

SIGNIFICANT FINDINGS SUMMARY

A special underwater inspection of Bridge No. 1-744-059 was performed on January 19 and 20, 2015. The underwater substructure units were generally in Fair condition. The reinforced concrete stems typically exhibit scaling up to 1-inch deep. Areas of moderate scaling up to 3-inches deep are present at isolated locations with and without exposed steel reinforcement with moderate section loss. The West Stem of Pier 5 exhibits up to 6-inch deep scaling with exposed steel reinforcement with up to 90% section loss. The top of the footings are exposed at Piers 2, 4 and 5. Steel sheet piling is present at Piers 1 through 5; the sheet piling typically protrudes up to 3-feet from the mudline. In accordance with the National Bridge Inspection Standards, DelDOT Underwater Bridge Inspection Guidelines, and based on the inspection findings it is recommended that the submerged substructure units of Bridge No. 1-744-059 be placed on an accelerated routine underwater inspection interval of 24 months.

1.0 INTRODUCTION

1.1 Purpose and Scope

DelDOT Bridge No. 1-744-059 carries Interstate 95 over the Christina River in New Castle County, Delaware. On January 19 and 20, 2015, Pennoni Associates Inc. performed a special underwater inspection at the bridge to verify the condition of all substructure units from the high water mark to the channel bottom. This report includes a description of the structure, the method of investigation, and a detailed description of the conditions noted. In addition, this report contains a condition assessment of the bridge components evaluated and presents recommendations for follow-up actions. River depth soundings were obtained around the substructure units, along the centerline of the bridge, along each fascia, and at cross sections of the channel at 50 and 100 feet upstream and downstream of the bridge.

1.2 General Description of the Structure

DelDOT Bridge No. 1-744-059 is a seven span bridge over the Christina River. The bridge is supported on two abutments and six piers. The North and South Abutments are each constructed of a reinforced concrete pile cap supported by cast in place concrete piles and were situated out of the water at the time of inspection. Piers 1 through 6 each consist of 3 reinforced concrete hammerhead style pier stems supported on individual footings founded on piles of unknown length and material. A location map for the bridge can be found in Appendix A. Photographs 1 and 2 in Appendix B show the overall views of the bridge. Refer to Figure 1 in Appendix C for a sketch of the bridge site.

1.3 Method of Investigation

A dive team consisting of commercially trained divers, led by a Delaware-registered Professional Engineer, conducted the underwater investigation. The team members and their duties for this inspection were as follows: Nicholas Ward, PE – Team Leader/Dive Supervisor; Andrew Fulton, EIT – Dive Inspector; Martin Anderson, EIT – Dive Inspector/Dive Tender; William Clinton – Dive Tender. The inspection was conducted using commercial surface supplied air diving equipment. During the inspection, the diver worked out of a 27-foot dive boat where the Dive Supervisor recorded the inspection notes. Access to the bridge was obtained via a public boat launch 1/2 miles east of the bridge.

2.0 EXISTING CONDITIONS

At the time the soundings were recorded on January 20, 2015, the waterline reference was measured from the southeast corner of Pier 4 from the bottom of the cap at the stem and

measured to be 18.0-feet. Depth soundings indicated that the maximum water depth at the bridge structure was 20.0 feet at the southwest corner of the Center Stem of Pier 4. Refer to Figure 1 in Appendix C for a Sounding Plan of the bridge. At the time of inspection, there were less than 6 inches of visibility and a water velocity of approximately 0 to 2.0 feet per second. The river is tidally influenced and has a tidal swing of approximately 6 feet.

The reinforced concrete stems typically exhibit scaling up to 1-inch deep from the mean high waterline to the channel bottom. The stems typically exhibit steel sheet piling that protrude from the mudline up to 3-feet high; the sheet piling typically exhibits minor to moderate surface corrosion. The top of the footing is exposed at Piers 2, 4 and 5. Timber debris up to 12-inch Diameter is typical around the stems of all piers. The channel bottom consisted of sand and silty sand with up to 3-feet of probe rod penetration outside the steel sheet piling and predominately gravel with up to 4 inches of probe rod penetration inside the steel sheet piling. Refer to Photographs 3 and 4 in Appendix B for a view of a typical pier and typical scale.

Overall, Pier 1 was in satisfactory condition. The previously noted area of riprap (stones measuring 1 to 3 feet in diameter) between the West Stem and the Center Stem was not observed. A 6-foot long section of steel H-pile is on the channel bottom just north of the steel sheet pile at the East Stem. Refer to Figure 2 in Appendix C for detailed inspection notes of Pier 1.

Overall, Pier 2 was in fair condition. The east and west ends of the Cent and East Stem's typically exhibit scaling up to 2-inches deep. The west face of the West Stem exhibits a 2' H x 3'-6" W x 3" D area of scaling with exposed corroded steel reinforcement (5 vertical and 3 horizontal steel bars) with up to 60% section loss at the waterline. The west end of the East Stem exhibits scaling up to 2'-6" H x 3'-6" W x up to 2 1/2" D with exposed corroded steel reinforcement (6 vertical and 2 horizontal steel bars) with up to 30% section loss at the waterline. The East Stem exhibits up to 1 1/2-inch deep scaling at the bottom 2-feet of stem on all faces. The top of the footing is exposed along the north and south faces of the Center Stem inside the steel sheet piling. A 6-foot long section of a steel H-pile is on the channel bottom along the north face of the exposed steel sheet pile at the Center Stem and a 3-foot long section of steel H-pile is at the southwest corner of the steel sheet piling. A 2 to 3-foot concrete overpour exists along the north face of the steel sheet pile from the west quarter point to the northeast corner at the East Stem. Refer to Figure 3 in Appendix C for detailed inspection notes of Pier 2.

Overall, Pier 3 was in fair condition. The stems typically exhibit a 2' H x 1 1/2" D band of scaling on all faces, 6-feet below the waterline. The west end of the West Stem exhibits a 5' H x 3'-6" W x 3" D area of scaling with exposed corroded steel reinforcement (3 vertical and 2 horizontal steel bars) with up to 20% section loss at the waterline. The west face of the East Stem exhibits a 2'-6" H x 3'-6" W x 3" D area of scaling with exposed corroded steel reinforcement (one horizontal bar with only the outer surface of the steel reinforcement exposed) at the waterline. A 10' L x 1' D scour depression extends 3-feet north of the north face of the West Stem; a 3' L x 1' D scour depression extended 3-feet out from the west face of the Center Stem; a 3' L x FW x 1' D scour depression extended 3-feet away from the north face of the East Stem. There is a 14' H x up to 1/16" W vertical crack on the east face of the Center Stem that terminates 4 feet below the waterline. Refer to Figure 4 in Appendix C for detailed inspection notes of Pier 3.

Overall, Pier 4 was in satisfactory condition. The east face of the West Stem exhibits 2' H x 3'-6" W x 3" D scaling with exposed corroded steel reinforcement (with 1 horizontal steel bar) at the waterline. The west face of the West Stem exhibits 2' H x 3'-6" W x 3" D scaling with exposed corroded steel reinforcement (1 vertical and 1 horizontal steel bar) at the waterline. At the center of the west face of the West Stem is a vertical crack up to 30' H x up to 1/16" W that terminates 5-feet

below the waterline. The previously reported area of scaling with exposed corroded steel reinforcement on the east and west faces of the East Stem 2-feet above the mudline was not observed. The top of the footing was exposed along the south face of the East Stem. Steel debris, up to 4-feet long, is on the channel bottom at the west face of the East Stem. Refer to Figure 5 in Appendix C for detailed inspection notes of Pier 4.

Overall, Pier 5 was in fair condition. The West Stem exhibits scaling, up to 2' H x FW x 6" D with exposed corroded steel reinforcement (4 horizontal and 5 vertical steel bars) with up to 90% section loss, 4-feet from the mudline on the west face. The West Stem exhibits 4' H x FW x up to 3" D scale with one horizontal steel bar exposed on the south, east and north faces, 2-feet from the mudline. The top of the footing was exposed around the entire Center Stem. There is map cracking and a 1/32-inch wide vertical crack extending 15-feet up from the band of scaling on the west face of the West Stem. The East Stem exhibits scaling up to 2' H x 8' L x 3" D with one exposed horizontal steel bar on the north face and 2' H x FW x 3" D with an exposed horizontal and vertical steel bar on the west face. Refer to Figure 6 in Appendix C for detailed inspection notes of Pier 5.

Overall, Pier 6 was in satisfactory condition. Refer to Figure 7 in Appendix C for detailed inspection notes of Pier 6.

The north embankment west of the bridge consisted of small cobbles up to 4 inches in diameter with minor vegetation. The South Embankment east of the bridge consisted of minor vegetation. Refer to Photographs 5 and 6 for channel views. Refer to Figure 1 in Appendix C for detailed inspection results of the embankments.

3.0 CONCLUSIONS AND RECOMMENDATIONS

3.1 Evaluation and Assessments

Overall, the submerged substructure units of Structure No. 1-744-059 are in fair condition. A comparison of the soundings recorded during the previous inspection on April 3, 2014 and the soundings taken during this inspection revealed no significant change in the channel bottom profile in the vicinity of the structure. The footing exposure at Piers 2, 4, and 5 are not of concern at this time given that the bottom of the footing was embedded below the current channel bottom, restrained within the steel sheet pile walls, and the footings are supported by piles. The scour depressions observed at Piers 2 and 3 are also not of concern at this time given that the bottom of the footing is embedded below the current channel bottom.

The timber debris accumulations does not affect the channel flow, and as a result, do not require removal at this time. If the debris accumulations increase in size or density, it may be necessary to remove the debris to reduce excessive lateral loads on the pier, limit further debris accumulation, and reduce the likelihood of general channel bottom and localized scour.

3.2 Recommended NBI Condition Ratings

Substructure Code (Item 60)	Channel and Channel Protection Code (Item 61)	Underwater Inspection Code (Item 92B) (Months)
5	6	24

The recommended NBI Rating for Item 60 (Substructure) is a 5. This rating is recommended due to the size of the scaling on the pier stems along with the exposed steel reinforcement.

The current NBI Rating for Item 61 (Channel and Channel Protection) is a 6. This rating is recommended due to the scour depressions at Piers 2 and 3 and the exposed footings at Piers 2, 4 and 5.

3.3 Recommendations

The bands of scaling and associated concrete deterioration at Piers 2 through 5 should be repaired. In lieu of traditional concrete patching repairs, which may be short-lived, consideration should be given to installing a fiberglass jacket system (or similar method) around each pier stem to provide a longer-life repair.

The channel bottom configuration should continue to be closely monitored during future underwater inspections to ensure that the footing exposure at Piers 2, 4, and 5 remains minimal and the scour depressions at Piers 2 and 3 are not increasing.

In accordance with the National Bridge Inspection Standards, DeIDOT Underwater Bridge Inspection Guidelines, and based on the inspection findings it is recommended that the submerged substructure units of Bridge No. 1-744-059 be placed on an accelerated routine underwater inspection interval of 24 months. It is also recommended that soundings be recorded at the substructure units during biennial inspections and during or immediately following any significant high water event to check if significant localized scour is occurring, in which case an underwater inspection interval less than 24 months may be warranted.

APPENDIX A – LOCATION MAP



DELAWARE DEPARTMENT OF TRANSPORTATION		
INTERSTATE 95 OVER CHRISTINA RIVER BRIDGE NO. 1-744-059 LOCATION MAP		
CREATED BY: ATF	121 Continental Drive, Suite 207 Newark, DE 19713 www.pennoni.com	DATE: 1/20/2015
CHECKED BY: NRW		SCALE: N.T.S.
PROJECT NO.: WTRQ1402		Appendix A



APPENDIX B – PHOTOGRAPHS



Photograph 1. Overall View of the East Elevation, Looking West.



Photograph 2. Overall View of the West Elevation, Looking East.



Photograph 3. Overall View of Pier 2, North Face, Looking South.



Photograph 4. View of Pier 4, South Face, Looking North.
Note: Typical 1/4" Deep Scale along the waterline.



Photograph 5. Tidal View, Looking West.



Photograph 6. Tidal View, Looking East.

APPENDIX C – FIGURES



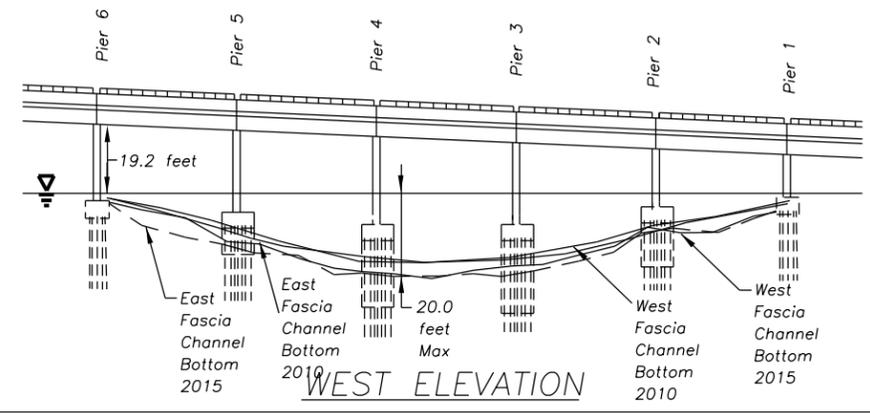
SOUNDING PLAN

- INSPECTION NOTES:**
- ① The North Embankment east of the bridge consisted of riprap measuring 6 to 12-inches in diameter with minor to moderate vegetation.
 - ② The North Embankment west of the bridge consisted of small cobbles up to 4-inches in diameter with minor vegetation.
 - ③ The South Embankment east of the bridge consisted of minor vegetation.
 - ④ The South Embankment west of the bridge consisted of riprap measuring 6 to 12-inches in diameter.
 - ⑤ The embankments under the bridge consisted of riprap measuring 6 to 12-inches in diameter from the mean high waterline to the mean low waterline.

LEGEND:

X.X CURRENT SOUNDINGS
 X.X 2010 BASE YEAR SOUNDINGS (ADJUSTED)

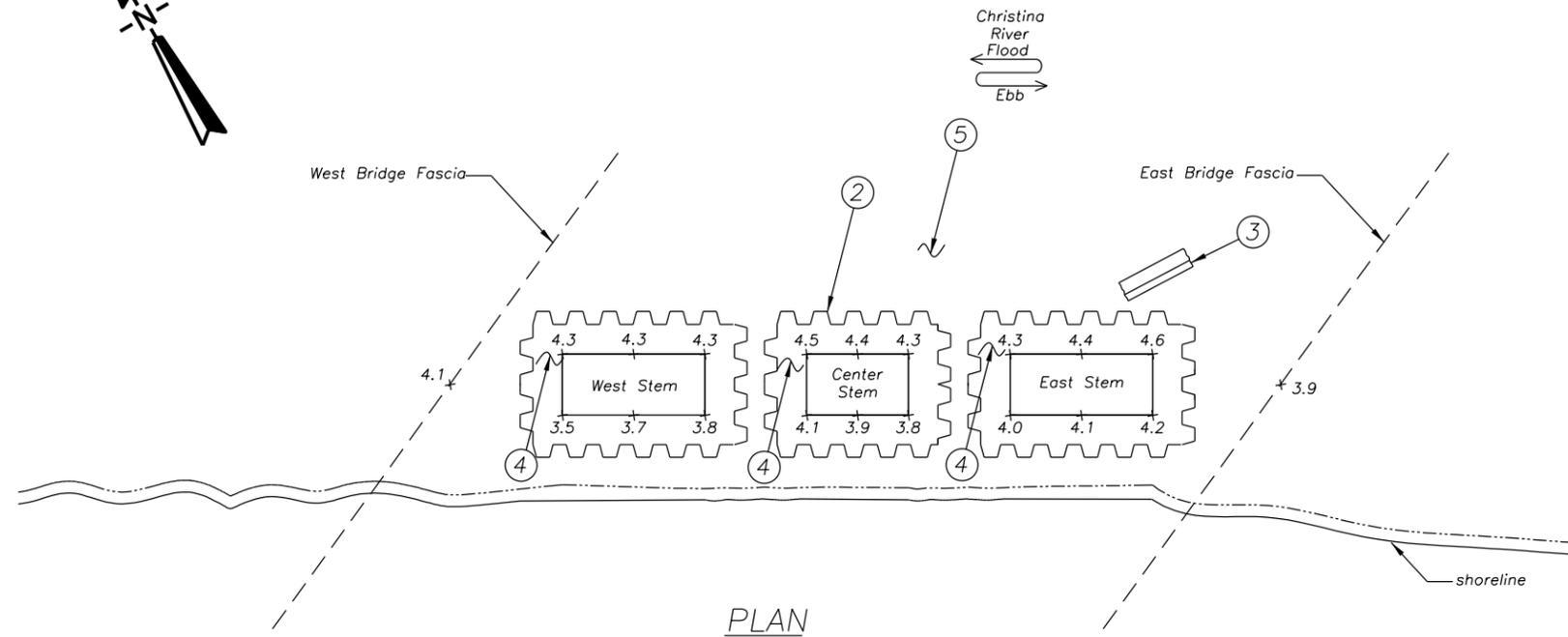
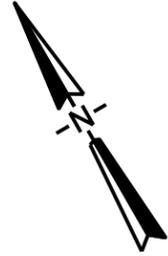
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WEST ELEVATION

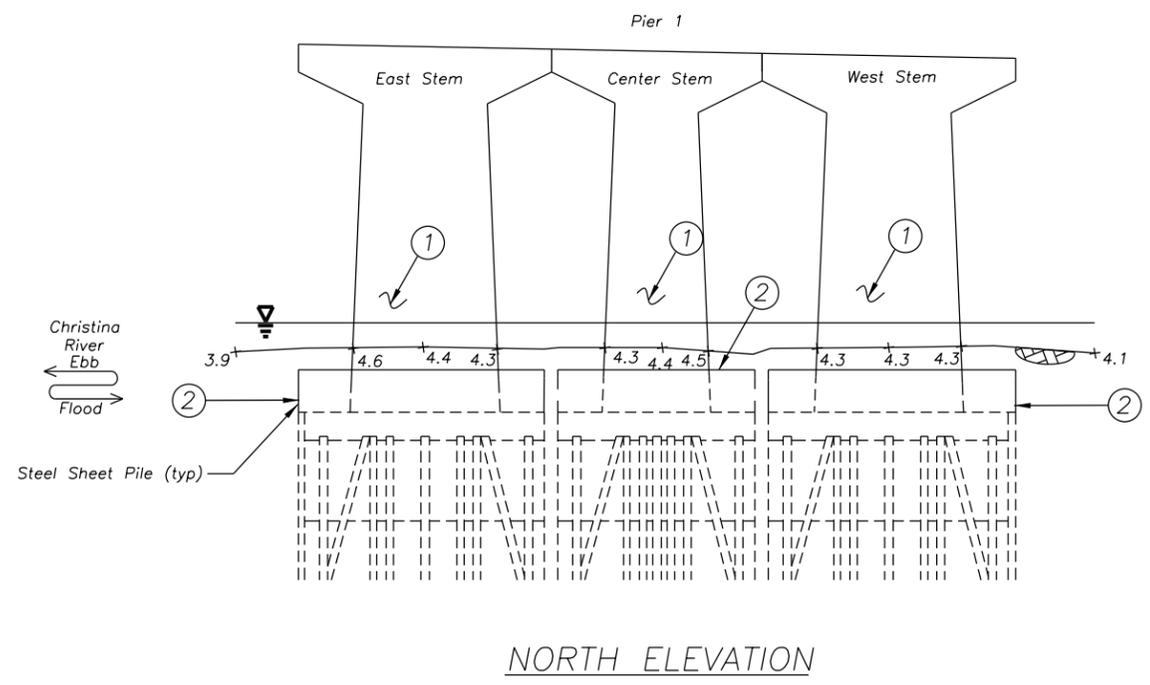
DELAWARE DEPARTMENT OF TRANSPORTATION		
INTERSTATE 95 OVER CHRISTINA RIVER BRIDGE NO. 1-744-059		
SOUNDING PLAN		
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JOB NO.: WTR01402		SCALE: N.T.S. FIGURE NO.: 1

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INSPECTION NOTES:

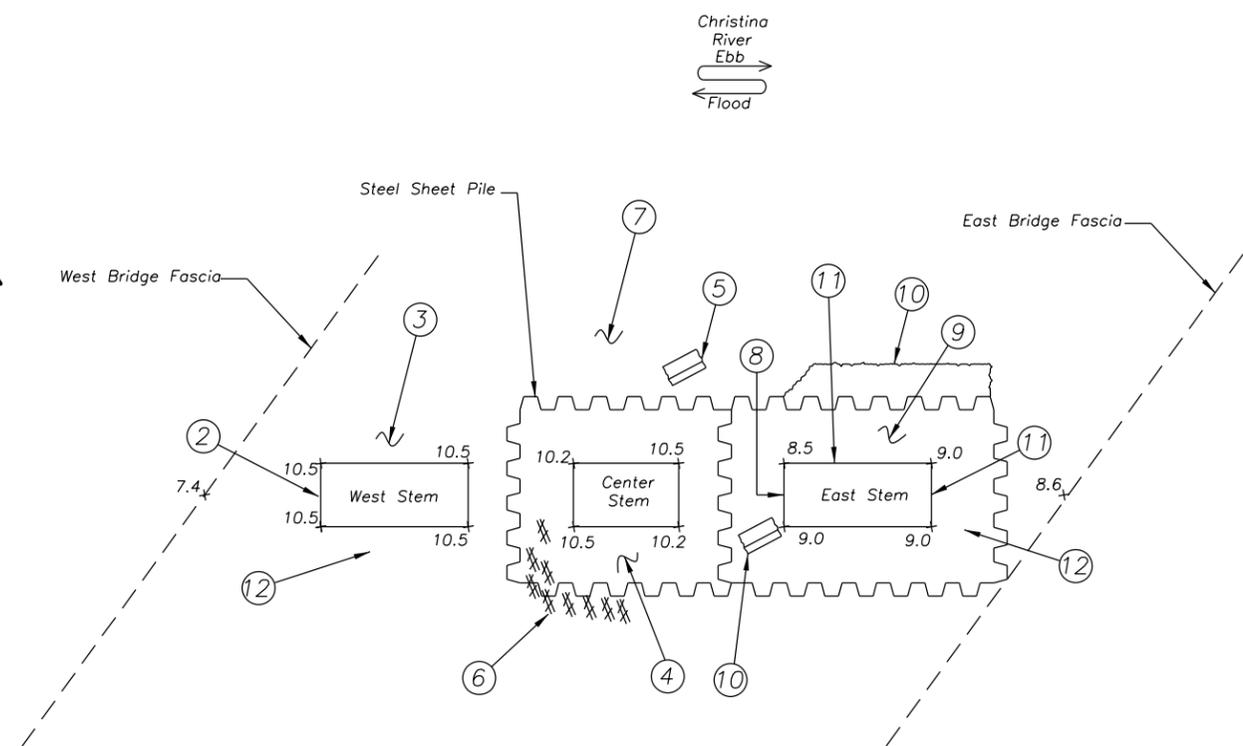
- ① The concrete surfaces of all Pier 1 Stems exhibit up to 1/2-inch deep scaling from the mean high waterline to the channel bottom.
- ② Steel sheet pile is approximately 4.5-feet off the north face of all pier stems and extends to the centerline of the east and west faces of all pier stems. The steel sheet pile extends out of the channel bottom approximately 1.2-feet. The sheeting is in good condition with minor surface corrosion.
- ③ Section of steel H-pile, 6-feet long, is north of the steel sheet piling at the East Stem.
- ④ Within the steel sheet pile, gravel with up to 2-inches of probe rod penetration existed.
- ⑤ The channel bottom outside the steel sheet pile consists of sandy silt with up to 3-feet of probe rod penetration.



LEGEND:

- x X.X Indicates water depth at the time of inspection in feet
- # Inspection note number

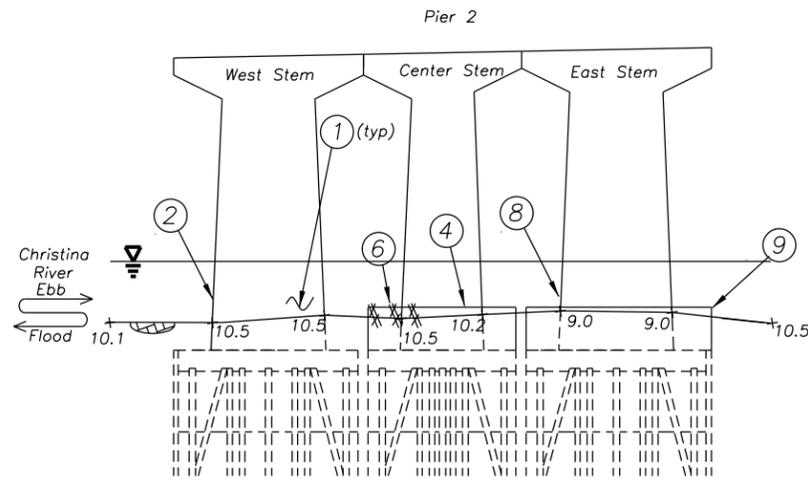
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INTERSTATE 95 OVER CHRISTINA RIVER BRIDGE NO. 1-744-059		
PIER 1 INSPECTION DETAILS		
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JOB NO.: WTR01402		FIGURE NO.: 2
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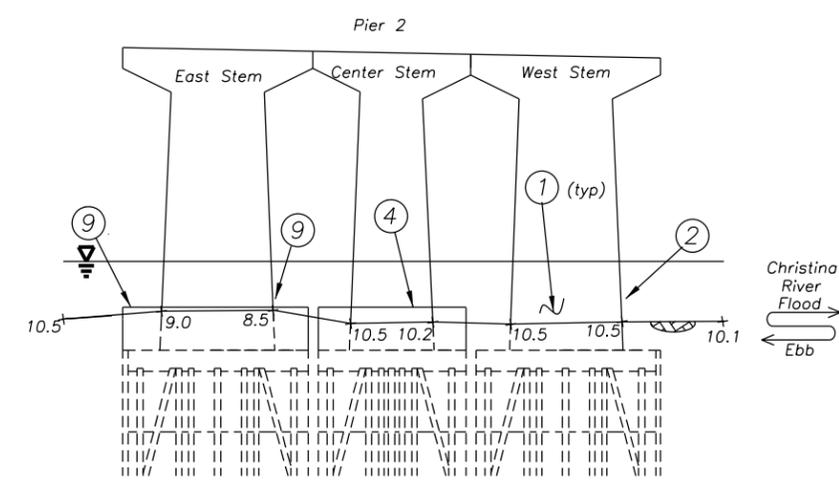
PLAN

INSPECTION NOTES:

- ① The concrete surfaces of all Pier 2 Stems exhibit a band of up to 3/4-inch scaling from 1-foot up from the mudline to 5-feet above the mudline.
- ② Spalling on the west nose of the West Stem, extending from the waterline to 2-feet below the waterline measuring 3.5' W x 3" D with exposed corroded steel reinforcement (5 vertical and 3 horizontal steel bars) with up to 60% section loss.
- ③ The channel bottom in the vicinity of the West Stem consists of gravel with up to 1-inch of probe rod penetration.
- ④ Steel sheet pile was exposed around the Center Stem, the top of the steel sheet pile was 2 to 2.5-feet from the mudline. The top of the footing was exposed along the north and south faces of the Center Stem inside the steel sheet pile. Within the steel sheet pile along the east and west faces of the Center Stem, sandy gravel with up to 1-foot probe rod penetration exists.
- ⑤ A section of a steel H-pile, 6-feet long, is on the channel bottom along the north face of the exposed steel sheet pile at the Center Stem.
- ⑥ Minor timber debris is present at the west nose of the Center Stem and extends 6-feet east, down the south face of the steel sheet pile.
- ⑦ The channel bottom outside the steel sheet pile the stems consists of sand with up to 4-inches probe rod penetration.
- ⑧ An area of spalling is present on the west nose of the East Stem extending from the waterline to 2.5-feet below the waterline measuring 3.5' W x 2.5" D with exposed corroded steel reinforcement (6 vertical and 2 horizontal rebars) with up to 30% section loss.
- ⑨ Steel sheet pile is exposed around the entire East Stem with the top of the steel sheet pile located 2 to 2.5-feet from the mudline. Within the steel sheet pile, there is gravel with 0-inches of probe rod penetration covering the footing. At the west nose there was a 3-foot long section of steel H-pile on the gravel.
- ⑩ Concrete overpour exists along the north face of the steel sheet pile from the west quarter point to the northeast corner at the East Stem. The overpour extends 2 to 3-feet out from the north face of the steel sheet pile with 6 to 18-inches of vertical exposure.
- ⑪ There is scaling in the East Stem measuring 2' H x 1 1/2" D. The scaling starts at gravel inside sheeting and extends around the perimeter.
- ⑫ The West and East Stem footings are exposed around the full perimeter.



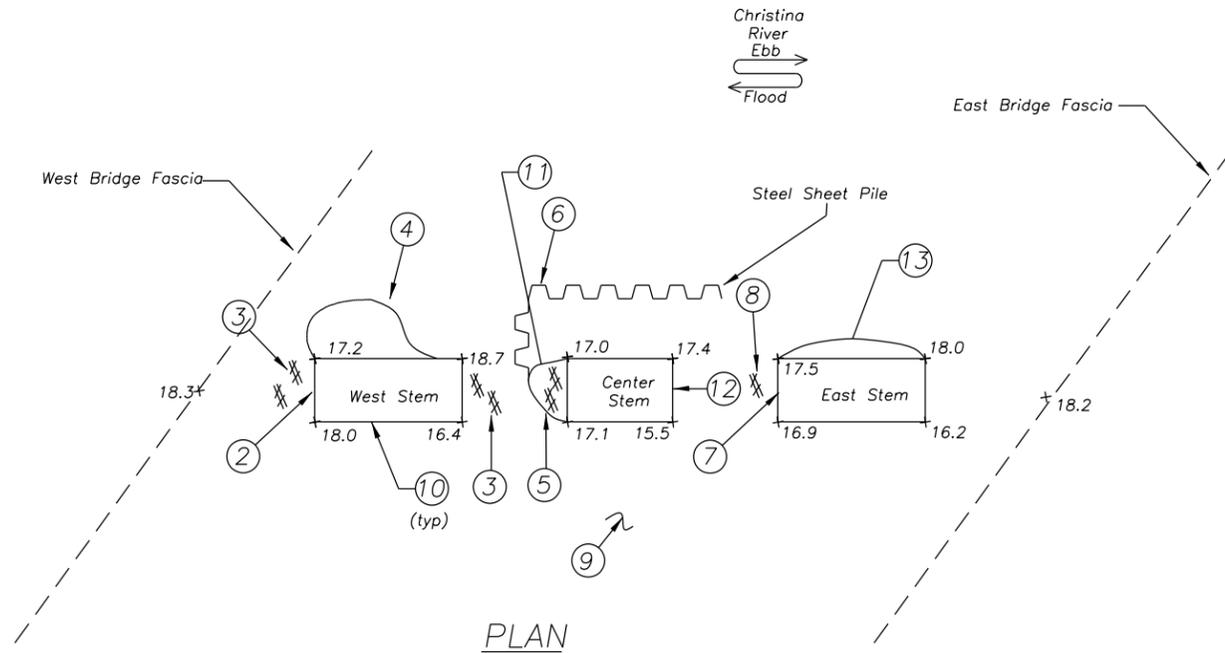
SOUTH ELEVATION



NORTH ELEVATION

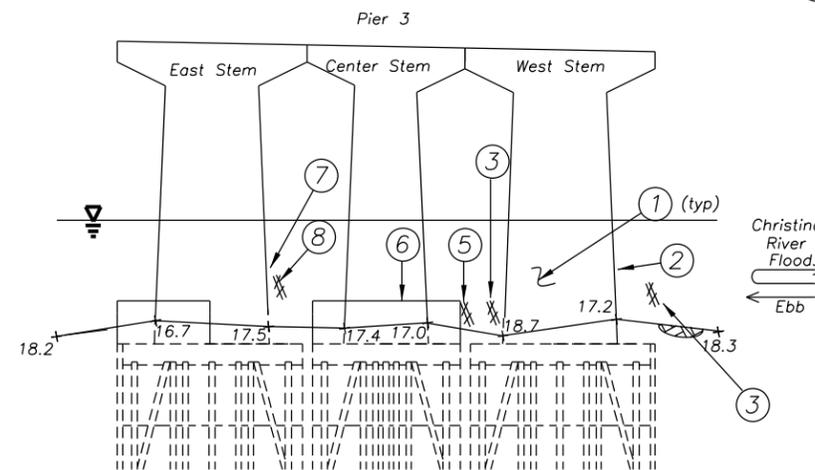
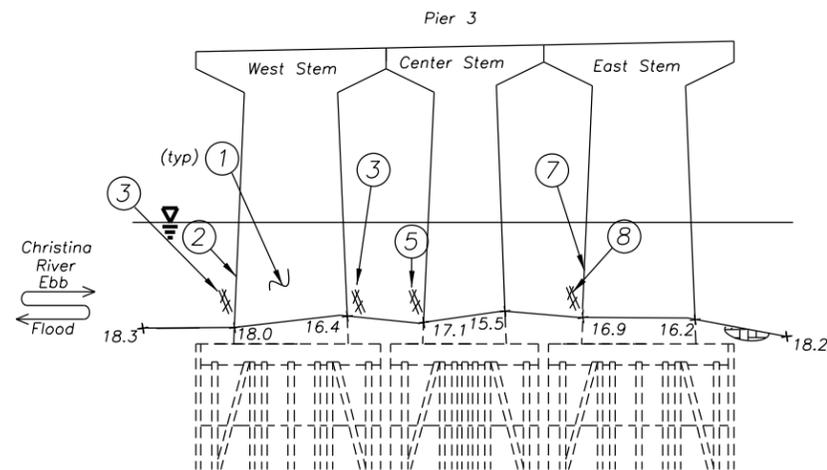
- LEGEND:
- x x.x Indicates water depth at the time of inspection in feet
 - # Inspection note number
 - ⌘ Timber debris

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PIER 2 INSPECTION DETAILS		
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JOB NO.: WTRQ1402		SCALE: N.T.S. FIGURE NO.: 3



INSPECTION NOTES:

- ① The concrete surfaces of all Pier 3 Stems exhibits a band of up to 1-inch deep scaling from the high water mark to the waterline.
- ② Area of spalling on the west nose of the West Stem extending from the waterline to 5-feet below the waterline measuring 3.5' W x 3" D with exposed corroded steel reinforcement (3 vertical and 2 horizontal steel bars) with 20% section loss.
- ③ Minor accumulations of timber debris measuring 2 to 6-inches in diameter exists at the east and west noses of the West Stem at the channel bottom.
- ④ A 10-foot long scour depression extended 3-feet off the north face of the West Stem and was 1-foot deep.
- ⑤ Minor accumulations of timber debris measuring 3 to 12-inches in diameter exists at the west nose of the Center Stem.
- ⑥ Steel sheet pile is exposed 14-feet below the waterline from the northeast corner of the Center Stem, along the north face, and terminated into the channel bottom at the centerline of the west face.
- ⑦ An area of scaling/spalling on the west nose of the East Stem extending from the waterline to 2.5-feet below the waterline measuring 3.5' W x 3" D with exposed corroded steel reinforcement (1 horizontal bar).
- ⑧ Minor accumulations of timber debris consisting of branches measuring up to 12-inches in diameter exists at the west nose of the East Stem.
- ⑨ The channel bottom in the vicinity of the pier consists of sand and gravel with up to 6-inches of probe rod penetration.
- ⑩ There is a band of deterioration 6-feet below the waterline measuring 2' H x 1 1/2" D on all faces of the pier stems.
- ⑪ A 3-foot wide scour depression extended 3-feet off the west face of the Center Stem and was 1-foot deep.
- ⑫ There is a 14' H x up to 1/16" W vertical crack on the east face of the Center Stem, starting at 4 feet below the waterline and extending up.
- ⑬ A full-width scour depression extended 3-feet off the north face of the East Stem and was 1-foot deep.



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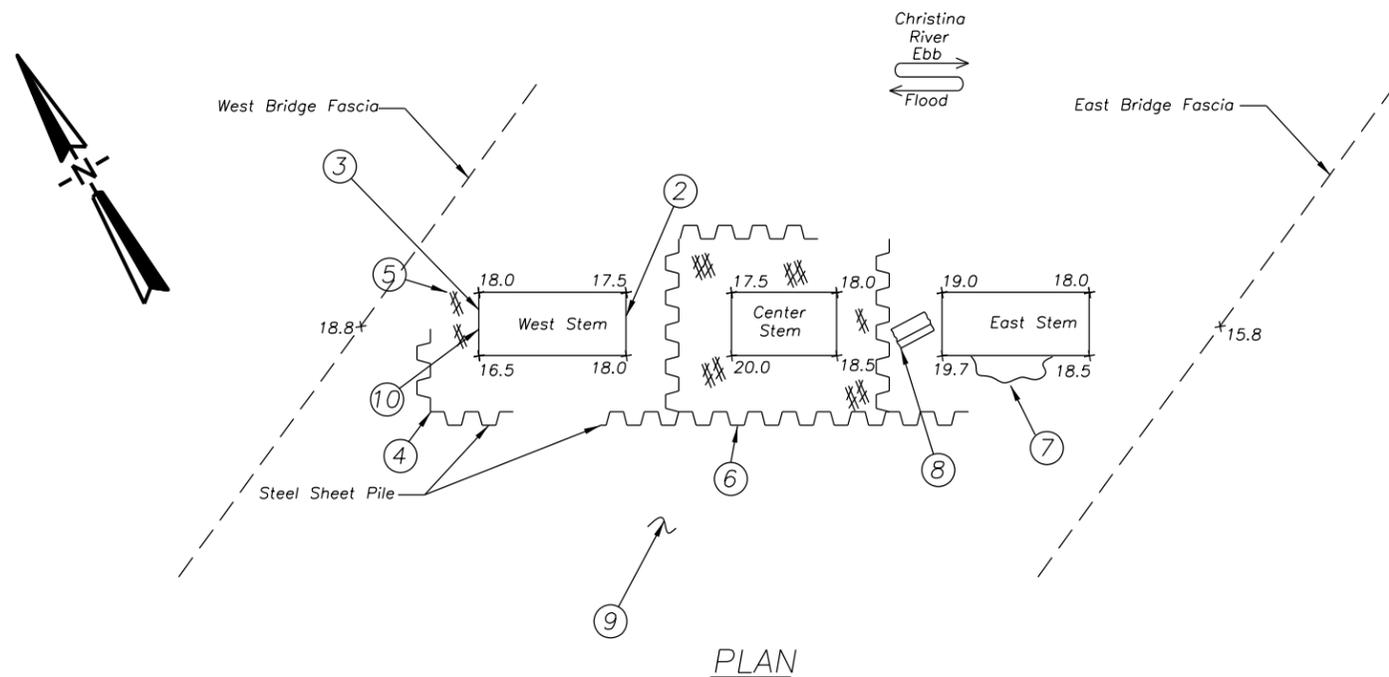
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- # Inspection note number
- X Timber debris

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BRIDGE NO. 1-744-059

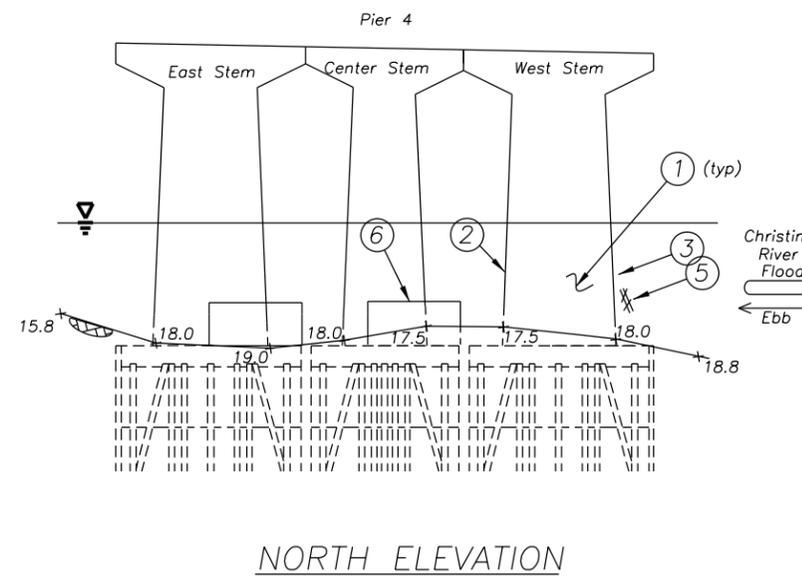
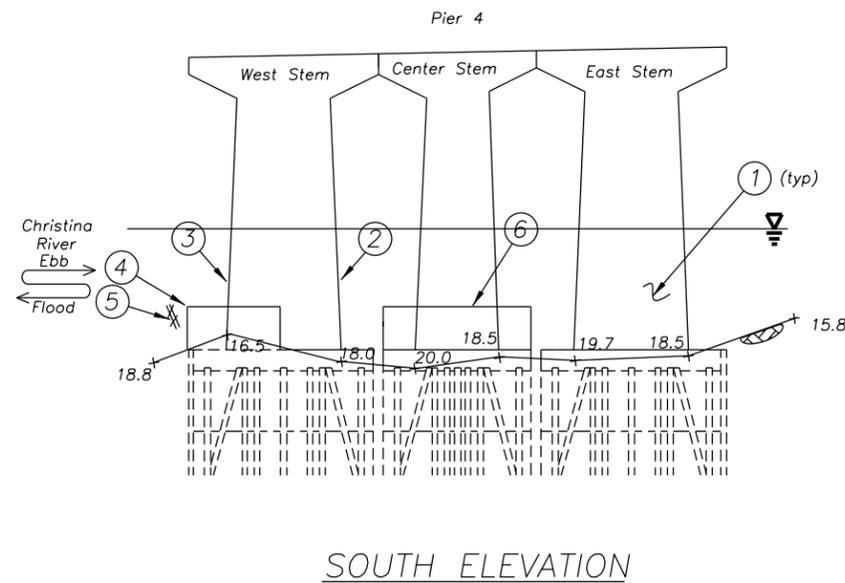
PIER 3 INSPECTION DETAILS

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INSPECTION NOTES:

- ① The concrete surfaces of all Pier 4 Stems exhibits a band of up to 1-inch deep scaling, 3 to 5-feet high, 3-feet below the waterline.
- ② Area of spalling on the east nose of the West Stem extending from 1 to 2.5 feet below the waterline measuring 3.5' W x 3" D with exposed corroded steel reinforcement.
- ③ Area of spalling on the west nose of the West Stem extending from 1 to 2.5 feet below the waterline measuring 3.5' W x 3" D with exposed corroded steel reinforcement (1 vertical and 1 horizontal steel bar).
- ④ Steel sheet pile is exposed from the centerline of the west nose of the West Stem extending to the southwest corner of the pier and extended 6-feet east on the south face of the pier. The steel sheet pile extended approximately 3-feet out of the channel bottom.
- ⑤ Moderate accumulations of timber debris consisting of branches measuring 6 to 12-inches in diameter exists at the west nose of the West Stem.
- ⑥ Steel sheet pile is exposed at the Center Stem along the south face, east face, west face, and extended 15-feet east along the north face from the northwest corner. The steel sheet pile extended approximately 2-feet out of the channel bottom. The top of the footing is exposed along the south face and west face inside the steel sheet pile.
- ⑦ The top of the footing at the East Stem is exposed along the south face of the pier and extended 2 to 4-feet off the pier stem.
- ⑧ Steel debris measuring approximately 4-feet long exists on the channel bottom at the west face of the East Stem.
- ⑨ The channel bottom in the vicinity of the pier consists of sand and gravel with up to 2-inches of probe rod penetration.
- ⑩ There is a 30' H x 1/16" W vertical crack starting 5-feet below the waterline, extending up the center of the west face of the West Stem.



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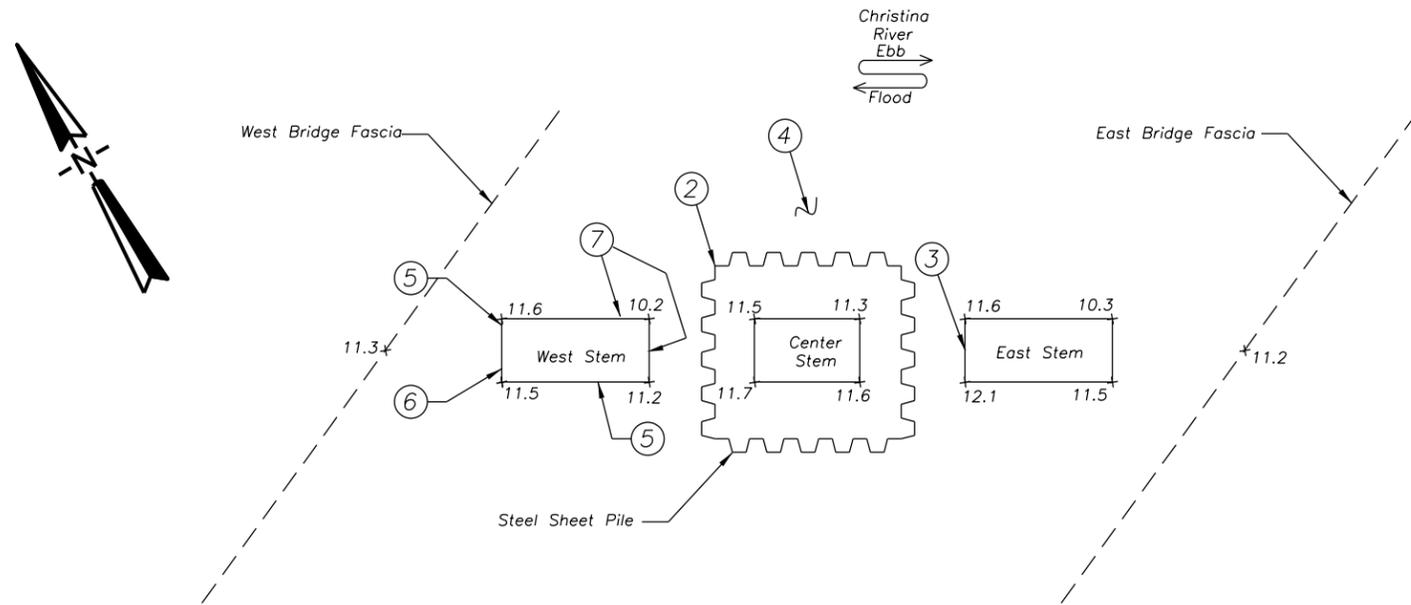
- x X.X Indicates water depth at the time of inspection in feet
- # Inspection note number
- ⌘ Timber debris

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PIER 4 INSPECTION DETAILS

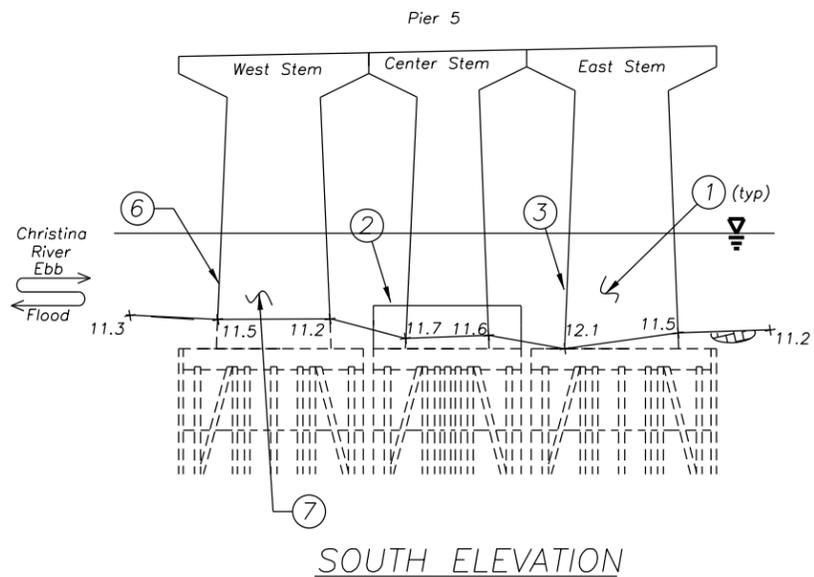
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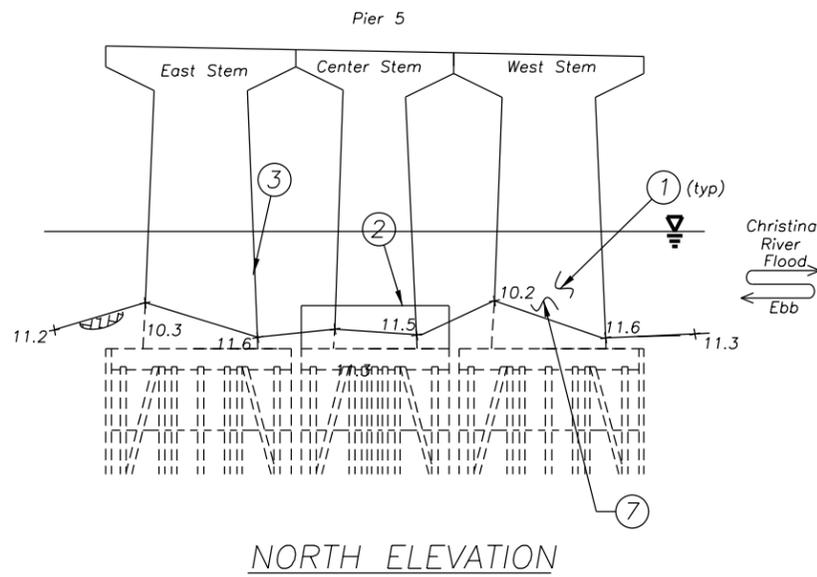
PLAN

INSPECTION NOTES:

- ① The concrete surfaces of all Pier 5 Stems exhibits a band of 1up to 1-inch deep scaling from the low water mark to 6-feet below the waterline.
- ② Steel sheet pile is exposed around the Center Stem and extended approximately 3.5-feet out from the channel bottom. The top of the footing is exposed within the steel sheet pile.
- ③ Area of scaling at the north and west faces of the East Stem measuring 2' H x 8' L x 3" D and 2' H x FW x 3" D, respectively, with exposed corroded vertical and horizontal steel reinforcement, 4-feet off the mudline.
- ④ The channel bottom in the vicinity of the pier consists of gravel and concrete debris measuring 3 to 8-inches in diameter.
- ⑤ There is map cracking and a 1/32-inch wide vertical crack extending 15-feet up from the band of scaling on the west face of the West Stem.
- ⑥ The scaling on the west face of the West Stem is 2' H x FW x 6" D with exposed corroded steel reinforcement (4 horizontal and 5 vertical steel bars) with up to 90% section loss, 4-feet off the mudline.
- ⑦ The scaling on the north, south, and east faces of the West Stem is 4' H x FW x 3" D with exposed steel reinforcement (1 horizontal steel bar), 2-feet off the mudline.



SOUTH ELEVATION



NORTH ELEVATION

LEGEND:

- x.X Indicates water depth at the time of inspection in feet
- # Inspection note number

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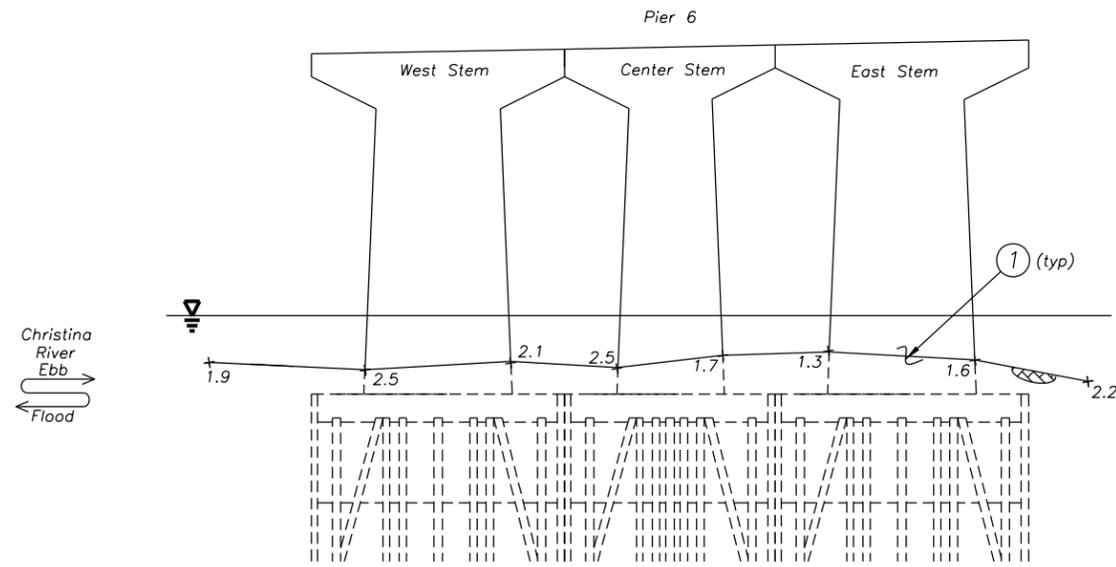
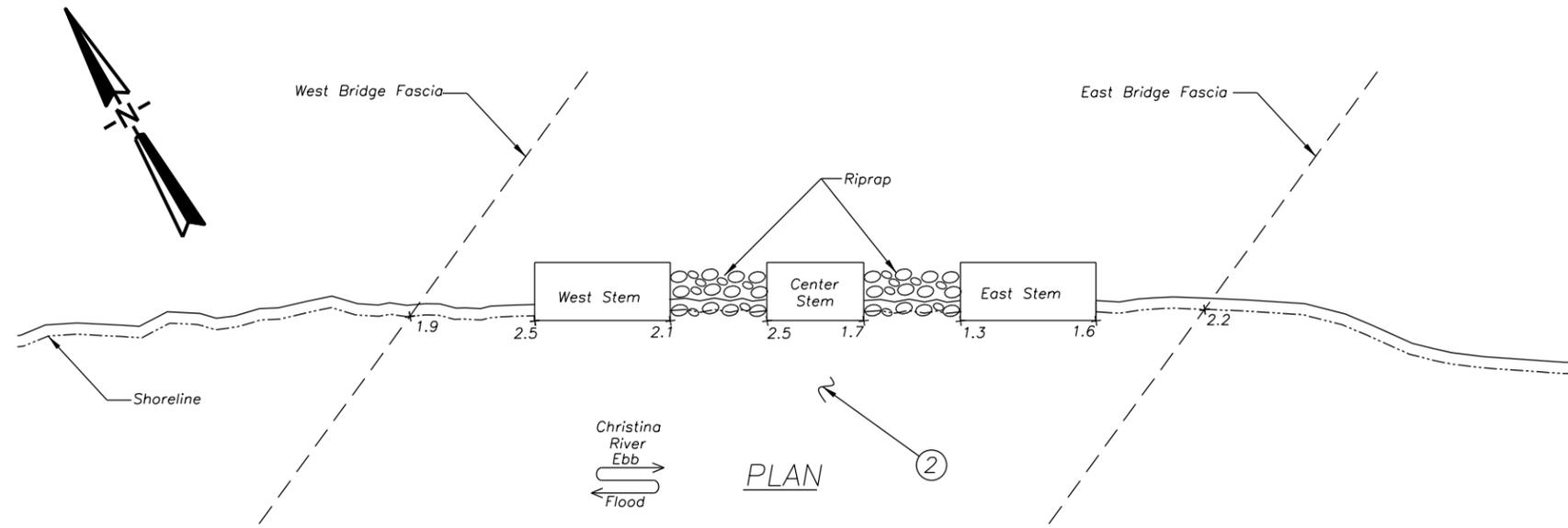
INTERSTATE 95 OVER CHRISTINA RIVER
BRIDGE NO. 1-744-059

PIER 5 INSPECTION DETAILS

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INSPECTION NOTES:

- ① The concrete surfaces of all Pier 6 Stems exhibits a band of up to 1/2-inch deep scaling from the mean high waterline to the mudline.
- ② The channel bottom in the vicinity of the pier consists of gravel and concrete debris measuring 3 to 8-inches in diameter with riprap between pier stems.



SOUTH ELEVATION

LEGEND:

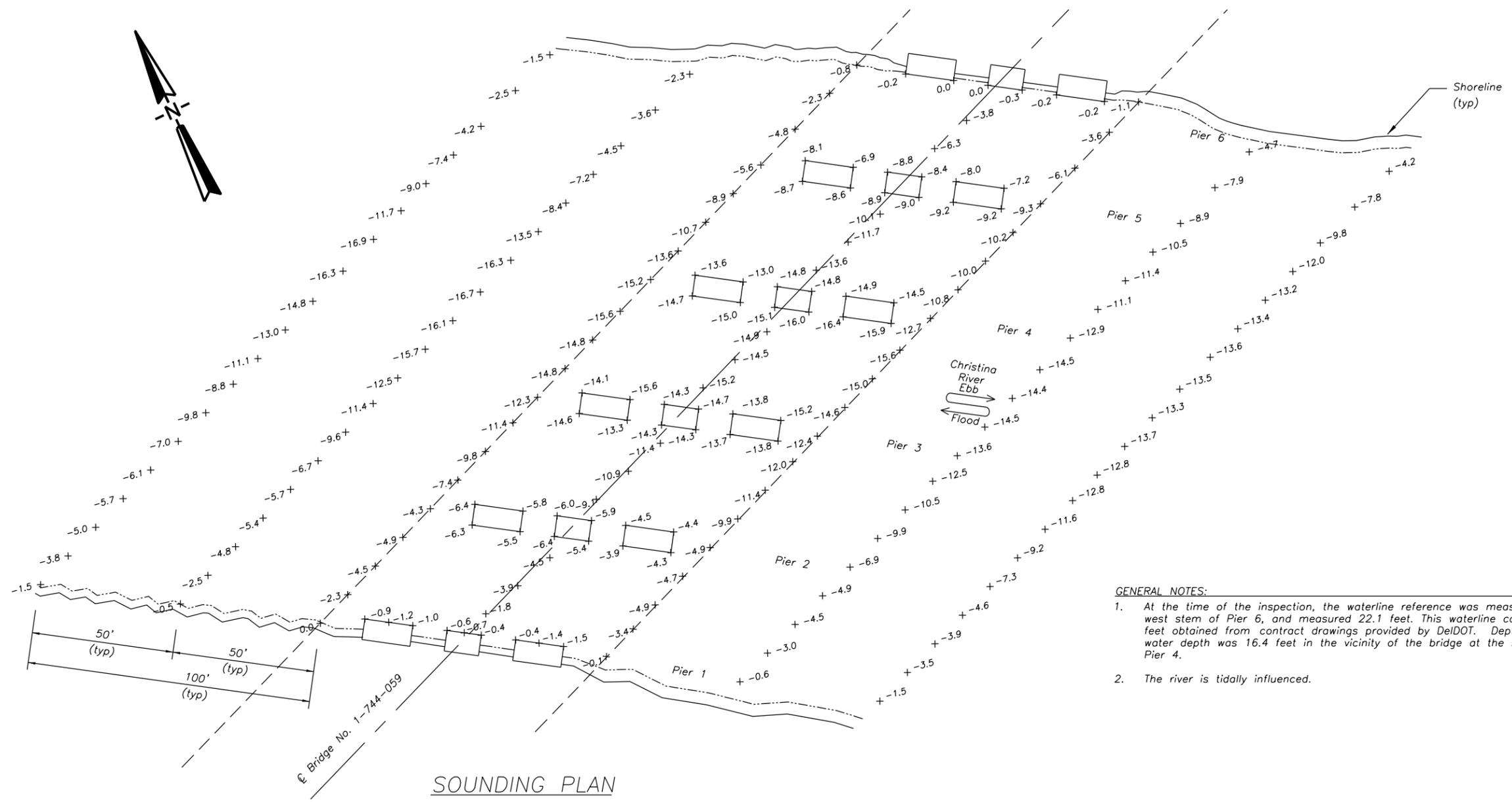
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- ① Inspection note number

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BRIDGE NO. 1-744-059

PIER 6 INSPECTION DETAILS

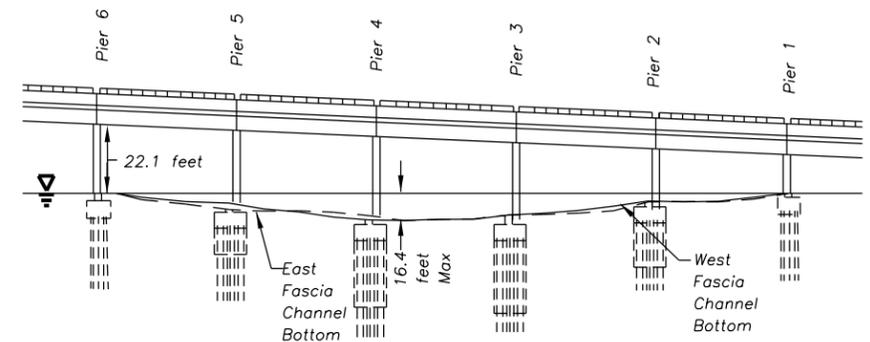
DRAWN BY: ATF		121 Continental Drive, Suite 207	DATE: 1/20/15
CHECKED BY: NRW		Newark, DE 19713	SCALE: N.T.S.
JOB NO.: WTRQ1402		www.pennoni.com	FIGURE NO.: 7



GENERAL NOTES:

1. At the time of the inspection, the waterline reference was measured from the southeast corner of the west stem of Pier 6, and measured 22.1 feet. This waterline corresponds to an actual elevation of 0.84 feet obtained from contract drawings provided by DelDOT. Depth soundings indicated that the maximum water depth was 16.4 feet in the vicinity of the bridge at the southwest corner of the east stem of Pier 4.
2. The river is tidally influenced.

LEGEND:
 + Indicates water depth at the time of inspection in feet
 (x) Inspection note number



WEST ELEVATION

DELAWARE DEPARTMENT OF TRANSPORTATION			
INTERSTATE 95 OVER CHRISTINA RIVER BRIDGE NO. 1-744-059			
BASE YEAR SOUNDING PLAN			
DRAWN BY: KPC	COLLINS ENGINEERS	10201 Lee Highway Suite B Fairfax, VA 22030 www.collinsengr.com	DATE: 4/21/10
CHECKED BY: TBW		SCALE: N.T.S.	
JOB NO.: 6428		FIGURE NO.: 8	