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UNDERWATER FACILITIES INSPECTIONS AND ASSESSMENTS AT
PHILADELPHIA NAVAL S. (U) CHILDS ENGINEERING CORP
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N62477-81-C-0448

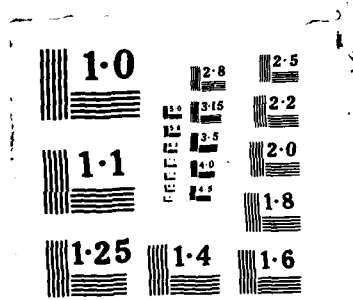
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UNDERWATER FACILITIES INSPECTIONS

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UNDERWATER FACILITIES
INSPECTIONS
AND
ASSESSMENTS
AT

PHILADELPHIA NAVAL SHIPYARD

PHILADELPHIA, PA

VOLUME II **FILE COPY**

FPO-1-83-(48) OCTOBER 1983

PERFORMED FOR: OCEAN ENGINEERING AND CONSTRUCTION PROJECT OFFICE
CHESAPEAKE DIVISION
NAVAL FACILITIES ENGINEERING COMMAND
WASHINGTON, D.C. 20374

UNDER: CONTRACT N62477-81-C-0448
TASK 7

BY: CHILDS ENGINEERING CORPORATION
MEDFIELD, MA

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The inspected facilities covered in Volume II are Pier 5, the Barge Basin and
associated Bulkhead, Pier 6, Pier 6-A and associated Bulkhead, the Drydock
Wharves and Wharves K, J, I, H and G.

Pier 5 has recently been rebuilt. There is a new concrete super- (Con't)

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structure and some new piles have been driven. The pile foundation was found to be in excellent condition. Generally the concrete superstructure is in excellent condition, however, upon cursory inspection it is revealed that there is some deterioration of the concrete truss cantilever on the east and west sides of the pier. Spalling of the concrete is occurring at or near the elevation of mean low water exposing the reinforcing steel to the marine environment. If the reinforcing steel is not protected from the marine environment, corrosion will occur and eventually cause a reduction in the live-load capacity of the truss. Providing proper protections for the steel is recommended. Tension cracks were observed on the concrete crane rail beams. However, when reinforcing steel is exposed to the marine environment it will corrode. This deterioration should be monitored. Live-loading on Pier 5 can be maintained at current levels (600 psf).

The pile foundation of the Barge Basin is in good condition. Anomalies are limited to damage caused by berthing forces at the perimeter of the basin. The bulkhead between the Barge Basin and Pier 6 has been partially reconstructed. The new structure, supported by steel H-piles, is in excellent condition. The older timber pile-supported structure is in good condition. The timber piles of a portion of the wharf near the Barge Basin are loaded eccentrically, a condition which is marginal and should be corrected. The seawall directly to the west of the Barge Basin is in poor condition and should be repaired. Live-loading on the Barge Basin and associated wharf can be maintained at current levels (200 psf).

Pier 6 is in good condition. There are 65 piles which have been damaged due to berthing forces generally occurring at the perimeter of the pier; these piles should be repaired. Otherwise, the timber pile foundation is in excellent condition. Live-loading on Pier 6 can be maintained at current levels (600 psf).

Pier 6-A and the associated Wharf to Pier 6 are in fair condition. There are 36 piles which have been damaged due to berthing forces, these piles should be repaired. Along the wharf from Pier 6-A to Pier 6 timber softness was detected to a depth of 4" in the structural timber. Due to the soft timber the live-load capacity of the structure should be reduced to 200 psf. The concrete seawall is beginning to deteriorate and should be repaired. At the southeast corner of Pier 6-A there are many broken piles in a concentrated area. As a result, the relieving platform is unsupported and in this area loading should be restricted to 50 psf until repairs have been made.

The Drydock Wharves have 242 piles with anomalies rendering them ineffective. These piles should be repaired. The general condition of the structural timber is good. Overall, live-loading can be maintained at current levels on the Drydock Wharves, however, a localized concentration of damaged piles occurs on Section A near Drydock No. 4 and until repairs are made, loading should be restricted to 100 psf in this area. The steel sheet pile along the inshore perimeter of Section A is showing signs of accelerated deterioration. Downgrading of the sheet piles' capacity to resist lateral earth pressure is not recommended at this time. Cathodic protection systems should be analyzed to determine possible sources of deterioration and protection alternatives. Possibly galvanic anodes could be installed to inhibit further deterioration of the sheet pile wall.

EXECUTIVE SUMMARY
(Volume II)

→ The inspected facilities covered in Volume II are Pier 5, the Barge Basin and associated Bulkhead, Pier 6, Pier 6-A and associated Bulkhead, the Drydock Wharves and Wharves K, J, I, H and G.

Pier 5 has recently been rebuilt. There is a new concrete superstructure and some new piles have been driven. The pile foundation was found to be in excellent condition. Generally the concrete superstructure is in excellent condition, however, upon cursory inspection it is revealed that there is some deterioration of the concrete truss cantilever on the east and west sides of the pier. Spalling of the concrete is occurring at or near the elevation of mean low water exposing the reinforcing steel to the marine environment. If the reinforcing steel is not protected from the marine environment, corrosion will occur and eventually cause a reduction in the live-load capacity of the truss. Providing proper protection for the steel is recommended. Tension cracks were observed on the concrete crane rail beam. The observed vertical cracking is a common condition in concrete beams. However, when reinforcing steel is exposed to the marine environment it will corrode. This deterioration should be monitored. Live-loading on Pier 5 can be maintained at current levels (600 psf).

The pile foundation of the Barge Basin is in good condition. Anomalies are limited to damage caused by berthing forces at the

perimeter of the basin. The bulkhead between the Barge Basin and Pier 6 has been partially reconstructed. The new structure, supported by steel H-piles, is in excellent condition. The older timber pile-supported structure is in good condition. The timber piles of a portion of the wharf near the Barge Basin are loaded eccentrically, a condition which is marginal and should be corrected. The seawall directly to the west of the Barge Basin is in poor condition and should be repaired. Live-loading on the Barge Basin and associated wharf can be maintained at current levels (200 psf).

Pier 6 is in good condition. There are 65 piles which have been damaged due to berthing forces generally occurring at the perimeter of the pier; these piles should be repaired. Otherwise, the timber pile foundation is in excellent condition. Live-loading on Pier 6 can be maintained at current levels (600 psf).

Pier 6-A and the associated Wharf to Pier 6 are in fair condition. There are 36 piles which have been damaged due to berthing forces, these piles should be repaired. Along the wharf from Pier 6-A to Pier 6 timber softness was detected to a depth of 4" in the structural timber. Due to the soft timber the live-load capacity of the structure should be reduced to 200 psf. The concrete seawall is beginning to deteriorate and should be repaired. At the southeast corner of Pier 6-A there are many broken piles in a concentrated area. As a result, the relieving platform is unsupported and in this area loading should be restricted to 50 psf until repairs have been made.

ii



Availability Codes	
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A-1	

The Drydock Wharves have 242 piles with anomalies rendering them ineffective. These piles should be repaired. The general condition of the structural timber is good. Overall, live-loading can be maintained at current levels on the Drydock Wharves, however, a localized concentration of damaged piles occurs on Section A near Drydock No. 4 and until repairs are made, loading should be restricted to 100 psf in this area. The steel sheet pile along the inshore perimeter of Section A is showing signs of accelerated deterioration. Downgrading of the sheet piles' capacity to resist lateral earth pressure is not recommended at this time. Cathodic protection systems should be analyzed to determine possible sources of deterioration and protection alternatives. Possibly galvanic anodes could be installed to inhibit further deterioration of the sheet pile wall.

The structural timber observed on Wharves K, J, I, H and G is in excellent condition. In two locations (Wharves K and J), there has been a localized failure of the relieving platform due to overloading on the top deck. In these two locations loading should be restricted until repairs are made. Portions of this wharf structure are translating in the outshore direction due to excessive lateral earth pressure exerted on the sheet pile wall. This creates eccentric loading on the vertical piles which, in turn, reduces their column capacity. At this time the combined stress occurring in the vertical piles is not critical, however, if translation is allowed to continue, overstressing will occur. The sections of wharf which have been observed to be translating

should be tied back and anchored. Until the wharf is stabilized, the area from the face of the wharf inshore 70' should be restricted to 300 psf live- loading. This will limit excessive lateral earth pressure due to live-loading from acting on the sheet pile wall.

Refer to the following Executive Summary Table to review each facility's construction, recommendations and repair cost estimates.

PHILADELPHIA NAVAL SHIPYARD

PHILADELPHIA, PENNSYLVANIA

EXECUTIVE SUMMARY TABLE

VOLUME II

<u>FACILITY</u>	<u>YEAR BUILT</u>	<u>TOTAL NO. OF PILES</u>	<u>SIZE (LxW-FT.)</u>	<u>STRUCTURES</u>	<u>RECOMMENDATIONS</u>
Pier 5	1912-1979	Approx. 3,000	790'x110'	Pile-supported high concrete deck structure	1) Replace broken pile. 2) Repair non-bearing, piles. 3) Monitor tension crack. 4) Repair spalling on deck and utility tunnel. 5) Re-inspect after repair.
Barge Basin & Bulkhead to Pier 6	Barge Basin: Circa 1939 Bulkhead to Pier 6: 1903-1979	Barge Basin: approx. 850 Bulkhead: approx. 740	Barge Basin: 163'x60' Bulkhead: 747' in length	The Barge Basin is a timber pile-supported, low deck, earth fill, relieving platform structure. The original portion of the bulkhead is a timber pile-supported, low deck, earth fill relieving platform structure. The rebuilt section consists of steel H-piles arranged in bents with a low steel deck.	1) Replace broken piles. 2) Repair non-bearing, and wild piles. 3) Repair eccentric pile through 8 of bulkhead. 4) Repair spalling on deck. 5) Re-inspect after repair.
Pier 6	Circa 1940	Approx. 8,500	970'x100'	Timber pile-supported, low deck, earth fill, relieving platform structure	1) Replace broken piles. 2) Post and brace broken, repair non-bearing, and displaced, and wild. 3) Re-inspect after repair.
Pier 6A & Bulkhead East to Pier 6	Circa 1903	Pier 6A: approx. 1,100 Bulkhead: approx. 84	Pier 6A: 235'x70' Bulkhead: 142.7' in length	Timber pile-supported, low deck, earth fill, relieving platform structure.	1) Replace or repair broken piles. 2) Repair split, wild, and piles. 3) Repair spalling on deck. 4) Immediate restriction 10' radius of broken made. 5) Limit live-load capacity. 6) Re-inspect after repair.

*Cost estimates are based on 1983 U.S. East Coast prices. Mobilization/demobilization costs have been omitted.

PHILADELPHIA NAVAL SHIPYARD

PHILADELPHIA, PENNSYLVANIA

EXECUTIVE SUMMARY TABLE

VOLUME II

<u>URES</u>	<u>RECOMMENDATIONS</u>	<u>ESTIMATED COST* (THOUSANDS)</u>
supported high concrete structure	1) Replace broken pile.	1.5
	2) Repair non-bearing, partially bearing and split piles.	2.4
	3) Monitor tension cracks in crane rail beam on a yearly basis.	--
	4) Repair spalling on concrete truss cantilever and utility tunnel.	19.8
	5) Re-inspect after repairs and in 6 years thereafter.	--
arge Basin is a timber supported, low deck, earth relieving platform structure.	1) Replace broken piles.	5.0
original portion of the bulk-	2) Repair non-bearing, partially bearing, split and wild piles.	8.4
is a timber pile-supported, deck, earth fill relieving structure.	3) Repair eccentric piles associated with Bents 4 through 8 of bulkhead. Re-inspect each year	10.0
built section consists of H-piles arranged in bents a low steel deck.	4) Repair spalling on concrete seawall.	3.8
	5) Re-inspect after repairs and in 6 years thereafter.	--
r pile-supported, low deck, fill, relieving platform structure	1) Replace broken perimeter piles.	15.0
	2) Post and brace broken interior piles, repair non-bearing, partially bearing, split and displaced, and wild piles.	20.0
	3) Re-inspect after repairs and in 6 years thereafter.	--
r pile-supported, low deck, fill, relieving platform structure.	1) Replace or repair broken piles.	36
	2) Repair split, wild, and partially bearing piles.	1.6
	3) Repair spalling on concrete seawall.	7.1
	4) Immediate restriction of live-loading within 10' radius of broken piles until repairs are made.	--
	5) Limit live-load capacity to 200 psf.	--
	6) Re-inspect after repairs and in 2 years thereafter.	--

PHILADELPHIA NAVAL SHIPYARD
EXECUTIVE SUMMARY TABLE, CONT'D.

VOLUME II

<u>FACILITY</u>	<u>YEAR BUILT</u>	<u>TOTAL NO. OF PILES</u>	<u>SIZE (LxW-FT.)</u>	<u>STRUCTURES</u>	<u>RECOMMENDATIONS</u>
Drydock Wharf	Circa 1941	Section "A" approx. 4,300	Section "A" 395'x600'x224'	Timber pile-supported, low deck, earth fill, relieving platform structure	1) Replace or repair
		Section "B" approx. 2,800	Section "B" 224'x280'x216'		2) Repair split and d and partially bear
		Section "C" approx. 1,500	Section "C" 214'x184'		3) Repair local pile d
					4) Repair damaged pile
Wharves K, J, I, H, and G	Circa 1943	12,060	3,315' in length	Timber pile-supported, low deck, earth fill, relieving platform structure.	5) Investigate cathod
					6) Downgrade live-load north of Bent 220 a until repairs are d
					7) Enforce dredge limi
					8) Re-inspect after r
					1) Replace broken pile
					2) Repair split piles
					3) Install tie-back st Wharves K, J, and capacity to 300 psf wharves inshore 70 completed.
					4) Repair damaged pile capacity to 0 psf repairs are complet
					5) Sections of wharf r should be inspected repairs and in 6 ye
					6) Shim non-bearing p

*Cost estimates are based on 1983 U.S. East Coast prices.
Mobilization/demobilization costs have been omitted.

PHILADELPHIA NAVAL SHIPYARD
EXECUTIVE SUMMARY TABLE, CONT'D.
VOLUME II

<u>URES</u>	<u>RECOMMENDATIONS</u>	<u>ESTIMATED COST (THOUSANDS)</u>
pile-supported, low deck, fill, relieving platform are	1) Replace or repair broken piles.	49
	2) Repair split and displaced, wild, non-bearing, and partially bearing piles.	77.2
	3) Repair local pile cap-deck failure.	1.1
	4) Repair damaged pile caps.	12
	5) Investigate cathodic protection system.	--
	6) Downgrade live-load capacity of Section "A" north of Bent 220 and inshore 20' to 100 psf until repairs are completed.	--
	7) Enforce dredge limits.	--
	8) Re-inspect after repairs and in 6 years thereafter.	--
pile-supported, low deck, fill, relieving platform ure.	1) Replace broken piles.	7.0
	2) Repair split piles, and wild piles.	14.4
	3) Install tie-back system along sections of Wharves K, J, and I. Restrict live-load capacity to 300 psf from the face of the wharves inshore 70' until repairs are completed.	605
	4) Repair damaged pile caps. Restrict live-load capacity to 0 psf in a radius of 10' until repairs are completed.	10
	5) Sections of wharf requiring tie-back system should be inspected yearly. Re-inspect after repairs and in 6 years thereafter.	--
	6) Shim non-bearing piles	26

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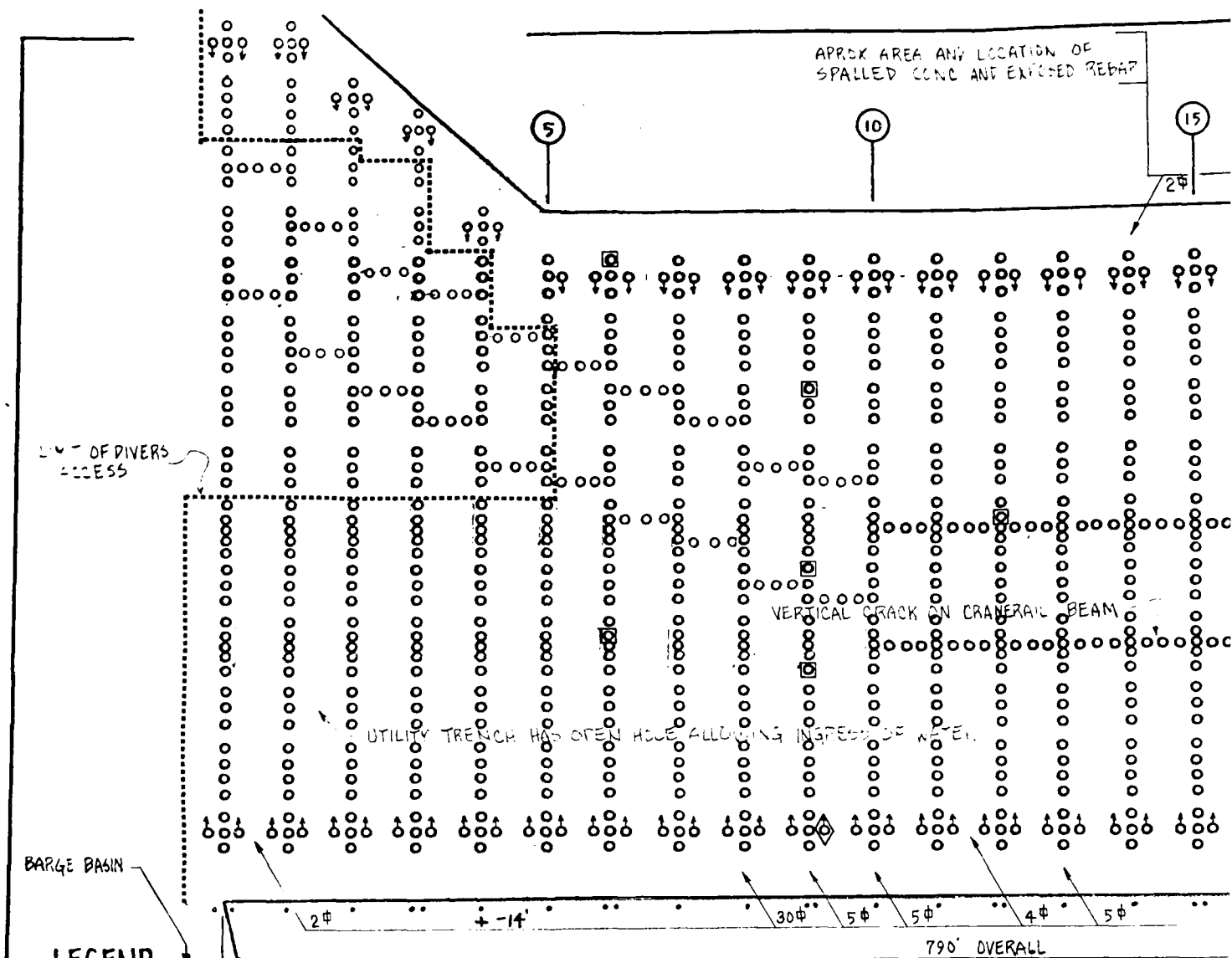
4.7 PIER 5

4.7.1 DESCRIPTION

Pier 5 is located to the west of Dry Dock No. 2 and to the east of the Barge Basin on the northern bank of the Delaware River (see Figures 4, [Vol. I] and 45-49).

The original pier constructed circa 1912 measured approximately 80' in width by 657' in length. The original pier was removed down to the tops of the piles or pile clamps and rebuilt circa 1944 to 1946. Public Works Drawing B-4000 and B-4001 indicate the rebuilt pier was enlarged to 110' in width by 767' in length. Apparently the pier was rebuilt again in 1979 to the existing structure. Its overall dimensions are approximately 790'x110'. The structure is supported by approximately 3,000 timber piles arranged in bents 10' on center. The design pile capacity is 20 tons. The present deck live-load capacity is 600 psf. The deck elevation is 12.39'. During our divers' inspection this facility was functioning as a berthing facility for a YFNB.

Reference 2 (See Appendix A-25)



LEGEND

- ◇ NON-BEARING PILE
 - ⊠ CORE LOCATION (PILE, CAP, DECK) LEVEL 3 INSPECTION
 - MODIFIED LEVEL 1 INSPECTION
 - .. LEVEL 1 INSPECTION
 - 50% 50 PERCENT OF PILE BEARING ON PILE CAP
- PERFORMED ON ALL PILES WITHIN BENT OR ROW

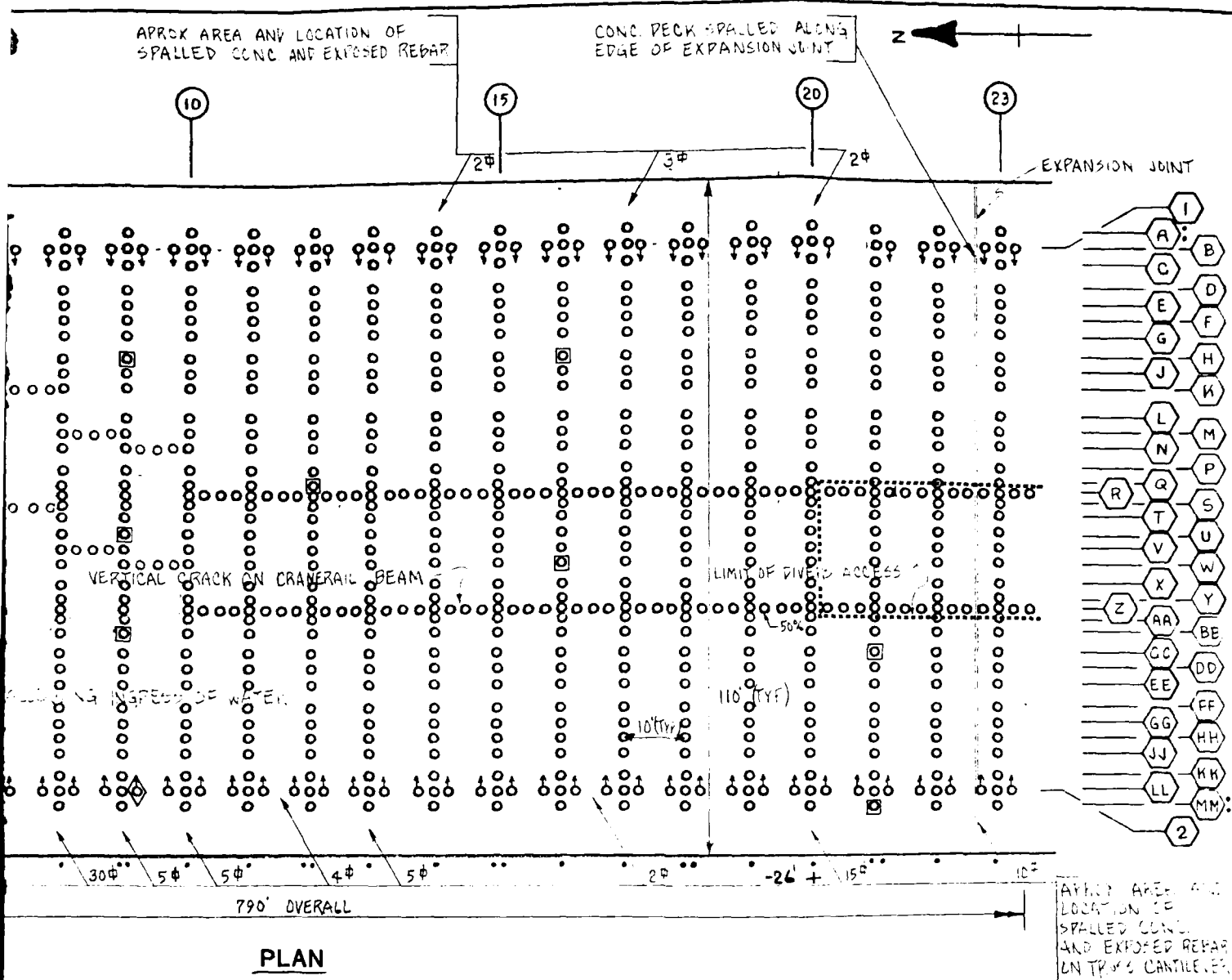
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PLAN

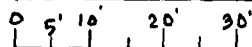
NOTES:

1. FILE SPACING VARIES WITHIN EACH PENT
2. MANY WELD FILES WHICH WERE PART OF THE OLD PIER - THEY EXIST AND ARE NOT LOCATED ON THE PLAN

REFERENCE

NAVJAC DWG NO. 2032643

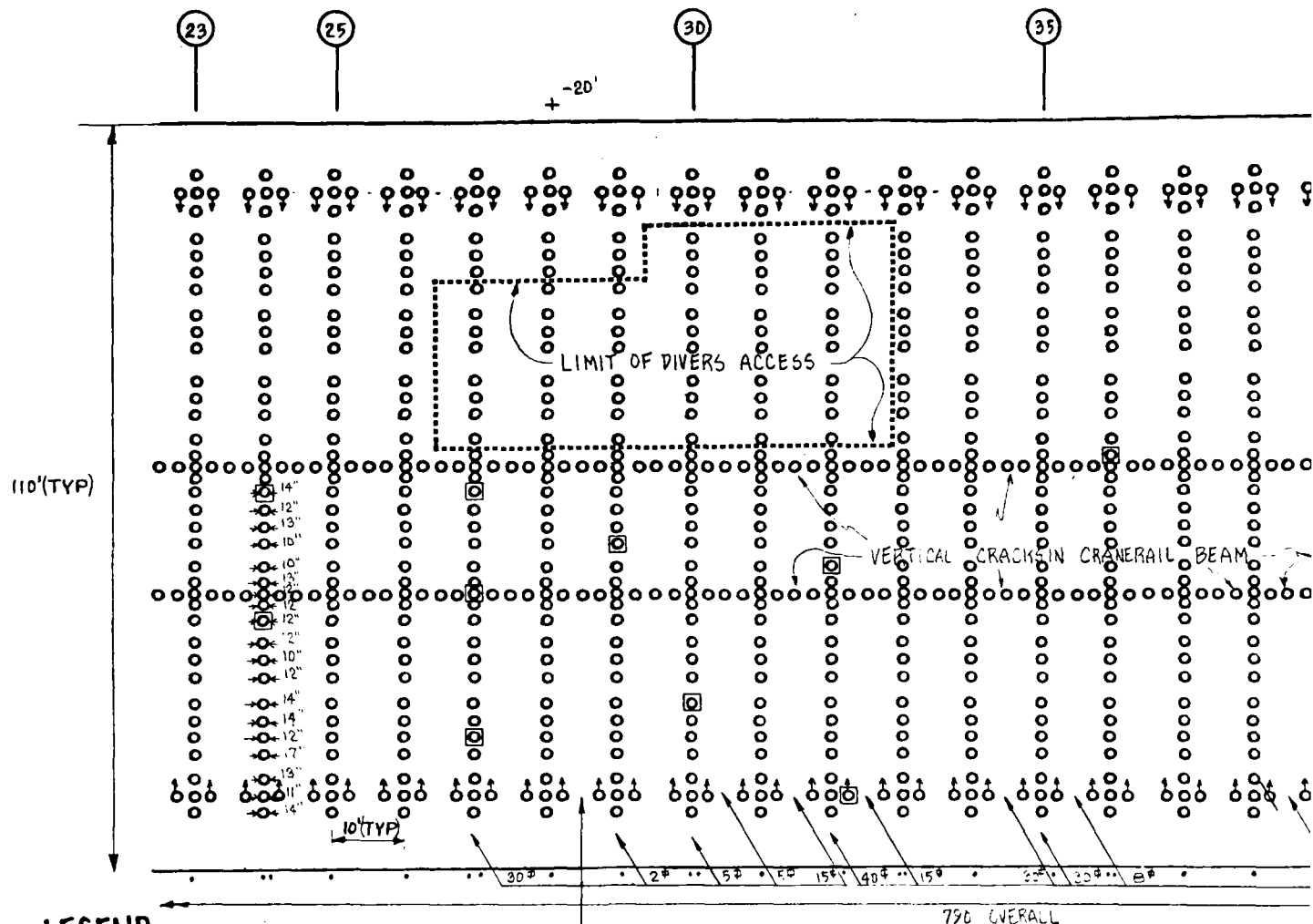
GRAPHIC SCALE



CHIL'S ENGINEERING CORPORATION
BOX 332
MEDFIELD, MA

CHESAPEAKE DIVISION
NAVAL FACILITIES ENGINEERING COMMAND
WASHINGTON, D.C.
PHILADELPHIA NAVAL SHIPYARD PHILADELPHIA, PA
PIER 5

FIG NO
45



LEGEND

- ◇ NON-BEARING PILE
 - BROKEN PILE
 - ⋈ DISPLACED-SPLIT PILE
 - ⊠ CORE LOCATION (PILE, CAP, DECK) LEVEL 3 INSPECTION
 - MINIMUM PILE DIAMETER, LEVEL 2 INSPECTION
 - +25' SOUNDINGS (FT) BELOW MLW
 - MODIFIED LEVEL 1 INSPECTION
 - .. LEVEL 1 INSPECTION
- PERFORMED ON ALL PILES
WITHIN BENT OR FLOW

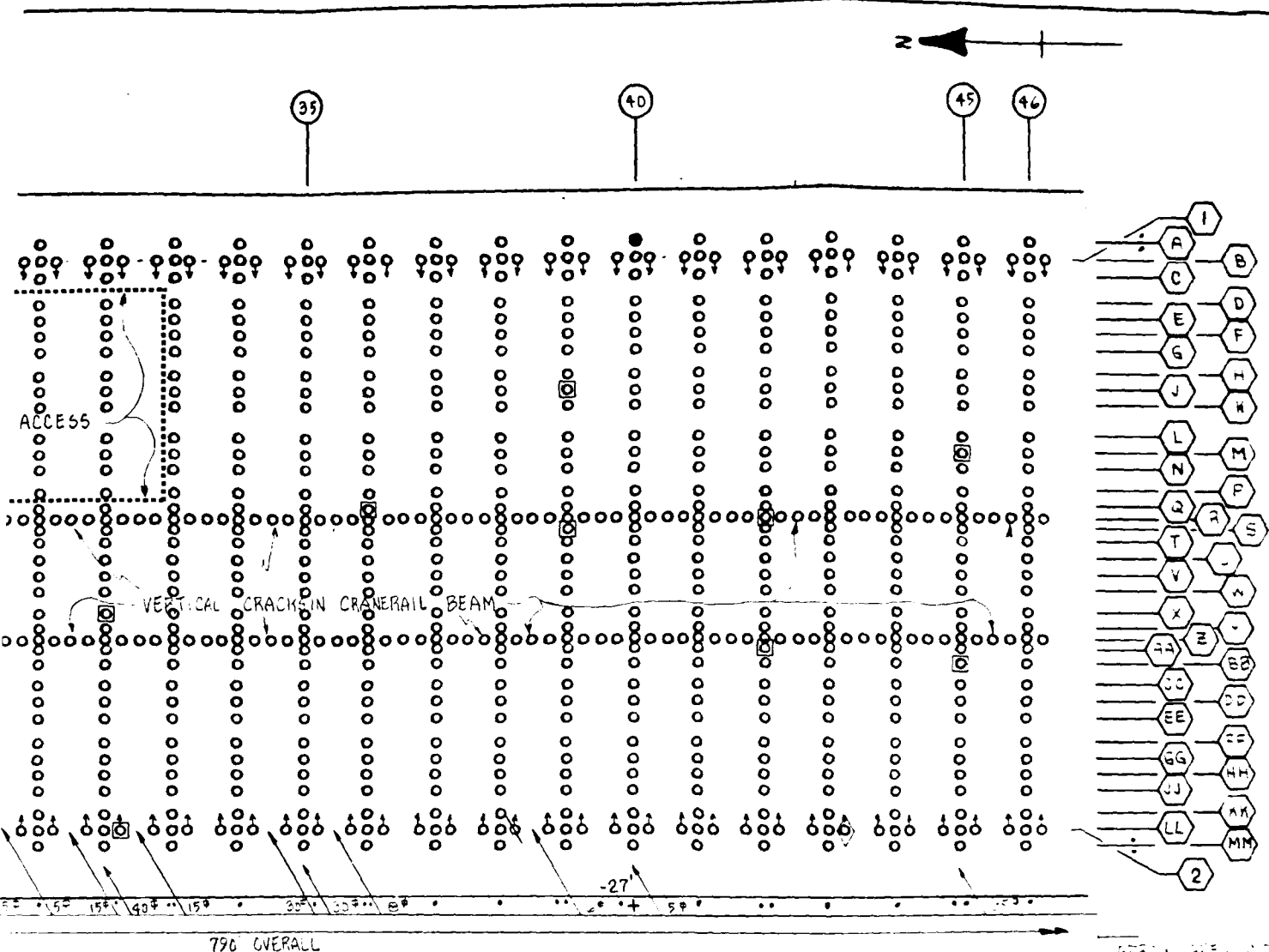
VERTICAL CRACK IN
UTILITY TRENCH

PLAN

NOTES

1. PILE SPACING
2. MANY WILD FI
AND ARE NOT
3. OBSERVATION OF
WAS BLOCKED

REFERENCE:
NAVFAC DWG # 2032643



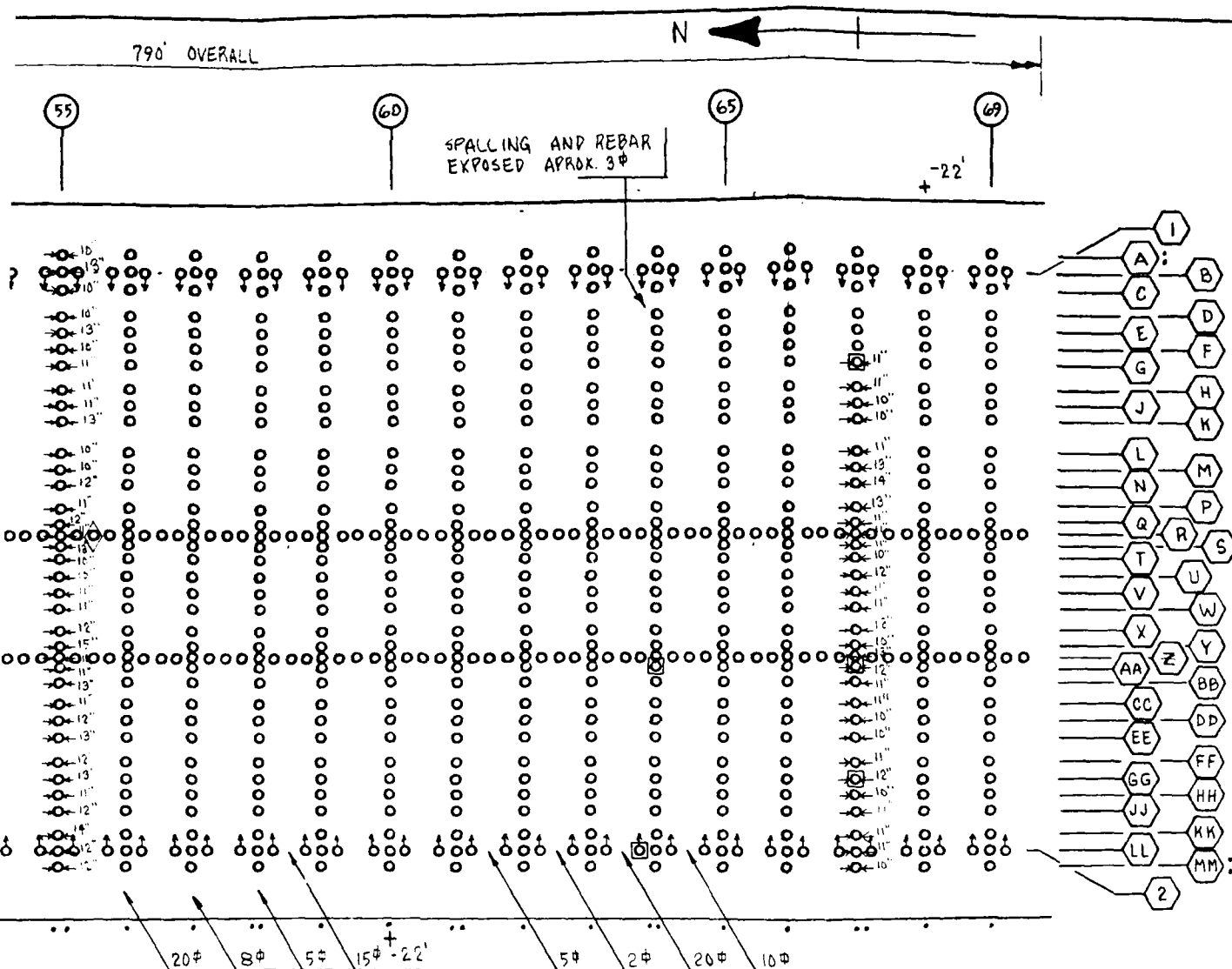
PLAN

NOTES

1. PILE SPACING VARIES WITHIN EACH BENT
2. MANY WILD PILES EXIST BUT ARE NOT INTEGRAL WITH THE STRUCTURE AND ARE NOT LOCATED ON THIS PLAN
3. OBSERVATION OF THE CANTILEVER STRUCTURE ON THE EAST SIDE OF THE PIER WAS BLOCKED BY BARGES DURING THE INSPECTION

REFERENCE:
NAVFAC DWG # 2032643

GRAPHIC SCALE	CHLOE ENGINEERING CORPORATION BOX 333 MEDFIELD, MA	CHESAPEAKE DIVISION NAVAL FACILITIES ENGINEERING COMMAND WASHINGTON, D.C.	
NOT TO SCALE		PHILADELPHIA NAVAL SHIPYARD PHILADELPHIA, PA	FIG NO PIER 5 46



PLAN

NOTES

1. PILE SPACING VARIES WITHIN EACH BENT
2. MANY WILD PILES EXIST BUT ARE NOT INTEGRAL WITH THE STRUCTURE AND ARE NOT LOCATED ON THIS PLAN
3. OBSERVATION OF THE CANTILEVER STRUCTURE ON THE EAST SIDE OF THE PIER WAS BLOCKED BY BARGES DURING THE INSPECTION

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GRAPHIC SCALE



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CORPORATION
BOX 373
MEDFIELD, MA

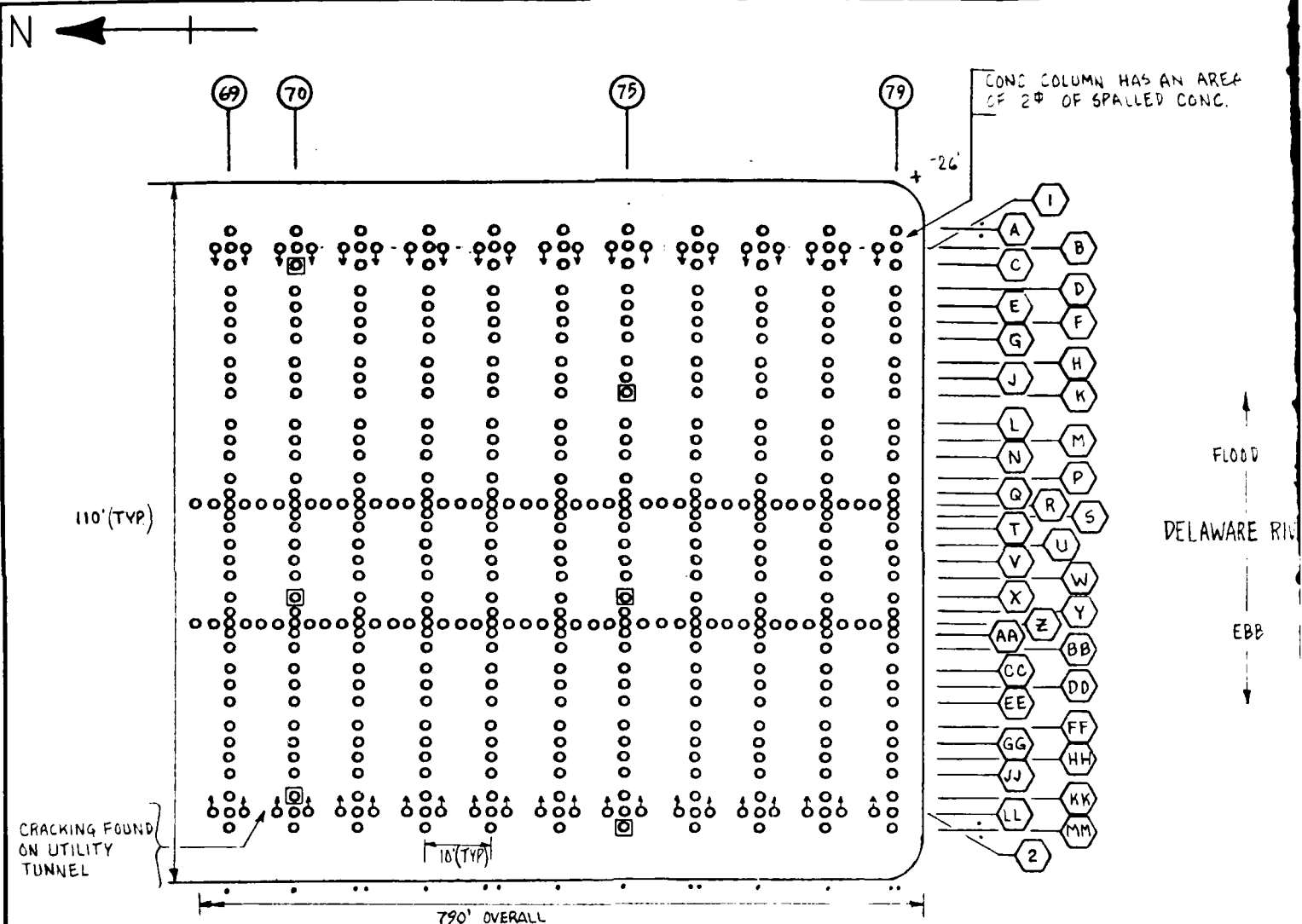
CHESAPEAKE DIVISION
NAVAL FACILITIES ENGINEERING COMMAND
WASHINGTON, D.C.

PHILADELPHIA NAVAL SHIPYARD PHILADELPHIA, PA

PIER 5

FIG NO

47

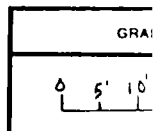


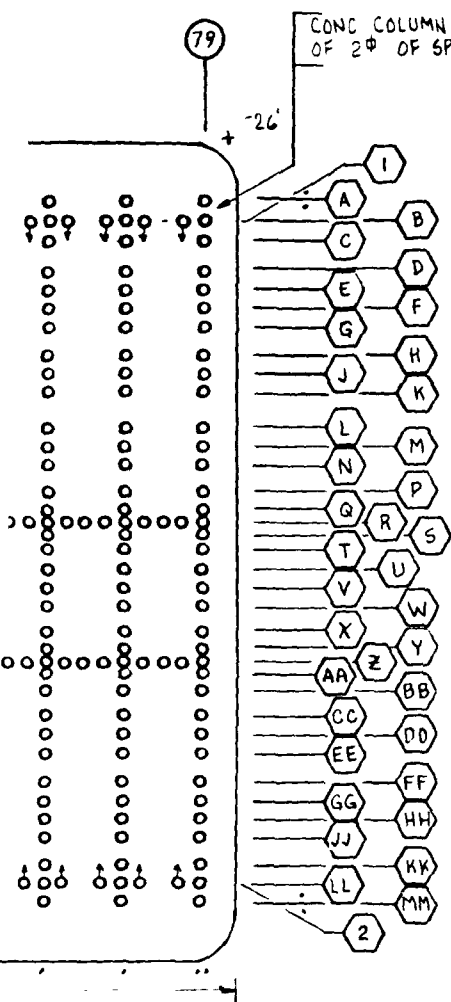
PLAN

LEGEND

- ☐ CORE LOCATION (PILE, CAP, DECK) LEVEL 3 INSPECTION
 - 25' SOUNDINGS (FT) BELOW MLW
 - MODIFIED LEVEL 1 INSPECTION
 - .. LEVEL 1 INSPECTION
- PERFORMED ON ALL PILES
WITHIN BENT OR ROW

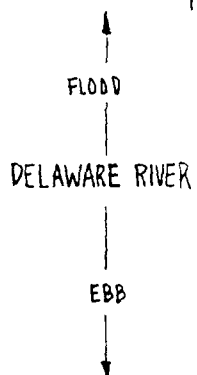
REFERENCE:
NAVFAC DWG NO. 2032643



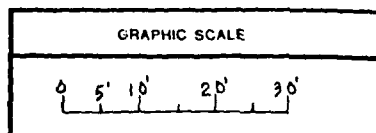


NOTES

1. PILE SPACING VARIES WITHIN EACH BENT



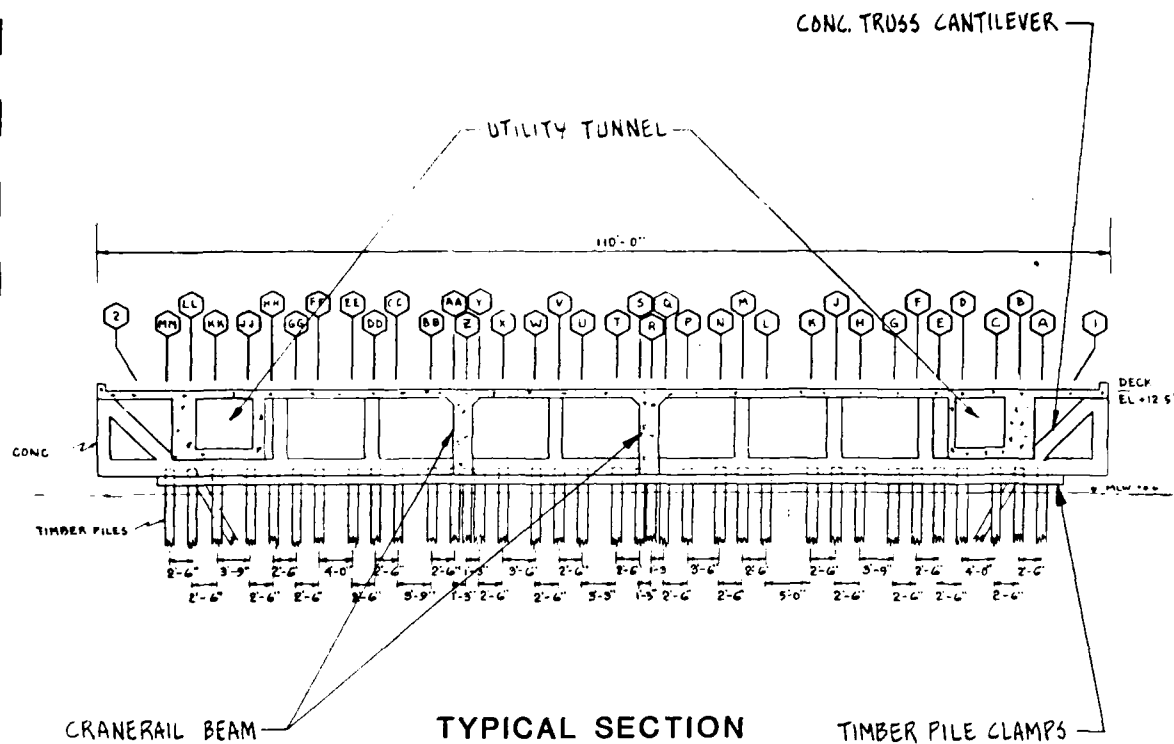
REFERENCE:
NAVFAC DWG NO 2032643



CHILOS ENGINEERING
CORPORATION
BOX 323
MEDFIELD, MA

CHESAPEAKE DIVISION
NAVAL FACILITIES ENGINEERING COMMAND
WASHINGTON, D.C.
PHILADELPHIA NAVAL SHIPYARD PHILADELPHIA, PA
PIER 5

FIG. 2
48



REFERENCE

NAVAC DWG NO. 2032643

GRAPHIC SCALE	CHILDS ENGINEERING CORPORATION BOX 333 MEDFIELD MA	CHESAPEAKE DIVISION NAVAL FACILITIES ENGINEERING COMMAND WASHINGTON D C PHILADELPHIA NAVAL SHIPYARD PHILADELPHIA, PA	
NO SCALE		PIER 5	FIG NO. 49

4.7.2 OBSERVED INSPECTION CONDITION

Quantities of specific anomalies found on Pier 5 are listed as follows:

- 1 broken pile
- 1 split and displaced pile
- 4 non-bearing piles
- 1 partially-bearing pile

The locations of these anomalies can be found on Figures 45 through 49.

From the observation of core samples taken at various locations on Pier 5 the condition of the timber was found to be excellent with softness ranging from 1/4" to 1/2". Minimum pile diameters observed range from 10"-17" and indicate that there has not been any loss of cross-sectional area since the time of original construction. Fasteners used on the timber portions of the structure are found to have no loss of steel due to corrosion (see Photo #31).

The concrete superstructure was generally found to have only minor damage. Some spalling was found on all of the concrete members comprising the truss cantilever at the perimeter of the pier and along the utility tunnel (see Photo #32). The approximate total area of concrete effected is 1400 sq. ft. In areas located on Figures 45 through 49 there is some reinforcing steel exposed to the environment. There are two concrete crane rail beams running the full length of the pier. Divers found that there are tension cracks extending to the full depth of the beams in various locations noted on Figures 45 and 46. In some areas of the concrete



PHOTO NO. 31: Pier 5, Bent 43, Pile LL; illustrates typical condition of pile to pile cap connection. Note sand and cement eroded from concrete exposing aggregate. Diameter of washer is 3".

PHOTO NO. 32: Pier 5, west side; shows spalling and cracking in concrete cantilever members at the edge of the pier.



superstructure near MLW, the fine aggregates have eroded out of the concrete leaving a rough surface of concrete consisting of the remaining large aggregates (see Photo #13, Vol. I).

Apparently the original structure of the pier was demolished and only partially removed. There are many piles which remain in place and unmarked on the figures since they are not part of the structure. Also, the original concrete structure was simply broken up and dropped onto the river bottom, where it remains.

4.7.3 STRUCTURAL ASSESSMENT

The timber pile foundation appears to be in excellent condition with no apparent deviations from the structure's original construction. The specific anomalies referred to earlier should be repaired in order to attain full live-load capacity.

The spalled areas on the concrete truss and utility tunnel are posing no immediate threat to the structure's live-load capacity, although if this condition is not repaired the deterioration of the concrete will continue and the reinforcing steel will be exposed to the marine environment and consequently, corrosion will occur. The unremoved demolished portions of the original structure do not effect the structural integrity of this facility.

Large tension cracks are an indication that the beam has been overstressed. Also when the steel reinforcing is exposed to the marine environment corrosion will occur. When corrosion significantly decreases the cross-sectional area of the steel, strength will be lost in the composite structure. Observations indicate that there was no significant corrosion occurring during the time of our inspection.

4.7.4 RECOMMENDATIONS

The single broken pile (see Figure 46) should be replaced. In order to properly install a new pile, it should be driven through the concrete deck and pulled into place. The estimated cost to install a new creosoted pile through the deck is \$1,500 plus mobilization and demobilization. The other six (6) piles with anomalies should be reconditioned (shimmed, posted or clamped, see Appendix A-15 through A-21) and refastened to the pile cap. The estimated cost for reconditioning is \$400 per pile. The total estimated cost would be \$2,400.

Initially, tension cracks in the crane rail beam should be inspected closely and then monitored on a yearly basis, so as to determine any change in conditions or deterioration of reinforcing steel. The spalled areas of the concrete truss cantilever and utility tunnel should be patched. The old concrete should be chipped away to sound concrete and cleaned where needed. Pneumatically-placed concrete should be placed to provide proper cover for the reinforcing steel. The estimated cost to provide proper cover and prepare the concrete surface is \$14.16/sq.ft. The total surface area in need of cover is 1,400 sq. ft. The total estimated cost of repair is \$19,824.

Live-loading in deck areas directly associated with damaged (broken, split and wild) piles should be restricted to 25% of the current recommended live-load capacity until those piles are repaired. Following the implementation of the recommended

repairs, live-loading can be maintained at current levels (600 psf). The estimated life of this facility with proper maintenance is in excess of 25 years. The entire facility should be re-inspected after repairs and in 6 years thereafter. This inspection will enable Shipard personnel to determine any change in existing conditions. This report should be used as a baseline for all future inspections.

4.8 BARGE BASIN AND THE BULKHEAD TO PIER 6

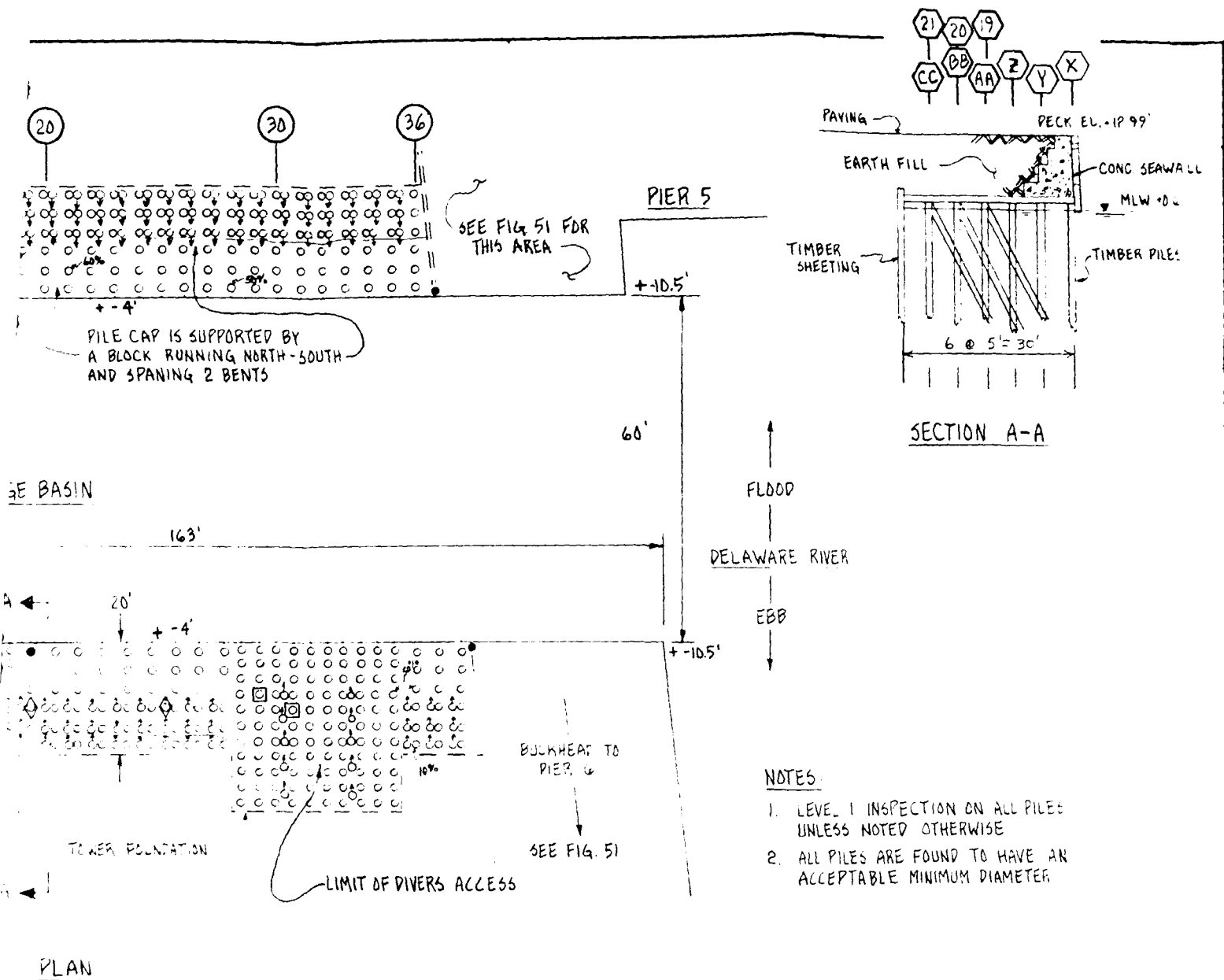
4.8.1 DESCRIPTION

The Barge Basin is located just to the west of Pier 5 (see Figure 50). The bulkhead from Pier 6 to the Barge Basin is located adjacent to and to the east of Pier 6 and runs past Dry Dock No. 3 to the Barge Basin (see Figures 4, [Vol. I] and 50-52).

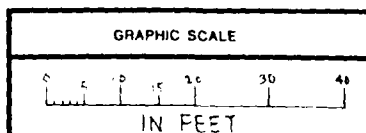
The Barge Basin was constructed circa 1939. This structure consists of a timber pile-supported, low deck, earth fill, relieving platform structure. Integral with this structure is the foundation associated with the barge crane. There are approximately 850 piles supporting this structure. The outer perimeter of the structure is bordered by timber sheet piles. The timber pile bearing capacity is assumed to be 15 tons. The top deck elevation is +12.99'. The Barge Basin was functioning as a transfer facility for barges during our divers' inspection (see Figure 50).

The bulkhead between Pier 6 and the Barge Basin was originally constructed circa 1903 and 1918. Part of the bulkhead collapsed and was rebuilt circa 1979. The rebuilt section consists of steel H-piles arranged in bents with a low steel deck. The original section remaining consists of a timber pile-supported, low deck, earth fill, relieving platform structure similar to the Barge Basin. There are approximately 740 piles supporting this structure.

Reference 2 (see Appendix A-25)



REFERENCE
PW DWG NO C-8994



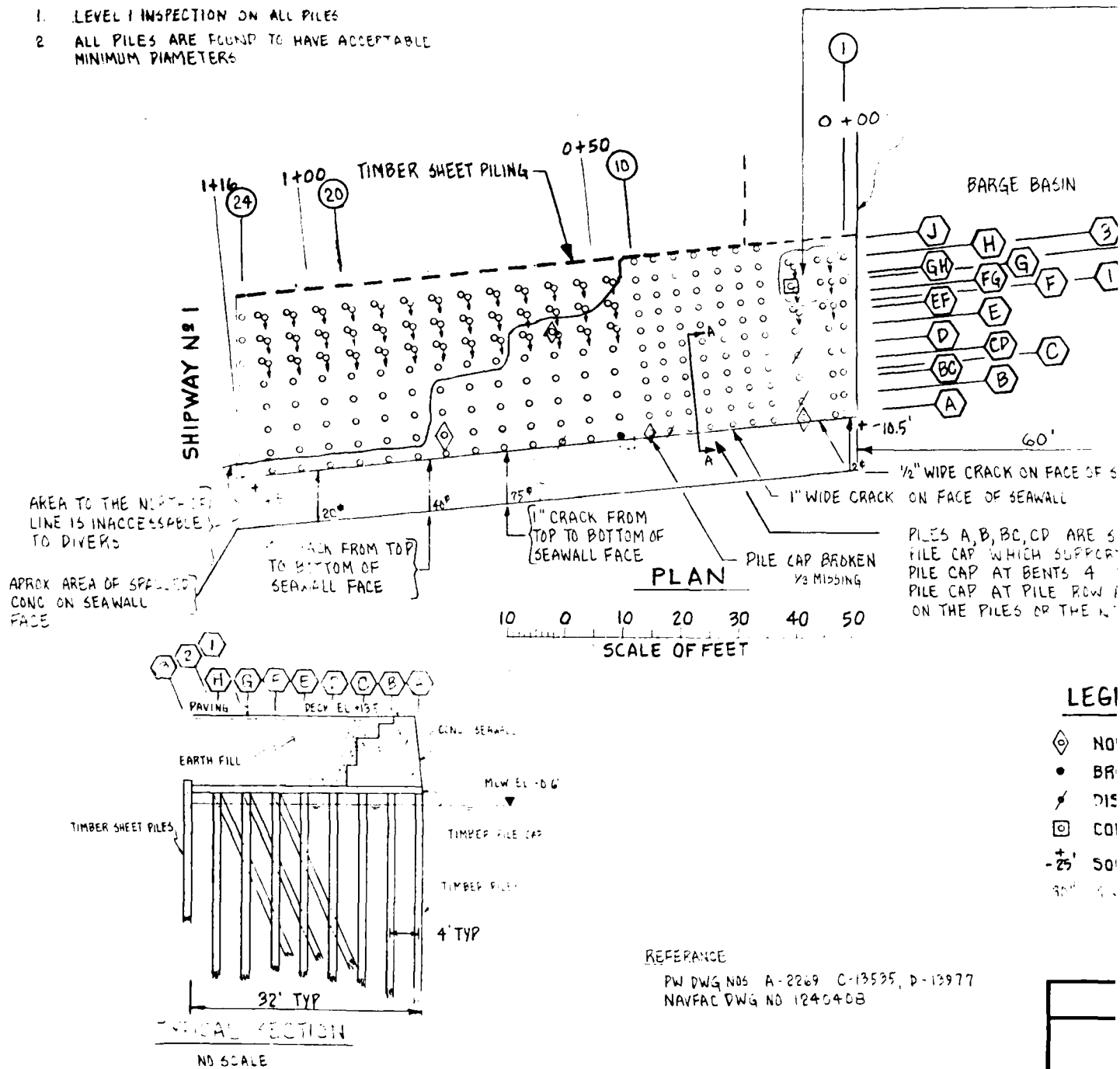
CHILDS ENGINEERING
CORPORATION
BOX 333
MEDFIELD MA

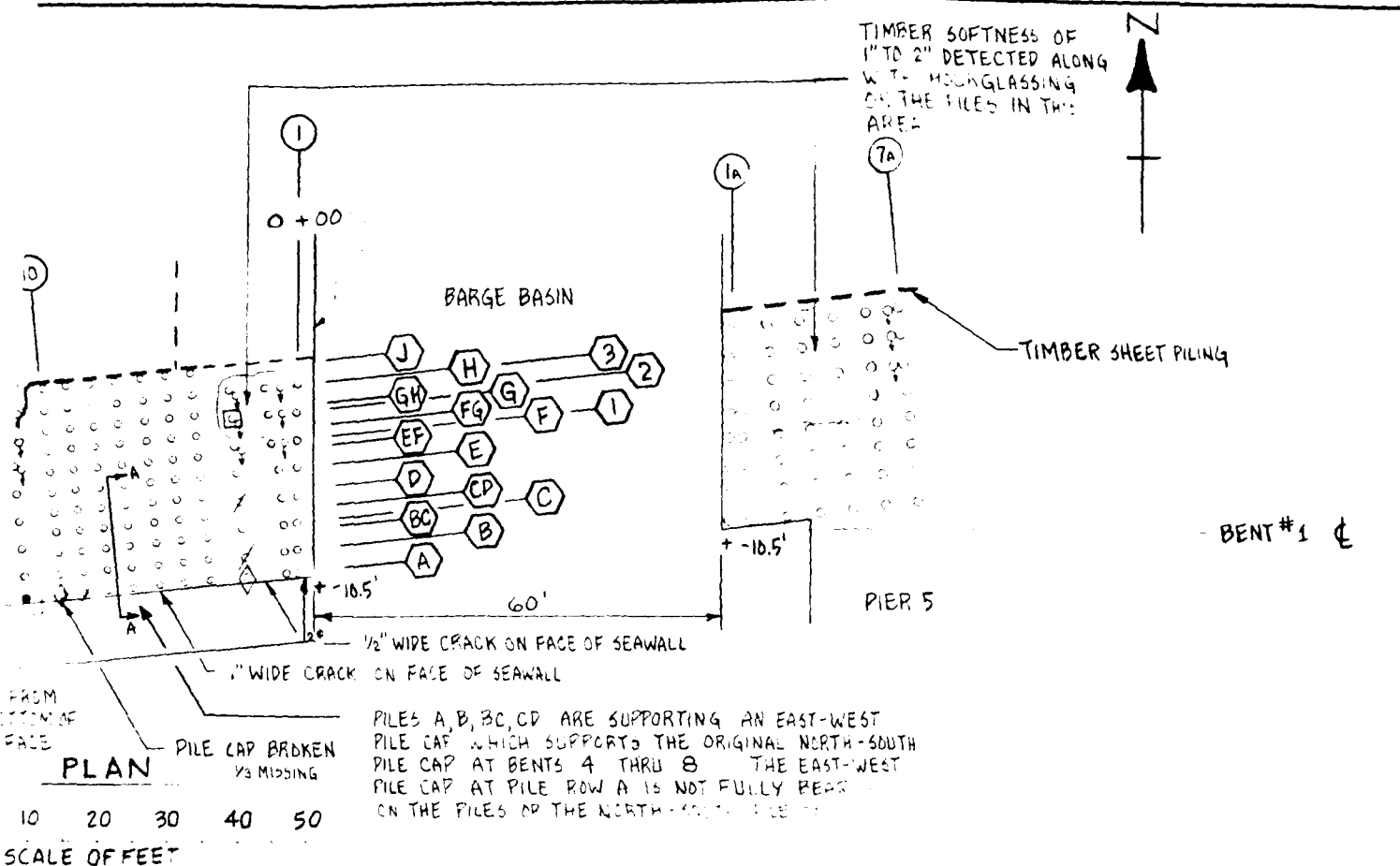
CHESAPEAKE DIVISION
NAVAL FACILITIES ENGINEERING COMMAND
WASHINGTON D C
PHILADELPHIA NAVAL SHIPYARD PHILADELPHIA PA
BARGE BASIN

FIG NO
50

NOTES

1. LEVEL 1 INSPECTION ON ALL PILES
2. ALL PILES ARE FOUND TO HAVE ACCEPTABLE MINIMUM DIAMETERS





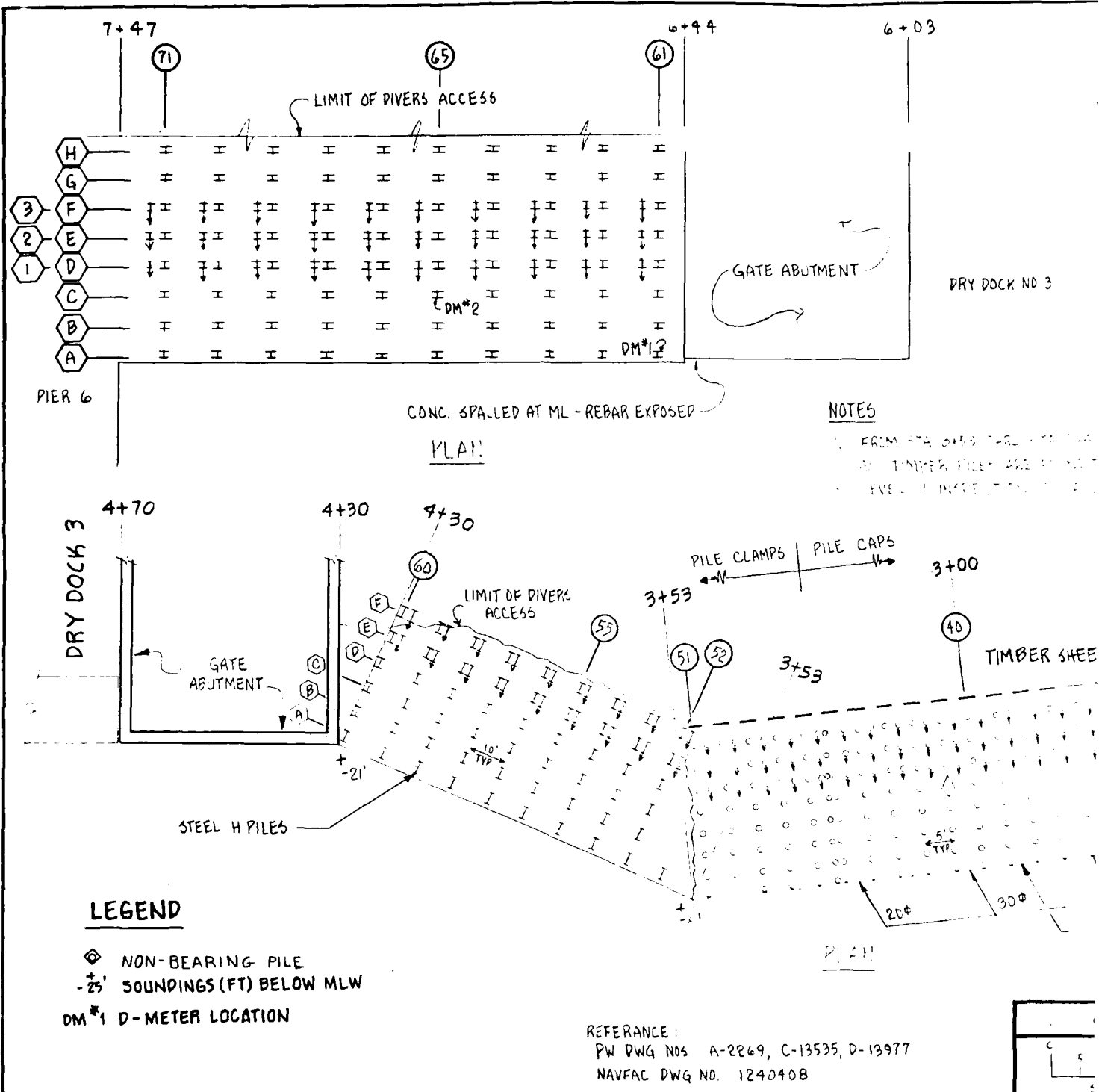
LEGEND

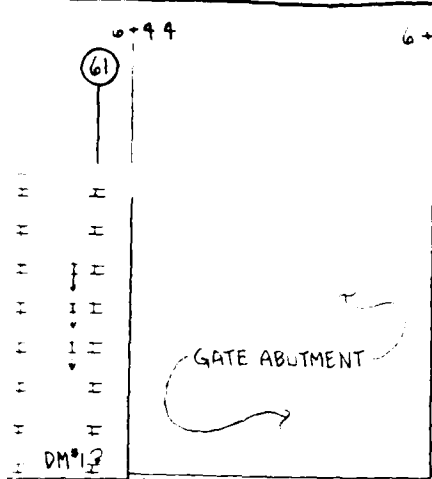
- ◊ NON-BEARING PILE
- BROKEN PILE
- ⚡ DISPLACED-SPLIT PILE
- ☐ CORE LOCATION (PILE, CAP, DECK) LEVEL 3 INSPECTION
- +25' SOUNDINGS (FT) BELOW MLW
- 30' SOUNDING (FT) BELOW MLW

REFERENCE

FW DWG NOS A-2269 C-13535, D-13977
NAVFAC DWG NO 12404DB

GRAPHIC SCALE	CHILDS ENGINEERING CORPORATION BOX 333 MEDFIELD MA	CHESAPEAKE DIVISION NAVAL FACILITIES ENGINEERING COMMAND WASHINGTON, D.C. PHILADELPHIA NAVAL SHIPYARD PHILADELPHIA, PA. F.O.N.
AS SHOWN		BULKHEAD TO PIER 6 51





STEEL THICKNESS READINGS

DM#1			DM#2		
EL (FT)	WEB (IN)	FLANGE (IN)	EL (FT)	WEB (IN)	FLANGE (IN)
+1.0	.495	.495	+1.0	.495	.475
0.0	.495	.480	0.0	.485	.475
-2.0	.515	.505	-2.0	.535	.475
-4.0	.460	.465	-4.0	.485	.475
-10.0	.480	.510	-10.0	.485	.480
ML (-24)	.490	.495	ML (-11)	.485	.480

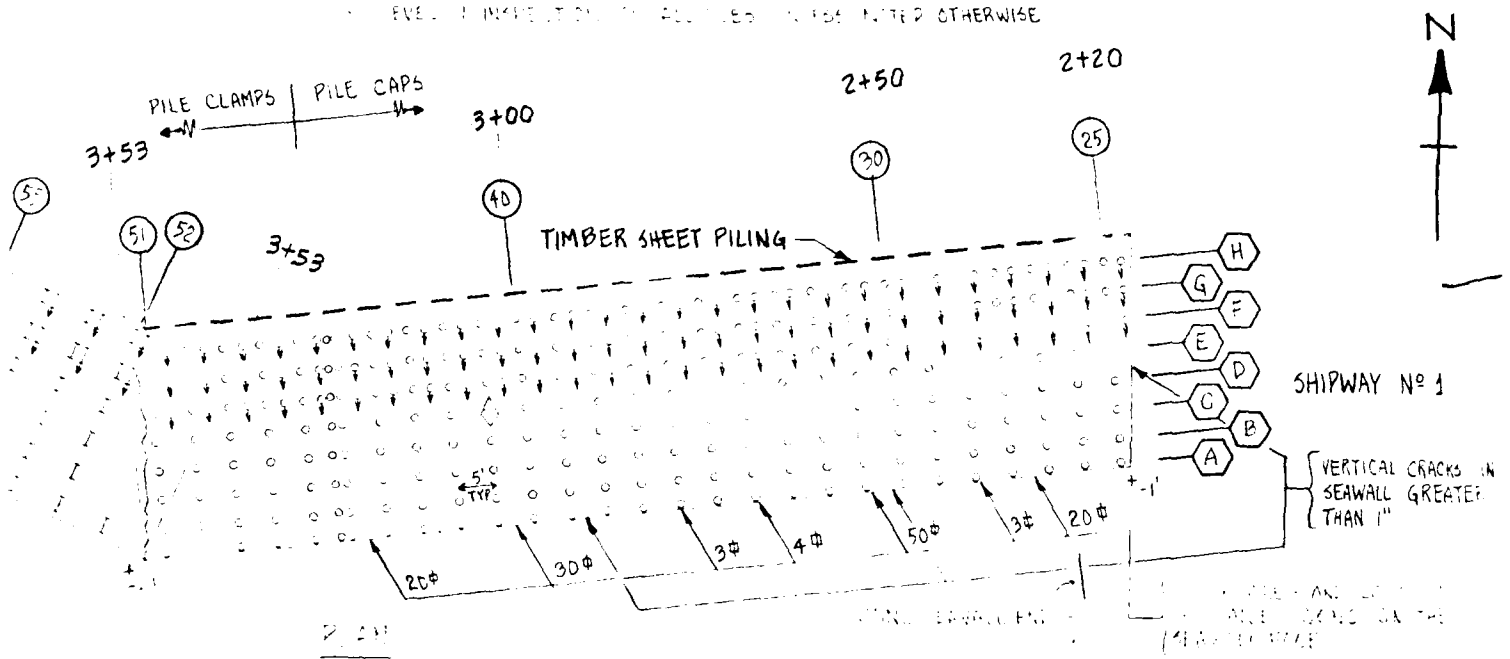
DRY DOCK NO 3

THEORETICAL VALUES FOR THE HP 14X73 - WEB .505" FLANGE .505"

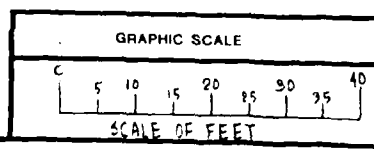
ERAP, EXPOSED

NOTES

1. FROM STA 0+55 TO STA 3+44 NEW STEEL PILES HAVE BEEN INSTALLED
2. TIMBER PILES ARE TO REMAIN AND A MINIMUM DIAMETER
3. LEVEL OF PROTECTION FOR ALL PILES TO BE ENTERED OTHERWISE



REFERENCE:
 PW DWG NOS A-2269, C-13535, D-13977
 NAVFAC DWG NO 1240408



CHILDS ENGINEERING CORPORATION BOX 333 MEDFIELD, MA	CHESAPEAKE DIVISION NAVAL FACILITIES ENGINEERING COMMAND WASHINGTON, D.C.	
	PHILADELPHIA NAVAL SHIPYARD PHILADELPHIA, PA	FIG NO
	BULKHEAD TO PIER 6	52

4.8.2 OBSERVED INSPECTION CONDITION

Specific anomalies noted on the structural piles are listed as follows:

Barge Basin

- 4 broken piles
- 3 non-bearing piles
- 2 wild piles
- 7 partially-bearing piles

Bulkhead from Pier 5 to Pier 6

- 1 broken pile
- 4 split piles
- 5 non-bearing piles

Locations of these anomalies are found on Figures 50, 51 and 52, (see Photos #33 and #34).

The general condition of the timber was found to be good. Pile diameters observed range from 9" to 14". From the inspection of core samples taken it was found that the outer layer of soft wood is approximately 1/2" to 1" thick. The timber piles in the bulkhead on either side of the Barge Basin (Bents 1-4 and 1A-7A) are effected by an outer layer of soft timber approximately 2" deep (see Figure 51). Associated with this is a slight hourglass shape, effecting the piles closer to the sheet pile wall (Rows G & H). Minimum pile diameters in this area are greater than 7".

Where the timber sheet pile was accessible, it was found to be in excellent condition. Bents 52 through 71 of the bulkhead have recently been reconstructed. The new construction consists of a steel H-pile supported low deck structure. The steel was found to

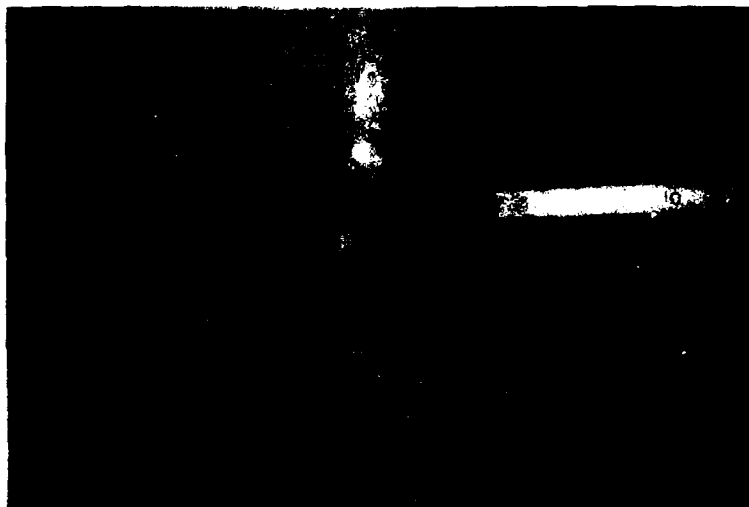


PHOTO NO. 33: Bent 10, Pile A; non-bearing
perimeter pile with drift pin
exposed, and broken pile cap.

PHOTO NO. 34: Bent 3, Pile A; illustrates
non-bearing pile.



have orange corrosion nodes (see Photo #35) covering most of its surface area. The surface of the steel was pitted, although there is not a significant loss of steel (see Photos #36 and #37).

The fender system along the bulkhead from Station 3+53 to 0+00 and around the Barge Basin is in poor condition. A new fender system has been installed along the new sections of the wharf and it is in excellent condition.

At Bents 4 through 8 of the bulkhead, the "A" pile row has been blocked with an east-west pile cap (2,12x12's) running below the normal pile cap. This repair is deteriorating. The blocking is not fully bearing on the pile or the pile cap and there is eccentric loading (see Figure 53).

The concrete seawall of the Barge Basin is in good condition and is functioning well. The concrete seawall associated with the older section of the bulkhead is deteriorating. Large cracks and spalled areas are present and noted on Figures 51 and 52. The total estimated surface area of spalled concrete is 270 square feet.



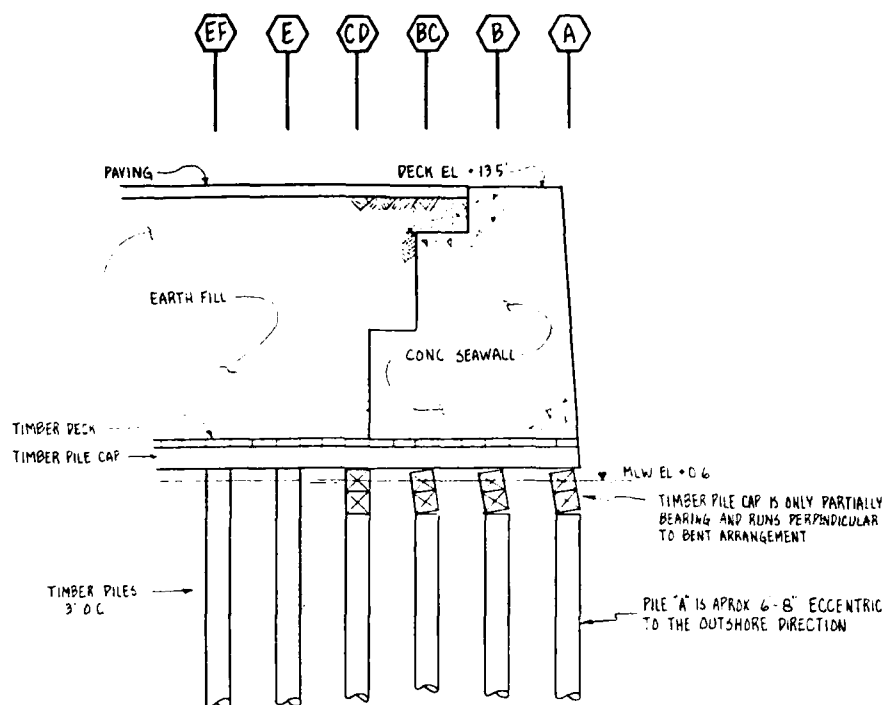
PHOTO NO. 35: Drydock 3 Bulkhead to Pier 6, Bent 65, Pile A; illustrates typical condition of steel H-pile, approx. El. -4'. Orange corrosion nodes 1"-2" diameter.

PHOTO NO. 36: Drydock 3 Bulkhead to Pier 6, Bent 65, Pile C, D-meter location at El. -4'; illustrates typical pitting of steel H-piles. Pits approx. 1/16" deep. Orange corrosion nodes 1"-2" diameter also visible.





PHOTO NO. 37: Drydock 3, Bulkhead to Pier 6,
Bent 64, Pile A; illustrates
corrosion and marine growth on
steel H-pile. Note flange
thickness.



SECTION A-A
NO SCALE

NOTE : SEE FIG. 51 FOR LOCATION OF SECTION A-A

GRAPHIC SCALE	CHILDS ENGINEERING CORPORATION BOX 333 MEDFIELD, MA	CHESAPEAKE DIVISION NAVAL FACILITIES ENGINEERING COMMAND WASHINGTON, D C	
AS SHOWN		PHILADELPHIA NAVAL SHIPYARD PHILADELPHIA, PA	FIG NO
		BULKHEAD TO PIER 6	53

4.8.3 STRUCTURAL ASSESSMENT

Calculations indicate that the structural piles are capable of carrying the imposed load (see Appendix A-1 to A-7). The steel H-piles have no apparent loss in section or capacity.

Some piles in Bents 4 through 8 have been blocked (see Figure 53). This repair is presently unstable. The "A" pile row in this area is most severely effected. Apparently there is a lateral force acting on the piles to the south. This is causing the repaired blocking to roll (see Figure 53). As a result, the piles are not fully bearing on the pile cap. The eccentricity created by this movement should be corrected.

The concrete seawall associated with the bulkhead from Station 0+00 through Station 3+53 has extensive spalling and cracking on its face. Although this condition is not good, the wall is functional as a gravity wall. The cracking and spalling should be repaired to prevent further deterioration.

4.8.4 RECOMMENDATIONS

The five (5) broken piles should be replaced by driving new piles. The estimated cost to drive a new perimeter pile is \$1,000. The total estimated cost is \$5,000.

The fifteen (15) non-bearing or partially bearing piles should be refastened to the pile cap and shimmed. The four (4) split piles should either be posted or refastened to the pile cap. The two (2) wild piles should be refastened to the pile cap. The estimated cost to repair one pile is \$400. The total estimated cost of repairs is \$8,400 (see Appendix A-15 to A-21 for details).

The condition of eccentric piles associated with Bents 4 through 8 should be repaired. The eccentric vertical piles should be pulled into a plumb position below the pile cap to assure that the piles are fully bearing on the caps. Fasten two 4x12 clamps below the pile caps running east and west. The new 4x12 clamps should run back to the "EF" pile row. In addition, 4x12 cross-bracing should be added to induce stability as shown in Appendix A-19. To install these repairs an estimated four-man diving crew with a small barge will take 5 days. At \$2,000/day the estimated cost is \$10,000 (see Appendix A-19).

Spalling on the face of the concrete seawall associated with the old bulkhead should be repaired. The surface of the concrete should be chipped away to sound concrete. In areas of significant loss of concrete, welded wire mesh should be installed.

Pneumatically-placed concrete should then be placed so as to provide sufficient cover to the area. The estimated cost per square foot of repair area is \$14.16. The total estimated cost is \$3,823 (270 sq.ft.).

Live-loading in deck areas directly associated with damaged (broken, split and wild) piles should be restricted to 25% of the current recommended live-load capacity until those piles are repaired. Upon implementation of these repairs, provided that dredge limits are abided by and that there is proper maintenance, the live-load capacity should remain at 100 psf, with exception to the new construction where the live-loading should be the original design capacity. The life expectancy of the old structure is in excess of 10 years. The life expectancy of the newest construction is in excess of 25 years.

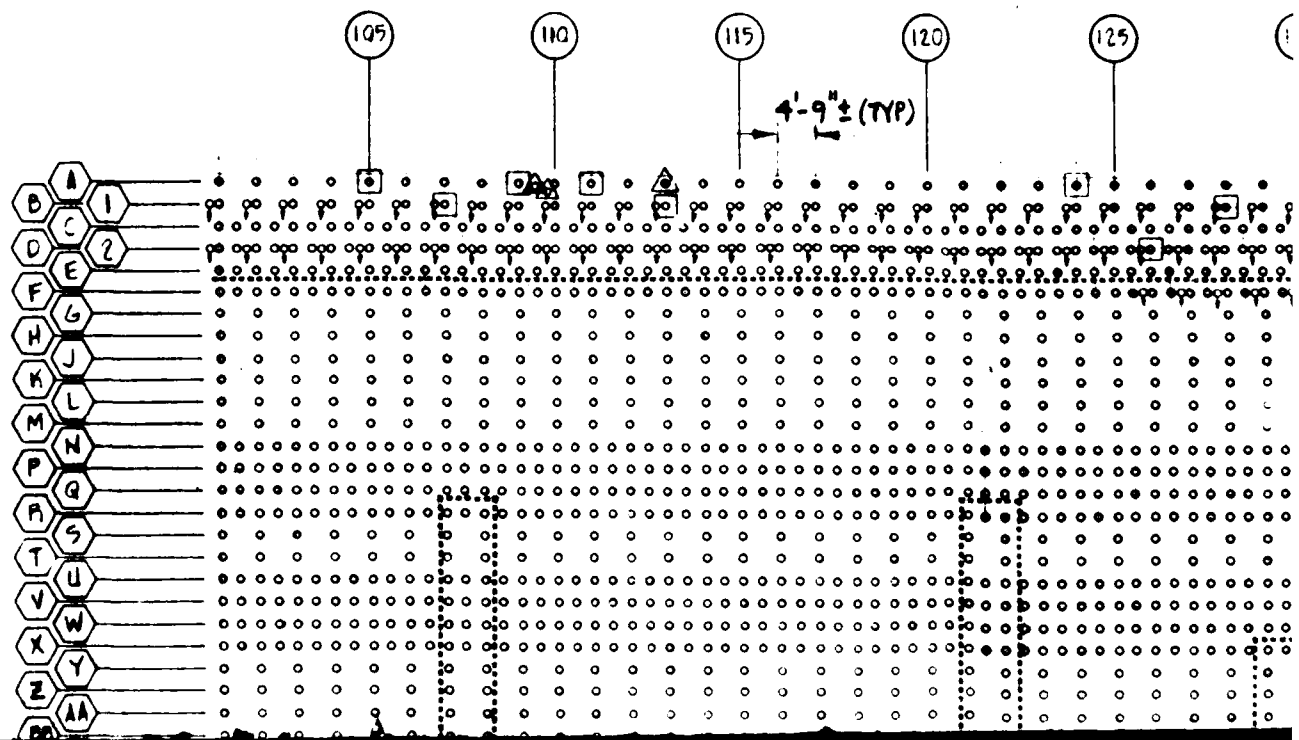
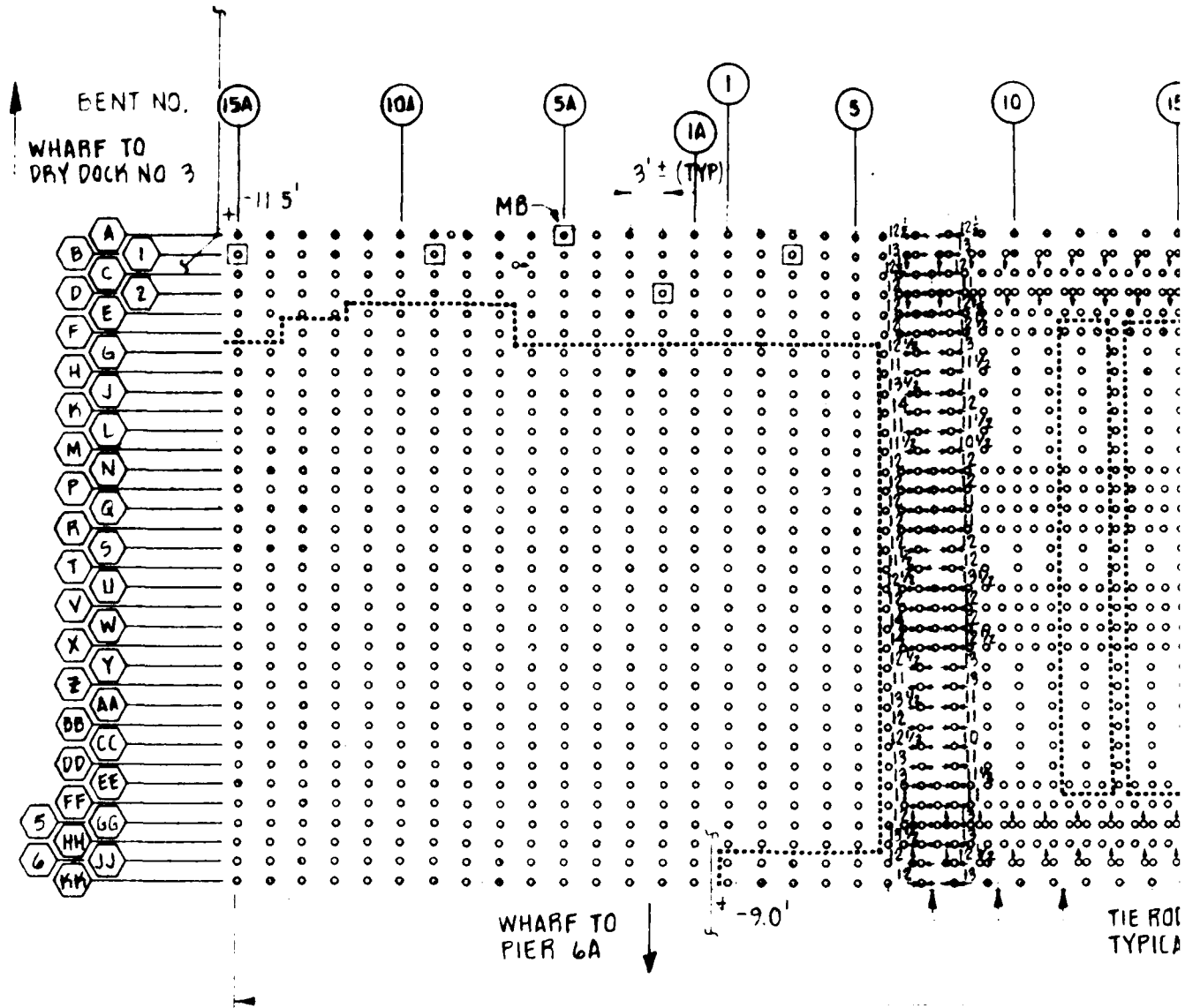
The entire bulkhead and Barge Basin should be reinspected after repairs and in 6 years thereafter. That portion of the bulkhead between Bents 4 and 8 should be inspected on a yearly basis due to the unstable condition present there. These inspections will enable Shipyard personnel to determine any change in conditions. This report should be used as a baseline for all future inspections.

4.9 PIER 6

4.9.1 DESCRIPTION

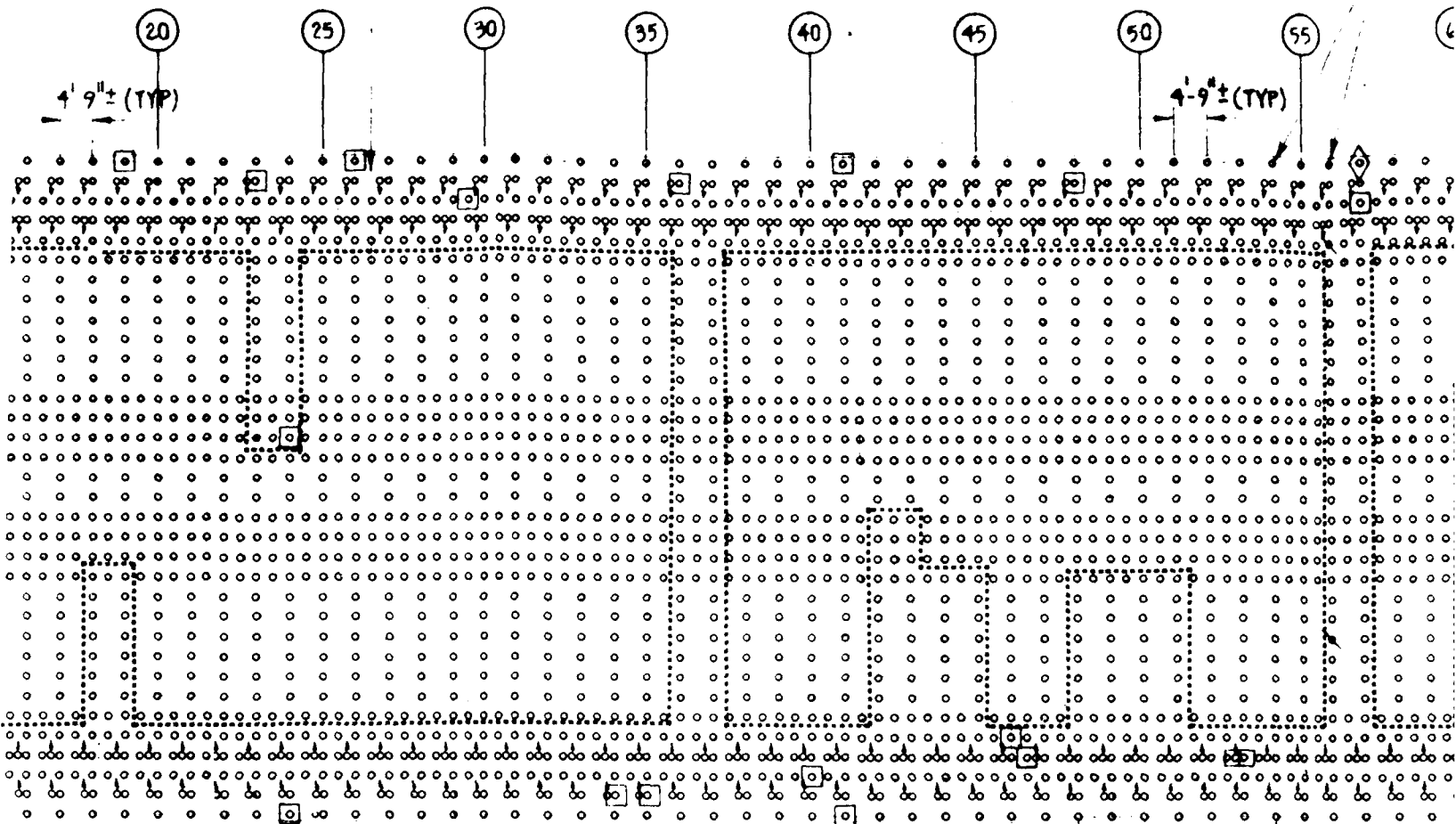
Pier 6 is located to the west of Dry Dock No. 3 and to the east of Pier 6-A on the northern bank of the Delaware River (see Figures 4 [Vol. I] and 54). This facility was constructed circa 1940 and is a timber pile-supported low deck, earth fill, relieving platform structure. The structure is approximately 970'x100' and is supported by approximately 8,500 timber piles. The timber pile capacity (driven) is assumed to be 15 tons. Presently the live-load capacity of Pier 6 is 600 psf. The top deck elevation of Pier 6 is +12.3'. During our divers' inspection Pier 6 was being used as a docking facility for various ships.

Reference 2 (see Appendix A-25)



DECK PLANK BROKEN,
NO FILL VISIBLE

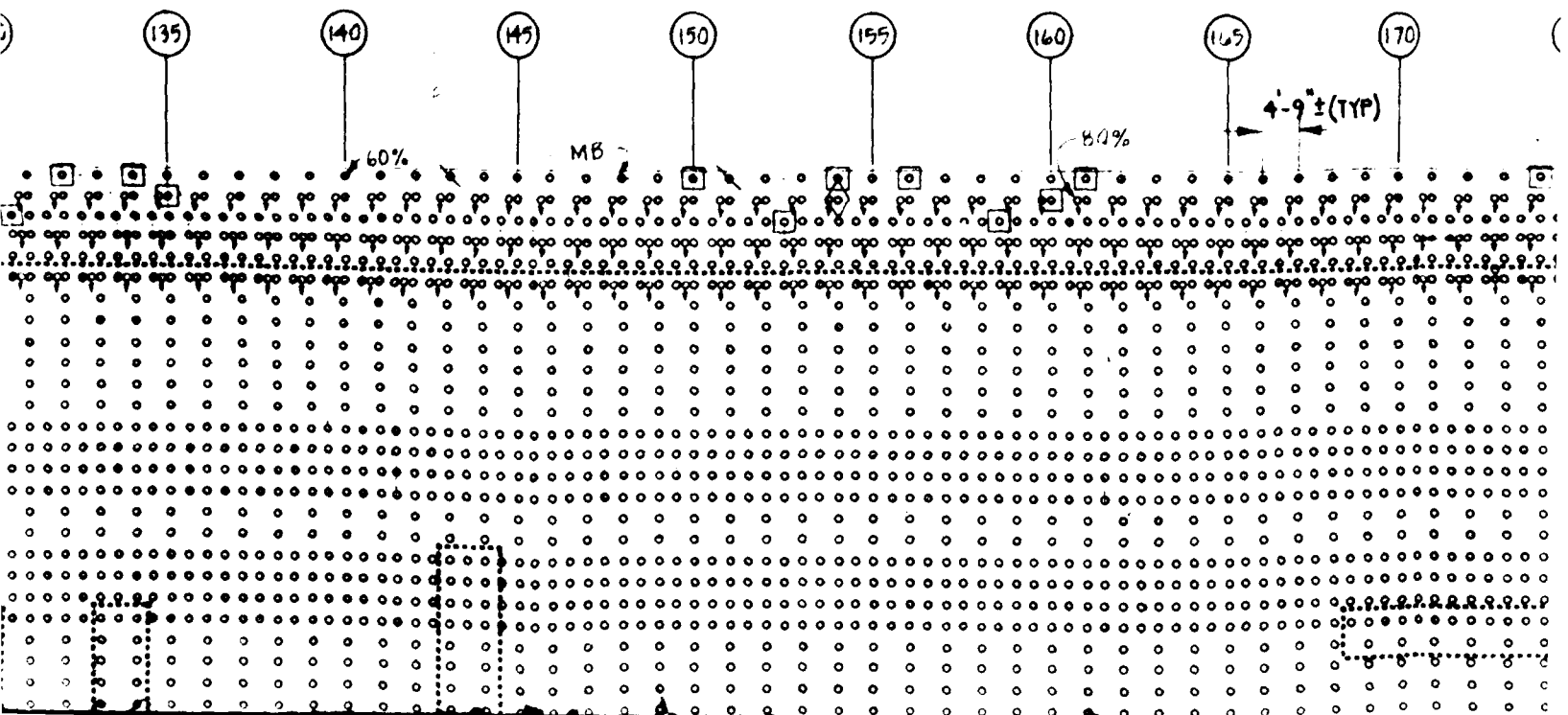
NE



LOCATION - EVERY OTHER BENT -
FOR FULL LENGTH OF PIER

950' ± OVERALL

PLAN



FILES

3" GAP BETWEEN
PILE CAP & DECKING

3" GAP BETWEEN PILE
CAP & DECKING

65

70

75

80

85

90

95

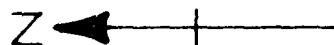
100

4'-9" ± (TYP)

-21.0'

-29.0'

95 % OF PERIMETER PILES IN THIS AREA HAVE BEEN REPAIRED



LEGEND

△ WILD PILE

◇ NON-BEARING PILE

• BROKEN PILE

✗ DISPLACED-SPLIT PILE

□ CORE LOCATION (PILE, CAP, DECK) LEVEL 3 INSP.

12" MINIMUM PILE DIAMETER, LEVEL 2 INSPECTION

50% 50 PERCENT OF PILE BEARING ON PILE CAP

○ BEARING PILE

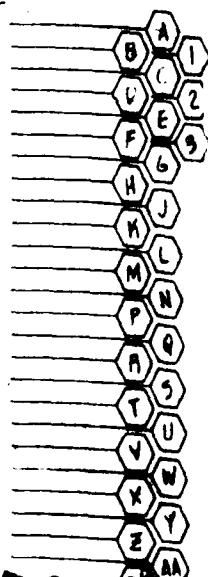
⚡ BATTER PILE

-26.0' SOUNDINGS (FT) BELOW MLW

MB MARINE BORERS OBSERVED

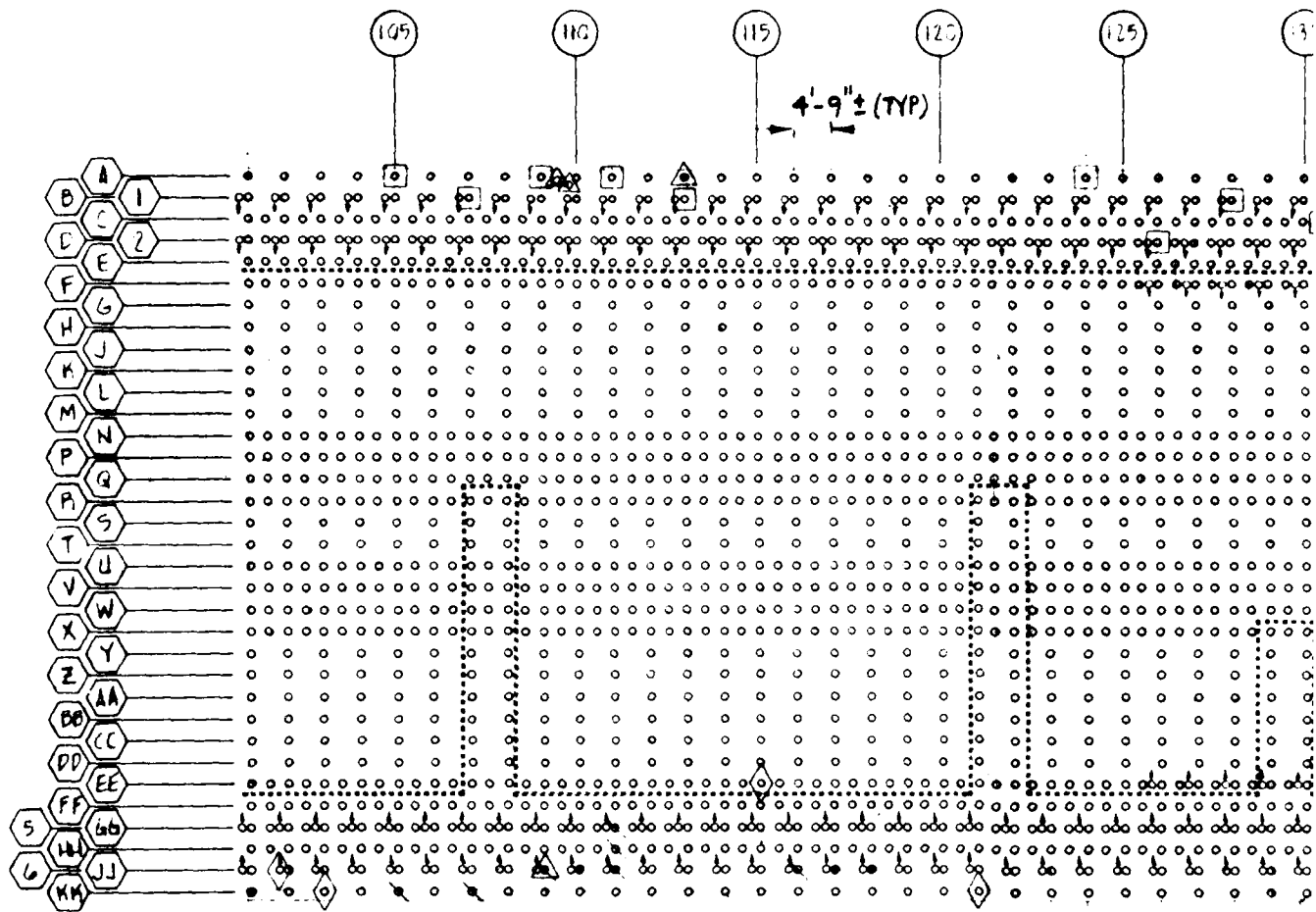
PILES WHICH
HAVE BEEN
REPAIRED

-26.0'



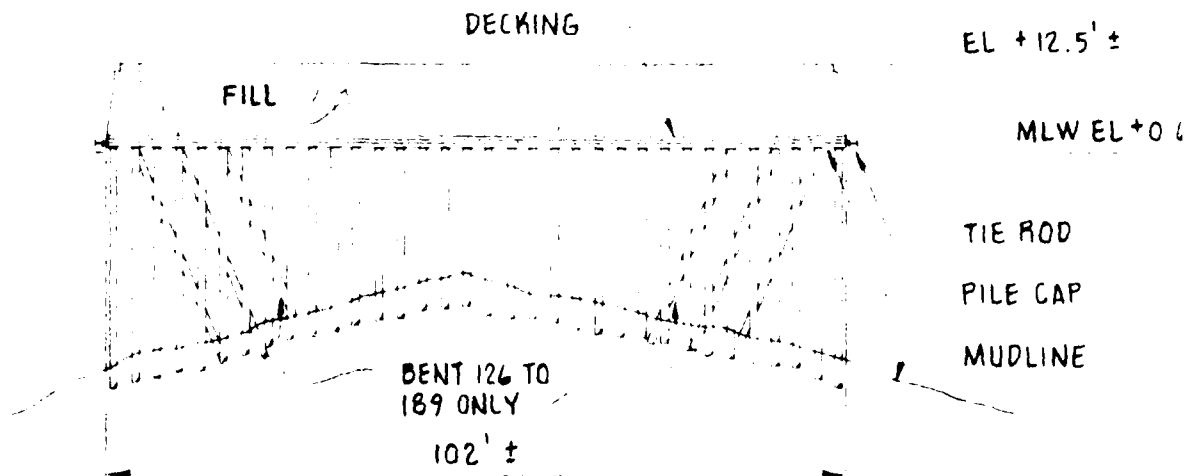
WHARF TO
PIER 6A

TIE ROD
TYPICAL



95% OF PERIMETER PILES IN THIS AREA HAVE BEEN REPAIRED

PILE CAP
CRUSHED

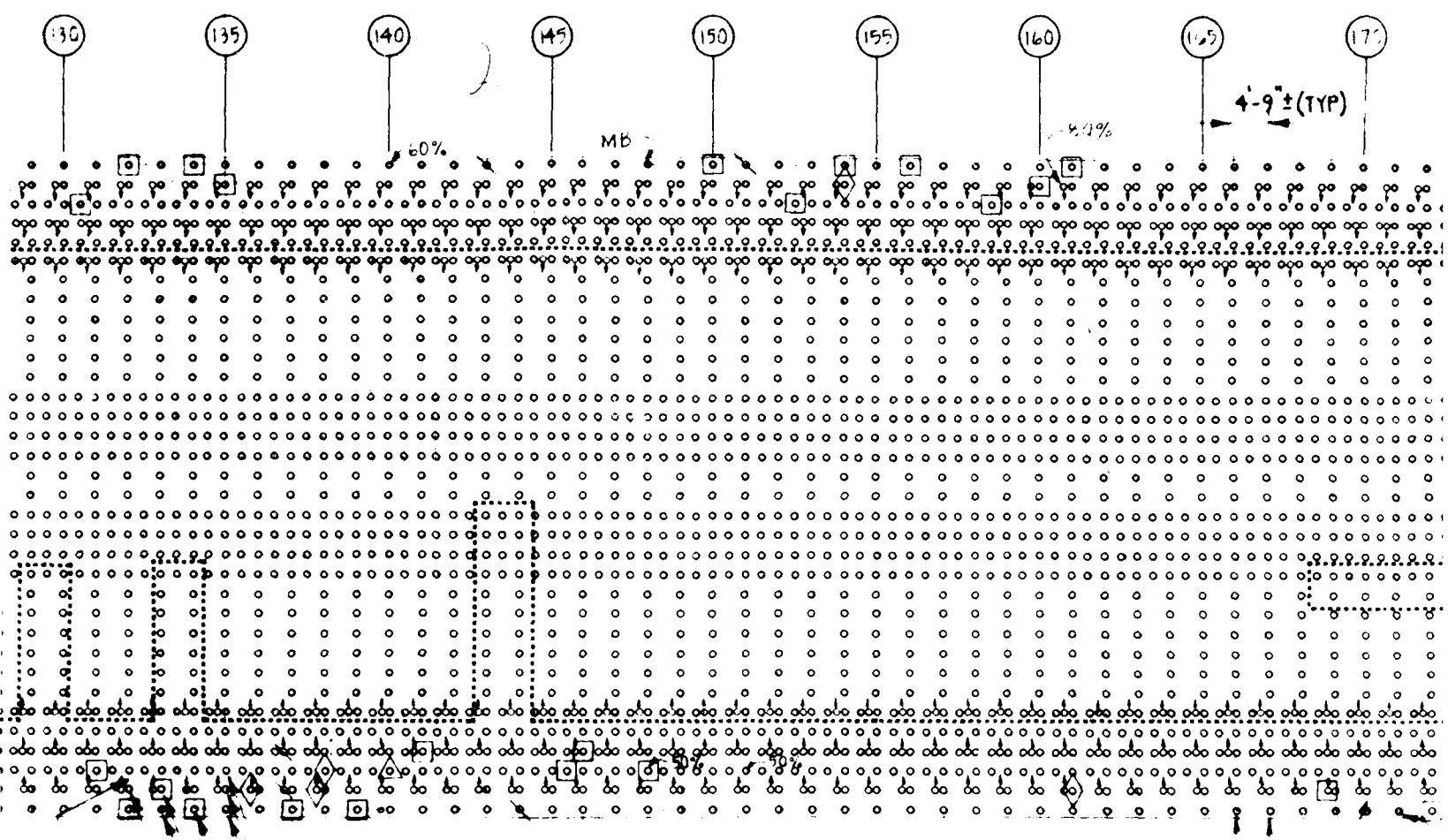


TYPICAL SECTION

ROD LOCATION EVERY OTHER BENT-
PILAL FOR FULL LENGTH OF PIER

950' ± OVERALL

PLAN



PILES WHICH HAVE BEEN REPAIRED

PILES WHICH HAVE
BEEN REPAIRED

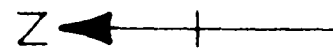
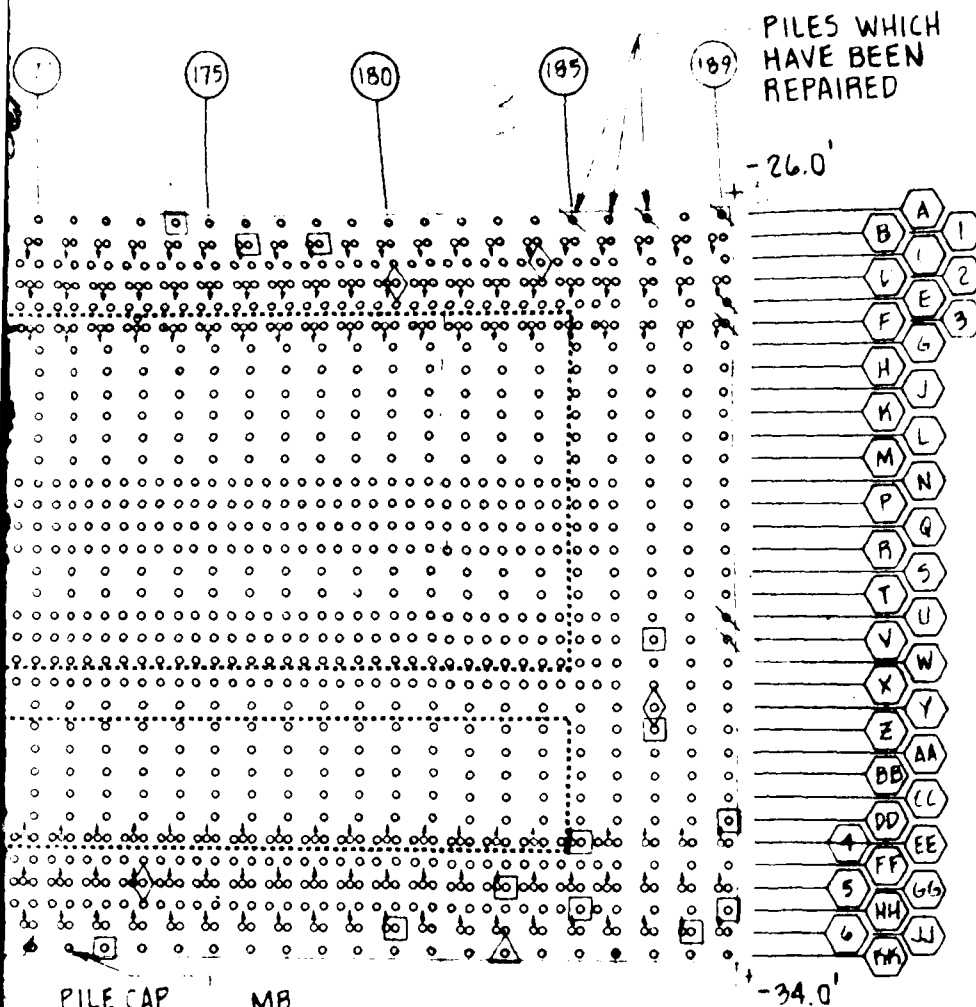
PILE
CRUS

950' ± OVERALL

PLAN

+0.6'

95 % OF PERIMETER PILES IN THIS AREA HAVE BEEN REPAI



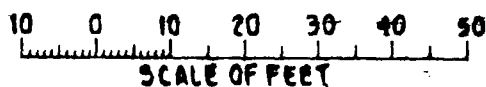
LEGEND

- △ WILD PILE
- NON-BEARING PILE
- BROKEN PILE
- ↘ DISPLACED-SPLIT PILE
- CORE LOCATION (PILE, CAP, C)
- 12" MINIMUM PILE DIAMETER
- 50% 50 PERCENT OF PILE BEARING
- BEARING PILE
- ⚡ BATTER PILE
- 26.0' SOUNDINGS (FT) BELOW M
- MB MARINE BORERS OBSERVE
- LIMIT OF DIVER'S ACCESS

NOTE:

- 1.) ACCESS TO MANY PILES R DUE TO SPACING OF PILES

GRAPHIC SCALE



CHILDS ENGINEERING
CORPORATION
BOX 333
MEDFIELD, MA

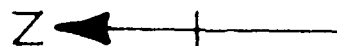
CHESAPEAKE
NAVAL FACILITIES ENG

WASHINGTON
PHILADELPHIA NAVAL SHIPYARD

PIER 6

95 % OF PERIMETER PILES IN THIS AREA HAVE BEEN REPAIRED

PILES WHICH
HAVE BEEN
REPAIRED

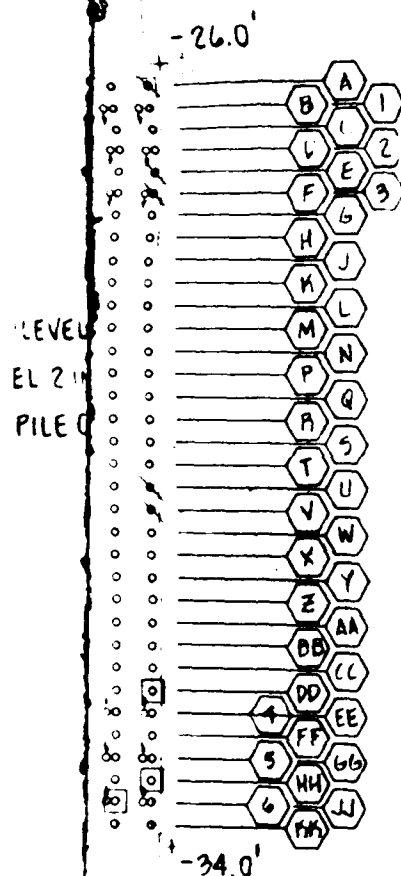


LEGEND

- ◊ WILD PILE
- ◊ NON-BEARING PILE
- BROKEN PILE
- ✗ DISPLACED-SPLIT PILE
- ◻ CORE LOCATION (PILE, CAP, DECK) LEVEL 3 INSP.
- 12" MINIMUM PILE DIAMETER, LEVEL 2 INSPECTION
- 50% 50 PERCENT OF PILE BEARING ON PILE CAP
- BEARING PILE
- ⋈ BATTER PILE
- 26.0' SOUNDINGS (FT) BELOW MLW
- MB ⋈ MARINE BORERS OBSERVED
- LIMIT OF DIVER'S ACCESS

NOTE:

- 1.) ACCESS TO MANY PILES RESTRICTED
DUE TO SPACING OF PILES.



BION
RING

PHILADELPHIA 30 40 50

CHILDS ENGINEERING
CORPORATION
BOX 333
MEDFIELD, MA

CHESAPEAKE DIVISION
NAVAL FACILITIES ENGINEERING COMMAND
WASHINGTON, D.C.

PHILADELPHIA NAVAL SHIPYARD PHILADELPHIA, PA

PIER 6

FIG. NO.

54

4.9.2 OBSERVED INSPECTION CONDITION

A list of the quantities of specific anomalies noted is as follows:

- 15 broken piles
- 14 non-bearing piles
- 25 split and displaced piles
- 6 wild piles
- 5 partially-bearing piles

The exact locations of these anomalies can be found on Figure 54. Access to all portions of the pier was not gained due to the close spacing of piles.

The timber throughout the pier was found to be in good condition. Core samples taken throughout the facility indicate that generally there is 1/4" to 1" of softness on all timber. The measurement of pile diameters and the observation of the timber conditions reveal that there has been no change in the minimum pile diameters of the structural piles since they were driven (see Photo #38).

The fasteners used throughout the facility are corroded, but can be classified as in good condition and functional. The fender system at the south end of the pier is suffering from fungal attack and is in poor condition. The rest of the fender system is in good condition. The concrete seawall is in excellent condition with only minor spalling and cracking.

The tie-rods used to provide lateral stability to the platform found throughout the facility are in excellent condition (see Photo #39, Appendix A-22). Although the corrosion rate on the webs of the H-sections seems to be accelerated, there is no structural deficiency.



PHOTO NO. 38: Pier 6, Bent 31, Pile A;
broken perimeter pile with
sapwood chipped away revealing
sound timber.

PHOTO NO. 39: Pier 6, Bents 170-171;
illustrates typical condition
of tie-rod with orange corrosion
node. Tie-rod diameter is 3".



At Bents 45 through 62 on the east side of the pier, there is a severe drop in the mudline elevation. At Bent 45 there is a 15' drop in the mudline between the C pile and the A pile. At Bent 62 this drop in elevation is only 3'.

In various locations throughout the facility marine borers were found. Although they are present, they have not caused any significant damage.

Between Bents 26 and 27 in the area of the B and C piles, a deck plank has failed (see Photo #40). This failure has opened up a gap in the deck. Behind this gap there is a second layer of timber deck material which is preventing the earth fill from leaching out.

On the west side of the pier from Bent 74 through Bent 138, extensive reconditioning of the perimeter piles has been undertaken. These repairs consist mainly of posted piles and refastened piles.



PHOTO NO. 40: Pier 6, Bents 26-27, Pile A;
broken deck plank, approx. 12"
wide as viewed from below the
relieving platform.

4.9.3 STRUCTURAL ASSESSMENT

The damaged piles located near the perimeter of the pier apparently are caused by excessive berthing forces. Generally this results in the failure of the fastening at the pile cap or a broken pile.

Apparently overdredging or silt displacement due to prop wash has occurred at Bent 45 on the east side of the pier. This condition does not effect the capacity of the piles in the area to necessitate a reduction in their load carrying capacity.

In the area of Bents 26 and 27, a deck timber has failed due to overloading. This is a localized failure which apparently was repaired previously. The surrounding timbers showed no sign of overloading. The repairs which were made to the structural piles on the west side of the pier are functioning as they were designed and are in good condition.

4.9.4 RECOMMENDATIONS

The 15 broken piles should be repaired. The broken perimeter piles should be replaced and the broken interior piles should be posted and braced. The total estimated cost of repair is \$15,000. The non-bearing piles, partially bearing piles, split and displaced piles and wild piles (50 piles total) should be refastened to the cap so that full bearing is attained. The total estimated cost of repair is \$20,000 (\$400 per repair). The dredging limits should be strictly enforced, particularly at the southern end of the pier.

Live-loading in deck areas directly associated with damaged (broken, split and wild) piles should be restricted to 25% of the current recommended live-load capacity until those piles are repaired. Following implementation of the recommended repairs, live-loading can be maintained at current levels (600 psf). Areas which were not directly observed are assumed to be in similar condition to those areas which were accessed. The estimated life of this structure is in excess of 25 years.

The entire pier should be re-inspected after repairs and in 6 years thereafter. This inspection will enable Shipyard personnel to determine any change of condition. This report should be used as a baseline for all future inspections.

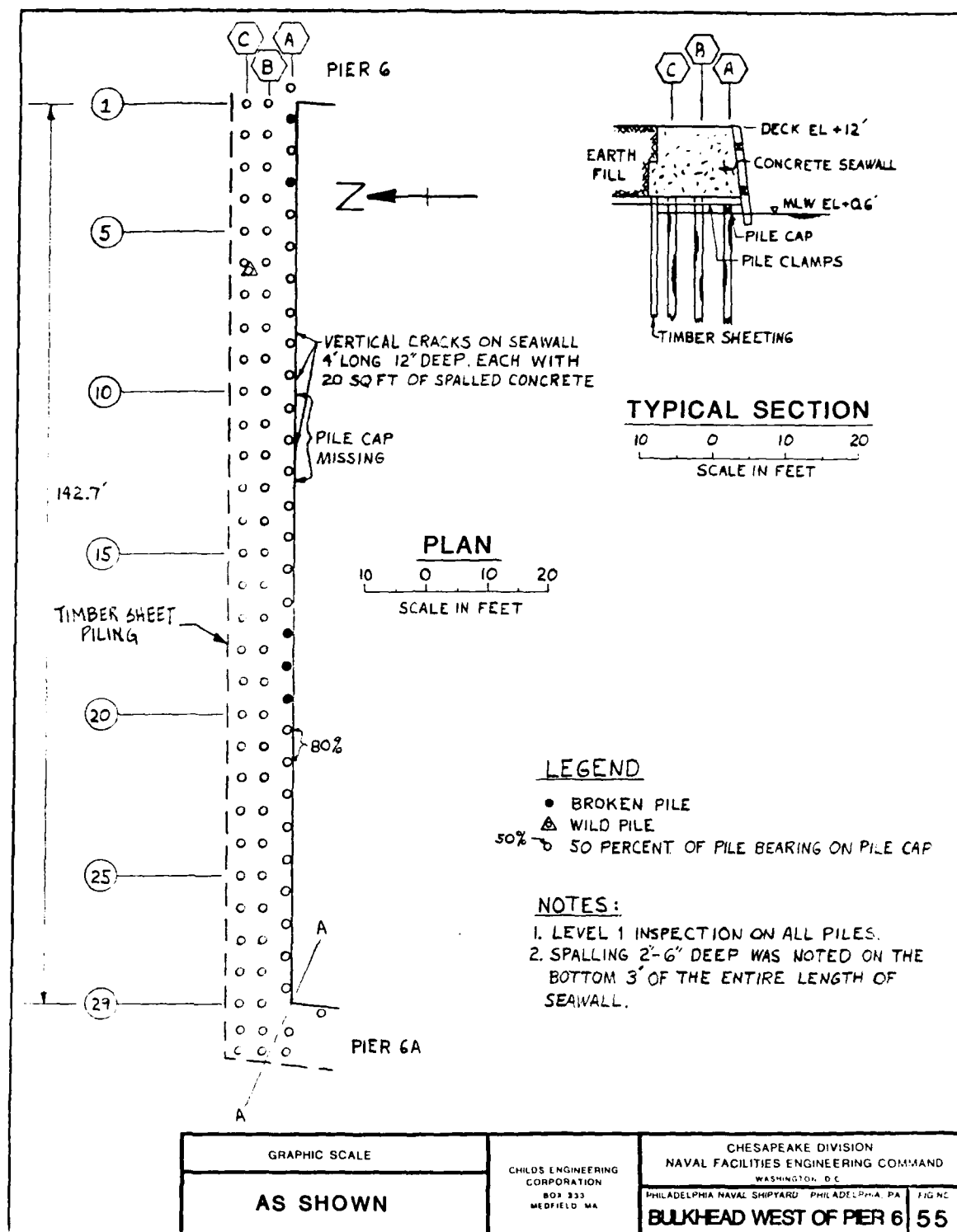
4.10 PIER 6A AND THE BULKHEAD EAST TO PIER 6

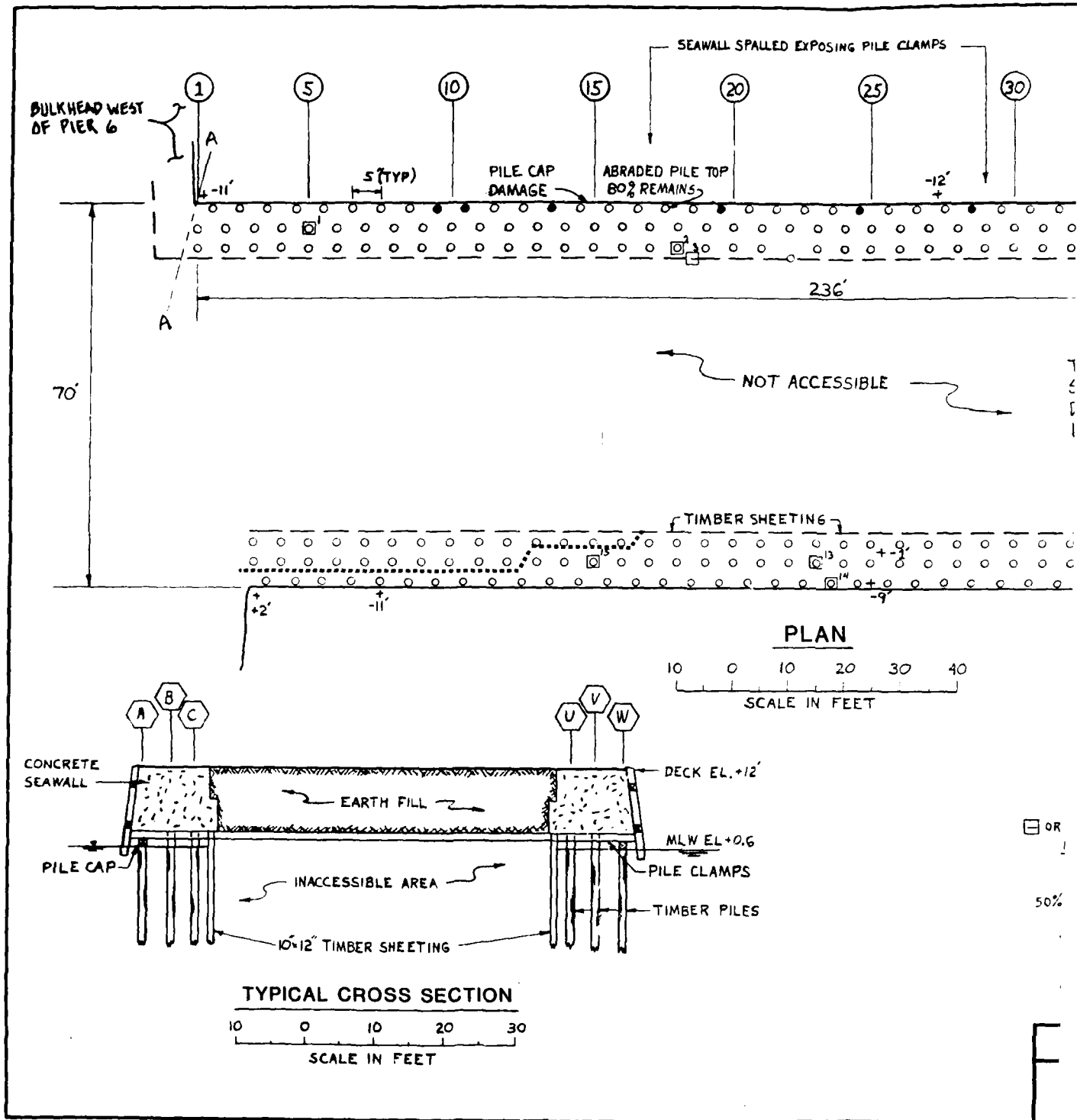
4.10.1 DESCRIPTION

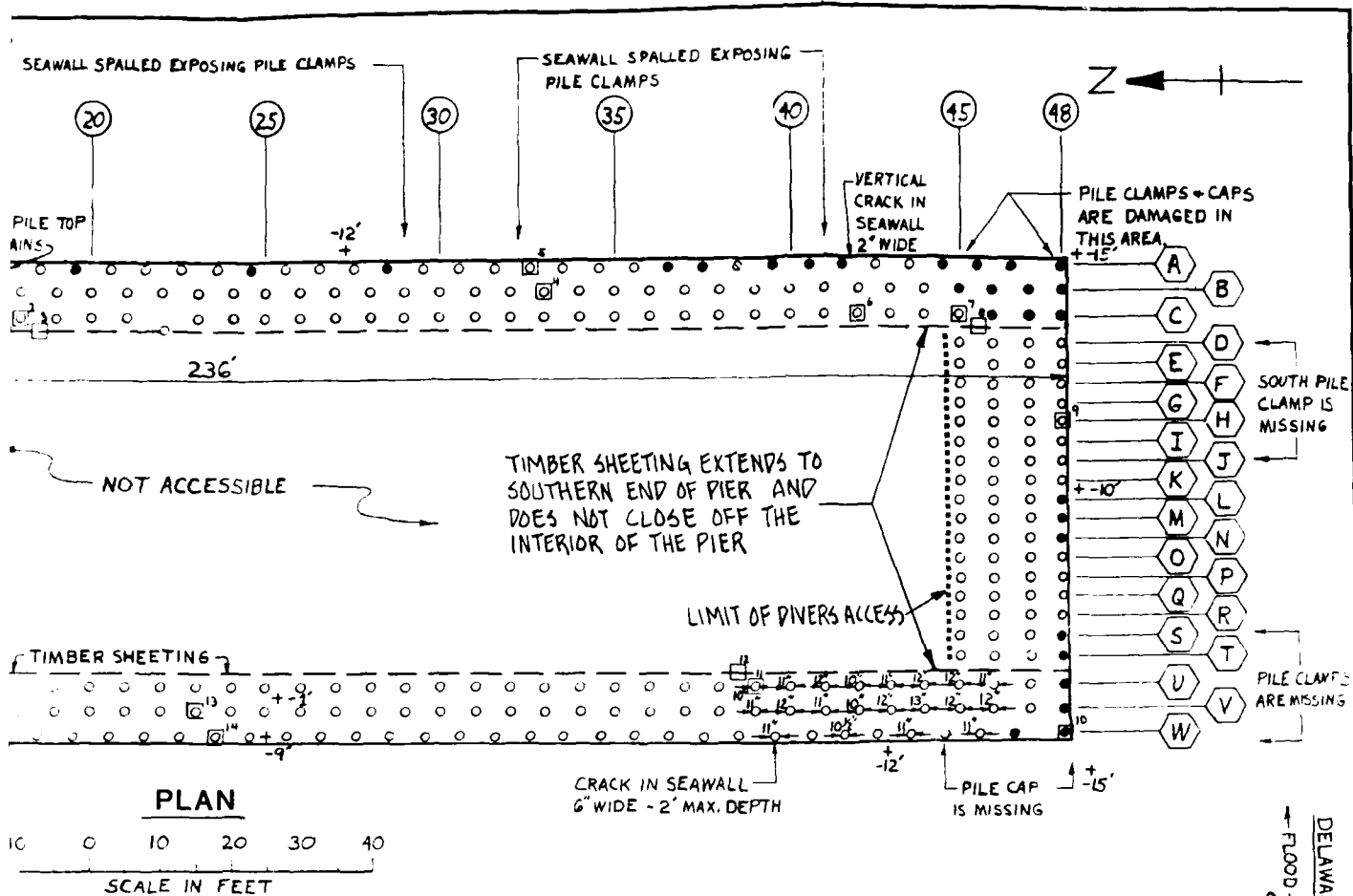
Pier 6A and the adjacent bulkhead to the east are located on the northern bank of the Delaware River just to the west of Pier 6 at the Philadelphia Naval Shipyard (see Figure 4, Vol. I). The structure was constructed circa 1903. Its overall dimensions are 235'x70'. The pier is a timber pile-supported, low deck, earth fill, relieving platform type of structure (see Figures 55, 56). There are approximately 1,100 timber-bearing piles. Each pile is assumed to have a driven capacity of 15 tons. The assumed allowable live-load capacity of the structure is 500 psf. During our diver's inspection this facility was functioning as a tool storage area for the shipyard workers.

The bulkhead between Pier 6 and Pier 6A is of similar relieving platform construction as Pier 6A. It is supported by 84 timber piles with a timber sheet pile wall running inshore of the "C" pile row (see Figure 55). The total length of the bulkhead is 142.7'.

Reference 2 (see Appendix A-25)







LEGEND

- BROKEN PILE
- DISPLACED - SPLIT PILE
- OR CORE LOCATION (PILE, CAP, DECK) LEVEL 3 INSPECTION
- MINIMUM PILE DIAMETER, LEVEL 2 INSPECTION
- 25' SOUNDINGS (FT) BELOW MLW
- 50% 50 PERCENT OF PILE BEARING ON PILE CAP
- LIMIT OF DIVERS ACCESS

NOTES:

1. LEVEL 1 INSPECTION ON ALL PILES - HIGHER LEVELS OF INSPECTION WHERE NOTED.

GRAPHIC SCALE	CHILDS ENGINEERING CORPORATION BOX 333 MEDFIELD, MA	CHESAPEAKE DIVISION NAVAL FACILITIES ENGINEERING COMMAND WASHINGTON, D.C. PHILADELPHIA NAVAL SHIPYARD PHILADELPHIA, PA	FIG NO
AS SHOWN		PIER 6A	56

4.10.2 OBSERVED INSPECTION-CONDITION

Specific anomalies noted concerning the structural piles are listed as follows:

- 36 broken piles
 - 1 split and displaced pile
 - 1 wild pile
 - 2 partially-bearing piles

Locations of these anomalies can be found on Figures 55 and 56.

Throughout Pier 6A and the associated bulkhead, soft spots were sporadically found in the timber of the piles, deck and sheet pile. The depth of softness in these spots ranges from 1-1/2" to 4" deep. The softness is assumed to be caused by a general deterioration of the timber fibers (see Section 4.0, Vol. I). The largest concentration of soft spots were found on the structural members of the bulkhead between Pier 6A and Pier 6. Pile diameters observed range from 10" to 13".

Pile diameters observed and measured indicate that there has been no significant change in the minimum cross-sectional area since they were driven. The fasteners observed are functional, although in some cases it is estimated that a 30% loss of steel cross-section has occurred.

As shown on Figures 55 and 56 there are areas where the seawall is spalled and cracked. Some of the cracks are as much as 6" wide. The approximate total surface area which is effected by spalling or cracking is 500 square feet.

The fender system is basically non-functional and/or missing throughout Pier 6A and the associated bulkhead. Along the full length of the west side of Pier 6A a soil berm exists along the "W" pile row. The difference in the mudline depth varies from 1' in height to 8' in height between the "U" and "W" pile rows. The apparent cause is a combination of siltation under the relieving platform and dredging adjacent to the perimeter of the pier.

4.10.3 STRUCTURAL ASSESSMENT

The specific anomalies listed in Section 4.10.2 are a result of lateral overloading due to berthing forces possibly transmitted by camels.

Soft timber will reduce the capacity of the effected member. According to calculations, see Appendix A-1 to A-8, the reduced column capacity of a pile with 4" of softness is still greater than the assumed driven capacity. Live-load capacity is limited by softness in the timber decking.

The cracking and spalling of the concrete seawall is a result of aging and settlement. Particular attention should be directed to the south end of Pier 6A. In the area of Bent 41, there are large cracks on both the east and west sides of the pier. This could be an indication that the south end of the pier is beginning to translate to the south. Although movement of the bearing piles was not detected, the fact that there are no north/south batter piles leads to the assumption that the only structural resistance to the lateral earth pressures is the timber piles' ability to resist bending and whatever cohesiveness the superstructure has to offer.

The soil berm along the west side of Pier 6A does exert some lateral pressure on the vertical bearing piles, however this pressure is not critical. The maximum dredge limits have not been exceeded and undermining is not a controlling factor in the analysis.

4.10.4 RECOMMENDATIONS

The 36 broken piles should be replaced or posted (see Appendix A-15 to A-22). The estimated cost to repair one pile is \$1,000. The total estimated cost of repair is \$36,000. The split pile, wild pile and partially bearing piles should be refastened to the pile cap. The estimated cost to repair one pile is \$400. The total estimated cost is \$1,600. At the south end of the pier where there are many damaged piles in close association to each other, live-loading should be prohibited.

Spalling and cracking on the face of the concrete seawall should be repaired. The surface of the concrete should be chipped away to sound concrete. Large cracks should be filled. In areas of significant loss of concrete, welded wire mesh should be installed. Pneumatically-placed concrete should then be placed so as to provide sufficient cover to the area. The estimated cost per square foot of repair area is \$14.16. The total estimated cost of repair is \$7,080 (500 sq.ft.).

Live-loading in deck areas directly associated with damaged (broken, split and wild) piles should be restricted to 25% of the current recommended live-load capacity until those piles are repaired. At the southeast end of the pier live-loading should be reduced to 50 psf in the concentrated area of broken piles. Due to the timber softness, the live-load capacity of Pier 6A and the bulkhead should be limited to 200 psf. Upon implementation of these repairs, provided that dredge limits are observed and the

structure is properly maintained, the life expectancy of the structure is in excess of 5 years.

Consideration should be made as to how to replace or rebuild the structure to return it to its original capacity, if that capacity is needed. The entire pier and bulkhead should be re-inspected after repairs and in 2 years thereafter. This inspection will enable Shipyard personnel to determine any change in conditions. This report should be used as a baseline for future inspections.

4.11 DRYDOCK WHARF

4.11.1 DESCRIPTION

The Drydock Wharf is located approximately 560 feet to the west of Pier 6A and to the east of Wharf K on the northern shore of the Delaware River (see Figures 4 [Vol. I] and 57). The Drydock Wharf is divided into three sections: Section "A" begins at the north-easternmost corner of the structure and continues to Drydock No. 4, it is sometimes known as the "Battleship Wharf"; Section "B" is located between Drydock No. 4 and Drydock No. 5; Section "C" is located between Drydock No. 5 and Wharf K, (see Figure 57). The low deck, earth-filled, timber pile-supported relieving platform structures were constructed circa 1941.

The east side of Section "A" is approximately 395 feet long, the south side 600 feet long, and the west side 224 feet long. Steel sheet piling is located approximately 50 feet inshore of the seawall and extends from the underside of the timber decking to the river bottom. Approximately 4,300 piles, including batter piles and intermediate bents are arranged in bents with 5-foot spacing, (see Figures 58 through 61). The design pile capacity is assumed to be 15 tons. The deck elevation is +14'. The designated live-load capacity at the time of our inspection is 700 psf. During our inspection Section "A" was being used as a permanent mooring for a battleship.

The east side of Section "B" is 224 feet long, the south side 280 feet long, and the west side 216 feet long. Steel sheet piling is located approximately 45 feet inshore of the seawall. Approxi-

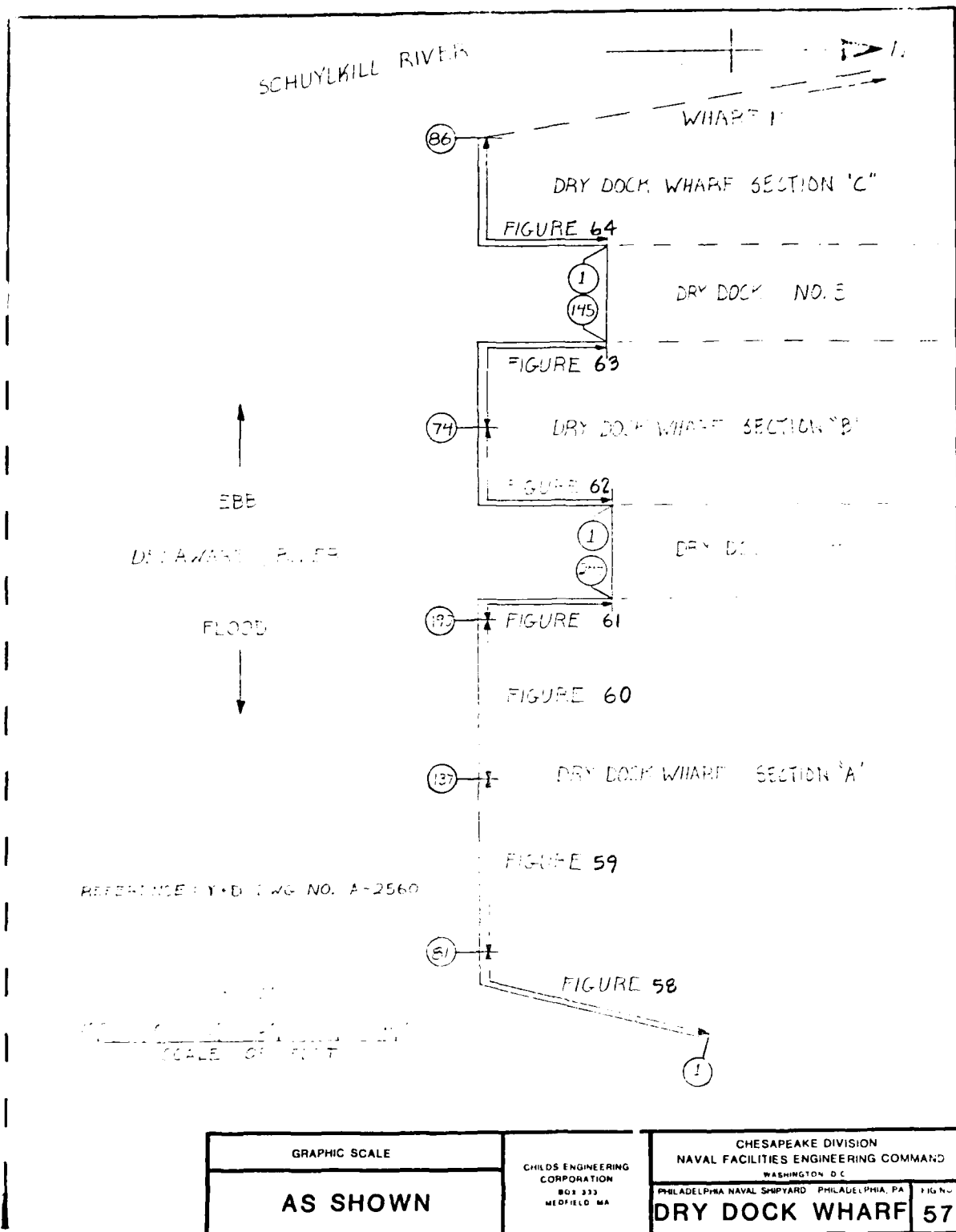
mately 2,800 piles, including batter piles and intermediate bents are arranged in bents with 5-foot spacing (see Figures 62 and 63).

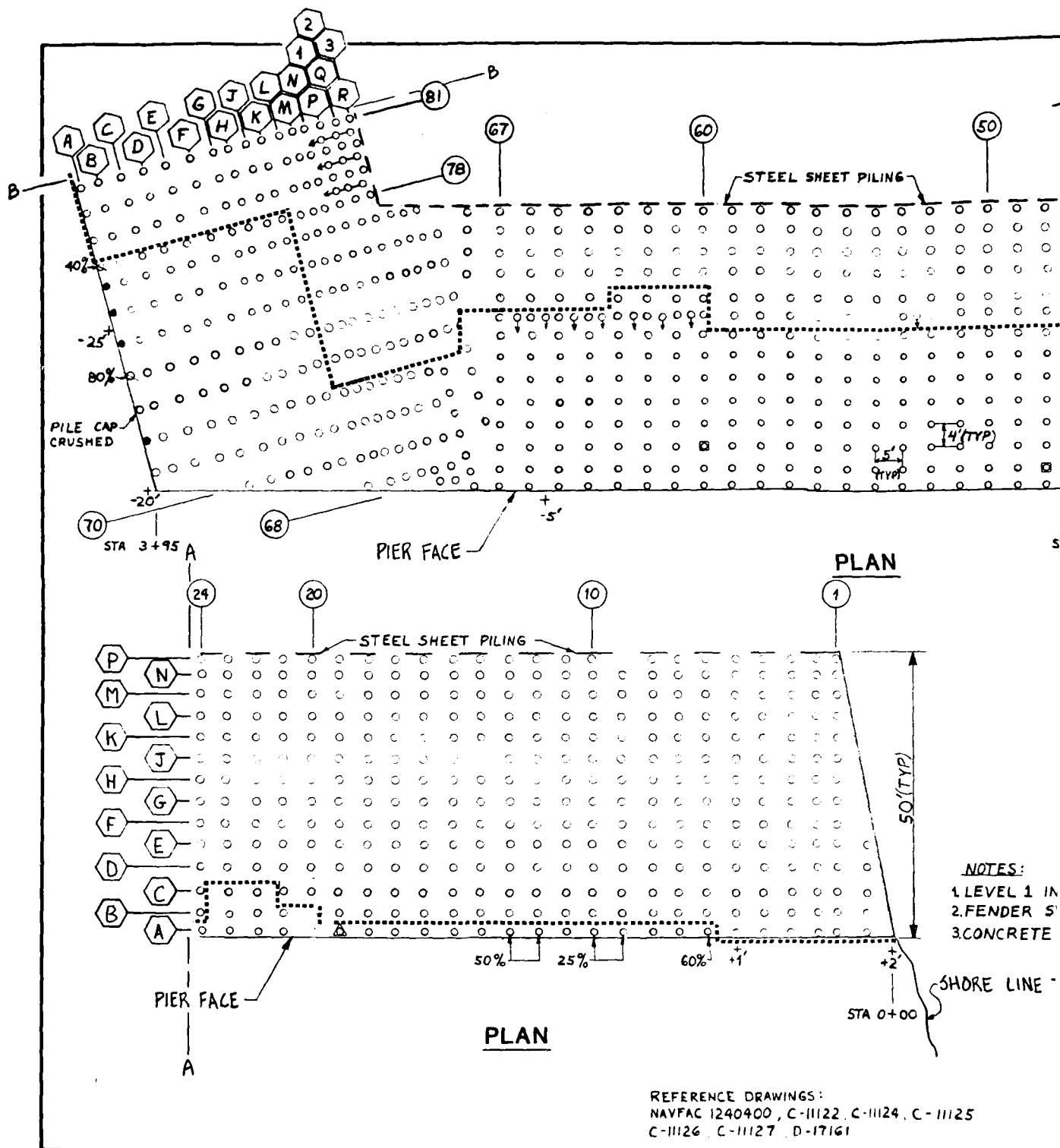
The design pile capacity is assumed to be 15 tons. The deck elevation is +14'. The designated live-load capacity at the time of our inspection is 300 psf. During our inspection Section "B" was being used as a temporary mooring for various oil barges, floating cranes and a personnel barge.

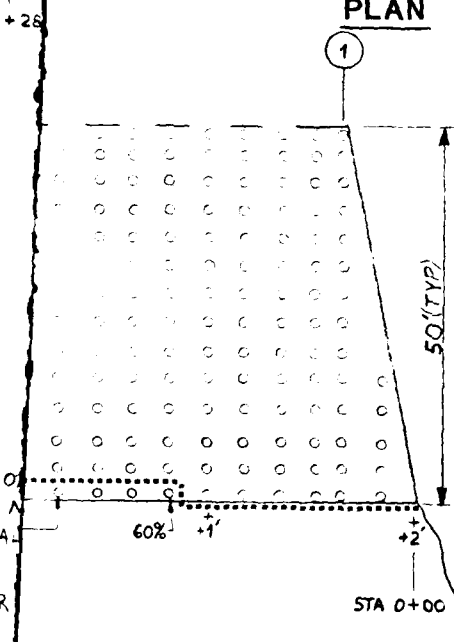
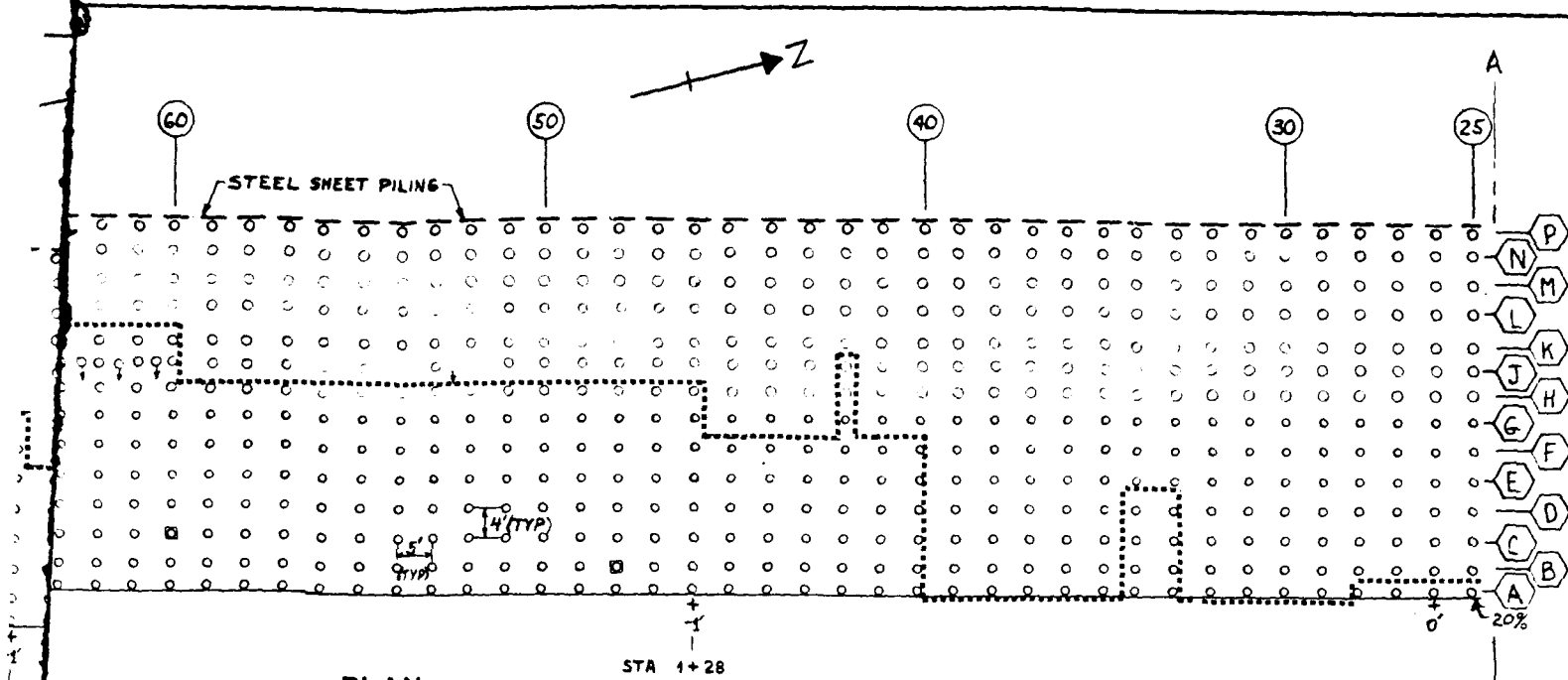
The east side of Section "C" is 214 feet long and the south side 184 feet long. Steel sheet piling is located approximately 50 feet inshore of the seawall. Approximately 1,500 piles including batter piles and intermediate bents are arranged in bents with 5-foot spacing (see Figure 64). The design pile capacity is assumed to be 15 tons. The deck elevation is +14'. The designated live-load capacity at the time of our inspection is 300 psf. During our inspection Section "C" was being used as a temporary mooring for various oil barges.

Typical cross sections of the drydock wharves can be found on Figure 65.

Reference 2 (see Appendix A-25)



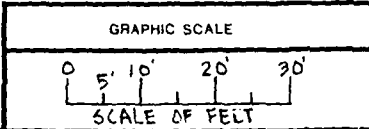




- LEGEND**
- △ WILD PILE
 - BROKEN PILE
 - ⊗ DISPLACED - SPLIT PILE
 - ⊠ CORE LOCATION, LEVEL 3 INSPECTION
 - 50% 50 PERCENT OF PILE BEARINGS ON PILE CAP
 - 20' SOUNDINGS (FT) BELOW MLW
 - LIMITS OF ACCESS

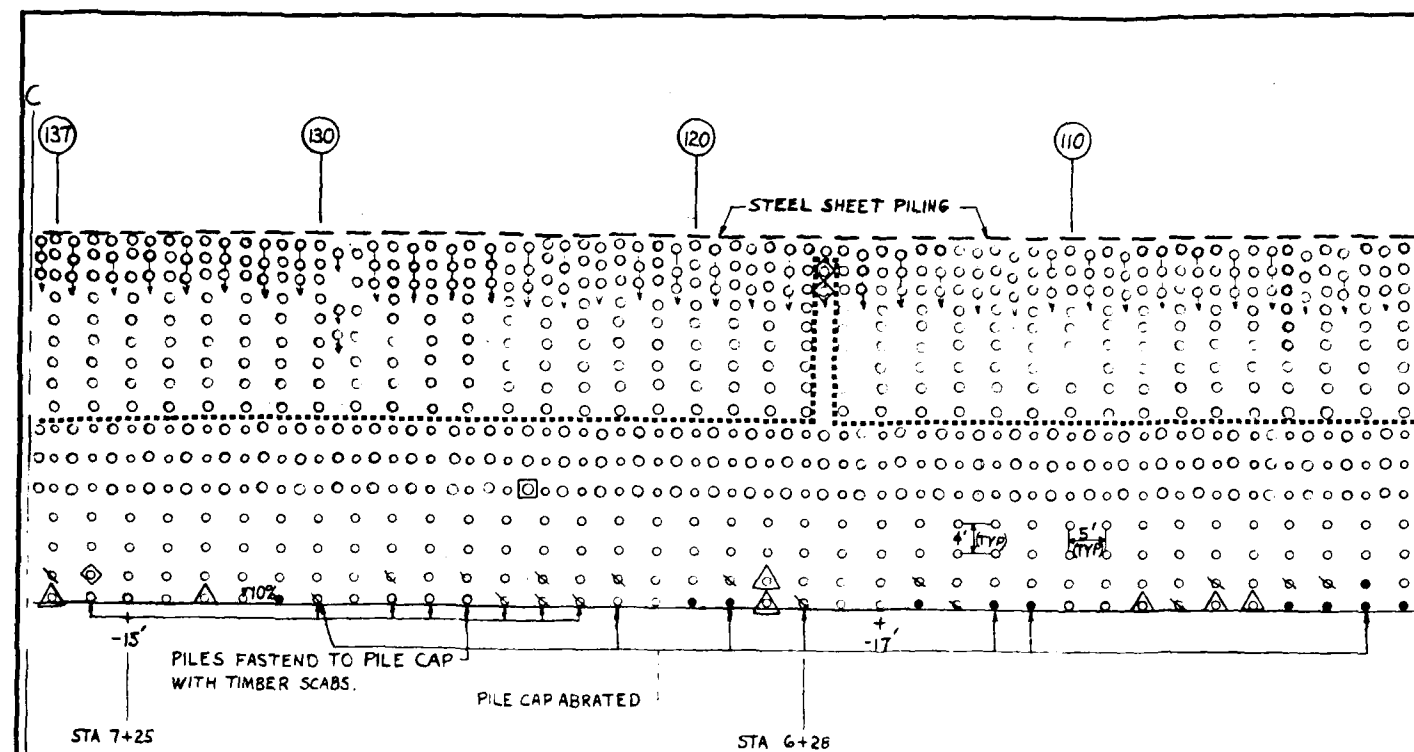
- NOTES:**
1. LEVEL 1 INSPECTION ON ALL PILES - HIGHER LEVELS OF INSPECTION WHERE NOTED.
 2. FENDER SYSTEM NON-EXISTANT OR HEAVILY DETERIORATED
 3. CONCRETE SEAWALL IN EXCELLANT CONDITION

REFERENCE DRAWINGS:
 NAVFAC 1240400, C-11122, C-11124, C-11125
 C-11126, C-11127, D-17161



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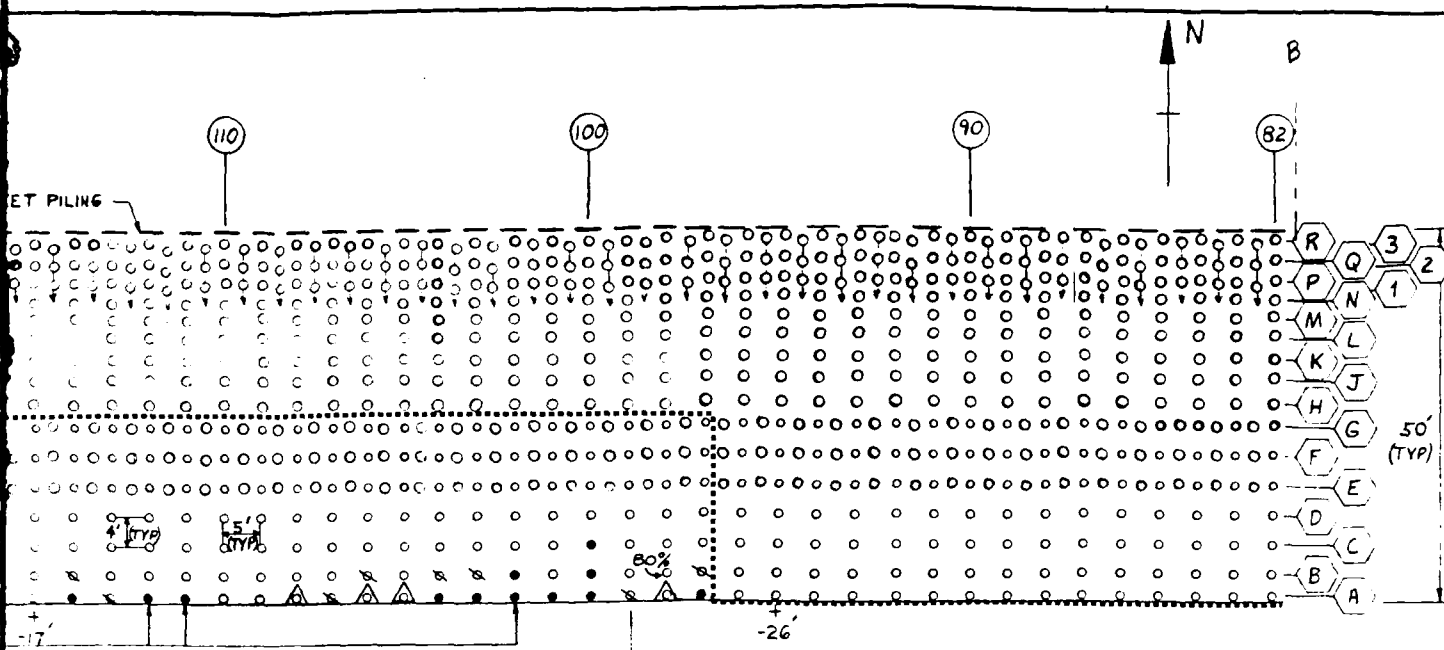
CHESAPEAKE DIVISION
 NAVAL FACILITIES ENGINEERING COMMAND
 WASHINGTON, D.C.
 PHILADELPHIA NAVAL SHIPYARD, PHILADELPHIA, PA
DRYDOCK WHARF "A" **58**



PLAN

EBB ← DELaware RIVER → FLOOD

REFERENCE DRAWINGS:
NAVFAC 1240400 C-11122, C-11124, C-11126
C-11125, C-11127, D-17161



PLAN

LEGEND

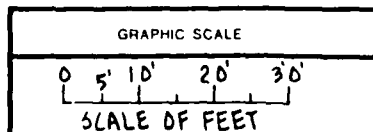
- △ WILD PILE
- ⊙ NON-BEARING PILE
- BROKEN PILE
- ⊗ DISPLACED-SPLIT PILE
- ⊠ CORE LOCATION, LEVEL 3 INSPECTION
- ⊡ 50 PERCENT OF PILE BEARING ON PILE CAP
- ±20 SOUNDINGS (FT) BELOW MLW
- LIMITS OF ACCESS

NOTES:

1. LEVEL 1 INSPECTION ON ALL PILES - HIGHER LEVELS OF INSPECTION WERE NOTED
2. TYPICAL CROSS SECTION FOUND ON FIGURE 70

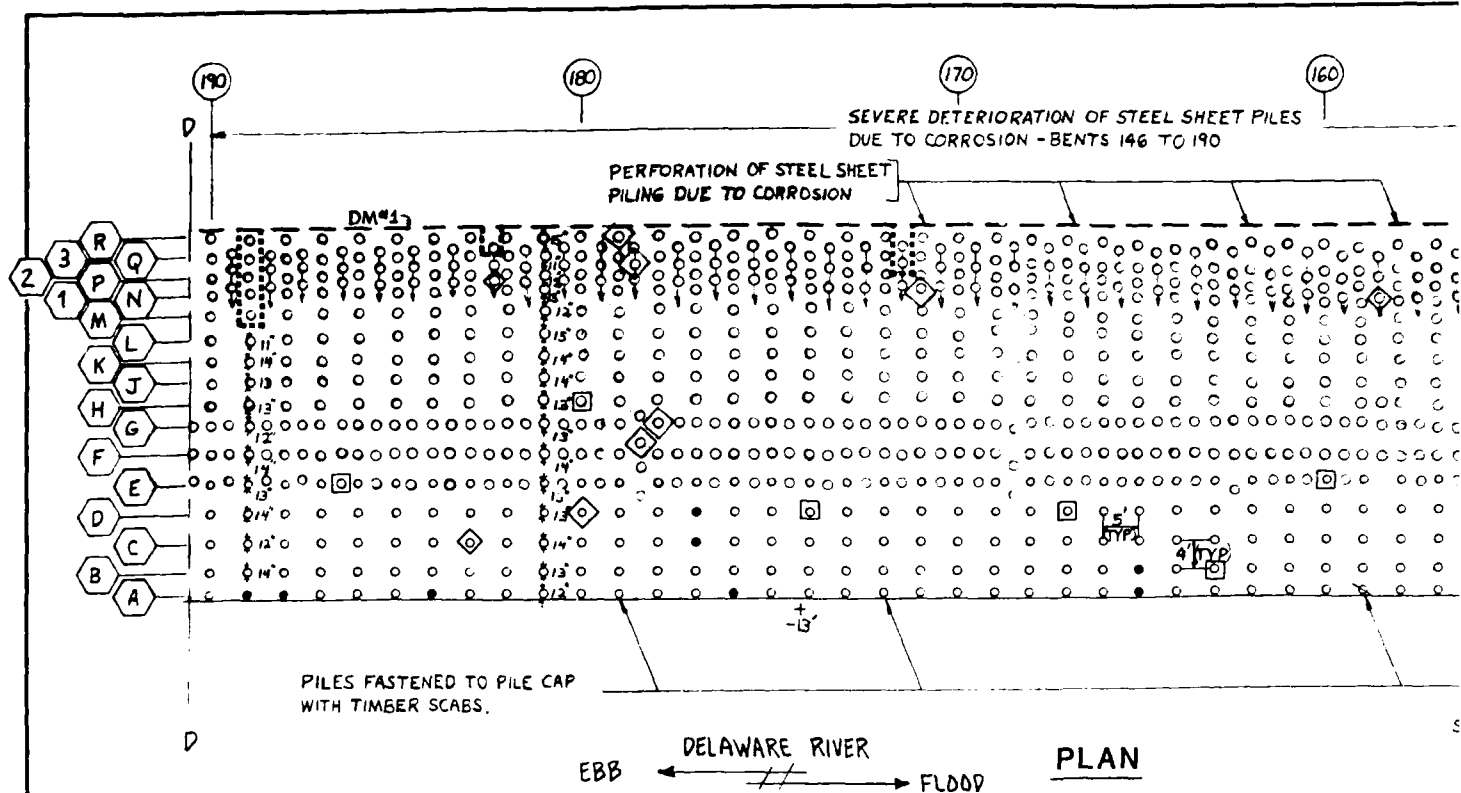
REFERENCE DRAWINGS:

NAVFAC 1240400, C-11122, C-11124, C-11126
C-11125, C-11127, D-17161



CHILDS ENGINEERING
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MEDFIELD MA

CHESAPEAKE DIVISION
NAVAL FACILITIES ENGINEERING COMMAND
WASHINGTON, D.C.
PHILADELPHIA NAVAL SHIPYARD PHILADELPHIA, PA
DRYDOCK WHARF "A" FIG NO 59



STEEL THICKNESS READINGS

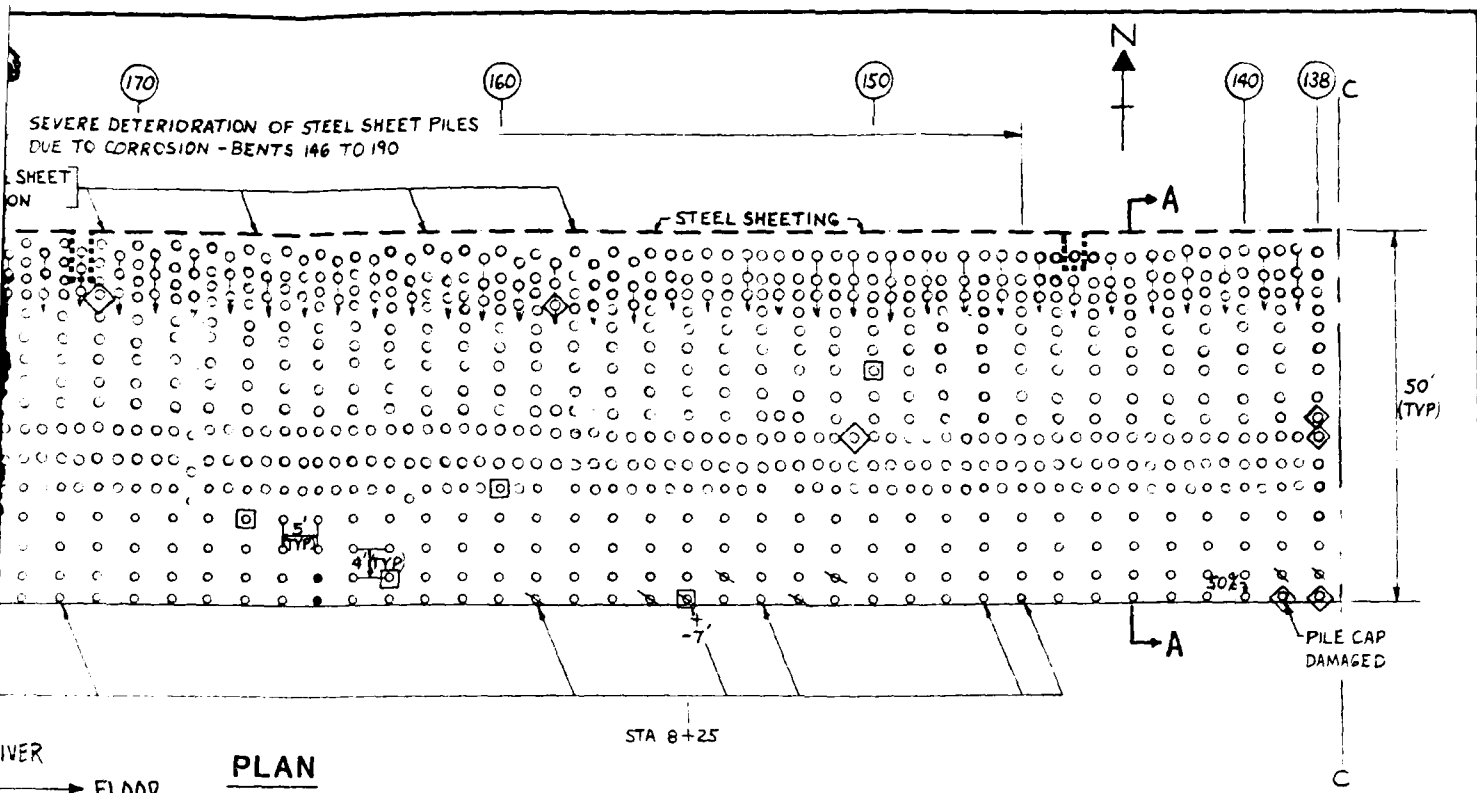
BENT 180

EL (FT BELOW MLW) READING (IN.)

-1 ON WEB	.325
-5 ON WEB	.355

THEORETICAL VALUE OF PZ32 SECTION
WEB - .375"

REFERENCE DRAWINGS:
NAVFAC 1240400, C-11122, C-11124
C-11125, C-11126, C-11127, D-17161



PLAN

STEEL THICKNESS READINGS

BENT 180

EL (FT BELOW MLW)	READING (IN.)
-1 ON WEB	.325
-5 ON WEB	.355

THEORETICAL VALUE OF PZ32 SECTION
WEB - .375"

LEGEND

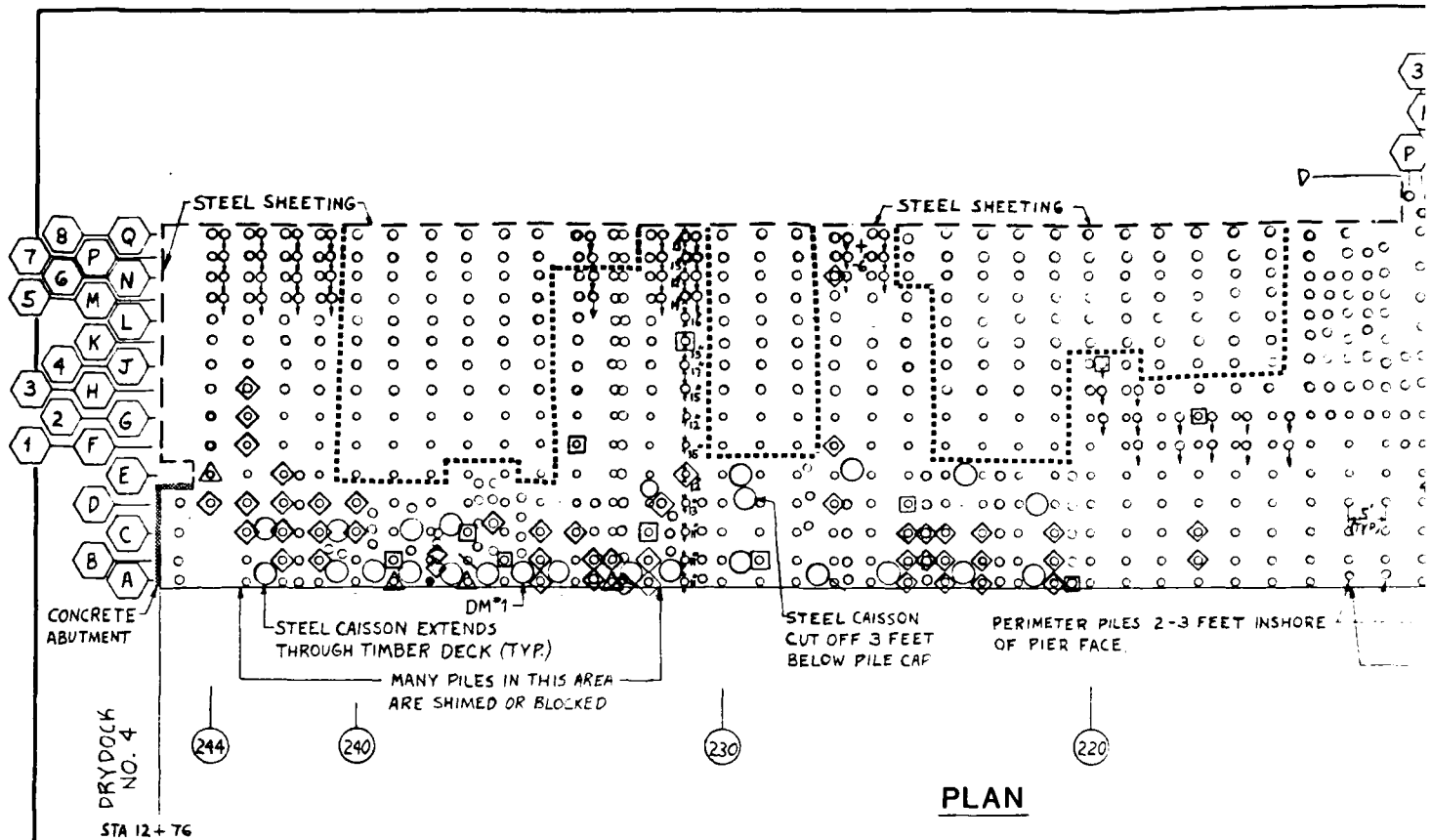
- ◇ NON-BEARING PILE
- BROKEN PILE
- ⊗ DISPLACED - SPLIT PILE
- ⊠ CORE LOCATION, LEVEL 3 INSPECTION
- ⊙ MINIMUM PILE DIAMETER, LEVEL 2 INSPECTION
- ⊕ 50 PERCENT OF PILE BEARING ON PILE CAP
- +2' SOUNDINGS (FT) BELOW MLW
- DM#1 D-METER LOCATION
- LIMITS OF ACCESS

NOTES:

1. LEVEL 1 INSPECTION ON ALL PILES -
HIGHER LEVELS OF INSPECTION WHERE NOTED.
2. CROSS SECTION FOUND ON FIGURE 70

REFERENCE DRAWINGS:
NAVFAC 1240400, C-11122, C-11124
C-11125, C-11126, C-11127, D-17161

GRAPHIC SCALE 0 5' 10' 20' 30' SCALE OF FEET	CHILDS ENGINEERING CORPORATION BOX 333 MEDFIELD MA	CHESAPEAKE DIVISION NAVAL FACILITIES ENGINEERING COMMAND WASHINGTON D.C. PHILADELPHIA NAVAL SHIPYARD PHILADELPHIA, PA DRYDOCK WHARF "A" 60
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PLAN

STEEL THICKNESS READING

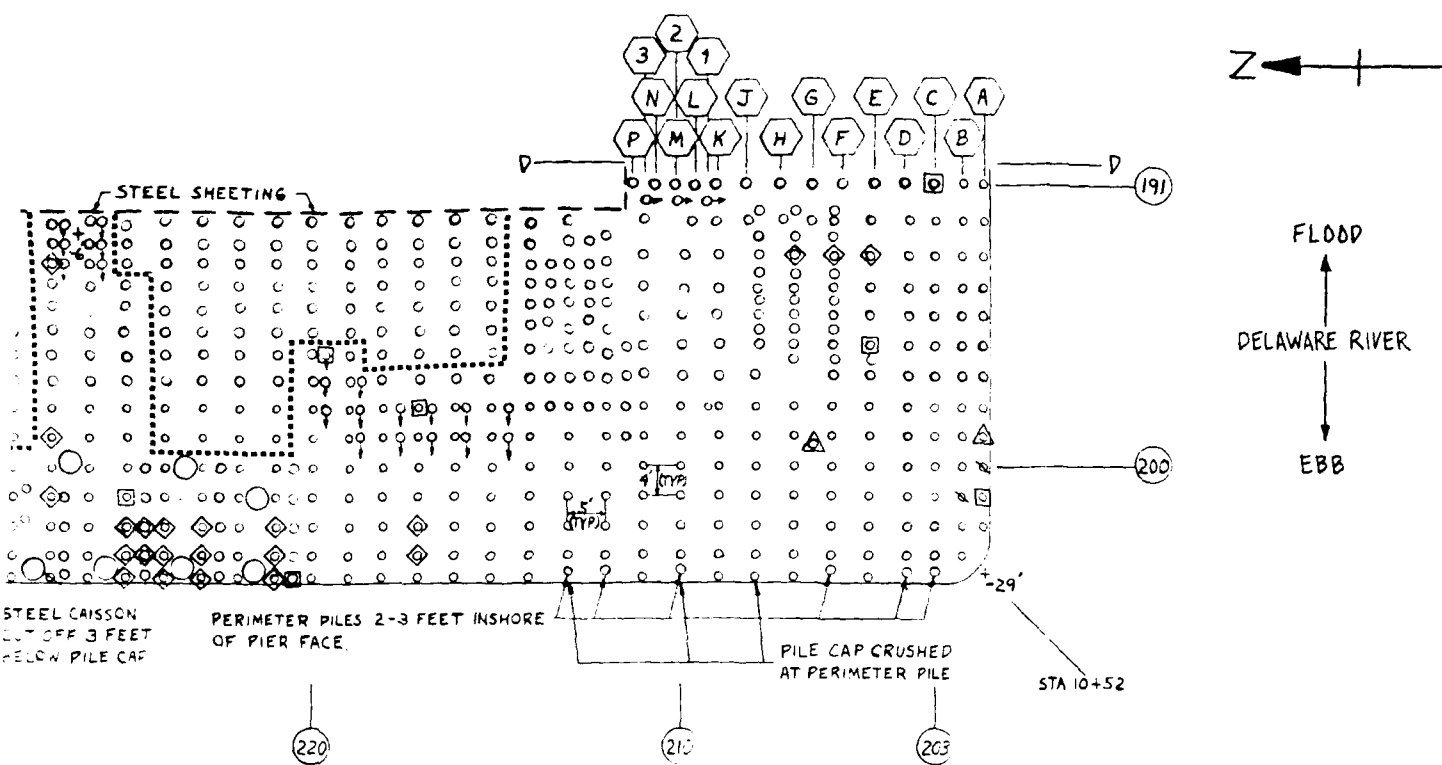
BENT 235-236 CAISSON - DM#1

EL. (FT. BELOW MLW)	READING (IN.)
0	.400
-2	.440
-4	.310
-6	.380
-8	.360
-10	.365
-15	.375
-20	.390

REFERENCE DRAWINGS:

NAVFAC 1240400, C-11122, C-11124
C-11125, C-11126, C-11127, D-17161

0
L



PLAN

LEGEND

- △ WILD PILE
- NON-BEARING PILE
- BROKEN PILE
- ⊗ DISPLACED - SPLIT PILE
- CORE LOCATION, LEVEL 3 INSPECTION
- ⊙ MINIMUM PILE DIAMETER, LEVEL 2 INSPECTION
- +25' SOUNDINGS (FT) BELOW MLW
- DM#1 D-METER LOCATION
- LIMITS OF ACCESS

NOTES:

1. LEVEL 1 INSPECTION ON ALL PILES -
HIGHER LEVELS OF INSPECTION WHERE NOTED

STEEL THICKNESS READING

BENT 235-236 CAISSON - DM#1

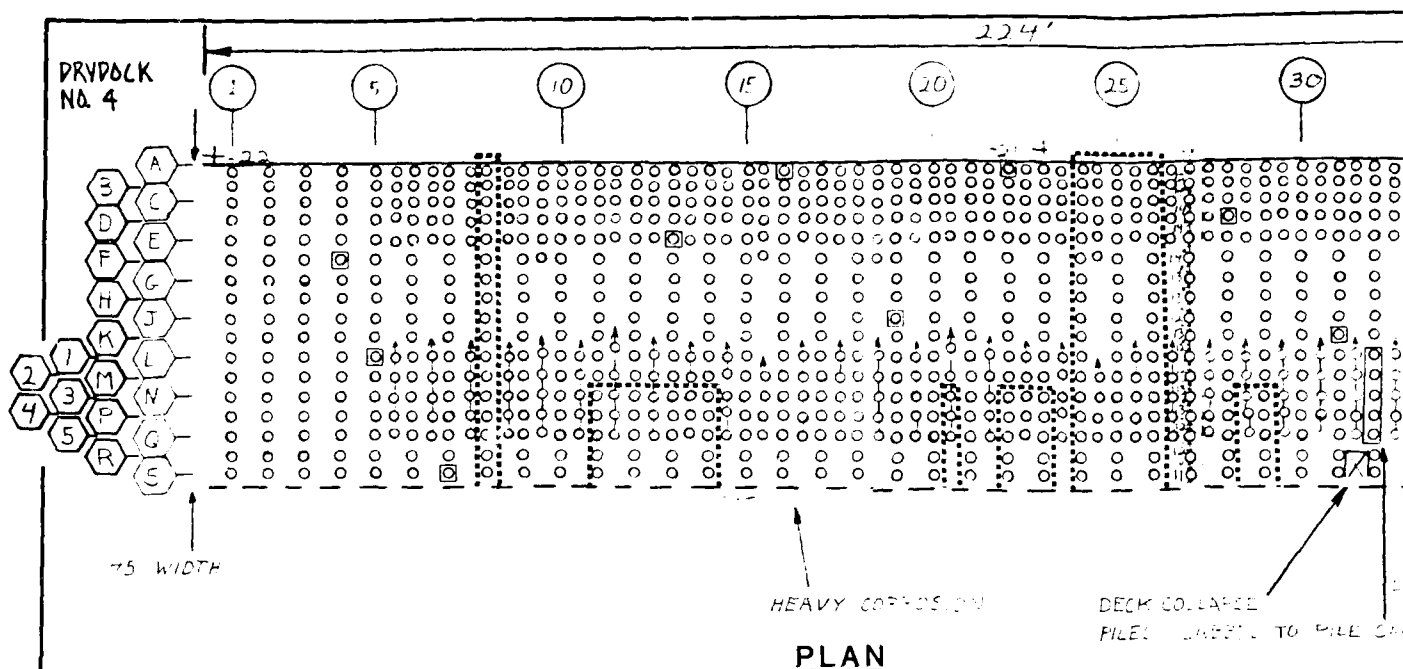
EL (FT BELOW MLW)	READING (IN)
0	.400
-2	.440
-4	.310
-6	.380
-8	.360
-10	.365
-15	.375
-20	.390

REFERENCE DRAWINGS:

NAVFAC 1240400, C-11122, C-11124
C-11125, C-11126, C-11127, D-17161

GRAPHIC SCALE 0 5' 10' 20' 30' SCALE OF FEET	CHILDS ENGINEERING CORPORATION BOX 333 MIDFIELD, MA	CHESAPEAKE DIVISION NAVAL FACILITIES ENGINEERING COMMAND WASHINGTON, D.C.	
		PHILADELPHIA NAVAL SHIPYARD PHILADELPHIA, PA	FIG NO 61

DRYDOCK WHARF "A"



LEGEND

- △ WILD PILE
 - ◇ NON-BEARING PILE
 - BROKEN PILE
 - ✕ DISPLACED - SPLIT PILE
 - CORE LOCATION, LEVEL 3 INSPECTION
 - +++ MINIMUM PILE DIAMETER, LEVEL 2 INSPECTION
 - SOUNDINGS (FT) BELOW MLL
 - 1 D-METER LOCATION
 - LIMITS OF ACCESS
- ON
3' VOID BETWEEN
AND CONCRETE
- STEEL SHEET P

NOTES

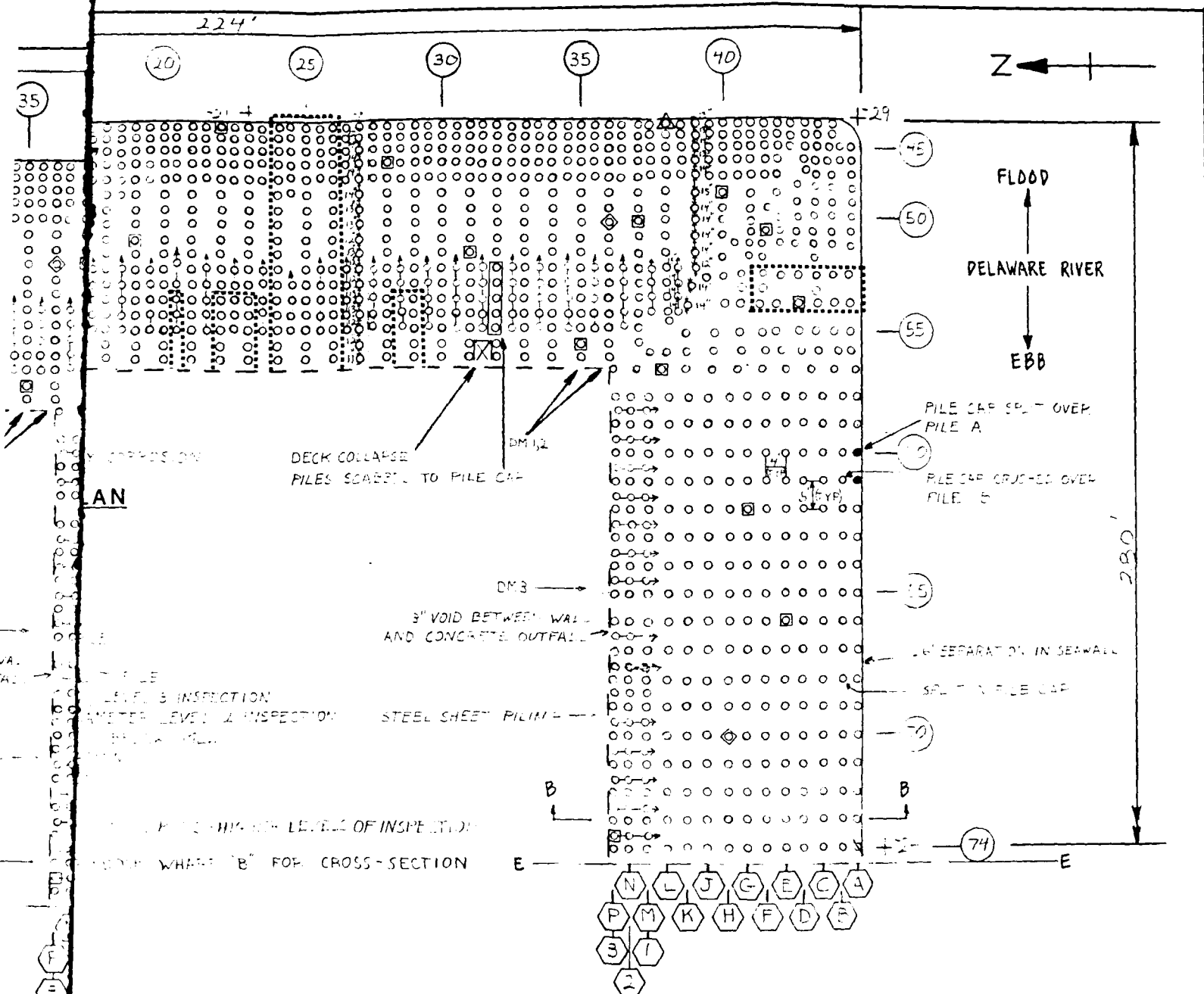
1. LEVEL 1 INSPECTION ON ALL PILES - HIGH OR LOW (SEE OF INSPECTOR) WHERE NOTED.
2. SEE FIGURE 70 DRYDOCK WHARF 'B' FOR CROSS-SECTION

STEEL THICKNESS READING

BENT	35	36	37
FLANGE FROM MLV	-3	-5	-7
FLANGE (IN)	.460	.460	.460
WEB (IN)	.340	.360	—

THEORETICAL PZ 32 VALUES ARE
WEB .375" FLANGE .500"

REFERENCE DRAWINGS: NAVFAC 1135438
PW C-10402, C-11127, C-11130, C-11131, C-11132, C-13536



DRAWINGS: NAVFAC 113545B
C-11127, C-11130, C-11131, C-11132, C-13536

GRAPHIC SCALE

0 5' 10' 20' 30'

SCALE OF FEET

CHILDS ENGINEERING
CORPORATION
BOX 333
MEDFIELD, MA

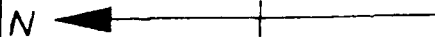
CHESAPEAKE DIVISION
NAVAL FACILITIES ENGINEERING COMMAND
WASHINGTON, D.C.

PHILADELPHIA NAVAL SHIPYARD PHILADELPHIA, PA

DRYDOCK WHARF "B"

FIG NO

62

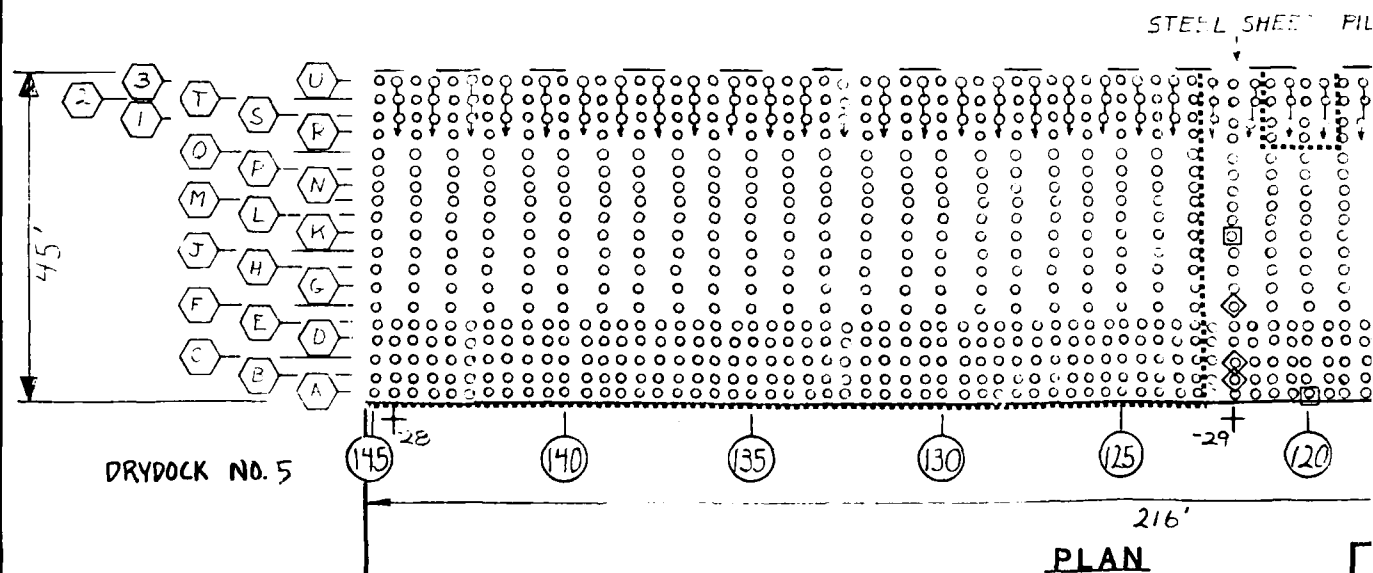


LEGEND

- △ WILD PILE
- ⊕ NON-BEARING PILE
- BROKEN PILE
- ⊗ DISPLACED - SPLIT PILE
- ⊠ CORE LOCATION, LEVEL 3 INSPE
- + SOUNDINGS (FT) BELOW MLW
- LIMITS OF ACCESS

NOTE:

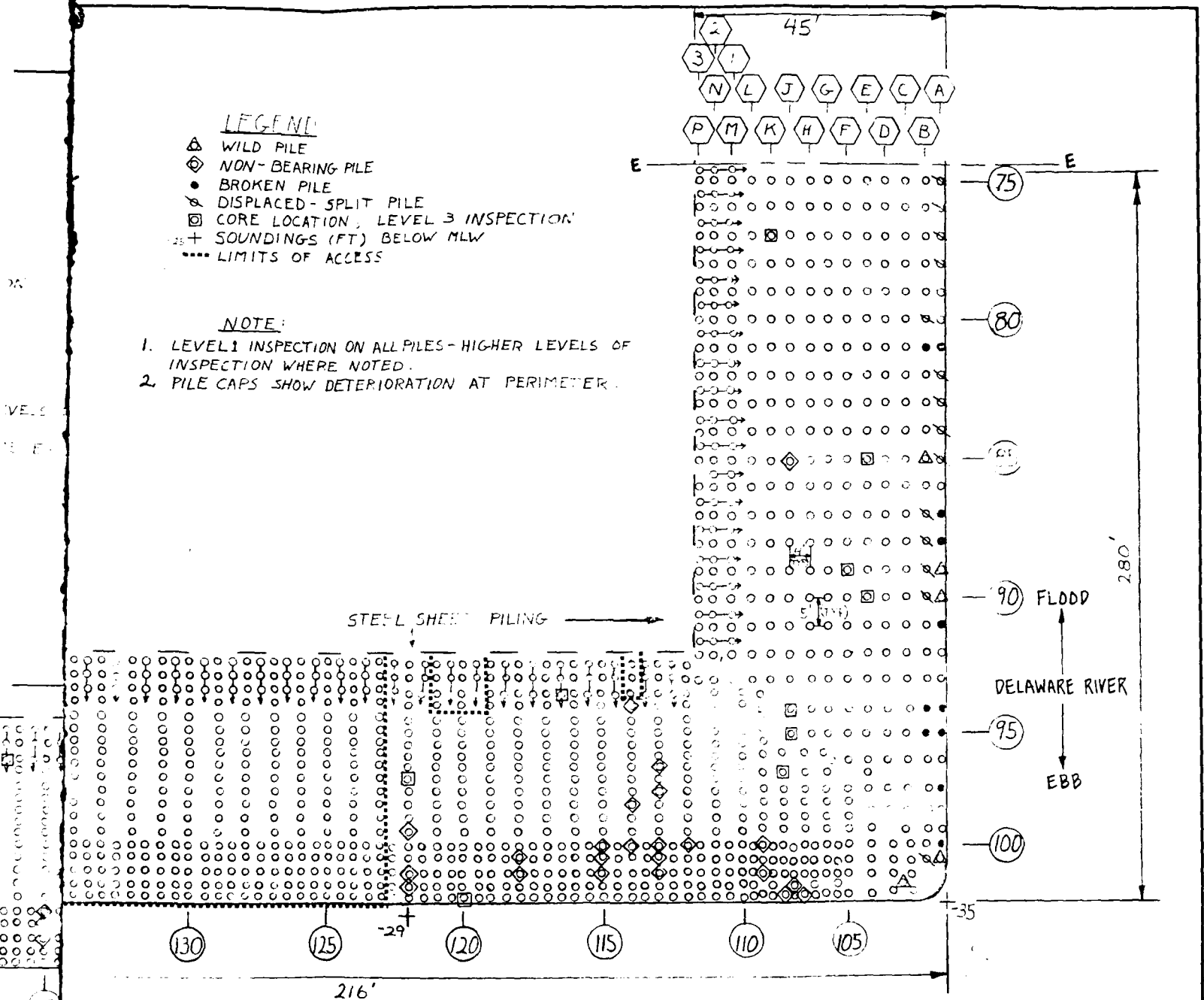
1. LEVEL 1 INSPECTION ON ALL PILES - HIGHER INSPECTION WHERE NOTED.
2. PILE CAPS SHOW DETEIORATION AT F



REFERENCE DRAWINGS : NAVFAC 113545B
 PW C-10402, C-11127, C-11130, C-11131, C-11132, C-13536

- LEGEND
- △ WILD PILE
 - ◇ NON-BEARING PILE
 - BROKEN PILE
 - ⊗ DISPLACED - SPLIT PILE
 - CORE LOCATION, LEVEL 3 INSPECTION
 - + SOUNDINGS (FT) BELOW MLW
 - LIMITS OF ACCESS

- NOTE:
1. LEVEL 1 INSPECTION ON ALL PILES - HIGHER LEVELS OF INSPECTION WHERE NOTED.
 2. PILE CAPS SHOW DETEIORATION AT PERIMETER.



PLAN

63 : NAVFAC 113545B
C-11130, C-11131, C-11132, C-13536

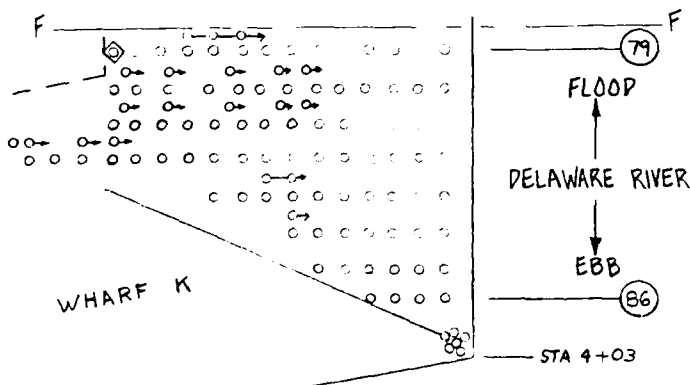
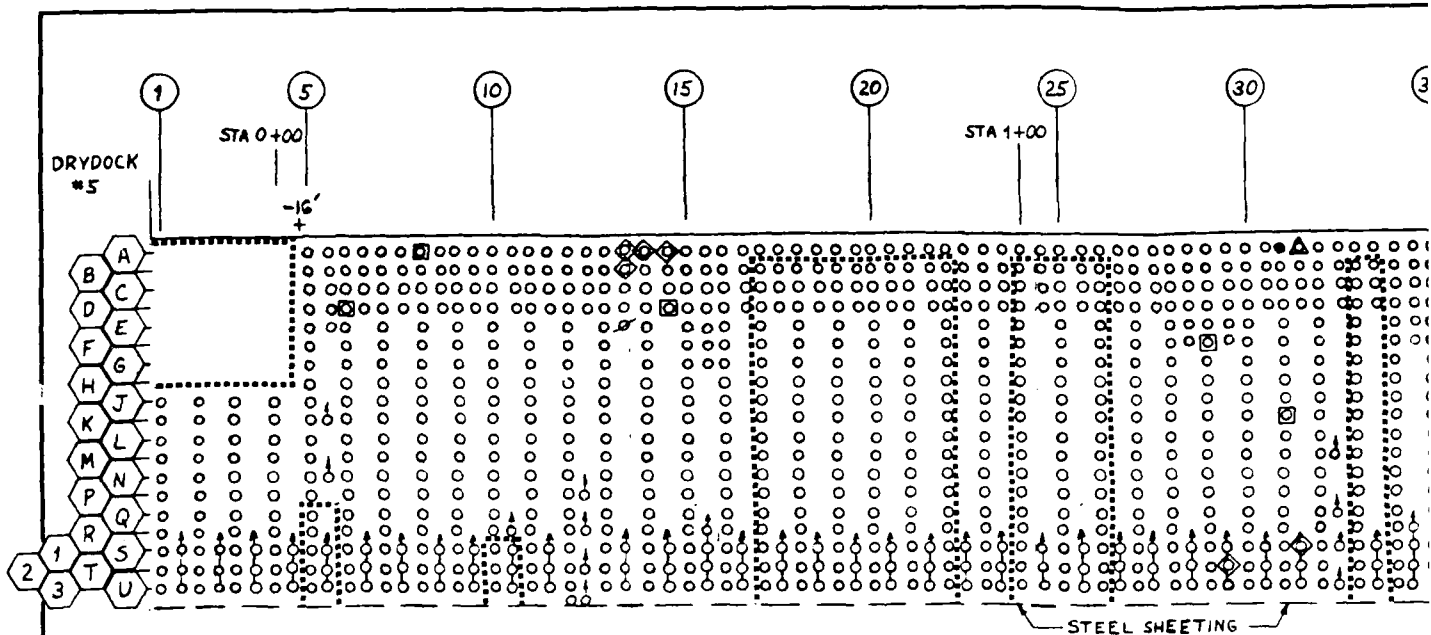
GRAPHIC SCALE

0 5' 10' 20' 30'
SCALE OF FEET

CHIDS ENGINEERING
CORPORATION
804 333
MEDFIELD MA

CHESAPEAKE DIVISION
NAVAL FACILITIES ENGINEERING COMMAND
WASHINGTON D C

PHILADELPHIA NAVAL SHIPYARD PHILADELPHIA, PA FIG NO
DRYDOCK WHARF "B" 63



PLAN

4" GAP BETWEEN WHALE - AND STEEL SHEETING

LEGEND

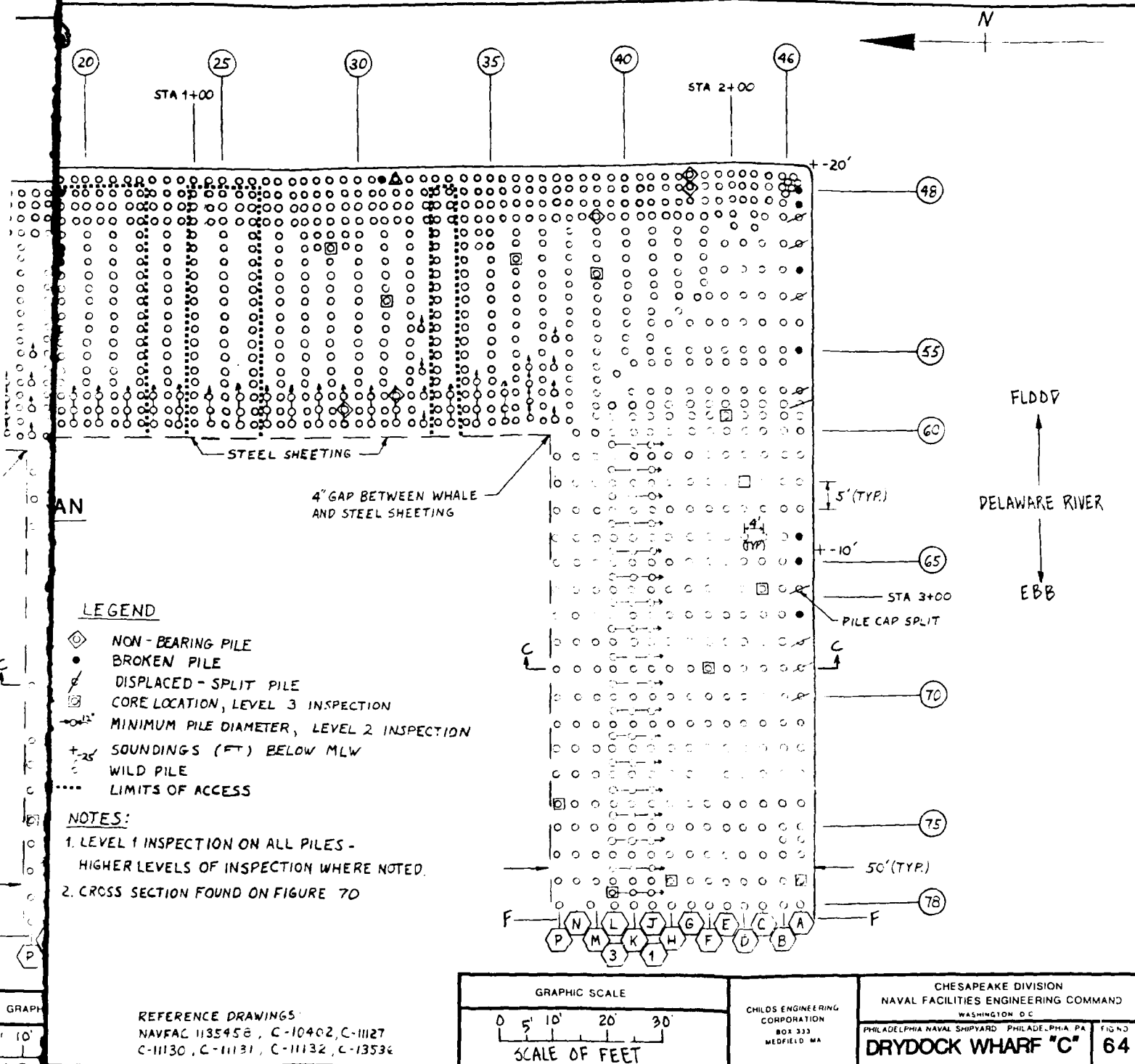
- ◇ NON-BEARING PILE
- BROKEN PILE
- ⚡ DISPLACED - SPLIT PILE
- ⊠ CORE LOCATION, LEVEL 3 INSPECTION
- ⊙ 12" MINIMUM PILE DIAMETER, LEVEL 2 INSPECTION
- + 25' SOUNDINGS (FT) BELOW MLW
- △ WILD PILE
- LIMITS OF ACCESS

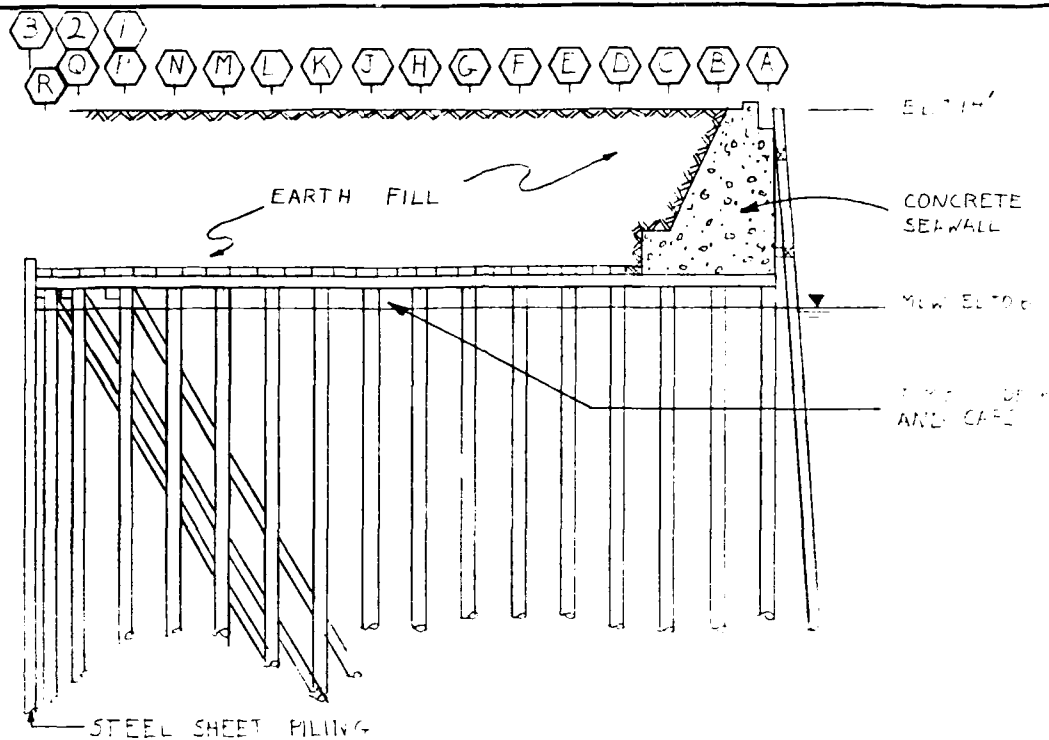
NOTES:

1. LEVEL 1 INSPECTION ON ALL PILES - HIGHER LEVELS OF INSPECTION WHERE NOTED.
2. CROSS SECTION FOUND ON FIGURE 70

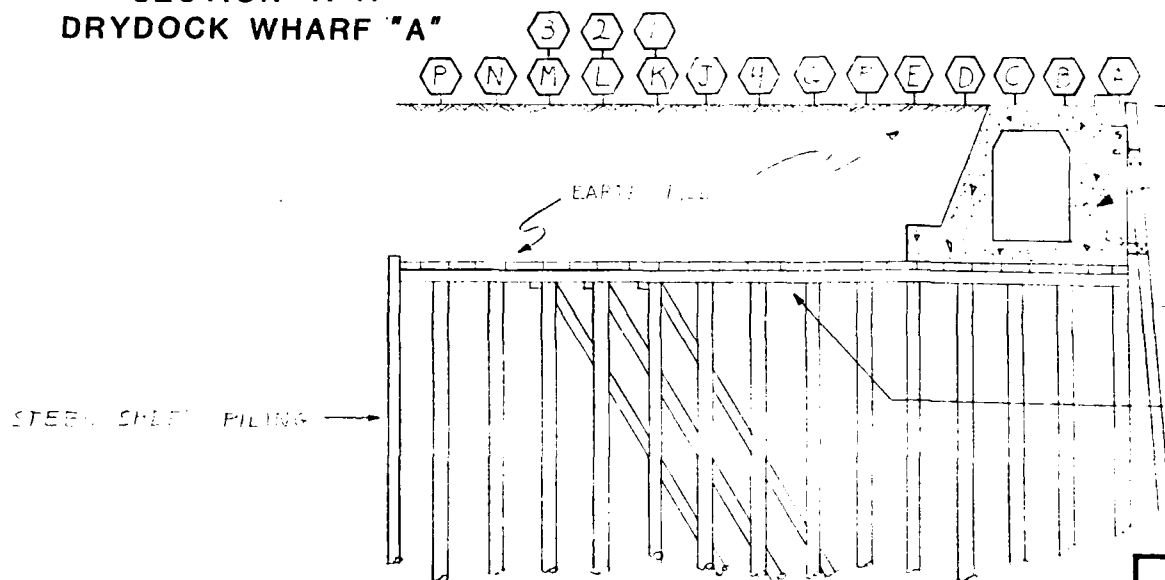
SCHUYLKILL RIVER
FLOOD ← // → EBB

REFERENCE DRAWINGS:
NAVFAC 1135458, C-10402, C-11127
C-11130, C-11131, C-11132, C-13536

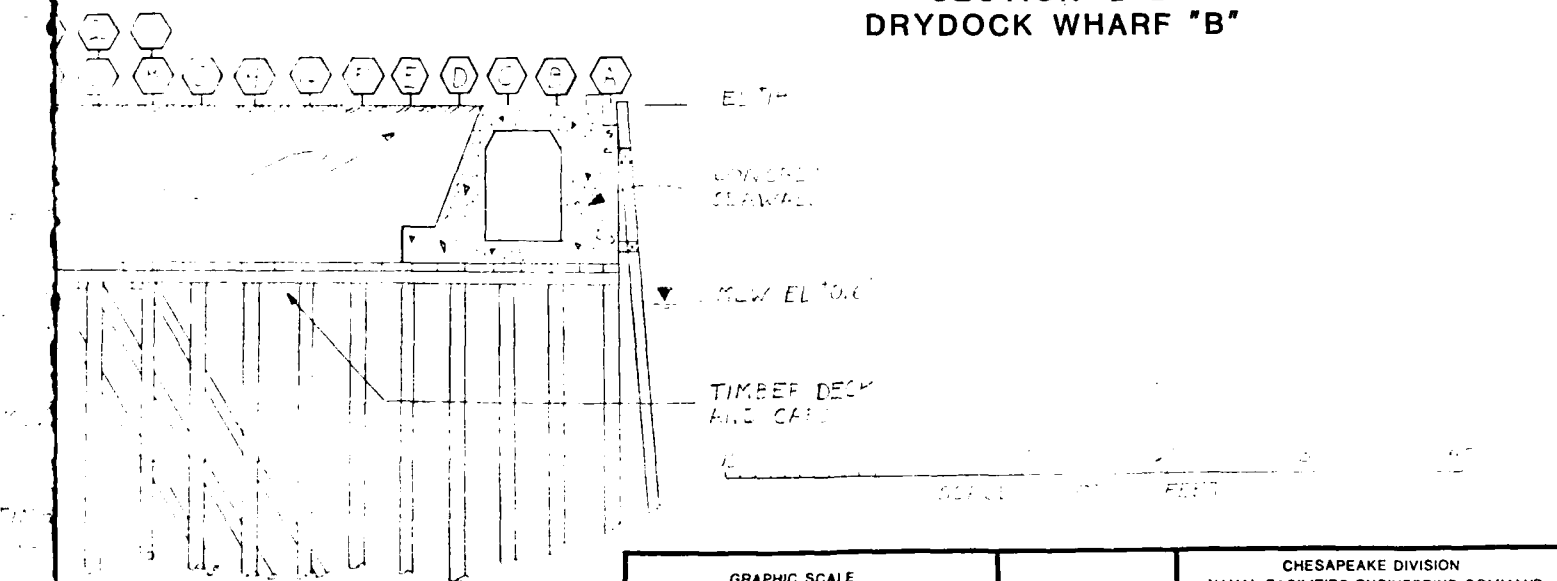
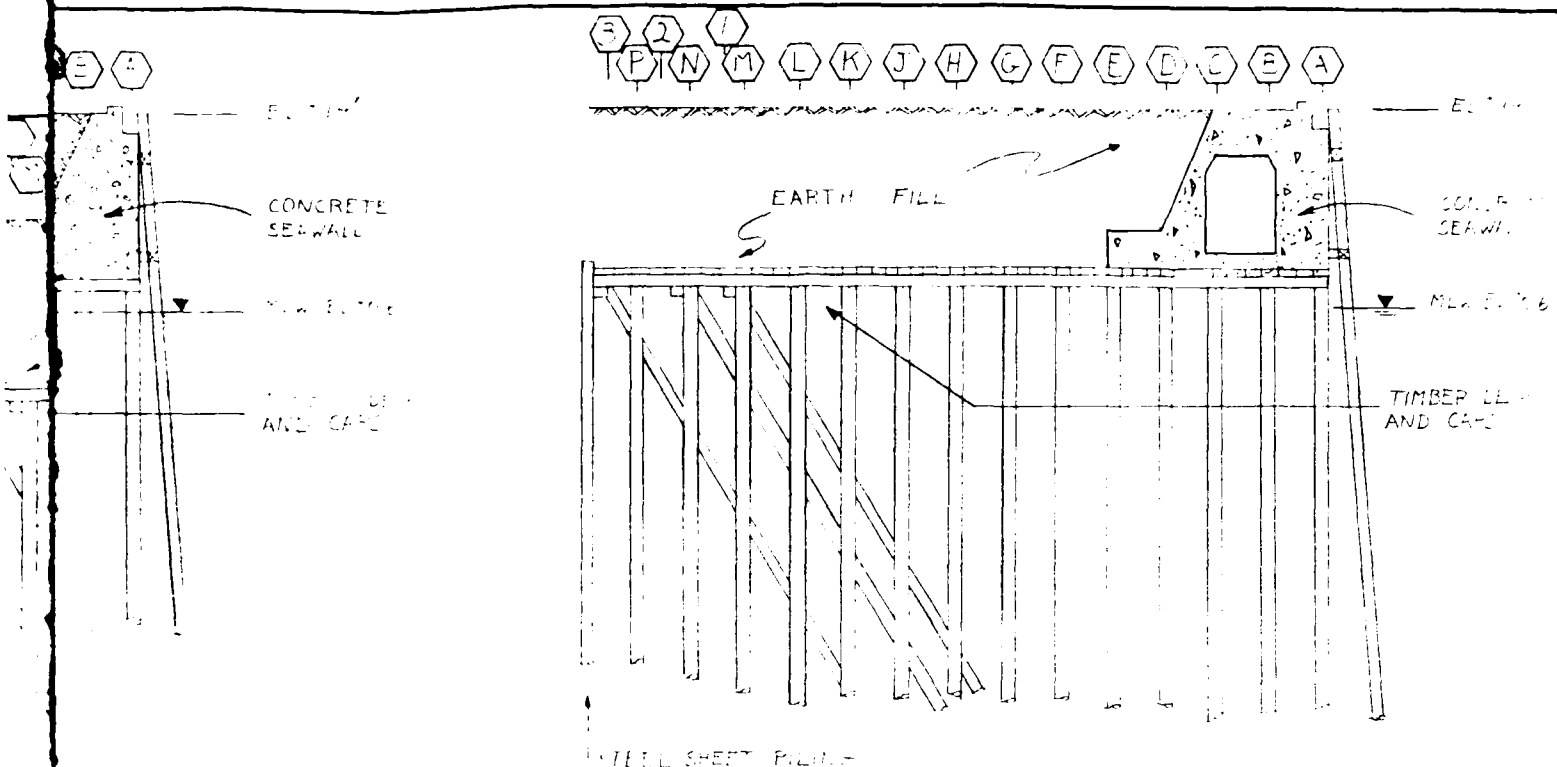




SECTION 'A-A'
DRYDOCK WHARF "A"



SECTION 'C-C'
DRYDOCK WHARF "C"



GRAPHIC SCALE	CHILDS ENGINEERING CORPORATION BOX 333 MEDFIELD, MA	CHESAPEAKE DIVISION NAVAL FACILITIES ENGINEERING COMMAND WASHINGTON, D.C. PHILADELPHIA NAVAL SHIPYARD, PHILADELPHIA, PA	FIG. NO. 65
AS SHOWN			

GRAPHIC SCALE
AS SHOWN

4.11.2 OBSERVED INSPECTION CONDITION

Specific anomalies detected which relate to the structural piles are tabulated as follows:

SECTION A

- 69 non-bearing piles
- 28 broken piles
- 33 split and displaced piles
- 9 piles with less than 100% bearing
- 15 wild piles

SECTION B

- 25 non-bearing piles
- 13 broken piles
- 15 split and displaced piles
- 6 wild piles

SECTION C

- 10 non-bearing piles
- 8 broken piles
- 10 split and displaced piles
- 1 wild pile

These anomalies can be located on Figures 58 through 64.

Visual inspection of core samples of timber piles, caps and decking indicate that there is no more than 1/2" of softness in the timber. This condition is found throughout the facility. Minimum pile diameters measured ranged from 11" to 18". Marine borers were not observed. From our observations we conclude that there has not been a loss of cross-sectional area associated with the timber piles since their placement.

Damage to pile caps (24 in all) was observed throughout Sections A, B and C of the facility. This damage is a result of abrasion and/or local overloading. Damage of the pile caps due to abrasion

is confined to areas where the fender system is no longer functional, while local overloading of the pile caps occurs where perimeter piles are broken or are located 2 to 3 feet inshore of the seawall (see Photo #41).

In general, inspection of fastenings reveals a 15-20% loss of steel due to corrosion. More extensive corrosion of the fastenings was observed in isolated areas.

The surface of the steel sheet piling is very rough and pitted. The outer layer of corrosion is a soft orange corrosion by-product with pockets of trapped gas. Closer to the surface of the steel is a harder black layer of corrosion by-product. Corrosion holes ranging from 1/2" diameter to 1"x18" were observed in the sheet pile wall along the south side of Section "A", (see Figure 60, Photo #42). The results of D-meter readings taken on the sheet pile wall indicate a steel loss of between 5 and 50% with the average steel loss approximately 15% (see Figures 60, 61, and 62 for D-meter readings).

Many shimmed and non-bearing piles were observed between Bents 220 through 244 of Section "A", with some piles shimmed up to 12 inches. Steel caissons approximately 5 feet in diameter were also observed in the area. The caissons extend through the decking. Caps that could transfer deck loads to the caissons were not observed.

A local failure of the timber decking was observed between Bents 31 and 32 of Section "B", adjacent to the steel sheet pile wall



PHOTO NO. 41: Drydock Wharf C, Bent 66, Pile A;
illustrates split in pile cap.
Failure of pile cap due to over-
loading.

PHOTO NO. 42: Drydock Wharf A, Bent 184;
rusty knuckle in steel sheet
pile wall, approx. El.-2'.
Corroded knuckle is approx. 3/4"
wide and 14" long.



(see Figure 62). Earth fill has leached out of the structure, but the extent of loss is not known.

The fender system along the east face of Section "A" is non-existent, and heavily damaged along the south face, particularly in the area where the battleship is moored. The fender systems of Sections "B" and "C" are in good condition.

The concrete seawall was observed to be in excellent condition in general, with the exception of a 6" wide vertical crack found between Bents 67 and 68 of Section "B".

By comparing soundings obtained by Childs Engineering Corporation personnel with maximum safe designed dredge depths obtained from the Hudson Engineers Report of 1976, it is noted that the maximum dredge depth has been exceeded at the southwest corner of Section "B" by 5 feet. Maximum dredge depths are approached but not exceeded at all other sounding locations.

4.11.3 STRUCTURAL ASSESSMENT

Most of the specific anomalies listed in the previous section are a result of local berthing forces. Lateral forces have broken, split and/or displaced many perimeter piles. As a result, in many areas pile caps are left unsupported at the perimeter leading to local failure of the pile cap. In addition, pile caps have been abraded or crushed by impact loads.

Non-bearing piles along the west side of Section "A" are the result of missing shims. The widespread use of shims and short posts in the area may be part of the original construction, or may have been required at a later date to counteract the effects of settlement. The function of the caissons located between Bents 221 through 243 cannot be determined from our inspection or through our government-furnished information. However, since the caissons extend through the deck, we must assume that they offer little vertical support to the deck.

As a result of our observations and analysis of the structural timber piles (see Appendix A-1 to A-8) we conclude that minimum pile diameters and the condition of the timber are both at acceptable levels.

The failure of the timber decking between Bents 31 and 32 of Section "B" adjacent to the steel sheet pile wall is a local condition and does not reflect a general weakness of the timber decking throughout the facility.

Corrosion holes in the knuckles and web of the sheet pile wall along the south side of Section "A" may result in loss of fill. Although no sinkholes were observed in the pavement adjacent to the holes, the possibility does exist that sinkholes will form in the future. The general loss of steel section of the knuckles and web due to corrosion does not at this time threaten the structural integrity of the sheet pile wall. However, if deterioration of the steel is allowed to continue, more holes will form, and the wall may reach a point where it is unable to restrain the lateral earth forces exerted on it.

Maximum safe designed dredge depths have been exceeded at the southwest corner of Section "B" by five (5) feet. Over-dredging threatens the lateral stability of the structure and should be avoided.

AD-A168 465

UNDERWATER FACILITIES INSPECTIONS AND ASSESSMENTS AT

2/2

PHILADELPHIA NAVAL STATION CHILD'S ENGINEERING CORP

MEDFELD MA OCT 83 CHES/NAUPAC-FPO-1-83(48)-2

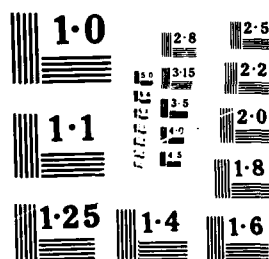
UNCLASSIFIED

N62477-81-C-0448

F/G 13/2

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DATE
FILMED
7-86
DTIC



4.11.4 RECOMMENDATIONS

The forty-nine (49) broken piles should be repaired by replacing them with new piles, (see Appendix A-15, A-18). The estimated cost per pile for repair with a new pile is \$1,000. The eighty (80) split and displaced or wild piles and the one hundred thirteen (113) non-bearing or partial bearing piles should be reconditioned (shimmed, posted or clamped, see Appendix A-16, A-17) and refastened where needed to the pile cap. The cost to recondition a pile is estimated to be \$400. The total estimated cost to implement these repairs is \$126,200.00 plus mobilization/demobilization.

We recommend that the local pile cap and deck failure observed on the east side of Section "B" be repaired to prevent further loss of fill (see Appendix A-21). The estimated cost of excavation and backfill is \$15/cu.yd. at approximately 30 cu.yd. = \$450.00. The estimated cost of timber is \$5/bf (in place) at approximately 120 bf = \$600.00, for an estimated total of \$1,050 plus mobilization/demobilization.

The twenty-four (24) damaged pile caps should be repaired. At an estimated cost of \$500/repair, the total estimated cost is \$12,000 plus mobilization/demobilization (see Appendix A-20).

We recommend that the cathodic protection system servicing the battleship mooring at Section A be analyzed to determine whether it is or has been contributing to the corrosion of the steel sheet pile wall. No specific repairs to the holes observed in the steel

sheet pile wall are recommended at this time. However, it is recommended that the wall be re-inspected every year to monitor the general loss of steel due to corrosion, the formation of new holes and the loss of fill material. Additionally, a protection system using galvanic anodes could be installed to prevent further deterioration of the steel.

We recommend that the dredge limits established in the Hudson Engineering Report of 1976 not be exceeded.

We recommend that the live-load capacity of Section "A" north of Bent 220 and inshore 20' be downgraded from 700 psf to 100 psf until the recommended repairs are completed in the area. It is emphasized that re-shimming non-bearing piles in the area may not be a permanent solution if the cause of the non-bearing piles is settlement.

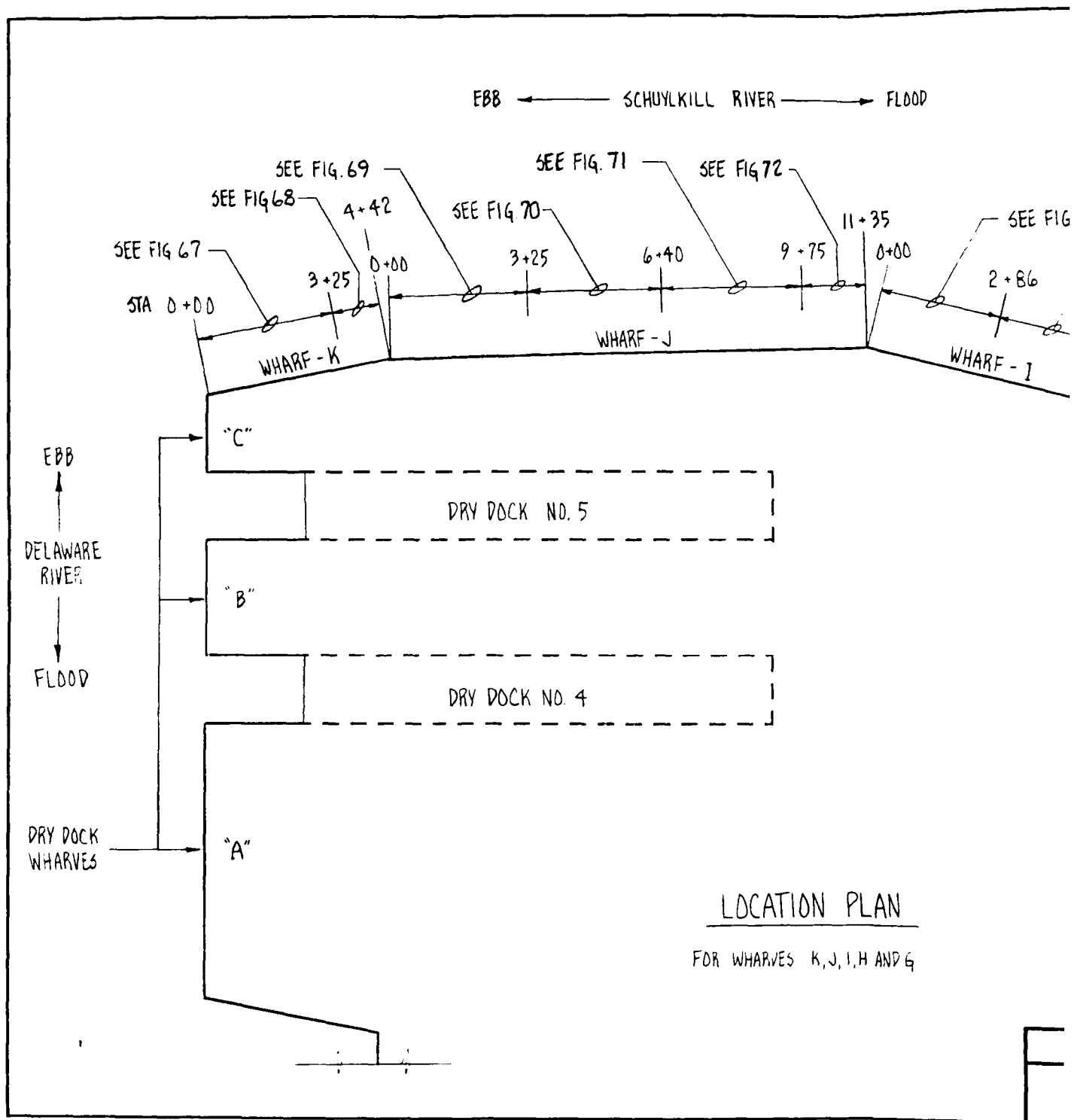
Live-loading in deck areas directly associated with damaged (broken, split and wild) piles should be restricted to 25% of the current recommended live-load capacity until those piles are repaired. Following the implementation of the recommended repairs, live-loading can be maintained at current levels (Wharf A, 700 psf; Wharves B and C, 300 psf). We estimate the life of the inspected portions of the facility to be in excess of 15 years. The entire wharf should be re-inspected after repairs are made and in 6 years thereafter. This inspection will enable Shipyard personnel to determine any changes of conditions. This report should be used as a baseline for future inspections.

4.12 WHARVES K, J, I, H, G

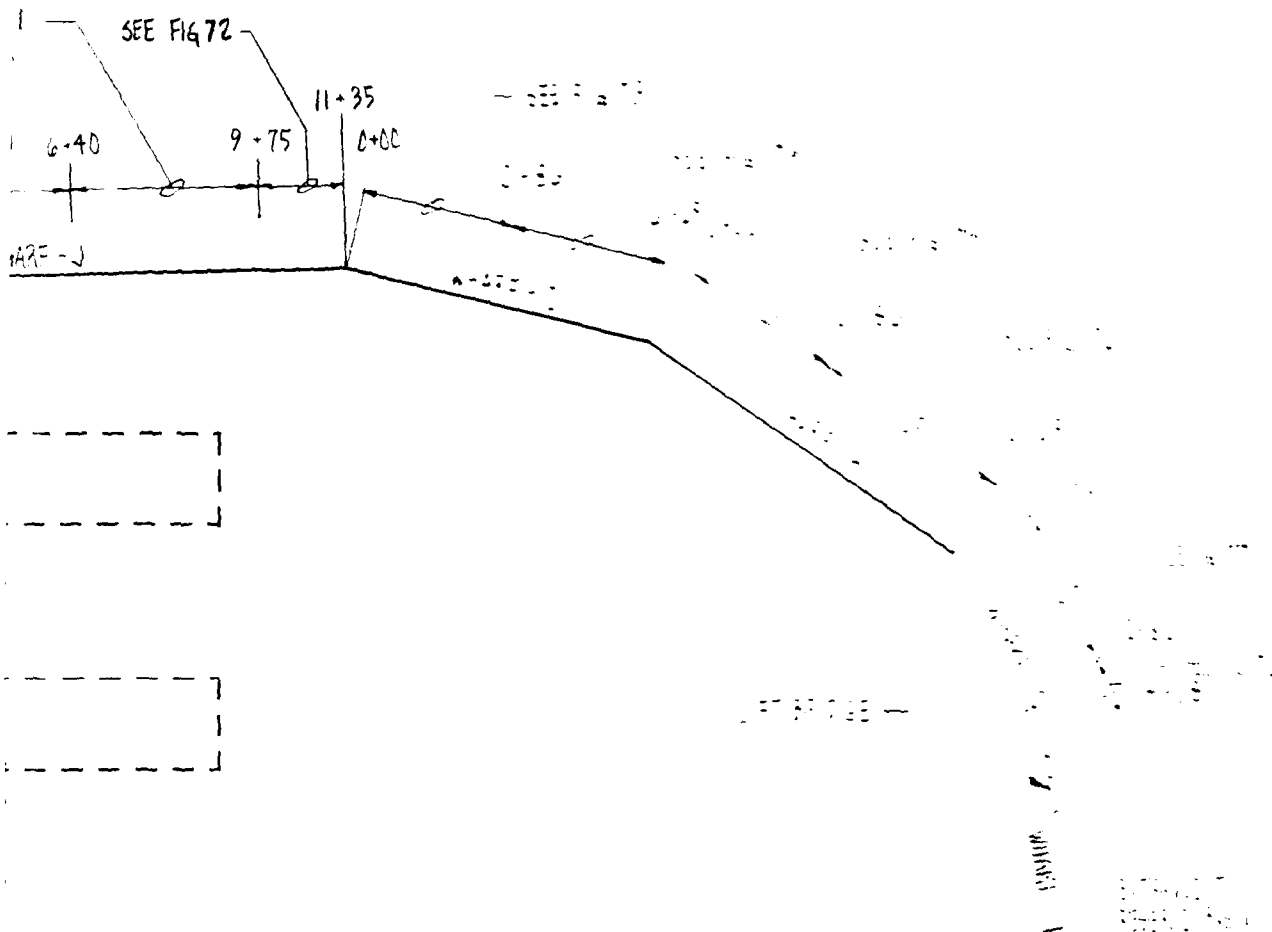
4.12.1 DESCRIPTION

Wharves K, J, I, H and G are located on the east shore of the Schuylkill River adjacent to the drydock wharves and to the west of Dry Dock No. 5 at the Philadelphia Naval Shipyard (see Figures 4 [Vol. I] and 66-78). These wharves were constructed circa 1943. The structure is a low deck, earth fill, timber pile-supported relieving platform. There are approximately 12,060 structural piles. The approximate total length of the Wharves K, J, I, H, and G is 3,315'. The timber pile capacity is assumed to be 15 tons per pile. The live-load capacity of these structures is 300 psf. During our diver's inspection these facilities were being used as a berthing area for various fuel barges.

Reference 2 (see Appendix A-25)



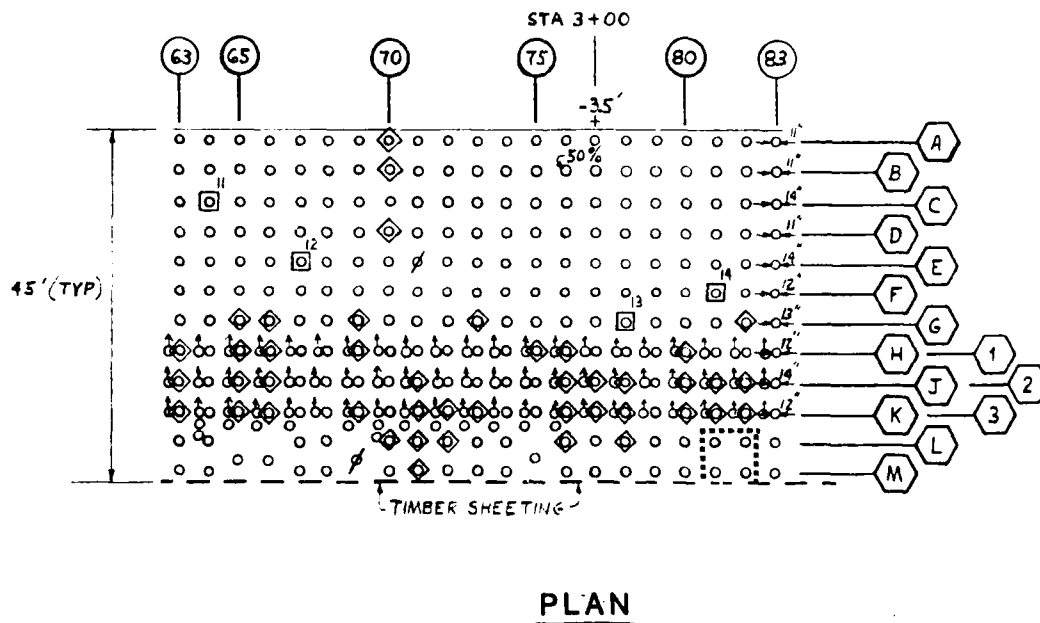
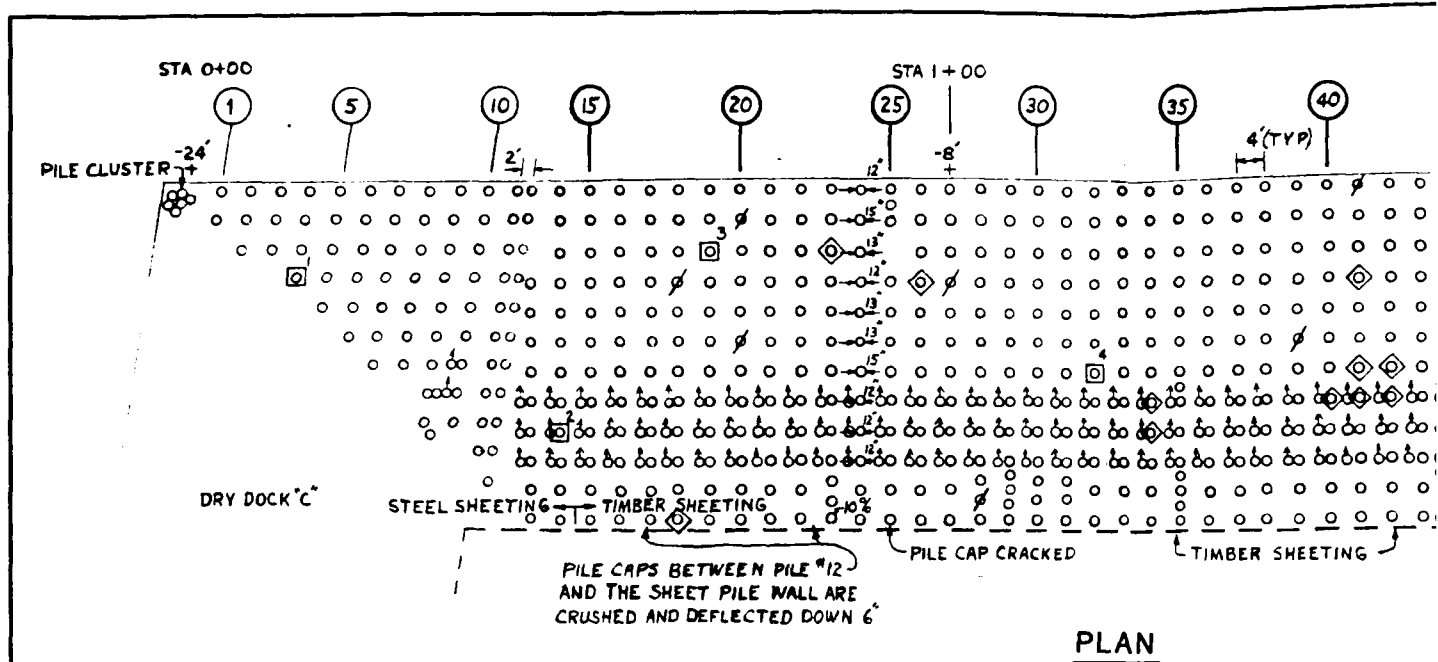
SCHUYLKILL RIVER → FLOOD



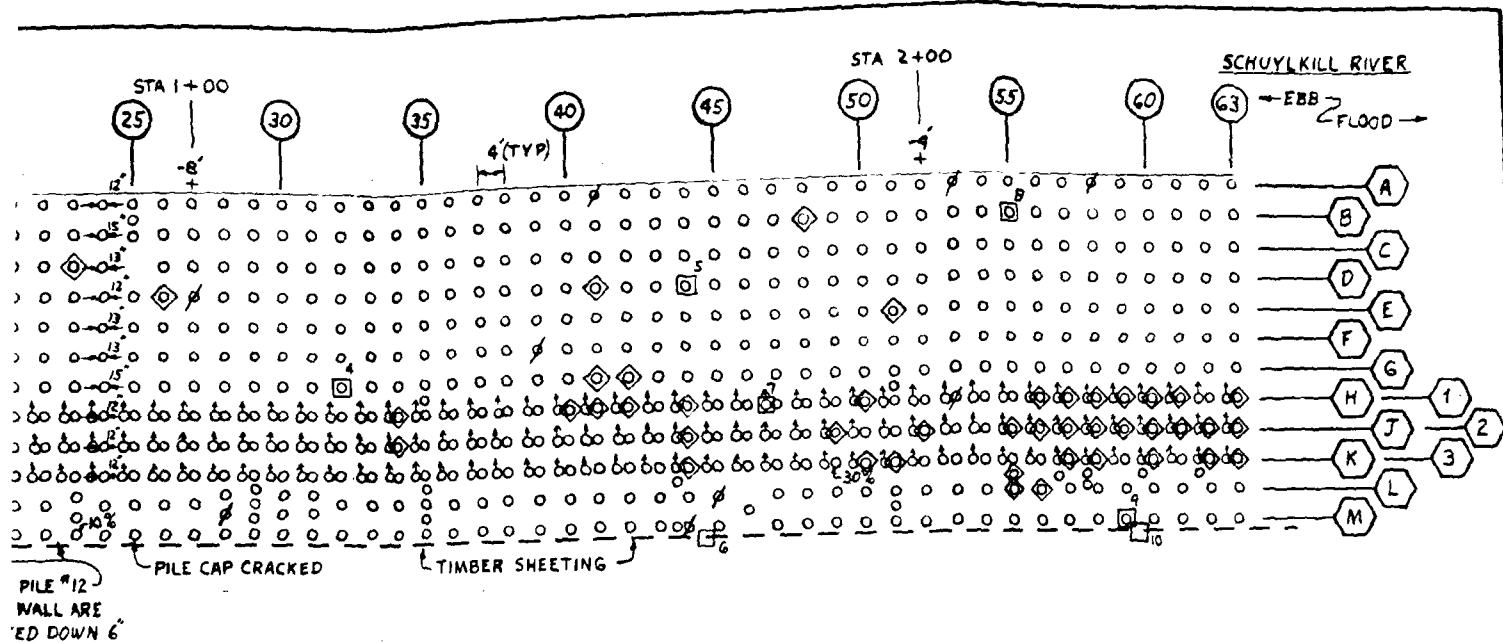
LOCATION PLAN

FOR WHARVES K, J, I, H AND G

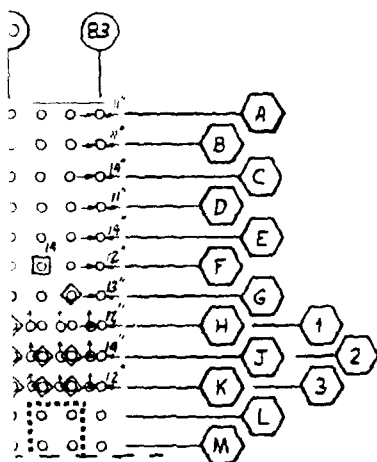
GRAPHIC SCALE	PHILADELPHIA ENGINEERING CORPORATION 100 N. 10TH ST. PHILADELPHIA, PA.	CHESEBROUGH DIVISION NAVAL FACILITIES ENGINEERING CENTER PHILADELPHIA, PA.
0 100 200 400 FEET		LOCATION PLAN 22



REFERENCE DRAWINGS:
C-11033 C-9774, C-10420
C-10422 C-11126, C-13537



PLAN



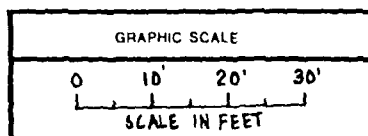
LEGEND

- ◊ NON-BEARING PILE
- ⚡ DISPLACED-SPLIT PILE
- or ◻ CORE LOCATION (PILE, CAP, DECK) LEVEL 3 INSPECTION
- 11' MINIMUM PILE DIAMETER, LEVEL 2 INSPECTION
- 25' SOUNDINGS (FT) BELOW MLW
- 50% 8 50 PERCENT OF PILE BEARING ON PILE CAP
- LIMIT OF DIVERS ACCESS

NOTES:

1. LEVEL 1 INSPECTION ON ALL PILES - HIGHER LEVELS OF INSPECTION WHERE NOTED.
2. TYPICAL CROSS SECTION FOUND ON FIGURE 73.

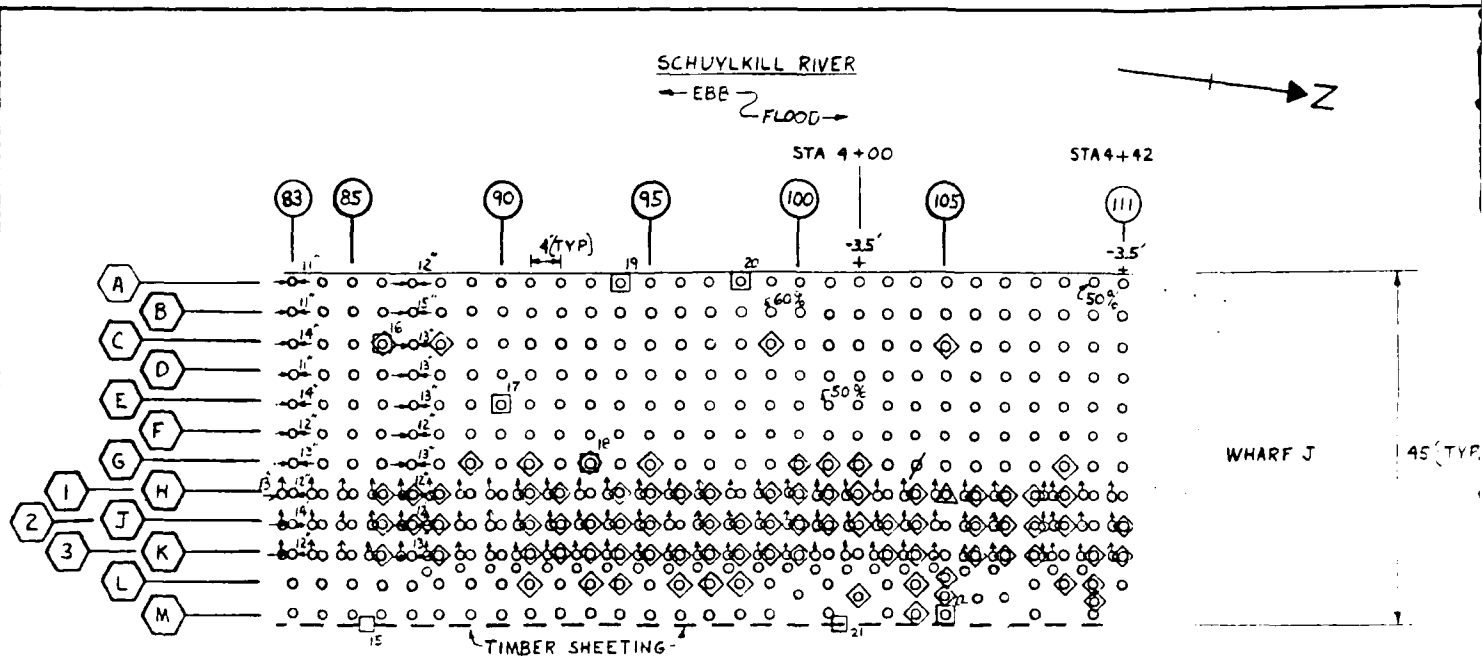
REFERENCE DRAWINGS:
C-11033 C-9774 C-10420
C-10422 C-11128 C-13537



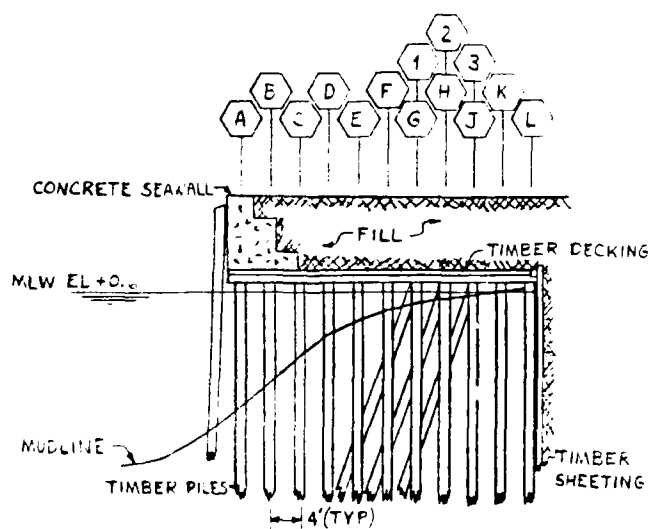
CHILDS ENGINEERING
CORPORATION
801 333
MEDFORD, MA

CHESAPEAKE DIVISION
NAVAL FACILITIES ENGINEERING COMMAND
WASHINGTON, D.C.
PHILADELPHIA NAVAL SHIPYARD PHILADELPHIA, PA
WHARF K

FIG NO
67

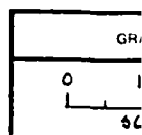


PLAN



TYPICAL CROSS SECTION

REFERENCE DRAWINGS:
 C-11033 C-9774 C-10420
 C-10422 C-11128 C-13537

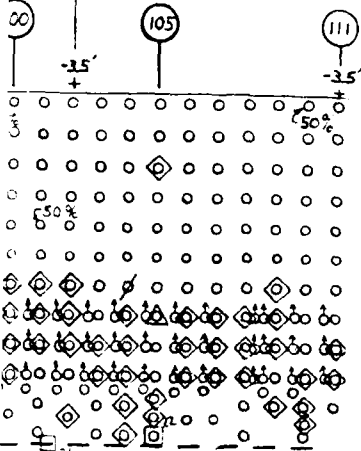


RIVER

100' →

STA 4+00

STA 4+42



WHARF J

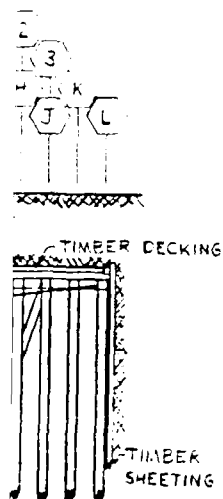
45' (TYP)

LEGEND

- △ WILD PILE
- ◇ NON-BEARING PILE
- ⚡ DISPLACED-SPLIT PILE
- OR ○ CORE LOCATION (PILE, CAP, DECK) LEVEL 3 INSPECTION
- 10" MINIMUM PILE DIAMETER, LEVEL 2 INSPECTION
- 25' SOUNDINGS (FT) BELOW MLW
- 50% 50 PERCENT OF PILE BEARING ON PILE CAP
- LIMIT OF DIVERS ACCESS

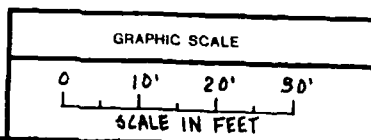
NOTES:

1. LEVEL 1 INSPECTION ON ALL PILES -
HIGHER LEVELS OF INSPECTION WHERE NOTED.



SECTION

REFERENCE DRAWINGS:
C-11033 C-9774 C-10420
C-10422 C-11128 C-13537



CHILDS ENGINEERING
CORPORATION
BOX 339
MILFORD MA

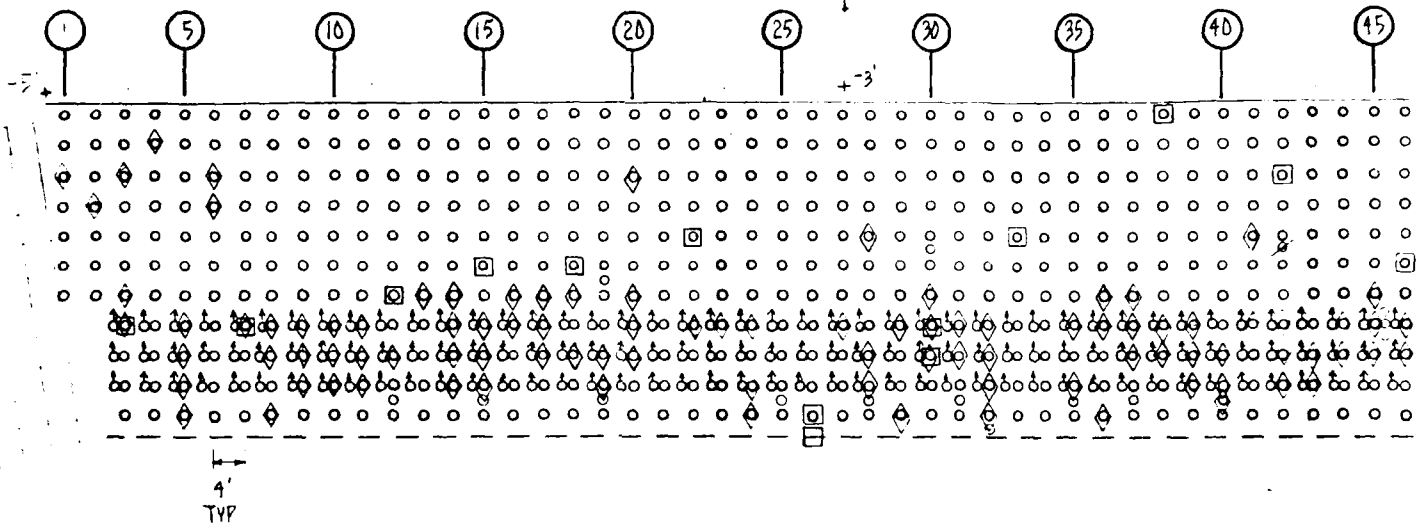
CHESAPEAKE DIVISION
NAVAL FACILITIES ENGINEERING COMMAND
WASHINGTON, D.C.

PHILADELPHIA NAVAL SHIPYARD PHILADELPHIA PA

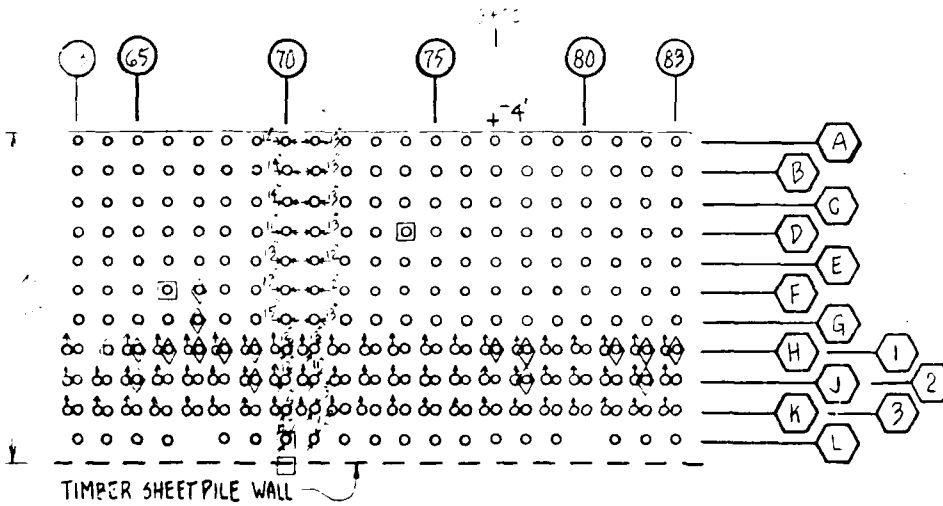
WHARF K

68

0+00 EBF - SCHU-KILL RIVER -> EBF



PLAN



PLAN

NOTES:

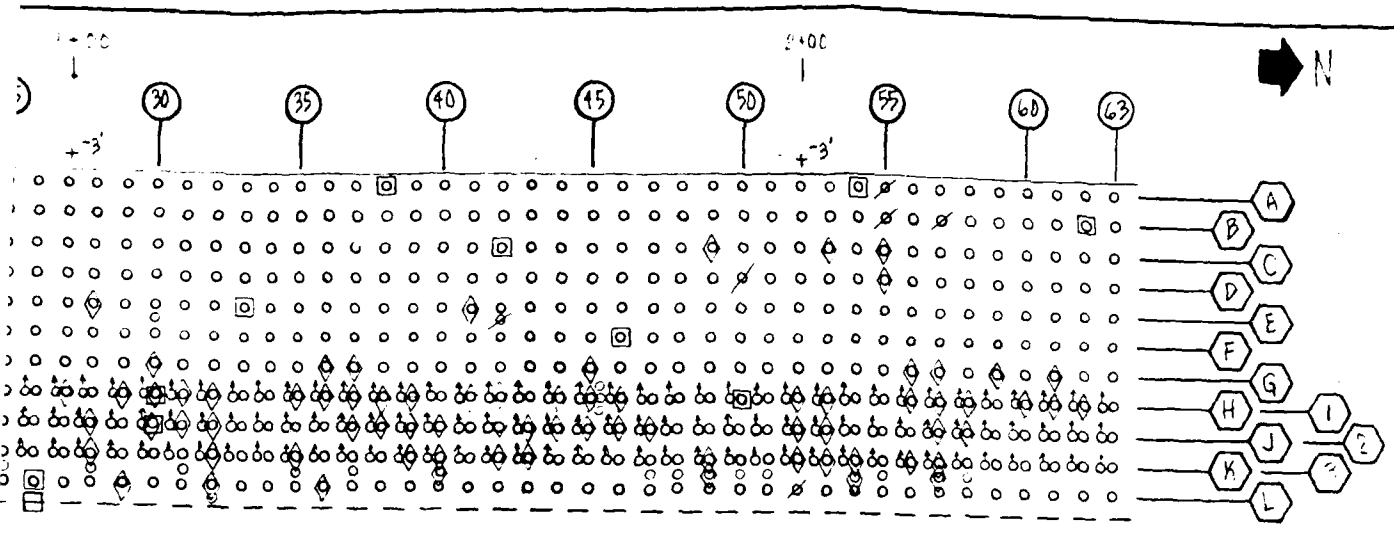
1. LEVEL 1 INSPECTION
2. CONC CURBING ALONG DURING THE INSPECTION
3. TYPICAL CROSS SECTION

REFERENCE:
DWG NOS

C-11023	C-9774
C-10420	C-10422
C-11128	C-13537

GRAPH

0 10'
SCALE



PLAN

LEGEND

- NON-BEARING PILE
- / DISPLACED-SPLIT PILE
- OR □ CORE LOCATION (PILE, CAP, DECK) LEVEL 3 INSPECTION
- MINIMUM PILE DIAMETER, LEVEL 2 INSPECTION
- 25' SOUNDINGS (FT) BELOW MLW

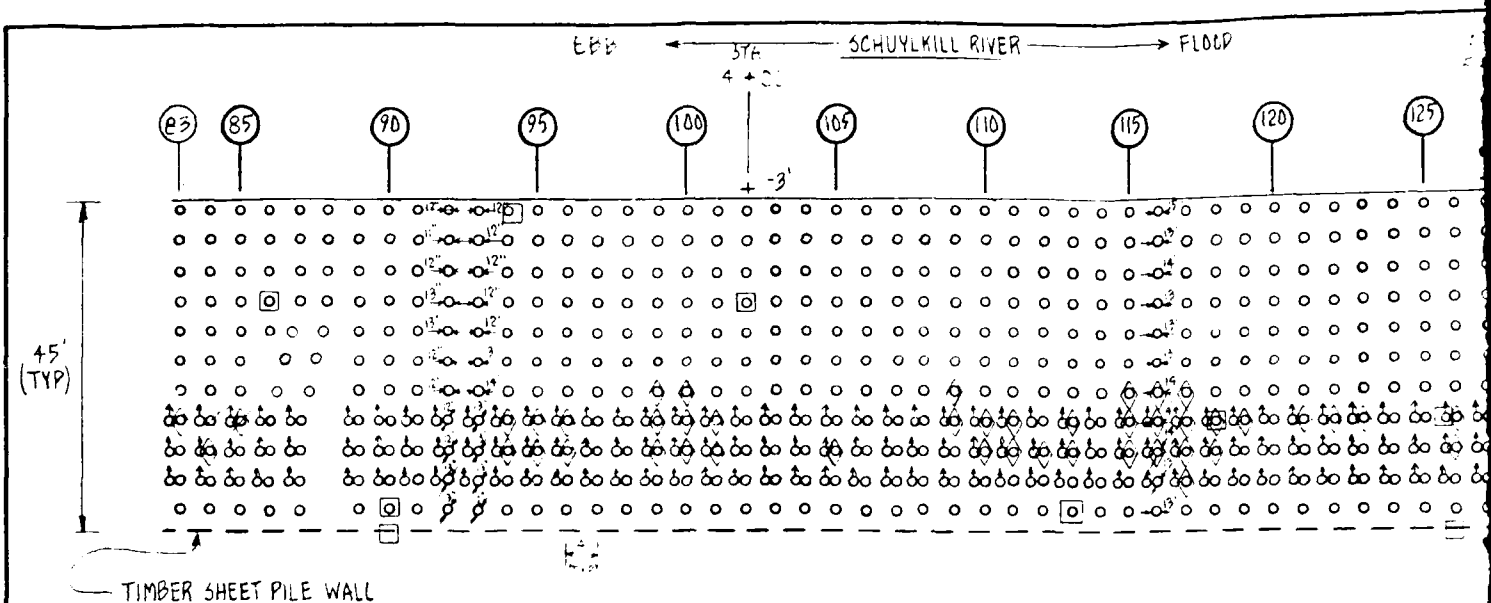
NOTES:

1. LEVEL 1 INSPECTION ON ALL PILES - HIGHER LEVELS OF INSPECTION WHERE NOTED
2. CONC. CURBING ALONG WHARF J IS DETERIORATED (REPAIRS WERE BEING INSTALLED DURING THE INSPECTION)
3. TYPICAL CROSS SECTION CAN BE FOUND ON FIGURE NO 77

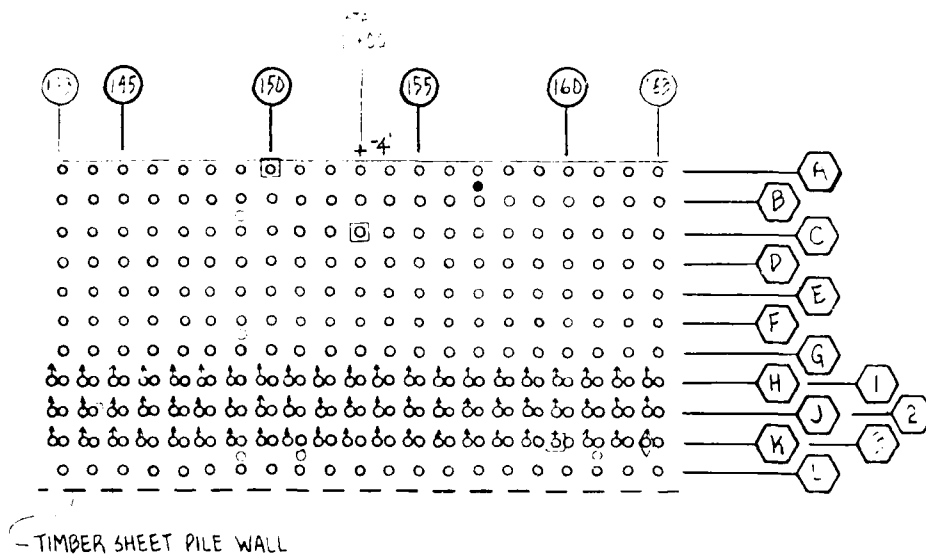
REFERENCE:
DWS NLS

- C-11033 C-9774
- C-10420 C-10422
- C-11126 C-13537

GRAPHIC SCALE 0 10' 20' 30' SCALE IN FEET	CHILDS ENGINEERING CORPORATION BOX 333 NEEDFIELD, MA	CHESAPEAKE DIVISION NAVAL FACILITIES ENGINEERING COMMAND WASHINGTON, D.C. PHILADELPHIA NAVAL SHIPYARD PHILADELPHIA, PA WHARF J
		FIG NO 69



PLAN



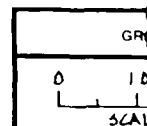
PLAN

NOTES:

1. LEVEL 1 INSPECTION ON ALL PILE
2. CONC CURBING ALONG WHARF
3. FENDER SYSTEM IN THE AREA
4. TYPICAL CROSS SECTION CAN BE

REFERENCE:

DWG NOS C-11033 C-9774 C-10422
C-10420 C-11128 C-13537



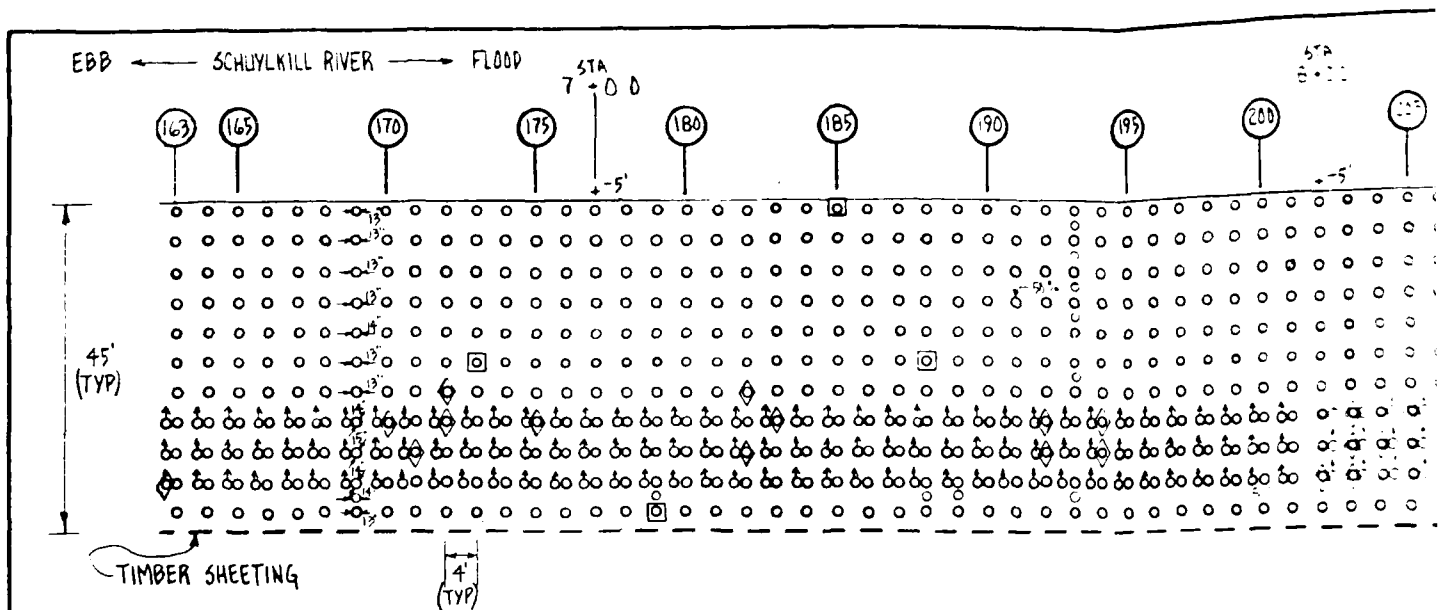


- ◊ NON-BEARING PILE
- BROKEN PILE
- / DISPLACED- SPLIT PILE
- ◻ CORE LOCATION (PILE, CAP, DECK) LEVEL 3 INSPECTION
- MINIMUM PILE DIAMETER, LEVEL 2 INSPECTION
- 25' SOUNDINGS (FT) BELOW MLW
- 50%—8 50 PERCENT OF PILE BEARING ON PILE CAP

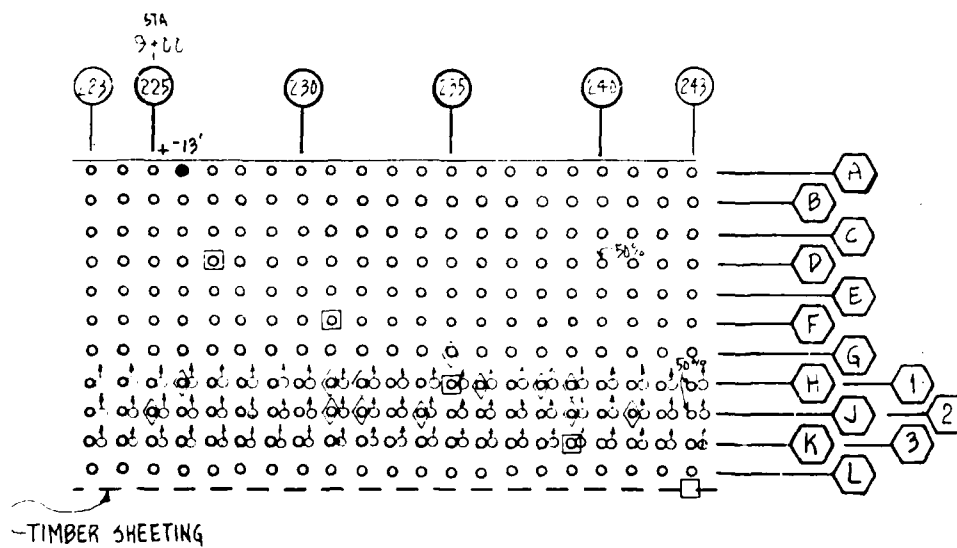
1. LEVEL 1 INSPECTION ON ALL PILES - HIGHER LEVELS OF INSPECTION WHERE NOTED
2. CONC CURBING ALONG WHARF J IS DETERIORATED
3. FENDER SYSTEM IN THE AREA OF STA 3+50 IS IN POOR CONDITION
4. TYPICAL CROSS SECTION CAN BE FOUND ON FIGURE NO 77

PWG NOS. C-11033 C-9774 C-10422
C-10420 C-11128 C-13537





PLAN



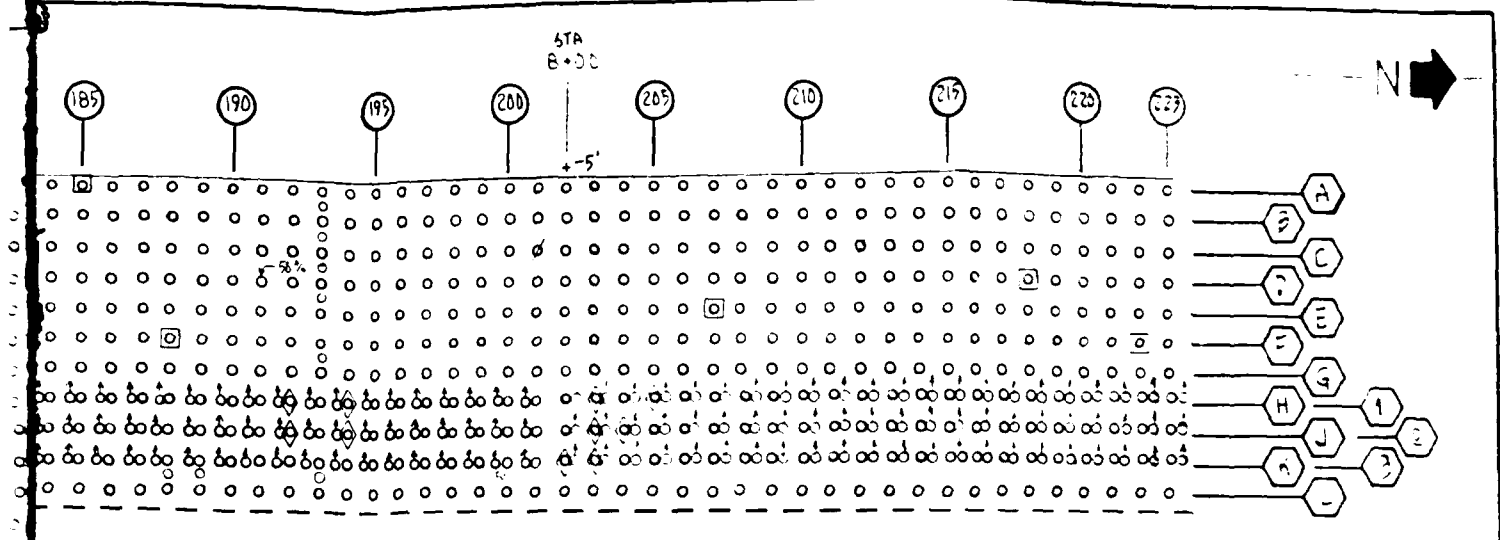
PLAN

NOTES

1. LEVEL 1 IN
2. LONG 200
3. TOTAL 100

REFERENCE

DWG NOS C-11033 C-9774
C-10420 C-10422
C-11128 C-13537



PLAN

LEGEND

- NON-BEARING PILE
- BROKEN PILE
- ⌵ DISPLACED- SPLIT PILE
- CORE LOCATION (PILE, CAP, DECK) LEVEL 3 INSPECTION
- ⌵ MINIMUM PILE DIAMETER, LEVEL 2 INSPECTION
- 25' SOUNDINGS (FT) BELOW MLW
- 50% 8 50 PERCENT OF PILE BEARING ON PILE CAP

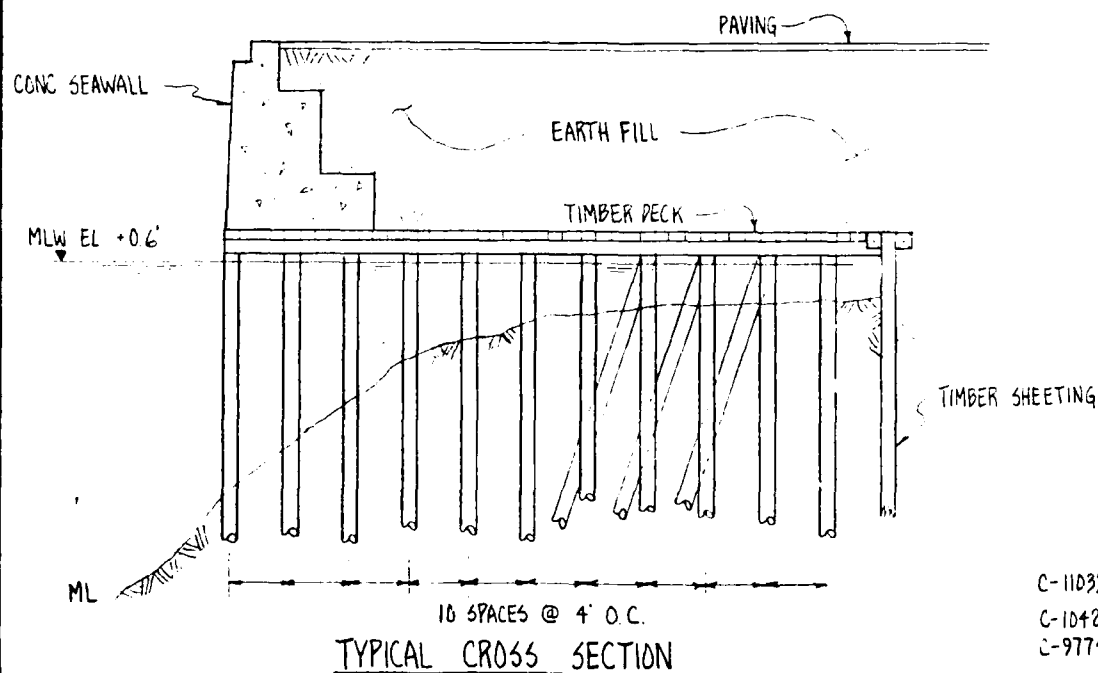
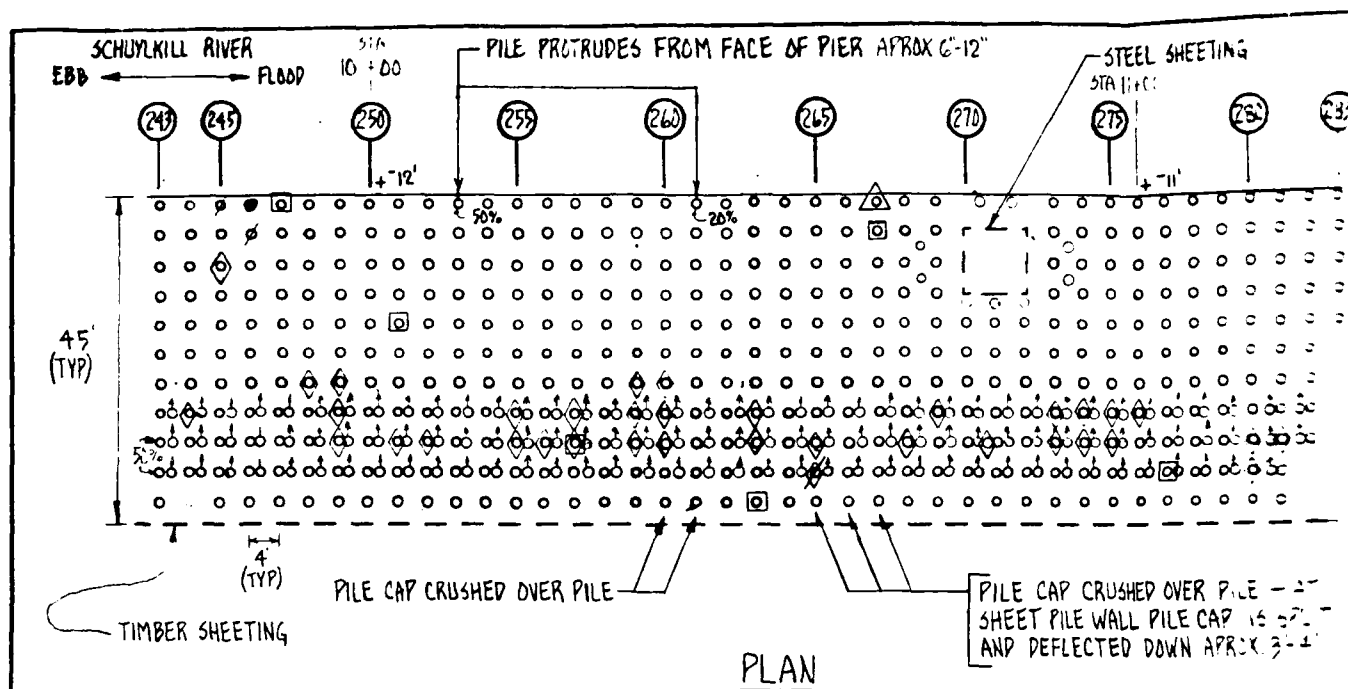
NOTES:

- 1 LEVEL 1 INSPECTION ON ALL PILES - HIGHER LEVELS OF INSPECTION WHERE NOTED
- 2 CONC CURBING ALONG PERIMETER OF WHARF J IS DETERIORATED
- 3 TYPICAL CROSS SECTION CAN BE FOUND ON FIGURE NO. 77

REFERENCE

Wg Nos C-11033 C-9774
C-10420 C-10422
C-11128 C-13537

GRAPHIC SCALE 0 10' 20' 30' SCALE IN FEET	CHILDS ENGINEERING CORPORATION BOX 333 WEDFIELD, MA	CHESAPEAKE DIVISION NAVAL FACILITIES ENGINEERING COMMAND WASHINGTON, D.C. PHILADELPHIA NAVAL SHIPYARD PHILADELPHIA, PA WHARF J 71
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NOTES

1. LEVEL +0.6'

REFERENCE

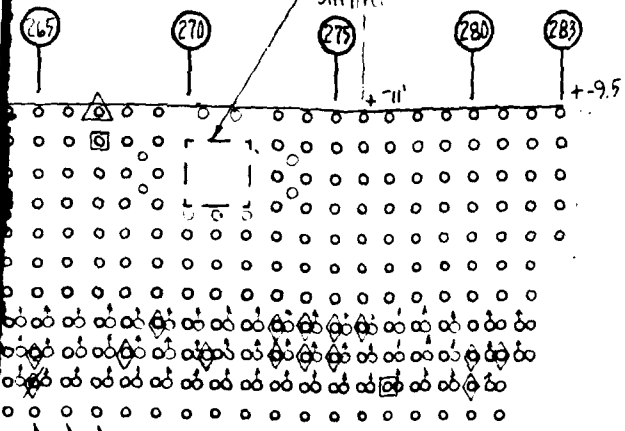
DWG. NOS.

C-11033	C-11128
C-10420	C-10422
C-9774	C-13537

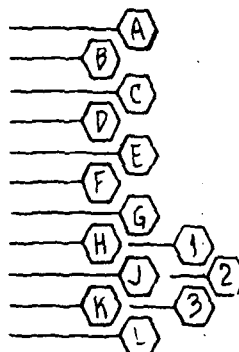
OF PIER APPROX 6'-12"

STEEL SHEETING

STA 11+00



WHARF I



PILE CAP CRUSHED OVER PILE - AT SHEET PILE WALL PILE CAP IS SPLIT AND DEFLECTED DOWN APPROX. 3'-4"

AN

LEGEND

- WILD PILE
- NON-BEARING PILE
- BROKEN PILE
- DISPLACED - SPLIT PILE
- CORE LOCATION (PILE, CAP, DECK) LEVEL 3 INSPECTION
- MINIMUM PILE DIAMETER, LEVEL 2 INSPECTION
- SOUNDINGS (FT) BELOW MLW
- 50 PERCENT OF PILE BEARING ON PILE CAP

NOTES:

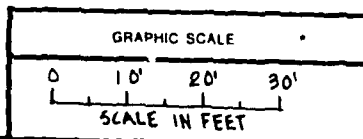
1. LEVEL 1 INSPECTION ON ALL PILES - HIGHER LEVELS WHERE NOTED

TIMBER SHEETING

REFERENCE

DWG. NOS.

C-11033 C-11128
C-10420 C-10422
C-9774 C-13537



CHILDS ENGINEERING
CORPORATION
BOX 323
MIDFIELD MA

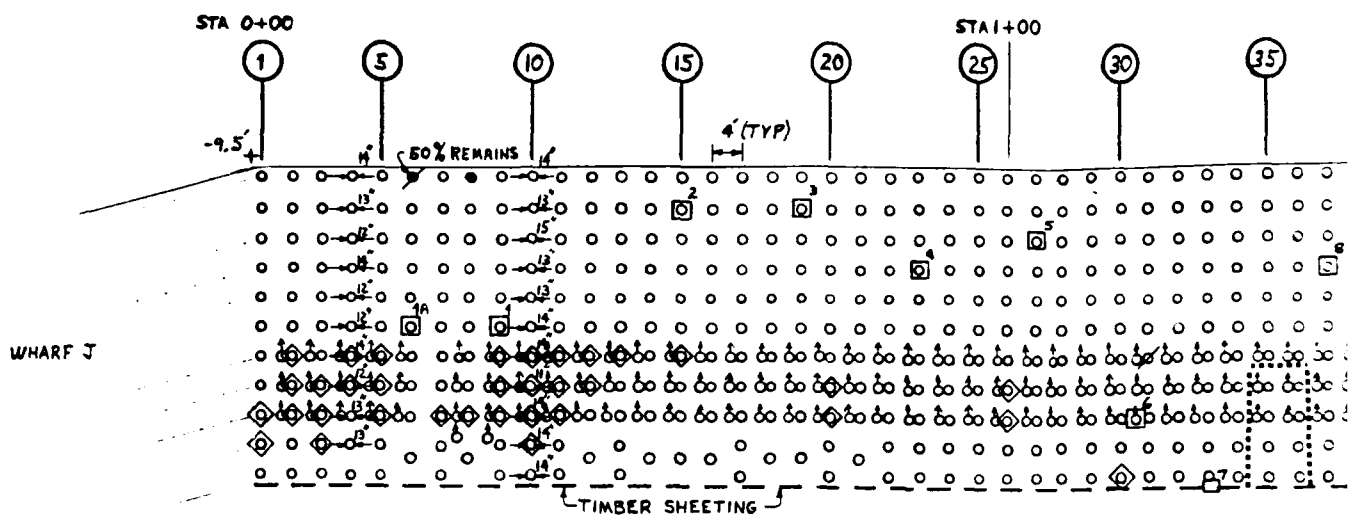
CHESAPEAKE DIVISION
NAVAL FACILITIES ENGINEERING COMMAND
WASHINGTON D.C.

PHILADELPHIA NAVAL SHIPYARD PHILADELPHIA PA

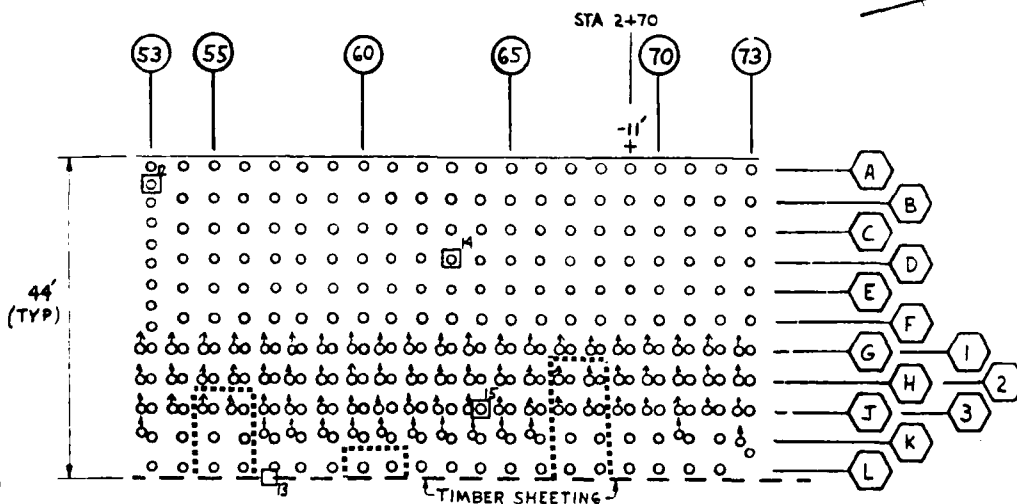
WHARF J

FIG NO

72



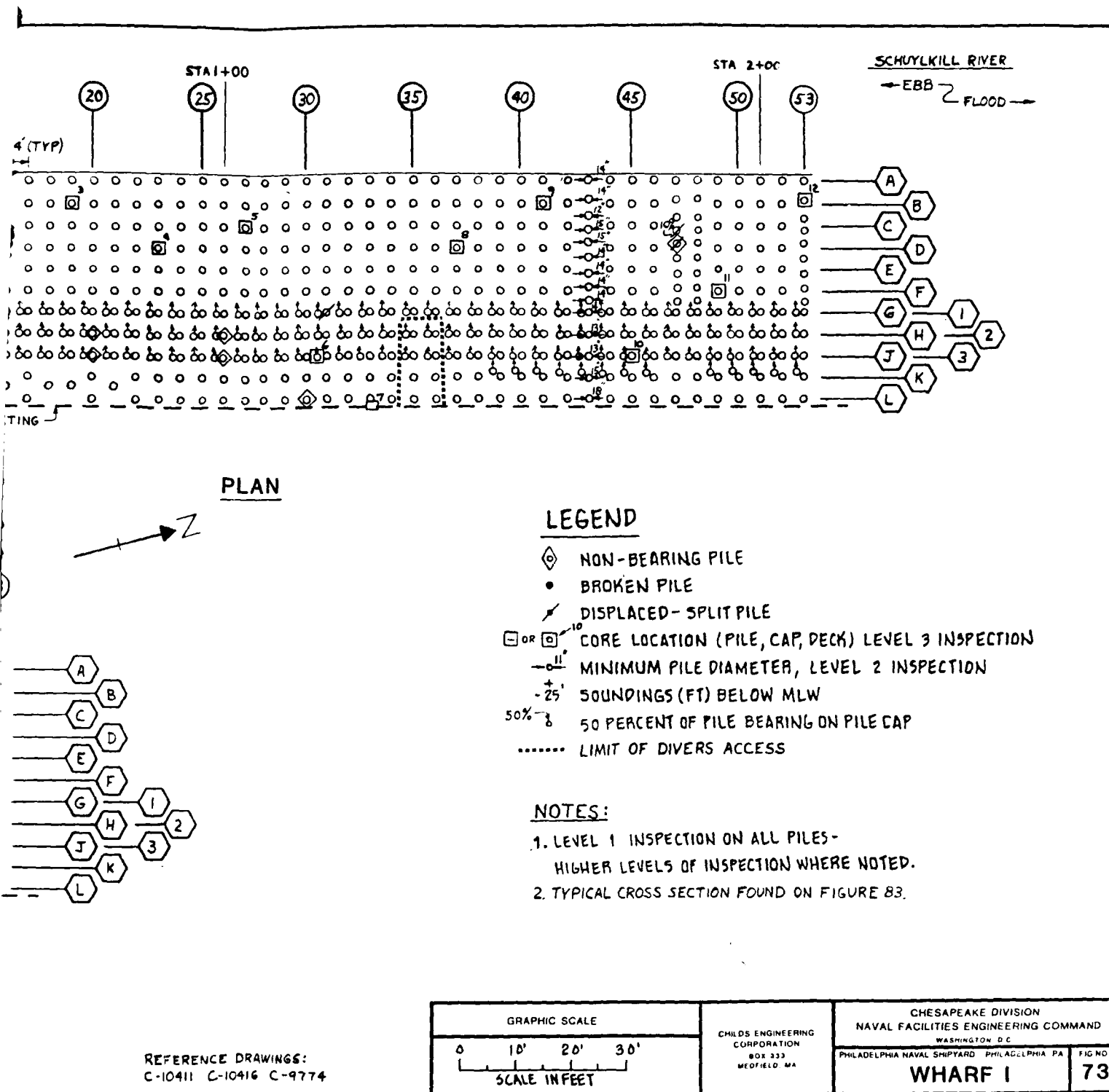
PLAN

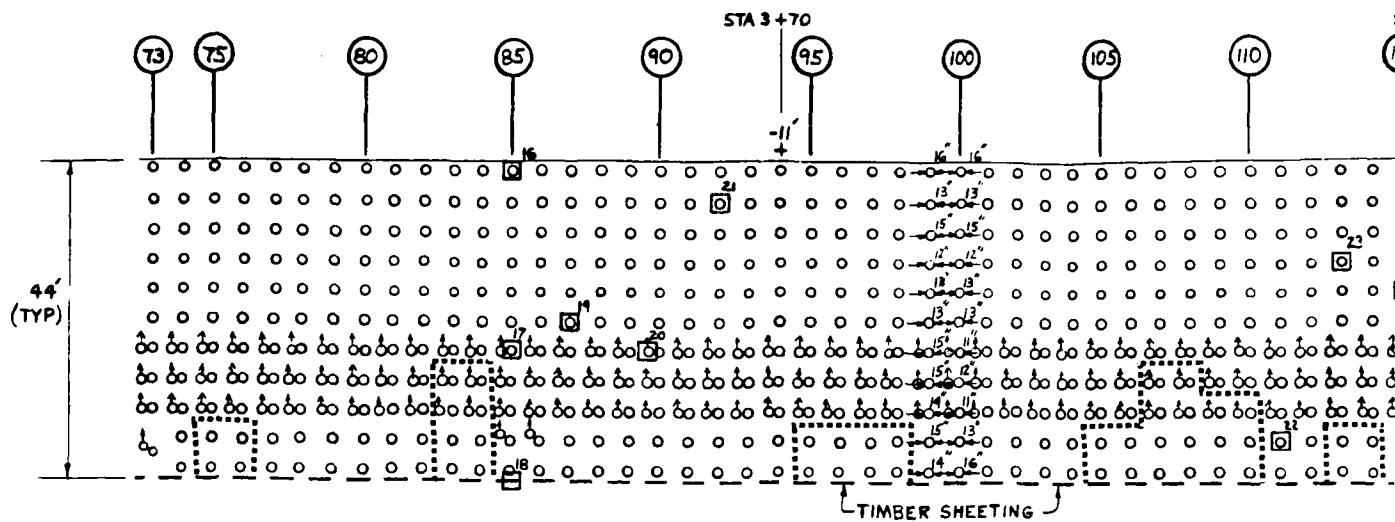


PLAN

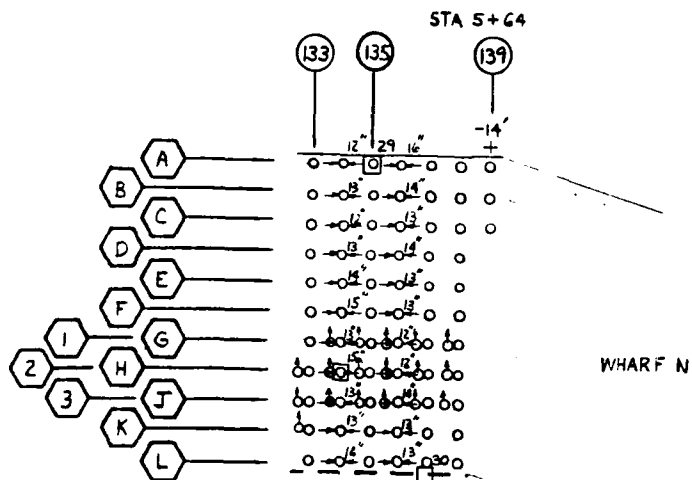
REFERENCE DRAWINGS:
C-10411 C-10416 C-9774

0
L



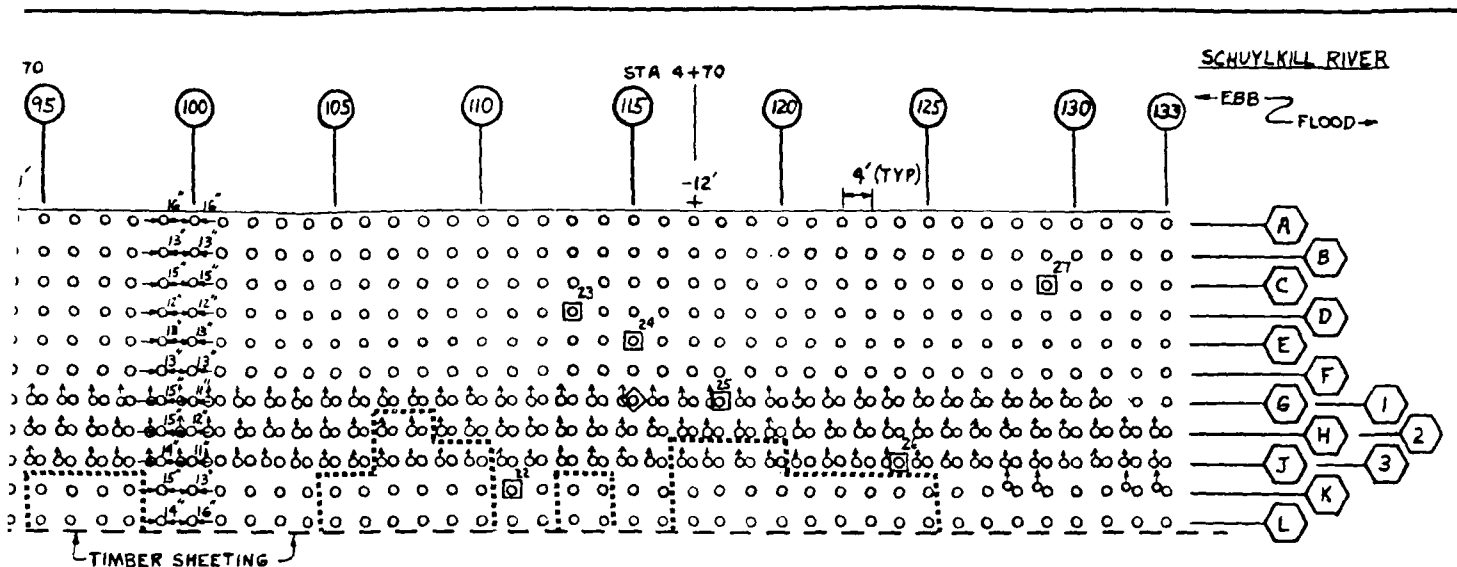


PLAN



PLAN

REFERENCE DRAWINGS:
C-10411 C-10416 C-9774



PLAN

LEGEND

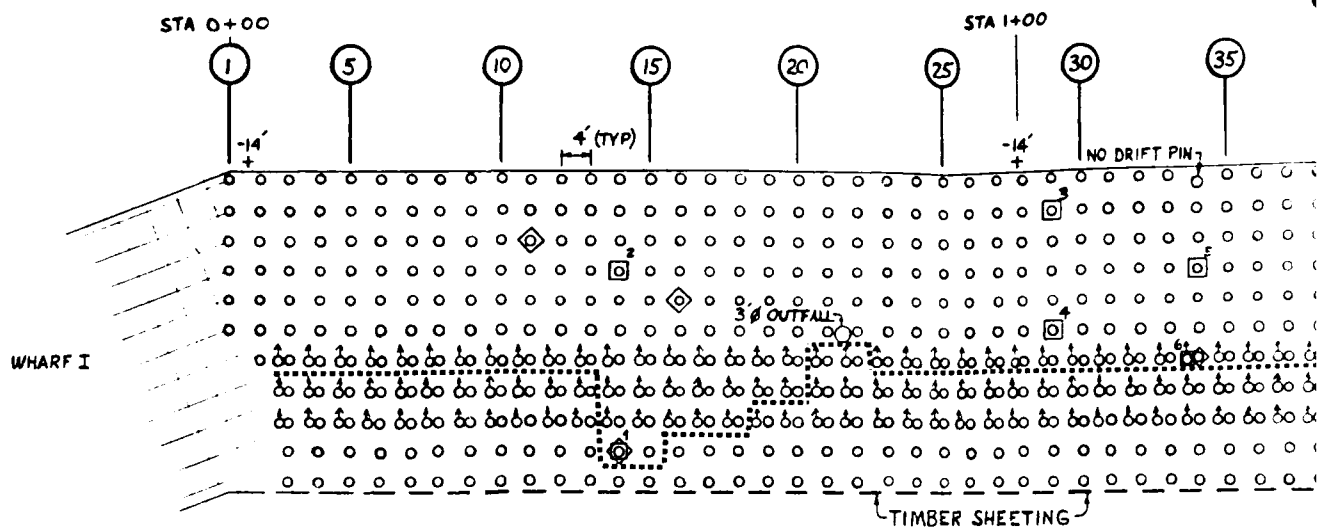
- NON-BEARING PILE
- CORE LOCATION (PILE, CAP, DECK) LEVEL 3 INSPECTION
- MINIMUM PILE DIAMETER, LEVEL 2 INSPECTION
- SOUNDINGS (FT) BELOW MLW
- LIMIT OF DIVERS ACCESS

NOTES:

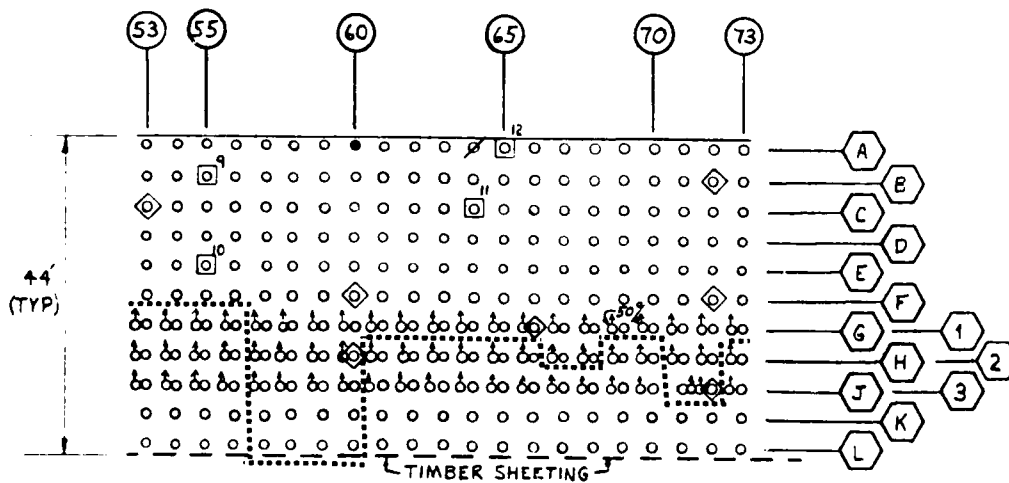
1. LEVEL 1 INSPECTION ON ALL PILES -
HIGHER LEVELS OF INSPECTION WHERE NOTED.
2. FENDER SYSTEM MISSING OR DAMAGED IN
THIS AREA BETWEEN BENTS 75 TO 139.
3. TYPICAL CROSS SECTION FOUND ON FIGURE 83.

REFERENCE DRAWINGS:
C-10411 C-10416 C-9774

GRAPHIC SCALE 0 10' 20' 30' SCALE IN FEET		CHILDS ENGINEERING CORPORATION BOX 333 MEDFIELD, MA	CHESAPEAKE DIVISION NAVAL FACILITIES ENGINEERING COMMAND WASHINGTON, D.C. PHILADELPHIA NAVAL SHIPYARD PHILADELPHIA, PA WHARF I	
			FIG NO 74	



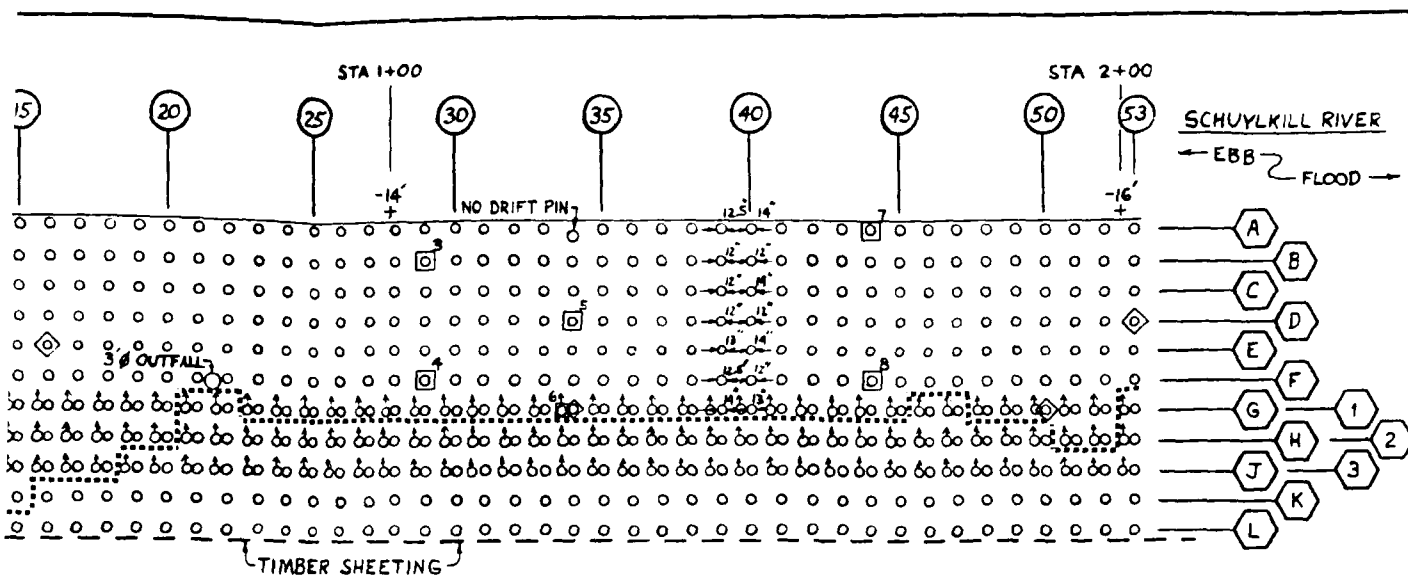
PLAN



PLAN

REFERENCE DRAWINGS:
 B-3296 B-3551 C-9774 C-10411 C-10414 C-11033
 C-13537 NAVFAC DWG. 1240403

GRA
0 1
50'



PLAN

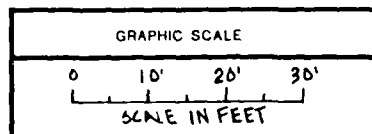
LEGEND

- ◇ NON-BEARING PILE
- BROKEN PILE
- / DISPLACED- SPLIT PILE
- CORE LOCATION (PILE, CAP, DECK) LEVEL 3 INSPECTION
- 10" — MINIMUM PILE DIAMETER, LEVEL 2 INSPECTION
- 25' - SOUNDINGS (FT) BELOW MLW
- 50% 50 PERCENT OF PILE BEARING ON PILE CAP
- LIMIT OF DIVERS ACCESS

NOTES:

1. LEVEL 1 INSPECTION ON ALL PILES -
HIGHER LEVELS OF INSPECTION WHERE NOTED.
2. TYPICAL CROSS SECTION FOUND ON FIGURE 83.

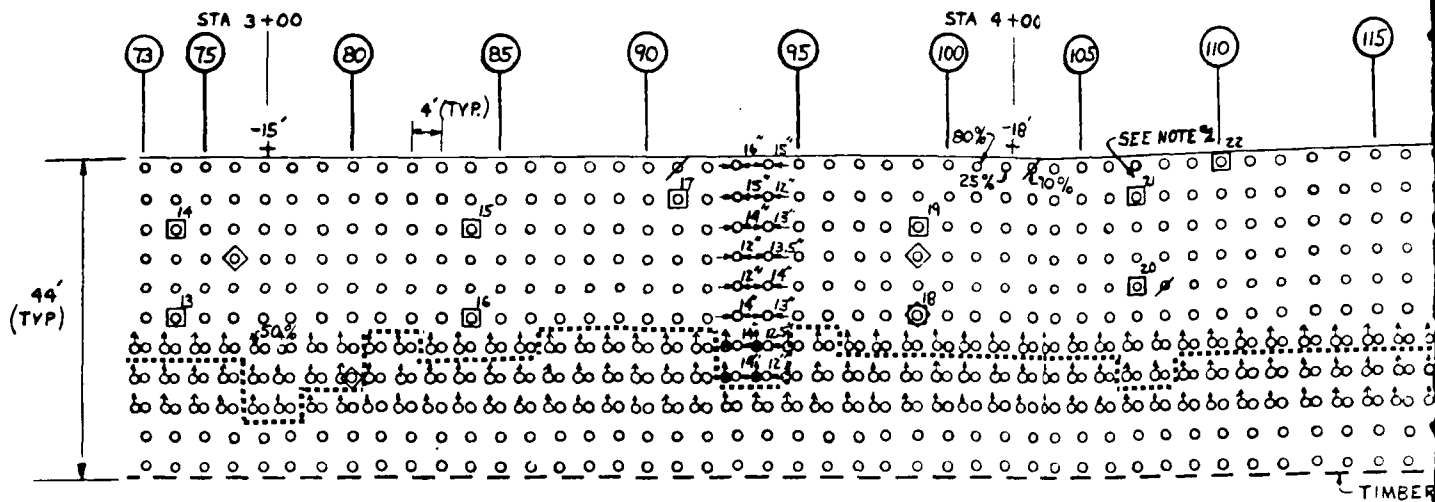
REFERENCE DRAWINGS:
3296 B-3551 C-9774 C-10411 C-10414 C-11033
3537 NAVFAC DWG 1240403



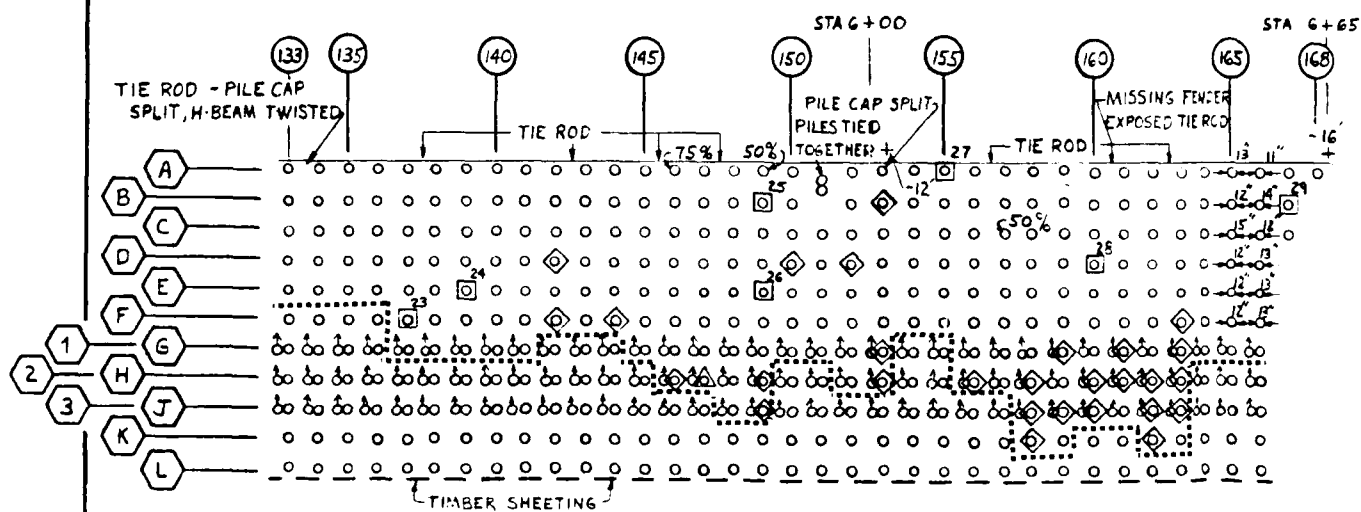
CHILDS ENGINEERING
CORPORATION
BOX 333
MEDFIELD, MA

CHESAPEAKE DIVISION
NAVAL FACILITIES ENGINEERING COMMAND
WASHINGTON, D.C.
PHILADELPHIA NAVAL SHIPYARD PHILADELPHIA, PA
WHARF H

FIG NO
75



PLAN

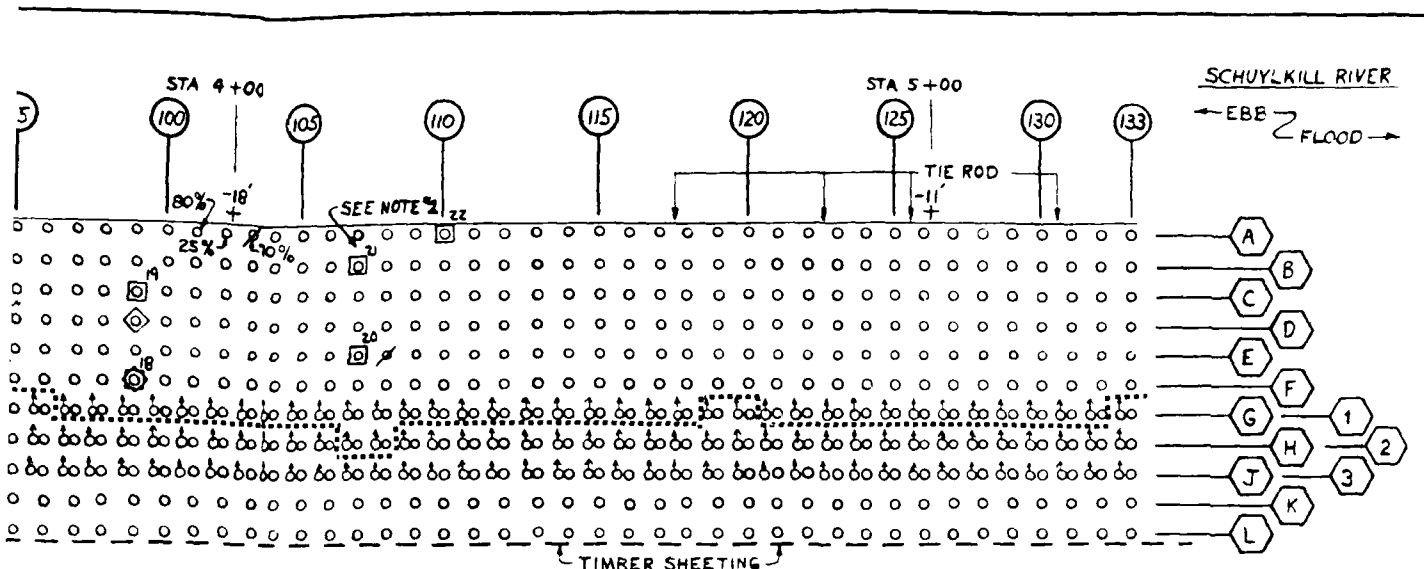


PLAN

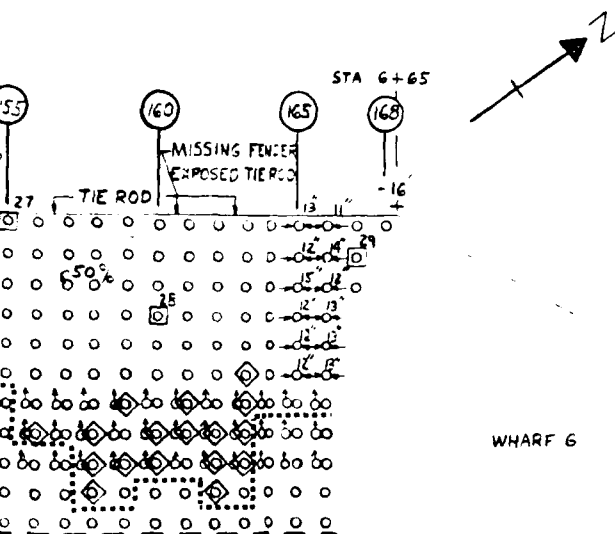
REFERENCE DRAWINGS:
B-3296 B-3551 C-9774 C-10411 C-10414 C-11033
C-13537 NAVFAC DWG. 1240403

GRAPH

0 10'
50'



PLAN



WHARF 6

LEGEND

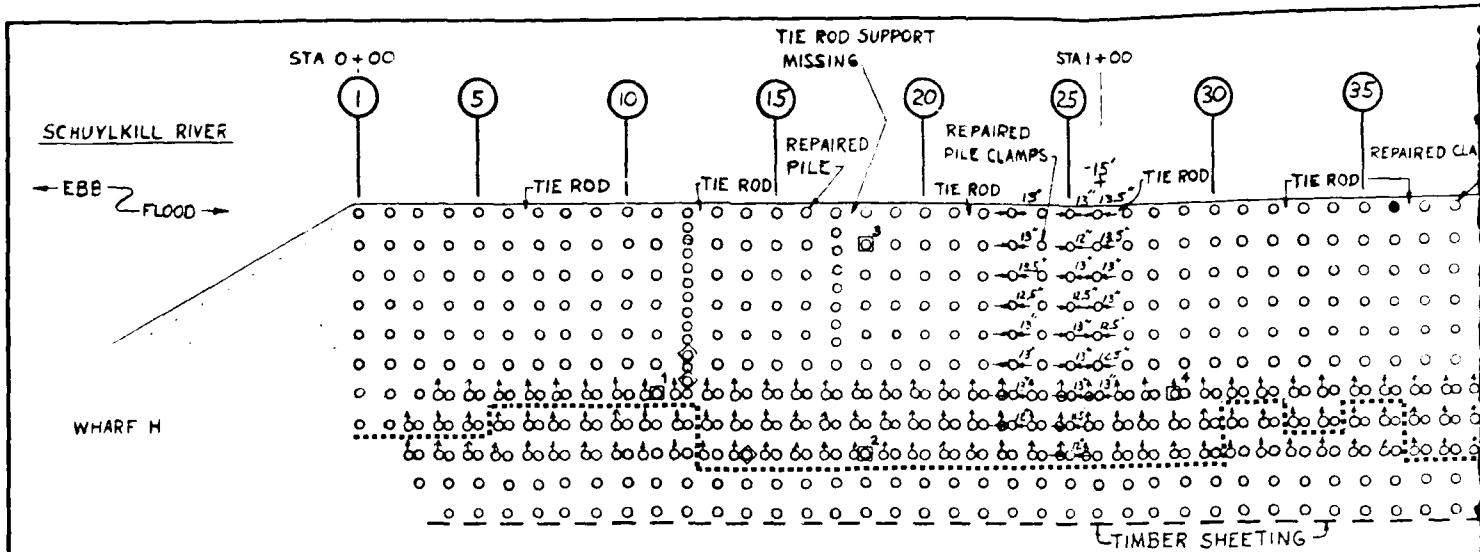
- △ WILD PILE
- ◇ NON-BEARING PILE
- ⚡ DISPLACED- SPLIT PILE
- CORE LOCATION (PILE, CAP, DECK) LEVEL 3 INSPECTION
- ⊖ MINIMUM PILE DIAMETER, LEVEL 2 INSPECTION
- 25' SOUNDINGS (FT) BELOW MLW
- 50% 50 PERCENT OF PILE BEARING ON PILE CAP
- LIMIT OF DIVERS ACCESS

NOTES:

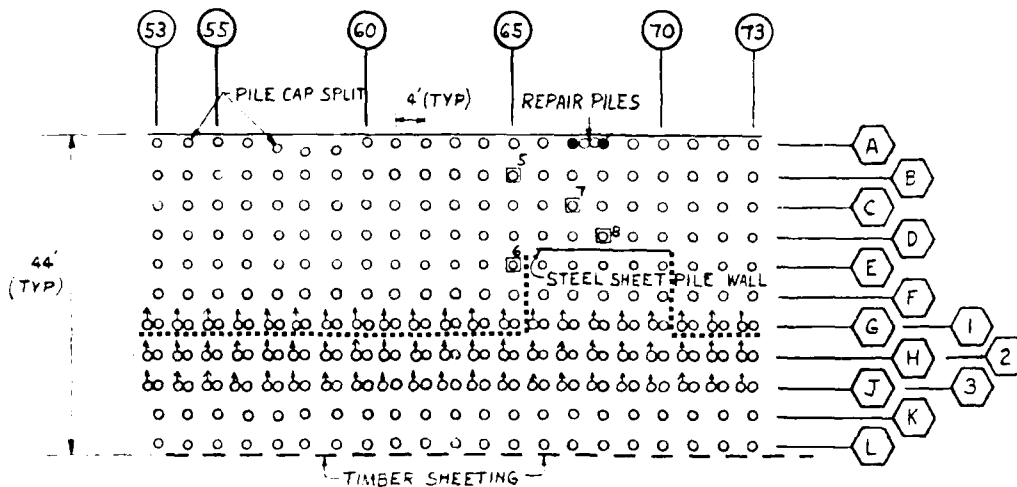
1. LEVEL 1 INSPECTION ON ALL PILES-
HIGHER LEVELS OF INSPECTION WHERE NOTED.
2. BENT 107 FILE 1 REPAIRED WITH WIRE ROPE TYING
PILE AND PILE CAP TOGETHER.
3. TYPICAL CROSS SECTION FOUND ON FIGURE 83.

REFERENCE DRAWINGS:
3296 B-3551 C-9774 C-10411 C-10414 C-11033
13537 NAVFAC DWG. 1240403

GRAPHIC SCALE 0 10' 20' 30' SCALE IN FEET	CHILDS ENGINEERING CORPORATION BOX 933 MEDFORD MA	CHESAPEAKE DIVISION NAVAL FACILITIES ENGINEERING COMMAND WASHINGTON D.C. PHILADELPHIA NAVAL SHIPYARD PHILADELPHIA PA WHARF H 76
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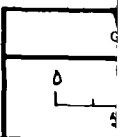


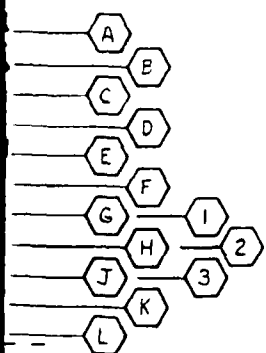
PLAN



PLAN

REFERENCE DRAWINGS:
 B-3296 B-3551 C-9774 C-10411 C-10414 C-11033
 C-13537 NAVFAC DWG 1240403



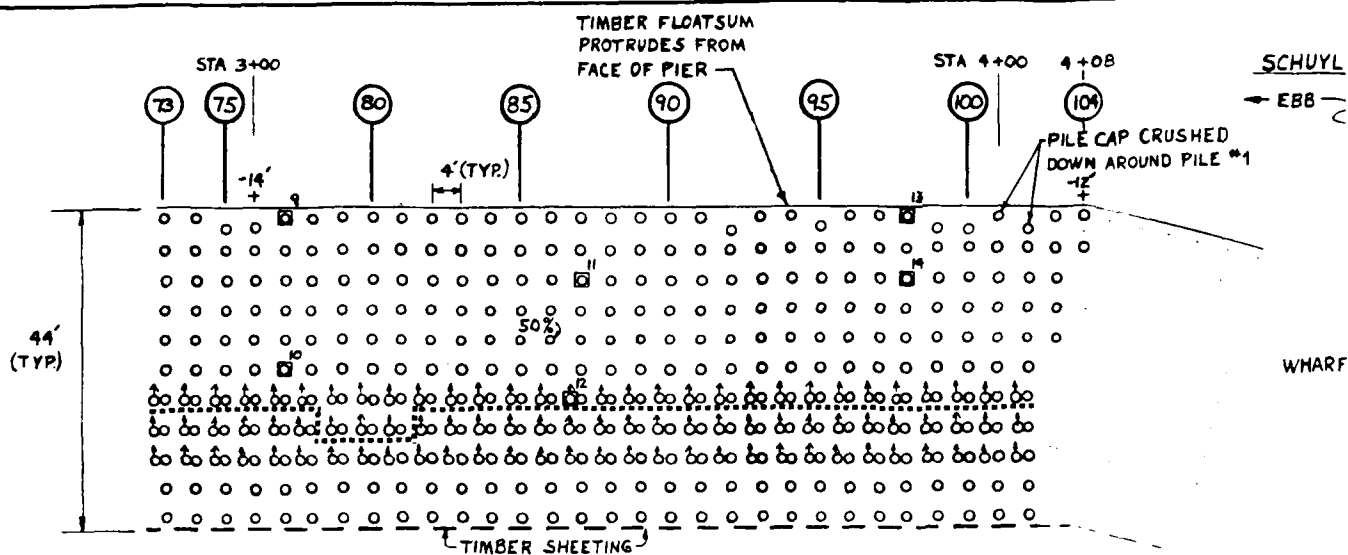


- ◊ NON-BEARING PILE
- BROKEN PILE
- ↘ DISPLACED - SPLIT PILE
- ☐ CORE LOCATION (PILE, CAP, DECK) LEVEL 3 INSPECTION
- C- MINIMUM PILE DIAMETER, LEVEL 2 INSPECTION
- 25' SOUNDINGS (FT) BELOW MLW
- LIMIT OF DIVERS ACCESS

1. LEVEL 1 INSPECTION ON ALL PILES-
HIGHER LEVELS OF INSPECTION WHERE NOTED.

2. TYPICAL CROSS SECTION FOUND ON FIGURE 83

77



PLAN
NOT TO SCALE



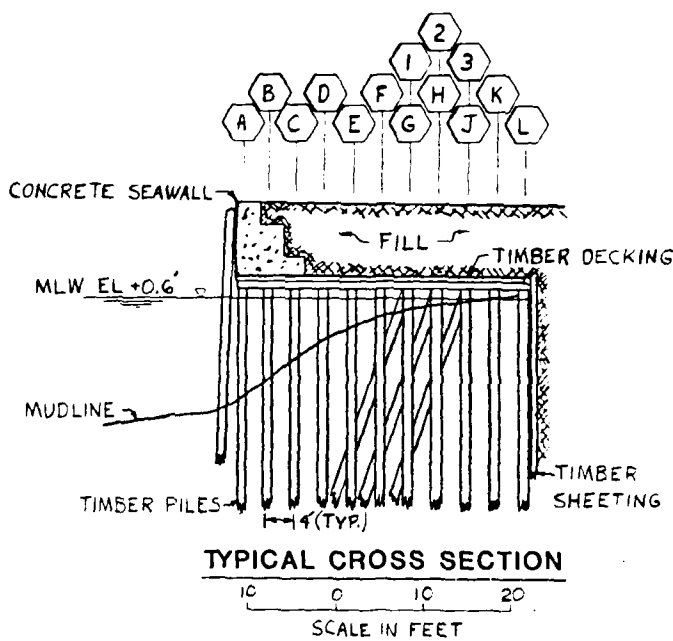
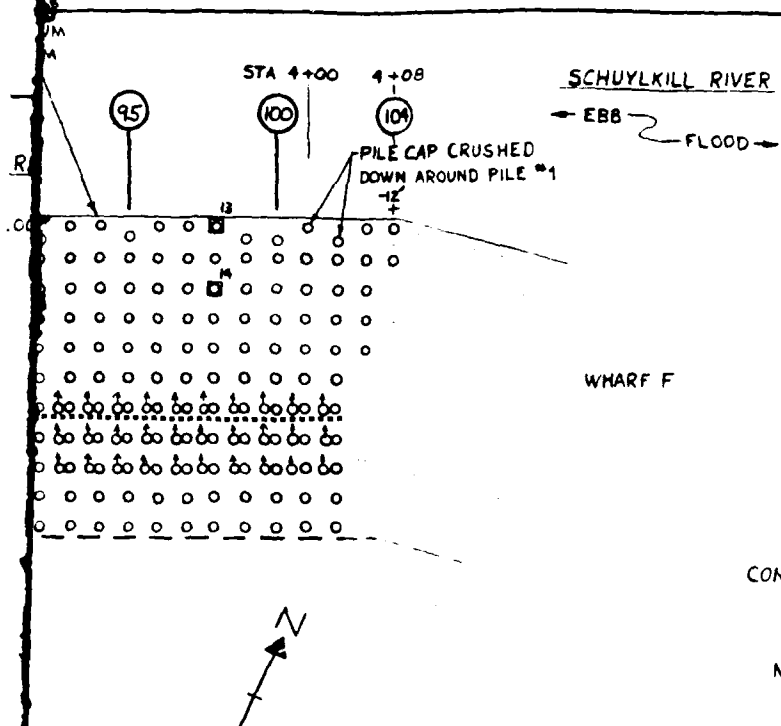
LEGEND

- ☐ CORE LOCATION (PILE, CAP, DECK) LEVEL 3 INSPECTION
- MINIMUM PILE DIAMETER, LEVEL 2 INSPECTION
- +25' SOUNDINGS (FT) BELOW MLW
- 50% 50 PERCENT OF PILE BEARING ON PILE CAP
- LIMIT OF DIVERS ACCESS

NOTES:

1. LEVEL 1 INSPECTION ON ALL PILES -
HIGHER LEVELS OF INSPECTION WHERE NOTED.

REFERENCE DRAWINGS:
B-3296 B-3551 C-9774 C-10411 C-10414 C-11033
C-12537 NAVFAC DWG. 1240403



INSPECTION
TION

REFERENCE DRAWINGS:
B-3296 B-3551 C-9774 C-10411 C-10414 C-11033
C-13537 NAVFAC DWG. 1240403

GRAPHIC SCALE 0 10' 20' 30' SCALE IN FEET	CHILDS ENGINEERING CORPORATION BOX 333 MEDFIELD, MA	CHESAPEAKE DIVISION NAVAL FACILITIES ENGINEERING COMMAND WASHINGTON, D.C. PHILADELPHIA NAVAL SHIPYARD PHILADELPHIA, PA WHARF G FIG. NO. 78
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4.12.2 OBSERVED INSPECTION CONDITION

Specific anomalies noted concerning the structural piles are listed as follows:

Wharf	K	J	I	H	G	Totals
Broken Piles	0	3	2	1	1	7
Split Piles	15	11	1	3	3	33
Non-Bearing Piles	170	262	36	44	3	515
Partially-Bearing piles	6	9	1	8	1	25
Wild Piles	1	1	0	1	0	3
Approx. Total No. of Piles	1665	4245	2085	2505	1560	

Throughout Wharves K, J, I, H and G, core samples of the timber piles, deck caps and timber sheet piles indicate that timber softness (see Section 4.0) ranges from 0" to 1/2" in depth.

The pile diameters which were measured, generally range from a minimum of 10" to a maximum of 16". There is no observed deterioration or reduction of the piles' cross-sectional area subsequent to being driven.

The fasteners which were visible appeared to have a thin layer of corrosion on the metal surface with little or no pitting observed. Estimated loss of steel due to corrosion is less than 20%.

The fender system is generally in poor condition along the majority of the wharves. Fungal attack on the timber and localized failure due to berthing forces are found throughout each wharf, with the exception of Wharf G which has been reconditioned.

The seawall along the wharves is functional and generally in good condition. There is minor spalling along the expansion joints (see Photo #43). The concrete curbing at the top of the seawall is deteriorating around the scuppers. Portions of the curbing along Wharf J were under repair during the inspection. At the time of inspection, it is estimated that approximately 5% of the total length of the curbing is in need of repair. The lower elevations of the seawall are showing some loss of the fine aggregate in the concrete as described in Section 4.0, Vol. I, Page 15, a condition which does not effect the overall strength of the concrete.

Along the full length of Wharves K, J, I, H, and G, the seawall has irregular bulges and separation of the expansion joints. This irregular bowing is particularly evident along Wharves K and J where the seawall is as much as 6" out of alignment.

As shown on Figures 67, 68, 69 and 76, there is a large number of non-bearing piles generally associated with the adjacent batter piles (see Photo #44). The highest concentration of the non-bearing piles occurs at the junction of Wharves K and J and along the north end of Wharf H.

The elevation of the mudline along the sheet pile wall ranged from -6' at Bent 15, Wharf K to -1' in areas which were inaccessible to the divers (Wharves G & H). Generally the mudline along the sheet pile wall was at El.-3 and had no severe variance in that elevation. Typically, at Pile C the mudline drops off at a sharper angle, then levels off outshore of the wharf.

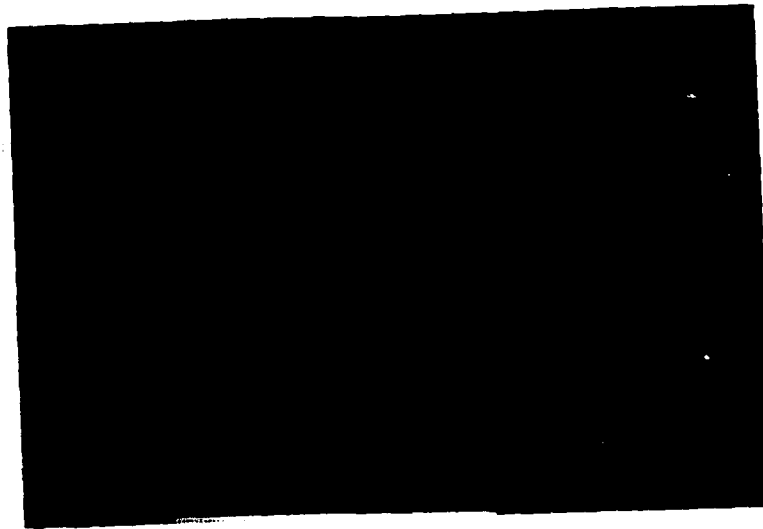
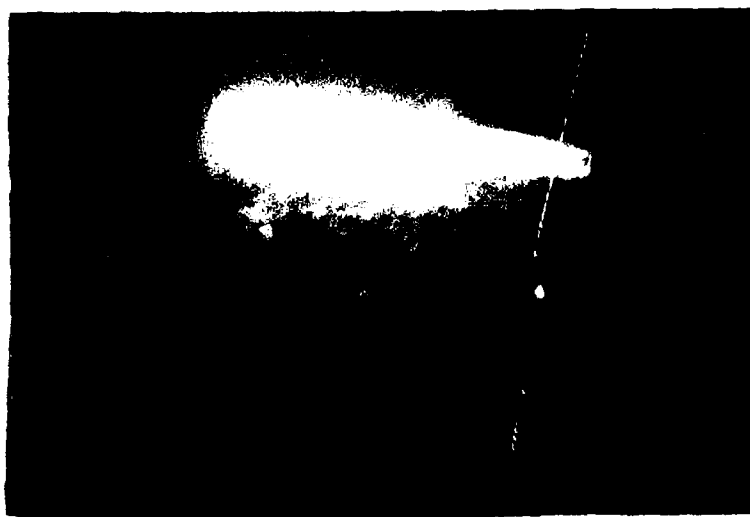


PHOTO NO. 43: Wharf H, Sta. 0+21; illustrates a 2" gap in the seawall construction joint. Note sand and cement eroded from concrete exposing aggregate.

PHOTO NO. 44: Wharf K, Bent 18, Pile M; non-bearing pile.



Pile cap failure has occurred in two locations. In the area of Station 0+75 on Wharf K, Bent 18 at Pile M (see Figure 67), the pile cap has failed in horizontal shear and vertical shear over the pile, (see Photo #45). It is also deflected down approximately 6"-8" from its original position. A similar situation has occurred on Wharf J at approximately Station 10+65, Pile L (see Figure 72). The pile cap has failed over the last pile in the bent. In each location approximately 4 to 6 bents are effected in varying degrees of severity.

At the north end of Wharf H and southwest end of Wharf G a tie-back system has been installed (see Figure 76). This system consists of a steel WF section spanning two pile caps, bearing on the ends of the pile caps. A steel rod is attached to the center of the WF section and runs parallel to the pile cap in the inshore direction. Presumably the tie-rod is anchored to a deadman behind the timber sheet pile wall. The condition of the tie-back system is consistent with its age. There were no visible signs of deterioration, however, there is some mechanical damage at Station 5+30 on Wharf H, where the WF section is deformed. Also on Wharf G, Station 0+70, there is a WF section missing. Apparently this damage was caused by excessive berthing force.

Wharf G has large quantities of flotsam entrapped below the relieving platform. This debris curtailed the divers' access to the sheet pile wall.

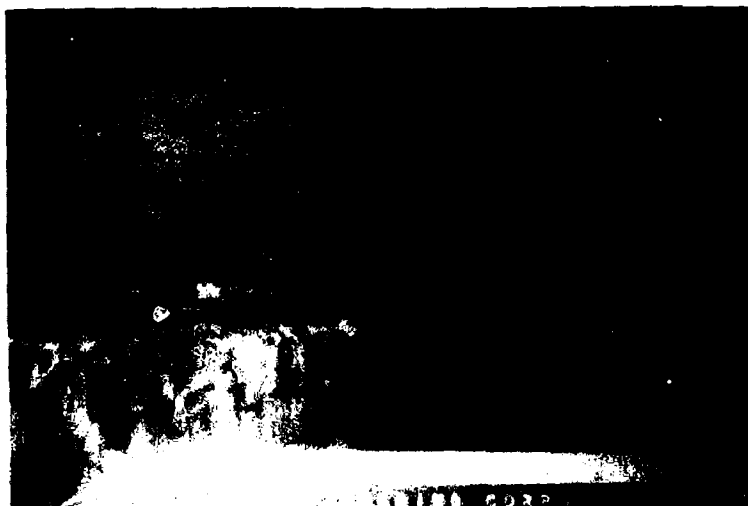


PHOTO NO. 45: Wharf K, Bent 18, Pile M;
illustrates failure of pile
cap due to overloading.

4.12.3 STRUCTURAL ASSESSMENT

Damage which occurs at the perimeter of the wharf can be attributed to excessive berthing forces transmitted by camels. These forces are allowed to effect the structural piles only when the fender system has failed or is non-existent.

Based on a maximum area of 16 sq. ft. supported by one pile, calculations indicate that there has been no change in the live-load capacity of these wharves (see Appendix A-1 to A-8). Minimum pile diameters and the condition of the timber are both at acceptable levels.

Alignment of the seawall and the location of high quantities of non-bearing piles are proportional to each other. Wherever there is a large concentration of non-bearing piles, the seawall is out of alignment. This condition arises from the translation of the relieving platform in the outshore direction. Accompanying the translation is the rotation of the batter piles and consequently the lifting of the relieving platform off the adjacent vertical piles. This condition is caused by excessive lateral earth pressure possibly originating from a live-load acting on the sheet pile wall. The equalizing reaction of the batter pile to lateral force is a vertical force in the upward direction. This condition can easily overstress the batter pile fastenings and create combined stresses in the vertical piles. If the translation is allowed to continue, eventually the overstressing will exceed the ultimate capacity of the timber and fasteners. As a result, failure of the structure will occur.

Lateral earth pressure originating from the soil retained by the vertical piles is an additional force which adds to the combined stress in the vertical pile. The lateral force generally is greatest where the mudline drops off at the face of the pier, at pile row B or C. The greater the slope of this drop-off, the greater the lateral pressures will be on the vertical pile. When dredging occurs the natural slump of the soil will not be achieved immediately due to the resistance offered by the vertical piles. At the present time lateral pressure due to the soil resting on the vertical piles does not contribute significantly to the forces acting on the vertical piles, however, in the future, if excessive dredging occurs along the face of the pier and the soils' natural slump is not allowed to occur, the lateral forces will be more significant.

The failure of the pile caps at Station 0+75 of Wharf K and Station 10+65 of Wharf J are similar in that they are both localized failures. The pile cap and the wale fastened to the timber sheet pile have been displaced downward approximately 4'6". Splitting and crushing of the pile cap have also occurred. The displacement of the wale is a result of overloading its connection to the timber sheet pile wall. When the fasteners failed, this transferred the load to the pile cap causing it to deflect and therefore fail in horizontal shear and vertical shear. The condition of the timber of the effected members is sound, therefore it is assumed that before the failure there was no loss of strength in the structure. The cause of the failure is then attributed to a local overload on the top deck.

4.12.4 RECOMMENDATIONS

The seven (7) broken piles should be replaced. A new creosoted pile should be driven adjacent to the old pile and sprung in under the pile cap, then shimmed to assure proper bearing area (see Appendix A-15 to A-18). The estimated cost to replace one pile in this fashion is \$1,000. The total estimated cost is \$7,000.

Split piles should be clamped or posted where necessary to assure full bearing of the pile and cap (see Appendix A-16, A-17). The estimated cost of one repair is \$400. There are 33 piles which are split. The total estimated cost of repair is \$13,200. The 3 wild piles should be refastened to the pile cap in a similar manner. The estimated cost per repair is \$400. The total estimated cost is \$1,200.

The 515 non-bearing piles in this area should be shimmed to attain full bearing. The average cost to shim one pile is estimated to be \$50. The estimated total cost is \$25,750. The non-bearing piles in this facility have not been included in the typical pile top repair tabulation because the quantities of non-bearing piles cannot be considered typical or average.

The translation of some sections of the seawall is a serious problem. Along Wharf K (Stations 1+35 through 4+42), Wharf J (Stations 0+00 through 5+00 and Stations 10+15 through 11+30) and Wharf I (Stations 0+00 through 0+50) tie-back systems should be installed to upgrade the capacity of the area behind the wharves. The surcharges applied to the soil inshore of the relieving

platform have created the overload condition resulting in the non-bearing piles. Until the tie-back systems are installed, live-loading behind the relieving platform's sheet pile wall (from the face of the wharves inshore 70') should be restricted to 300 psf (see Appendix A-23). The tie-back system should be of the same construction to that installed on Wharves G and H. This system consists of a WF section bearing on the ends of two pile caps with a 3" diameter tie-rod bolted to the WF section and running parallel to the pile caps in the inshore direction (see Appendix A-22). Approximately 90' inshore there should be an anchoring system, preferably steel H-piles driven with opposing batter along the axis of tension. Depending upon soil conditions, a conventional concrete anchor system could be used in place of steel H-piles. The total number of tie-backs needed is 121. If a tie-back system is employed, the live-load capacity of the wharf itself will not be upgraded, only the live-load capacity of the area directly inshore of the sheet pile wall. Potentially, this area could be upgraded to a live-load of 600 psf. The cost of one tie-rod, installed, is estimated to be \$5,000. The total estimated cost of repair is \$605,000.

These repairs will solve the problem as it exists presently, however, in the future tie-backs will have to be installed along the full length of the wharf to stabilize the bulkhead as it reacts to loading inshore of the sheet pile. The magnitude of the total cost of these repairs is very large with respect to the improvement of loading capacity. Rebuilding the wharf with a

tied-back steel sheet pile wall would greatly increase a larger portion of the facilities' live-load capacity.

At approximately Station 0+75 of Wharf K and Station 10+65 of Wharf J, repairs should be made to the damaged pile caps. To properly repair the structure, the earth fill above the damaged area should be excavated and shored. The damaged portions of the pile caps and deck planks should be replaced with new timber. The wale running along the top of the sheet pile should be repositioned and refastened. The earth fill should then be replaced. There are 9 sections of pile cap that need to be replaced and approximately 124 sq.ft. of deck plank in need of repair. The total cost of repair is approximately \$10,000. See Appendix A-21 for cost breakdown and cross-section. Until the pile caps are repaired, live-loading should be restricted to 0 psf in a radius of 10' around the perimeter of the two damaged areas. Upon completion of the described repairs the live-load capacity will be 300 psf.

Live-loading in deck areas directly associated with damaged (broken, split and wild) piles should be restricted to 25% of the current recommended live-load capacity until those piles are repaired. Following the implementation of the recommended repairs, live-loading can be maintained at current levels (300 psf). Provided that dredge limits are observed, and that the structure is properly maintained, the life expectancy of the structure is in excess of 20 years.

The entire wharf should be re-inspected after repairs and in 6 years thereafter. The portions of the wharves that have been observed to be translating outshore should be inspected on a yearly basis. This will enable Shipyard personnel to determine any change in conditions. This report should be used as a baseline for future inspections.

APPENDIX

CALCULATIONS

Average capacity of relieving platform structure . . .	A-1 - A-7
Timber pile data summary	A - 8
Typical reduced timber capacity due to softness . . .	A-9 - A-11
Timber sheet pile analysis	A-12 - A-13
Forces acting on batter piles (Wharves K, J, I, H & G)	A - 14

CONCEPTUAL DESIGN

Replacement timber pile	A - 15
Refastening of timber pile	A - 16
Posted timber pile	A - 17
Timber pile long post	A - 18
Timber bracing detail	A - 19
Pile cap sister	A - 20
Pile cap repair	A - 21
Tie-back detail	A - 22
300 psf live-load extension (Wharves K, J, I, H, G). .	A - 23
Cost Estimate Breakdowns	A - 24
References	A - 25

CHILDS ENGINEERING CORPORATION

Box 333
MEDFIELD, MA 02052

JOB PNST

SHEET NO. _____

OF _____

CALCULATED BY _____

CDS

DATE _____

CHECKED BY _____

FAT

DATE 11-21-83

SCALE _____

THE MAJORITY OF THE FACILITIES AT THE PNST
CONSIST OF THE LOW DECK, EARTH FILL, TIMBER PILE
SUPPORTED, RELIEVING PLATFORM STRUCTURE. GENERALLY
THE BENT SPACING IS 4' ON CENTER AND THE
PILE SPACING IS 4' ON CENTER. DUE TO LOOSE
QUALITY CONTROL DURING THE CONSTRUCTION OF SOME
FACILITIES, ON A REGULAR BASIS THE BENT SPACING
IS AS MUCH AS 5' AND THE PILE SPACING IS ALSO
5'. THESE MAXIMUM SPACINGS ARE NOT TYPICAL AND
ARE NOT CONTROLLING FACTORS. THE FOLLOWING
CALCULATIONS HAVE TAKEN THE AVERAGE EXISTING
CONDITION AND DETERMINED THE LIMITING COMPONENTS
WITH RESPECT TO THE TOP DECK LIVE LOAD CAPACITY.
ALSO IN THE APPENDIX ARE ANALYSES OF SPECIAL
ANOMALIES AND NON-TYPICAL CONDITIONS.

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JOB PNJY

SHEET NO. 1 OF 2

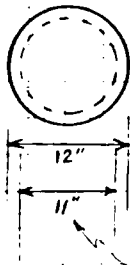
CALCULATED BY CDS

DATE 11-0-83

CHECKED BY FAR

DATE 11-21-83

SCALE _____



DETERMINE TIMBER PILE COLUMN CAPACITY

ASSUME :

$$E = 1.6 \times 10^6 \text{ \#/IN}^2$$

$$L = 480" = 40'$$

$$K = .7$$

$$r = 2.75 \text{ IN}$$

REDUCED PILE DIAMETER
DUE TO TIMBER SOFTNESS

FROM THE TIMBER CONSTRUCTION MANUAL

USE:
$$F_c' = \frac{3.619 \cdot E}{\left(\frac{KL}{r}\right)^2}$$

AISC

$$F_c' = 387 \text{ \#/IN}^2$$

$$F_c = 387 \text{ \#/IN}^2 (0.9) \quad \leftarrow \text{DURATION OF LOAD FACTOR}$$

$$F_c = 348 \text{ \#/IN}^2$$

$$P = F_c A$$

$$P = (348 \text{ \#/IN}^2) \cdot 95 \text{ IN}^2$$

$$P = 33 \text{ K} = 16.5 \text{ TONS}$$

16.5 T COLUMN CAPACITY > 15 T DRIVEN CAPACITY

THEREFORE THE DRIVEN CAPACITY IS LIMITING

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MEDFIELD, MA 02052

JOB KNDY

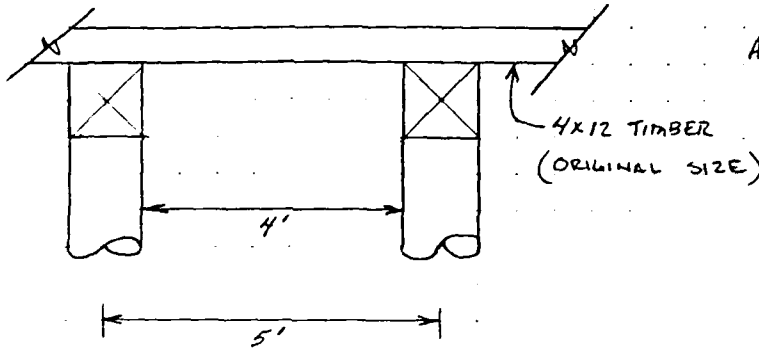
SHEET NO 2 OF 6

CALCULATED BY CDS DATE 11-9-83

CHECKED BY FAYZ DATE 11-21-83

SCALE

DETERMINE DECK TIMBER CAPACITY



ASSUME: $F_b = 1650 \text{ #/IN}^2$
 $M_{max} = \frac{Wl^2}{12}$

$F_v = 120 \text{ #/IN}^2$
 $F_{c\perp} = 315 \text{ #/IN}^2$
 $l = 48''$

REDUCED SECTION = $3\frac{1}{2} \times 11\frac{1}{4}$

BENDING

$S = 23 \text{ IN}^3$
 $M_{max} = S F_b \cdot 9$ DURATION OF LOAD FACTOR
 $W_{max} = 34 \text{ IN K}$

$W = \frac{12 M_{max}}{l^2}$

$W = .17 \text{ K/IN} = 2.13 \text{ K/FT}$

HORIZ. SHEAR

FOR RECTANGULAR BEAMS $F_v = \frac{3V}{2A}$

$W = \frac{2 F_v A \cdot 9}{3 \cdot l'} (2)$ $l' = 40''$

$W = .14 \text{ K/IN} = 1.68 \text{ K/FT} \text{ LIMITING}$

CRUSHING

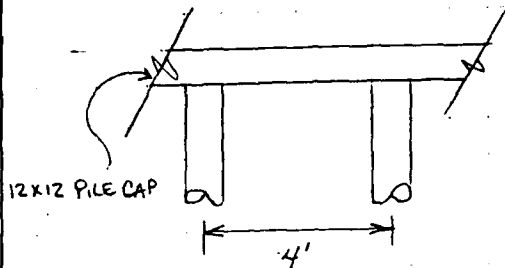
AREA OF BEARING 144 IN^2 DURATION OF LOAD

$W = \frac{(315 \text{ #/IN}^2)(144 \text{ IN}^2) \cdot 9 \cdot (.67)}{60 \text{ IN}}$ MOISTURE CONTENT FACTOR

$W = 455 \text{ #/IN} = 5.46 \text{ K/FT}$ TCM

P.250
TABLE
2.14 g

DETERMINE TIMBER PILE CAP CAPACITY



ASSUME: $F_b = 1650 \text{ \#/in}^2$
 $M_{max} = \frac{WL^2}{12}$
 $F_v = 120 \text{ \#/in}^2$
 $F_{c1} = 315 \text{ \#/in}^2$

USE REDUCED SECTION DUE TO SOFTNESS
11x11

BENDING

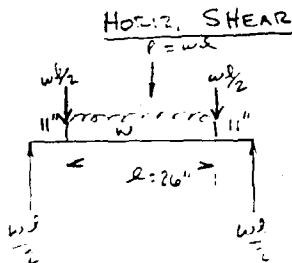
$$S = 221 \text{ in}^3$$

$$M_{max} = S F_b .9 \quad \leftarrow \text{DURATION OF LOAD FACTOR}$$

$$M_{max} = 328,185 \text{ in-lb}$$

$$W = \frac{12 M_{max}}{L^2}$$

$$W = 1.7 \text{ k/in} = 20 \text{ k/ft}$$



CRUSHING

FOR RECTANGULAR BEAMS $F_v = \frac{3V}{2A}$

$$W = \frac{2 F_v A .9}{3L} \quad \leftarrow \text{DURATION OF LOAD}$$

$$W = 6.7 \text{ \#/in} = 8 \text{ k/ft} \quad \text{LIMITING}$$

AREA OF BEARING, $A_b = 180 \text{ in}^2$

$$W = \frac{(315 \text{ \#/in}^2)(180 \text{ in}^2) .9 .67}{48 \text{ in}} \quad \leftarrow \text{DURATION OF LOAD, MOISTURE CONTENT FACTOR}$$

$$W = 8.54 \text{ k/ft}$$

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JOB INDY

SHEET NO. 4

OF 6

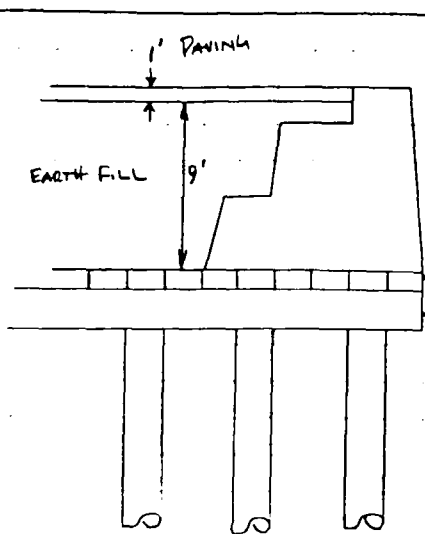
CALCULATED BY CDS

DATE 11-9-83

CHECKED BY FAZ

DATE 11-21-83

SCALE _____



DETERMINE UNIT DEAD LOAD IMPOSED
BY LOW DECK, EARTH FILL, RELIEVING PLATFORM
STRUCTURE.

$$\text{WEIGHT OF PAVING} = 150 \text{ #/ft}^2 = 150 \text{ #}$$

$$\text{WEIGHT OF EARTH FILL} = 125 \text{ #/ft}^3 @ 9 \text{ ft}^2 = 1125 \text{ #}$$

$$(\gamma_{\text{SAT}} = 125 \text{ #/ft}^3)$$

$$\text{WEIGHT OF 4" DECK} = 64 \text{ #/ft}^3 @ .33 \text{ ft}^3 = 21 \text{ #}$$

$$\underline{1296 \text{ #/ft}^2}$$

$$\text{WEIGHT OF PILE CAP} = 64 \text{ #/ft}^3 @ 4 \text{ ft}^3 = 256 \text{ #}$$

- IN CONSIDERING THE DL ON TIMBER PILES
AND TIMBER PILE CAPS USE A UNIT LOAD OF 1.5 K/ft^2
- IN CONSIDERING THE DL ON THE TIMBER DECKING
USE A UNIT LOAD OF 1.3 K/ft^2

IN ASSUMING MAXIMUM BENT SPACING OF 5' AND A
PILE SPACING OF 4' WE CAN DETERMINE THE
ALLOWABLE LIVE LOAD CAPACITY

LIMITING FACTORS -

PILECAP - 8 K/FT

DECK PLANK - 1.68 K/FT²

TIMBER PILE - 30 K

- THE DL ON THE TIMBER PILE IS 1.5 K/FT²; ASSUME
AN AREA OF 16 FT² IS SUPPORTED BY 1 PILE DUE TO
THE TYPICAL LOAD DISTRIBUTION.

$$\text{TOTAL DL} = 24 \text{ K}$$

$$\text{ALLOWABLE LOAD} = 30 \text{ K / PILE}$$

$$\text{LL} = 30 \text{ K} - 24 \text{ K} = 6 \text{ K}$$

$$\text{LL} = 375 \text{ PSF}$$

IF THE ALLOWABLE LOAD IS 40 K / PILE
THEN LL = 1000 PSF

- THE DL ON THE PILE CAP IS 1.5 K/FT²; ASSUME
AN AREA OF 16 FT² IS SUPPORTED.

$$\text{TOTAL DL} = 24 \text{ K}$$

$$\text{ALLOWABLE LOAD FOR 4' SPAN} = 32 \text{ K}$$

$$\text{LL} = 32 \text{ K} - 24 \text{ K} = 8 \text{ K}$$

$$= 500 \text{ \#/FT}^2$$

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CHECKED BY TATC
SCALE

- THE DL ON THE DECK PLANKING IS 1.3 K/ft^2
WITH A 5' BENT SPACING; THE LENGTH
OF DECK PLANK UNDER CONSIDERATION IS 3.33'

$$\begin{aligned}\text{TOTAL DL} &= 4.3 \text{ K} \\ \text{TOTAL ALLOWABLE LOAD} &= 5.5 \text{ K}\end{aligned}$$

$$\begin{aligned}\text{LL} &= 5.5 \text{ K} - 4.3 \text{ K} = 1.2 \text{ K} \\ &= 388 \text{ \#/ft}^2\end{aligned}$$

IN THE TYPICAL RELIEVING PLATFORM STRUCTURE
THE TIMBER DECKING IS THE CAPACITY WHICH
LIMITS THE LIVE LOADING. THE CALCULATIONS
SHOW THAT $388 \text{ \#/ft}^2$ IS THE MAXIMUM LL
THAT THE TYPICAL RELIEVING PLATFORM CAN HANDLE.
ALTHOUGH, IF THE PILE SPACING AND BENT SPACING
ARE LESS THAN 4' AND 5' RESPECTIVELY, THE CAPACITY
OF THE RELIEVING PLATFORM IS MUCH GREATER.

TIMBER PILE DATA SUMMARY

<u>FACILITY</u>	<u>**RANGE OF STRUCTURAL TIMBER SOFTNESS DETECTED</u>	<u>RANGE OF PILE DIAMETERS OBSERVED</u>	<u>TIMBER PILE DRIVEN CAPACITY***</u>
Eastern Seawall	3/4" ave.	11" - 15"	3 - 20
Pier 7	2" - 6"	10" - 15"	15
Pier 1 & Bulkhead	1" ave.	11"	15
Pier 2	1" - 2"	10" - 14"	15
Wharves 4A & 4B	3/4" ave.	9" - 14"	15
Pier 4	1/2" ave.	9" - 13"	15 - 20
Pier 5	1/4" - 1/2"	10" - 17"	20
Barge Basin & Bkhd	1/2" - 1"	9" - 14"	15
Pier 6	1/4" - 1"	10" - 14"	15
Pier 6A-Bulkhead	1" - 4"	10" - 13"	15
DD Wharves	1/2" ave.	11" - 18"	15
Wharves K,J,I,H,G	1/2" ave.	10" - 16"	15
Wharf F/Pier F	1/2" - 1"	11" - 15"	15
Wharf E	1/2" - 1 1/2"	9" - 14"	15
Rowan Ave.	NA*	NA*	NA*
2nd Street	1 1/2" - 3"	9" - 12"	15
Preble Ave.	1 1/2" - 2"	8" - 10"	15
Broad Street	1 1/2" - 3"	11" - 14"	15
Wharf L	1/2" - 1 1/2"	9" - 10"	15
Wharf N	1" - 3"	9" - 14"	15

* NA = Not Applicable

** For detailed account of timber softness, i.e., variations between piles, caps, decking; see individual facility's Observed Inspection Condition.

*** Timber pile driven capacities have been extrapolated from GFI such as the Hudson Engineers Report or actual NAVFAC or PW drawings.

TYPICAL TIMBER SOFTNESS

PIER 7

DETERMINE REDUCED CAPACITY OF TIMBER PILE CAP DUE TO TIMBER SOFTNESS.

$$\begin{aligned} F_b &= 1650 \text{ #/in}^2 \\ F_v &= 120 \text{ #/in}^2 \\ F_{cl} &= 315 \text{ #/in}^2 \\ L &= 48'' \end{aligned}$$



ORIGINAL 12x12 CAP
 $A = 144 \text{ in}^2$

AREA OF TIMBER REMAINING AFTER AFTER A REDUCTION IS CONSIDERED.

ASSUME $A' \approx 95 \text{ in}^2$

BENDING

$$\begin{aligned} S &= 130 \text{ in}^3 \\ M_{max} &= S F_b \cdot 0.9 \\ M_{max} &= 193 \text{ IN-K} \end{aligned}$$

DURATION OF LOAD FACTOR

$$W = \frac{12 M_{max}}{L^2} = 12.1 \text{ K/FT}$$

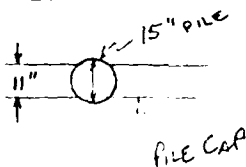
HORIZ. SHEAR

$$\text{USE } F_v = \frac{3V}{2A}$$

$$\text{WHERE } V = W L$$

$$W = \frac{2 F_v A' \cdot 0.9}{3 L} (2) = \underline{\underline{6.3 \text{ K/FT}}}$$

CRUSHING



ASSUME AREA OF BEARING $A' \approx 165''$

HORIZONTAL LOAD REDUCTION FACTOR

$$W = \frac{(315 \text{ #/in}^2) (165 \text{ in}^2) \cdot 0.9 \cdot 0.67}{48 \text{ in}} = 7.8 \text{ K/FT}$$

$$W = \frac{F_{cl} A' \cdot 0.9 \cdot 0.67}{2}$$

TYPICAL TIMBER SOFTNESS

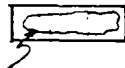
PIER 7

DETERMINE REDUCED CAPACITY OF TIMBER DECKING
DUE TO SOFTNESS.

$$F_b = 1650 \text{ #/IN}^2$$

$$F_v = 120 \text{ #/IN}^2$$

$$F_{CL} = 315 \text{ #/IN}^2$$



ORIGINAL 4x12 DECKING

AREA OF TIMBER REMAINING AFTER A REDUCTION
IS CONSIDERED

$$\text{ASSUME } A' \approx 30 \text{ IN}^2$$

BENDING

$$S = 15 \text{ IN}^3$$

$$M_{max} = S F_b .9$$

$$M_{max} = 22.2 \text{ IN-K}$$

DURATION OF LOAD FACTOR

$$W = \frac{12 M_{max}}{l^2} = 1.37 \text{ K/FT} \quad \text{WHERE } l = 48'$$

HORIZ. SHEAR

$$W = \frac{2 F_v A' .9}{3 l} (2) = 1.23 \text{ K/FT} \quad \text{WHERE } l = 48'$$

CRUSHING

AREA OF BEARING 120 IN²

$$W = \frac{(315 \text{ #/IN}^2)(120 \text{ IN}^2) .9 .68}{60 \text{ IN}} = 4.6 \text{ K/FT}$$

MOISTURE CONTENT
REDUCED FACTOR

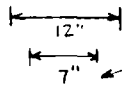
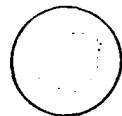
WE CONCLUDE THAT THE LIMITING FACTOR ON
PIER 7 IS THE HORIZONTAL SHEAR CAPACITY OF
THE REDUCED SECTION OF THE DECK PLANK

- WHEN LOADING ON THE DECK PLANK IS ANALISED THE
DL = 1.3 K/FT² > ALLOWABLE LOAD = 1.23 K/FT²
- THIS IS A CONDITION OF IMPENDING FAILURE -

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JOB 498-82-F PMSY
SHEET NO. 1 OF 1
CALCULATED BY CDS DATE 1/12/84
CHECKED BY FJT DATE
SCALE NONE

REDUCED TIMBER PILE CAPACITY
(BULKHEAD BETWEEN PIER 6 AND PIER 6A)



REDUCED CAPACITY
DUE TO TIMBER SOFTNESS

ASSUME: $E = 1.6 \times 10^6 \text{ #/IN}^2$
 $L = 15' = 180"$
 $K = .7$
 $r = 1.75 \text{ IN}$

FROM AISC USE:

$$F_c' = \frac{3.619 E}{\left(\frac{KL}{r}\right)^2}$$

$$F_c' = 1.1 \text{ KSI}$$

$$F_c = 1.1 \text{ KSI} (.9) \leftarrow \text{REDUCTION OF LOAD FACTOR}$$

$$F_c = .99 \text{ KSI}$$

$$P = F_c A$$

$$P = .99 \text{ KSI} (38.5 \text{ IN}^2)$$

$$P = 38.1 \text{ K} = 19 \text{ T}$$

19T COL. CAP. > 15T DRIVEN CAP

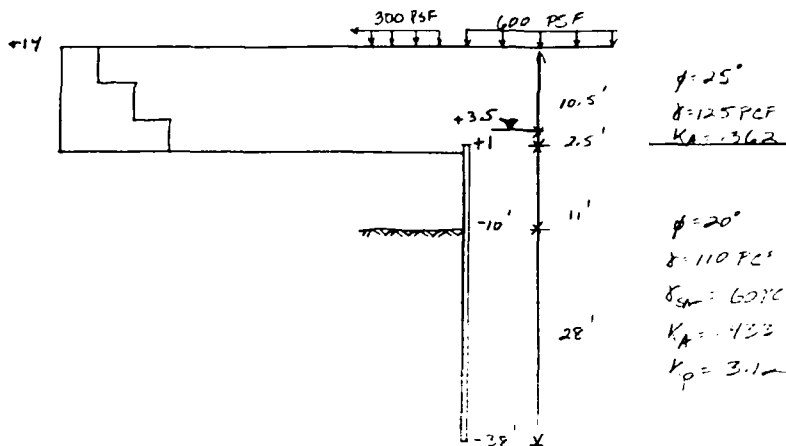
∴ DRIVEN CAPACITY IS LIMITING

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JOB PILEY
SHEET NO 1 OF 2
CALCULATED BY FAT DATE 1/9/84
CHECKED BY CDS DATE 1/12/84
SCALE _____

TIMBER SHEET PILE ANALYSIS



$$\begin{aligned} \text{SURCHARGE ACTING @ FL } +1 &= 600 \text{ PSF} + \text{WT SOIL} \\ &= 600 \text{ PSF} + (10.5' \times 125 \text{ PCF}) + 2.5' (60 \text{ PCF}) \\ &= 2062 \text{ PSF} \end{aligned}$$

DETERMINE X - FT OF CONTRAFLEXURE

$$\begin{aligned} \text{FOR } \phi = 20^\circ \quad X &= 0.14 H' \quad H' = 11 + \frac{8}{1} = 11 + \frac{2062}{125} = 27.5 \\ X &= 2.8 \end{aligned}$$

$$L = H_T + X = 11 + 2.8 = 13.8'$$

CALCULATE TOTAL LOAD W ON L

$$W = \left(\frac{893 + 1179}{2} \right) (11) + \left(\frac{1179 + 728}{2} \right) (2.8) = 14,035 \text{ LB/FT RUN WALL}$$

RECORDING

$$M_{MAX} = \frac{WL^2}{8} = \frac{(14,035)(13.8')^2}{8} = 24.3 \text{ FT-K}$$

USING 11.5 x 11.5 X-SECTION

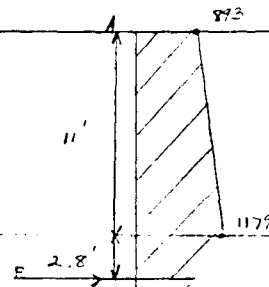
$$S = 253.5 \text{ IN}^2 \quad F_b = 1650 \text{ PSI}$$

$$(S)(F_b)(1.9) = 31.4 \text{ FT-K} > 24.3 \text{ FT-K} \checkmark$$

CHILDS ENGINEERING CORPORATION
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JOB: 8115
SHEET NO: 2 OF 2
CALCULATED BY: JAT DATE: 1/9/87
CHECKED BY: DATE:
SCALE:

COL 1	COL 2	COL 3	COL 4	COL 5
γ_h	γ_h	γ_{wh}	P_A	P_P
2,063	-	-	893	-
2723	0	-	1179	0
2403	1680	-	1900	5242



HORIZONTAL SHEAR
EMPA

$$\frac{(893)(11.79)(11.79)}{2} + \frac{(722)(11.79)(11.79)}{2} + \frac{(722)(11.79)(11.79)}{2} = 1382$$

EMPA

$$V_{A-E} = \frac{EMPA}{2} = \frac{(1382)(11.79)}{2} (11.79)$$

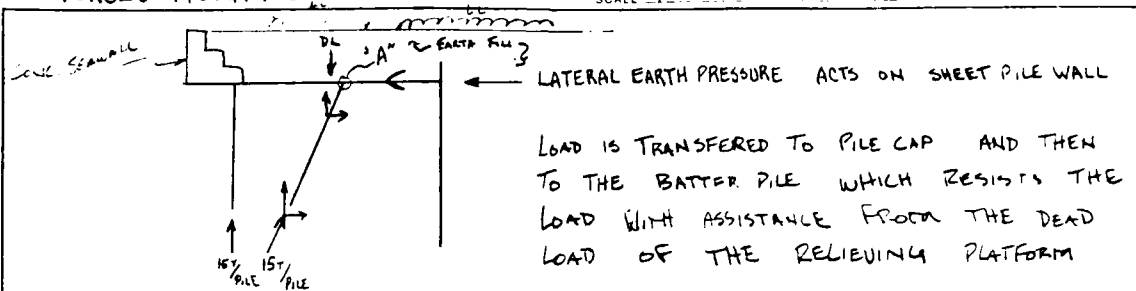
$$= 10.6 K > 7.1 K \quad \checkmark$$

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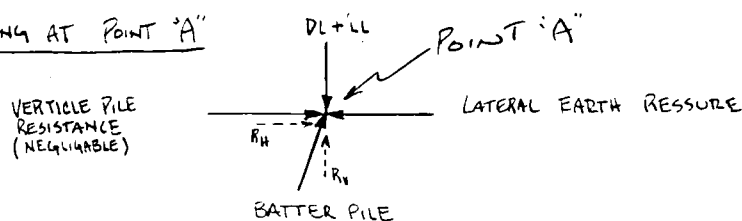
JOB 498-82-F FNEY

SHEET NO. 1
CALCULATED BY CDS DATE 1/10/84
CHECKED BY DLP DATE 1/84
SCALE NONE

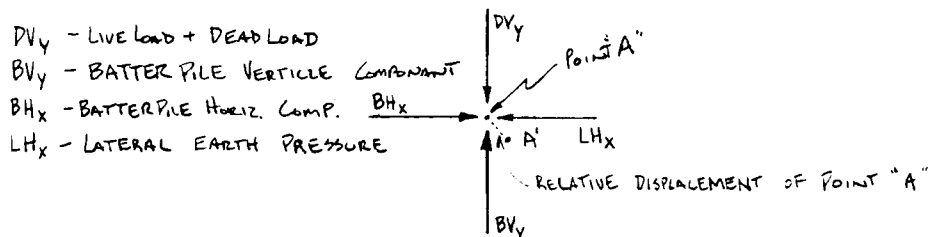
FORCES ACTING ON BATTER PILE



FORCES ACTING AT POINT 'A'



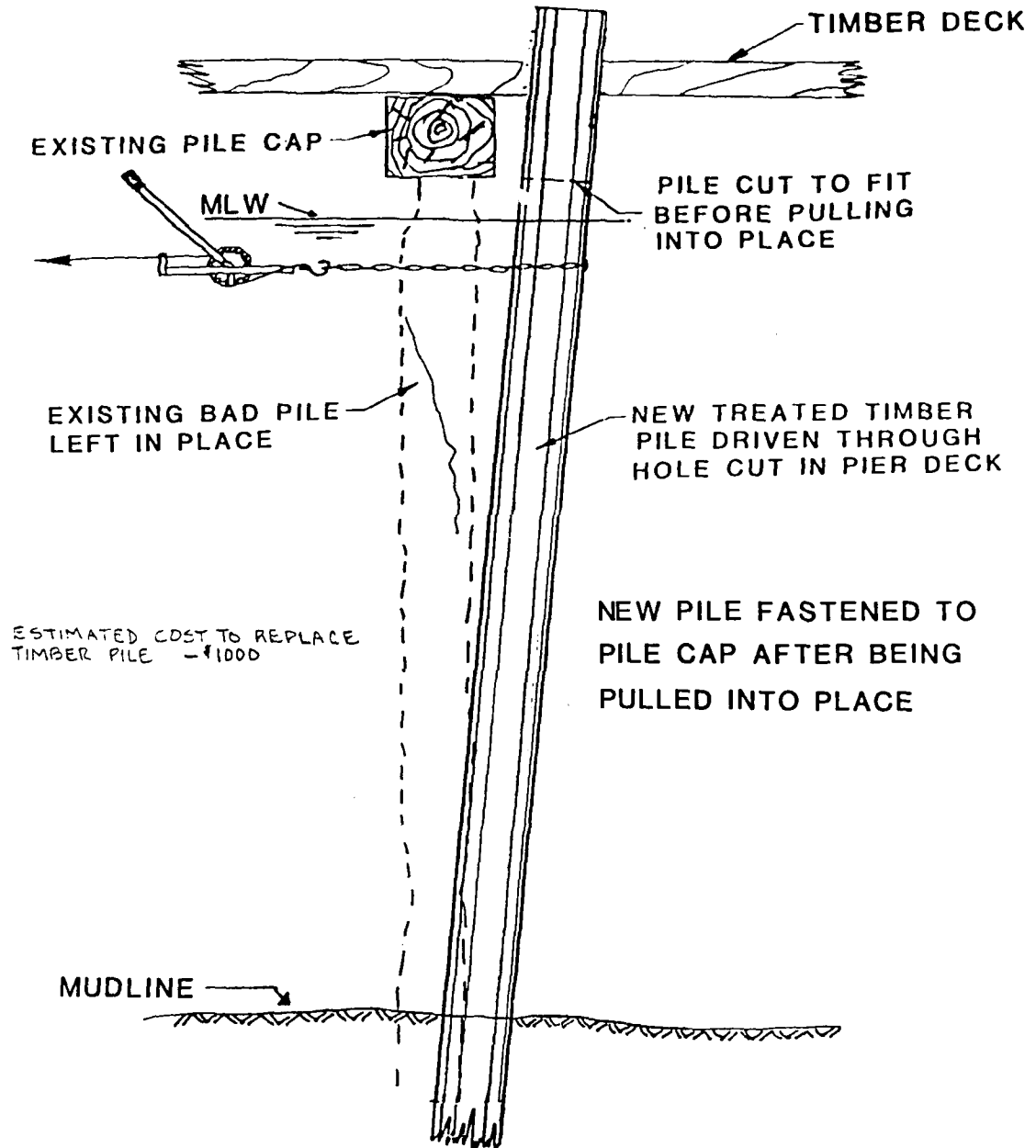
RESOLUTION OF FORCES



NOTE: TO DEVELOPE DISPLACEMENT OF POINT 'A' AS SHOWN, THE RESULTANT OF LH_X AND BV_Y MUST EXCEED THE RESULTANT OF DV_Y AND BH_X

- AS OBSERVED ON WHARVES K, J, I, H AND G THE REACTION AT POINT 'A' HAS BEEN UPWARD AND IN THE OUTSHORE DIRECTION THIS REACTION IS A RESULT OF AN EXCESSIVE LATERAL EARTH PRESSURE. APARENTLY THIS CONDITION IS IN EQUILIBRIUM DUE TO A REDUCTION OF THE LATERAL EARTH PRESSURE ATTRIBUTED TO A REMOVAL OF A LIVE LOAD BEHIND THE SHEET PILE WALL OR POSSIBLY A REDUCTION OF PRESSURE AS A RESULT OF THE MOVEMENT OF THE SHEETPILE WALL

REPLACEMENT TIMBER PILE CONCEPTUAL DESIGN



ESTIMATED COST TO REPLACE
TIMBER PILE - \$1000

GRAPHIC SCALE

NO SCALE

CHILDS ENGINEERING
CORPORATION
BOX 333
MIDFIELD, MA

A-15

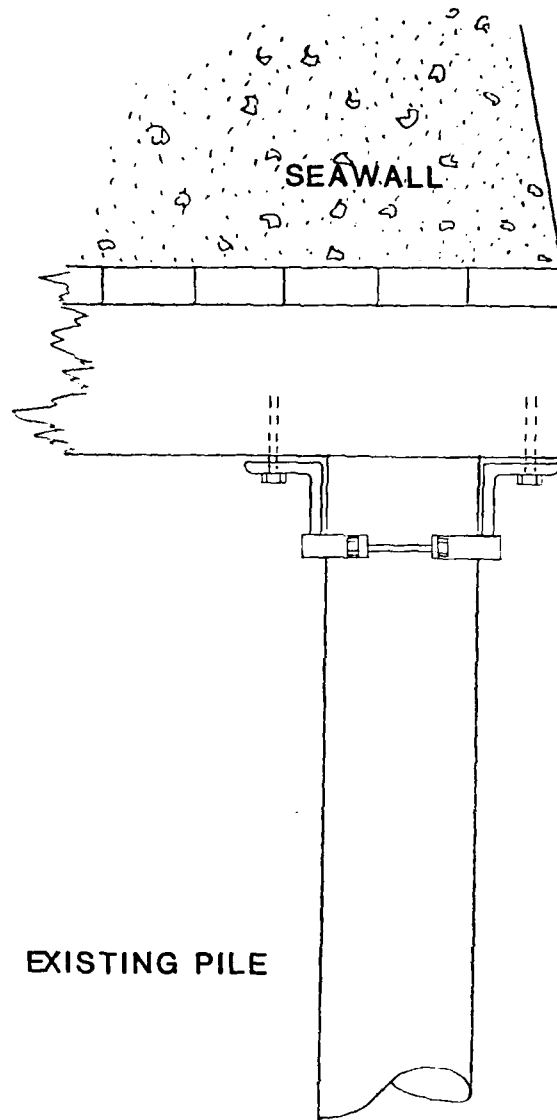
CHESAPEAKE DIVISION
NAVAL FACILITIES ENGINEERING COMMAND
WASHINGTON, D.C.

PHILADELPHIA NAVAL SHIPYARD PHILADELPHIA, PA FIG NO

REPLACEMENT TIMBER PILE

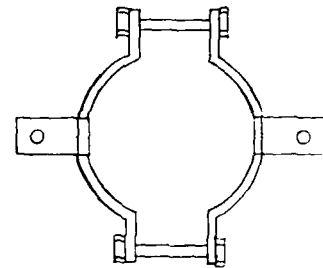
CONCEPTUAL DESIGN

REFASTEN TIMBER PILE TO PILE CAP



EXISTING PIER DECK

EXISTING PILE CAP



PLAN

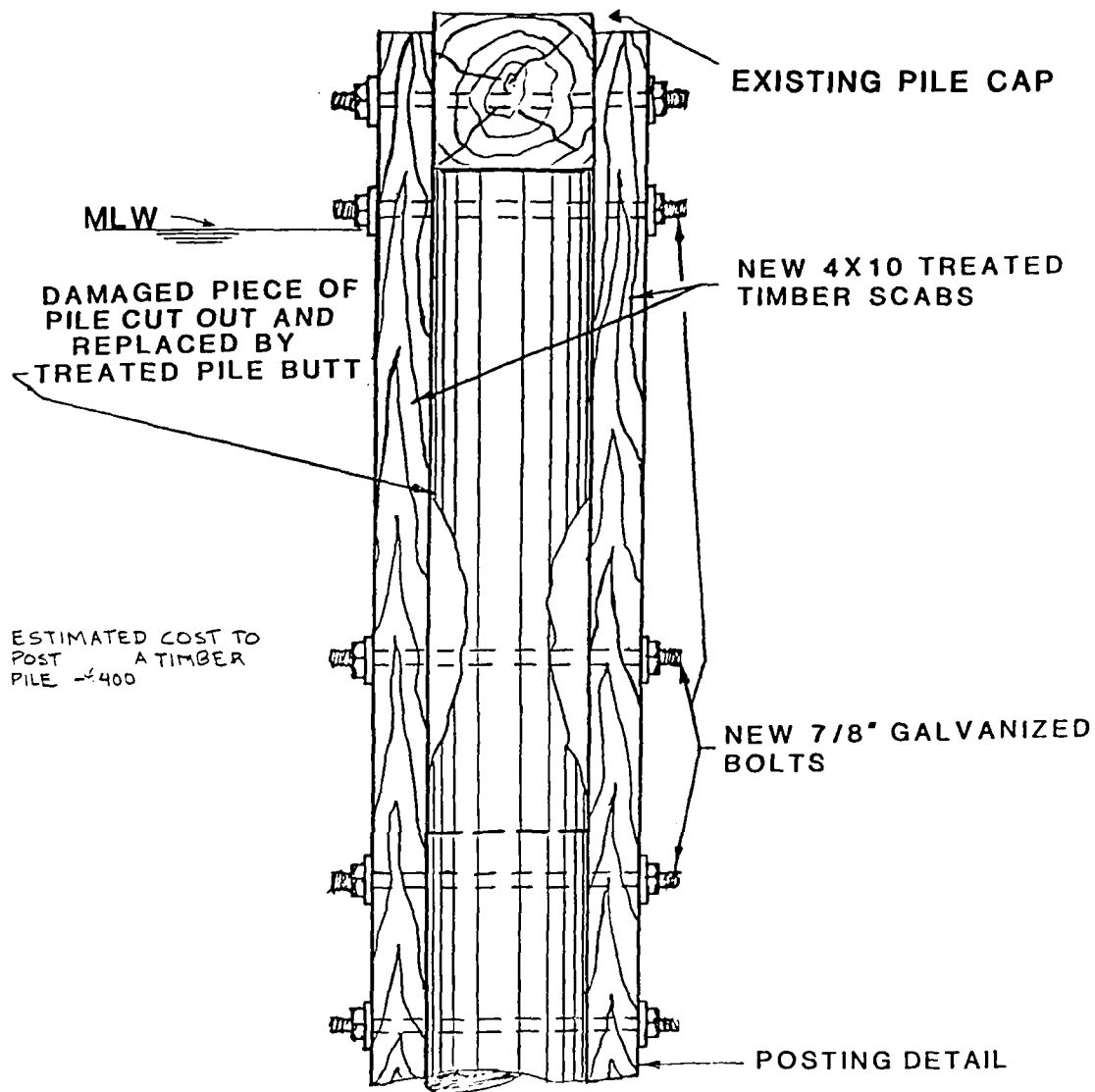
EXISTING PILE

ELEVATION

ESTIMATED COST TO REFASTEN
TIMBER PILE TO PILE CAP - \$400

GRAPHIC SCALE	CHILDS ENGINEERING CORPORATION BOX 333 MEDFIELD, MA	CHESAPEAKE DIVISION NAVAL FACILITIES ENGINEERING COMMAND WASHINGTON DC		
NO SCALE		PHILADELPHIA NAVAL SHIPYARD	PHILADELPHIA, PA	FIG NO
A-16		CLAMP TIMBER PILE		

POSTED TIMBER PILE **CONCEPTUAL DESIGN**

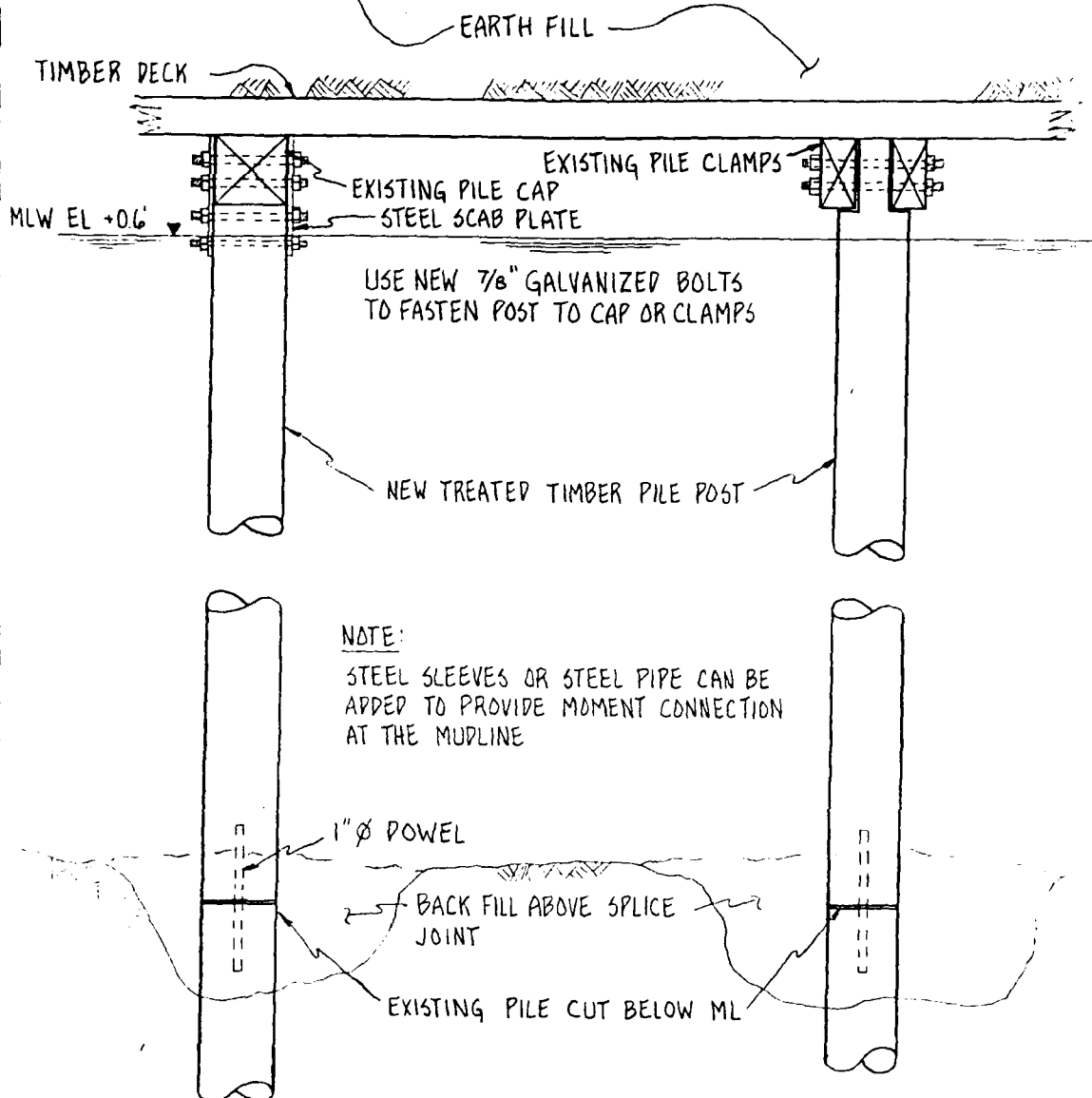


ESTIMATED COST TO
 POST A TIMBER
 PILE - \$400

GRAPHIC SCALE	CHILDS ENGINEERING CORPORATION BOX 333 MEDFIELD, MA	CHESAPEAKE DIVISION NAVAL FACILITIES ENGINEERING COMMAND WASHINGTON, D.C. PHILADELPHIA NAVAL SHIPYARD PHILADELPHIA, PA	
NO SCALE		POSTED TIMBER PILE	FIG NO

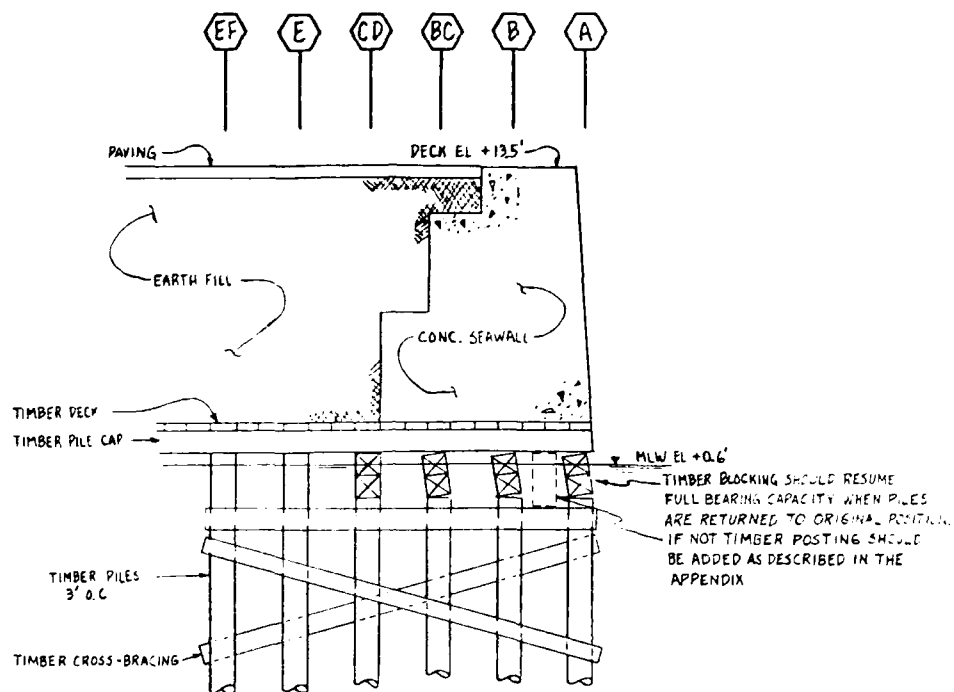
A-17

TIMBER PILE LONG POST CONCEPTUAL DESIGN



- NOTE:** 1. CROSS BRACING MUST BE USED BETWEEN ADJACENT LONG POSTS TO INSURE STABILITY IF THERE IS NO MOMENT CONN. AT THE ML
2. ESTIMATED COST OF REPAIR IS \$1000 PER PILE

GRAPHIC SCALE	CHILDS ENGINEERING CORPORATION BOX 233 DFIELD, MA	CHESAPEAKE DIVISION NAVAL FACILITIES ENGINEERING COMMAND WASHINGTON, D.C.	
NO SCALE		PHILADELPHIA NAVAL SHIPYARD PHILADELPHIA, PA TIMBER PILE LONG POST	FIG NO.



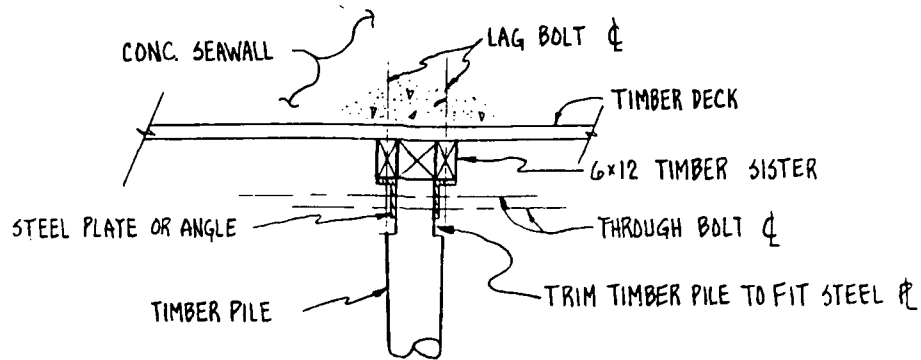
SECTION

CONCEPTUAL DESIGN

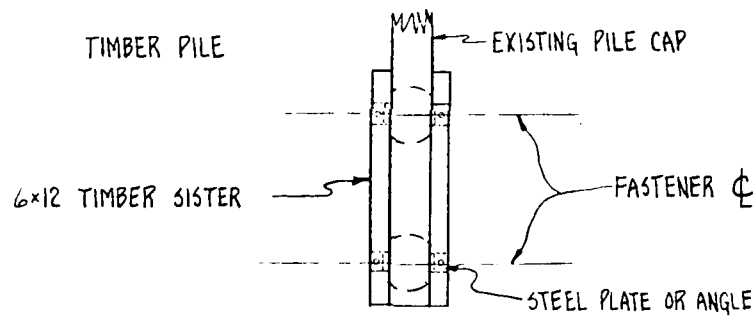
BENTS 4 THRU 8
BULKHEAD WEST OF BARGE BASIN

GRAPHIC SCALE	CHILDS ENGINEERING CORPORATION BOX 333 MILFORD MA A- 19	CHESAPEAKE DIVISION NAVAL FACILITIES ENGINEERING COMMAND WASHINGTON D C	
NOT TO SCALE		PHILADELPHIA NAVAL SHIPYARD PHILADELPHIA, PA TIMBER BRACING DETAIL	FIG NO A5

CONCEPTUAL DESIGN

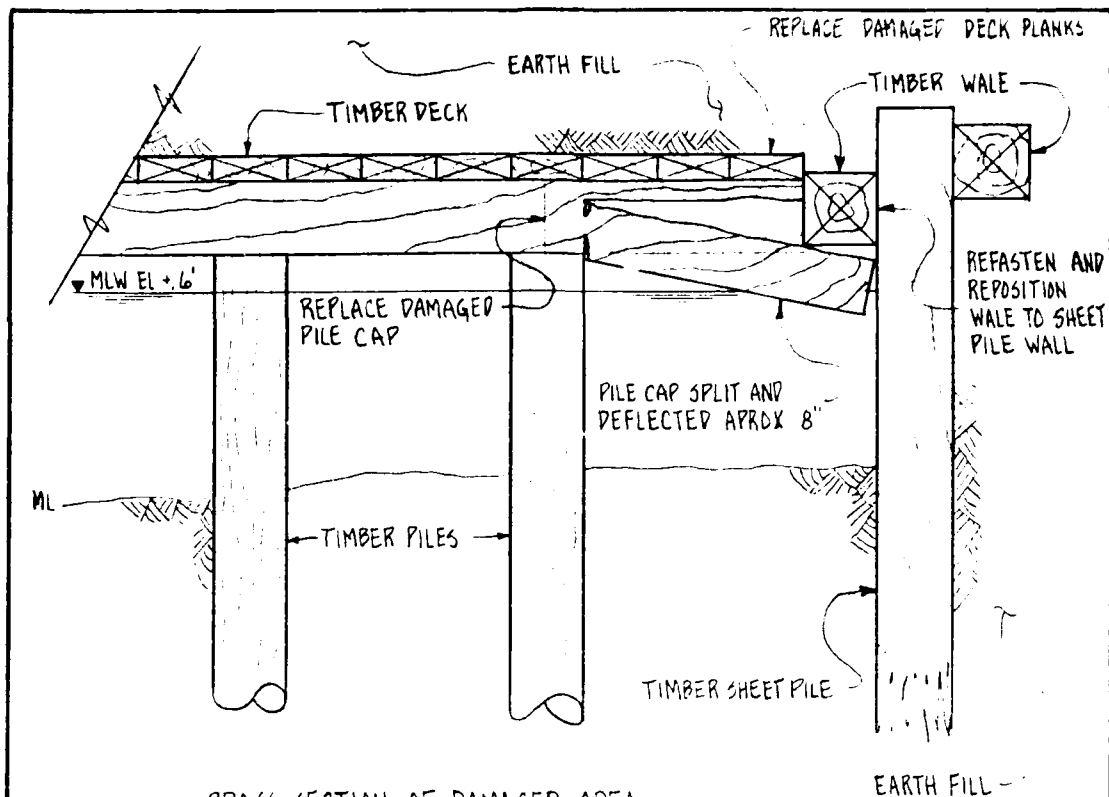


SECTION



PLAN

GRAPHIC SCALE	CHILDS ENGINEERING CORPORATION BOX 898 MEDFIELD, MA	CHESAPEAKE DIVISION NAVAL FACILITIES ENGINEERING COMMAND WASHINGTON, D.C. PHILADELPHIA NAVAL SHIPYARD PHILADELPHIA, PA	
NOT TO SCALE		PILE CAP SISTER	FIG NO



CROSS SECTION OF DAMAGED AREA

(WHARF K, STA 0+75; WHARF J, STA 10+65)

REPAIR PROCEDURE

1. LOCATE DAMAGED AREA OF WHARF
2. EXCAVATE OVER DAMAGED AREA
3. REPLACE ANY DAMAGED STRUCTURAL MEMBER
4. BACKFILL EXCAVATION

COST ESTIMATES

1. COST OF EXCAVATION AND BACKFILL - \$15/CUYF @ APPROX. 289 CUYF = \$4335
 2. COST OF TIMBER - \$5/BF (INPLACE) @ APPROX 1052 BF = 5260
- TOTAL EST. COST \$ 9595 + MOB-DEM:0

GRAPHIC SCALE



CHILDS ENGINEERING
CORPORATION
BOX 333
MEDFIELD, MA

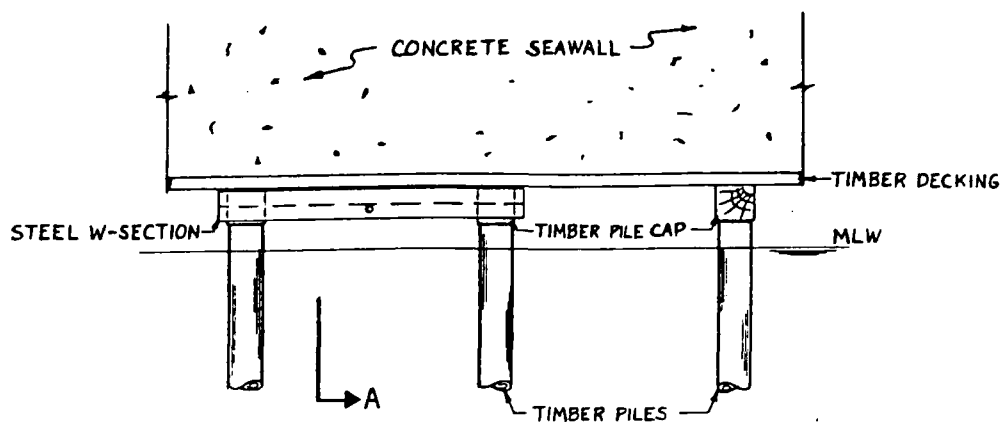
A-21

CHESAPEAKE DIVISION
NAVAL FACILITIES ENGINEERING COMMAND
WASHINGTON, D.C.

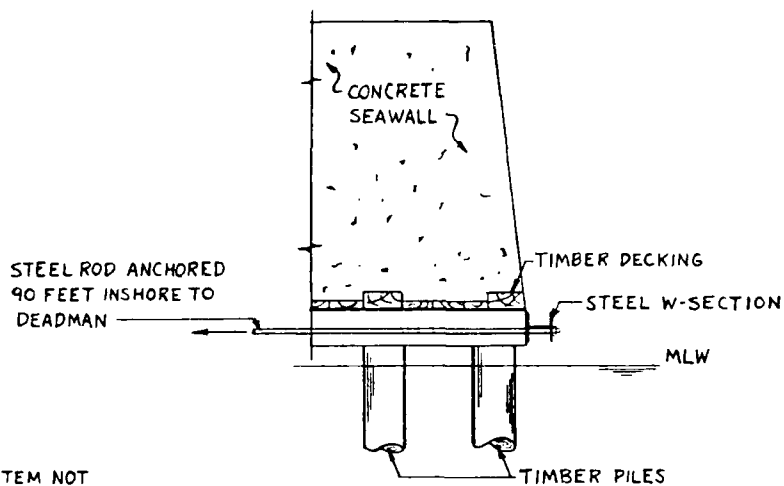
PHILADELPHIA NAVAL SHIPYARD PHILADELPHIA, PA FIG NO

PILE CAP REPAIR

CONCEPTUAL DESIGN



ELEVATION

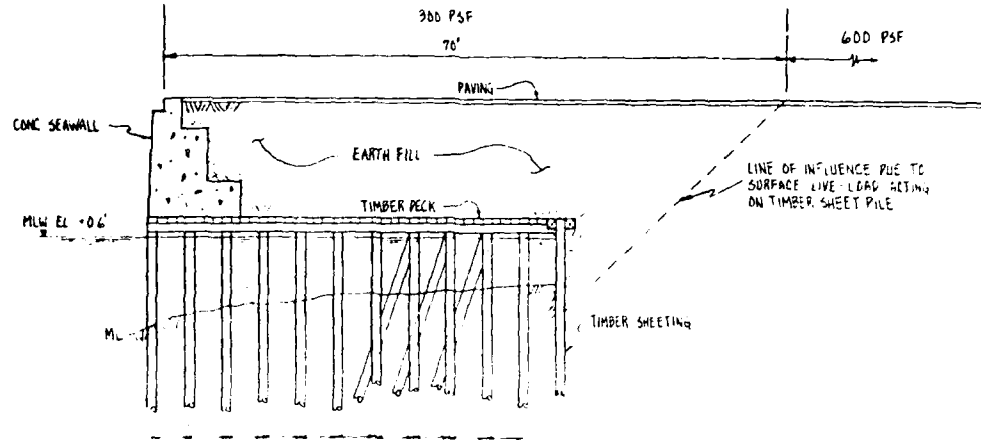


NOTE:
FENDER SYSTEM NOT
SHOWN FOR CLARITY

SECTION - A

GRAPHIC SCALE	CHILDS ENGINEERING CORPORATION BOX 333 MEDFIELD, MA A- 22	CHESAPEAKE DIVISION NAVAL FACILITIES ENGINEERING COMMAND WASHINGTON, D.C. PHILADELPHIA NAVAL SHIPYARD PHILADELPHIA, PA	
NOT TO SCALE		TIE-BACK DETAIL	FIG NO. A8

IN AREAS WHERE TRANSLATION WAS OCCURRED, THE 300-PSF
LIVE LOAD LIMIT SHOULD BE EXTENDED TO 70' FROM THE FACE
OF THE WHARF AS SHOWN



10 SPACES @ 4' O.C.
TYPICAL CROSS SECTION
(WARVES: K, J, I, H, G)

GRAPHIC SCALE

NOT TO SCALE

CHILDS ENGINEERING
CORPORATION
BOX 233
MEDFIELD, MA

A-23

CHESAPEAKE DIVISION
NAVAL FACILITIES ENGINEERING COMMAND
WASHINGTON, D.C.

PHILADELPHIA NAVAL SHIPYARD PHILADELPHIA, PA
LIVE LOAD EXTENSION
WHARVES K, J, I, H, G

FIG. NO.

A9

CHILDS ENGINEERING CORPORATION

Box 333
MEDFIELD, MA 02052

JOB INDI

SHEET NO. 1

OF 1

CALCULATED BY CDS

DATE

CHECKED BY

DATE

SCALE

- 1) REPLACEMENT PILE - UNIT COST \$1000 (IN PLACE)
- 2) PILE TOP REPAIR I.E. REFASTEN, SHORT POST, PILE CAP SISTER

ASSUME: CREW

1 FOREMAN	} \$1100 / DAY
2 DOCK BUILDERS	
1 LABORER	
1 DIVER	

AVERAGE LABOR COST PER REPAIR - 275

MATERIALS COST PER REPAIR - 125

AVE. COST/REPAIR \$400

- 3) LONG POST REPAIR

CREW COST/DAY \$1100 / DAY

CREW COST/REPAIR \$750

MATERIALS COST/REPAIR \$250

AVE COST/REPAIR \$1000

- 4) TIMBER SHEET PILE REPAIR

2 STEEL H-PILES IN PLACE (UNIT COST)	\$2000
COST OF MISC. MATERIALS	500
COST OF LABOR	500

EST. TOTAL \$3000

NOTE: ① COSTS ARE BASED ON 1983 U.S. EAST COAST PRICES.
② COSTS DO NOT INCLUDE MOBILIZATION/DEMOBILIZATION

REFERENCES

1. Master Plan for Naval Base, Philadelphia, PA
August 1975
2. Divers Inspection, Engineering Evaluation and
Preliminary Recommendations for Piers and
Bulkheads at the Philadelphia Naval Shipyard,
Philadelphia, Pennsylvania; prepared by
Hudson Engineers, Inc., Philadelphia, PA
September 1976

END

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