Scour

Depth Upstream of Pier: 54.97 ft

Velocity Upstream of Pier: 11.17 ft/s

Width of Pier: 5.00 ft

Length of Pier: 8.00 ft

Angle of Attack: 0.00 Degrees

RESULT PARAMETERS

Froude Number Upstream: 0.27

Correction Factor for Pier Nose Shape (K1): 1.10

Correction Factor of Angle of Attack (K2): 1.00

Pier Length to Pier Width (L/a): 1.60

Correction Factor for Bed Condition (K3): 1.10

Scour Depth: 15.83 ft

Pier Name: Pier 8

PIER SCOUR

Computation Type: HEC-18

INPUT PARAMETERS

Pier Shape: Square Nose

Bed Condition: Clear-Water Scour

Depth Upstream of Pier: 54.97 ft

Velocity Upstream of Pier: 11.17 ft/s

Width of Pier: 4.50 ft

Length of Pier: 9.00 ft

Angle of Attack: 0.00 Degrees

RESULT PARAMETERS

Froude Number Upstream: 0.27

Correction Factor for Pier Nose Shape (K1): 1.10

Correction Factor of Angle of Attack (K2): 1.00

Pier Length to Pier Width (L/a): 2.00

Correction Factor for Bed Condition (K3): 1.10

Scour Depth: 14.78 ft

Pier Name: Pier 7

PIER SCOUR

Computation Type: HEC-18

INPUT PARAMETERS

Pier Shape: Square Nose

Bed Condition: Clear-Water Scour

Depth Upstream of Pier: 54.97 ft

Velocity Upstream of Pier: 11.17 ft/s

Width of Pier: 4.50 ft

Length of Pier: 9.00 ft

Angle of Attack: 0.00 Degrees

RESULT PARAMETERS

Froude Number Upstream: 0.27

Correction Factor for Pier Nose Shape (K1): 1.10

Correction Factor of Angle of Attack (K2): 1.00

Pier Length to Pier Width (L/a): 2.00

Correction Factor for Bed Condition (K3): 1.10

Scour Depth: 14.78 ft

Pier Name: Pier 6

PIER SCOUR

Computation Type: HEC-18

INPUT PARAMETERS

Pier Shape: Square Nose

Bed Condition: Clear-Water Scour

Depth Upstream of Pier: 54.97 ft

Velocity Upstream of Pier: 11.17 ft/s

Width of Pier: 5.00 ft

Length of Pier: 7.00 ft

Angle of Attack: 0.00 Degrees

RESULT PARAMETERS

Froude Number Upstream: 0.27

Correction Factor for Pier Nose Shape (K1): 1.10

Correction Factor of Angle of Attack (K2): 1.00

Pier Length to Pier Width (L/a): 1.40

Correction Factor for Bed Condition (K3): 1.10

Scour Depth: 15.83 ft

Pier Name: Pier 5

PIER SCOUR

Computation Type: HEC-18

INPUT PARAMETERS

Pier Shape: Square Nose

Bed Condition: Clear-Water Scour

Depth Upstream of Pier: 54.97 ft

Velocity Upstream of Pier: 11.17 ft/s

Width of Pier: 4.50 ft

Length of Pier: 9.00 ft

Angle of Attack: 0.00 Degrees

RESULT PARAMETERS

Froude Number Upstream: 0.27

Correction Factor for Pier Nose Shape (K1): 1.10

Correction Factor of Angle of Attack (K2): 1.00

Pier Length to Pier Width (L/a): 2.00

Correction Factor for Bed Condition (K3): 1.10

Scour Depth: 14.78 ft

Pier Name: Pier 4

PIER SCOUR

Computation Type: HEC-18

INPUT PARAMETERS

Pier Shape: Square Nose

Bed Condition: Clear-Water Scour

Depth Upstream of Pier: 54.97 ft

Velocity Upstream of Pier: 11.17 ft/s

Width of Pier: 4.00 ft

Length of Pier: 8.00 ft

Angle of Attack: 0.00 Degrees

RESULT PARAMETERS

Froude Number Upstream: 0.27

Correction Factor for Pier Nose Shape (K1): 1.10

Correction Factor of Angle of Attack (K2): 1.00

Pier Length to Pier Width (L/a): 2.00

Correction Factor for Bed Condition (K3): 1.10

Scour Depth: 13.69 ft

Pier Name: Pier 3

PIER SCOUR

Computation Type: HEC-18

INPUT PARAMETERS

Pier Shape: Square Nose
Bed Condition: Clear-Water Scour
Depth Upstream of Pier: 54.97 ft
Velocity Upstream of Pier: 11.17 ft/s
Width of Pier: 5.00 ft
Length of Pier: 7.00 ft
Angle of Attack: 0.00 Degrees
RESULT PARAMETERS
Froude Number Upstream: 0.27
Correction Factor for Pier Nose Shape (K1): 1.10
Correction Factor of Angle of Attack (K2): 1.00
Pier Length to Pier Width (L/a): 1.40
Correction Factor for Bed Condition (K3): 1.10
Scour Depth: 15.83 ft
Pier Name: Pier 2
PIER SCOUR
Computation Type: HEC-18
INPUT PARAMETERS
Pier Shape: Square Nose
Bed Condition: Clear-Water Scour
Depth Upstream of Pier: 54.97 ft
Velocity Upstream of Pier: 11.17 ft/s
Width of Pier: 4.50 ft
Length of Pier: 9.00 ft
Angle of Attack: 0.00 Degrees
RESULT PARAMETERS
Froude Number Upstream: 0.27
Correction Factor for Pier Nose Shape (K1): 1.10
Correction Factor of Angle of Attack (K2): 1.00
Pier Length to Pier Width (L/a): 2.00
Correction Factor for Bed Condition (K3): 1.10
Scour Depth: 14.78 ft
Pier Name: Pier 1
PIER SCOUR
Computation Type: HEC-18
INPUT PARAMETERS
Pier Shape: Square Nose
Bed Condition: Clear-Water Scour
Depth Upstream of Pier: 54.97 ft
Velocity Upstream of Pier: 11.17 ft/s
Width of Pier: 4.00 ft
Length of Pier: 8.00 ft
Angle of Attack: 0.00 Degrees
RESULT PARAMETERS
Froude Number Upstream: 0.27
Correction Factor for Pier Nose Shape (K1): 1.10
Correction Factor of Angle of Attack (K2): 1.00
Pier Length to Pier Width (L/a): 2.00

Correction Factor for Bed Condition (K3): 1.10
Scour Depth: 13.69 ft
LEFT ABUTMENT DETAILS
ABUTMENT SCOUR
Computation Type: NCHRP
Input Parameters
NCHRP METHOD
Abutment Type: Spill-through abutment
Angle of Embankment to Flow: 91.11 Degrees
Centerline Length of Embankment: 0.00 ft
Projected Length of Embankment: 0.00 ft
Width of Flood Plain: 0.00 ft
Unit Discharge, Upstream in Main Channel (q1):
64.59 cfs
Unit Discharge in the Constricted Area (q2):
199.11 cfs/ft
D50: 0.010058 mm
Upstream Flow Depth: 16.22 ft
Flow Depth Prior to Scour: 12.96 ft
RESULT PARAMETERS
q2/q1: 3.08
Average Velocity Upstream: 3.98 ft/s
Critical Velocity above which Bed Material of Size
D and Smaller will be Transported: 0.57 ft/s
Scour Condition: Live Bed
Embankment Length/Floodplain Width Ratio:
0.00
Scour Condition: b (overbank)
Amplification Factor: 1.48
Flow Depth including Contraction Scour: 42.57 ft
Maximum Flow Depth including Abutment
Scour: 62.86 ft
Scour Hole Depth from NCHRP Method: 49.90 ft