Report of Findings

Pier 5 Waterfront Facilities Inspection and Assessment

Boston Planning and Development Agency
1 City Hall Square #9
Boston, MA 02201

January 4, 2024
Project I.D.: 23B004

Solving our clients' toughest science and engineering challenges.

Waterfront Facilities Inspection and Assessment

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Executive Summary

Foth Infrastructure and Environment, LLC. (Foth) performed a topside waterfront facilities routine inspection of Pier 5 in the Charleston Navy Yard area of Boston, Massachusetts. The topside inspection was performed over three (3) working days between June and July of, 2023. The inspections were led by an on-site engineer within Foth's Ports & Harbors group. In total 368 individual structural elements were inspected, logged, and provided a damage rating.

The routine inspection focused on the following elements of Pier 5: piles and pile caps. The purpose of the routine inspection was to assess the general condition and assign damage ratings, as prescribed by the American Society of Civil Engineers (ASCE) Manuals and Reports on Engineering Practice No. 130 - Waterfront Facilities Inspection and Assessment (ASCE WFI 130).

Based on the observations and findings at the time of the inspection, the condition of the structure is as follows. See section 3.2 on page 16 for condition descriptions.

Pier 5 is overall in ***Serious*** condition.

BPDA Pier 5 Inspection Report

1. Introduction

1.1 Purpose / Agreement

Foth Infrastructure and Environment, LLC. (Foth) was contracted by the Boston Planning and Development Agency (BPDA) to perform a Waterfront Facilities Routine Inspection of Pier 5 located in the Charleston Navy Yard area of Boston, Massachusetts. The objective of the inspection was to provide a condition rating for Pier 5.

Foth performed the above water portions of the waterfront facilities routine inspection of Pier 5 from a small work vessel. The routine inspection was completed on July 12, 2023. Weather conditions varied over the course of the inspection. Inspections were focused three hours before and after low tide on each day.

Dates of Above Water Inspection: June 28, July 7, and July 12, 2023

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	Harrison Chouinard	Inspection Team Engineer
	Ethan Bowe	Inspection Team Engineer

This report reflects the conditions of the Waterfront Facilities located at Pier 5 that were present and visible at the time of the inspection. This report of findings has the purpose to assign condition ratings to each inspected element.

This report has been prepared for the exclusive use of the Boston Planning and Development Agency (BPDA). Any other use, publication, or the like of any data contained herein, by other parties without express consent of Foth is prohibited. The report was prepared by Wilton F. Gray IV, E.I.T., Paul Marsala, and Scott Skuncik, P.E. Questions or concerns regarding this report or the contents contained herein should be directed to Foth addressed to Scott Skuncik, P.E. at (401) 236-0361.

1.2 Scope and Limits of Work

The inspection included the following structures of Pier 5: Steel Piles and Concrete Pile Caps. This Inspection and Structural Assessment were performed in general compliance with ASCE Manuals and Reports on Engineering Practice No. 130 - Waterfront Facilities Inspection and Assessment (ASCE WFI 130). For clarity, the scope of services provided within this report are described below.

Foth mobilized a two-person inspection team to examine the above water conditions from a small work vessel. Inspections were targeted around low tide during each inspection day to maximize the extent of visible structures.

Topside structural inspections were conducted over three (3) days by Foth at Pier 5 during June and July of 2023. During the first day of inspections it was determined that access underneath the pier would not be possible due to the deteriorated state of the structure, specifically the potential for falling concrete and rebar. For safety, the inspections were limited to visible elements from the outer bents of the pier. Standards of practice were taken from the Waterfront Facilities Inspection and Assessment guidance published by the American Society of Civil Engineers (ASCE). Concrete pile caps were given a Level I inspection, using visual/tactile methods for 100% of the safely accessible caps in the outer row of the pier. Level II inspection, removing growth and corrosion near the waterline at low to mid tides and visually observing, was performed on 160 piles, approximately 10% of the total number of piles which is in line with the ASCE guidance. Of those 160 piles, 154 were measured for remaining steel thickness of the piles using a PosiTector Ultrasonic Thickness Gauge (UTG), well above the minimum recommended 5% of total piles, as recommended by ASCE. It was also observed that the most severe deterioration of the piles could be seen in the few feet below the Mean Low Water Line where thickness measurements could not be obtained, therefor thickness measurements should be considered conservative as they relate to the overall condition of the steel piles.

No underwater inspections were performed as part of this inspection. All inspection work was limited to elements which were above water and visible during the time of inspection. Additionally, all inspection work was performed from the perimeter of the pier and at no time did Foth enter further under the pier than the first row of piles due to safety concerns, as described later in this report.

1.3 Facility Background & Description of the Structure

Pier 5 is located in the Charleston Navy Yard area of Boston, Massachusetts. The pier was constructed by the US Navy in 1943, and is currently approximately 665' long by 125' wide. The pier is supported by approximately 1,650 steel H-piles. The piles are spliced longitudinally from shorter pile sections with 1" steel plate. The piles were encased in steel reinforced concrete jackets that extend down several feet below Mean Low Water. The deck and pile caps are constructed of reinforced concrete.

Pier 5 extends from the shoreline in a southeasterly direction. 1943 pile record plans show 116 bents of steel H-piles encased in reinforced concrete with the main pier consisting of 13 rows of piles per bent. Four (4) additional rows of battered piles supplement the vertical pile grid, and additional rows of piles support the wider section of pier at the shoreward-most edge. Each pile has a reinforced concrete pile cap which supports the reinforced concrete deck. Bents are aligned in a northeast to southwest direction, with the rows running perpendicular to the shoreline in a northwest to southeast direction.

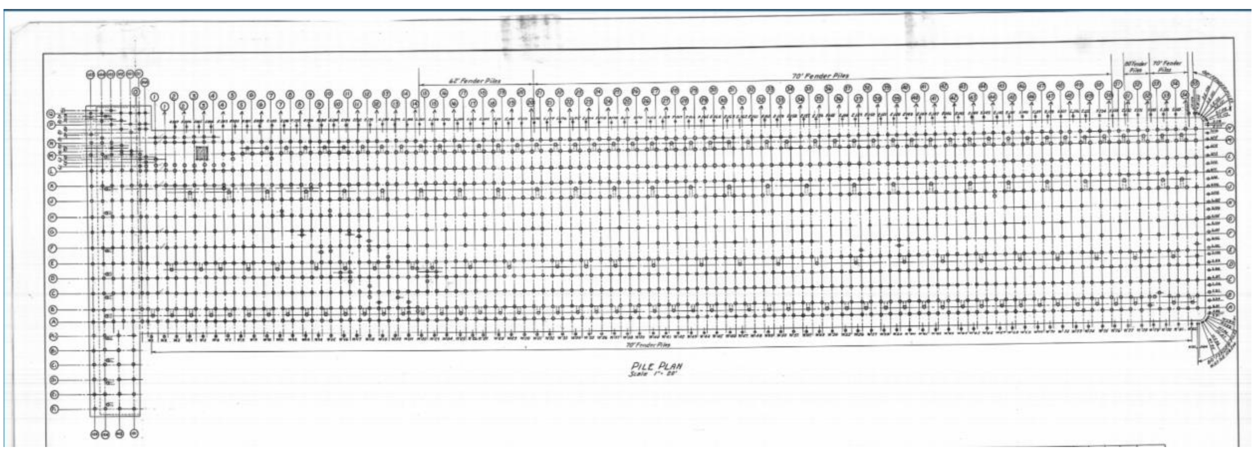

Figure 1 Pier 5 pile plan from 1943 record drawing.

Several rows of piles along the shoreward edge of the pier are behind a steel sheet pile wall and/or could not be inspected due to the mudline rising above Mean Low Water (MLW). Bents were numbered in the field, and Foth developed a plan to reference bents 1-116 throughout this report. Note that the field numbering for the purpose of photographs does not correspond to the corrected plan numbering due to the western bents being non-visible during the time of inspection.

2. Summary of Observations

Foth performed a visual inspection of the existing maritime infrastructure above the water line to determine the structural condition of the piles and pile caps at the project site. Level I visual inspection was performed on 13% of the structural elements to ascertain the condition of the existing infrastructure. Ultrasonic thickness (UT) readings were taken on approximately 100% of the accessible steel piles, or about 10% of the entire structure. Photographic documentation was collected of typical and noteworthy conditions.

2.1 Pile Cap Observations

Typical observations noted during the inspection of the pile caps included exposed reinforcing steel, deterioration of the concrete, structural cracking, and partial breakage of concrete and reinforcing steel.

2.2 Concrete Encased H Pile Observations

Typical observations noted during the inspection of the piles included that the majority of the piles were observed to be missing the concrete reinforcement and corrugated jackets. In areas where the jackets were missing, the reinforcing steel was exposed, broken or severely corroded with section loss in many piles. Additionally, the flanges of many of the steel H Piles were observed to be highly corroded with flaking steel and section loss on flanges at the approximate Mean Low Water Line. 36% of the measured steel H-piles showed section loss of more than 50%, and more than half of all measured piles (56%) showed section loss of more than 30%. Below the waterline more severe section loss could be observed than was measurable by the UT gauge, and several cases of complete section loss could be seen.

Because the structural significance of the reinforced concrete jackets are not known with 100% confidence at this time, the damage of this element was not considered in rating the damage of the steel h-pile elements. However, it should be noted that the due to the extreme deterioration of concrete as well as most of the reinforcing rebar on all observed piles that the damage rating for all piles would be "Severe" if these were included. Further, this can be said of many of the inner rows of piles that can be seen from outside the outer rows of piles but cannot be accessed close enough for a thorough inspection.

3. Evaluation and Assessment

3.1 Damage Ratings

An element level damage rating was assigned to each structural element inspected during the investigation. The rating reflects the damage of the individual element only and is independent of the element's structural importance and the type of inspection being conducted. The damage rating varies per element. The general rating terms are as follows: (NI) Not Inspected, (ND) No Defects, (MN) Minor, (MD) Moderate, (MJ) Major, (SV) Severe.

3.1.1 Pile Cap Damage Ratings

Pile caps were inspected visually from the exterior of the pier, and damage ratings were assigned with guidance from "Manuals and Reports on Engineering Practice No. 130" published by the ASCE and shown in Table 1 and Figure 2 below. Figure 3 shows pile cap 18E, which is an example of a "Major" damage element. Exposed reinforcement and chemical deterioration are the primary reasons for this damage assessment, with structural cracks and partial breakage supporting the assessment. Figure 4 shows pile cap 30E, which is an example of pile caps that were rated as having "Severe" damage. Specifically cited in this assessment are structural cracks wider than ¼" and exposed steel due to chemical deterioration. Figure 5 shows pile cap 26E and is an example of pile caps that were rated as having "Minor" damage.

Table 1 Damage Ratings for Reinforced Concrete Elements. Source: ASCE Manuals and Reports on Engineering Practice No. 130

Damage Rating		Existing Damage[a]	Exclusions [Defects Requiring Elevation to the Next Higher Damage Rating(s)]
NI	Not Inspected	• Not inspected, inaccessible, or passed by[b]	
ND	No Defects	• Good original hard surface, hard material, sound	
MN	Minor	• Mechanical abrasion or impact spalls up to 1 in. in depth • Occasional corrosion stains or small pop-out corrosion spalls • General cracks up to 1/16 in. in width	Minor damage not appropriate if • Structural damage • Corrosion cracks • Chemical deterioration[c]
MD	Moderate	• Structural cracks up to 1/16 in. in width • Corrosion cracks up to 1/4 in. in width • Chemical deterioration: Random cracks up to 1/16 in. in width; "Soft" concrete and/or rounding of corners up to 1 in. deep • Mechanical abrasion or impact spalls greater than 1 in. in depth	Moderate damage not appropriate if • Structural breakage and/or spalls • Exposed reinforcement • Loss of cross section due to chemical deterioration beyond rounding of corner edges
MJ	Major	• Structural cracks 1/16 in. to 1/4 in. in width and partial breakage (through section cracking with structural spalls) • Corrosion cracks wider than 1/4 in. and open or closed corrosion spalls (excluding pop-outs) • Multiple cracks and disintegration of surface layer due to chemical deterioration • Mechanical abrasion or impact spalls exposing the reinforcing	Major damage not appropriate if • Loss of cross section exceeding 30% due to any cause
SV	Severe	• Structural cracks wider than 1/4 in. or complete breakage • Complete loss of concrete cover due to corrosion of reinforcing steel with more than 30% of diameter loss for any main reinforcing bar • Loss of bearing and displacement at connections • Loss of concrete cover (exposed steel) due to chemical deterioration • Loss of more 30% of cross section due to any cause	

[a]Any defect listed is sufficient to identify relevant damage grade.
[b]If not inspected due to inaccessibility or passed by, note as such.
[c]Chemical deterioration: Sulfate attack, alkali-silica reaction, alkali-aggregate reaction, alkali-carbonate reaction ettringite distress, or other chemical/concrete deterioration.

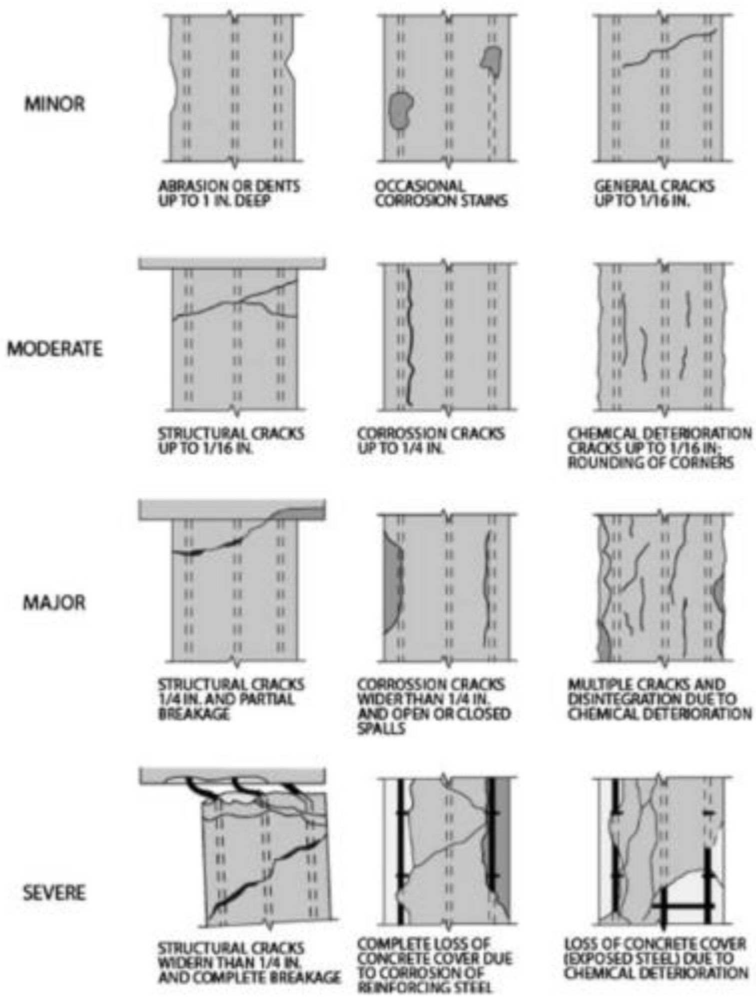

Figure 2 Damage ratings for reinforced concrete elements. Source: ASCE Manuals and Reports on Engineering Practice No. 130

Figure 3 Example of "Major" damage pile cap. Corresponds to corrected pile 18E on the Foth pile plan. Note exposed reinforcement and chemical deterioration with structural cracks.

Figure 4 Example of "Severe" damage pile cap. Corresponds to corrected pile 30E on the Foth pile plan. Note exposed reinforcement due to chemical deterioration and structural cracks >1/4".

Figure 5 Example of "Minor" damage pile cap. Corresponds to corrected pile 26E on the Foth pile plan. No visible corrosion cracks or chemical deterioration. Note corrosion stains and non-structural cracks <1/16".

In all, 74% of pile caps were found to have “Major” damage with 18% found to have “Severe” damage. The remaining 8% of pile caps were found to have “Minor” damage. A color-coded plan of the pile cap damage assessment can be found in **Appendix A**. Concrete Encased H-Pile Damage Ratings
The steel H-piles that support Pier 5 were encased in reinforced concrete for the upper intertidal and dry portion of the piles. At present, the reinforced concrete encasement is severely deteriorated exposing the reinforcing rebar and flanges of the H-piles themselves on all but a few piles, On many piles the reinforcing rebar has corroded to the point of being completely missing. At several locations splice plates were observed, and the weld material was observed to have 100% deterioration.

To quantify the amount of section loss and overall deterioration of the steel H-piles, a PosiTector Ultrasonic Thickness Gauge (UTG) was used. In accordance with standard best practices, the most severely corroded section of each steel H-pile was targeted and marine growth and loose rust were removed. Then measurements were made with the UTG to determine the remaining thickness of steel. Remaining thickness of each pile was tabulated and compared to the original thickness, assumed to be that of an HP 14x102 steel pile of 0.705”, and percent loss calculated. Each measured pile was then assigned a damage rating according to the ASCE manual summarized in Table 2.

Table 2 Damage rating of steel H-piles according to percent loss from the ASCE manual, with percent of inspected H-piles falling within that damage rating category..

Damage Rating	%Loss Lower	%Loss Upper	% of Inspected Piles w/ This Damage Rating
Minor	0%	15%	30%
Moderate	15%	30%	14%
Major	30%	50%	21%
Severe	50%	100%	36%

Of the 154 H-piles measured for remaining steel thickness around the perimeter of the pier, 30% were categorized as Minor, 14% as Moderate, 21% as Major, and 36% as Severe damage. Photographic representative examples of these damages are shown in Figure 6 through Figure 10. A summary of the quantitative steel H-pile damage ratings in plan view can be found in **Appendix B**. A table summarizing the damage ratings of both the pile caps and steel h-piles can be found in **Appendix C**.

Figure 6 Minor damage H-pile example, pile 38-W on the Foth plan.

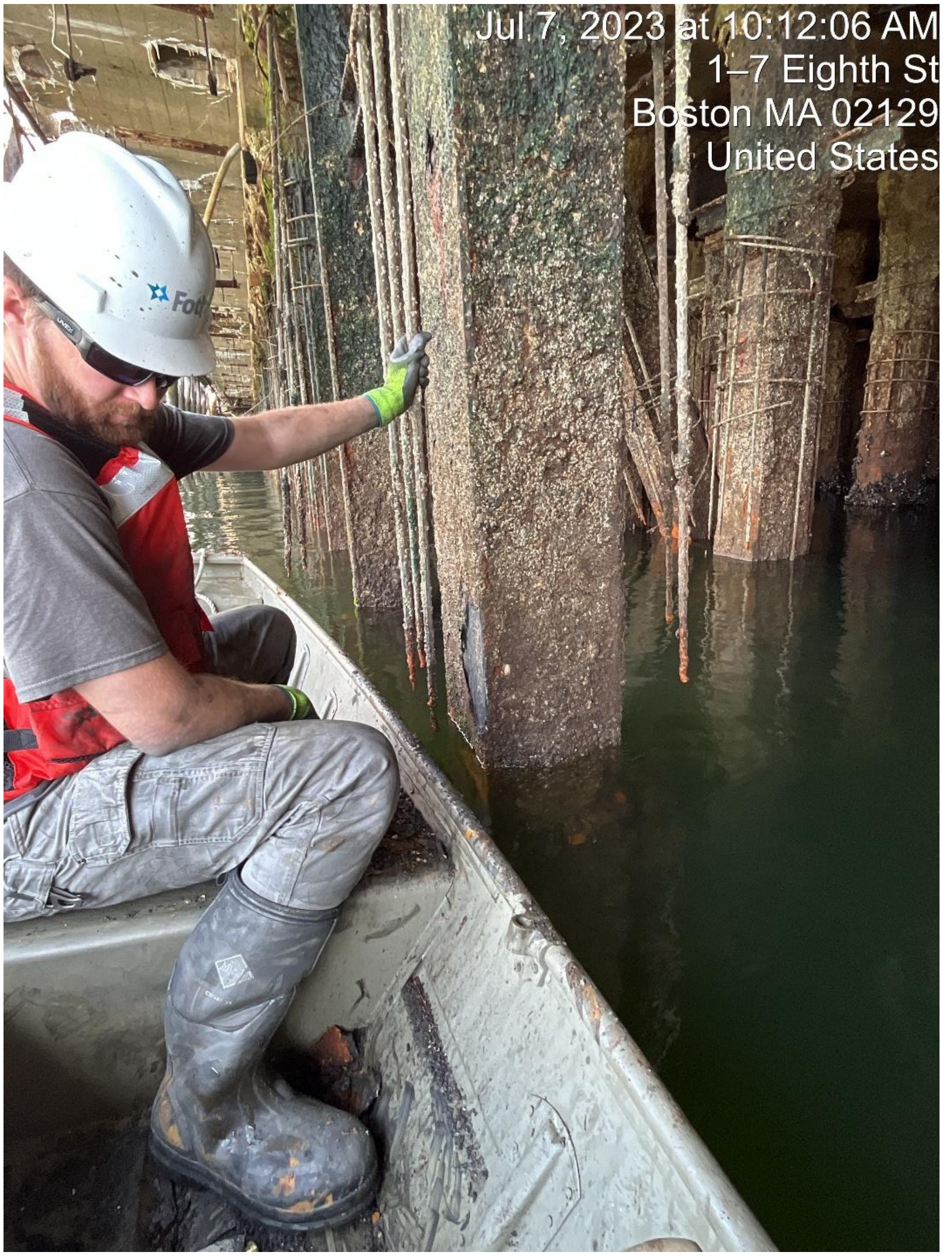

Figure 7 Pile 34-W, an example of a moderate damage pile. Measured steel thickness 0.51", 28% loss.

Figure 8 Pile 111-W, and example of a Major damage pile. Measured steel thickness of 0.47", 33% loss. Note the knifed edge that has corroded almost all the way through.

Figure 9 Pile 103-E, example of a Severe damage pile. Measured thickness of .015", 79% loss. Below the waterline it was noted that corrosion goes all the way through the flange.

Figure 10 Pile 102-W, another example of a Severe damage pile. 0.13" of steel measured, 82% loss. Complete loss of flange just below waterline.

3.2 Condition Assessment Ratings

Based off the observations and damage ratings provided, condition assessment ratings were provided to each group of structural elements. Condition Assessment Rating criteria from the ASCE WFI 130 (Table 2-14) were used. See definitions of the condition ratings below.

Definitions (Condition Ratings)

Not Inspected: Inaccessible or passed by.

Good: No visible or only minor damage was noted. Structural elements may show very minor deterioration, but no overstressing was observed. No repairs are required.

Satisfactory: Limited minor to moderate defects or deterioration are observed, but no overstressing was observed. No repairs are required.

Fair: All primary structural elements are sound, but minor to moderate defects or deterioration was observed. Localized areas of moderate to advanced deterioration may be present but do not significantly reduce the load-bearing capacity of the structure. Repairs recommended, but the priority of the recommended repairs are low.

Poor: Advanced deterioration or overstressing was observed on the widespread portions of the structure but does not significantly reduce the load-bearing capacity of the structure. Repairs may need to be carried out with moderate urgency.

Serious: Advanced deterioration overstressing, or breakage may have significantly affected the load-bearing capacity of primary structural components. Local failures are possible and loading restriction may be necessary. Repairs may be carried out on a high-priority basis with urgency.

Critical: Very advanced deterioration, overstressing or breakage has resulted in localized failure(s) of primary structure components. More widespread failures are possible or likely to occur, and load restrictions should be implemented as necessary. Repairs may need to be carried out on a very high priority basis with strong urgency.

3.2.1 Pier 5 Condition Assessment

Overall Pier 5 is in Serious condition due to the advanced deterioration on both the pile caps and the piles which have affected the load bearing capacity of primary structural components. Foth recommends that Pier 5 continue to be closed for public access until repairs to the Pier can be made.

4. Historical Inspection Review/Existing Documents

Obtaining quantitative measurements of the piles above is a crucial step in assessing the overall condition of the pier by allowing for an unbiassed designation of condition from field measured values. However, it cannot be ignored that the worst condition of the piles were observed to be at or below the low tide water elevation. While the field measurements were planned to take advantage of the lower half of the tide cycle to obtain measurements as close to the most severe pile condition as possible, a correlation between measured thickness and tide cycle is apparent. Therefor it should be understood that thickness measurements taken during this investigation, despite being accurate datapoints at the accessible elevations of the pile at the time, may show piles in better condition than they actually are. This is particularly true the farther from the low tide condition that measurements were taken.

While the Foth inspections were conducted independent of prior inspections and reports, the further deteriorated state of the structure below the low-tide line and available access of this inspection cannot be responsibly ignored. For this reason, documentation of the pier condition from below the low-tide waterline from previous inspections by others is documented below.

In November of 2017, Childs Engineering Corporation conducted an inspection of Pier 5 including an underwater dive inspection. This inspection revealed the poor condition of the splice plates, the majority of which are below the low water elevation. Figure 11 shows one of these splice plate locations where all weld material is missing. The 1987 inspection report by Childs indicated the same, finding that "Approximately 75% of the exposed [above mudline] splices have little or no weld material remaining. In some cases the plates are loose and have fallen off. On three piles the weld material is completely gone and the piles have shifted to a position of misalignment by approximately three inches." (Inspection and Analysis of the Existing Conditions of Pier 5 in the Charleston Navy Yard, 2017) Given the spliced nature of the H-piles, and the documented condition of those splices, the condition of the piles as determined from measuring the remaining steel above the waterline needs to be taken as an absolute best condition of the pile as a whole and likely does not accurately describe the condition of the structure.

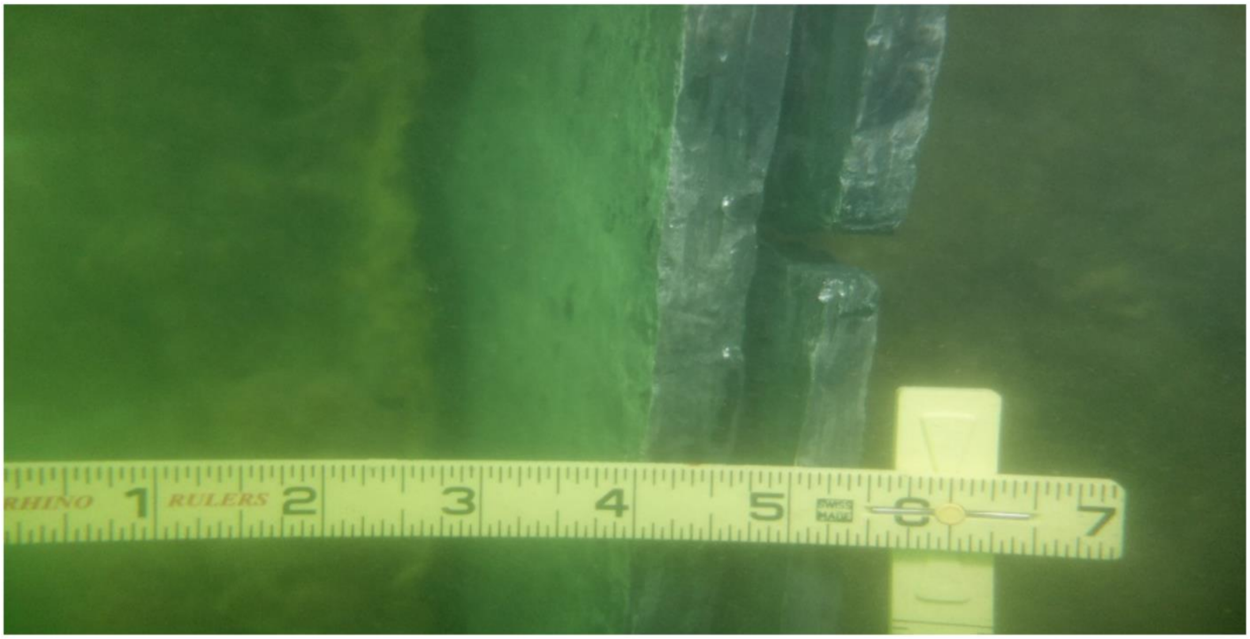

Figure 11 H-pile splice plate location showing complete loss of weld material. Source: Childs Engineering Corporation Pier 5 2017 Evaluation Report

Appendix A - Pile Cap Damage Rating Plan

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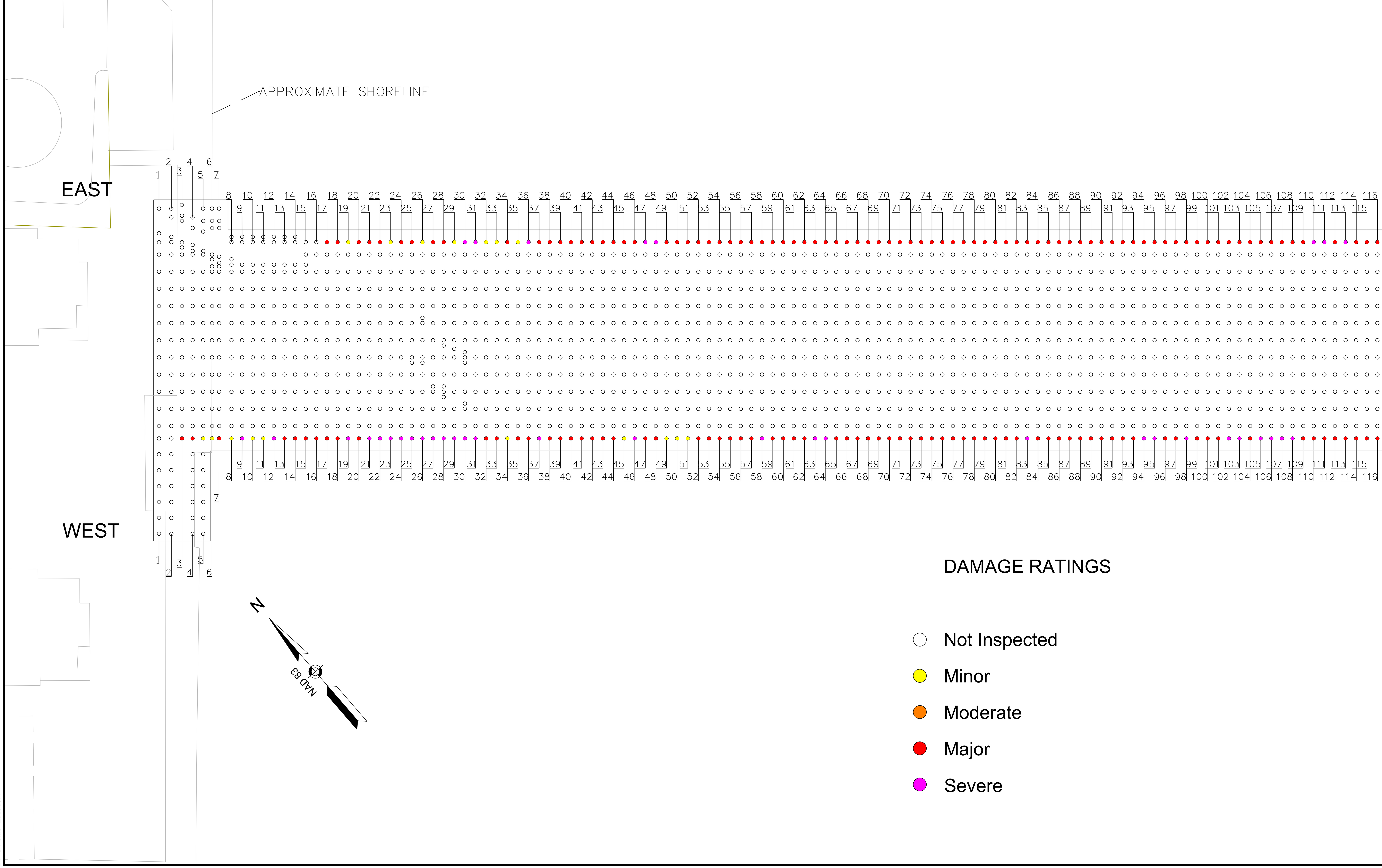
PILE CAP DAMAGE RATING FROM VISUAL INSPECTION



DAMAGE RATINGS

- Not Inspected
- Minor
- Moderate
- Major
- Severe

Foth

BOSTON PLANNING AND DEVELOPMENT AGENCY
BOSTON, MA

PIER 5 CONDITION ASSESSMENT REPORT

REVISIONS

NO	BY	DATE	DESCRIPTION
△			
△			
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DATE OF PREPARATION

	BY	DATE
SURVEYED	N/A	N/A
DRAWN	PMM	9/6/23
DESIGNED	N/A	N/A
CHECKED	SS	9/8

SHEET TITLE:
BPDA PIER 5

PILE CAP DAMAGE RATINGS

ISSUANCE:
INSPECTION REPORT

PROJECT NO: 0023B004.00

SHEET NUMBER
A02

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Appendix B - H-Pile Damage Rating Plan

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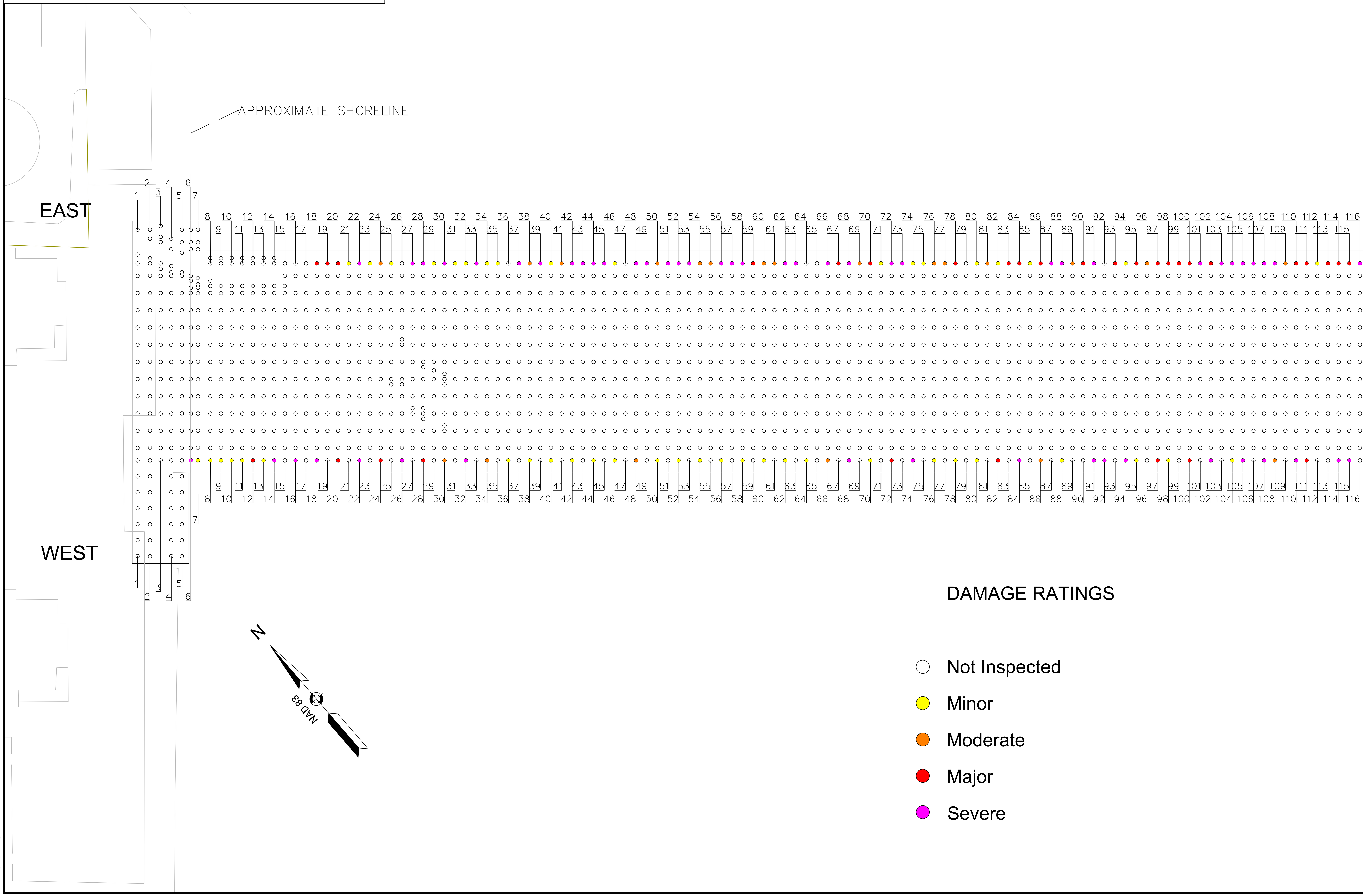
STEEL H PILE DAMAGE RATINGS
% LOSS FROM UT READINGS ASSUMES ORIGINAL H-PILES WERE HP 14X102



Foth

BOSTON PLANNING AND DEVELOPMENT AGENCY
BOSTON, MA

PIER 5 CONDITION ASSESSMENT REPORT

REVISIONS

NO	BY	DATE	DESCRIPTION

DATE OF PREPARATION

	BY	DATE
SURVEYED	N/A	N/A
DRAWN	PMM	9/6/23
DESIGNED	N/A	N/A
CHECKED	SS	9/8

SHEET TITLE:
BPDA PIER 5

H PILE DAMAGE RATINGS

ISSUANCE:
INSPECTION REPORT

PROJECT NO: 0023B004.00

SHEET NUMBER
A03

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Appendix C - Pile Cap and Steel H-Pile Inspection Summary Table

Boston Navy Yard Pier 5 Inspection June & July 2023

NI = Not Inspected

*Steel thickness measured with a PosiTector Ultrasonic Thickness Gauge (UTG)

*H-Pile % loss assumes the piles are HP 14x102

Foth Pile Plan ID	H-Pile Thickness Remaining (in.)*	H-Pile % Loss**	H-Pile Damage Rating	Pile Cap Damage Rating	Foth Pile Plan ID	H-Pile Thickness Remaining (in.)*	H-Pile % Loss**	H-Pile Damage Rating	Pile Cap Damage Rating
1-W	NI		NI	0	1-E	NI		NI	0
2-W	NI		NI	0	2-E	NI		NI	0
3-W	NI		NI	Major	3-E	NI		NI	0
4-W	NI		NI	Major	4-E	NI		NI	0
5-W	NI		NI	Minor	5-E	NI		NI	0
6-W	0.35	50%	Severe	Minor	6-E	NI		NI	0
7-W	0.64	9%	Minor	Major	7-E	NI		NI	0
8-W	0.63	11%	Minor	Minor	8-E	NI		NI	0
9-W	0.69	2%	Minor	Severe	9-E	NI		NI	0
10-W	0.67	5%	Minor	Minor	10-E	NI		NI	0
11-W	0.75	-6%	Minor	Minor	11-E	NI		NI	0
12-W	0.4	43%	Major	Severe	12-E	NI		NI	0
13-W				Major	13-E	NI		NI	0
14-W	0.31	56%	Severe	Major	14-E	NI		NI	0
15-W	NI		NI	Major	15-E	NI		NI	0
16-W	0.32	55%	Severe	Major	16-E	NI		NI	0
17-W	NI		NI	Major	17-E	NI		NI	Major
18-W	0.24	66%	Severe	Major	18-E	0.38	46%	Major	Major
19-W	NI		NI	Severe	19-E	0.4	43%	Major	Minor
20-W	0.36	49%	Major	Major	20-E	0.37	48%	Major	Major
21-W	NI		NI	Severe	21-E	0.71	-1%	Minor	Major
22-W	0.23	67%	Severe	Severe	22-E	0.29	59%	Severe	Major
23-W	NI		NI	Severe	23-E	0.7	1%	Minor	Minor
24-W	0.41	42%	Major	Severe	24-E	0.55	22%	Moderate	Major
25-W	NI		NI	Severe	25-E	0.79	-12%	Minor	Major
26-W	0.2	72%	Severe	Severe	26-E	NI		NI	Minor
27-W	NI		NI	Severe	27-E	0.18	74%	Severe	Major
28-W	0.4	43%	Major	Severe	28-E	0.23	67%	Severe	Major
29-W	NI		NI	Severe	29-E	0.71	-1%	Minor	Minor
30-W	0.57	19%	Moderate	Severe	30-E	0.26	63%	Severe	Severe
31-W	NI		NI	Severe	31-E	0.67	5%	Minor	Severe
32-W	0.28	60%	Severe	Major	32-E	0.68	4%	Minor	Minor
33-W	NI		NI	Major	33-E	0.25	65%	Severe	Minor
34-W	0.51	28%	Moderate	Minor	34-E	0.7	1%	Minor	Major
35-W	NI		NI	Major	35-E	0.65	8%	Minor	Minor
36-W			Minor	Major	36-E	NI		NI	Severe
37-W	NI		NI	Severe	37-E	0.14	80%	Severe	Major
38-W	0.61	13%	Minor	Major	38-E	0.57	19%	Moderate	Major
39-W	NI		NI	Major	39-E	0.2	72%	Severe	Major
40-W	0.68	4%	Minor	Major	40-E	0.68	4%	Minor	Major
41-W	NI		NI	Major	41-E	0.56	21%	Moderate	Major
42-W	0.72	-2%	Minor	Major	42-E	0	100%	Severe	Major
43-W	NI		NI	Major	43-E	0.05	93%	Severe	Major
44-W	0.7	1%	Minor	Major	44-E	0.23	67%	Severe	Major
45-W	NI		NI	Minor	45-E	0.21	70%	Severe	Major
46-W	0.69	2%	Minor	Severe	46-E	0.63	11%	Minor	Major
47-W	NI		NI	Major	47-E	NI		NI	Severe
48-W	0.59	16%	Moderate	Major	48-E	0.11	84%	Severe	Severe
49-W	NI		NI	Minor	49-E	0.3	57%	Severe	Major
50-W	0.64	9%	Minor	Minor	50-E	0.56	21%	Moderate	Major
51-W	NI		NI	Minor	51-E	0.17	76%	Severe	Major
52-W	0.73	-4%	Minor	Major	52-E	0.22	69%	Severe	Major
53-W	NI		NI	Major	53-E	0.18	74%	Severe	Major
54-W	0.72	-2%	Minor	Major	54-E	0.52	26%	Moderate	Major
55-W	NI		NI	Major	55-E	0.57	19%	Moderate	Major
56-W	0.74	-5%	Minor	Major	56-E	0.32	55%	Severe	Major
57-W	NI		NI	Major	57-E	0.22	69%	Severe	Major
58-W	0.72	-2%	Minor	Severe	58-E	0.16	77%	Severe	Major
59-W	NI		NI	Major	59-E	0.37	48%	Major	Major
60-W	0.68	4%	Minor	Major	60-E	0.56	21%	Moderate	Major
61-W	NI		NI	Major	61-E	0.57	19%	Moderate	Major
62-W	0.69	2%	Minor	Major	62-E	0.21	70%	Severe	Major
63-W	NI		NI	Severe	63-E	0.1	86%	Severe	Major
64-W	0.63	11%	Minor	Severe	64-E	NI		NI	Major
65-W	NI		NI	Major	65-E	NI		NI	Major
66-W	0.55	22%	Moderate	Major	66-E	0.3	57%	Severe	Major
67-W	NI		NI	Major	67-E	0.49	30%	Major	Major

68-W	0.3	57%	Severe	Major	68-E	0.15	79%	Severe	Major
69-W	NI		NI	Major	69-E	0.52	26%	Moderate	Major
70-W	0.74	-5%	Minor	Major	70-E	0.39	45%	Major	Major
71-W	NI		NI	Major	71-E	0.64	9%	Minor	Major
72-W	0.39	45%	Major	Major	72-E	0.23	67%	Severe	Major
73-W	NI		NI	Major	73-E	0.31	56%	Severe	Major
74-W	0.28	60%	Severe	Major	74-E	0.64	9%	Minor	Major
75-W	NI		NI	Severe	75-E	0.68	4%	Minor	Major
76-W	0.65	8%	Minor	Major	76-E	0.53	25%	Moderate	Major
77-W	NI		NI	Major	77-E	0.53	25%	Moderate	Major
78-W	0.61	13%	Minor	Major	78-E	0.41	42%	Major	Major
79-W	NI		NI	Major	79-E	NI		NI	Major
80-W	0.67	5%	Minor	Major	80-E	0.65	8%	Minor	Major
81-W	NI		NI	Major	81-E	0.58	18%	Moderate	Major
82-W	0.44	38%	Major	Major	82-E	0.64	9%	Minor	Major
83-W	NI		NI	Severe	83-E	0.41	42%	Major	Major
84-W	0.33	53%	Severe	Major	84-E	0.38	46%	Major	Major
85-W	NI		NI	Major	85-E	0.72	-2%	Minor	Major
86-W	0.55	22%	Moderate	Major	86-E	0.43	39%	Major	Major
87-W	NI		NI	Major	87-E	0.29	59%	Severe	Major
88-W	0.64	9%	Minor	Major	88-E	0.24	66%	Severe	Major
89-W	NI		NI	Major	89-E	0.52	26%	Moderate	Major
90-W	NI		NI	Major	90-E	0.47	33%	Major	Major
91-W	0.3	57%	Severe	Major	91-E	0.22	69%	Severe	Major
92-W	0.33	53%	Severe	Major	92-E	NI		NI	Major
93-W	NI		NI	Major	93-E	0.41	42%	Major	Major
94-W	0.13	82%	Severe	Severe	94-E	0.69	2%	Minor	Major
95-W	0.69	2%	Minor	Severe	95-E	0.44	38%	Major	Major
96-W	NI		NI	Major	96-E	0.51	28%	Moderate	Major
97-W	0.4	43%	Major	Major	97-E	0.4	43%	Major	Major
98-W	0.75	-6%	Minor	Severe	98-E	0.42	40%	Major	Major
99-W	NI		NI	Major	99-E	0.4	43%	Major	Major
100-W	0.39	45%	Major	Major	100-E	0.36	49%	Major	Major
101-W	NI		NI	Major	101-E	0.25	65%	Severe	Major
102-W	0.13	82%	Severe	Severe	102-E	0.37	48%	Major	Major
103-W	NI		NI	Severe	103-E	0.15	79%	Severe	Major
104-W	0.68	4%	Minor	Major	104-E	0.28	60%	Severe	Major
105-W	0.27	62%	Severe	Severe	105-E	0.31	56%	Severe	Major
106-W	NI		NI	Severe	106-E	0.26	63%	Severe	Major
107-W	0.25	65%	Severe	Severe	107-E	0.28	60%	Severe	Major
108-W	0.52	26%	Moderate	Severe	108-E	0.31	56%	Severe	Major
109-W	NI		NI	Major	109-E	0.52	26%	Moderate	Major
110-W	0.18	74%	Severe	Major	110-E	0.38	46%	Major	Severe
111-W	0.47	33%	Major	Major	111-E	0.48	32%	Major	Severe
112-W	NI		NI	Major	112-E	0.7	1%	Minor	Major
113-W	NI		NI	Major	113-E	0.36	49%	Major	Severe
114-W	0.26	63%	Severe	Major	114-E	0.44	38%	Major	Major
115-W	0.17	76%	Severe	Major	115-E	0.48	32%	Major	Major
116-W	NI		NI	Major	116-E	0.23	67%	Severe	Major