119285	BEL-00009-1950 (SFN 0701211)	November 19, 2025
PID Number	*Bridge Name*	*Date*

BEL-00009-1950 (SFN: 0701211)

Scour Plan of Action

State Route 9 over Wheeling Creek

Wheeling Township, Belmont County

PID: 119285

Prepared by:

2LMN

2LMN, Inc.

2475 Sugar Grove Rd, SE

Lancaster, OH 43130

STATE OF OHIO
Julia A.
Hart
11/19/2025
E-69738
REGISTERED
PROFESSIONAL ENGINEER

Julia A. Hart

Digitally signed by Julia A. Hart
DN: C=US, E=Julia.Hart@2lmn.com, O="2LMN, Inc.", CN=Julia A. Hart
Reason: I am approving this document
Date: 2025.11.19 12:15:12-05'00'

Prepared for:

Ohio Department of Transportation

Ohio Department of Transportation – District 11

2201 Reiser Ave

New Philadelphia, OH 44663

SCOUR VULNERABLE BRIDGE - PLAN OF ACTION

1. GENERAL INFORMATION

Structure number: 0701211	City, County, State: Fairpoint, Belmont County, Ohio	Waterway: Wheeling Creek
Structure name: BEL-00009-1950	State highway or facility carried: SR 9	Owner: ODOT

Year built: 1984	Year rebuilt: N/A	Bridge replacement plans (if scheduled): N/A Anticipated opening date: N/A

Structure type: ☒ Bridge ☐ Culvert
Structure description: Cont. Reinforced Concrete Slab Bridge w/ Capped Piles Structure.
Structure Size: 30'-0" ~ 37'-6" ~ 30'-0"

Foundations: ☒ Known,
Type: rear abut piling, rear & fwd. pier: HP (12x53); fwd abut: spread footing

Depth: rear abut: 20' (bottom of footing EL. 904.94', datum corrected 904.37'); Capped pile piers, rear pier: 28'; fwd. pier: 29'; fwd abut: bottom of footing EL. 907.66, datum corrected 907.09'

☐ Unknown

Subsurface soil information (*check all that apply*): ☐ Non-cohesive ☒ Cohesive ☐ Rock

Bridge ADT: 1848	Year/ADT: 2015	% Trucks: _____

Does the bridge provide service to emergency facilities and/or an evacuation route (Y/N)? ____
If so, describe: _____

2. RESPONSIBILITY FOR POA

Author(s) of POA (name, title, agency/organization, telephone, pager, email):
Mike Pyles, PE, 2LMN Mike.Pyles@2LMN.com; Julia Hart, PE, 2LMN Julia.Hart@2lmn.com
Date: 8/13/2025

Concurrences on POA (name, title, agency/organization, telephone, pager, email):
Raymond Trivoli, PE, District Bridge Engineer, ODOT District 11, 330-308-6905, Raymond.Trivoli@dot.ohio.gov

POA updated by (name, title, agency, organization): _____ Date of update: ___
Items update: _____

POA to be updated every _____ months by (name, title, agency/organization):_____

Date of next update:_____

3. SCOUR VULNERABILITY

a. Current B.AP.03 Code: ☒ C ☐ D ☐ U Other: _____

b. Source of Scour Vul. Code: ☐ Observed ☐ Appraisal ☐ Calculated Other: _____

c. Scour 9-0 Summary: 6

d. Scour History: _____

4. RECOMMENDED ACTION(S) (see Sections 6 and 7)

	Recommended		Implemented	
a. Increased Inspection Frequency	☐ Yes	☒ No	☐ Yes	☐ No
b. Fixed Monitoring Device(s)	☐ Yes	☒ No	☐ Yes	☐ No
c. Flood Monitoring Program	☐ Yes	☒ No	☐ Yes	☐ No
d. Hydraulic/Structural Countermeasures	☒ Yes	☐ No	☐ Yes	☐ No

5. SNBI CODING INFORMATION

	Current	Previous
B.IE.03 Routine Inspection Completion Date	04/23/2025	08/27/2024
B.C.03 Substructure	4	4
B.C.09 Channel	6	6
B.C.10 Channel Protection	5	Blank
B.AP.02 Overtopping Likelihood	1 – Remote – once every 100 years or less frequently	1 – Remote – once every 100 years or less frequently
Comments: (drift, scour holes, etc. - depict in sketches in Section 10)	_____	_____

6. MONITORING PROGRAM

☒ **Regular Inspection Program** ☐w/surveyed cross sections
Items to Watch: Overtopping of MSE Wall, scouring around pier piles

☐ **Increased Inspection Frequency of __ mo.** ☐w/surveyed cross sections
Items to Watch: _____

☐ **Underwater Inspection Required**
Items to Watch: _____

☐ **Increased Underwater Inspection Frequency of __ mo.**
Items to Watch: _____

☐ **Fixed Monitoring Device(s)**
Type of Instrument: _____
Installation location(s): _____
Sample Interval: ☐ 30 min. ☐ 1 hr. ☐ 6 hrs. ☐ 12 hrs. ☐ Other: _____
Frequency of data download and review: ☐ Daily ☐ Weekly ☐ Monthly ☐ Other _____
Scour alert elevation(s) for each pier/abutment: _____
Scour critical elevations(s) for each pier/abutment:_____
Survey ties: _____
Criteria of termination for fixed monitoring: _____

☒ **Flood Monitoring Program**

Type: ☐ Visual inspection

☐ Instrument (*check all that apply*):

☒ Portable ☐ Geophysical ☐ Sonar ☒ Other: Probing/Check for Overtopping

Flood monitoring required: ☒ Yes ☐ No

Flood monitoring event defined by (*check all that apply*):

☐ Discharge _____ ☐ Stage _____

☐ Elev. measured from _____ ☐ Rainfall _____ (in/mm) per _____ (hour)

☐ Flood forecasting information: _____

☐ Flood warning system: _____

Frequency of flood monitoring: ☐1 hr. ☐3 hrs. ☐6 hrs. ☐ Other: _____

Post-flood monitoring required: ☐ No ☐Yes, within _____ days

Frequency of post-flood monitoring: ☐Daily ☐Weekly ☐Monthly ☐Other: _____

Criteria for termination of flood monitoring: _____

Criteria for termination of post-flood monitoring: _____

Scour alert elevation(s) for each pier/abutment: 908.0 Top of MSE Wall Elev (datum corrected)

Scour critical elevation(s) for each pier/abutment: _____

Note: Additional details for action(s) required may be included in Section 8.

Action(s) required if scour alert elevation detected (*include notification and closure procedures*): _____

Action(s) required if scour critical elevation detected (*include notification and closure procedures*): _____

Agency and department responsible for monitoring: Ohio Department of Transportation, District 11

Contact person (*include name, title, telephone, pager, e-mail*): Raymond Trivoli, PE, District Bridge Engineer, ODOT District 11, 330-308-6905, Raymond.Trivoli@dot.ohio.gov

7. COUNTERMEASURE RECOMMENDATIONS

Prioritize alternatives below. Include information on any hydraulic, structural or monitoring countermeasures.

☐ **Only monitoring required (see Section 6 and Section 10 – Attachment F)**

Estimated cost $_____

☒ **Structural/hydraulic countermeasures considered (see Section 10, Attachment F):**

Priority Ranking	**Estimated cost**
(1) Riprap	$ 43,983
(2) Gabions	$ 34,497
(3) _____	$ _____
(4) _____	$ _____
(5) _____	$ _____

Basis for the selection of the preferred scour countermeasure: The basis for the selection are countermeasures suitable for abutments and piers, constructability constrains, and life cycle costs.

Countermeasure implementation project type:

☐ Proposed Construction Project ☐ Maintenance Project

☐ Programmed Construction - Project Lead Agency:
☐ Bridge Bureau ☐ Road Design ☐ Other _____

Agency and department responsible for countermeasure program (if different from Section 6 contact for monitoring): _____

Contact person (*include name, title, telephone, pager, e-mail*): Raymond Trivoli, PE, District Bridge Engineer, ODOT District 11, 330-308-6905, Raymond.Trivoli@dot.ohio.gov

Target design completion date: _____

Target construction completion date: _____

Countermeasures already completed: _____

8. BRIDGE CLOSURE PLAN

Scour monitoring criteria for consideration of bridge closure:

☐ Water surface elevation reaches _____ at _____
☐ Overtopping road or structure
☐ Scour measurement results / Monitoring device (See Section 6)
☒ Observed structure movement / Settlement
☐ Discharge: _____ cfs/cms
☐ Flood forecast: _____
☒ Other: ☐ Debris accumulation ☐ Movement of riprap/other armor protection
☒ Loss of road embankment

Emergency repair plans (*include source(s), contact(s), cost, installation directions*): _____

Agency and department responsible for closure: Ohio Department of Transportation, District 11

Contact persons (name, title, agency/organization, telephone, pager, email): Raymond Trivoli, PE, District Bridge Engineer, ODOT District 11, 330-308-6905, Raymond.Trivoli@dot.ohio.gov

Criteria for re-opening the bridge: The bridge will require an inspection to ensure that it is structurally sound.

Agency and person responsible for re-opening the bridge after inspection: Raymond Trivoli, PE, District Bridge Engineer, ODOT District 11, 330-308-6905, Raymond.Trivoli@dot.ohio.gov

9. DETOUR ROUTE

Detour route description (route number, from/to, distance from bridge, etc.) - Include map in Section 10, Attachment E.
Total Distance: 14.13mi, Additional Distance: 3.99 mi
Northbound direction: US 40 to SR 331 to SR 149, end detour at SR 9
Southbound direction: SR 149 to SR 331 to US 40, end detour at SR 9
Distance from Bridge: 0.64 mi (Northbound), 3.01 mi (Southbound)

Bridges on Detour Route:

Bridge Number	Waterway	Load Limitations	B.AP.03 Code
3401936	Campbells Run	120	0
0705209	Crabapple Run	125	B
0705136	Wheeling Crk	125	0
0705161	N/A	150	Not over Waterway
0701564	N/A	150	Not over Waterway
0701572	N/A	150	Not over Waterway

Traffic control equipment (detour signing and barriers) and location(s): See attachment E
Additional considerations or critical issues (susceptibility to overtopping, limited waterway adequacy, lane restrictions, etc.) : _____
News release, other public notice (include authorized person(s), information to be provided and limitations): _____

10. ATTACHMENTS

Please indicate which materials are being submitted with this POA:

☒ **Attachment A: Boring logs and/or other subsurface information**

☐ **Attachment B: Cross sections from current and previous inspection reports**

☒ **Attachment C: Bridge elevation showing existing streambed, foundation depth(s) and observed and/or calculated scour depths**

☒ **Attachment D: Plan view showing location of scour holes, debris, etc.**

☒ **Attachment E: Map showing detour route(s)**

☒ **Attachment F: Supporting documentation, calculations, estimates and conceptual designs for scour countermeasures.**

☒ **Attachment G: Photos**

☐ **Attachment H: Other information: _____**

Attachment A:
Boring logs and/or other subsurface information

D05/D06/D11 SNBI Inspection, PID 119285

Bedrock Scour Properties

Bridge	SFN	Spans	Substructure	Boring	GS	TR	Found. Elev.	Foundation Rock	Q_u (psi)	Q_u (MPa)	RQD	J_n	J_r	J_a	J_s	M_s	K_b	K_d	K	Scourable?	τ_c (Pa)	τ_c (psf)	Notes
BEL-7-6.92	0700274	4	Rear Abut.	B-3	678.5	598	669.84/673.35	Limestone	7500	51.71	75	1.50	3.50	2.00	1.00	51.71	50.00	1.75	4524.69	Scour Resistant Rock	17025.66	355.59	Outside of Flow Area - No Abutment Scour Possible
			Pier 1	B-3	654	606.5	644.5/647	Sandstone & Shale	1500	10.34	30	1.50	2.25	3.00	1.00	10.34	20.00	0.75	155.13	Scourable Rock	3152.54	65.84	Pier Scour
			Pier 2	B-6	644	631.7	628	Weathered Shale	1000	6.89	10	1.50	2.00	4.00	1.00	5.92	6.67	0.50	19.74	Scourable Rock	1124.65	23.49	Pier Scour
			Pier 3 L	B-7	650	660	645	Clay Shale & Coal	750	5.17	10	1.50	2.00	4.00	1.00	4.38	6.67	0.50	14.60	Scourable Rock	967.00	20.20	Outside of Flow Area - No Pier Scour Possible
			Pier 3 R	B-7	664	660	654	Limestone	7500	51.71	50	1.50	2.50	4.00	1.00	51.71	33.33	0.63	1077.31	Scourable Rock	8307.67	173.51	Outside of Flow Area - No Pier Scour Possible
			Fwd. Abut.	B-7	690	690	682	Limestone	7500	51.71	30	1.50	2.50	4.00	1.00	51.71	20.00	0.63	646.38	Scourable Rock	6435.09	134.40	Outside of Flow Area - No Abutment Scour Possible
BEL-7-23.67	0700770	1	Rear Abut.	B-3	626.4	626.4	619.79	Sandstone	1500	10.34	50	1.50	3.00	3.00	1.00	10.34	33.33	1.00	344.74	Scourable Rock	4699.53	98.15	Abutment Scour
			Fwd. Abut.	B-3	630	626.4	619.79	Sandstone	1500	10.34	50	1.50	3.00	3.00	1.00	10.34	33.33	1.00	344.74	Scourable Rock	4699.53	98.15	Abutment Scour
BEL-9-7.36	0700886	1	Rear Abut.	B-2	1035	1035.0	1030.25	Shale	1500	10.34	30	1.50	2.25	4.00	1.00	10.34	20.00	0.56	116.35	Scourable Rock	2730.18	57.02	3-Sided Culvert Scour (without wing wall case)
			Fwd. Abut.	B-3	1034	1033.9	1030.25	Shale	1500	10.34	50	1.50	2.25	3.00	1.00	10.34	33.33	0.75	258.55	Scourable Rock	4069.91	85.00	3-Sided Culvert Scour (without wing wall case)
BEL-9-9.64	0700940	1	Rear Abut.	B-1	975.9	975.9	972	Limestone	7500	51.71	65	1.50	3.00	2.00	1.00	51.71	43.33	1.50	3361.20	Scourable Rock	14674.27	306.48	Abutment Scour
			Fwd. Abut.	B-4	975.9	974.5	972	Limestone	7500	51.71	65	1.50	3.00	2.00	1.00	51.71	43.33	1.50	3361.20	Scourable Rock	14674.27	306.48	Abutment Scour
BEL-9-19.30	0701211	3	Rear Abut.	B-1	909.8	884.7	904.95	Shale	71	0.49	10	1.50	2.00	3.50	1.00	0.37	6.67	0.57	1.40	Scourable Rock	299.86	6.26	Abutment Scour. SPT blow count data for bedrock, estimated Qu using GDM 404.3.
			Pier 1	B-1	908.9	886.7	908.9	Shale	90	0.62	10	1.50	2.00	3.50	1.00	0.47	6.67	0.57	1.80	Scourable Rock	339.62	7.09	Pier Scour
			Pier 2	B-2	905.9	889.9	905.9	Shale	109	0.75	10	1.50	2.00	3.50	1.00	0.58	6.67	0.57	2.20	Scourable Rock	375.55	7.84	Pier Scour
			Fwd. Abut.	B-2	905.3	889.8	889.46	Shale	128	0.88	10	1.50	2.00	3.50	1.00	0.68	6.67	0.57	2.61	Scourable Rock	408.60	8.53	Abutment Scour
BEL-70-25.76	0702943	6	Rear Abut.	A-1	664	657.5	683.50	Not Enough Information	-	-	-	-	-	-	-	-	-	-	-	-	-	-	Outside of Flow Area - No Abutment Scour Possible
			Pier 1	B-4	664	648.3	656.00	Shale	1500	10.34	30	1.50	2.25	2.00	1.00	10.34	20.00	1.13	232.70	Scourable Rock	3861.06	80.64	Outside of Flow Area - No Pier Scour Possible
			Pier 2	A-3,B-9	664	646.7	656.00	Sandstone	2250	15.51	50	1.50	3.00	2.00	1.00	15.51	33.33	1.50	775.66	Scourable Rock	7049.29	147.23	Outside of Flow Area - No Pier Scour Possible
			Pier 3		666	632.0	659.00	Not Enough Information	-	-	-	-	-	-	-	-	-	-	-	-	-	-	Outside of Flow Area - No Pier Scour Possible
			Pier 4	B-13	635	620.3	620.00	Shale	1000	6.89	10	1.50	2.00	3.00	1.00	5.92	6.67	0.67	26.32	Scourable Rock	1298.64	27.12	Pier Scour
			Pier 5	A-4,A-5,B-18	636	612.0	620.00	Claystone	700	4.83	10	1.50	2.00	4.00	1.00	4.07	6.67	0.50	13.58	Scourable Rock	932.60	19.48	Pier Scour
			Fwd. Abut.	A-6	635	617	663.00	Not Enough Information	-	-	-	-	-	-	-	-	-	-	-	-	-	-	Not Enough Information. New boring recommeded.
BEL-70-26.85	0703095	7	Rear Abut.	227,229,230,3	643.2	612.5	675.0	Sandstone	1000	6.89	10	1.50	2.50	4.00	1.00	5.92	6.67	0.63	24.68	Scourable Rock	1257.40	26.26	Abutment Scour
			Pier 1	231, 40	643.2	611.3	638.0/633.5	Sandstone	1000	6.89	10	1.50	2.50	4.00	1.00	5.92	6.67	0.63	24.68	Scourable Rock	1257.40	26.26	Pier Scour
			Pier 2	41	641.7	610.9	634.0	Sandstone	1500	10.34	20	1.50	2.50	3.50	1.00	10.34	13.33	0.71	98.50	Scourable Rock	2512.00	52.46	Pier Scour. See soil overburden tab. New boring recommeded.
			Pier 3	B-4,B-5,B-6,23	622.8	612.3	610.0	Sandstone	1500	10.34	50	1.50	3.00	2.50	1.00	10.34	33.33	1.20	413.69	Scourable Rock	5148.07	107.52	Pier Scour
			Pier 4	B-1,B-2,B-3,23	623.7	615.5	610.0	Siltstone	1000	6.89	35	1.50	2.75	3.00	1.00	5.92	23.33	0.92	126.69	Scourable Rock	2848.88	59.50	Pier Scour
			Pier 5	B-15	650.5	613.0	610.0/639.5	Sandstone	1500	10.34	65	1.50	3.00	2.50	1.00	10.34	43.33	1.20	537.79	Scourable Rock	5869.71	122.59	Pier Scour
			Pier 6	(None)	653.2	-	639.5/645.0	Not Enough Information	-	-	-	-	-	-	-	-	-	-	-	-	-	-	Not Enough Information. New boring recommeded.
			Pier 7	(None)	634.0	-	605	Not Enough Information	-	-	-	-	-	-	-	-	-	-	-	-	-	-	Not Enough Information. New boring recommeded.

D05/D06/D11 SNBI Inspection, PID 119285

Soil Scour Properties

Bridge	SFN	Spans	Substructure	Boring	GS	TR	Found. Elev.	Soil Layer	Top Elev.	Bottom Elev.	Soil Class	N_{60}	Agg %	CS %	FS %	Silt %	Clay %	D_{50} (mm)	F (%)	PI (%)	w (%)	q_u (psf)	τ_c (psf)	τ_c (Pa)	$D_{50,equiv}$ (mm)	EC Coeff.	Notes
BEL-7-6.92	0700274	4	Rear Abut.	B-3	678.5	598	669.84/673.35	0	650	660	N/A	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	Outside of Flow Area - No Abutment Scour Possible
			Pier 1	B-3	654	606.5	644.5/647	1	654	643.8	A-6a	20	32	7	11	29	22	0.0705	51	12	18	5000	0.1520	7.2763	7.2763	3.14	Embankment Fill
								2	643.8	633.8	A-2-6	18	54	9	12	10	16	2.5385	26	14	22	4375	0.0310	1.4846	1.4846	3.34	Cohesive w/D50 greater than 0.2mm. See OGE's email 1/23/25 for additional information. It would be advantageous to represent this layer with the D50 (2.539mm) rather than Tc (1.485 PS)
								3	633.8	631.3	A-6a	7	34	11	19	16	20	0.2692	36	11	18	1750	0.0450	2.1540	2.1540	3.07	Cohesive w/D50 greater than 0.2mm. See OGE's email 1/23/25 for additional information
								4	631.3	620	A-2-4	18	37	12	20	13	18	0.4007	31	7	14	0	0.0084	0.4007	0.4007	1.72	Granular
								5	620	608.8	A-1-b	45	49	10	18	9	15	1.6153	24	1	12	0	0.0337	1.6153	1.6153	2.45	Granular
								6	608.8	606.5	A-4a	35	33	7	15	28	17	0.1337	45	9	22	8750	0.0690	3.3041	3.3041	2.87	Cohesive
			Pier 2	B-6	644	631.7	628	1	644	641.7	A-6a	15	35	8	11	25	21	0.1409	46	12	17	3750	0.1251	5.9886	5.9886	3.17	Cohesive
								2	641.7	636.7	A-2-4	32	38	12	18	13	19	0.4250	32	0	16	0	0.0089	0.4250	0.4250	1.75	Granular
								3	636.7	634.2	A-6a	36	27	1	2	46	24	0.0231	70	12	18	9000	0.3667	17.5566	17.5566	3.17	Cohesive
								4	634.2	631.7	A-4a	41	34	3	4	33	26	0.0358	59	8	16	10250	0.2050	9.8158	9.8158	2.75	Cohesive
			Pier 3 L	B-7	650	660	645	0	650	660	N/A	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	Outside of Flow Area - No Pier Scour Possible
			Pier 3 R	B-7	664	660	654	0	664	660	N/A	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	Outside of Flow Area - No Pier Scour Possible
			Fwd. Abut.	B-7	690	690	682	0	690	690	N/A	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	Outside of Flow Area - No Abutment Scour Possible
BEL-7-23.67	0700770	1	Rear Abut.	B-3	626.4	626.4	619.79	0	626.4	626.4	N/A	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	No Soil at this Location - See Bedrock
			Fwd. Abut.	B-3	630	626.4	619.79	1	630	626.4	A-7-6	15	3	1	8	38	51	0.0048	89	16	32	3750	0.1921	9.1961	9.1961	3.48	Cohesive
BEL-9-7.36	0700886	1	Rear Abut.	B-2	1035	1035	1030.25	0	1035	1035	N/A	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	No Soil at this Location - See Bedrock
			Fwd. Abut.	B-3	1034	1033.9	1030.25	0	1033.9	1033.9	N/A	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	No Soil at this Location - See Bedrock
BEL-9-9.64	0700940	1	Rear Abut.	B-1	975.9	975.9	972	0	975.9	975.9	N/A	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	No Soil at this Location - See Bedrock
			Fwd. Abut.	B-4	975.9	974.5	972	1	975.9	974.5	A-2-4	100	31	15	19	23	12	0.2950	35	0	22	0	0.0062	0.2950	0.2950	1.56	Granular
BEL-9-19.30	0701211	3	Rear Abut.	B-1	909.8	884.7	904.95	1	909.8	903.7	A-7-6	4	25	16	15	19	25	0.1501	44	27	37	1000	0.0409	1.9563	1.9563	4.02	Cohesive
								2	903.7	898.7	A-4a	4	22	17	16	21	24	0.1290	45	4	31	1000	0.0051	0.2435	0.2435	2.21	Cohesive
								3	898.7	893.7	A-7-5	4	42	13	22	10	13	0.7711	23	12	11	1000	0.0440	2.1075	2.1075	3.17	Cohesive
								4	893.7	888.7	A-1-b	18	17	29	21	15	18	0.3054	33	0	16	0	0.0064	0.3054	0.3054	1.58	Granular
								5	888.7	884.7	A-3a	47	39	10	4	26	21	0.2755	47	0	6	0	0.0058	0.2755	0.2755	1.53	Granular
			Pier 1	B-1	908.9	886.7	908.9	1	908.9	903.7	A-7-6	4	25	16	15	19	25	0.1501	44	27	37	1000	0.0409	1.9563	1.9563	4.02	Cohesive
								2	903.7	898.7	A-4a	4	22	17	16	21	24	0.1290	45	4	31	1000	0.0051	0.2435	0.2435	2.21	Cohesive
								3	898.7	893.7	A-7-5	4	42	13	22	10	13	0.7711	23	12	11	1000	0.0440	2.1075	2.1075	3.17	Cohesive
								4	893.7	888.7	A-1-b	18	17	29	21	15	18	0.3054	33	0	16	0	0.0064	0.3054	0.3054	1.58	Granular
								5	888.7	886.7	A-3a	47	39	10	4	26	21	0.2755	47	0	6	0	0.0058	0.2755	0.2755	1.53	Granular
			Pier 2	B-2	905.9	889.9	905.9	1	905.9	903.6	A-7-6	4	8	4	7	22	59	0.0039	81	27	22	1000	0.3916	18.7523	18.7523	4.02	Cohesive
								2	903.6	898.6	A-6b	10	19	6	6	21	48	0.0065	69	18.5	22	2500	0.2508	12.0090	12.0090	3.64	Cohesive
								3	898.6	893.6	A-4a	5	0	0	38	32	30	0.0272	62	10	28	1250	0.0426	2.0389	2.0389	2.97	Cohesive
								4	893.6	889.9	A-1-a	23	79	3	6	4	8	6.5193	12	0	19	0	0.1362	6.5193	6.5193	3.18	Granular. Estimated D50, see email from OGE 1/23/25 for more information.
			Fwd. Abut.	B-2	905.3	889.8	889.46	1	905.3	903.6	A-7-6	4	8	4	7	22	59	0.0039	81	27	22	1000	0.3916	18.7523	18.7523	4.02	Cohesive
								2	903.6	898.6	A-6b	10	19	6	6	21	48	0.0065	69	18.5	22	2500	0.2508	12.0090	12.0090	3.64	Cohesive
								3	898.6	893.6	A-4a	5	0	0	38	32	30	0.0272	62	10	28	1250	0.0426	2.0389	2.0389	2.97	Cohesive
								4	893.6	889.8	A-1-a	23	79	3	6	4	8	6.5193	12	0	19	0	0.1362	6.5193	6.5193	3.18	Granular. Estimated D50, see email from OGE 1/23/25 for more information.
BEL-70-25.76	0702943	6	Pier 4	B-13	635	620.3	620	1	635	631.3	A-4a	19	27	10	8	17	38	0.0338	55	7	14	4750	0.1438	6.8854	6.8854	2.63	Cohesive
								2	631.3	626.3	A-1-a	14	74	10	9	2	5	5.6809	7	0	18	0	0.1186	5.6809	5.6809	3.11	Granular. Estimated D50, see email from OGE 1/23/25 for more information.
								3	626.3	621.3	A-2-4	50	43	18	10	11	18	1.0951	29	10	10	0	0.0229	1.0951	1.0951	2.25	Granular
								4	621.3	620.3	A-4a	55	14	1	3	34	48	0.0059	82	6	15	13750	0.3486	16.6924	16.6924	2.50	Cohesive
			Pier 5	B-18	636	612	620	1	636	632	A-4a	15	27	10	8	17	38	0.0338	55	7	14	3750	0.1308	6.2642	6.2642	2.63	Cohesive (Visually Classified A-4a w/ stone fragments)
								2	632	627	A-2-4	12	59	7	8	12	14	3.2679	26	7	35	0	0.0683	3.2679	3.2679	2.82	Granular. Estimated D50, see email from OGE 1/23/25 for more information.
								3	627	622	A-1-a	24	79	8	6	3	4	6.5193	7	0	19	0	0.1362	6.5193	6.5193	3.18	Granular. Estimated D50, see email from OGE 1/23/25 for more information.
								4	622	621	A-1-a	28	71	7	12	3	7	5.1821	10	0	7	0	0.1082	5.1821	5.1821	3.06	Granular. Estimated D50, see email from OGE 1/23/25 for more information.

D05/D06/D11 SNBI Inspection, PID 119285

Soil Scour Properties

Bridge	SFN	Spans	Substructure	Boring	GS	TR	Found. Elev.	Soil Layer	Top Elev.	Bottom Elev.	Soil Class	N_{60}	Agg %	CS %	FS %	Silt %	Clay %	D_{50} (mm)	F (%)	PI (%)	w (%)	q_u (psf)	τ_c (psf)	τ_c (Pa)	$D_{50,equiv}$ (mm)	EC Coeff.	Notes
								5	621	612	A-1-a	100	82	6	5	4	3	7.0237	7	0	7	0	0.1467	7.0237	7.0237	3.22	Granular (Visually classified sanstone/limestone cobbles & fragments). If calculated scour reaches this layer, this layer becomes critical to the scour analysis, it would probably be best to take another boring here.
BEL-70-26.85	0703095	7	Rear Abut.	229	643.2	612.5	675.0	1	643.2	640.6	A-6b	9	43	7	5	16	29	0.4250	45	19	27	2250	0.0703	3.3659	3.3659	3.67	Cohesive
								2	640.6	630.6	A-1-a	17	63	16	10	3	8	3.8859	11	0	27	0	0.0812	3.8859	3.8859	2.91	Granular. Estimated D50, see email from OGE 1/23/25 for more information.
								3	630.6	620.6	A-7-5	20	0	1	2	41	56	0.0042	97	19	32	5000	0.3200	15.3238	15.3238	3.67	Cohesive
								4	620.6	615.6	A-7-6	10	0	2	6	36	56	0.0042	92	24	35	2500	0.2471	11.8317	11.8317	3.91	Cohesive
								5	615.6	612.5	A-7-6	11	0	1	5	41	53	0.0046	94	23	32	2750	0.3033	14.5242	14.5242	3.87	Cohesive
			Pier 1	231	643.2	611.3	638.0/633.5	1	643.2	636.3	A-3a	8	39	10	4	26	21	0.2755	47	0	6	0	0.0058	0.2755	0.2755	1.53	Granular (Visually classified cinders, coal, silt, bricks, gravel, cobbles)
								2	636.3	631.3	A-4a	24	14	21	17	22	26	0.0920	48	4	32	2000	0.0072	0.3431	0.3431	2.21	Cohesive
								3	631.3	626.3	A-7-6	22	0	1	5	43	51	0.0048	94	22	31	5500	0.4026	19.2745	19.2745	3.82	Cohesive
								4	626.3	621.3	A-7-6	22	0	0	4	42	54	0.0044	96	19	34	5500	0.2885	13.8123	13.8123	3.67	Cohesive
								5	621.3	616.3	A-6b	15	0	0	8	44	48	0.0057	92	17	29	3750	0.2704	12.9459	12.9459	3.55	Cohesive
								6	616.3	611.3	A-6a	20	0	0	10	45	45	0.0068	90	14	29	5000	0.2256	10.7994	10.7994	3.34	Cohesive
			Pier 2	41	641.7	610.9	634	1	641.7	635.5	A-6b	15	43	7	5	16	29	0.4250	45	19	23	3750	0.1188	5.6901	5.6901	3.67	Cohesive. One one historic boring (No. 41) which had no soil information. Alex used soil borings from adjacent substructures to estimate the soils, but they are a best guess. May want to drill here again.
								2	635.5	630.5	A-4a	59	14	21	17	22	26	0.0920	48	4	35	14750	0.0133	0.6378	0.6378	2.21	Cohesive
								3	630.5	625.5	A-4a	43	14	21	17	22	26	0.0920	48	4	26	10750	0.0213	1.0184	1.0184	2.21	Cohesive
								4	625.5	620.5	A-7-5	18	0	1	2	41	56	0.0042	97	19	34	4500	0.2718	13.0139	13.0139	3.67	Cohesive
								5	620.5	615.5	A-7-6	24	0	2	6	36	56	0.0042	92	24	40	6000	0.2685	12.8572	12.8572	3.91	Cohesive
								6	615.5	610.9	A-7-6	14	0	1	5	41	53	0.0046	94	23	31	3500	0.3560	17.0436	17.0436	3.87	Cohesive
			Pier 3	B-5,B-6	622.8	612.3	610	1	622.8	619.5	A-7-6	8	0	0	8	48	44	0.0070	92	17	39	2000	0.1163	5.5667	5.5667	3.55	Cohesive
								2	619.5	617.0	A-7-6	19	0	0	5	47	48	0.0056	95	18	37	4750	0.2097	10.0400	10.0400	3.61	Cohesive
								3	617.0	615.5	A-6a	12	0	1	20	47	32	0.0141	79	13	34	3000	0.0936	4.4815	4.4815	3.26	Cohesive
								4	615.5	613.0	A-6a	5	11	4	24	36	25	0.0328	61	13	42	1250	0.0258	1.2337	1.2337	3.26	Cohesive
								5	613.0	612.3	A-1-b	22	36	18	21	17	8	0.5996	25	0	15	0	0.0125	0.5996	0.5996	1.93	Granular
			Pier 4	B-3	623.7	615.5	610	1	623.7	621.5	A-6a	15	0	3	19	52	26	0.0174	78	13	37	3750	0.0842	4.0335	4.0335	3.26	Cohesive
								2	621.5	620.0	A-6b	13	27	2	10	42	19	0.0369	61	17	34	3250	0.0817	3.9102	3.9102	3.55	Cohesive
								3	620.0	618.5	A-7-6	23	28	3	10	39	20	0.0401	59	17	35	5750	0.0906	4.3369	4.3369	3.55	Cohesive
								4	618.5	617.0	A-7-6	18	10	0	7	54	29	0.0143	83	18	31	4500	0.2231	10.6839	10.6839	3.61	Cohesive
								5	617.0	615.5	A-6b	24	37	4	9	32	18	0.0750	50	16	33	6000	0.0688	3.2937	3.2937	3.48	Cohesive
			Pier 5	B-15	650.5	613.0	610.0/639.5	1	650.5	646.0	A-3a	5	39	10	4	26	21	0.2755	47	0	6	0	0.0058	0.2755	0.2755	1.53	Granular (Visually classified FILL)
								2	646.0	641.0	A-1-b	5	30	24	22	14	10	0.5502	24	0	39	0	0.0115	0.5502	0.5502	1.89	Granular
								3	641.0	636.0	A-2-4	18	47	15	9	20	9	1.4672	29	0	34	0	0.0306	1.4672	1.4672	2.40	Granular
								4	636.0	631.0	A-6a	33	30	7	8	30	25	0.0478	55	11	18	8250	0.1952	9.3482	9.3482	3.07	Cohesive
								5	631.0	626.0	A-2-4	60	65	10	7	13	5	4.2037	18	9	25	0	0.0878	4.2037	4.2037	2.95	Granular. Estimated D50, see email from OGE 1/23/25 for more information.
								6	626.0	621.0	A-6a	11	0	1	23	49	27	0.0178	76	12	37	2750	0.0637	3.0482	3.0482	3.17	Cohesive
								7	621.0	616.0	A-7-6	33	0	0	12	54	34	0.0112	88	18	31	8250	0.3197	15.3050	15.3050	3.61	Cohesive
								8	616.0	613.0	A-6a	18	0	0	20	57	23	0.0180	80	14	32	4500	0.1403	6.7187	6.7187	3.34	Cohesive

Blue Highlight - D50 <0.2mm provided, but not recognized by FHWA or OHE. Based on current standards, D50=0.2mm should be used.

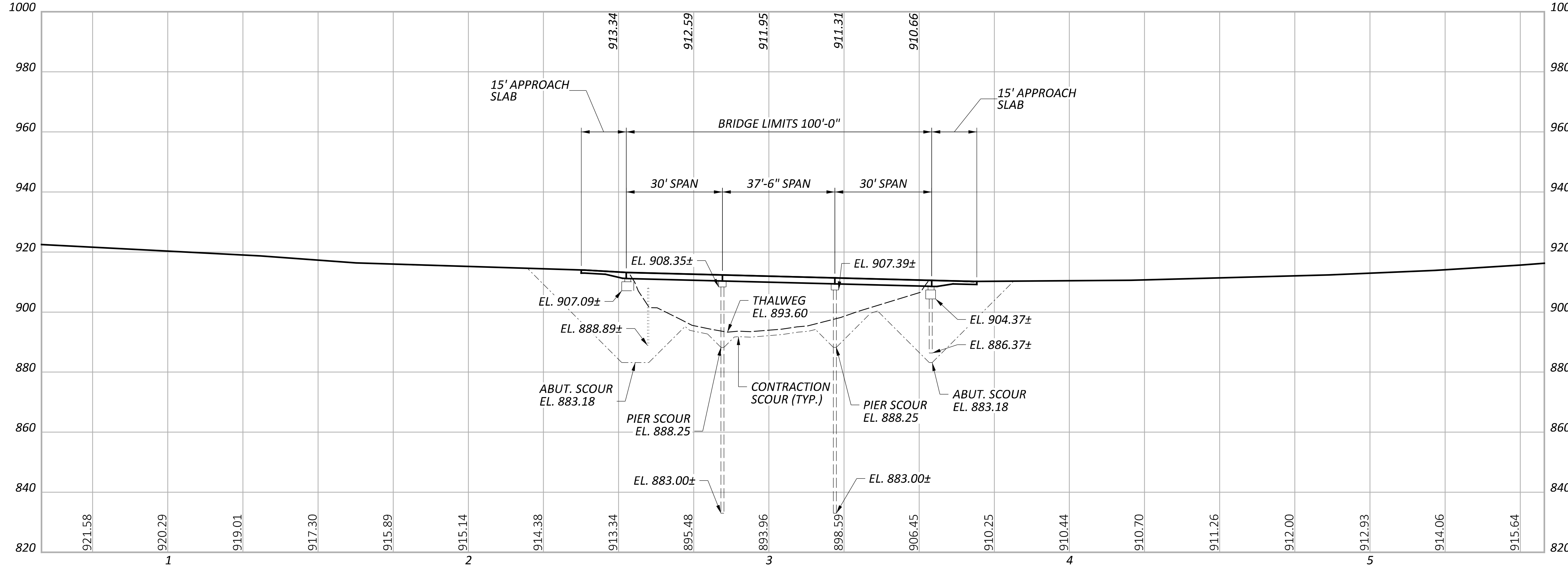
If any structures are shown to be scour critical because of the scour of cohesive soils, it may force us to collect undisturbed samples and subject them to laboratory flume testing to directy measure Tc, which is allow and recongized by OHE and FHWA. Or we could wait on the results of OGE's research project and possibly re-evalute using revised scour parameters.

Attachment B:
Cross sections from current and previous inspection reports

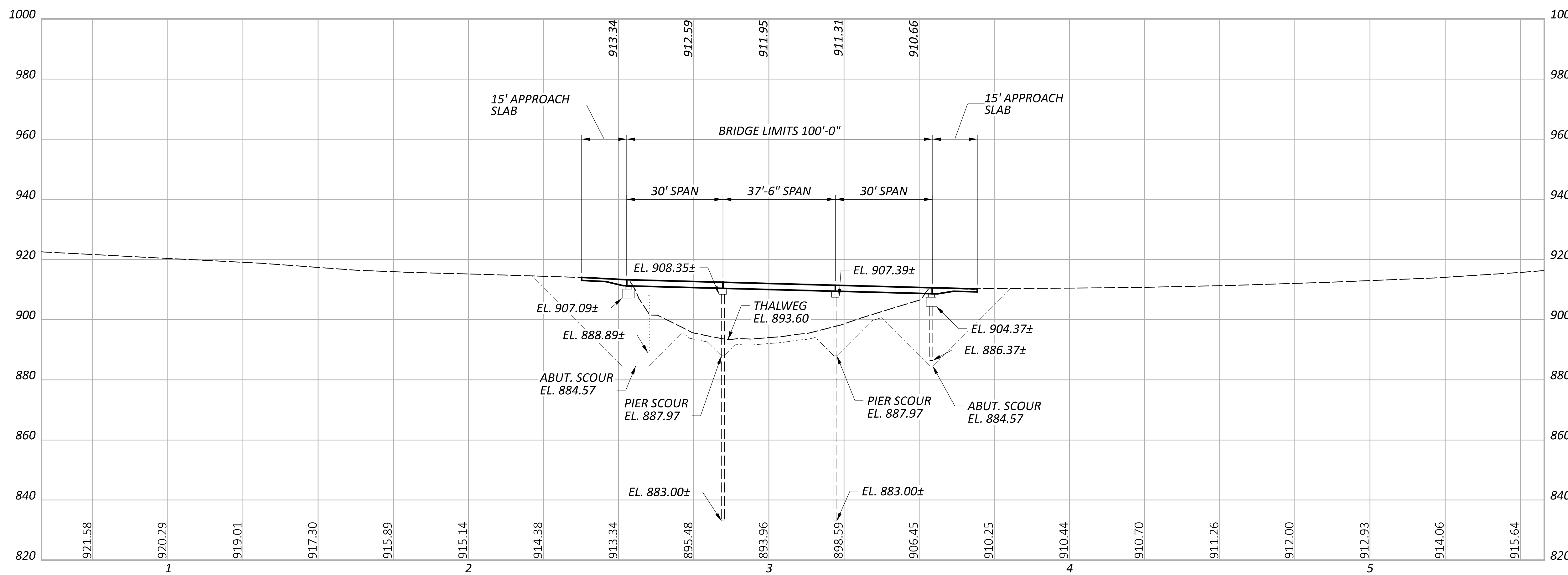
None available

Attachment C:
Bridge elevation showing existing streambed, foundation depth(s) and observed and/or calculated scour depths

NOTES:
1. *ALL EXISTING PILING IS HP12X53.*
2. *ALL DIMENSIONS ARE FROM EXISTING PLANS AND ARE ±.*
3. *BOTTOM FOOTING AND PILING ELEVATIONS ARE FROM EXISTING PLANS AND ARE DATUM CORRECTED AND SHOULD BE CONSIDERED ±.*



SFN 0701211 PROFILE ALONG ℄ SR 9 - SCOUR PLOT FOR 2% AEP

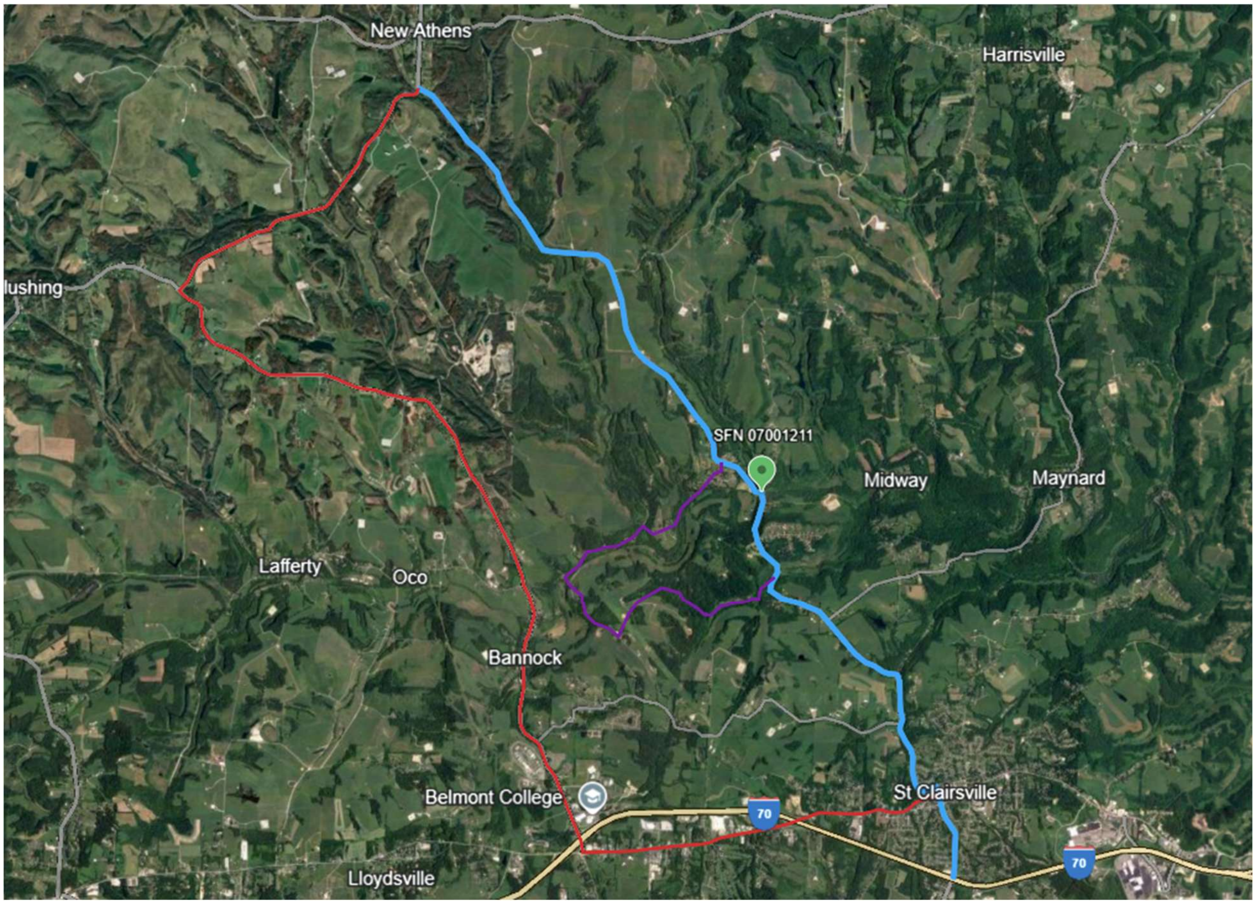


SFN 0701211 PROFILE ALONG ℄ SR 9 - SCOUR PLOT FOR 1% AEP

Attachment D:
Plan view showing location of scour holes, debris, etc.
To be provided by Palmer

Attachment E:
Map showing detour route(s)

Proposed Detour (SFN 0701211)



: **State Route Detour**

: **Normal Route**

: **Local (Unsigned) Detour**

State Route Detour:

Length: 14.13 mi

Additional Length: 3.99 mi

Description:

Northbound: US 40 to SR 331 to SR 149, end detour at SR 9

Southbound: SR 149 to SR 331 to US 40, end detour at SR 9

Local (Unsigned) Detour:

Length: 4.84 mi

Additional Length: 3.47 mi

Description:

Northbound: Pogue Rd to Lee Rd to Crabapple Rd to Columbia St, end detour at SR 9

Southbound: Columbia St to Crabapple Rd to Lee Rd to Pogue Rd, end detour at SR 9

BRIDGE INFO:

Bridge	Waterway	Load Limitations	B.AP.03 Code
3401936	Campbells Run	120	0
0705209	Crabapple Run	125	B
0705136	Wheeling Crk	125	0
0705161	N/A	150	Not over Waterway
0701564	N/A	150	Not over Waterway
0701572	N/A	150	Not over Waterway

Detour Signage:

2

2

22

12

12

24

4

2

4

2

“Road Closed Ahead” (W20-3-36): 2
“Arrow Pointing Up” (M6-3-30): 11

Attachment F:
Supporting documentation, calculations, estimates and conceptual designs for scour countermeasures.

SFN 0701211 - Total Scour Summary

Alternatives	Location	Scour (ft) for 2% AEP Storm (Scour Design)	Scour Elevation (ft) for 2% AEP Storm (Design Flood)	Scour (ft) for 1% AEP Storm (Scour Check Flood)	Scour Elevation (ft) for 1% AEP Storm (Design Flood)
Existing	Rear Abutment	10.42	883.18	9.03	884.57
	Contraction	1.80		1.90	
	Pier	3.55		3.73	
	Pier + Contraction	5.35	888.25	5.63	887.97
	Forward Abutment	10.42	883.18	9.03	884.57

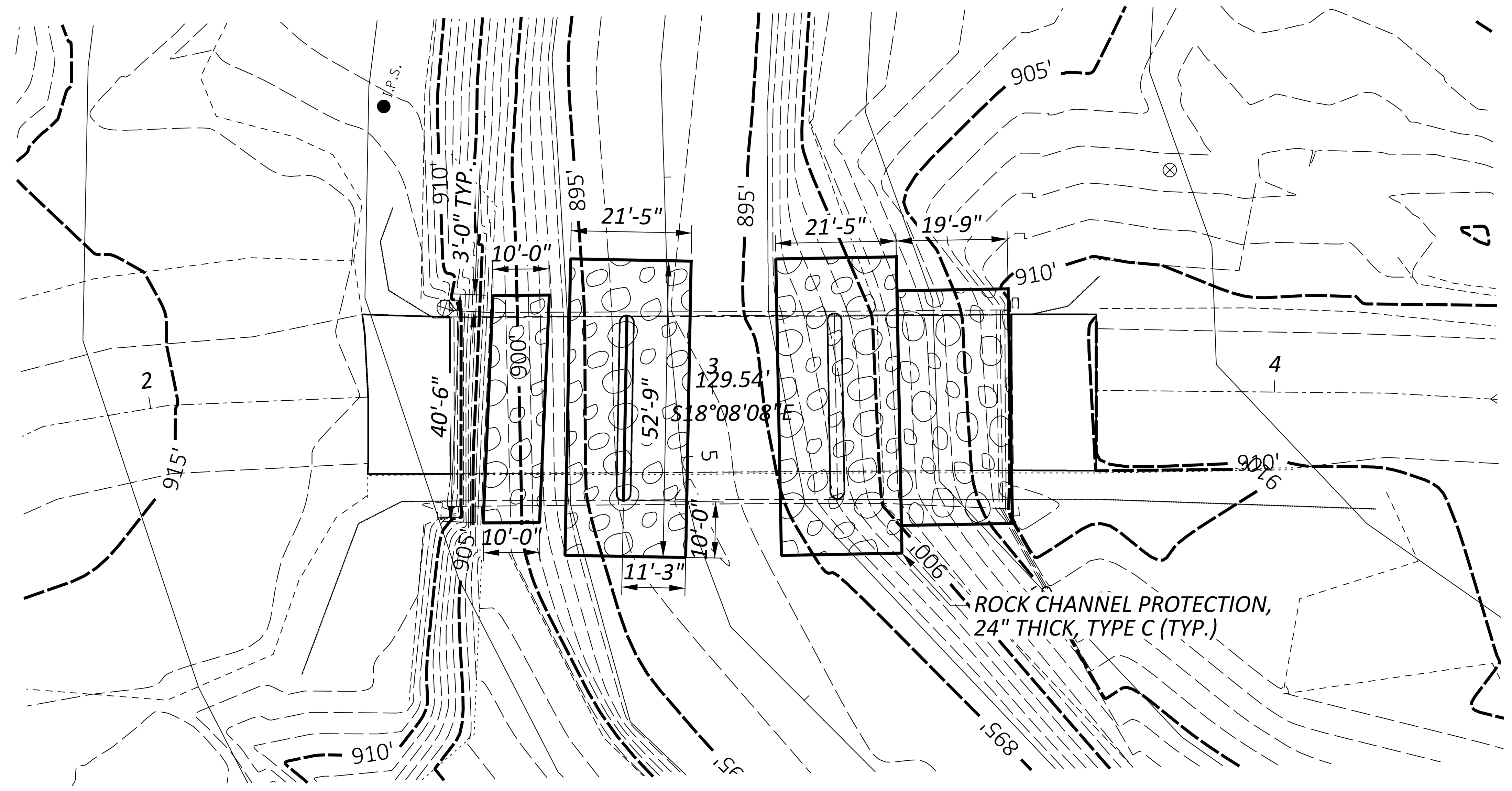
Item 601 - Rock Channel Protection, Type C, with Aggregate Filter

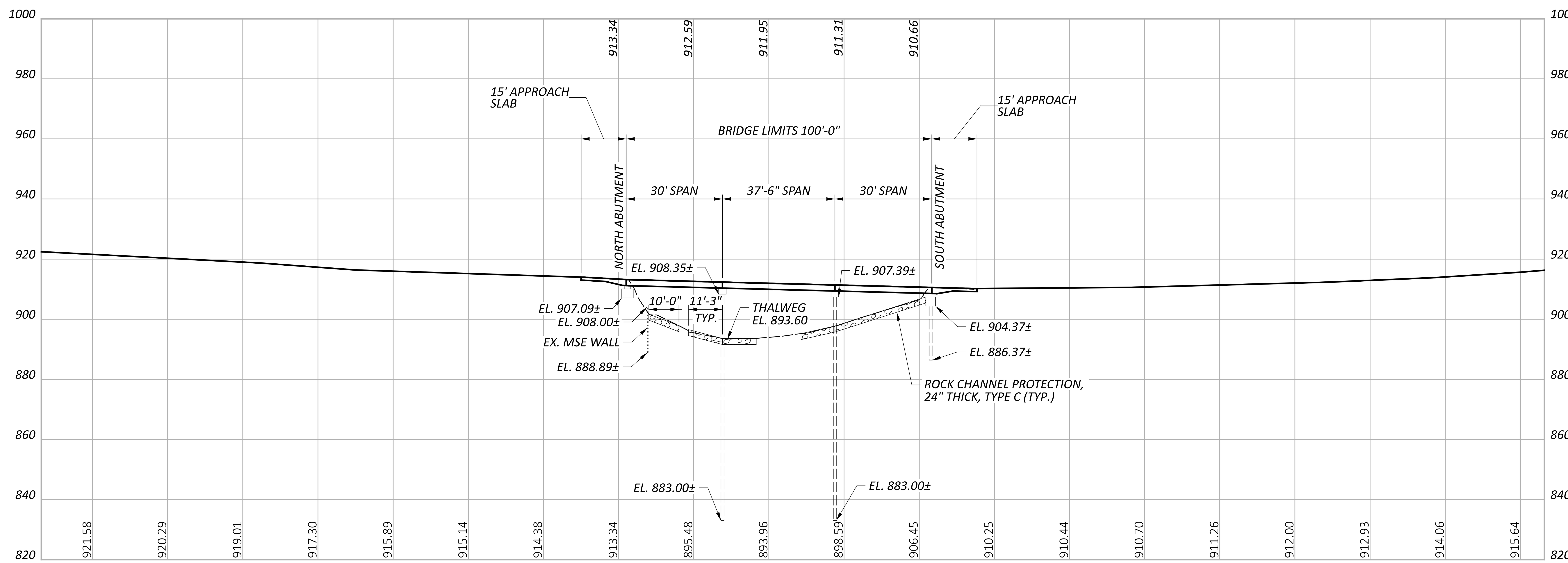
	Area from ORD (SF)	*Depth (FT)*	*CF*	*CY*	*Unit Cost*	*Total Cost*
North Abutment	404.91	2	809.82	30		
North Pier	1131.32	2	2262.64	84		
South Pier	1131.32	2	2262.64	84		
South Abutment	825.23	2	1650.46	61		
Total				259	$170.00	$43,983

Item 838 - Gabions, As Per lan

	Area from ORD (SF)	*Depth (FT)*	*CF*	*CY*	*Unit Cost*	*Total Cost*
North Abutment	404.91	0.67	269.94	10		
North Pier	1131.32	0.67	754.2133	28		
South Pier	1131.32	0.67	754.2133	28		
South Abutment	825.23	0.67	550.1533	20		
Total				86	$400.00	$34,497

NOTES:
1. ALL EXISTING PILING IS HP12X53.
2. ALL DIMENSIONS ARE FROM EXISTING PLANS AND ARE ±.
3. BOTTOM FOOTING AND PILING ELEVATIONS ARE FROM EXISTING PLANS AND ARE DATUM CORRECTED AND SHOULD BE CONSIDERED ±.
4. AREA OF TOCK CHANNEL PROTECTION EQUATES TO AREA OF GABION BASKETS.





SFN 0701211 PROFILE ALONG ℄ SR 9 - SCOUR COUNTER MEASURES
(ROCK CHANNEL PROTECTION SHOWN, GABION BASKETS SIMILAR)

Recommended Scour Countermeasures

The following countermeasures are recommended for application to bridge abutments and piers:

1. Riprap Revetment (ITEM 601 - Rock Channel Protection, Type C, w/ aggregate filter)

601.09 Rock Channel Protection. Furnish material conforming to 703.19. When specified with a filter, provide a filter consisting of Geotextile Fabric or a 6- inch (150 mm) bed of aggregate conforming to 703.19. When placing rock, exercise reasonable care to ensure that the finished surface of the protected channel conforms to the channel cross-sections shown on the plans.

If Geotextile Fabric is used, prepare the surface to receive the fabric to a relatively smooth surface, free of obstruction and debris. With the long dimension parallel to the flow direction, loosely place the fabric without wrinkles and creases. Where joints are necessary, provide a 12 inch (0.3 m) minimum overlap, with the upstream strip overlapping the downstream strip. Place securing pins with washers at a minimum distance apart of 2 feet (0.6 m) along the joints and at a minimum distance apart of 5 feet (1.5 m) everywhere else. When required by the plans fill all voids with grout.

SEE HYDRAULIC TOOLBOX RIPRAP REVETMENT DESIGN CALCULATIONS AND OHIO DOT CONSTRUCTION AND MATERIAL SPECIFICATIONS BELOW

Provide the following layer thickness and sizes:

- Abutment: 24 inches, D_{50} = 12 inches – Type C
- Piers: 24 inches, D_{50} = 12 inches – Type C

Provide the following and gabions lateral extent:

- Pier: Twice the pier width (1.0 ft) or 10 foot minimum

Location and Design Manual Volume 2 – Drainage Design

1107.3 Bridge Rock Channel Protection

Provide RCP for bridges over waterways at the following locations:

A. The entire spill-through slope

B. Front side of abutments and wingwalls

C. Corner cones

Use **Table 1007-1** to determine the Scour Design Flood used to calculate Channel Mean Velocity.

Table 1107-1

Channel Mean Velocity (ft/s)	RCP Type	Thickness (inch)
0-8	C	24
8-10	B	30
Above 10	A	36

Contact OHE when Velocities exceed 12 fps.

Special circumstances such as protection on the stream bank located on the outside of a curve or where ice flow is problematic may require greater rock thickness.

Show the locations, length, and the top of slope elevations for the RCP on the Structure Site Plan. Show the RCP in greater detail in the roadway

703.19 Rock and Aggregate Materials for Item 601.

B. Dumped Rock Fill and Rock Channel Protection. Furnish gravel, broken recycled portland cement concrete (RPCC), broken sandstone, broken siltstone, and broken limestone for dumped rock fill and rock channel protection. Furnish sandstone, siltstone, and limestone that is free of laminations, seams, and fractures, or injury due to blasting.

Furnish dumped rock fill and rock channel protection materials consisting of the four material types defined below:

1. Type A material has at least 85 percent of the total material by weight larger than an 18-inch (0.5 m) but less than a 30-inch (0.8 m) square opening and at least 50 percent of the total material by weight larger than a 24-inch (0.6 m) square opening. Furnish material smaller than an 18-inch (0.5 m) square opening that consists predominantly of rock spalls and rock fines, and that is free of soil.

2. Type B material has at least 85 percent of the total material by weight larger than a 12-inch (0.3 m) but less than a 24-inch (0.6 m) square opening and at least 50 percent of the total material by weight larger than an 18-inch (0.5 m) square opening. Furnish material smaller than a 12-inch (0.3 m) square opening that consists predominantly of rock spalls and rock fines, and that is free of soil.

3. Type C material has at least 85 percent of the total material by weight larger than a 6-inch (150 mm) but less than an 18-inch (0.5 m) square opening and at least 50 percent of the total material by weight larger than a 12-inch (0.3 m) square opening. Furnish material smaller than a 6-inch (150 mm) square opening that consists predominantly of rock spalls and rock fines, and that is free of soil.

4. Type D material has at least 85 percent of the total material by weight larger than a 3-inch (75 mm) but less than a 12-inch (0.3 m) square opening and at least 50 percent of the total material by weight larger than a 6-inch (150 mm) square opening. Furnish material smaller than a 3-inch (75 mm) square opening that consists predominantly of rock spalls and rock fines, and that is free of soil.

B. HEC-23 Volume 2 – Design Guideline 4

4.2.3 Thickness of Riprap

All stones should be contained reasonably well within the riprap layer thickness, with little or no oversize stones protruding above the surface of the riprap matrix. The following criteria are recommended in NCHRP Report 568 for revetment riprap:

1. Layer thickness should not be less than the spherical diameter of the D100 stone nor less than 1.5 times the spherical diameter of the D50 stone, whichever results in the greater thickness.

2. Layer thickness should not be less than 1 ft (0.30 m) for practical placement.

3. Layer thickness determined either by criterion 1 or 2 should be increased by 50% when the riprap is placed underwater to compensate for uncertainties associated with this placement condition.

Table 4.1 provides recommended gradations for ten standard classes of riprap.

Table 4.1. Minimum and Maximum Allowable Particle Size in Inches.								
Nominal Riprap Class by Median Particle Diameter		d15		d50		d85		d100
Class	Size	Min	Max	Min	Max	Min	Max	Max
I	6 in	3.7	5.2	5.7	6.9	7.8	9.2	12.0
II	9 in	5.5	7.8	8.5	10.5	11.5	14.0	18.0
III	12 in	7.3	10.5	11.5	14.0	15.5	18.5	24.0
IV	15 in	9.2	13.0	14.5	17.5	19.5	23.0	30.0
V	18 in	11.0	15.5	17.0	20.5	23.5	27.5	36.0
VI	21 in	13.0	18.5	20.0	24.0	27.5	32.5	42.0
VII	24 in	14.5	21.0	23.0	27.5	31.0	37.0	48.0
VIII	30 in	18.5	26.0	28.5	34.5	39.0	46.0	60.0
IX	36 in	22.0	31.5	34.0	41.5	47.0	55.5	72.0
X	42 in	25.5	36.5	40.0	48.5	54.5	64.5	84.0
Note: Particle size d corresponds to the intermediate ("B") axis of the particle.								

B. HEC-23 Volume 2 – Design Guideline 11

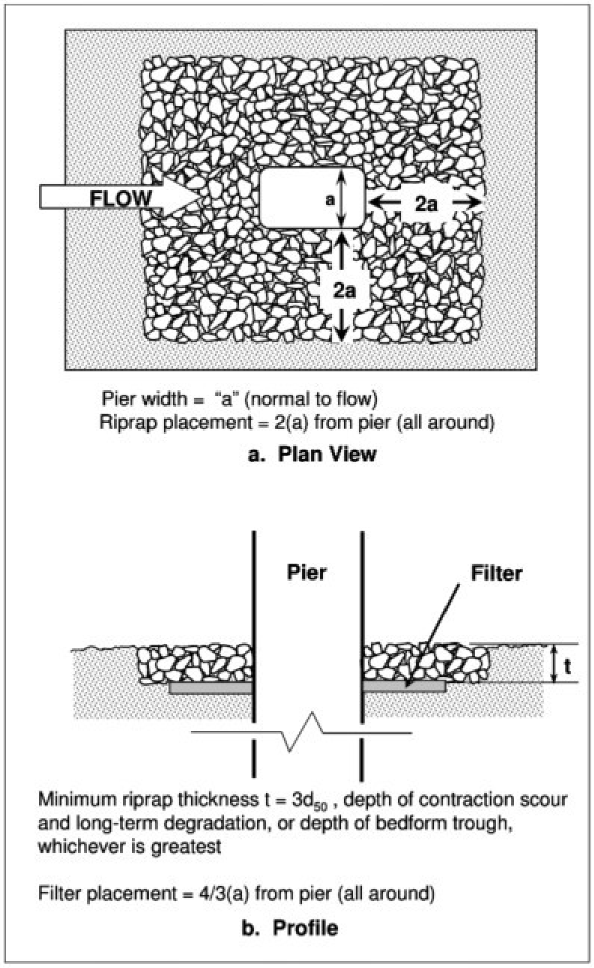


Figure 11.15. Riprap layout diagram for pier scour protection.

C. HEC-23 Volume 2 – Design Guideline 14

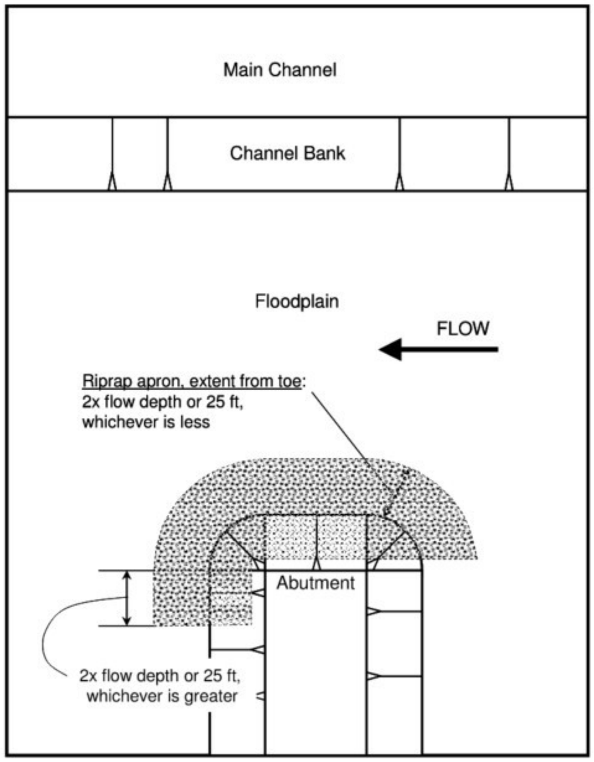


Figure 14.7. Plan view of the extent of rock riprap apron (Lagasse et al. 2006).

Extent of Riprap (ODOT Rock Channel Protection)

a. The apron should extend from the toe of the abutment into the bridge waterway a distance equal to twice the flow depth in the overbank area near the embankment, but need not exceed 25 ft (Atayee eta l. 1993)

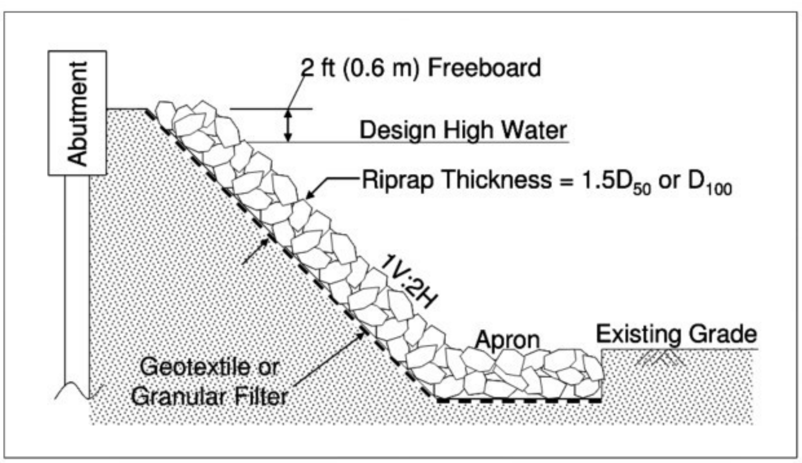


Figure 14.8. Typical cross section for abutment riprap (Lagasse et al. 2006).

D. Handbook of Scour Countermeasures Designs FHWA-NJ-2005-027 – Chapter 5

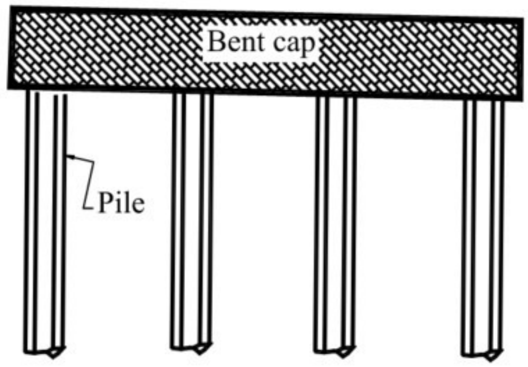


Figure 5.8: Bridge supported on long piles - Erosion at pile bents will increase the long column effect and reduce safe axial capacity of piles. (This is the type of pier used for SFN 0701211.)

2. <u>Gabion Mattress – Bank Revetment and Bed Armor – Item 838E20701 GABIONS, AS PER PLAN (HEC-23 Volume 2 – Design Guideline 10)</u>

USE: 8 INCH GABIONS WITH 5 INCH STONE

Gabion mattresses are containers constructed of wire mesh and filled with rocks. The length of a gabion mattress is greater than the width, and the width is greater than the thickness. Diaphragms are inserted widthwise into the mattress to create compartments (Figure 10.1). Wire is typically galvanized or coated with polyvinyl chloride to resist corrosion, and either welded or twisted into a lattice. Stones used to fill the containers can be either angular rock or rounded cobbles; however, angular rock is preferred due to the higher degree of natural interlocking of the stone fill. During installation, individual mattresses are connected together by lacing wire or other connectors to form a continuous structure.

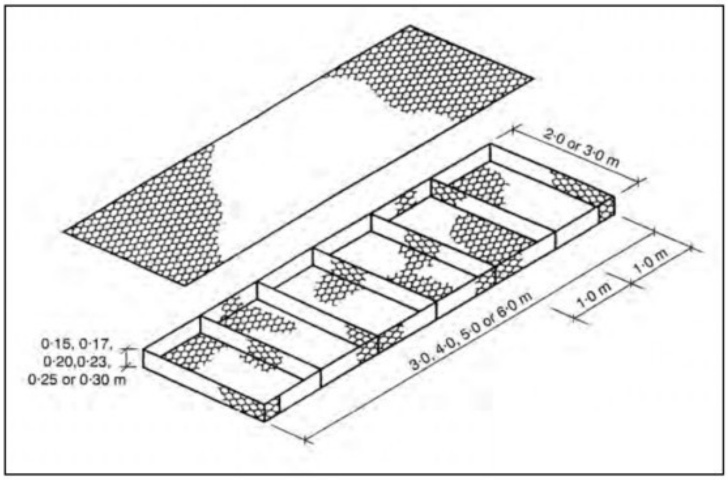


Figure 10.1. Gabion mattress showing typical dimensions (after Hemphill and Bramley 1989).

Extent of Gabions

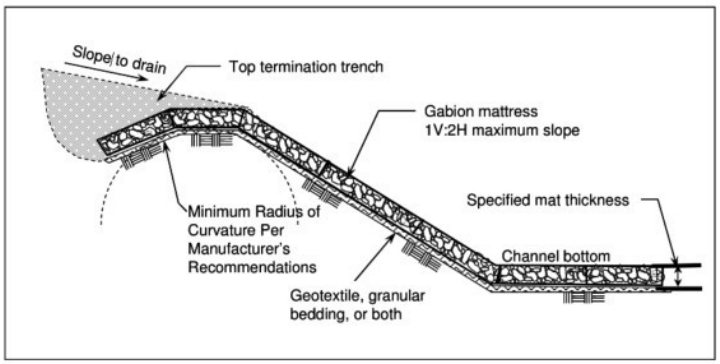


Figure 10.4. Recommended layout detail for bank and bed armor.

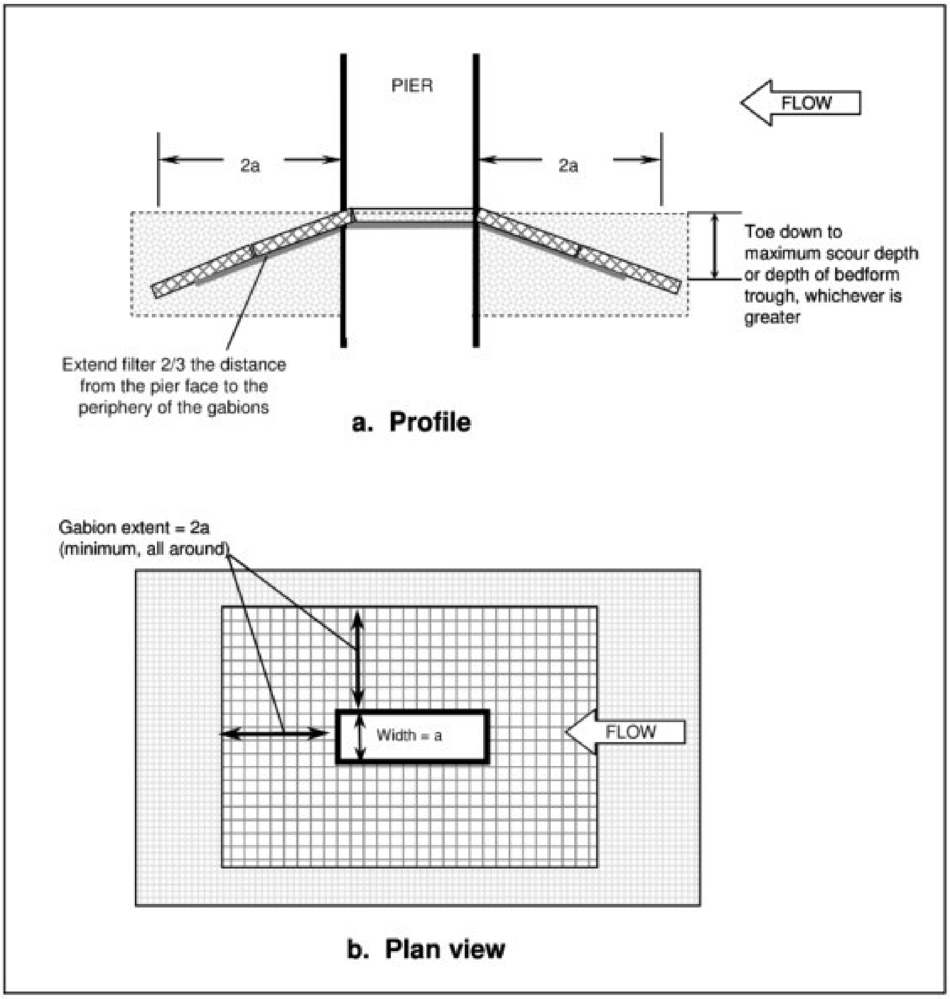


Figure 10.7. Gabion mattress layout diagram for pier scour countermeasures.

3. Handbook of Scour Countermeasures Designs FHWA-NJ-2005-027 – Chapter 11

Types of Gabions

The following types of gabions are commonly used as armoring countermeasures:

1. Gabion Sacks

They are used when construction in "the dry" is not possible. In the absence of cofferdams, gabion sacks are placed directly in water. The minimum dimension of a gabion sack ranges between 18 inches to 3 feet.

2. Gabion Boxes or Baskets

Gabion boxes are larger in size than the sacks. The minimum dimension of a gabion box ranges between 2 to 4 feet. They are more suitable for higher velocities.

3. Gabion or Reno Mattresses

They are thinner than sacks or boxes and have lesser weight per unit area. Minimum thickness varies between 8 inches to 18 inches. The mattress is manufactured in greater lengths than the length of a gabion sack or gabion box. For higher scour depths, two mattresses can be placed on top of each other and tied together. Due to their flexibility, they are more commonly used than gabion sacks or boxes.

4. Wire Enclosed Riprap

It differs from the Reno Mattress in that it is larger in size and is a continuous framework rather than individual interconnected boxes or baskets. It is used for slope protection at riverbanks and as guide banks. Riprap stone sizes that are used are less uniform when compared to other three types discussed above. However, wire enclosed riprap may be used in conjunction with gabions that are placed at the toe of a slope. The thickness of wire-enclosed riprap varies between 12 to 18 inches. Wire enclosed riprap is generally anchored with steel stakes or spikes to the embankment. Design Guideline 3 of HEC-23 provides detailed guidelines for wire-enclosed riprap.

Table 11.1: Sizing of Gabions Based on Design Velocity.

Gabion Thickness (ft)	Stone Size (inch)	Critical Velocity (ft/sec)	Limiting Velocity (ft/sec)
0.49-0.56	3.3	≤11.5	13.8
	4.3	13.8	14.8
0.75-0.82	3.3	11.8	18.0
	4.7	14.8	20.0
1.0	3.9	13.8	18.0
	4.9	16.4	21.0
1.64	5.9	19.0	24.9
	7.5	21.0	26.2

Based on Agostoni (1988) and CIRIA (2002)

In sizing gabions using Table 11.1, the following additional requirements should be observed:

(Minimum) stone size > 1.25 x Maximum spacing between wires

(Maximum) stone size < 2/3 x Height of basket or box

(Minimum) height of basket > 6 in.

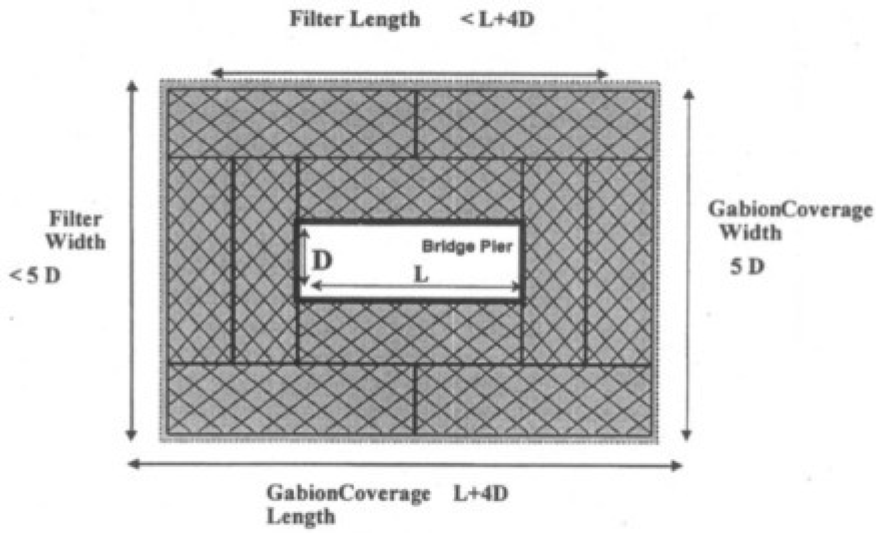


Figure 11.4: Extent of Gabions and Geotextile Filter around Bridge Piers.

Figures 11.5 and 11.6 show typical layouts of gabions for embankments and spill-through bridge abutments. For small openings, the gabion nets should extend the full width between the two abutments.

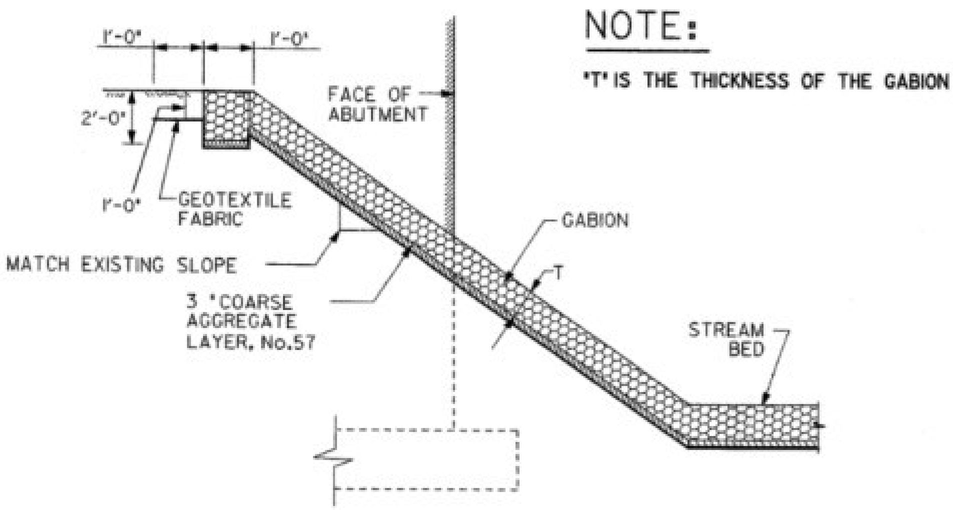


Figure 11.5: Gabion Detail at Embankment

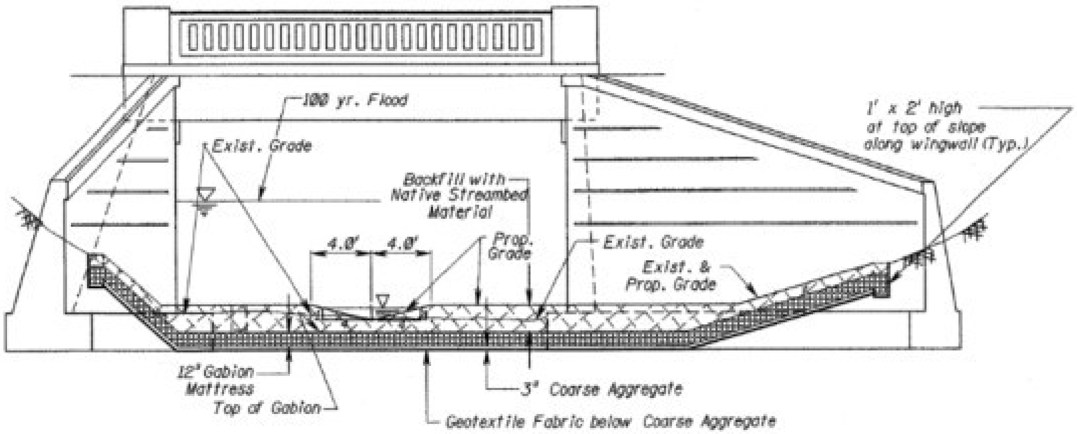


Figure 11.6: Gabion Detail at Embankment: Upstream Elevation, Looking Downstream.

Hydraulic Analysis Report

ITEM 601 SLOPE AND CHANNEL PROTECTION - Rock Channel Protection

Project Data

Project Title: Project - SFN 0701211

Designer: 2LMN

Project Date: Friday, February 23, 2024

Project Units: U.S. Customary Units

Notes: Abutment Revetment Analysis based on 1% AEP (100-year) Flood Event

Riprap Analysis: Riprap Analysis

Notes:

Input Parameters

Riprap Type: Abutments

The structure is a guidebank

Set-back Length: 1 ft

The set-back length is the distance from the near edge of the main channel to the toe of abutment

Main Channel Average Flow Depth: 12.17 ft – 1% AEP (100-year) Hydraulic Depth from HEC-RAS

Flow Depth at Toe of Abutment: 12.17 ft – 1% AEP (100-year) Hydraulic Depth from HEC-RAS

Calculations will use either total or overbank discharges.

Total Discharge: 7610 cfs

Overbank Discharge: 55.68 cfs

Total Bridge Area: 1078.18 ft^2

Setback Area: 1 ft^2

Maximum Channel Velocity: 7.07 ft/s

Specific Gravity of Riprap: 2.65

Result Parameters
Set-back ratio: 0.0821693

Characteristic Velocity: 7.05819 ft/s

Froude Number at the Abutment Toe: 0.356694

Abutment Coefficient: 1.02

Computed D50: 291.751 mm (11.5 inches)

Riprap Class
Riprap shape should be angular

Riprap Class Name: CLASS III
OHIO DOT SPECIFICATIONS REQUIRES TYPE C RIPRAP, WHICH IS EQUIVALENT TO CLASS III.

Riprap Class Order: 3
The following values are an 'average' of the size fraction range for the selected riprap class.

D100: 609.60 mm (24 inches)

D85: 431.80 mm

D50: 317.50 mm (12.5 inches)

D15: 228.60 mm

Layout Recommendations
Minimum Riprap Thickness: 288.00 mm (11.3 inches)

Minimum Horizontal Extent of the Toe Apron from the Abutment Toe: 24.34 ft

Minimum Extent of "Wrap Around" beyond the Abutment Radius, along the Approach Embankment: 25 ft

See HEC 23, Figure 14.7

No channel used in calculations

Hydraulic Analysis Report

ITEM 601 SLOPE AND CHANNEL PROTECTION - Rock Channel Protection

Project Data

Project Title: Project - SFN 0701211

Designer:

Project Date: Friday, February 23, 2024

Project Units: U.S. Customary Units

Notes: Pier Revetment Analysis based on 1% AEP (100-year) Flood Event

Riprap Analysis: Riprap Analysis

Notes:

Input Parameters

Riprap Type: Piers

The velocity is specified as average velocity at the bridge

Channel Average Velocity (at the bridge): 7.07 ft/s

Velocity Adjustment Factor for location in the channel: 0.9

The piers have a square shape

Pier Width (normal to flow): 1 ft

Contraction Scour Depth: 1.90 ft

Bed Form Depth: 2.99 ft (approximately 0.2 times the 1% AEP depth of flow)

Specific Gravity of Riprap: 2.65

Result Parameters

Design Scour Depth: 3.73 ft

Design Velocity: 10.8171 ft/s

Design velocity never less than average channel velocity

Computed D50: 232.447 mm (9.15 inches)

Riprap Class

Riprap shape should be angular

Riprap Class Name: CLASS II

OHIO DOT SPECIFICATIONS REQUIRES TYPE C RIPRAP, WHICH IS EQUIVALENT TO CLASS III.

Riprap Class Order: 2

The following values are an 'average' of the size fraction range for the selected riprap class.

D100: 457.20 mm (18 inches)

D85: 330.20 mm

D50: 241.30 mm (9.5 inches)

D15: 177.80 mm

Layout Recommendations

Depth of Riprap below Streambed: 28.5 ft

Design thickness of riprap below streambed is greatest of Contraction Scour Depth (includes Long-Term Degradation, if applicable), Bed Form Depth, or 3x Design D50

Minimum Riprap Extent: 2 ft

Filter Placement Extent: 1.33333 ft

See HEC 23, Figure 11.15

No channel used in calculations

Attachment G:
Photos

Figure 1: Photo 4738, SFN 0701211, Wheeling Creek, Downstream

Figure 2: Photo 4739, SFN 0701211, Wheeling Creek, Downstream

Figure 3: Photo 4741, SFN 0701211, Wheeling Creek, Downstream

Figure 4: Photo 4742, SFN 0701211, Wheeling Creek, Downstream

Figure 5: Photo 4743, SFN 0701211, Wheeling Creek, Downstream

Figure 6: Photo 4744, SFN 0701211, Wheeling Creek, Downstream

Figure 7: Photo 4745, SFN 0701211, Wheeling Creek, Downstream

Figure 8: Photo 4732, SFN 0701211, Wheeling Creek, Upstream

Figure 9: Photo 4733, SFN 0701211, Wheeling Creek, Upstream

Figure 10: Photo 4734, SFN 0701211, Wheeling Creek, Upstream

Figure 11: Photo 4735, SFN 0701211, Wheeling Creek, Upstream

Figure 12: Photo 4736, SFN 0701211, Wheeling Creek, Upstream

Figure 13: Photo 4737, SFN 0701211, Wheeling Creek, Upstream

Figure 14: Photo 4740, SFN 0701211, Wheeling Creek, Upstream

Figure 15: Photo 4746, SFN 0701211, Wheeling Creek, Upstream

Figure 16: Photo 4747, SFN 0701211, Wheeling Creek, Upstream

Figure 17: Photo 4748, SFN 0701211, Wheeling Creek, Upstream

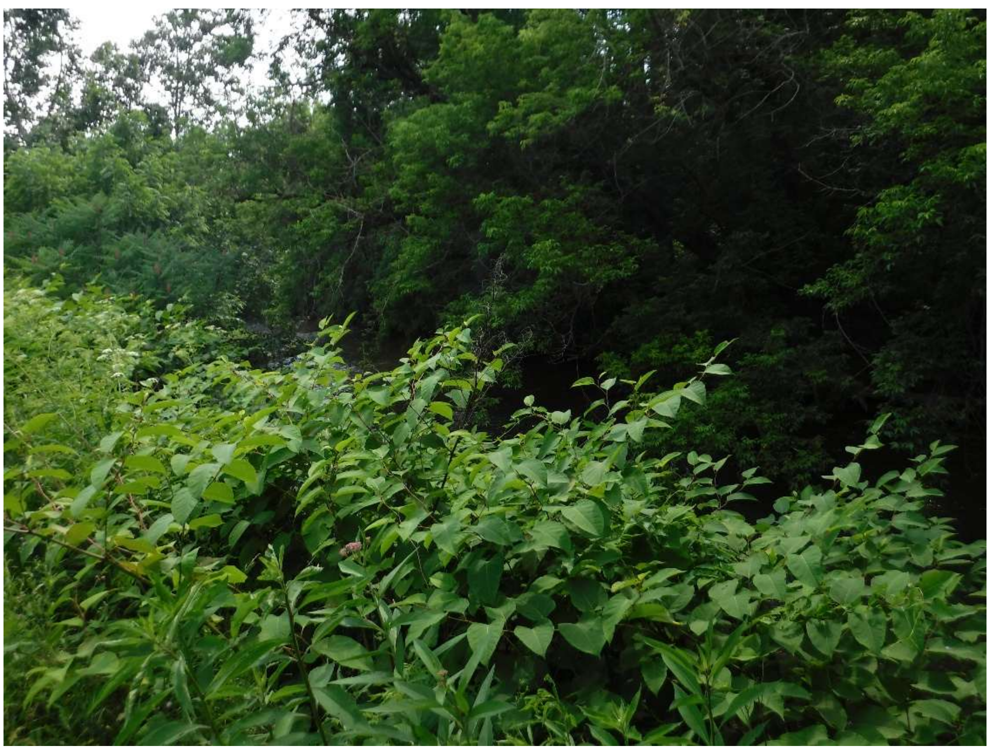


Figure 18: Photo 4749, SFN 0701211, Wheeling Creek, Upstream

Attachment H:
Other information: ______
Not Used