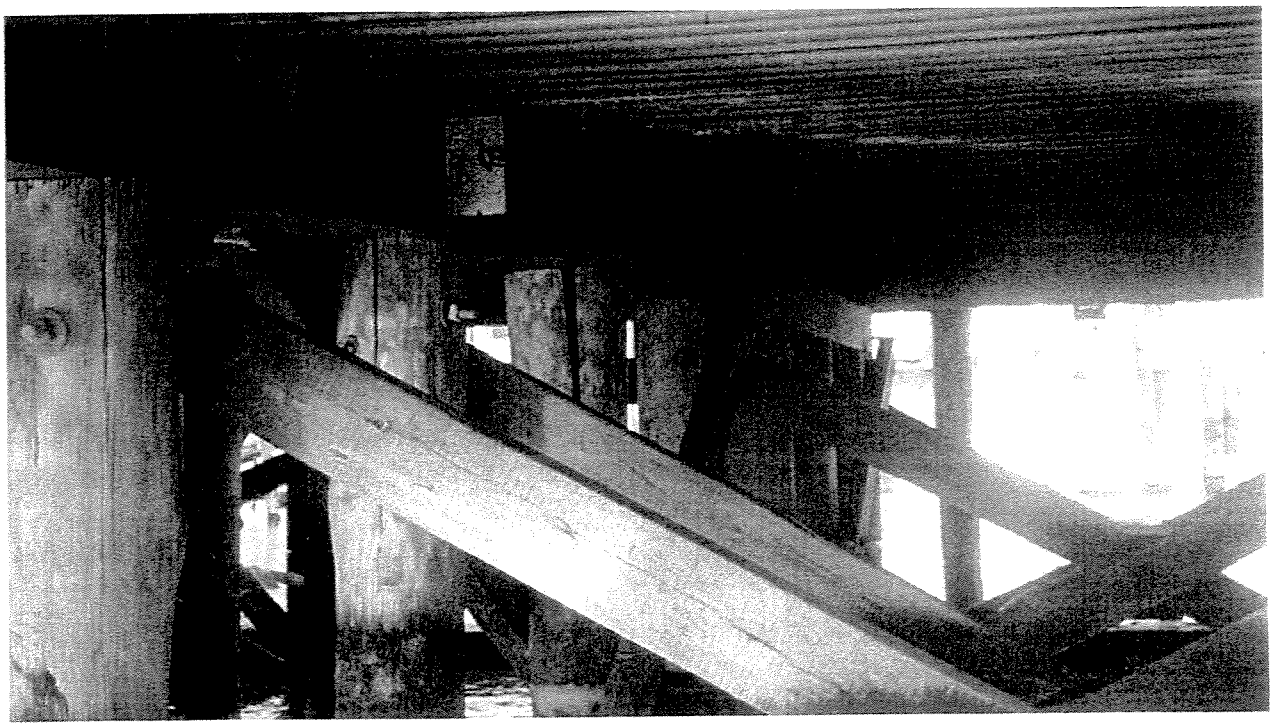
UNDERWATER INSPECTION AND EVALUATION REPORT

PIER 1-A &1-B BENTS 28 to 74
ST. GEORGE FERRY TERMINAL
MAINTENANCE FACILITY
STATEN ISLAND, NEW YORK

February 2004



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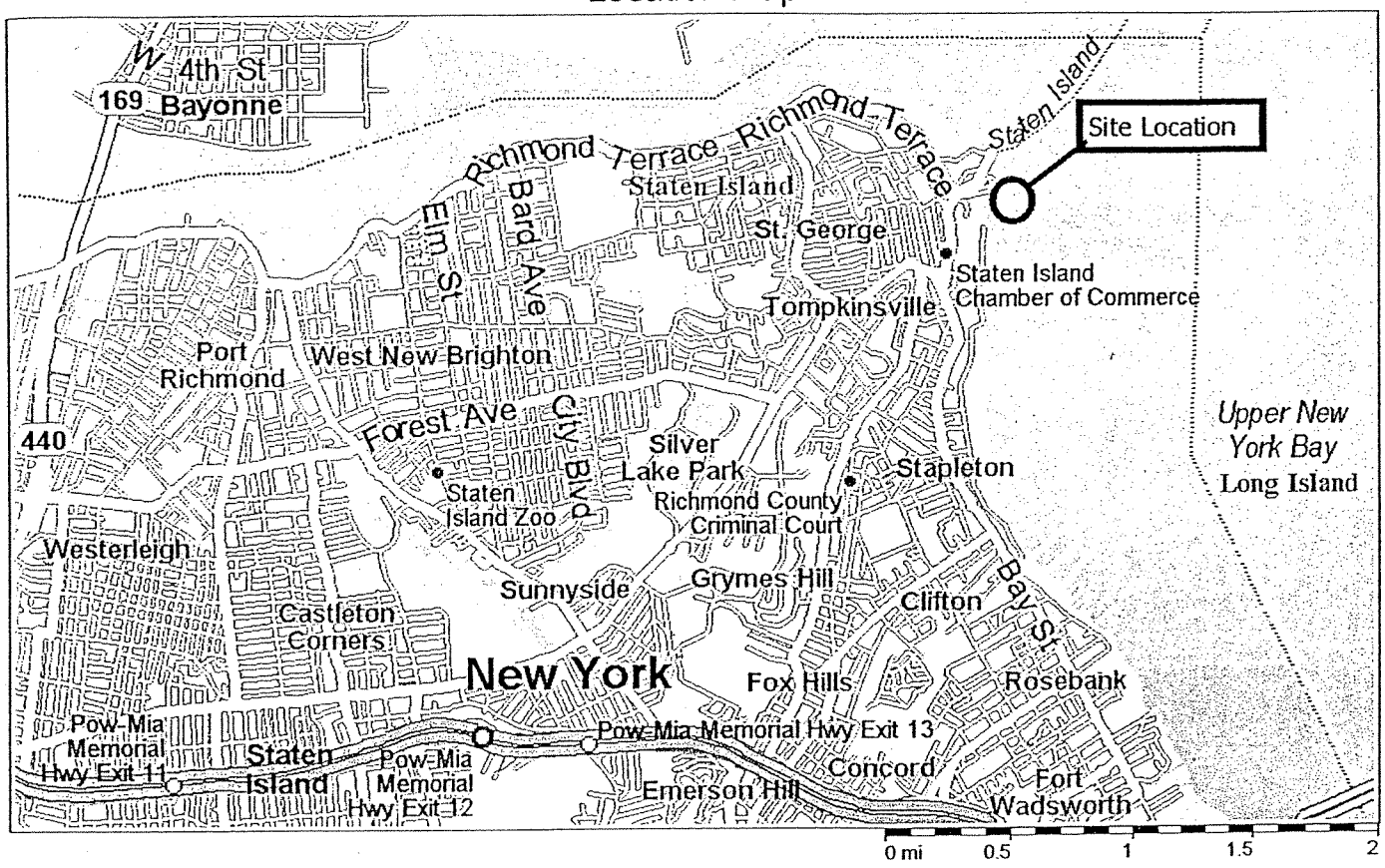
Location Map



INTRODUCTION

Atlantic Engineering, LLC, (AE) was contracted by Weidlinger Associates to perform an inspection of Pier 1A and 1B Bents 28 to 74 at the St. George Ferry Maintenance Facility, Staten Island NY. This portion of the pier structure is approximately 50' wide (North-South) and approximately 500' long (East-West). Approximately 500 piles where inspected from the timber piles cap to the mudline. The associated pile caps and the system of horizontal and diagonal bracing were also inspected, as well as the underside of the concrete deck. Atlantic Engineering has recently completed the inspection and evaluation report for the ship impact area of Bents 75 through Bents 80 on the east end of the pier. At this location, evidence of marine borer activity and significant loss of pile cross-sectional area was noted in a few piles. This finding, along with the anticipated construction repair of the east end of the pier and associated loading with heavy equipment was the stimulus for this inspection. This evaluation focused on the identification of marine borer activity and any associated loss of cross-sectional area.

The pier is constructed from a cast in place concrete deck on timber cap beams supported by timber piles. Battered timber piles on the exterior, as well as a system of diagonal and horizontal timber bracing in the tidal zone, provide lateral support to the pier and piles. Timber fender piles and several dolphins (clusters of timber fender piles) provide a buffer against minor vessel impact. Inspection of the timber fender system was not included in the scope of this inspection. No previous underwater inspection report was provided prior to the inspection.

The inspection was supervised by Bryan Juncosa, P.E./Diver. All elements where inspected from the underside of the reinforced concrete deck to the mudline. Inspection time was maximized during periods of low tide in order to improve efficiency of the inspection and the quality of the photography. Measurements and information was gathered in order to determine the condition of the structures and to make repair recommendations. 100% of the piles were visually inspected for deterioration and were sounded with an inspection hammer. A "Level II, Hands-on Inspection" was performed on approximately 10% of the piles. This including measurement of pile diameters at 3 elevations, exposed pile height, and probing of the piles with a pointed tool to identify deterioration and rotted areas. In addition, "Level III, Destructive Testing" was conducted on several piles using a 1 ½" coring drill bit. Cores where recovered and studied in order to observe the extent of marine borer infestation and the level of creosote treatment.

This report includes a summary of findings and recommendations, a deficiency plan with soundings, deficiency tables, sketches of the structure, and 35 mm photos.

SUMMARY OF FINDINGS

GENERAL

The overall condition of the pier is satisfactory with few elements of the structure considered poor. Evidence of marine borer activity is widespread with minor to moderate levels of activity on multiple piles and braces. However, significant destruction is limited to a several timber piles and some timber braces.

A dual 6 x 12 timber cap beam supports the reinforced concrete deck at bents 63 to 74. The tops of the 16" to 20" diameter timber piles are "notched" in order to accept the timber cap beam. Piles are driven in north-south rows (bents) at a 6' center-to-center spacing. Pile bents are spaced at 12' center-to-center. The construction for bents 28 to 62 is similar, except that galvanized corrugated metal deck forms remain in place, and 12 x 12 timber cap beams are used as an alternative to the dual 6 x 12 cap. This area of the pier was reconstructed in 1991.

For the purposes of this inspection each bent is numbered and each pile is given a letter designation. The northern most pile in a bent is the "A" pile; the southern most is the "I" pile. In addition to these "plumb" piles, battered piles are typically observed at every other bent at the "A" and "I" position. Also, a system of 4 x 8 diagonal and horizontal bracing is constructed in the tidal zone between pairs of bents (see plans and sketches for configuration).

DECK FRAMING AND PILES

Most of the timber piles are in good condition with a several piles rated as fair or poor. Two distinctly different types of timber piles are observed. The "newer" sections of the pier are constructed using "greenheart" piles as a substitute to the original creosote treated timber piles. Greenheart piles were observed at all locations from bents 28 to 62 and at most "A" and "I" positions for bents 62 to 74. The greenheart piles are normally selected for there durability in the marine environment, hardness (resistance to marine borers), and overall structural performance. The original creosote treated piles typically exhibit greater deterioration. The deficiency table and pile plan within this report gives detailed information on pile defects and levels of marine borer activity.

The overall condition of the timber bracing is fair with moderate deterioration of the members due to rot and/or marine borer activity. Several broken, loose, or missing members are identified in the deficiency table and are recommended for replacement. The Timber bracing at low water elevation between bents 62 to 74 at low water elevations is noticeably more deteriorated than the other sections of the pier. Bracing hardware from 62 to 74 exhibits moderate corrosion, while bracing hardware at low water at bents 28 to 61 exhibit minor corrosion.

The underside of the concrete deck from bents 62 to 74 is good with a few hairline cracks with efflorescence. Timber pile caps at this section of the pier are satisfactory with minor abrasion damage typically noted at the cap ends. The corrugated galvanized steel stay-in-place forms at bents 61 to 28 are in very good condition, while the 12 x12 timber cap beams at this location are also very good.

MARINE BORER ACTIVITY AND DESTRUCTIVE TESTING

There are two species of Marine Borer normally found in the northeastern United States. The organisms survive best in well-oxygenated, clean, brackish water. Improved pollution control in the NYC harbor has lead to a resurgence in marine borer activity over the last few decades. Both the Limnoria marine borer and the Teredo marine borer were identified during this inspection.

Limnoria – Commonly referred to as wood gribbles, these crustaceans are tiny wood eaters that attack from the outside, continually reducing the diameter of a timber pile. Severe attack will result in an hourglass shape to the pile.

Teredo – Commonly referred to as shipworms, these mollusks burrow minute holes into the timber and attack from within. Severe attack will result in a hollowing of the pile, leaving just the outer shell. This "hollowing" may be exposed when the outer annulus is damaged or deteriorated.

In an effort to reduce the destructive effect of the marine borer special materials are chosen for there resistance to marine borer attack. Timber piles are often treated with creosote to help preserve the wood and at the same time resist marine borer attack. Greenheart piles are chosen for their superior structural properties and resist marine borers due to the high density and high relative hardness. The observed effect of the borers is distinctly different for these two types of piles.

Visual inspection of the greenheart piles revealed minor to moderate activity from the Teredo marine borer. The outer annulus of the pile commonly exhibited vertical "Teredo tracks" or tunnels at multiple elevations along the entire pile circumference. It was assumed that the destruction was limited the soft outer annulus of the greenheart piles with no significant loss of cross-sectional area. This assumption was confirmed by destructive testing revealing a hard inner core with no evidence of marine borer activity.

There was minimal borer activity noted on the outer annulus of the creosote treated timber piles. The outsides of these piles are typically well treated with creosote and the borers cannot penetrate in to the pile core, which is typically more susceptible to attack. However, open bolt holes, voids, and gouges in the piles give the borers entry to the core of the pile. The outcome is a concealed tunneling resulting in a hollowing effect. Both

Teredo and Limnoria marine borers where identified in these areas. Piles were "sounded" with an inspection hammer to help identify these areas. Core sampling of the piles revealed that creosote treatment extended in to the pile core.

In conclusion, although higher levels of borer activity are observed on the greenheart piles through visual inspection, the damaging effect seems to be negligible at this time. The effect of the borers on the creosote treated piles is of greater concern due to the concealed nature. Regular inspection should be performed on these piles with particular attention to open bolt holes and voids typically found near low water and in areas where bracing connections are made.

RECOMMENDATIONS and DEFICIENCY TABLES

Due to the overall satisfactory conditions observed during the inspection only a few isolated elements are in need of repair. Although structural redundancy should allow continued use of the pier, no excessive loading should be placed on the deck above poor piles. Marine Borer activity should be monitored with future routine dive inspections on a regularly scheduled interval.

Based on the findings of this inspection the following items should be addressed:

Deficiency/Recommendation Table

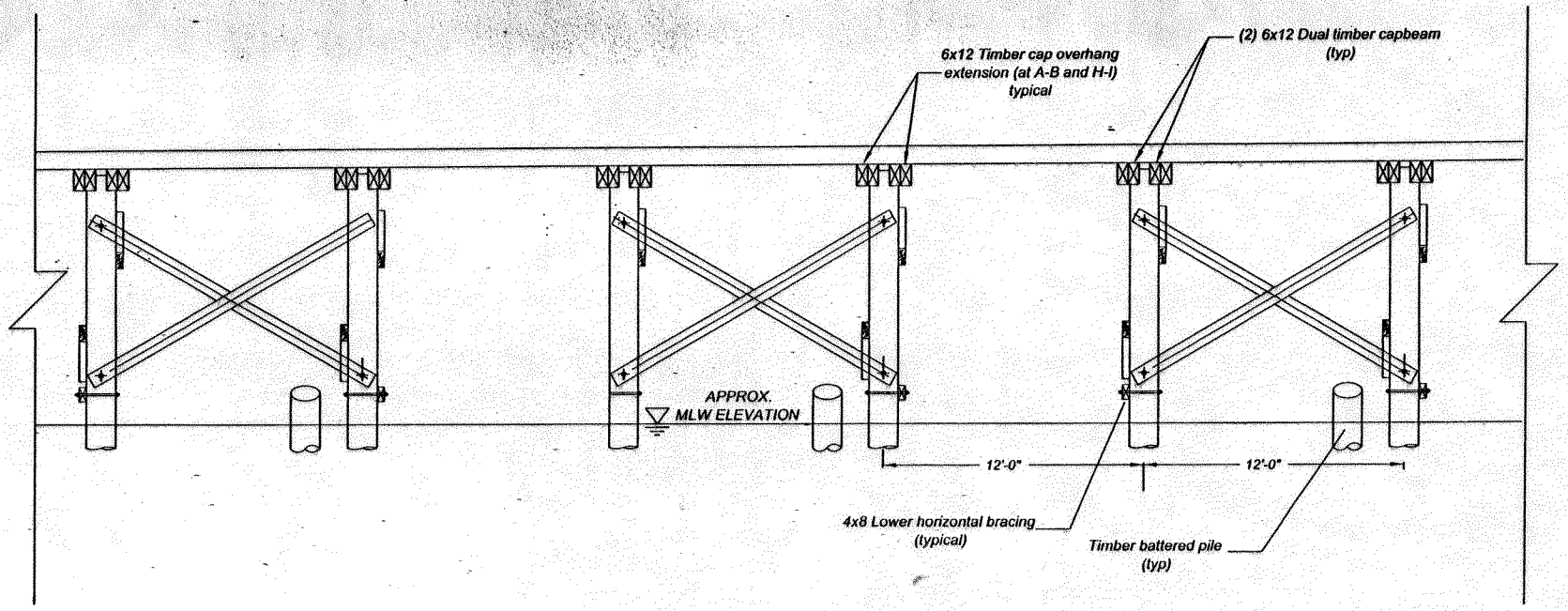
Element	Deficiency Description	Recommendation
Pile 74/C	50% L.O.S. with hollowing at the bolt hole some trace of Teredo.	Remove poor portion of pile and replace with pile post detail (10 LF)
Pile 73/H	25% L.O.S. 3' B.W.L. with some trace of Teredo.	Remove poor portion of pile and replace with pile post detail (10 LF)
Pile 73/G	25% L.O.S. 3' B.W.L. with some trace of Teredo (pile rating F).	Remove poor portion of pile and replace with pile post detail (10 LF)
Pile 72/B	95% L.O.S. with some evidence of Limnoria (pile rating P).	Remove poor portion of pile and replace with pile post detail (10 LF)
Pile 72/F	40% L.O.S. moderate marine bore activity 4' B.W.L. (pile rating P).	Remove poor portion of pile and replace with pile post detail (10 LF)
Pile 67/H	80% L.O.S. with hollowing at the bolt hole with some trace of Teredo near mudline (pile rating P).	Remove poor portion of pile and replace with pile post detail (10 LF)
Pile 67/G	80% L.O.S. with hollowing at the bolt hole with some trace of Teredo near mudline (pile rating P).	Remove poor portion of pile and replace with pile post detail (10 LF)
Pile 65/I	50% L.O.S. with some evidence of marine bore activity. Some abrasion damage 10% L.O.S. (pile rating P).	Remove poor portion of pile and replace with pile post detail (10 LF)
Pile 63/H	50% L.O.S. with hollowing at the bolt hole (pile rating P).	Remove poor portion of pile and replace with pile post detail (10 LF)
Pile 63/I	50% L.O.S. with hollowing at the bolt hole (pile rating P).	Remove poor portion of pile and replace with pile post detail (10 LF)
N/S Diag. Brace @ 74/A	4 x 8 Diagonal brace rotted and loose	Remove and replace timber brace and hardware. (15 LF)
N/S Diag. Brace @ 74/D	4 x 8 Diagonal brace rotted and loose	Remove and replace timber brace and hardware. (15 LF)

Element	Deficiency Description	Recommendation
N/S Diag. Brace @ 72/F	4 x 8 Diagonal brace rotted and loose	Remove and replace timber brace and hardware. (15 LF)
N/S Diag. Brace @ 70/D	4 x 8 Diagonal brace rotted and loose	Remove and replace timber brace and hardware. (15 LF)
N/S Diag. Brace @ 70/F	4 x 8 Diagonal brace rotted and loose	Remove and replace timber brace and hardware. (15 LF)
N/S Diag. Brace @ 68/I	4 x 8 Diagonal brace rotted and loose with Limnoria marine borer activity, 50% L.O.S.	Remove and replace timber brace and hardware. (15 LF)
E/WDiag. Brace @ 67/G	4 x 8 Diagonal brace rotted and hollowing at a bolt hole and with Limnoria marine borer. activity, 50% L.O.S.	Remove and replace timber brace and hardware. (15 LF)
N/S Diag. Brace @ 66/C	4 x 8 Diagonal brace missing hardware	Replace hardware. (LS)
N/S Diag. Brace @ 66/F	4 x 8 Diagonal brace rotted and loose with Limnoria marine borer activity, 50% L.O.S.	Remove and replace timber brace and hardware. (15 LF)

Legend

L.O.S - Loss of section
B.W.L. – Below water line
P – Pile rated as poor
F – Pile rated as fair

SKETCHES



TYPICAL SECTION OF BENTS 62 TO 74
LOOKING NORTH
Scale 1"=5'

NOTE: SECTION AT BENTS 28 TO 61 SIMILAR

U/W Inspection and Evaluation
St George Ferry Terminal
Pier 1-B
1" = 5'
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Atlantic Engineering, LLC
Suite 21, Kinnelon Rd.
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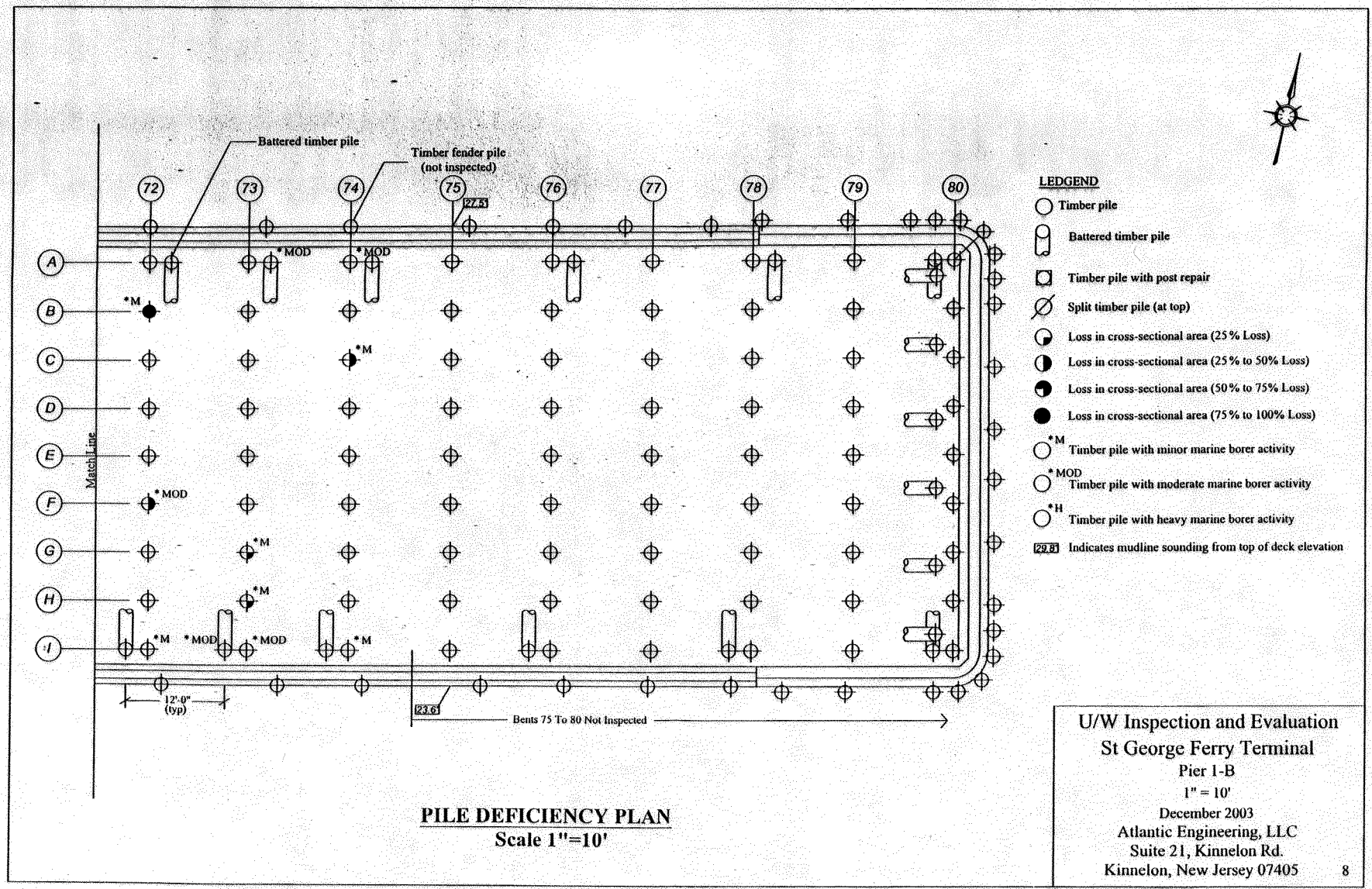

PILE DEFICIENCY PLAN
Scale 1"=10'

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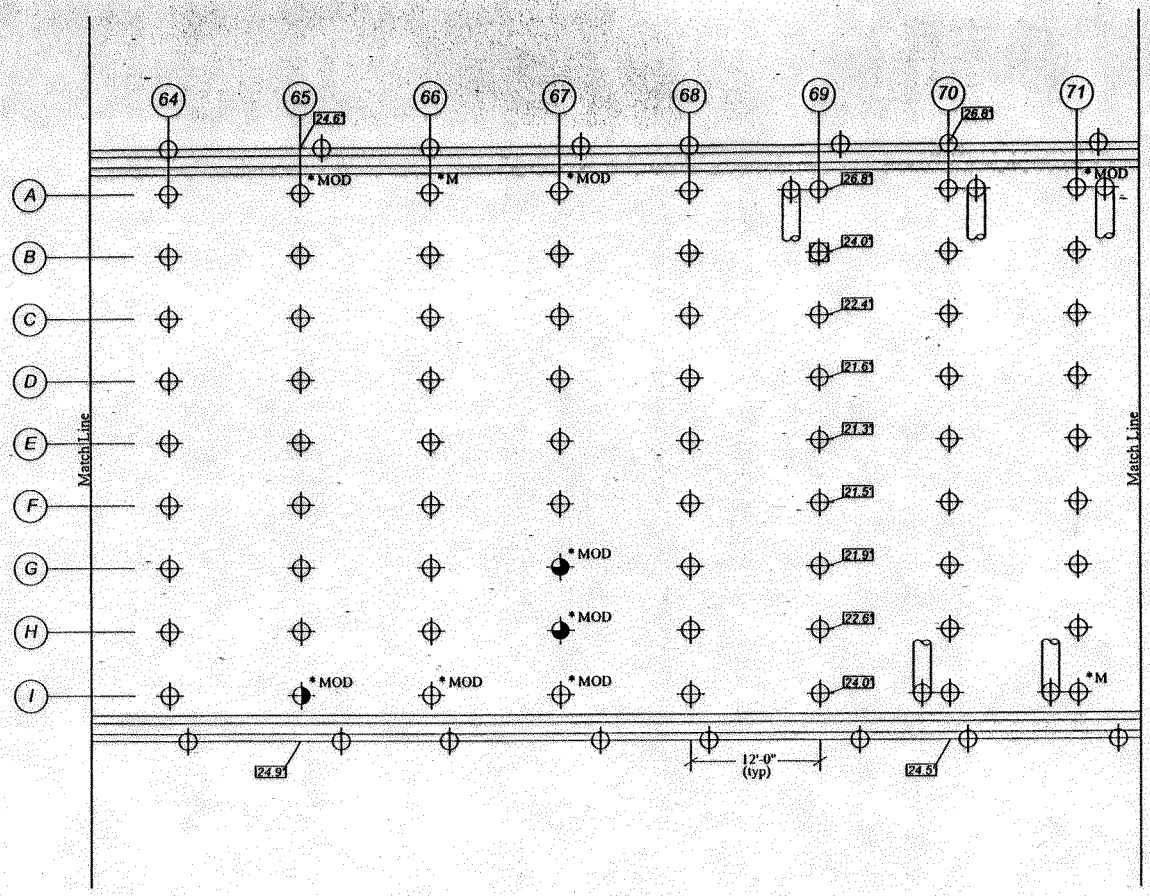

PILE DEFICIENCY PLAN
Scale 1"=10'

LEDGEND

- Timber pile
- Battered timber pile
- Timber pile with post repair
- Split timber pile (at top)
- Loss in cross-sectional area (25% Loss)
- Loss in cross-sectional area (25% to 50% Loss)
- Loss in cross-sectional area (50% to 75% Loss)
- Loss in cross-sectional area (75% to 100% Loss)
- *M Timber pile with minor marine borer activity
- *MOD Timber pile with moderate marine borer activity
- *H Timber pile with heavy marine borer activity
- 29.8 Indicates mudline sounding from top of deck elevation

U/W Inspection and Evaluation
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Pier 1-B
1" = 10'
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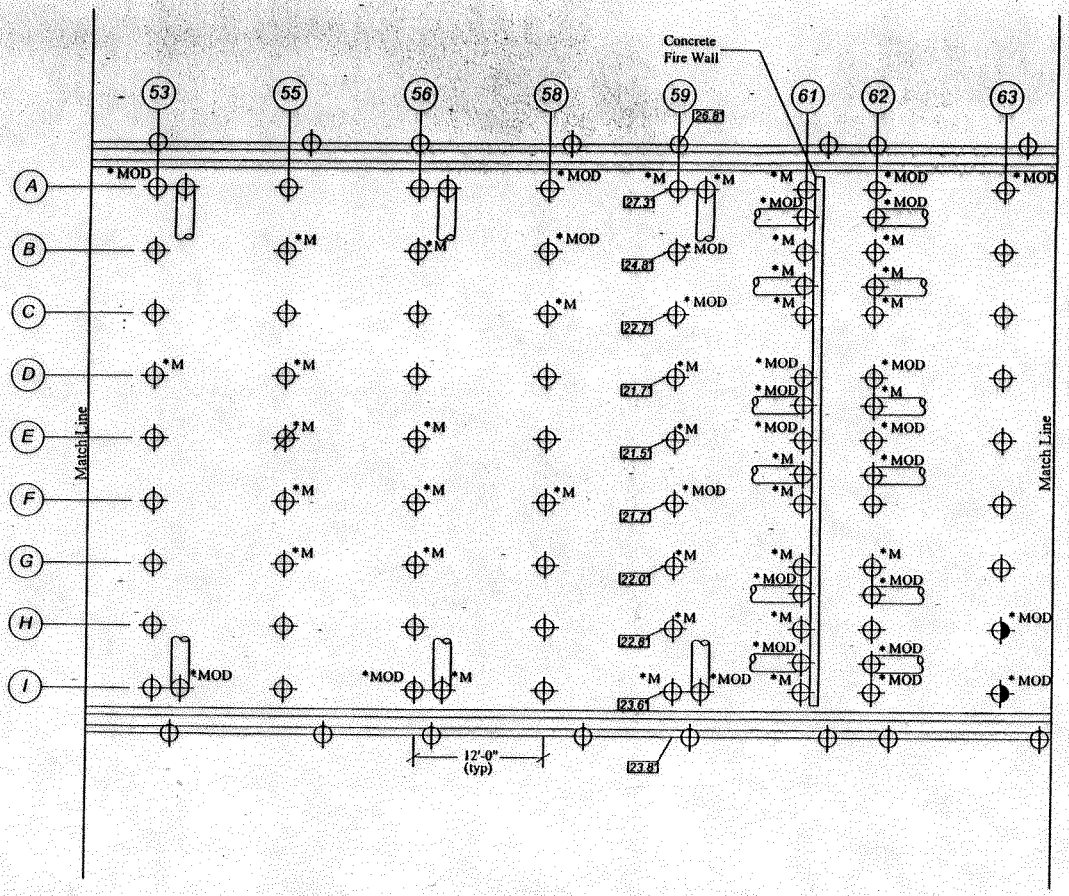

PILE DEFICIENCY PLAN
Scale 1"=10'

LEDGEND

- Timber pile
- Battered timber pile
- Timber pile with post repair
- Split timber pile (at top)
- Loss in cross-sectional area (25% Loss)
- Loss in cross-sectional area (25% to 50% Loss)
- Loss in cross-sectional area (50% to 75% Loss)
- Loss in cross-sectional area (75% to 100% Loss)
- *M Timber pile with minor marine borer activity
- *MOD Timber pile with moderate marine borer activity
- *H Timber pile with heavy marine borer activity
- 29.81 Indicates mudline sounding from top of deck elevation

U/W Inspection and Evaluation
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Pier 1-B
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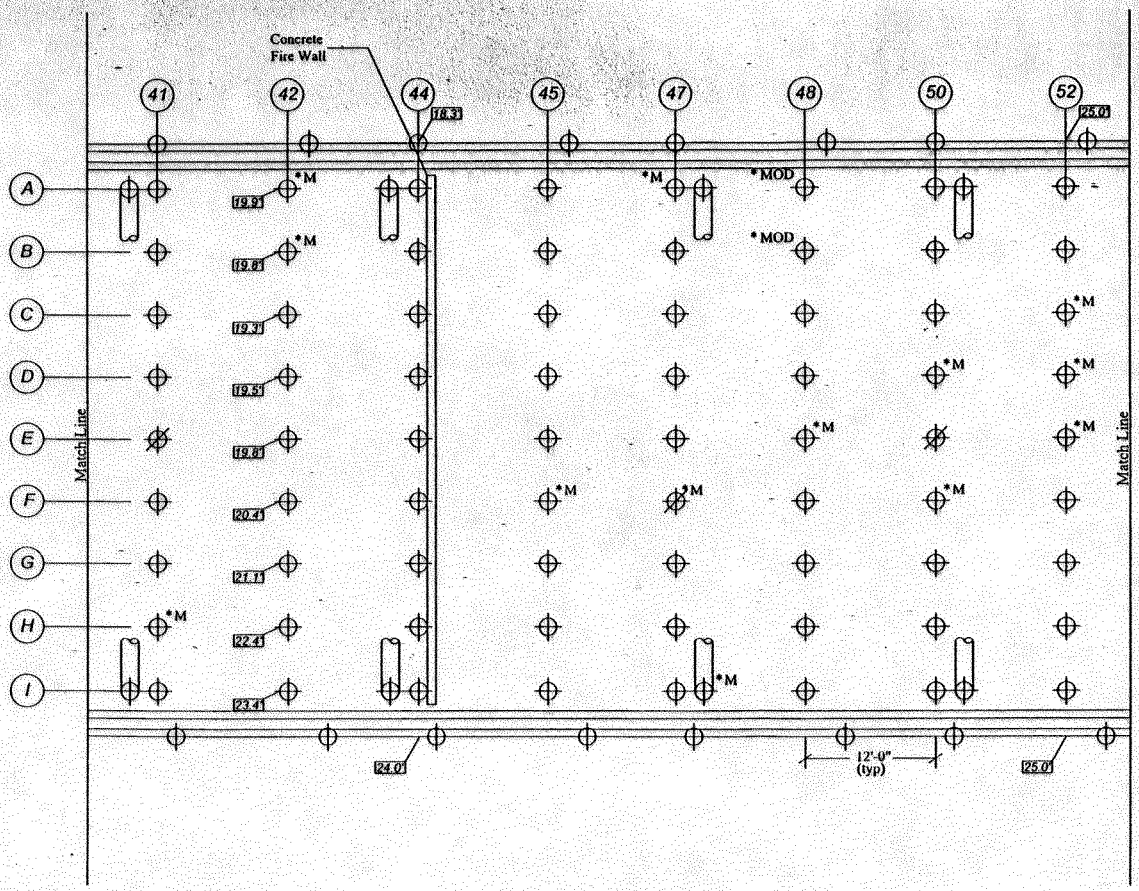

PILE DEFICIENCY PLAN
Scale 1"=10'

LEDGEND

- Timber pile
- Battered timber pile
- Timber pile with post repair
- Split timber pile (at top)
- Loss in cross-sectional area (25% Loss)
- Loss in cross-sectional area (25% to 50% Loss)
- Loss in cross-sectional area (50% to 75% Loss)
- Loss in cross-sectional area (75% to 100% Loss)
- *M Timber pile with minor marine borer activity
- *MOD Timber pile with moderate marine borer activity
- *H Timber pile with heavy marine borer activity
- 29.8' Indicates mudline sounding from top of deck elevation

U/W Inspection and Evaluation
St George Ferry Terminal
Pier 1-B
1" = 10'
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Atlantic Engineering, LLC
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Kinnelon, New Jersey 07405

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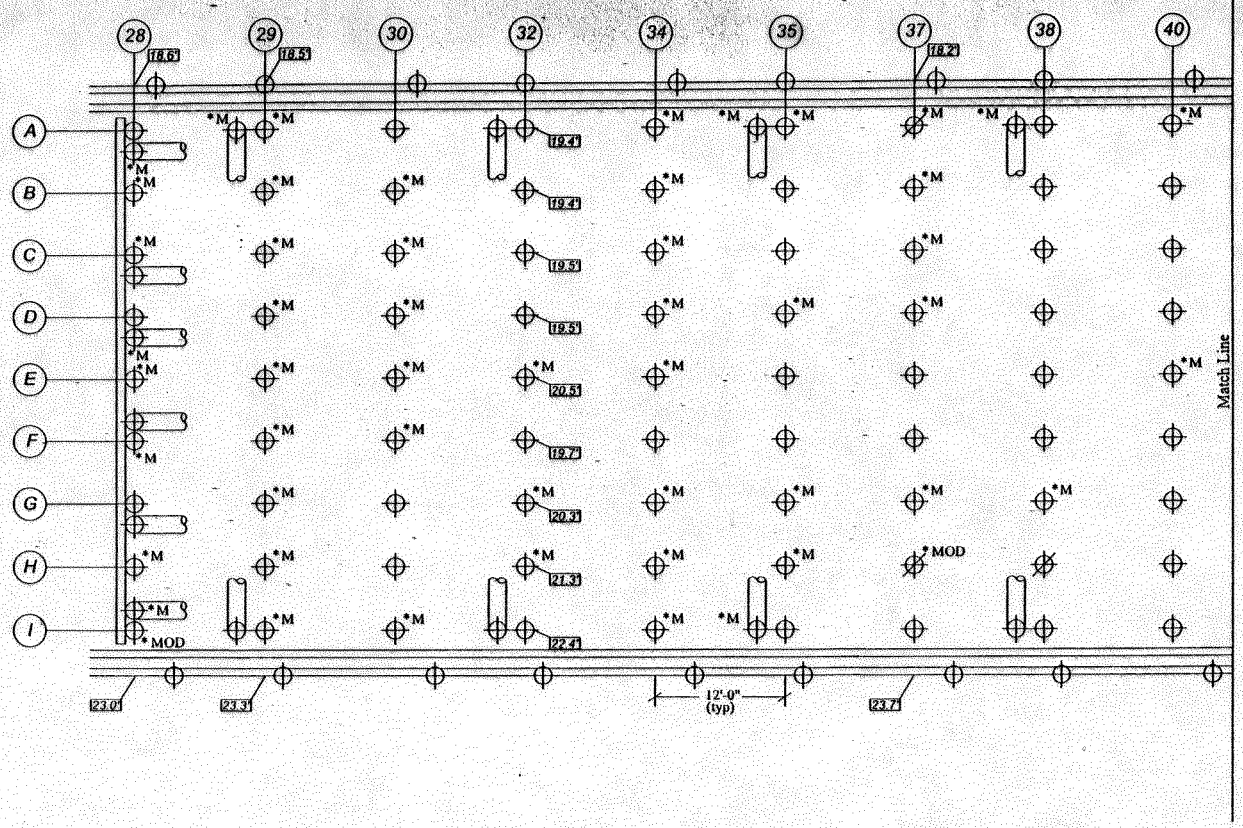
NTSB 02149



PILE DEFICIENCY PLAN
Scale 1"=10'

LEDGEND

- Timber pile
- Battered timber pile
- Timber pile with post repair
- Split timber pile (at top)
- Loss in cross-sectional area (25% Loss)
- Loss in cross-sectional area (25% to 50% Loss)
- Loss in cross-sectional area (50% to 75% Loss)
- Loss in cross-sectional area (75% to 100% Loss)
- *M Timber pile with minor marine borer activity
- *MOD Timber pile with moderate marine borer activity
- *H Timber pile with heavy marine borer activity
- 29.6' Indicates mudline sounding from top of deck elevation

U/W Inspection and Evaluation
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Pier 1-B
1" = 10'
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PHOTOGRAPHS

PHOTO 1 - Bent 38, "I" pile. Typical configuration and underside of deck in good condition looking NE.

PHOTO 2 – Bent 66 between piles "E" and "F." Brace exhibits rot in the tidal zone with 50% loss of cross-sectional area looking east.

PHOTO 3 - Bent 68/69, typical underside of concrete deck exhibits hair line cracking with efflorescence looking north.

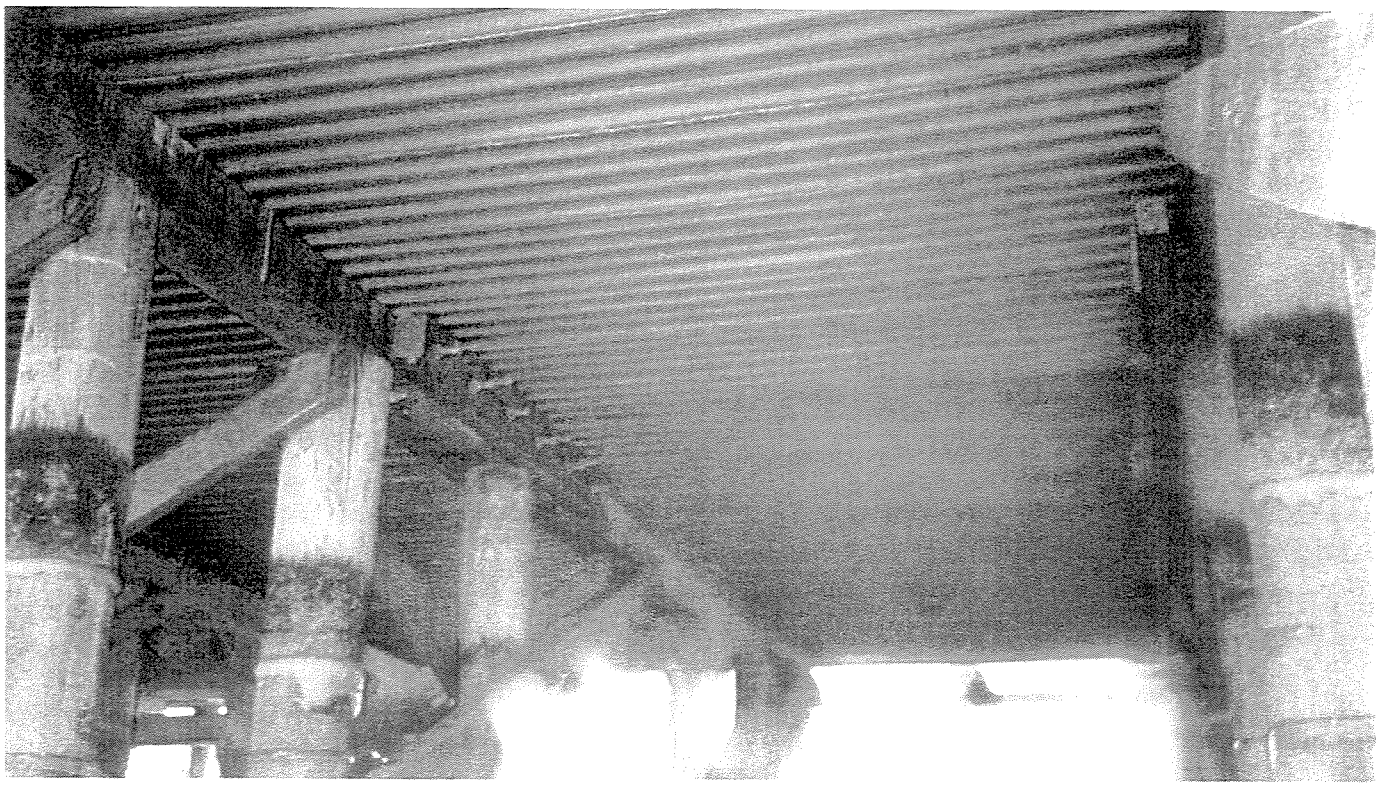

PHOTO 4 – Bent 58/59, typical underside of deck in good condition with corrugated galvanized steel stay-in-place forms looking north.

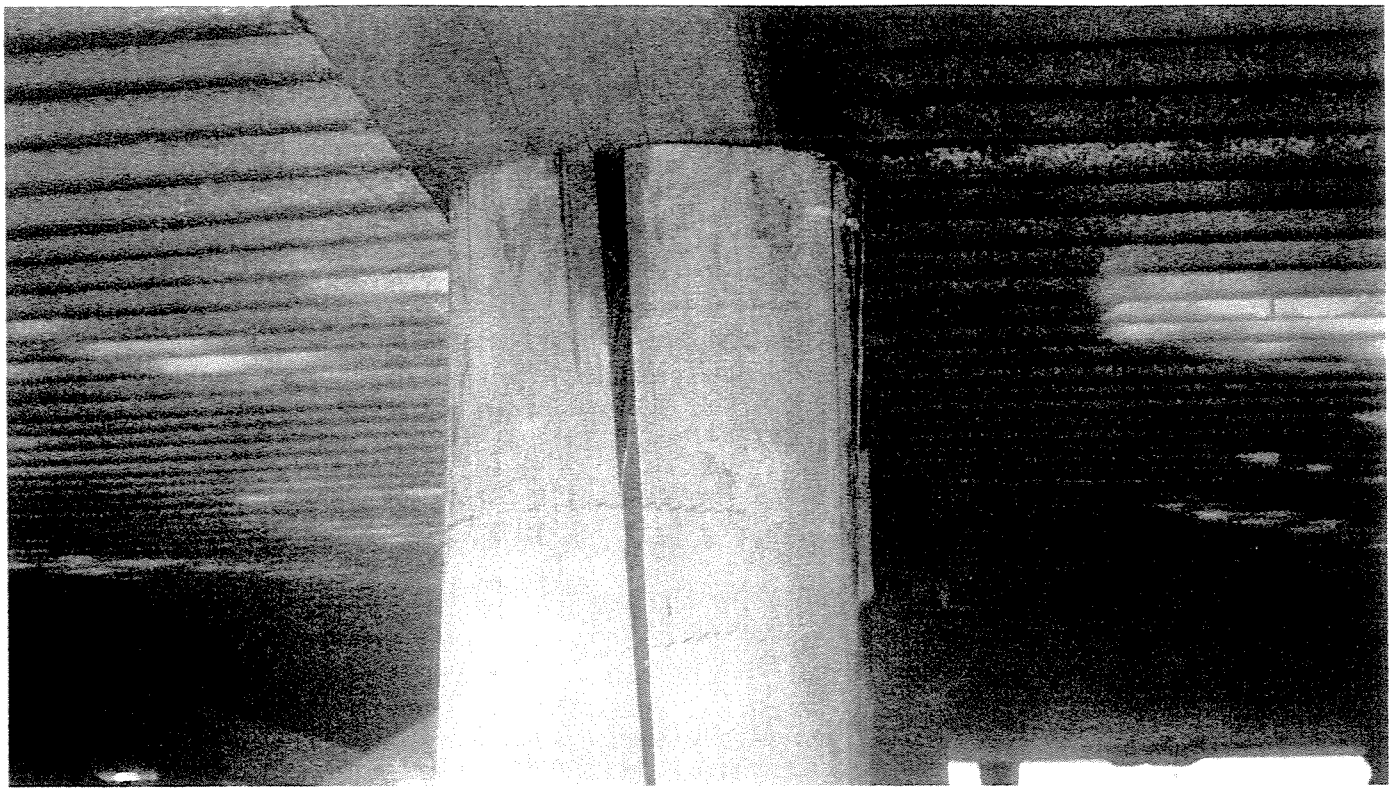

PHOTO 5 - Pile 38 H, split at top looking north.

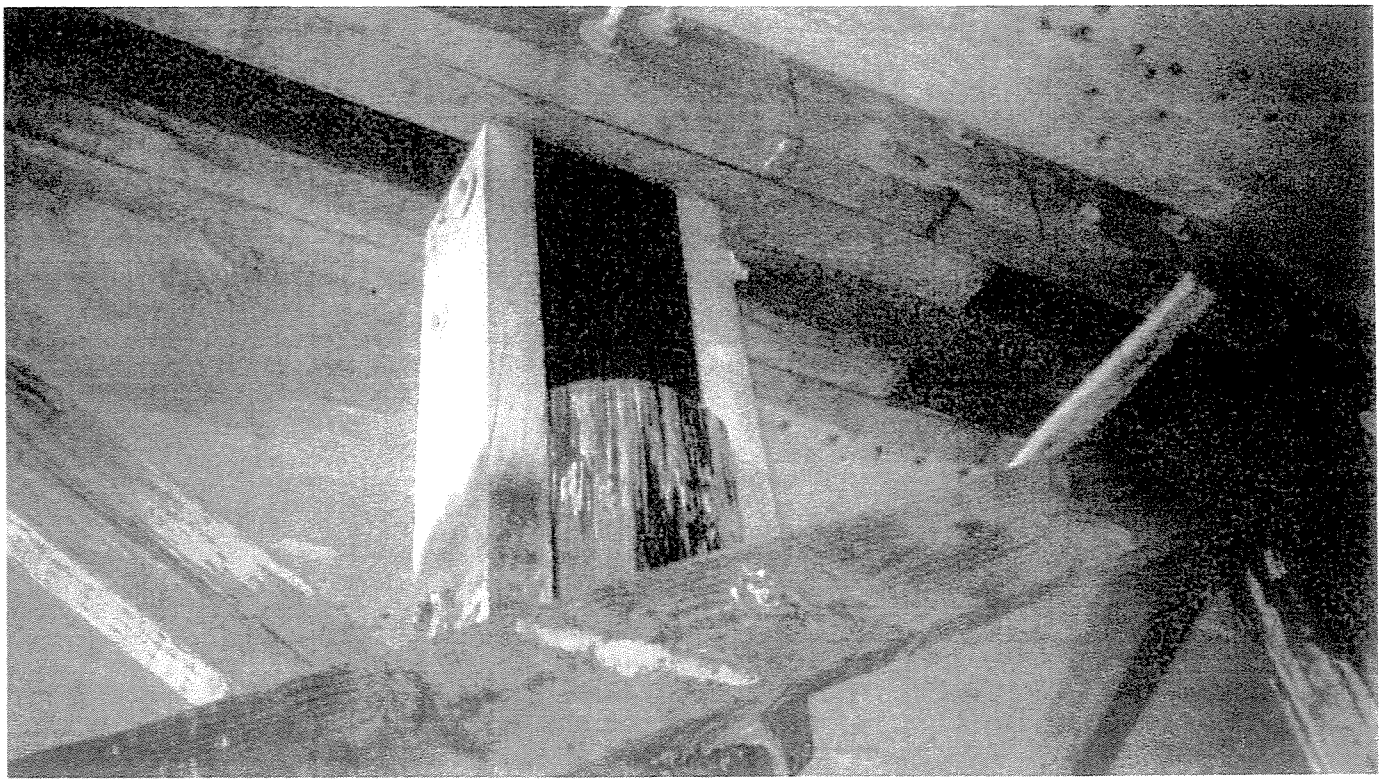

PHOTO 6 – Pile 69 B, 2' post repair looking SE.

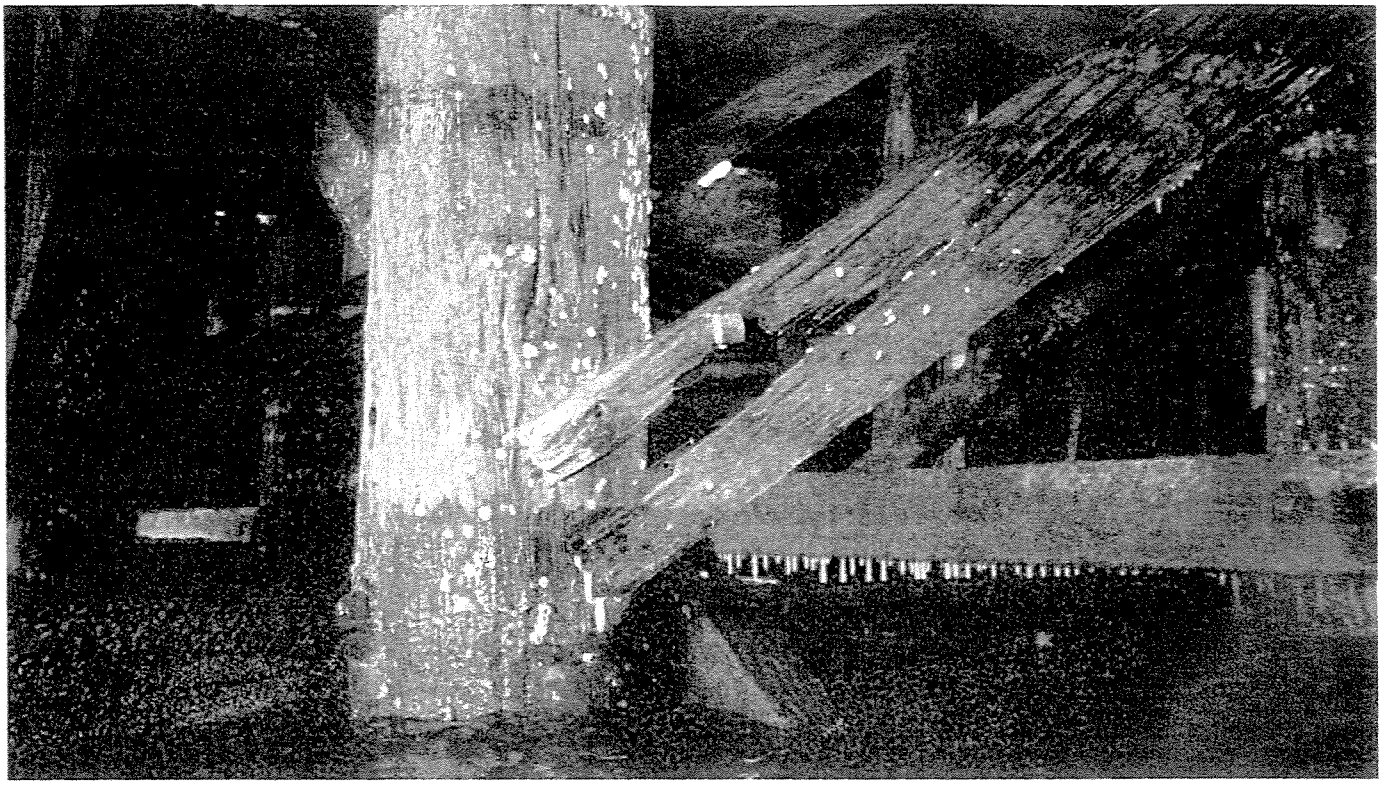

PHOTO 7 - Pile 74 A, E/W diagonal brace is broken and loose looking SE.

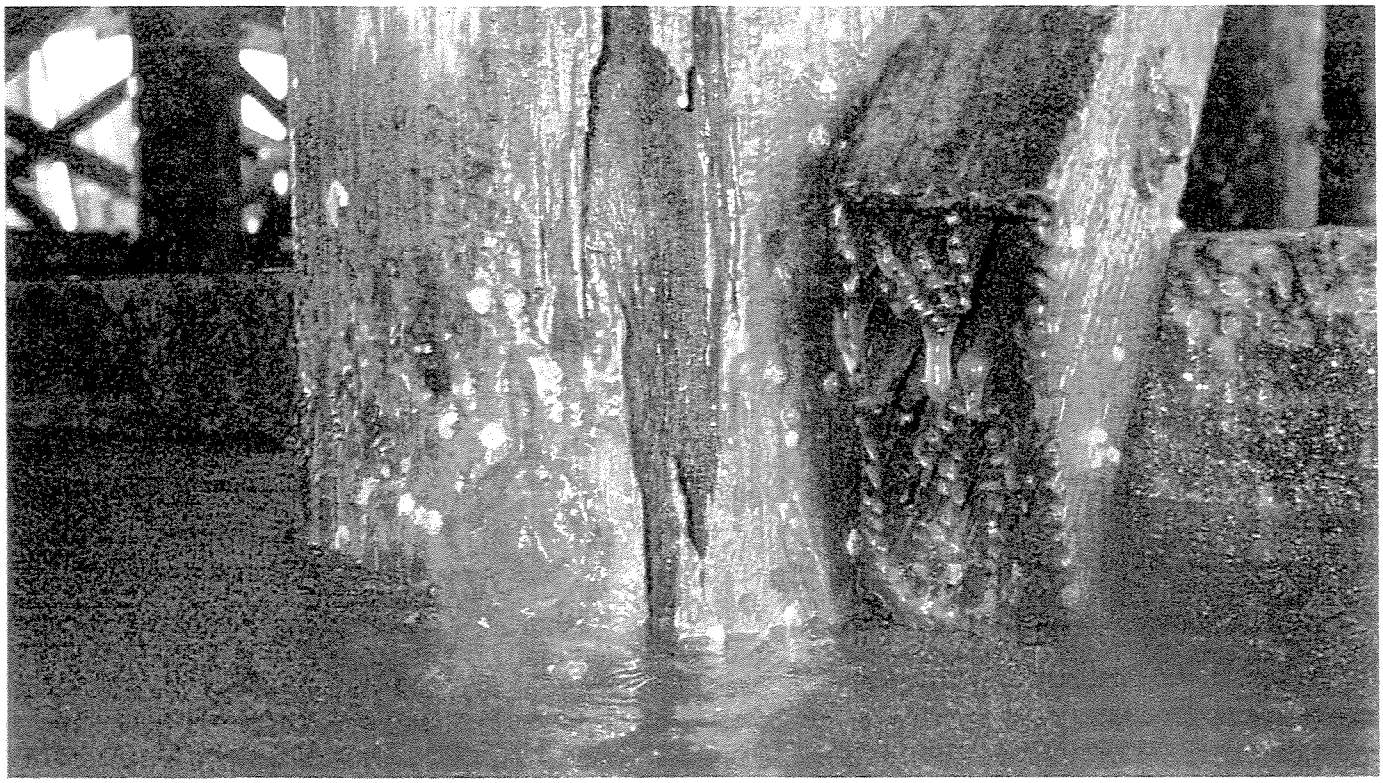

PHOTO 8 – Pile 73 G exhibits 25% loss with Limnoria marine borer activity looking NE.

PHOTO 9 - Pile 72 B exhibits 90% loss of cross-sectional area with "hollowing." Outer annulus conceals extent of deterioration, typical of hollowing at creosote treated timber pile, looking south.

PHOTO 10 – Pile 61 I (batter). Moderate localized Teredo marine borer activity on outer annulus of the greenheart pile, looking NW.

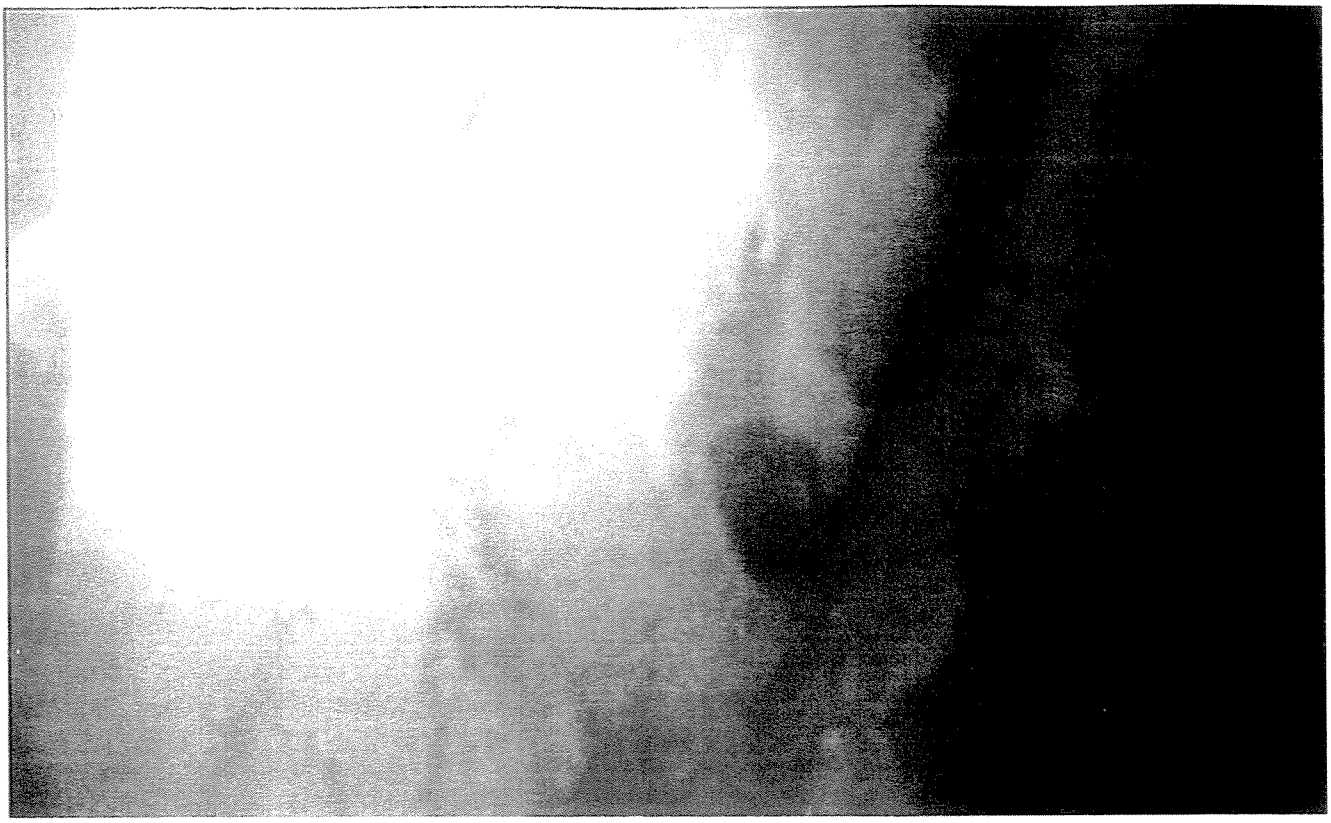

PHOTO 11 - Pile 71 I at the mudline. Several tracks from the Teredo marine borer on the outer annulus looking NW.

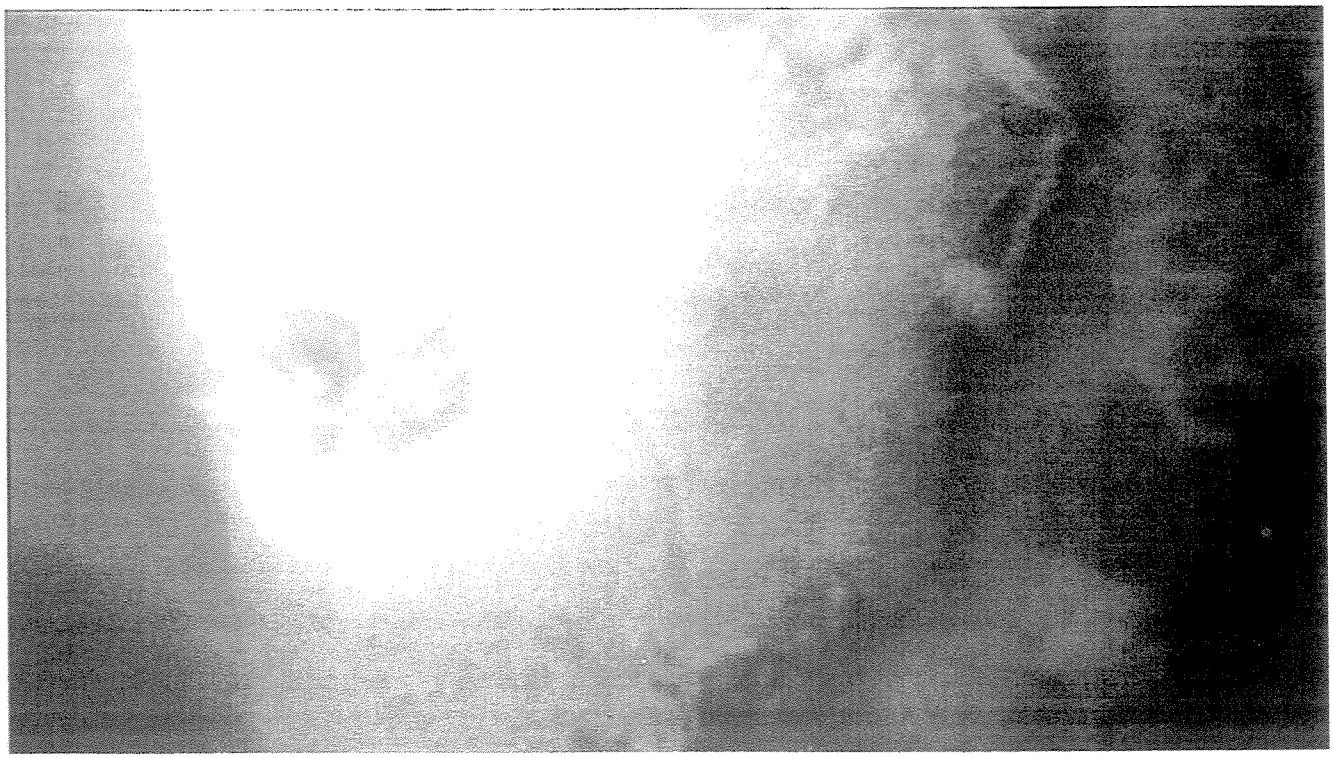

PHOTO 12 – Pile 67 A, 10 above the mudline. Several tracks from the Teredo marine borer on the outer annulus looking east.

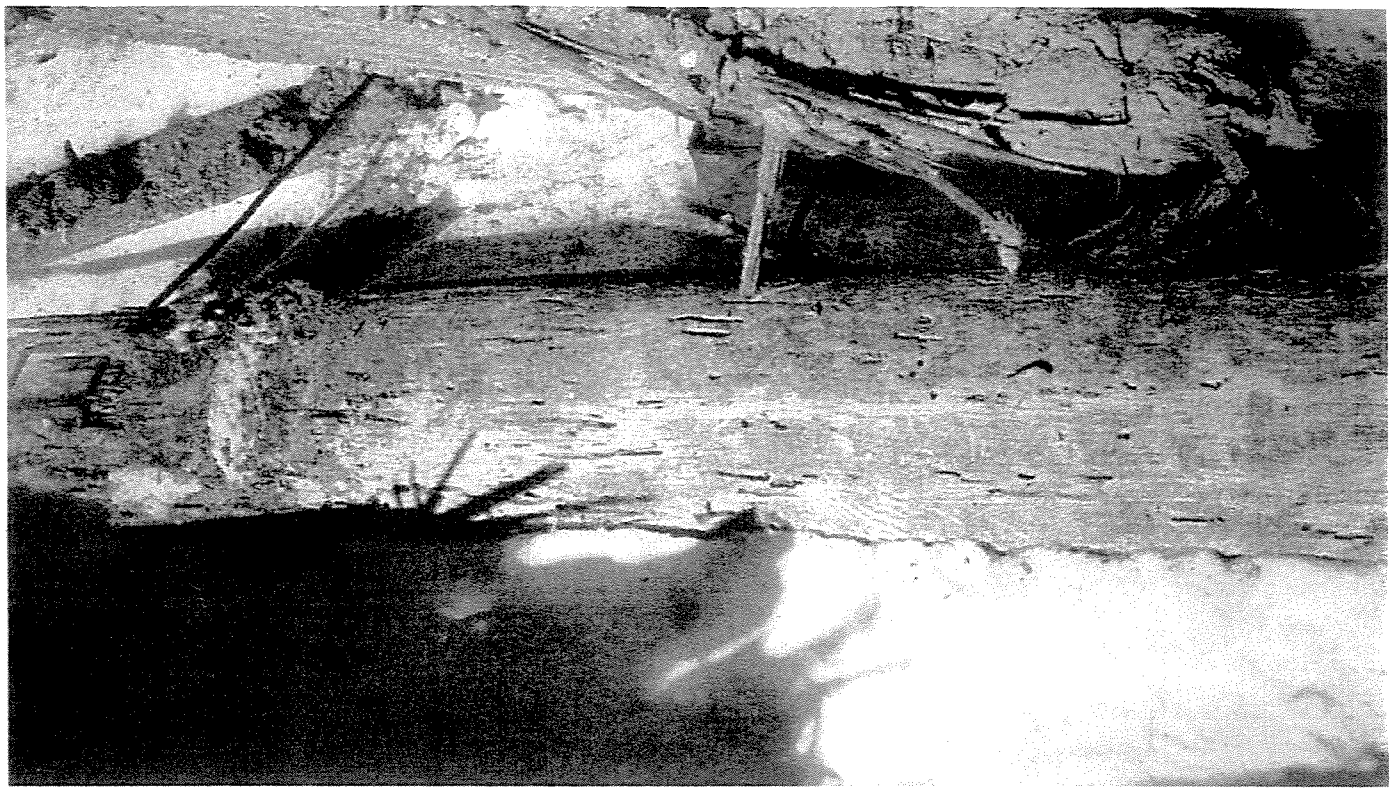

PHOTO 13 - Greenheart pile on top of the deck ("pulled" from the mud). Typical of view of moderate Teredo activity observed below water at various greenheart piles from mean-low-water to the mudline.

PHOTO 14 – The above referenced pile was sectioned with a saw revealing a solid inner core. Damage is limited to the outer annuls with no significant loss of cross-sectional area.

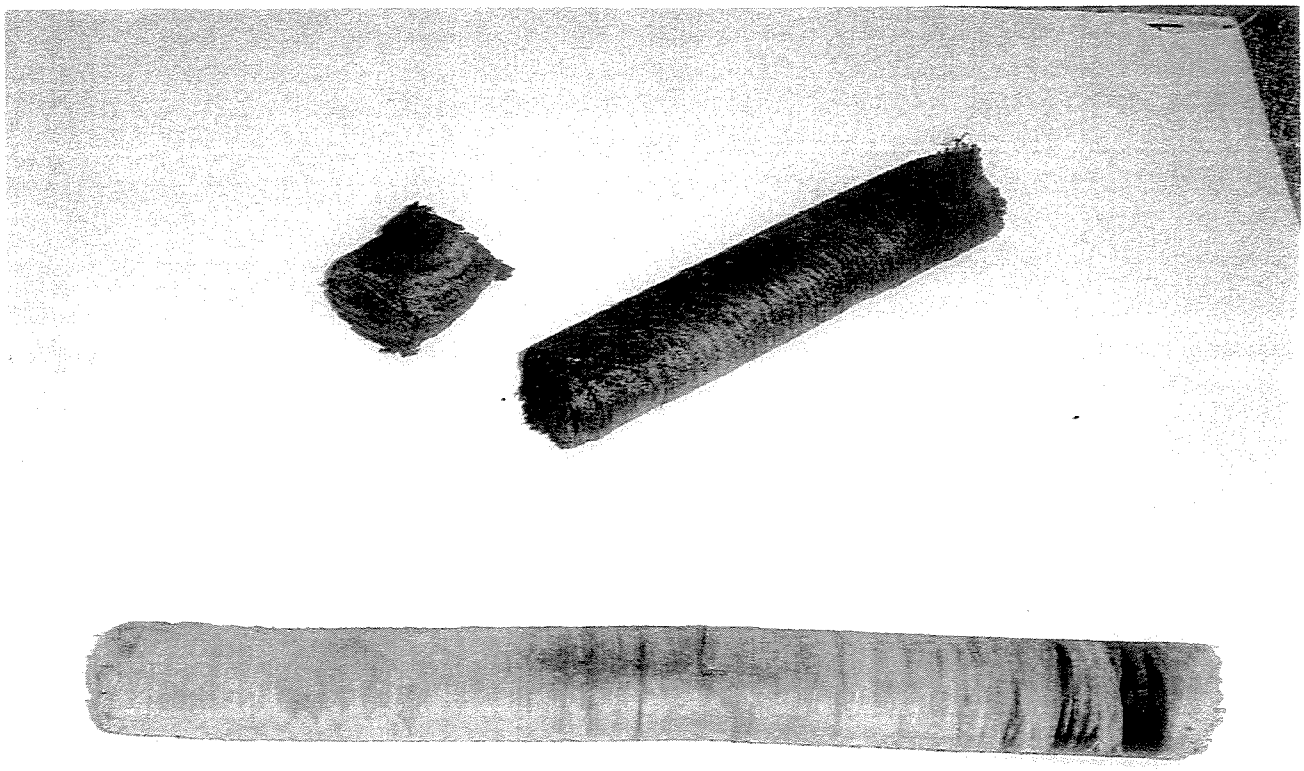

PHOTO 15 - Core Sample from a creosote treated pile (top) and a greenheart pile (bottom). Both cores reveal activity is limited to the exposed "outside" of the pile. Creosote pile is well treated throughout. Live Limnoria borers were observed on the outside of the creosote core sample.

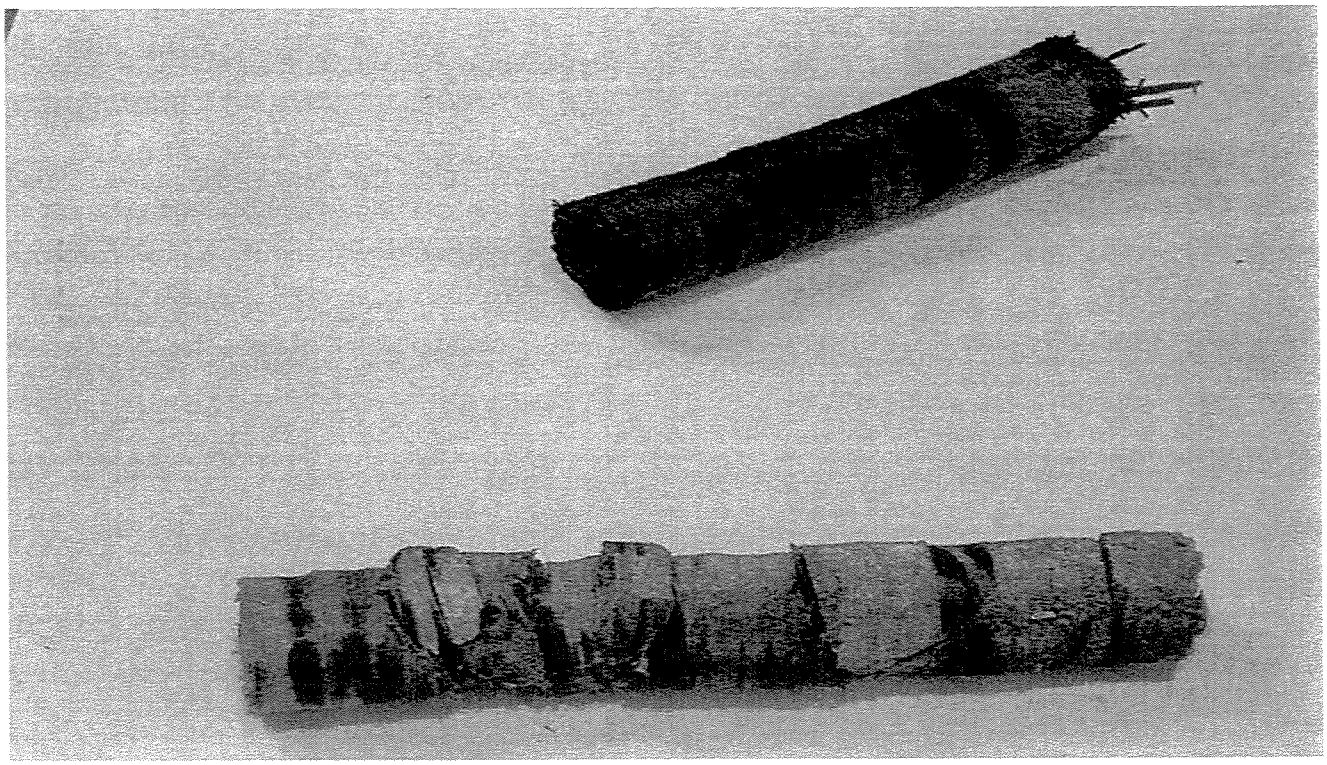

PHOTO 16 – Core Sample from a creosote treated pile (top) and a greenheart pile (bottom). Both cores reveal activity is limited to the "outside" of the pile. Creosote pile is well treated throughout. The Creosote piles sampled exhibited loss of section and hollowing at the core