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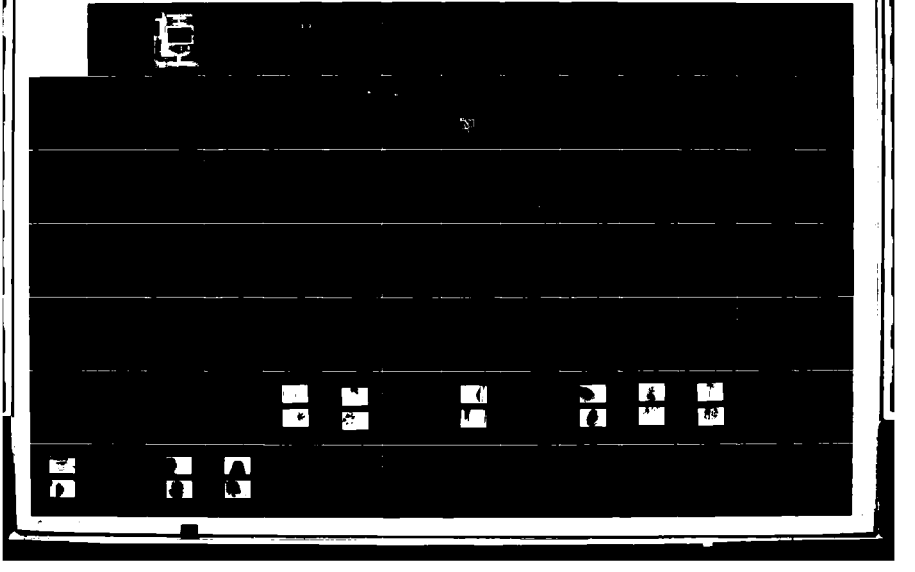

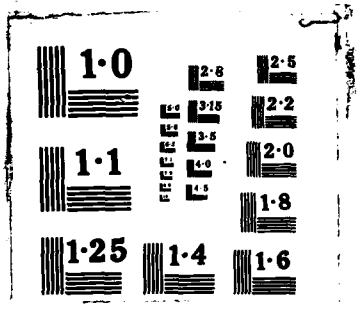
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UNDERWATER FACILITIES
INSPECTION AND ASSESSMENT
AT

PUGET SOUND NAVAL SHIPYARD
BREMERTON, WASHINGTON

FPO-1-82(08) SEPTEMBER 1981

PERFORMED FOR:

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

UNDER:

CONTRACT N62477-81-C-0161
TASK 2

BY:

COLLINS ENGINEERS, INC.
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A visual "swim-by" inspection was made of all facilities under investigation and a more detailed visual and tactile inspection was made of representative components of each facility. Ultrasonic thickess measurements were made of selected steel components. The detailed inspection included wire brush cleaning and scraping of the areas, and documentation of conditions with color photographs.

Generally, the underwater inspection indicated that the submerged portions of the facilities included in this project are in good to excellent conditions. No immediate repairs are necessary.

There are, however, areas of distress and deterioration that should be repaired to maintain the long term serviceability of the facility.

Design live loads for each facility are contained in the report. No reductions from these design loads are warranted.

FOREWORD

The scope of the inspection at the Puget Sound Naval Shipyard in Bremerton, Washington and the detail to which it was performed and reported was tailored specifically to the conditions at this facility. This report or the procedure associated with its formation is not intended to be a standard for inspections or reports covering other activities. Attempts are being made, however, toward establishing standards for procedures and formats for inspection and assessment reports. Through these standards, inspections performed by different persons, on many facilities and under a wide range of conditions can be effectively compared. Puget Sound facilities, like previous operations mandated under the underwater portion of the Specialized Inspection Program, will contribute significantly toward acheiving that objective.

It should be noted that the choice of the level of inspection and the procedural detail to be employed will be an engineering judgment made separately for each activity/facility to suit its unique situation and needs. Accordingly, the procedures used at the Puget Sound Naval Shipyard, rather than serve as a detailed model for inspections elsewhere, will provide guidance with general applicability to future inspections.

EXECUTIVE SUMMARY

In September, 1981, an underwater inspection was conducted at the Puget Sound Naval Shipyard, Bremerton, Washington to assess the condition of the submerged portions of the following structures:

Piers	Moorings	Quaywalls
B, D, 3, 4, 5, 6, 7, 8, 9	A, E, F, G	693, 694 729, 730

A visual "swim-by" inspection was made of all facilities under investigation and a more detailed visual and tactile inspection was made of representative components of each facility. Ultrasonic thickness measurements were made of selected steel components. The detailed inspection included wire brush cleaning and scraping of the areas, and documentation of conditions with color photographs.

Generally, the underwater inspection indicated that the submerged portions of the facilities included in this project are in good to excellent condition. No immediate repairs are necessary.

There are, however, areas of distress and deterioration that should be repaired to maintain the long term serviceability of the facility.

Design live loads for each facility are contained in the report. No reductions from these design loads are warranted.

The table beginning on the following page summarizes the condition of each facility and recommended repairs with associated costs.

Executive Summary Table

Facility	Year Built or Modified	No. of Vertical Bearing Piles or Subpiers	No. of Batter Piles	Facility Size* Length by Width	Structure Type	Recommended Repairs and Estimated Cost
Mooring G	1946	131	41	925 ft. by 16-55 ft.	Precast Concrete Piles & Steel Sheet Pile Cells	None
Mooring F	1946	137	43	925 ft. by 16-55 ft.	Precast Concrete Piles & Steel Sheet Pile Cells	None
Mooring E	1946	175	50	925 ft. by 16-55 ft.	Precast Concrete Piles & Steel Sheet Pile Cells	None
Quaywall 730	1941	670	334	1255 ft. by 40 ft.	Steel Sheet Piles & Precast Concrete Piles	None
Pier D	1946	484	282	1200 ft. by 60 ft.	Precast Concrete Piles	None
Supply Pier	1942	81	---	780 ft. by 120 ft.	Concrete subpiers	None
Quaywall 729	1922	---	---	475 ft. by 26 ft.	Concrete Frame Concrete Sheet Piles	None
Pier B	1946	484	282	1197 ft. by 60 ft.	Precast Concrete Piles	Repair 4 damaged piles above water; $8,000
Pier 9, Structure 823	1962	93	18	179 ft. by 80 ft.	Precast Concrete Piles & Concrete encased H-Piles	None

*Approximate overall dimensions indicated for principal axes at deck; refer to plans

Executive Summary Table (Continued)

Facility	Year Built or Modified	No. of Vertical Bearing Piles or Subpiers	No. of Batter Piles	Facility Size* Length by Width	Structure Type	Recommended Repairs and Estimated Cost
Small Boat Pier Structure 852	1972	82	32	175 ft. by 57 ft.	Steel H-Piles	Repair damaged encasement of 1 pile; $500
Mooring A	1946	135	42	1060 ft. by 16-55 ft.	Precast Concrete Piles & Steel Sheet Pile Cells	None
Pier 3	1943	471	---	1400 ft. by 120 ft.	Precast Concrete Piles & Concrete Subpiers	None
Quaywall 696	1940	150	30	89 ft. by 51 ft.	Steel Sheet Piles & Precast Concrete	None
Quaywall 693	1940	50	10	253 ft. by 51 ft.	Steel Sheet Piles & Precast Concrete	None
Pier 4	1914	287	9	1400 ft. by 80 ft.	Precast Concrete Piles & Concrete Subpiers	Repair 1 pile; $5,000
Pier 5	1923	160	---	1200 ft. by 80 ft.	Concrete subpiers	None
Pier 6	1926	235	4	1317 ft. by 100 ft.	Concrete subpiers	None
Pier 7	1943	75	---	697 ft. by 90 ft.	Concrete subpiers	None
Pier 8	1911	178	10	502 ft. by 62 ft.	Precast Concrete Piles & Concrete subpiers	None

*Approximate overall dimensions indicated for principal axes at deck; refer to plans

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INSPECTION AND ASSESSMENT

AT

PUGET SOUND NAVAL SHIPYARD

BREMERTON, WASHINGTON

1. INTRODUCTION

1.1 Purpose and Scope

This report consists of the results of a detailed underwater inspection and assessment of submerged portions of many of the Navy waterfront facilities at the Puget Sound Naval Shipyard in Bremerton, Washington.

The investigation was conducted by Collins Engineers, Inc. for the Ocean Engineering and Construction Project Office of the Chesapeake Division, Naval Facilities Engineering Command as Task No. 2 of Contract N62477-81-C-0161.

The task consisted of furnishing the engineering services necessary to achieve an assessment of the apparent general condition of the structural members supporting Piers 3, 4, 5, 6, 7, 8, 9, 852, B and D; the Supply Pier; Mooring Platforms A, E, F and G; and Quaywalls 693, 694, 729, and 730 at the Shipyard. The facilities are constructed of concrete sheet piling, steel sheet piling, concrete piles, concrete subpiers, and steel H-piles.

1.2 Field Investigation Phase

The field investigation phase consisted of an underwater inspection of submerged pilings and bulkheads by a structural engineer-diver and technician-divers. The inspection was conducted in such detail as to permit a general assessment of the physical condition of the portions of the substructure that are submerged or subject to frequent wetting by wave or tidal action. A visual "swim-by" inspection was made of all facilities under investigation and a more detailed visual and tactile inspection was made of selected facility components. This detailed inspection included scraping and wire brush cleaning of the components.

The "swim-by" inspection was conducted in accordance with the government's guidelines for Level I inspections, and the

detailed inspection was conducted in accordance with the guidelines for Level II Inspections. Those levels of inspection are defined below.

Level I: General Inspection: This type of inspection is essentially a "swim-by" overview, which does not involve cleaning of any structural elements, and therefore can be conducted much more rapidly than the other levels of inspection. The Level I inspection should confirm as-built structual plans and detect obvious major damage or deterioration due to overstress (collisions, ice), severe corrosion, or extensive biological attack. The underwater inspector shall generally rely primarily on visual and tactile observations to make condition assessments. Visual documentation (utilizing underwater television and/or photography) may be included with the quantity and quality adequate for documentation of the findings which will be representative of the facility condition.

Level II: Detailed Inspection: This type of inspection will often require prior cleaning of the structural elements. The purpose of the Level II inspection is to detect surface damage which may be hidden by marine growth and/or deteriorated surface material. Generally, cleaning is time consuming, and therefore is generally restricted to areas that are critical or which may be representative of the entire structure itself. The amount and thoroughness of cleaning to be performed is governed by what is necessary to discern the exterior physical condition of the structural members, and to rapidly obtain nominal measurements by means of simple instruments such as calipers, measuring tapes, and ice picks. This level of assessment should identify areas that have been mechanically damaged or are in advanced states of deterioration. Visual documentation (utilizing underwater television and/or photography) and a sampling of physical measurements should be included with the quantity and quality adequate for documentation of the findings which will be representative of the facility condition.

1.3 Assessment Phase

The assessment phase of the investigation consists of documenting the configuration of the existing structures; summarizing the conditions encountered during the field inspection; evaluating their structural significance; and recommending actions that should be taken to insure long-term cost-effective maintenance and utilization of the facilities. Estimated costs for repairs are also included.

The assessment is presented in this report complete with sketches depicting the configuration of the existing facilities, and sketches and photographs illustrating existing conditions.

2. ACTIVITY DESCRIPTION

2.1 Name of Activity

Puget Sound Naval Shipyard, Bremerton, Washington

2.2 Location of Activity

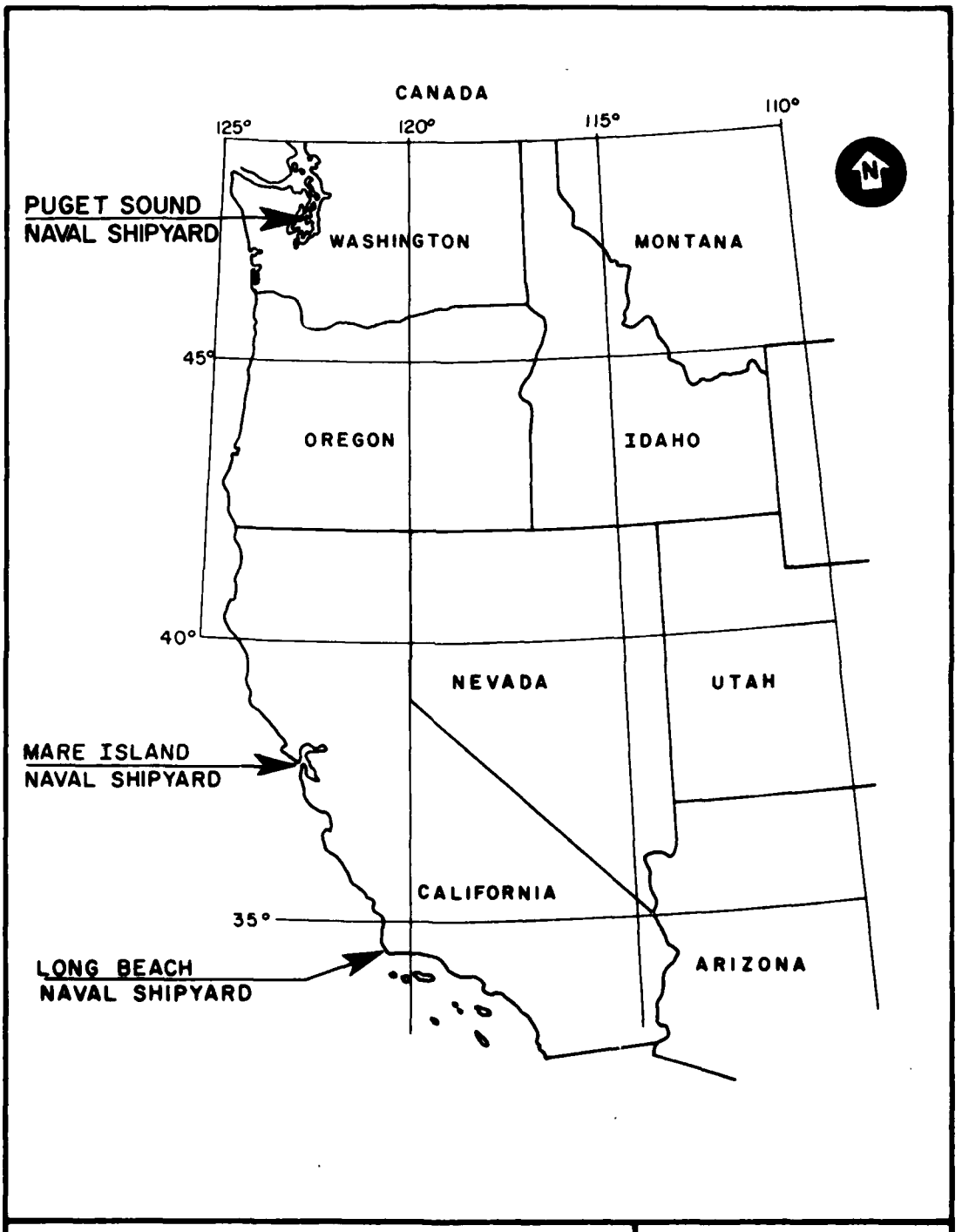
The Puget Sound Naval Shipyard is located in the City of Bremerton , Kitsap County, Washington on the Kitsap Peninsula. The Shipyard borders on Sinclair Inlet of Puget Sound, fourteen miles west of Seattle, with easy access to the Pacific Ocean. It is situated at Longitude 122°-38'W and Latitude 47°-33'N. Puget Sound Naval Shipyard is approximately 55 miles south of the Canadian border as shown on Figure 1, following this page. The Puget Sound Naval Shipyard is one of three Naval Shipyards on the Pacific Coast, the others being Mare Island Naval Shipyard in the San Francisco Bay area, and Long Beach Naval Shipyard in the Los Angeles area.

The Bremerton Naval Complex has grown from a small Naval Station in 1891 to an activity which today includes a Naval shipyard, supply center, hospital, reserve fleet and associated community personnel support facilities. The Complex centers on the Puget Sound Naval Shipyard located in the City of Bremerton, Washington. Figure 2 on Page 2-3 shows the Puget Sound area. Figure 3 on Page 2-4 is an overall aerial view of the Shipyard area. Within the Shipyard boundaries are the Marine Barracks (MARBKS), the Naval Hospital (NAVHOSP), the headquarters of the Naval Supply Center (NSC), the Naval Inactive Ship Maintenance Facility (INACTSHIPFAC), the Navy Publications and Printing Service Office (NPPSO), and the Navy Commissary Store (COMSYSTO). The entire Naval complex occupies an area of approximately 283 acres of hard land and 334 acres of submerged land.

Added to the above area are non-contiguous components which include Camp Wesley Harris Small Arms Firing Range, five miles from the Shipyard; Camp McKean, the Navy recreation facility on Kitsap Lake, some three miles from the Shipyard; the Naval Supply Center Manchester Annex, four miles east of the Shipyard; the Jackson Park Housing project at Bremerton Annex, three miles northwest of Bremerton; East Park Housing in East Bremerton; and Olalla Housing, 18 miles from the Shipyard.

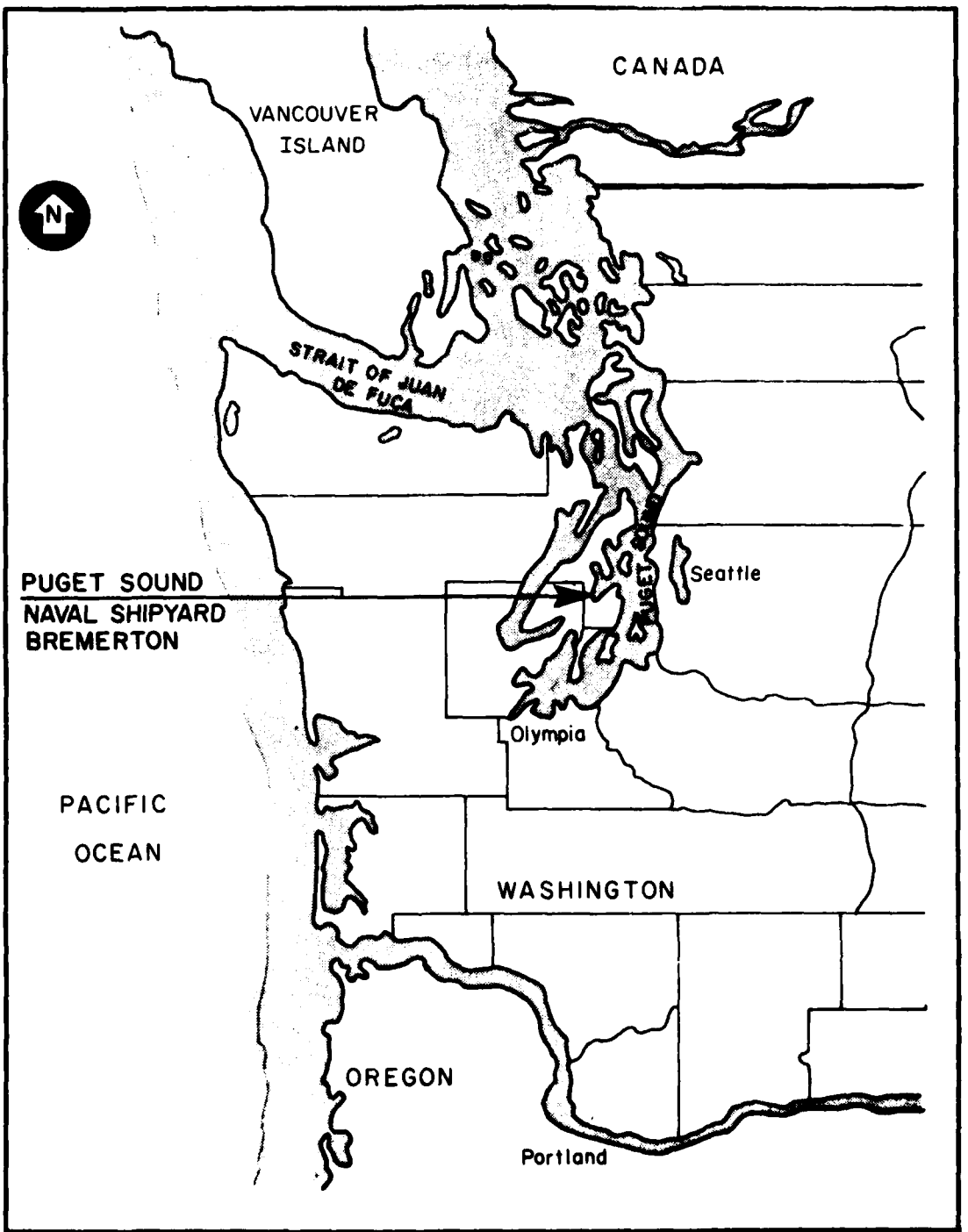
2.3 Mission of Activity

The mission of the Puget Sound Naval Shipyard is to provide logistic support for assigned ships and service craft; to perform authorized work in connection with construction, conversion, overhaul, repair, alteration, drydocking, and outfitting of ships and craft, as assigned; to perform manufacturing research, development and test work, as assigned; and to provide services and materials to other activities and units, as directed by competent authority.



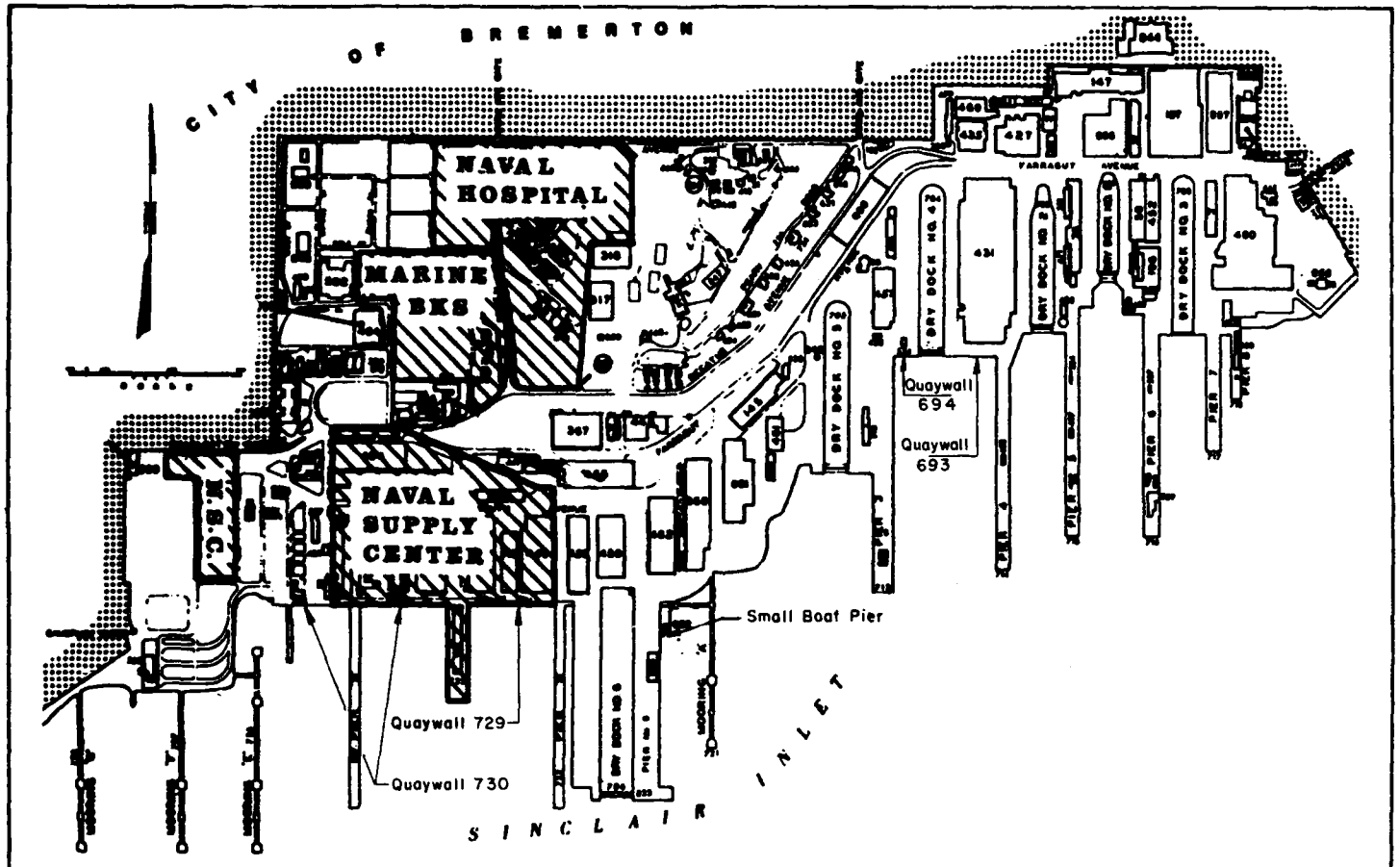
LOCATION MAP
PUGET SOUND NAVAL SHIPYARD
BREMERTON, WASHINGTON

FIGURE 1



AREA MAP
PUGET SOUND NAVAL SHIPYARD
BREMERTON, WASHINGTON

FIGURE 2



FACILITY MAP
PUGET SOUND NAVAL SHIPYARD
BREMERTON , WASHINGTON

FIGURE 3

The Shipyard has a range of shipbuilding and repair capabilities exceeding that of any other Naval or private shipyard in the country. It has the largest drydock in the Navy and is the only facility on the West Coast capable of accomodating aircraft carriers in the Forrestal and Enterprise class on a completely adequate basis.

2.4 Description of Activity

This program is concerned with the waterfront facilities which provide the interface between ships and shore support activities. These facilities are located within a secured section of the shipyard designated as the "Industrial Area". The principal waterfront facilities are shown in Figure 3.

Figure 4, following this page, identifies the Shipyard berthing of the principal piers and land mooring by their length and maximum ship capacity.

2.5 Environmental Data

2.5.1 Topography

The core area of Bremerton consists primarily of a series of north-south ridges with a relatively flat, mesa-like surface on the eastern end. This flat area, which contains the Naval Shipyard and the Bremerton central business district slopes down to the surrounding water on the north, east and south sides.

The native groundcover in the area consists of Douglas Fir, Cedar, and Hemlock. Within a distance of 25 to 40 miles in a westerly direction from Bremerton, the Olympic Mountains rise to elevations of 4,000 to 7,000 feet. The higher peaks are covered with snow most of the year and there are several glaciers on Mount Olympus (Elevation 7,954 feet). In an easterly direction and within a distance of 60 miles, the Cascade Mountain range rises to average elevations of 5,000 to 7,000 feet with snowcapped peaks in excess of 10,000 feet. The Olympic Mountains shield this region from the more intense winter storms moving inland from the North Pacific, and the Cascades are very effective in protecting Puget Sound lowlands from the higher summer and lower winter temperatures experienced east of this range.

2.5.2 Climate

The climate is predominantly a mid-latitude, west coast, marine-type with cool summers, rather mild winters, moist air and a small range in temperature. The position and intensity of the semi-permanent high and low pressure regions over the North Pacific have a decided influence on the climate. A clockwise circulation

FIGURE 4

TABLE OF PIERS, MOORINGS AND QUAYWALLS

Characteristics for Puget Sound Naval Shipyard Facilitie

Structure (Structure No.)	Yr. Built/ Reconstructed	Length	Maximum Capacity	Berthing Area
Mooring G (728)	1946	925 ft. 925 ft.	Inactive Ships; Single and Multiple Moorings	West East
Mooring F (724)	1946	925 ft. 925 ft.	Inactive Ships; Single and Multiple Moorings	West East
Mooring E (726)	1946	1,040 ft. 1,215 ft.	Inactive Ships; Single and Multiple Moorings	West East
Quaywall (730)	1941	1,255 ft.		
Pier D (724)	1946	1,200 ft.	Carriers	
Supply Pier (723)	1942	780 ft.	Supply Ship	
Quaywall Structure (729)	1922	475 ft.		
Pier B (722)	1946	1,200 ft.	Carriers	
Pier 9 (823)	1962	179 ft.	Dry Dock Caisson and Tugs	
Small Boat Pier (852)	1972	175 ft.	Small Craft	

Structure (Structure No.)	Yr. Rec
Mooring A (721)	19
Pier 3 (713)	19
Quaywall (694)	19
Quaywall (693)	19
Pier 4 (714)	19
Pier 5 (715) 5A & 5C 5B & 5D	19
Pier 6 (716) 6A & 6B 6B & 6D	19
Pier 7 (717) 7A 7B	19
Pier 8 (718) 8B	19

FIGURE 4

TABLE OF PIERS, MOORINGS AND QUAYWALLS

teristics for Puget Sound Naval Shipyard Facilities

city	Berthing Area	Structure (Structure No.)	Yr. Built/ Reconstructed	Length	Maximum Capacity	Berthing Area
ps; ultiple	West East	Mooring A (721)	1946	1,040 ft. 840 ft.	Inactive Ships; Single and Multiple Moorings	West East
ips; Multiple	West East	Pier 3 (713)	1943	700 ft. 1,500 ft.	Cruiser CVA, CVA, (N)	West East
ips; Multiple	West East	Quaywall (694)	1940	84 ft.		
		Quaywall (693)	1940	253 ft		
		Pier 4 (714)	1914	1,275 ft. 1,410 ft.	CVA Cruiser & DD	West East
		Pier 5 5A & 5C 5B & 5D (715)	1923	1,200 ft. 1,360 ft.	Cruiser & DD CVA (not if CVA at 6A & 6C)	West East
		Pier 6 6A & 6B (716) 6B & 6D	1926	1,360 ft. 1,200 ft.	CVA (not if CVA at 5B & 5D) Cruiser & DD	West East
		Pier 7 7A 7B (717)	1943	730 ft. 730 ft.	Cruiser DD and Tugs	West East
isson		Pier 8 8B (718)	1911	330 ft.	Tugs	

2

of air around the high pressure center, which spreads northward into the Gulf of Alaska in the later spring and summer, brings a flow of air from a northwesterly direction into the State. This air is comparatively cool and dry, resulting in a dry season beginning in late Spring and reaching a peak in July and August. In mid-summer, it is not unusual for two to four weeks to pass with only a trace of precipitation. Occasionally, hot, dry air from east of the Cascades reaches the Puget Sound area for brief periods. The relative humidity is low under these conditions and the hottest days are not unpleasant. The average afternoon temperature during the warmest summer months is in the 70's and the nighttime readings are in the 50's. Each summer, temperatures can be expected to rise above 80°F on ten to twenty days and reach 90°F or slightly higher on three to five days.

During the fall and winter, the low pressure center located near the Aleutian Islands intensifies, moves southward and the "High" becomes smaller and also moves southward. A circulation of air around these two pressure systems brings a prevailing flow of warm, moist air from a southwesterly direction into the State. This results in a rainy season beginning about October, reaching a peak in midwinter, then gradually decreasing in the spring. Snowfall is generally light and the depth on the ground in the lower elevations near the Shipyard seldom exceeds three to six inches; however, snow can be expected to increase with distance from the water and with an increase in elevation. The average afternoon temperature in midwinter is in the 40's and nighttime readings are in the 30's.

The number of days with minimum temperatures below freezing ranges from 19 to 79. Occasionally, cold air from Canada or east of the Cascades will reach this area for brief periods. Skies are usually clear under these conditions. Minimum temperatures may range from 10 to 20 degrees and maximums may fail to rise above freezing for a few days. Average summer (June through August) temperatures are 73°F maximum and 51°F minimum, with record extremes of 99°F and 40°F. Average winter (December through February) temperatures are 47°F maximum and 35°F minimum, with record extremes of 62°F and 10°F.

Tidal range at the site is:

	P.S.N.S.*	NOS**
Extreme High Water	124.8	15.4
Mean Higher High Water	121.1	11.7
Mean High Water	120.2	10.8
Mean Sea Level	116.2	6.8
Mean Lower Low Water	109.4	0
Extreme Low Water	105.0	-4.4

*P.S.N.S. = Puget Sound Naval Shipyard Datum
**NOS = National Ocean Survey Datum

2.5.3 Soils Characteristics

Beneath the waters of Sinclair Inlet a variable thickness of soft and plastic post-glacial estuarine deposits overlie glacial outwash and glacial till. The transition between the estuarine and the outwash materials is relatively sharp. Fine grained materials were sorted and shifted by tidal movements and gradually dropped from suspension to form the upper deposit of soft, green organic clay. Underlying the clay is a complex arrangement of granular materials, stratified at their top and heterogeneous in character below, becoming increasingly coarse grained with depth.

The bluff rising behind the Shipyard is composed of outwash materials showing the distinct stratification of torrential deposits. The area of the Bremerton Annex which rises from Ostrich Bay generally is composed of heterogeneous glacial till but exposures in cuts show stratified granular outwash lying above and within the till at certain locations.

From the time the area was first occupied, conditions on the waterfront of the Shipyard have been altered greatly. Seaward of the original shoreline of 1889 (near the toe of the bluff), fill had been placed on the surface of the original beach to form what is now the level yard area. Most of the material for this fill had been obtained from excavations along the face of the bluff. In addition to the land reclamation projects along the waterfront, the Shipyard had increased its usuable land area by filling the marshy area located in the northwest corner of the Shipyard.

The area demonstrates considerable differences in soil types and bearing capacities. A soils investigation for this specific area states that a surface ground fill exists in depths ranging from two to six feet overlying a relatively soft peaty silt (probably original creek bottom) which, in turn overlies a medium dense to very dense sand and silt, varying from four to sixteen feet in depth. This means that, while the surface represents a solid layer of earth (fill), there is a soft sandwich of silt which, when subjected to pressure, will deform and cause differential settlement in a structure. Under this type of soil condition, the normal remedy is to drive piles into the dense strata to support the foundation and floor slab.

The upland soils in the Shipyard have been classified as alderwood loam, which is a brown to gray gritty loam containing small rounded iron-cemented pellets called "shot". The color becomes lighter with the depth. At about a 30-inch depth, a silica-cemented hardpan layer is generally encountered which restricts drainage to some extent.

2.5.4 Seismic Activity

Earthquake information is available from reports of seismic activity in the Pacific Northwest dating back to 1841. Since that date, 39 strong-motion earthquakes have been noted in the Puget Sound area. Information on these prior to 1930 is

sketchy, but adequate to establish facts. A strong-motion earthquake is defined as having an intensity of six or more on the Modified Mercalli Scale which is an evaluation of real damage rather that the Richter Scale which is based on the magnitude of total energy released.

On 13 April 1949, a major shock of intensity 7, Modified Mercalli, occurred in this area. Significant damage was sustained by Shipyard buildings due to this shock. Estimates of property damage in the Puget Sound Area ran up to twenty million dollars. Due to seismic activity, the Puget Sound area has been placed in Zone 3, Major Damage, on the seismic probablility map contained in NAVFAC Publication P-355.

On 29 April 1965, at 0829 hours, this area experienced its most recent major shock. The official report by the USC&GS and leading seismologists in the area state that the duration was 45 seconds and the energy release was 6.5 on the Richter Scale (7 on the Modified Mercalli Scale). This earthquake caused substantial damage in the area and to certain buildings within the shipyard.

3. PROJECT DESCRIPTION

3.1 Facilities Inspected

Mooring G
Mooring F
Mooring E
Quaywall Structure 730
Pier D
Supply Pier
Quaywall Structure 729
Pier B
Pier 9; Structure 823
Small Boat Pier; Structure 852
Mooring A
Pier 3
Quaywall Structure 694
Quaywall Structure 693
Pier 4
Pier 5
Pier 6
Pier 7
Pier 8

3.2 Description of Facilities

The following sections describe the structural configuration of each facility. The figures included for each facility were developed from available drawings and inspection reports. These figures may be found on the page or pages immediately following the descriptive section. These documents were verified as to their general conformance with actual field conditions by visual observations.

Design load data, where available is summarized for each structure. It should be noted that special equipment design loads or permissible load reductions for specific elements are generally not shown in these summaries.

Most of the facilities are protected from vessels by timber fender pile systems and camels.

The underwater visibility at the time of the inspection averaged from ten to fifteen feet. All water depths described in the following section are referred to Mean Lower Low Water, Elevation 0.00, N.O.S. Datum.

In describing the underwater structures, the terms "piles" and "piling" refer to timber piles, steel sheet piles, steel H-piles, precast concrete bearing piles, and precast concrete sheet piles. The term "subpier" refers to cast-in-place concrete shafts, and belled foundations, where present.

3.2.1 Mooring G

Mooring G is approximately 925 ft. long. It consists of two steel sheet pile cloverleaf shaped cellular cofferdam islands each supporting a reinforced concrete deck approximately 51 ft. by 55 ft. These two islands and the shore are connected by cast-in-place reinforced concrete beam and slab decks supported by two rows of vertical and batter precast concrete piles. The deck structures are generally 16 ft. wide.

The water depth near the outboard island is approximately 50 ft. At the inboard end of the mooring platform, the riprap shoreline slopes beneath the structure.

Refer to Figure 5 for a plan of the mooring platform and typical details showing the configuration of the structure.

3.2.2 Mooring F

Mooring F is similar to Mooring G. Refer to Figure 6.

3.2.3. Mooring E

Mooring E is similar in construction to Mooring G, but it has four steel sheet pile cellular cofferdam islands. It is approximately 1,215 ft long and it is connected to shore by a 127 ft long precast concrete pile supported deck at right angles to the longitudinal axis of the mooring platform. Refer to Figure 7.

3.2.4. Quaywall Structure 730

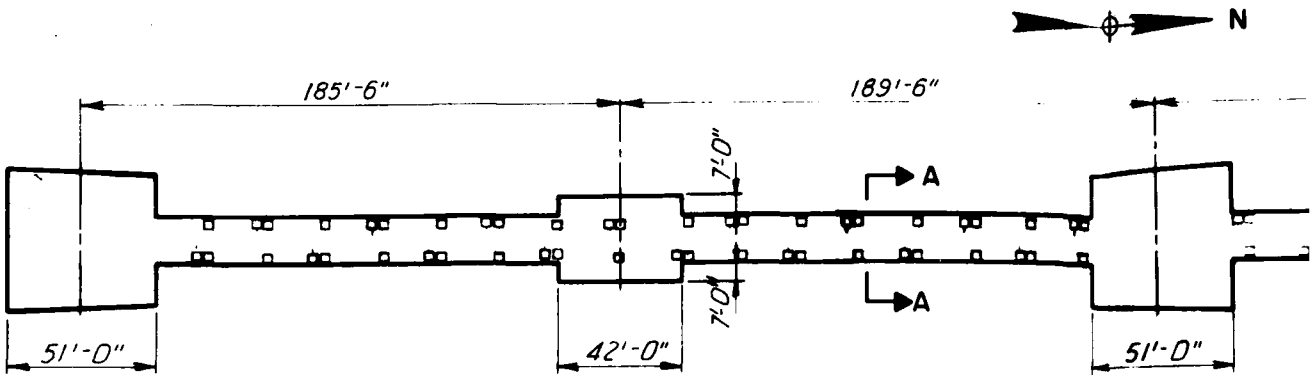
Quaywall Structure 730 extends in an approximately east-west direction from the Supply Pier to the west end of the active portion of the Shipyard for a total length of about 1,255 ft. The structure is approximately 40 ft. wide and is used for material storage and vehicle parking. At the west end, the structure turns north for approximately 225 ft. The quaywall consists of a steel sheet pile cutoff wall, and vertical and batter precast concrete piles supporting a cast-in-place reinforced concrete deck.

A riprap slope wall extends above the waterline at the sheet pile cutoff wall. It is approximately 20 to 25 ft. deep at the front face of the structure.

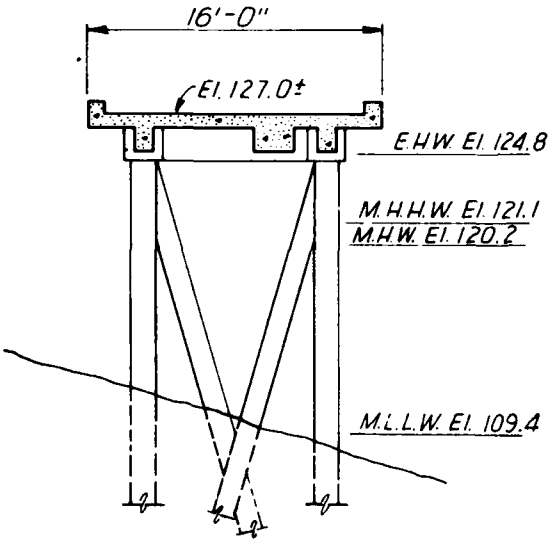
Refer to Figure 8 for a plan of the quaywall and a typical section showing the configuration of the structure.

3.2.5 Pier D

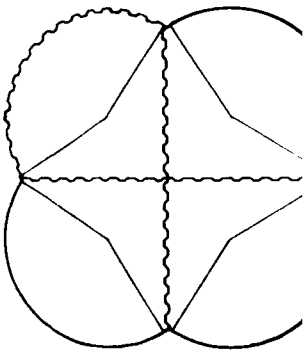
Pier D is approximately 1,200 ft. long and 60 ft. wide. The pier is generally constructed of precast concrete vertical and batter piles supporting a cast-in-place concrete beam and slab deck system. There are also what appear to be concrete filled steel pipe piles near the outboard end of the pier in Bents 3 to 5.



PLAN

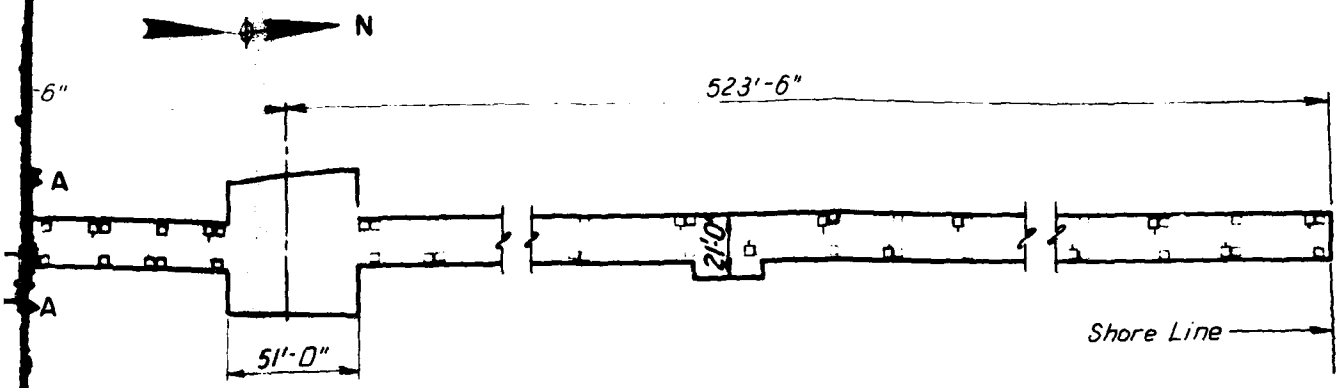


TYPICAL CROSS SECTION A-A



TYPICAL ISLAND CELL

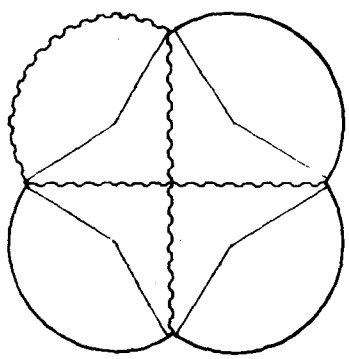
1



PLAN

DESIGN LOADS:
Deck Live Load : 200psf or H15 plus 15% Impact
Pile Brg. Cap. = 25T

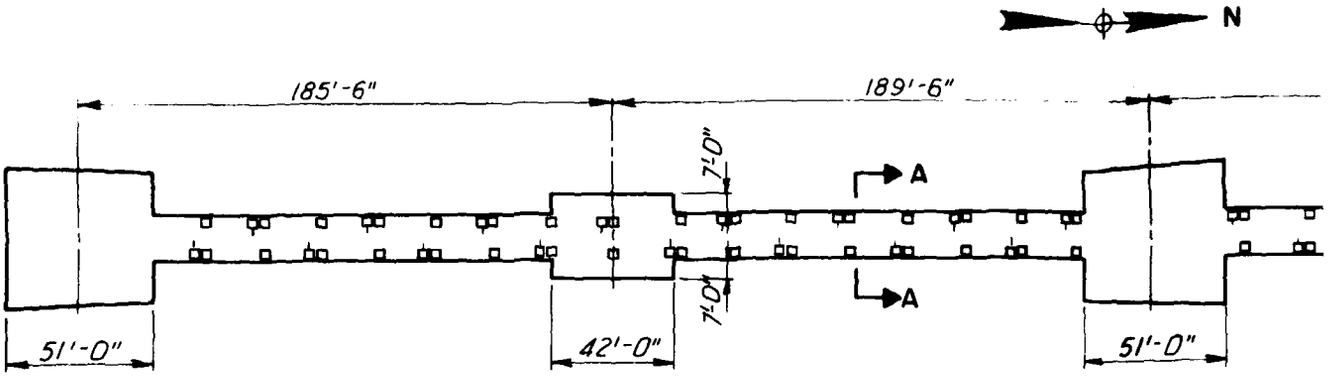
Note:
This drawing developed in part from Y. & D. Drwg. No. 428614, 428615 ; P.W. Drwg. No. 32033 & 32034.



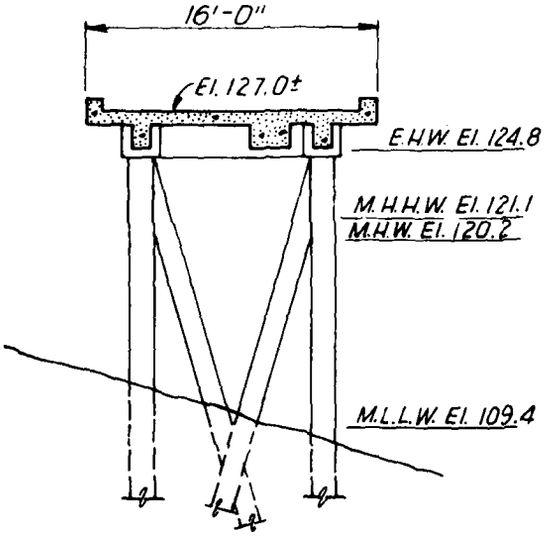
TYPICAL ISLAND CELL PLAN

PUGET SOUND NAVAL SHIPYARD	
MOORING G	
CHESAPEAKE DIVISION NAVAL FACILITIES ENGINEERING COMMAND WASHINGTON, D. C.	
COLLINS ENGINEERS, INC.	FIGURE 5

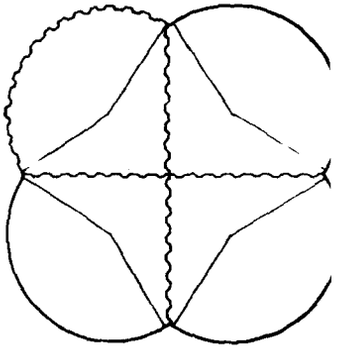
2



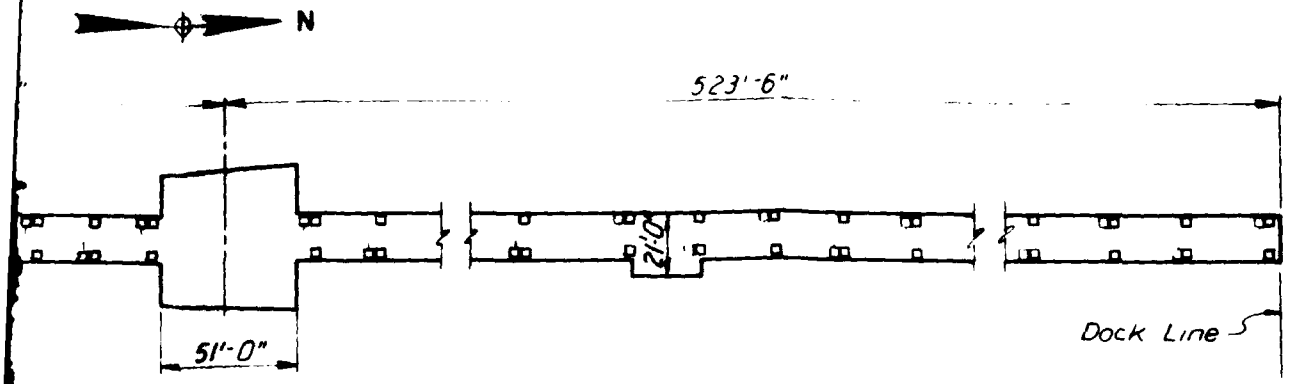
PLAN



TYPICAL CROSS SECTION A-A



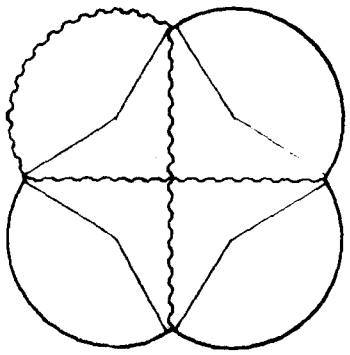
TYPICAL ISLAND CELL PI



PLAN

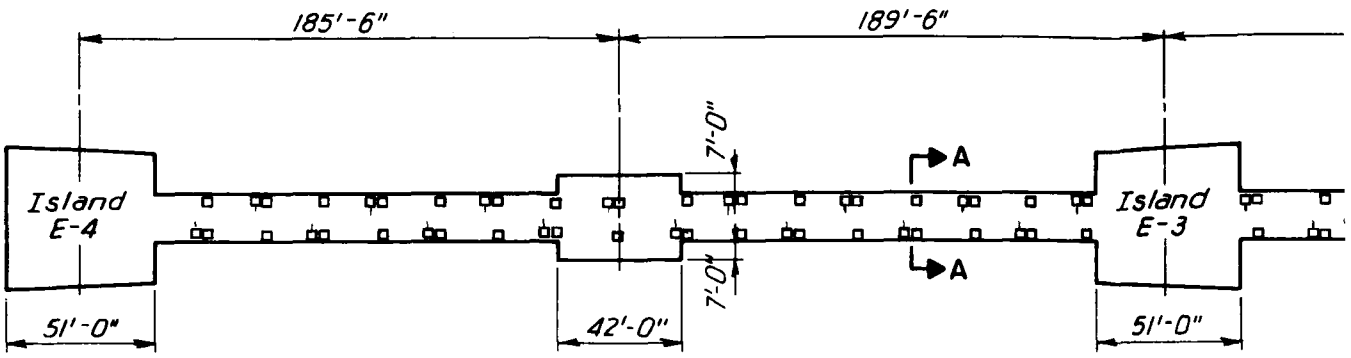
DESIGN LOADS:
Deck Live Load : 200psf or H15 plus 15% Impact
Pile Brg. Cap. = 25T

Note:
This drawing developed in part from Y. & D. Drwg. No. 428614, 428615 ; P.W. Drwg. No. 32033 & 32034.

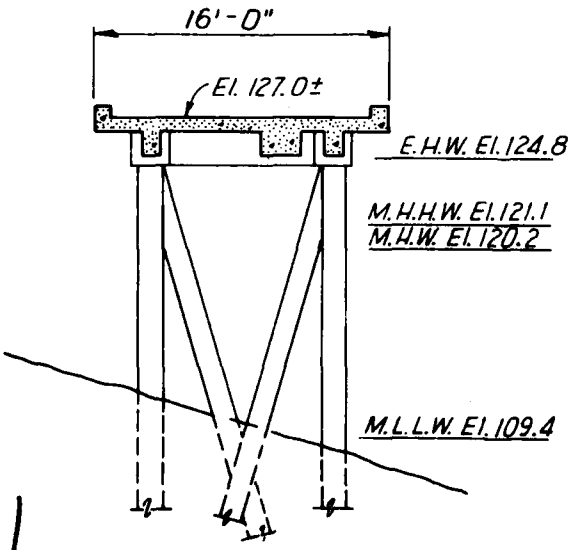


TYPICAL ISLAND CELL PLAN

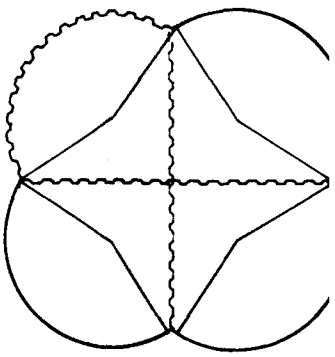
PUGET SOUND NAVAL SHIPYARD	
MOORING F	
CHESAPEAKE DIVISION NAVAL FACILITIES ENGINEERING COMMAND WASHINGTON, D.C.	
COLLINS ENGINEERS, INC.	FIGURE 6



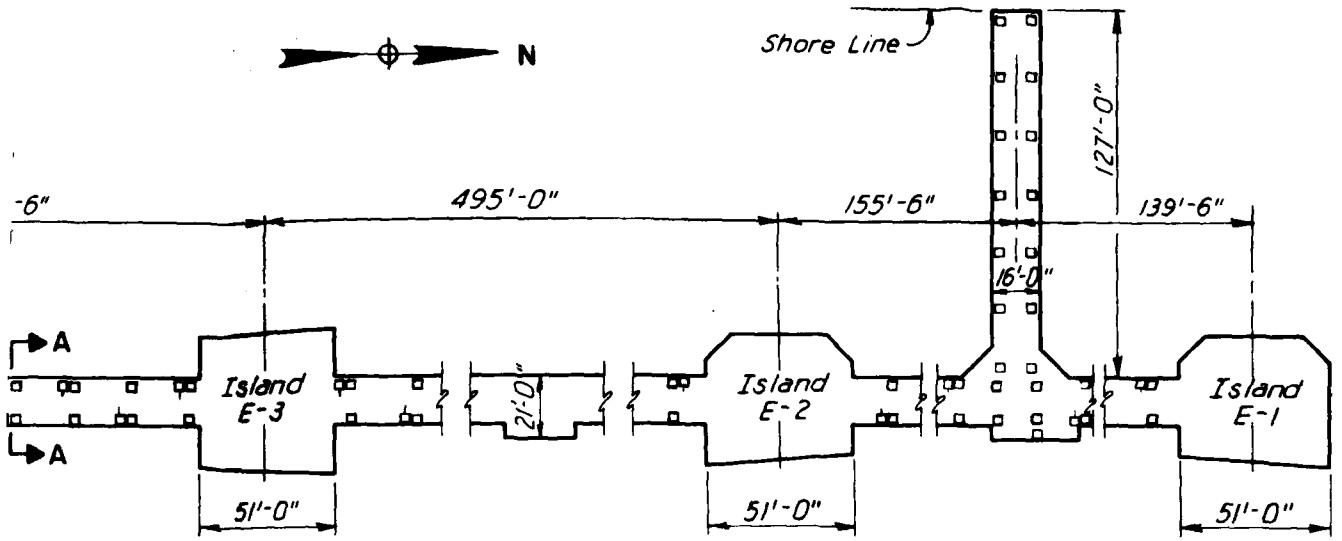
PLAN



TYPICAL CROSS SECTION A-A



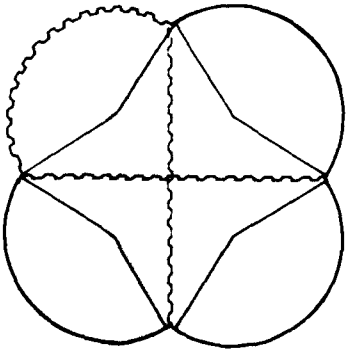
TYPICAL ISLAND CELL P



PLAN

DESIGN LOADS:
Deck Live Load: 200 psf or H15 plus 15% Impact
Pile Brg. Cap. = 25 T

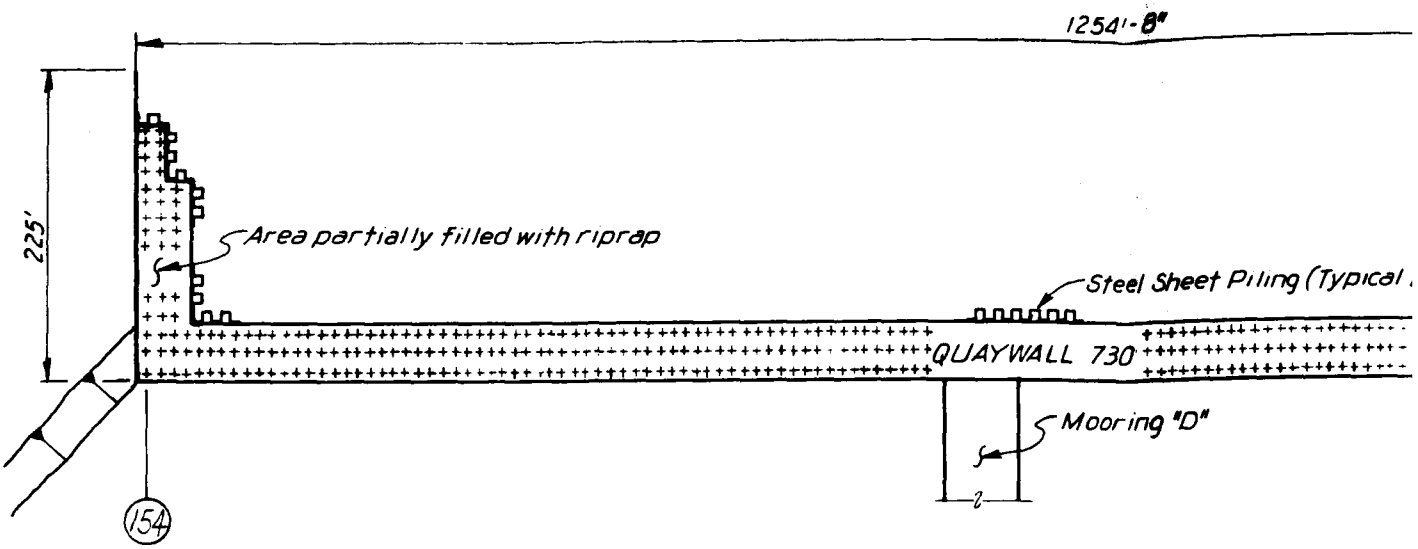
Note:
This drawing developed in part from Y.&D. Drwg. No. 428614, 428615 ; P.W. Drwg. No. 32033, 32034



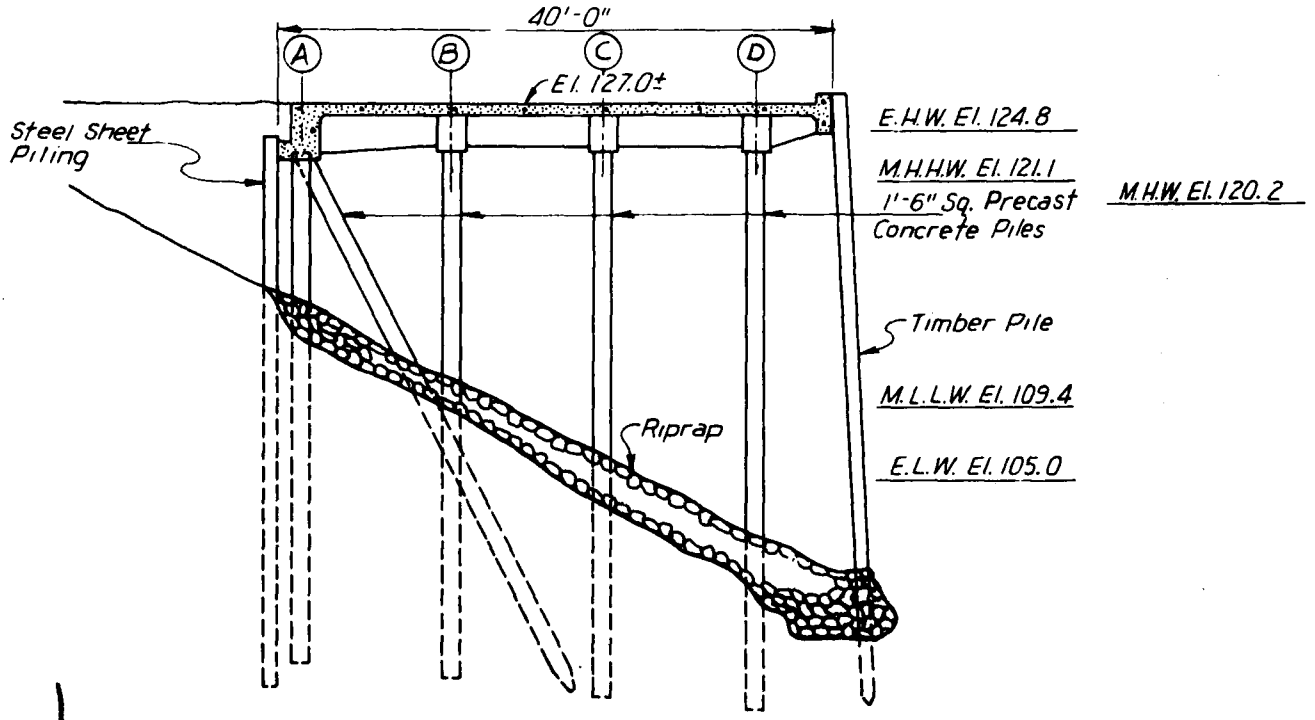
TYPICAL ISLAND CELL PLAN

2

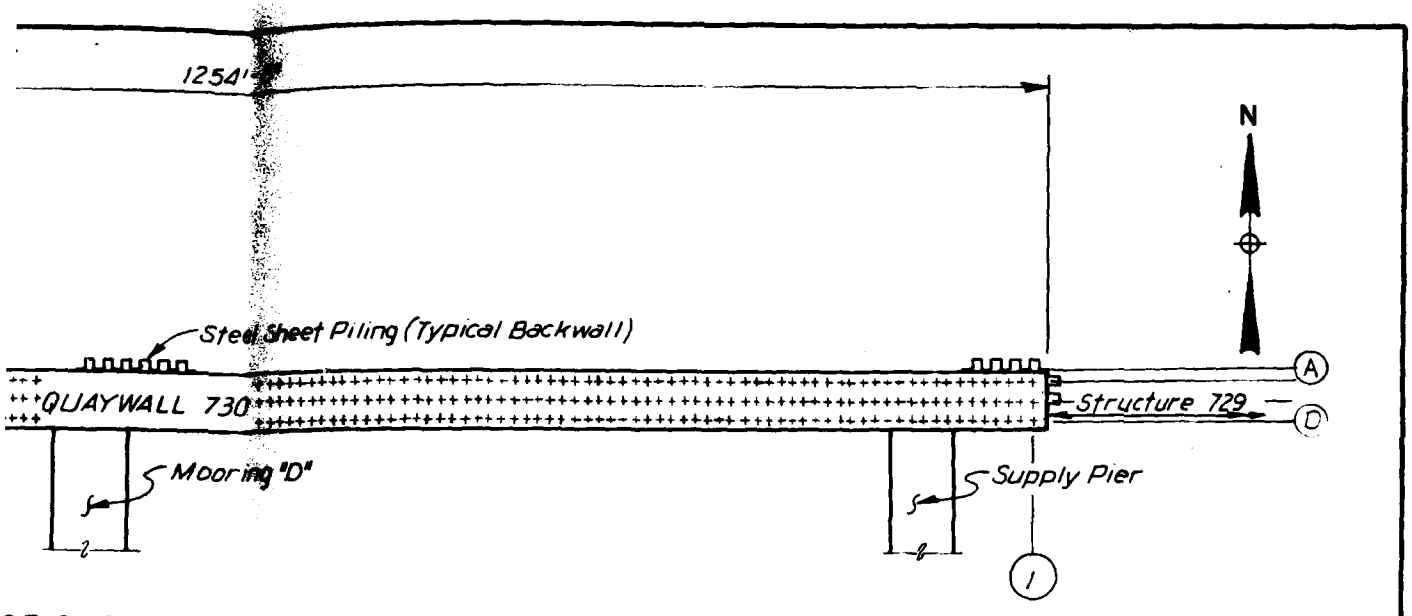
PUGET SOUND NAVAL SHIPYARD	
MOORING E	
CHESAPEAKE DIVISION NAVAL FACILITIES ENGINEERING COMMAND WASHINGTON, D. C.	
COLLINS ENGINEERS, INC.	FIGURE 7



PLAN OF QUAYWALL



TYPICAL TRANSVERSE SECTION



OF QUAYWALL

DESIGN LOADS:
Deck Live Load = 550 psf
Pile Loading = 64,000 Lb.

H.W. El. 124.8

H.H.W. El. 121.1

6" Sq. Precast
ncrete Piles

M.H.W. El. 120.2

NOTE:
This drawing developed in part from Y.&D. Drwg. No. 161,105, P.W. Drwg. No. 19,467

Timber Pile

L.L.W. El. 109.4

L.W. El. 105.0

PUGET SOUND NAVAL SHIPYARD	
QUAYWALL STRUCTURE 730	
CHESAPEAKE DIVISION NAVAL FACILITIES ENGINEERING COMMAND WASHINGTON, D.C.	
COLLINS ENGINEERS, INC.	FIGURE 8

2.

The water depth along the pier varies from approximately 25 ft at the inboard end to 40 ft at the outboard end. Generally, the water is 35 to 40 ft deep.

Refer to Figure 9 for a plan of the pier and a typical section showing the general configuration of the structure.

3.2.6 Supply Pier

The Supply Pier is approximately 800 ft long by 120 ft wide. The pier is generally constructed of three rows of 4 ft diameter cast-in-place concrete subpiers supporting a concrete beam and slab deck. At the inboard end of the pier, the first row of supports consists of three groups of eighteen one foot square precast concrete piles.

The water depth along the pier varies from approximately 20 ft at the inboard end to 40 ft at the outboard end. Generally, the water is 35 to 40 ft deep.

Refer to Figure 10 for a plan of the pier and a typical section showing the general configuration of the structure.

3.2.7 Quaywall Structure 729

This structure is approximately 475 ft long by 36 ft wide. It consists of a concrete deck slab supported along the length of the wall by a counterfort type concrete retaining wall and two rows of concrete columns. The wall and columns are supported by a concrete floor slab cast atop timber framing and timber piles, and a continuous line of precast concrete sheet piles along the outboard face.

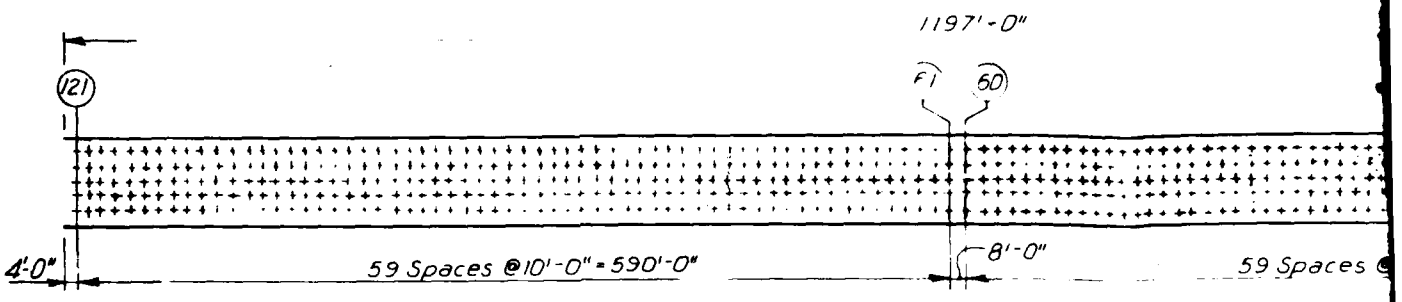
The water depth at the outboard face generally varies from 6 to 12 feet.

Refer to Figure 11 for a plan and a typical section showing the configuration of the structure.

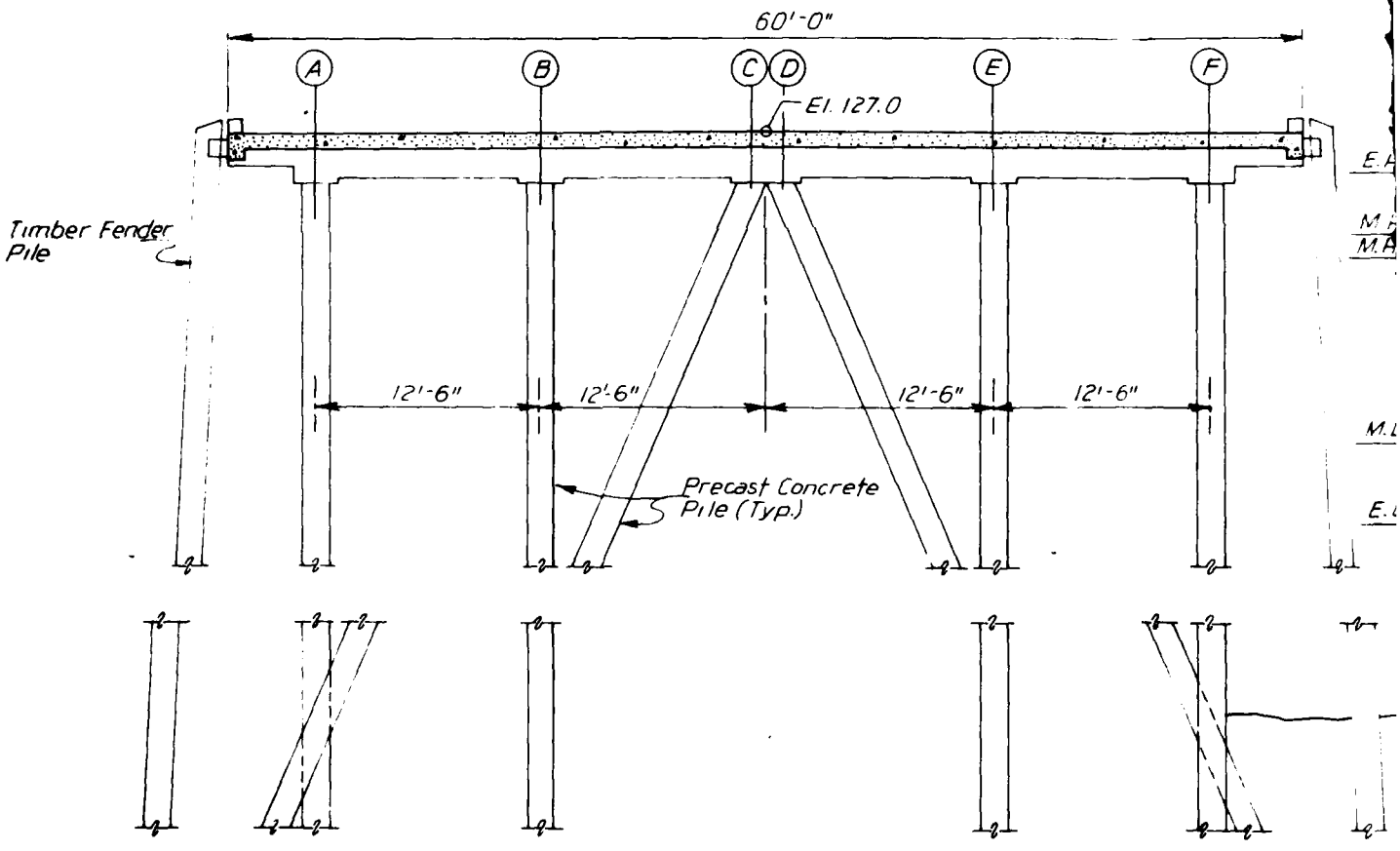
3.2.8 Pier B

Pier B is about 1,200 ft long and 60 ft wide. The pier is generally constructed of precast concrete vertical and batter piles supporting a cast-in-place concrete beam and slab deck system.

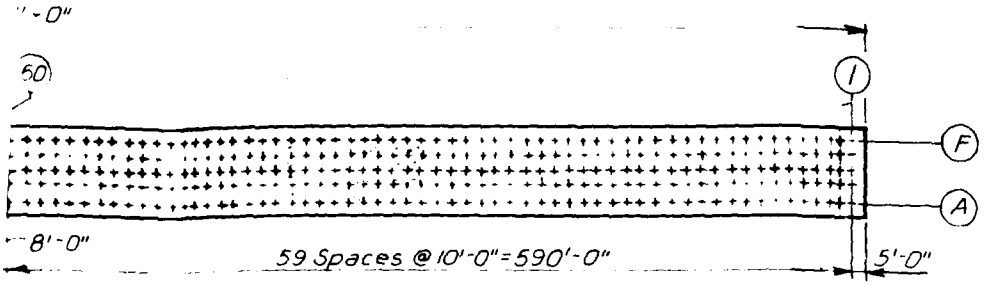
The water depth along the pier varies from approximately 14 ft at the inboard end to 50 ft at the outboard end. Generally, the bottom slopes downward from east to west so that the east line of piles are in approximately 35 to 40 ft of water, while the west line of piles is generally in 45 to 50 ft deep water.



PLAN



TYPICAL CROSS SECTION



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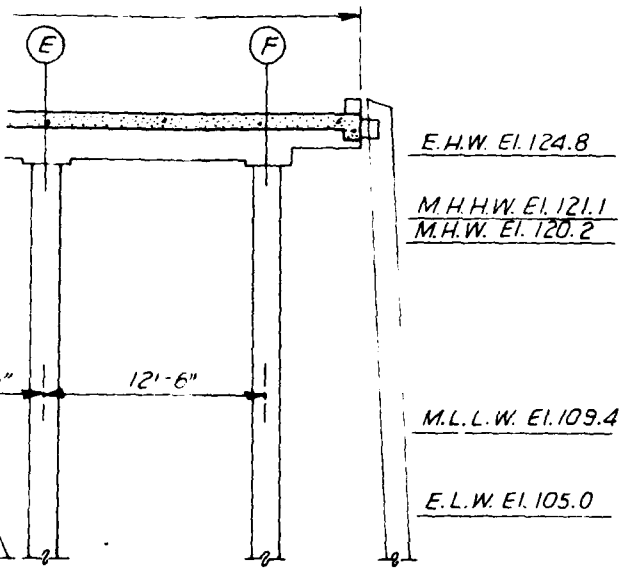
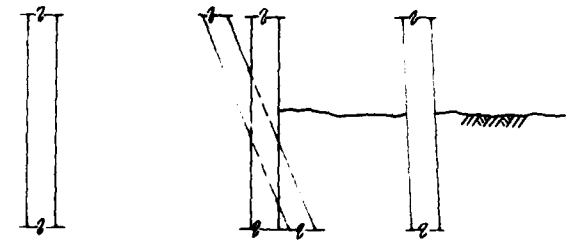


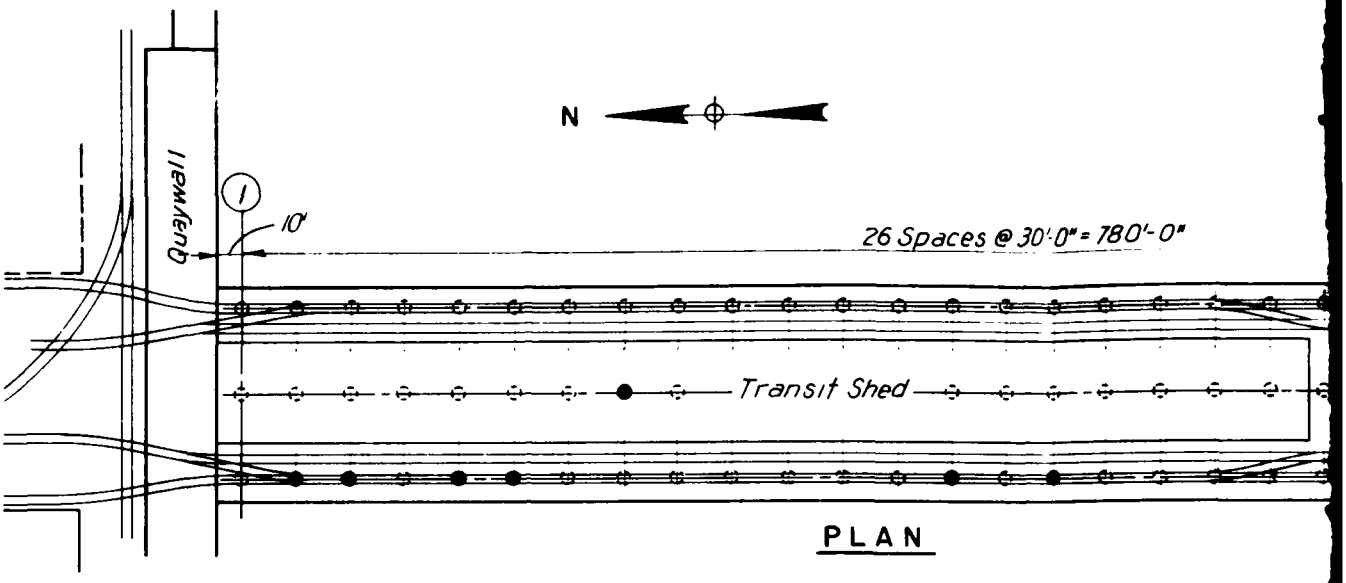


DESIGN LOADS:
Live Load: 600 psf or H20 plus 15% Impact or 35 K Load over Area 2'-6" square
Pile Brg. Cap.: 45 T

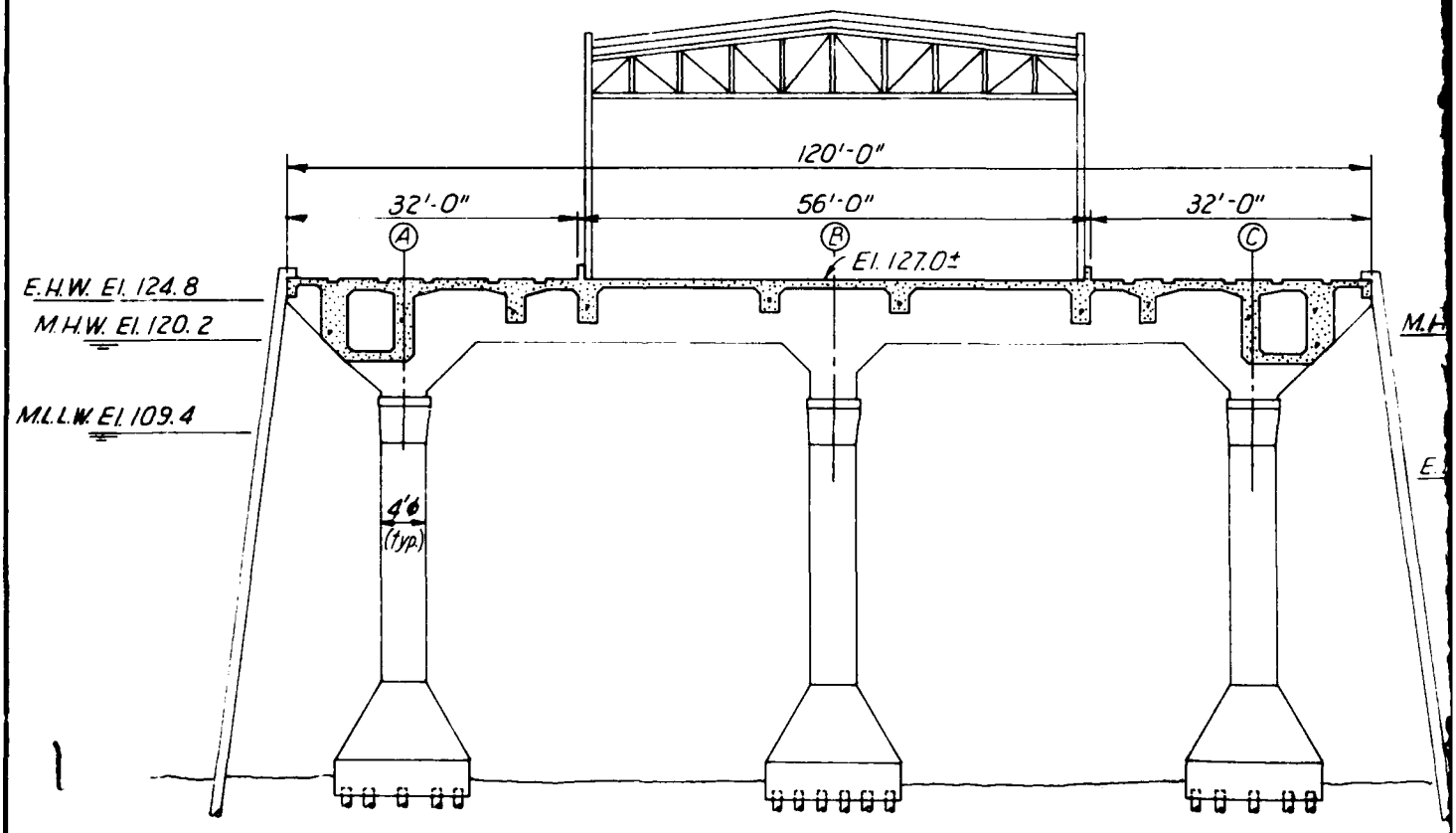
Note:
This drawing developed in part from Y & D Drwg. No. 428605, P.W. Drwg. No. 3202A

ON

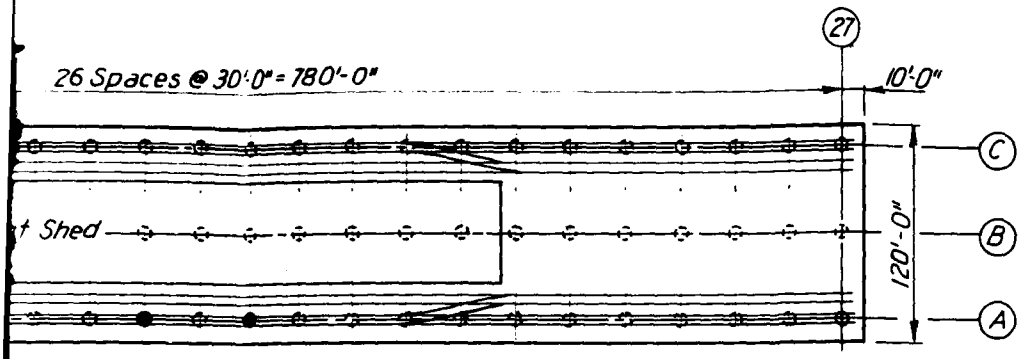
PUGET SOUND NAVAL SHIPYARD	
PIER D	
CHESAPEAKE DIVISION NAVAL FACILITIES ENGINEERING COMMAND WASHINGTON, D. C.	
COLLINS ENGINEERS, INC.	FIGURE 9



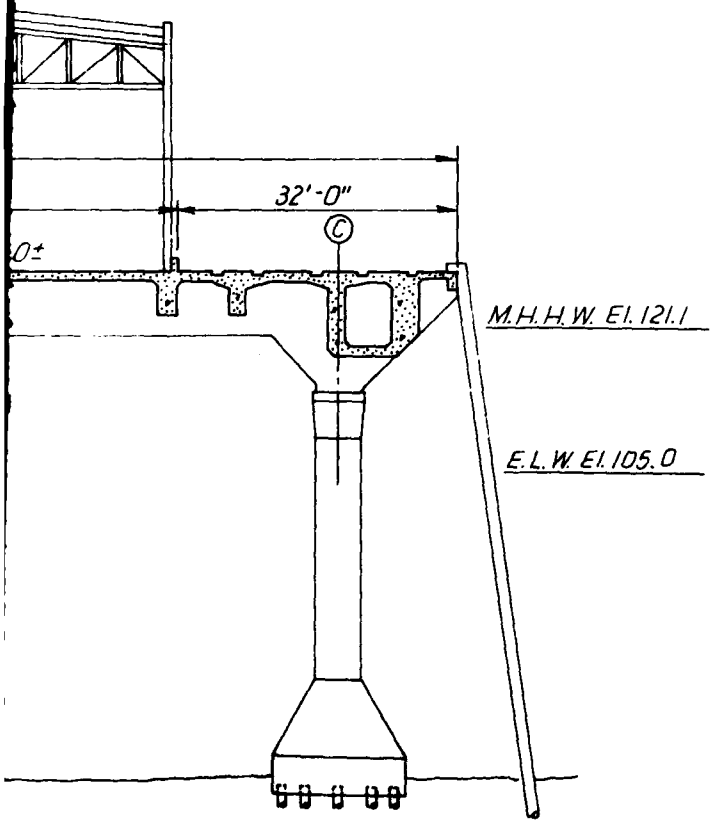
PLAN



TYPICAL CROSS SECTION



PLAN

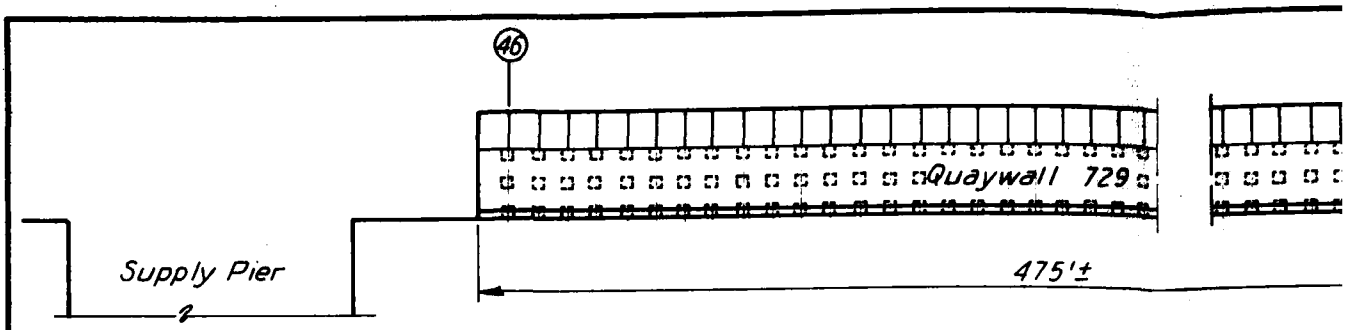


ECTION

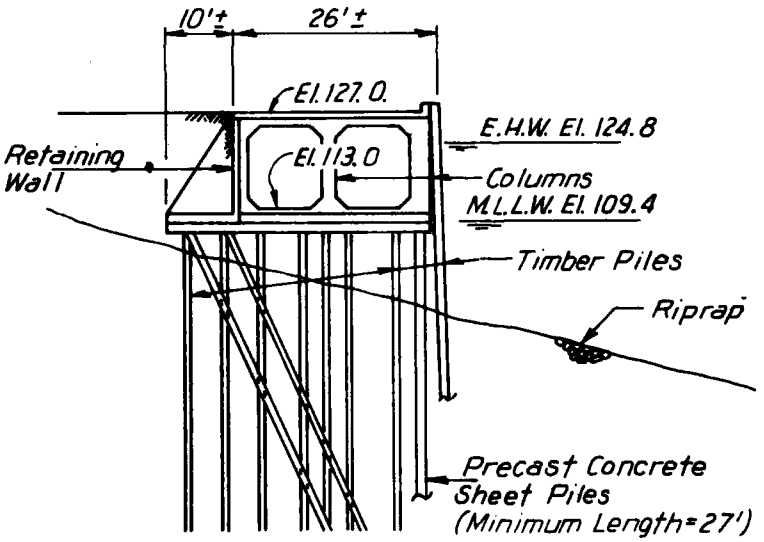
Design Live Load:
Deck = 600 psf

Note:
This drawing developed in part from P.W. Drwgs. 19751 & 20683
• Subpiers inspected to Level II

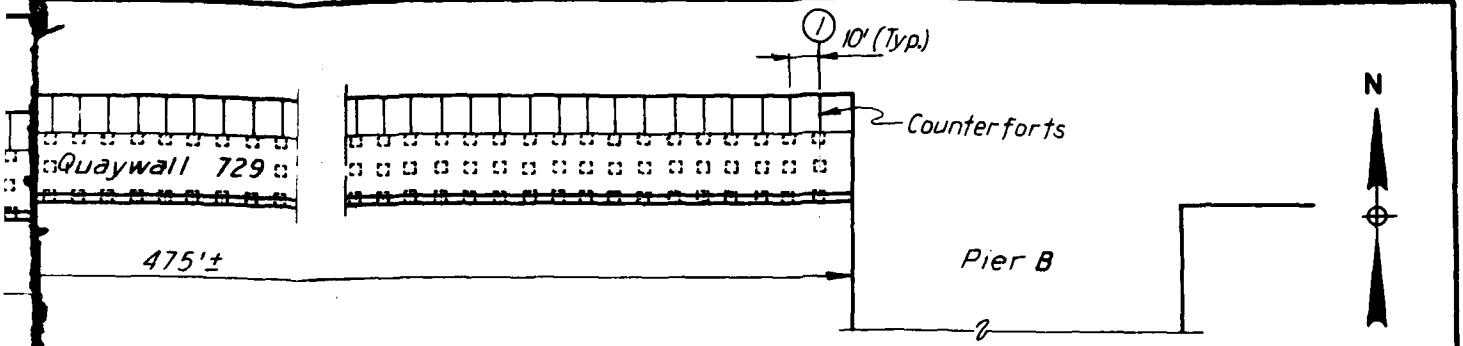
PUGET SOUND NAVAL SHIPYARD	
SUPPLY PIER	
CHESAPEAKE DIVISION NAVAL FACILITIES ENGINEERING COMMAND WASHINGTON, D. C.	
COLLINS ENGINEERS, INC.	FIGURE 10



PLAN



TYPICAL SECTION



PLAN

Note:
This drawing developed in part from N.Y.P.S. Drwg. No. 6374 & 6375

Design Load:
Deck = 600 psf

PUGET SOUND NAVAL SHIPYARD	
QUAYWALL STRUCTURE 729	
CHESAPEAKE DIVISION NAVAL FACILITIES ENGINEERING COMMAND WASHINGTON, D.C.	
COLLINS ENGINEERS, INC.	FIGURE 11

Refer to Figure 12 for a plan of the pier and a typical section showing the general configuration of the structure.

3.2.9 Pier 9; Structure 823

Structure 823 is located at the outboard end of Pier 9. It is approximately 180 ft long by 80 ft wide. It is of quaywall type construction with a steel sheet pile cutoff wall and octagonal prestressed concrete piles supporting a cast-in-place concrete deck.

A riprap slope wall extends to near the waterline at the sheet pile wall on the north edge of the structure. It is approximately 34 ft deep along the outboard faces of the structure.

Refer to Figure 13 for a plan and a typical section showing the configuration of the structure.

3.2.10 Small Boat Pier, Structure 852

Structure 852 is located immediately east of the inboard end of Pier 9. It is a two finger pier approximately 175 ft long by 60 ft wide. It is generally constructed of vertical and batter steel H-piles supporting a cast-in-place concrete beam and slab deck. The steel piles are generally encased in concrete from the bottom of the concrete deck to approximately two feet below Mean Lower Low Water.

The water depth along the pier varies from approximately 30 ft at its outboard end to 12 ft along Pier 9 to 3 ft at the north inboard end.

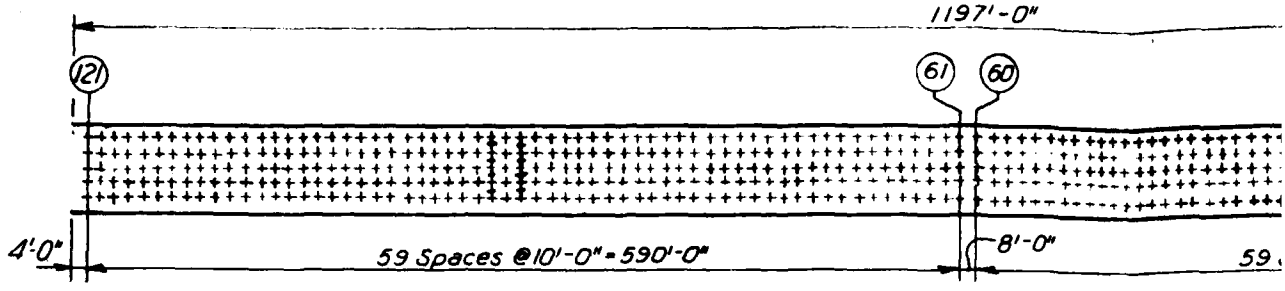
Refer to Figure 14 for a plan of the pier and typical sections showing the general configuration of the structure.

3.2.11 Mooring A

Mooring A is approximately 1,060 ft long. It consists of two steel sheet pile cloverleaf shape cellular cofferdam islands each supporting a reinforced concrete deck approximately 51 ft by 55 ft. These islands are connected to each other and the shore by cast-in-place reinforced concrete beam and slab decks supported by vertical and batter precast concrete piles. These deck structures have a minimum width of 16 ft. At the north end of the mooring, at the shoreline, the deck structure is supported by steel H-piles.

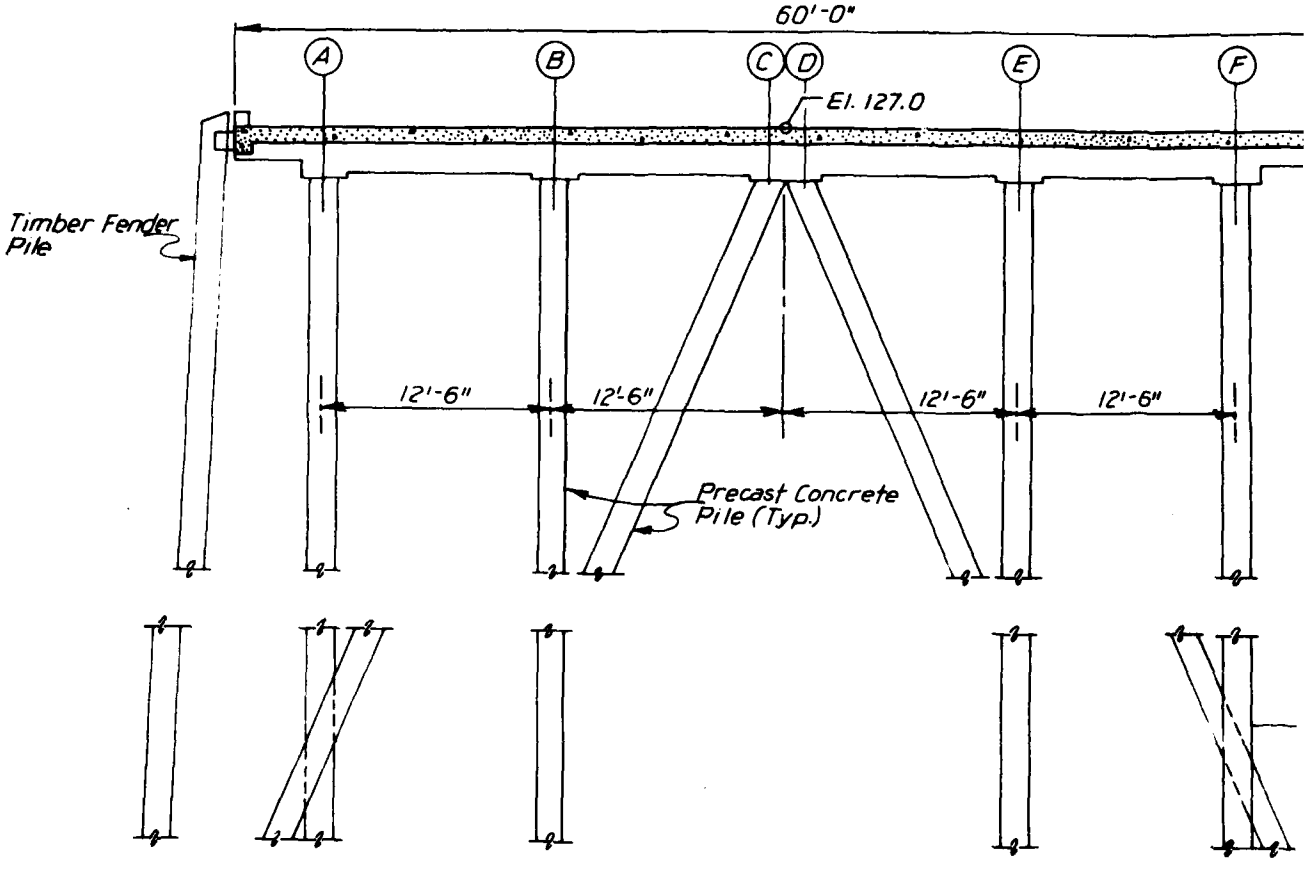
The water along the mooring platform is generally 35 ft deep. At the inboard ends of the platform, the riprap shore slopes beneath the structure.

Refer to Figure 15 for a plan of the mooring platform and typical details showing the configuration of the structure.

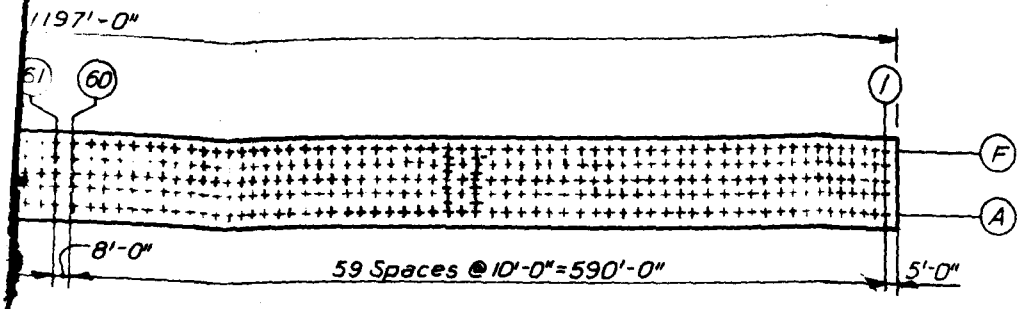


PLAN

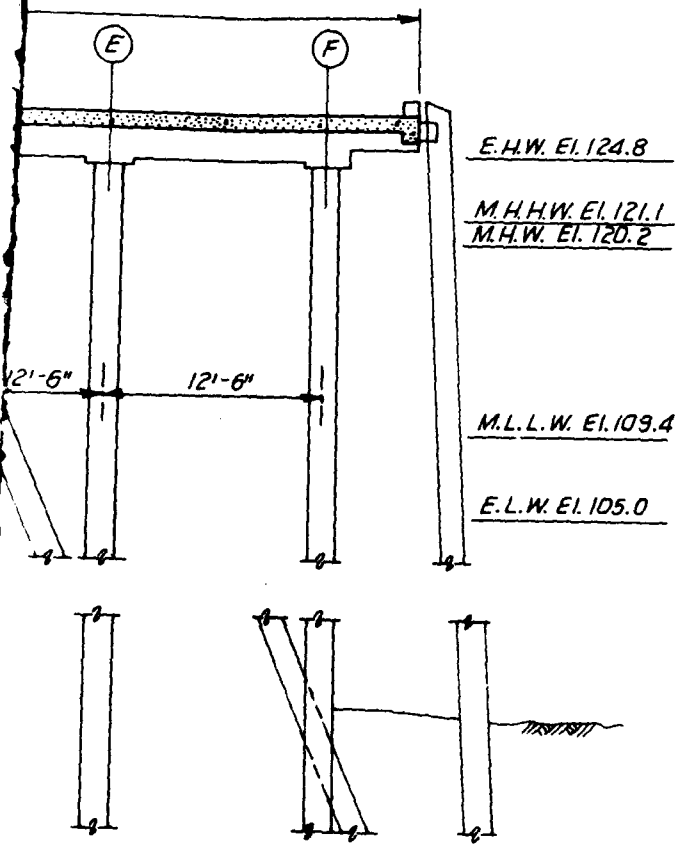
N



TYPICAL CROSS SECTION



PLAN



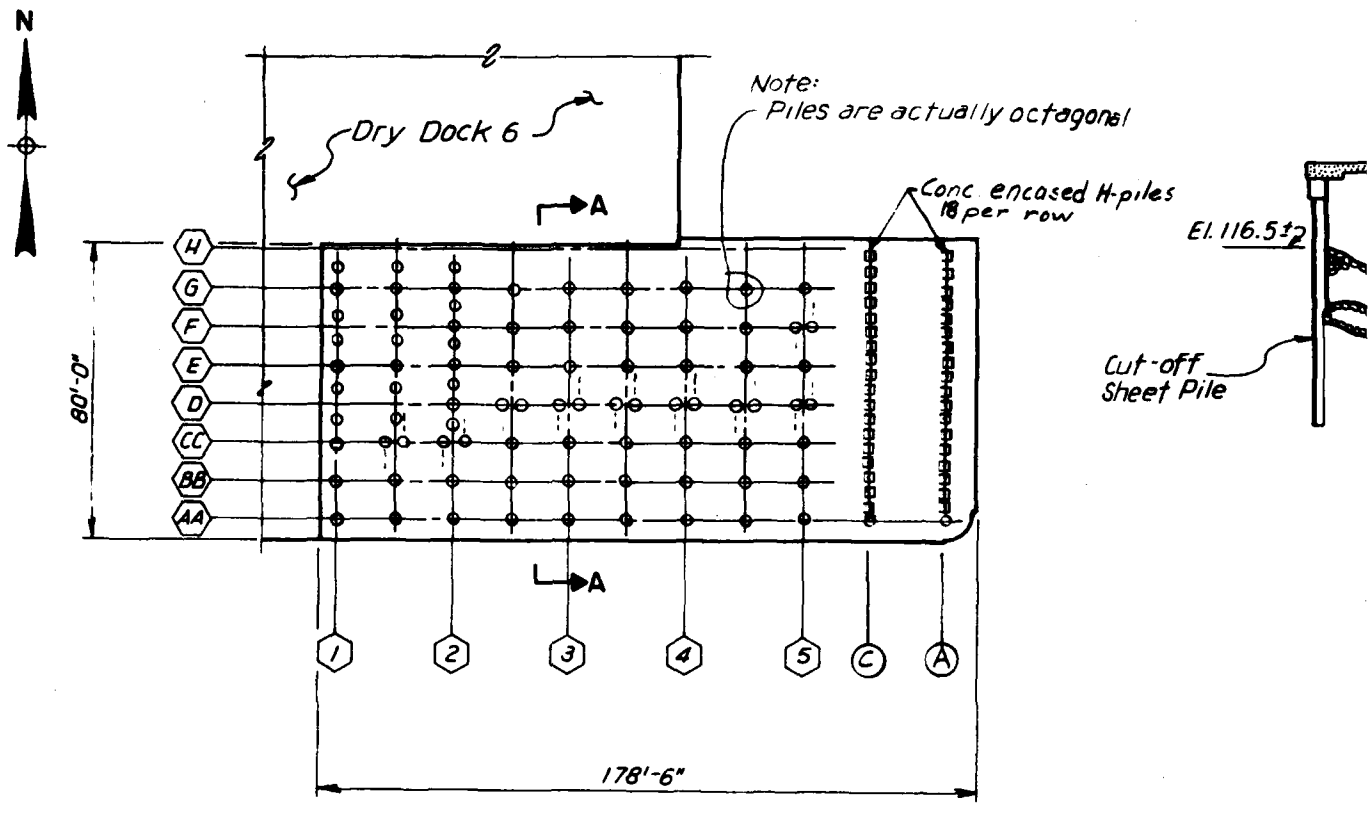
TION

DESIGN LOADS:
Live Load: 600 psf or H20 plus 15% Impact or 35K Load over Area 2'-6" square
Pile Brg. Cap. : 45T

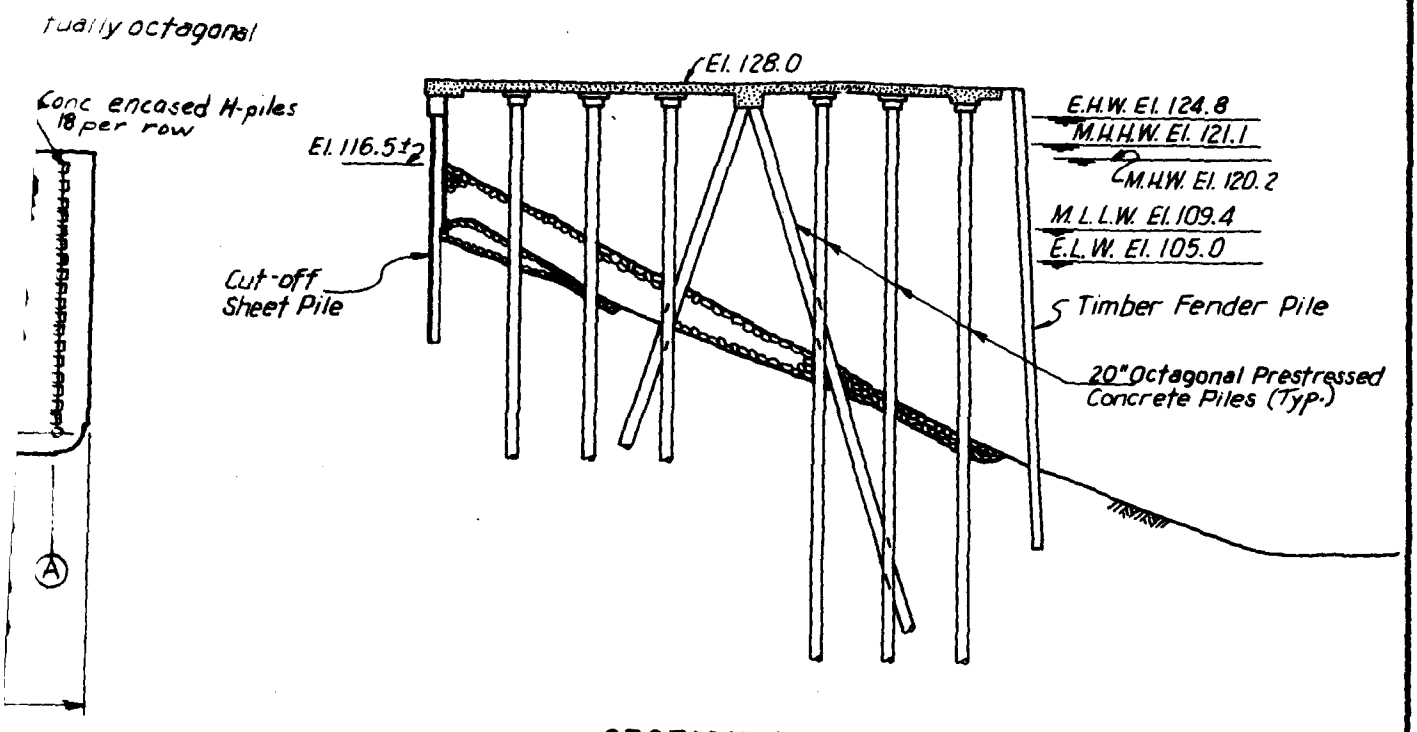
Note:
This drawing developed in part from Y. & D. Drwg. No. 428605, P.W. Drwg. No. 3202A

2

PUGET SOUND NAVAL SHIPYARD	
PIER B	
CHESAPEAKE DIVISION NAVAL FACILITIES ENGINEERING COMMAND WASHINGTON, D. C.	
COLLINS ENGINEERS, INC.	FIGURE 12


N
Dry Dock 6
Note:
Piles are actually octagonal
Conc. encased H-piles
18 per row
A
A
H
G
F
E
D
CC
BB
AA
80'-0"
1
2
3
4
5
C
A
178'-6"
El. 116.5±2
Cut-off
Sheet Pile

PLAN

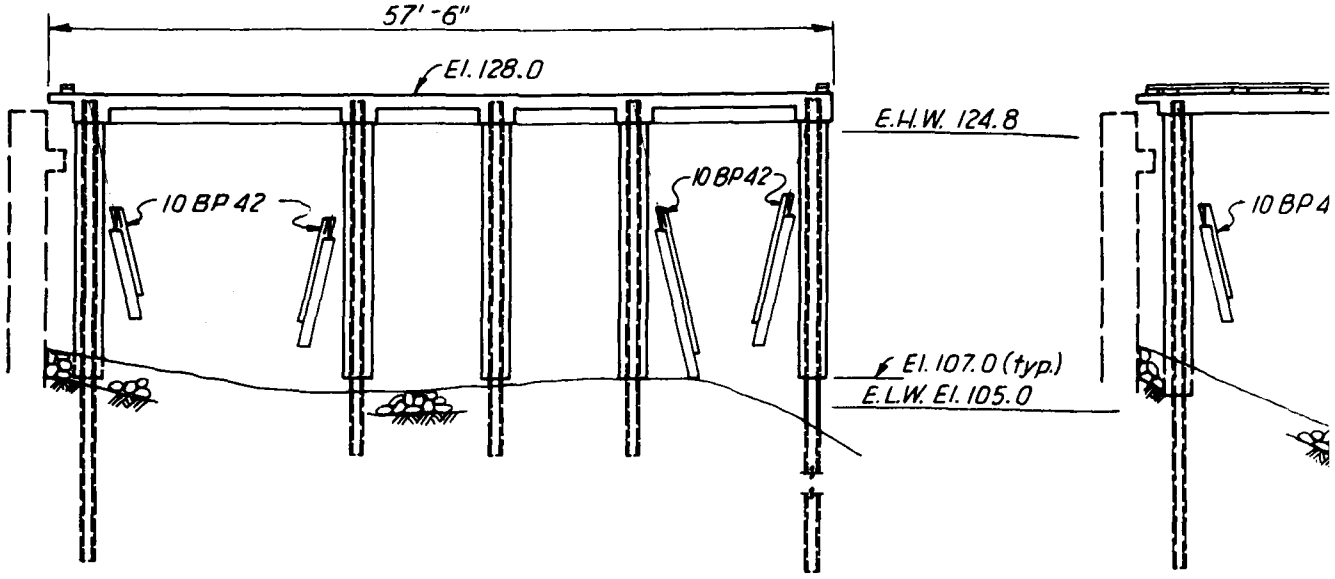


SECTION A-A

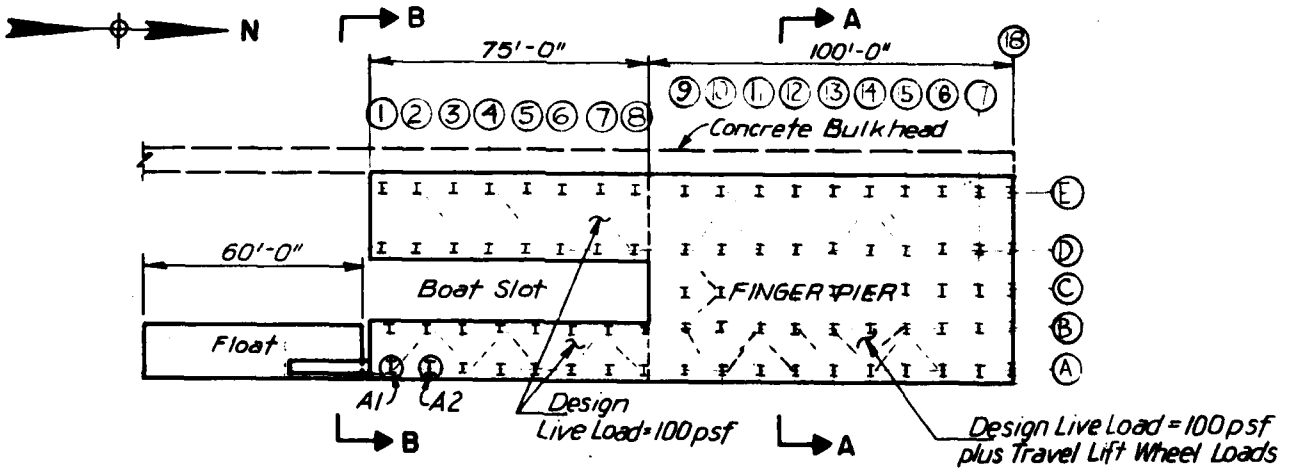
Note:
This drawing developed in part from Y. & D. Drwg. No. 825, 165 ; P.W. Drwg. No. 40075

2.

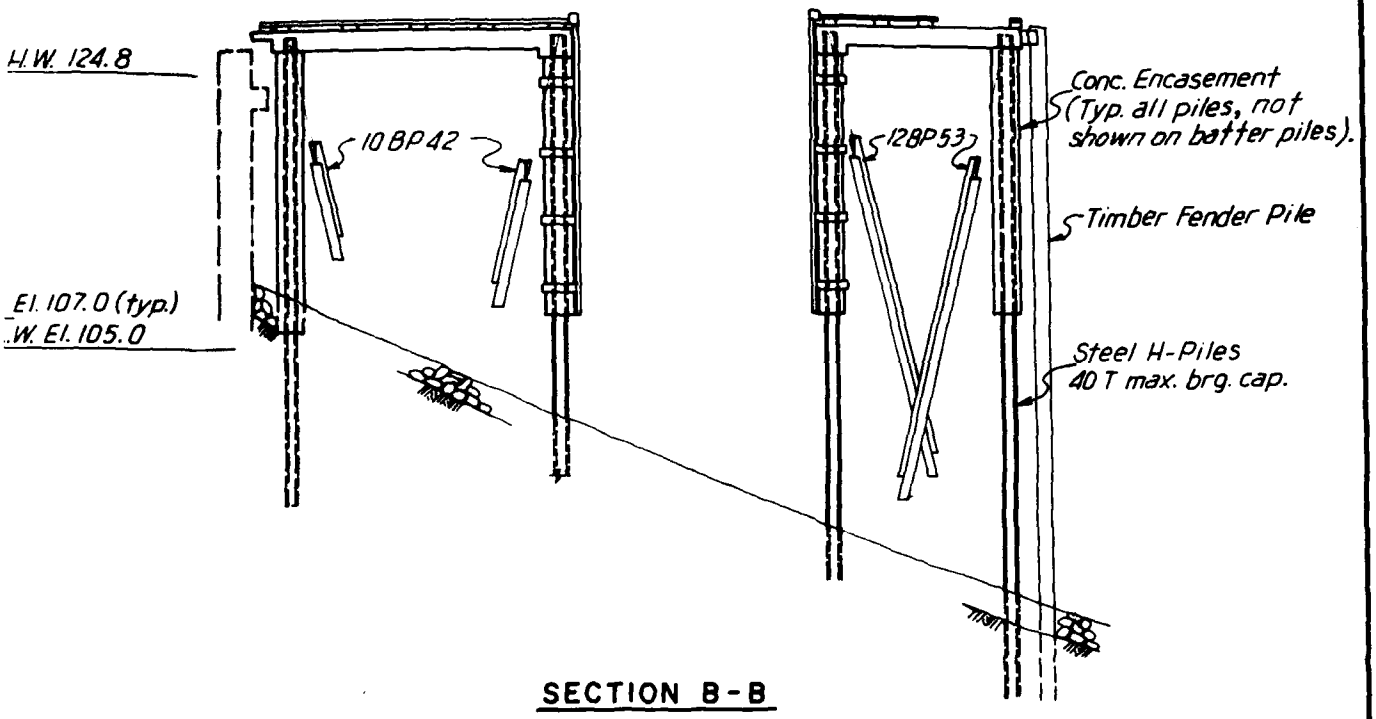
PUGET SOUND NAVAL SHIPYARD	
PIER 9 STRUCTURE 823	
CHESAPEAKE DIVISION NAVAL FACILITIES ENGINEERING COMMAND WASHINGTON, D. C.	
COLLINS ENGINEERS, INC.	FIGURE 13



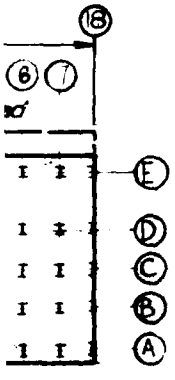
SECTION A-A



PLAN



SECTION B-B



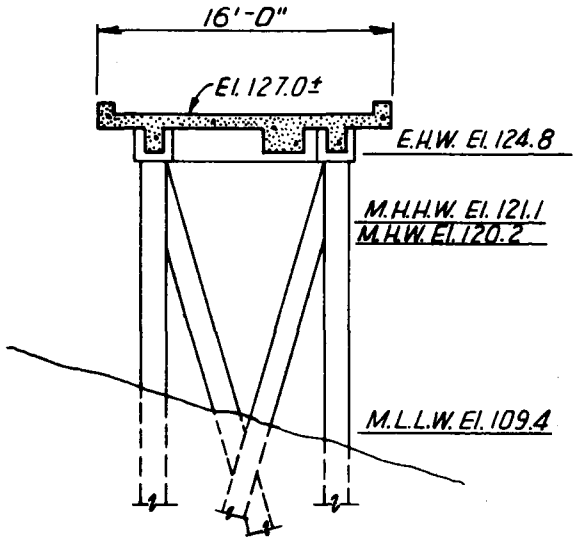
Design Live Load = 100 psf
plus Travel Lift Wheel Loads

Note:
This drawing developed in part from P.W. Drwg. No. 44151, 44152 ; NAVFAC Drwg. No. 1, 341, 352 & 353
(I) Piles given Level II inspection

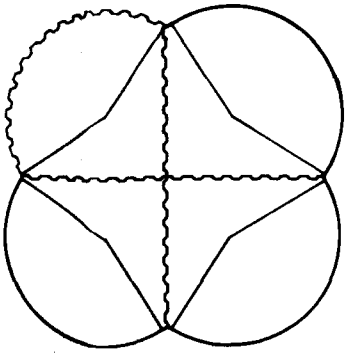
PUGET SOUND NAVAL SHIPYARD	
SMALL BOAT PIER STRUCTURE 852	
CHESAPEAKE DIVISION NAVAL FACILITIES ENGINEERING COMMAND WASHINGTON, D.C.	
COLLINS ENGINEERS, INC.	FIGURE 14

2

3-14

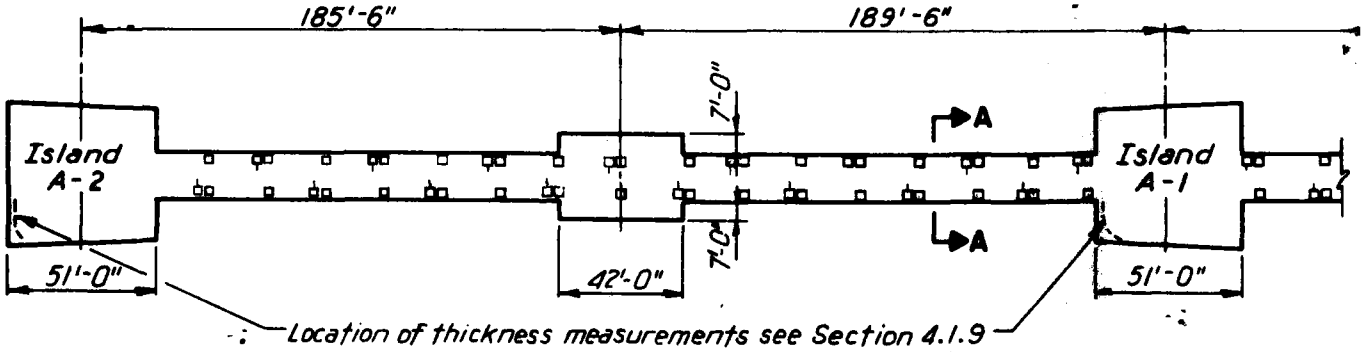


TYPICAL CROSS SECTION A-A



TYPICAL ISLAND CELL PL

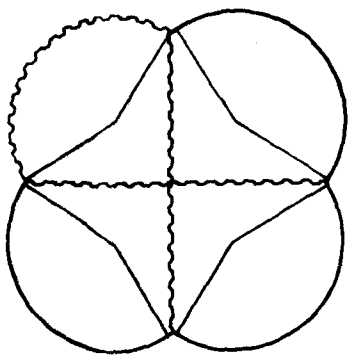
N



PLAN

DESIGN LOADS:
Deck Live Load: 2
Pile Brg. Cap. = 25

Note:
This drawing dev
No. 428611, 428612
32031, 32034.



TYPICAL ISLAND CELL PLAN

PLAN

DESIGN LOADS:
Deck Live Load: 200 p.s.f. or H15 plus 15% Impact
Pile Brg. Cap. = 25 T

Note:
This drawing developed in part from Y. & D. Drwg. No. 428611, 428612, 428615 ; P.W. Drwg. No. 32030, 32031, 32034.

PUGET SOUND NAVAL SHIPYARD

MOORING A

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

COLLINS ENGINEERS, INC. | FIGURE 15

3.2.12 Pier 3

Pier 3 is approximately 1,450 ft long by 120 ft wide. The outboard end of the pier consists of four rows of 5 ft diameter concrete subpiers, each supported on 36 timber piles, with a concrete beam and girder deck system. The water along this portion of the pier generally ranges from 35 to 40 ft deep.

The inboard end of the pier is similar in construction to a quaywall. It consists of a steel sheet pile cutoff wall, groups of precast concrete piles, and a row of 5 ft diameter columns supported on concrete subpiers supporting a cast-in-place reinforced concrete deck. The water in this portion of the pier varies from approximately 15 to 35 ft deep along the east side. Along the sheet pile wall, the riprap slope wall terminates near the waterline.

Refer to Figure 16 for a plan of the pier and typical section showing the configuation of the structure.

3.2.13 Quaywall Structure 694

Quaywall Structure 694 is approximately 84 ft long by 51 ft wide. It consists of a steel sheet pile cutoff wall, and vertical and batter precast concrete piles supporting a cast-in-place reinforced concrete deck.

A riprap slope wall extends to the waterline at the sheet pile cutoff wall and it is approximately 15 to 20 feet deep at the front face of the structure.

Refer to Figure 17 for a plan of the quaywall and a typical section showing the configuration of the structure.

3.2.14 Quaywall Structure 693

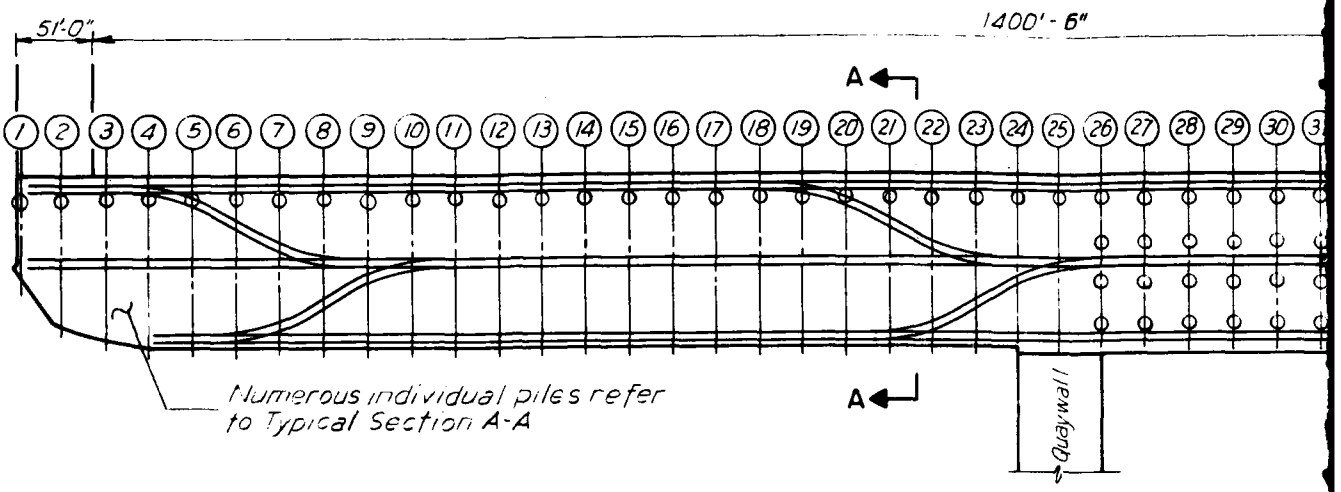
Quaywall Structure 693 is similar to Quaywall Structure 694 except that it is approximately 253 ft long. Refer to Figure 17.

3.2.15 Pier 4

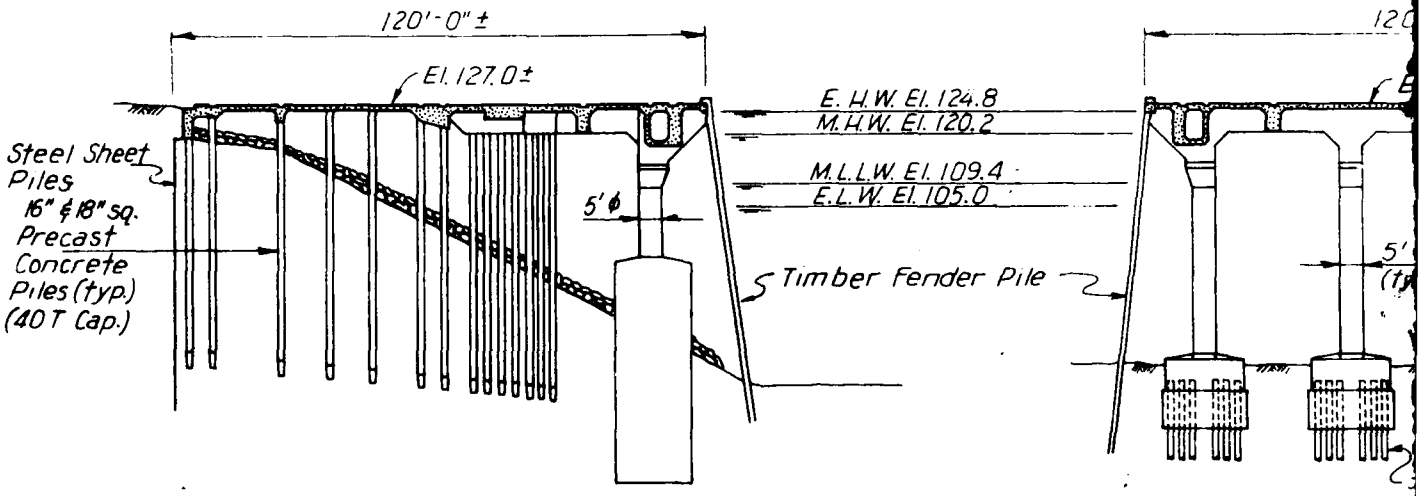
Pier 4 is approximately 1,400 ft long by 80 ft wide. It consists of three sections: the outboard section; the inboard section; and the approach.

The outboard section consists of 4 ft. 6 in. diameter subpiers with belled bases supporting a concrete girder, beam and slab deck. There are three subpiers per bent.

The inboard section consists of 5 ft diameter concrete subpier shafts with belled bases supporting a concrete girder, beam and slab deck. All of the belled bases except the inboard four

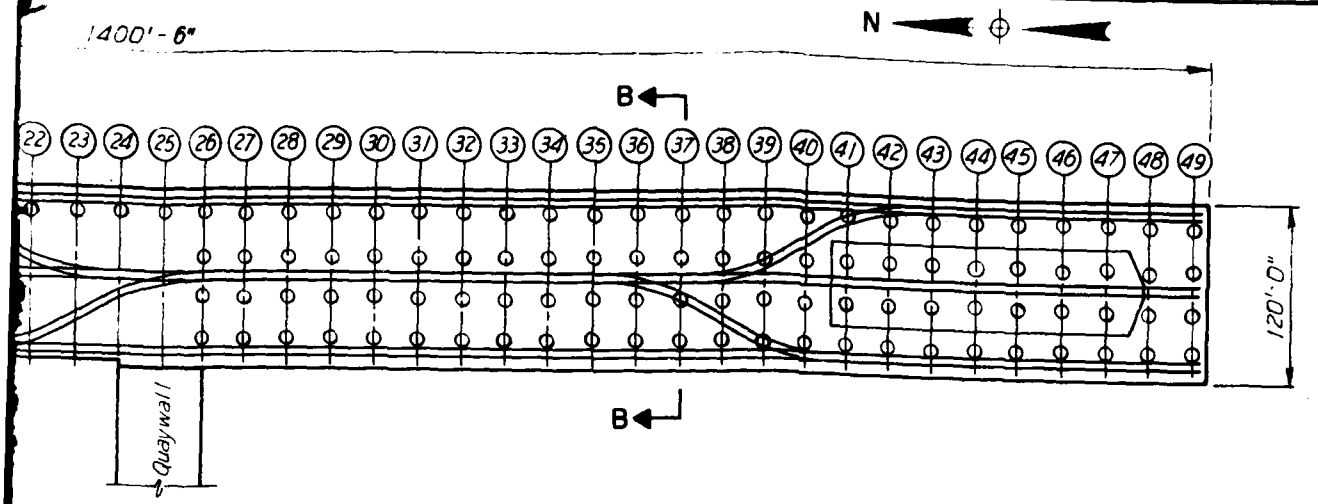


PLAN

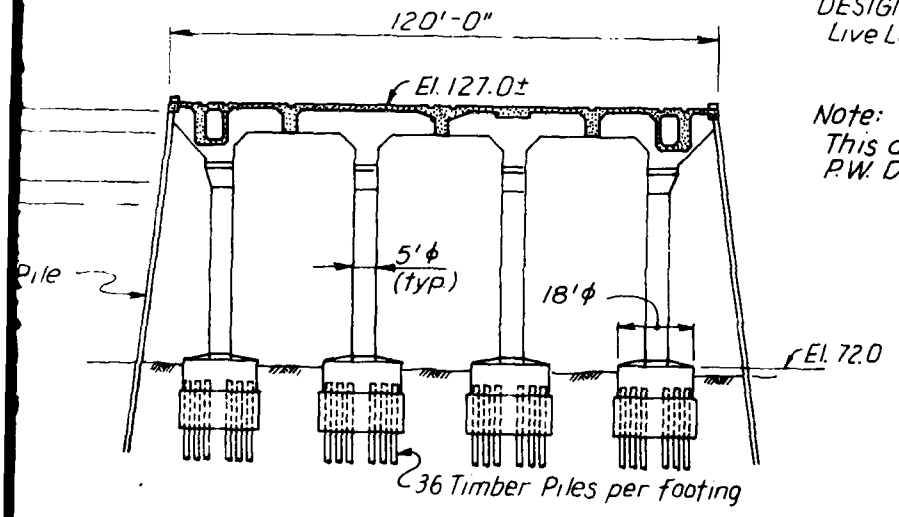


SECTION A-A
(Typical - Inboard End)
Bents 1-25

SECT
(Typical



PLAN

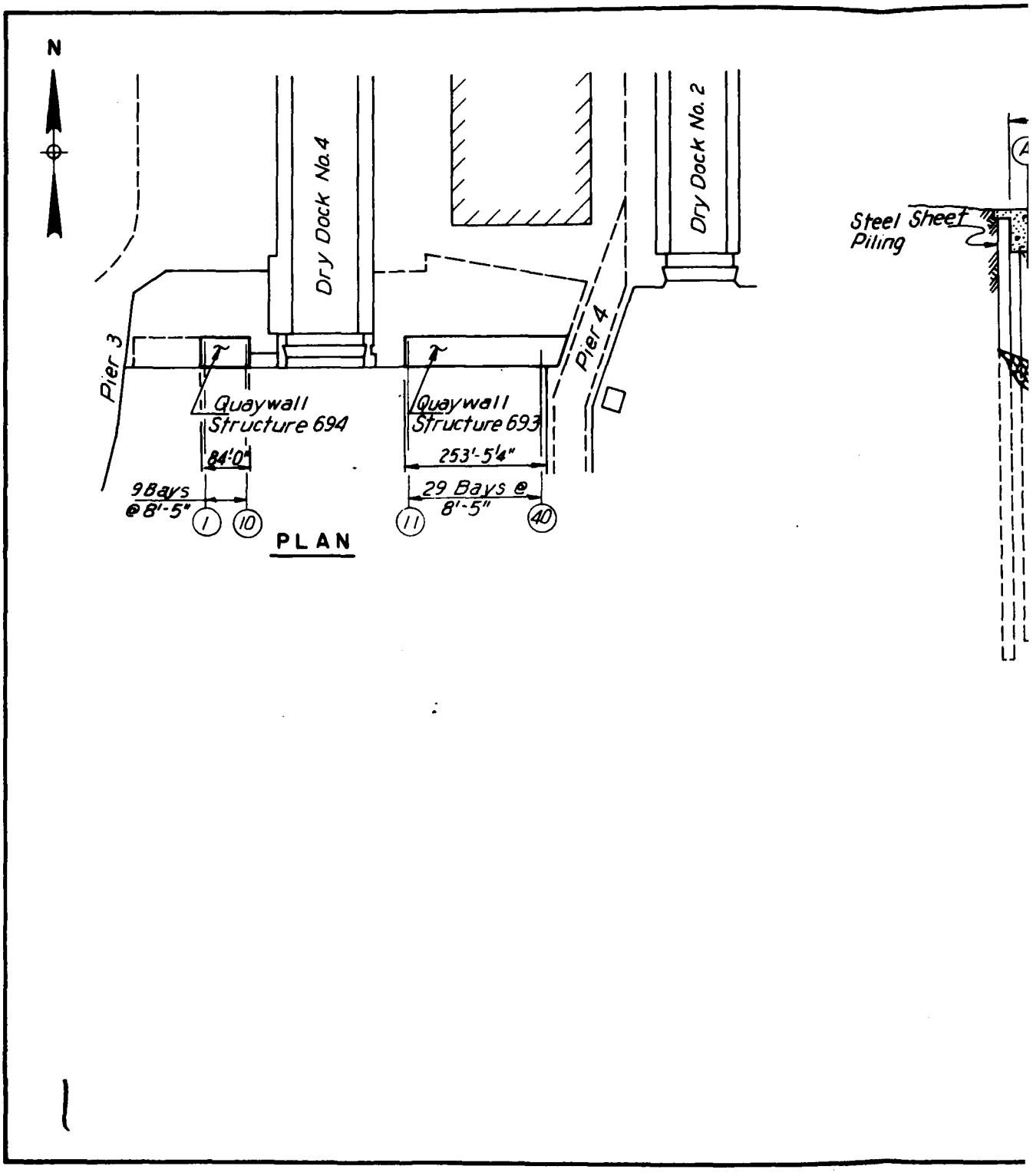


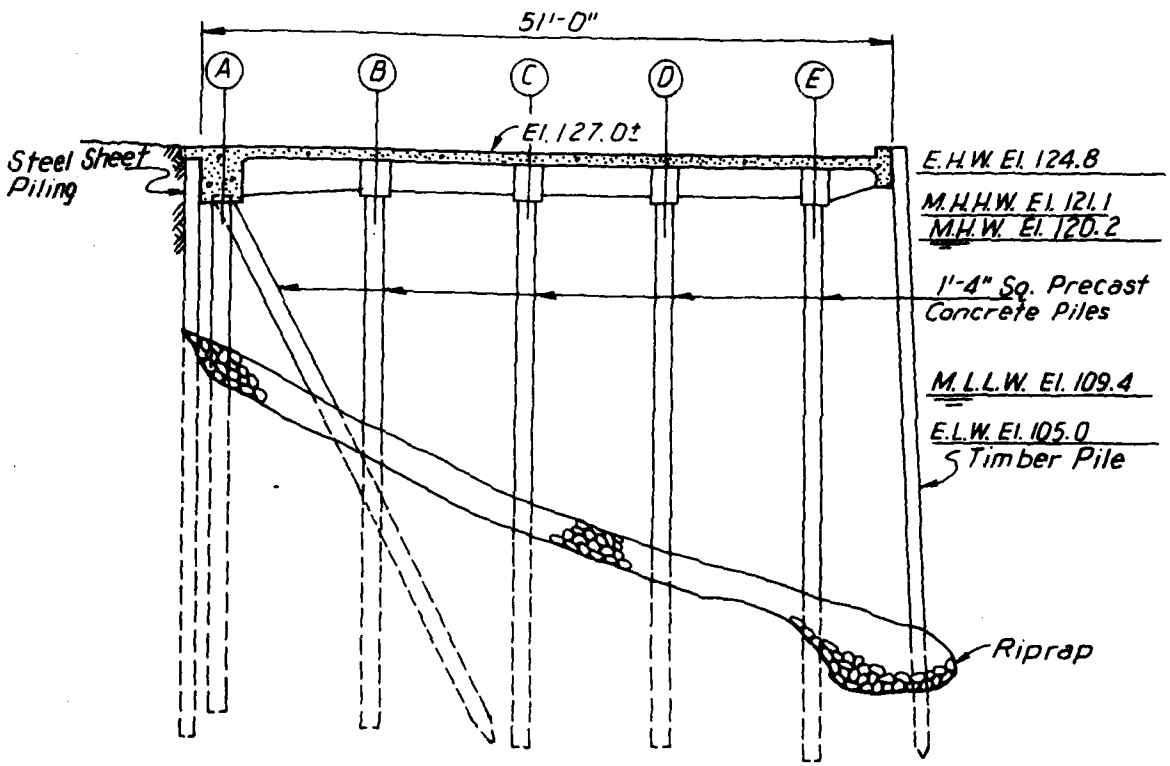
SECTION B-B
(Typical Outboard End)

DESIGN LOADS:
Live Load: Slab = 900 psf
Subpiers = 630 psf

Note:
This drawing developed in part from P.W. Drwg. No. 18611 & 18613

PUGET SOUND NAVAL SHIPYARD	
PIER 3	
CHESAPEAKE DIVISION NAVAL FACILITIES ENGINEERING COMMAND WASHINGTON, D.C.	
COLLINS ENGINEERS, INC.	FIGURE 16


N
Dry Dock No. 4
Dry Dock No. 2
Pier 3
Pier 4
Quaywall Structure 694
Quaywall Structure 693
84'0"
253'-5¼"
9 Bays @ 8'-5"
29 Bays @ 8'-5"
1
10
11
40
PLAN
Steel Sheet Piling



TYPICAL TRANSVERSE SECTION

Note:
This drawing developed in part from Y. & D. Drwg. No. 131325; P.W. Drwg. No. 15637

PUGET SOUND NAVAL SHIPYARD	
QUAY WALL STRUCTURES 693 & 694	
CHESAPEAKE DIVISION NAVAL FACILITIES ENGINEERING COMMAND WASHINGTON, D.C.	
COLLINS ENGINEERS, INC.	FIGURE 17

bents are supported on timber pile groups. There are four columns per bent. Available plans indicate that the original diameter of the shafts was 4 ft., and the shafts and bells were enlarged as part of repairs made during or before the 1930's.

The approach to the pier consists of precast reinforced concrete vertical and batter piles approximately 2 ft. square supporting a concrete deck slab.

The water depth along the pier varies from approximately 20 ft at the inboard end to 40 ft at the outboard end. Generally, the water is 35 to 40 ft deep.

Refer to Figure 18 for a plan of the pier and typical sections showing the general configuration of the structure.

3.2.16 Pier 5

Pier 5 is approximately 1,200 ft long by 80 ft wide. It consists of four rows of concrete subpiers with a concrete beam and girder deck system.

The water depth along the pier varies from approximately 20 ft at the inboard end to 40 ft at the outboard end. Generally, the water is 35 to 40 ft deep.

Refer to Figure 19 for a plan of the pier and a typical section showing the general configuration of the structure.

3.2.17 Pier 6

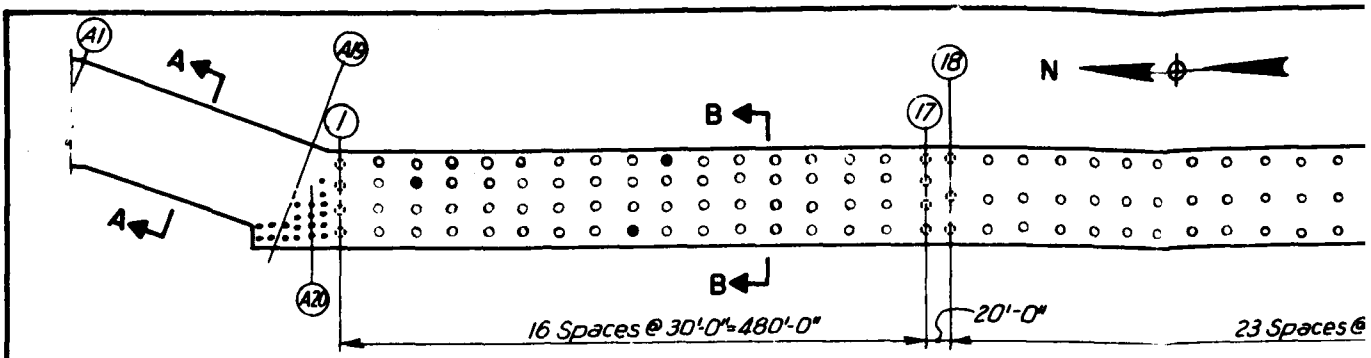
Pier 6 is approximately 1,320 ft long by 100 ft wide. It generally consists of five rows of concrete subpiers with bell shaped bases supported on timber piles, and a concrete girder, beam and slab deck system. There are additional vertical and batter columns under the pier's hammerhead crane.

The water depth along the pier varies from approximately 8 ft at the inboard end to approximately 55 ft at the outboard end. Generally, the water is 40 to 50 ft deep.

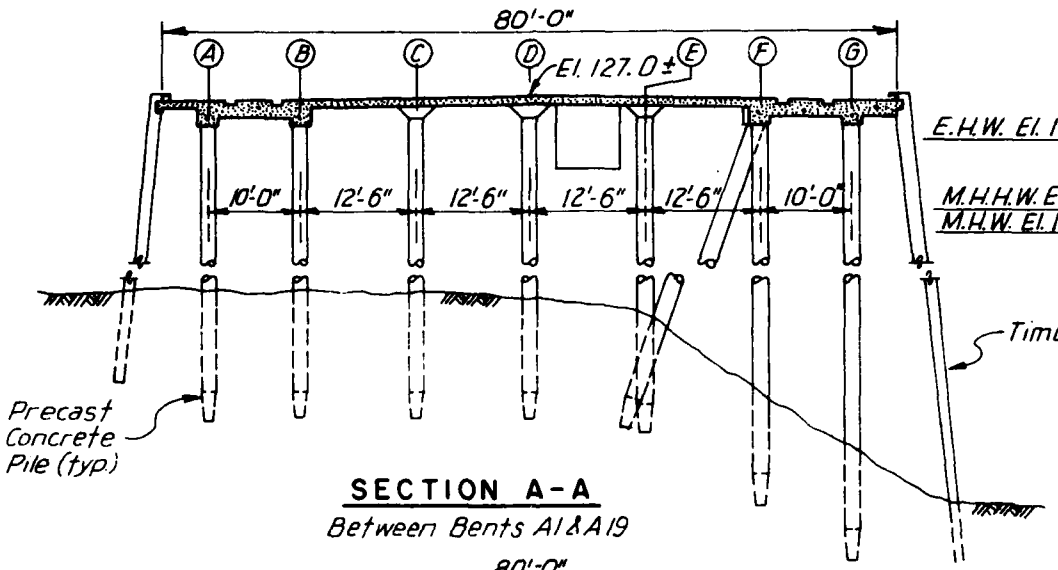
Refer to Figure 20 for a plan of the pier and a typical section showing the general configuration of the structure.

3.2.18 Pier 7

Pier 7 is approximately 730 ft long by 90 ft wide. It generally consists of three rows of concrete subpiers with bell shaped bases, and a concrete girder, beam and slab deck system.

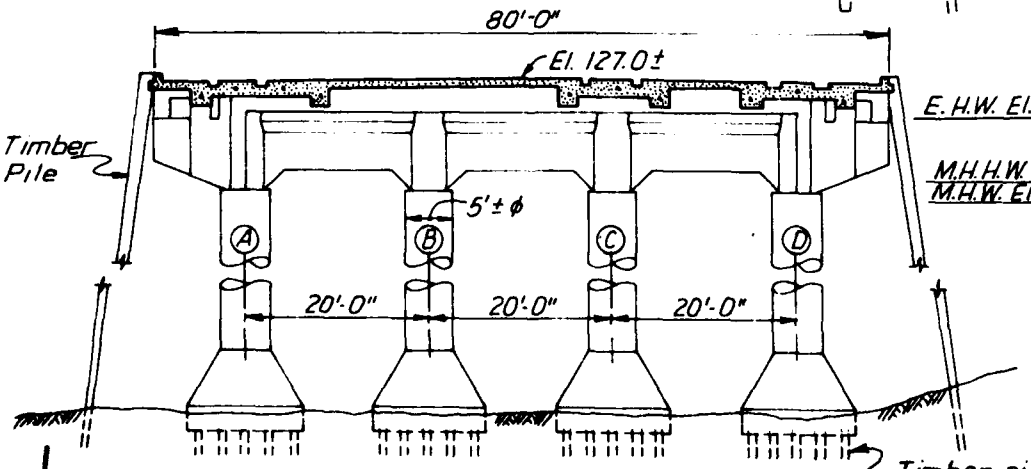


PLAN

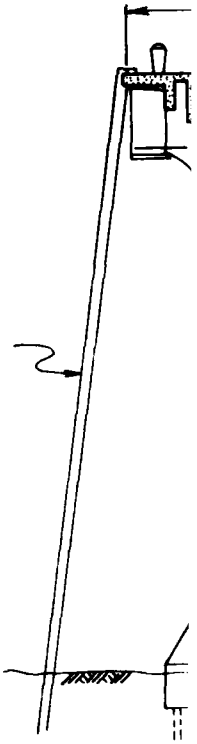


SECTION A-A

Between Bents A1 & A19

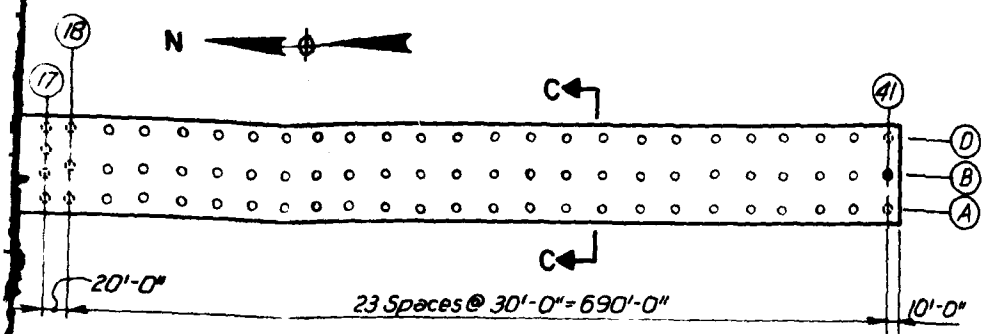


SECTION B-B

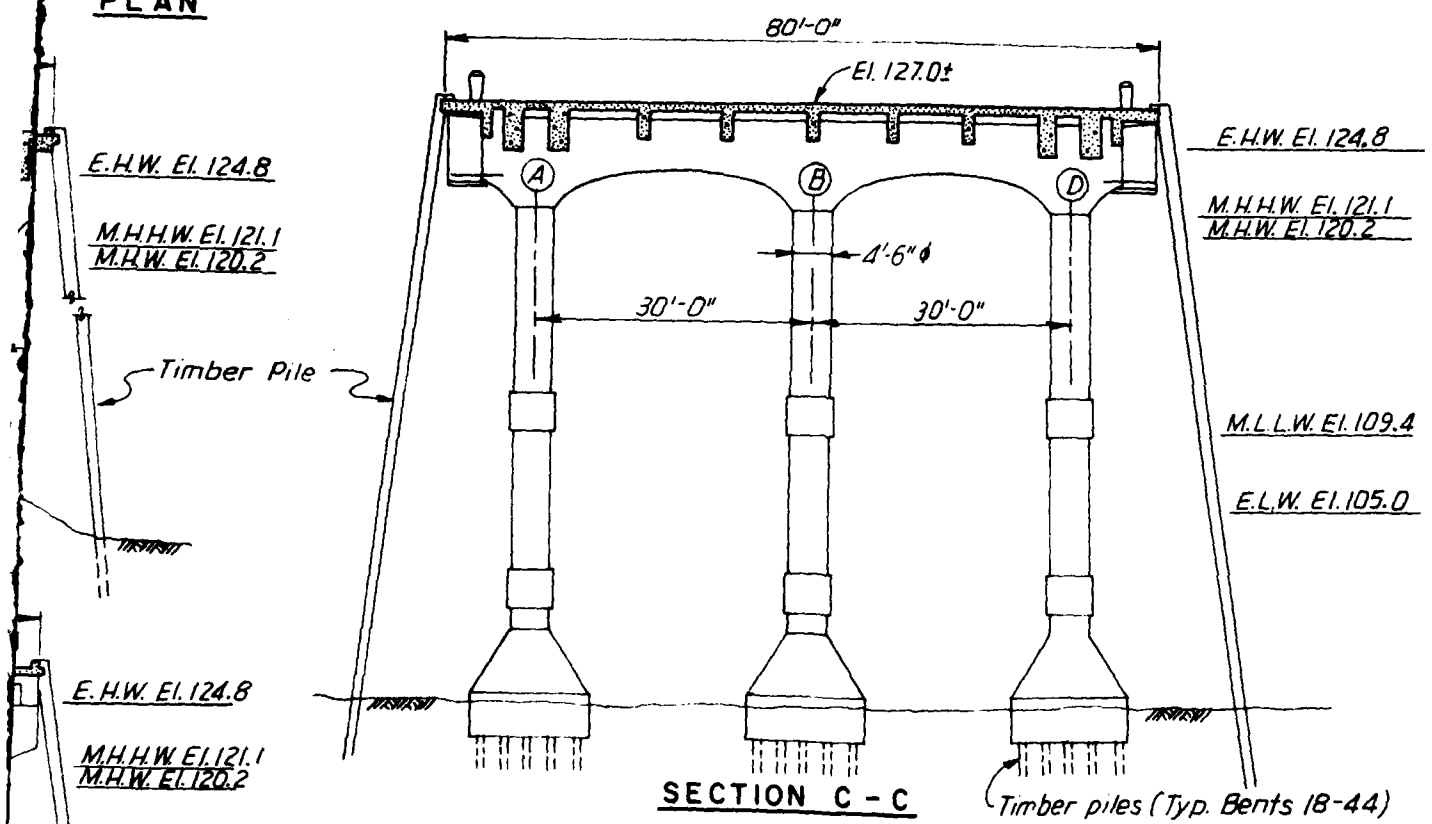


DESIGN LOAD
Deck Live Lo

Note:
This drawing
R.W. Drwg. 96
• Piles rece



PLAN



SECTION C - C

DESIGN LOAD:
Deck Live Load: 600 psf

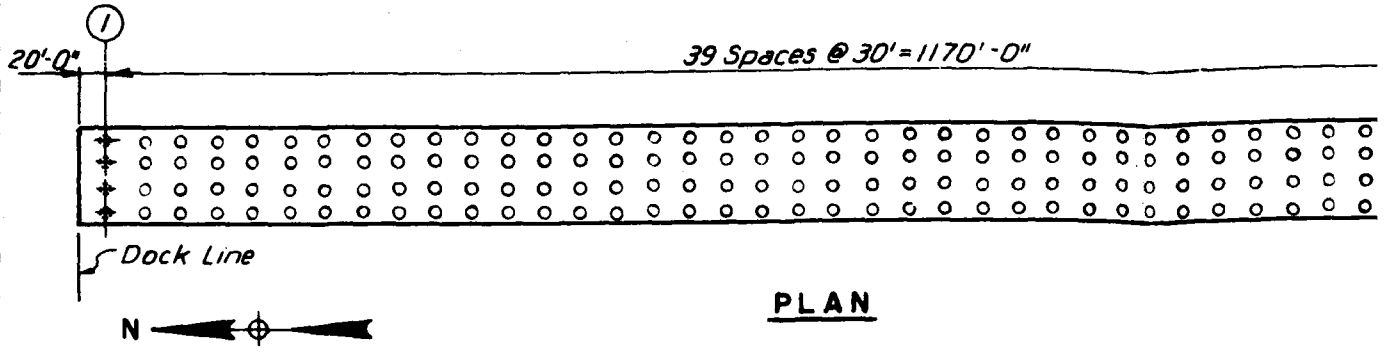
Note:
This drawing developed in part from P.W. Drwg. 9636 & 9637
● Piles receiving Level II inspection

PUGET SOUND NAVAL SHIPYARD

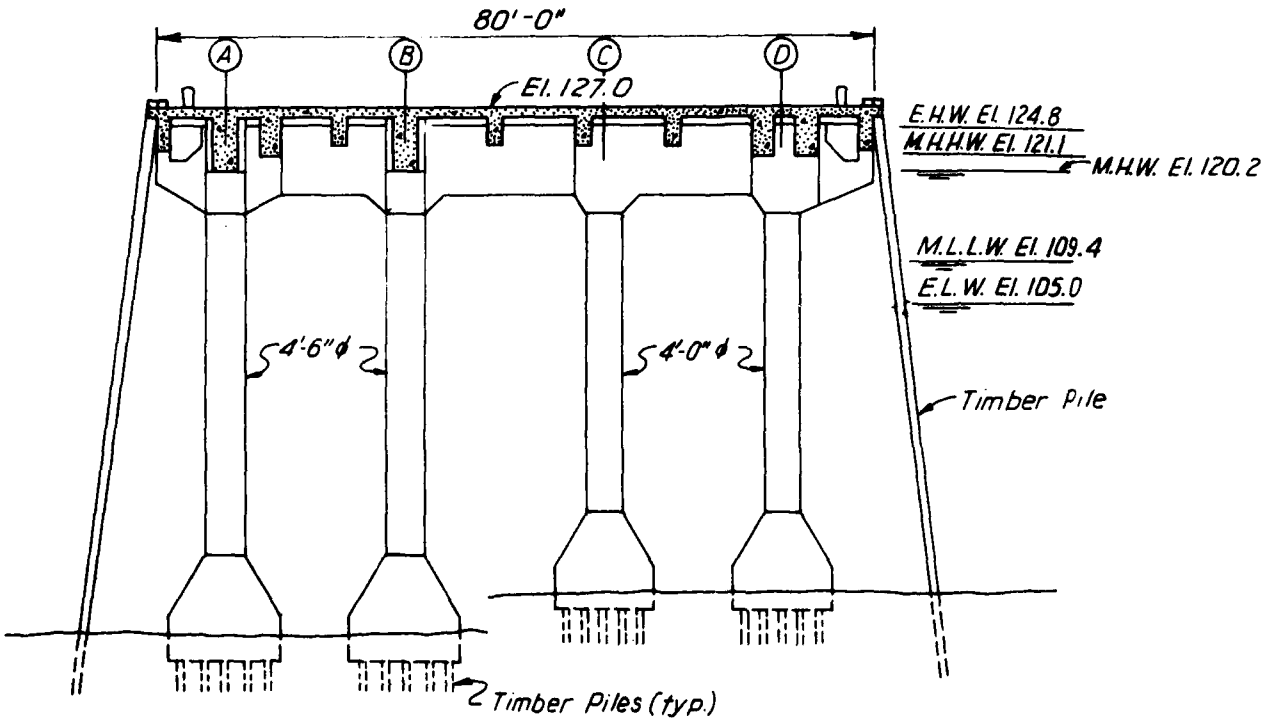
PIER 4

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

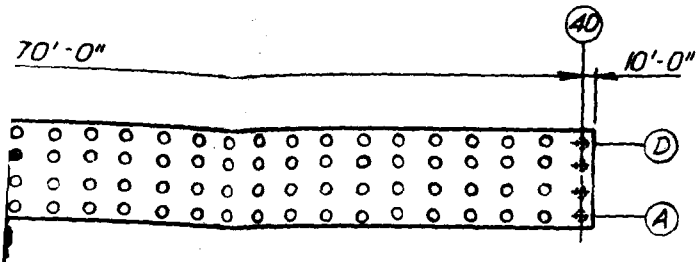
COLLINS ENGINEERS, INC. | FIGURE 18



PLAN



TYPICAL SECTION



E.H.W. El. 124.8
M.H.H.W. El. 121.1
M.H.W. El. 120.2

M.L.L.W. El. 109.4
E.L.W. El. 105.0

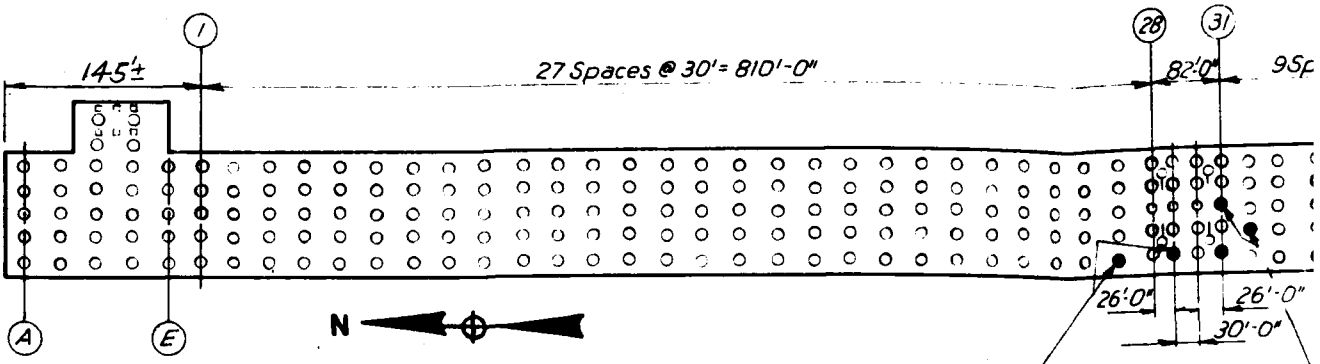
Timber Pile

DESIGN:
Deck Live Load = 600 psf

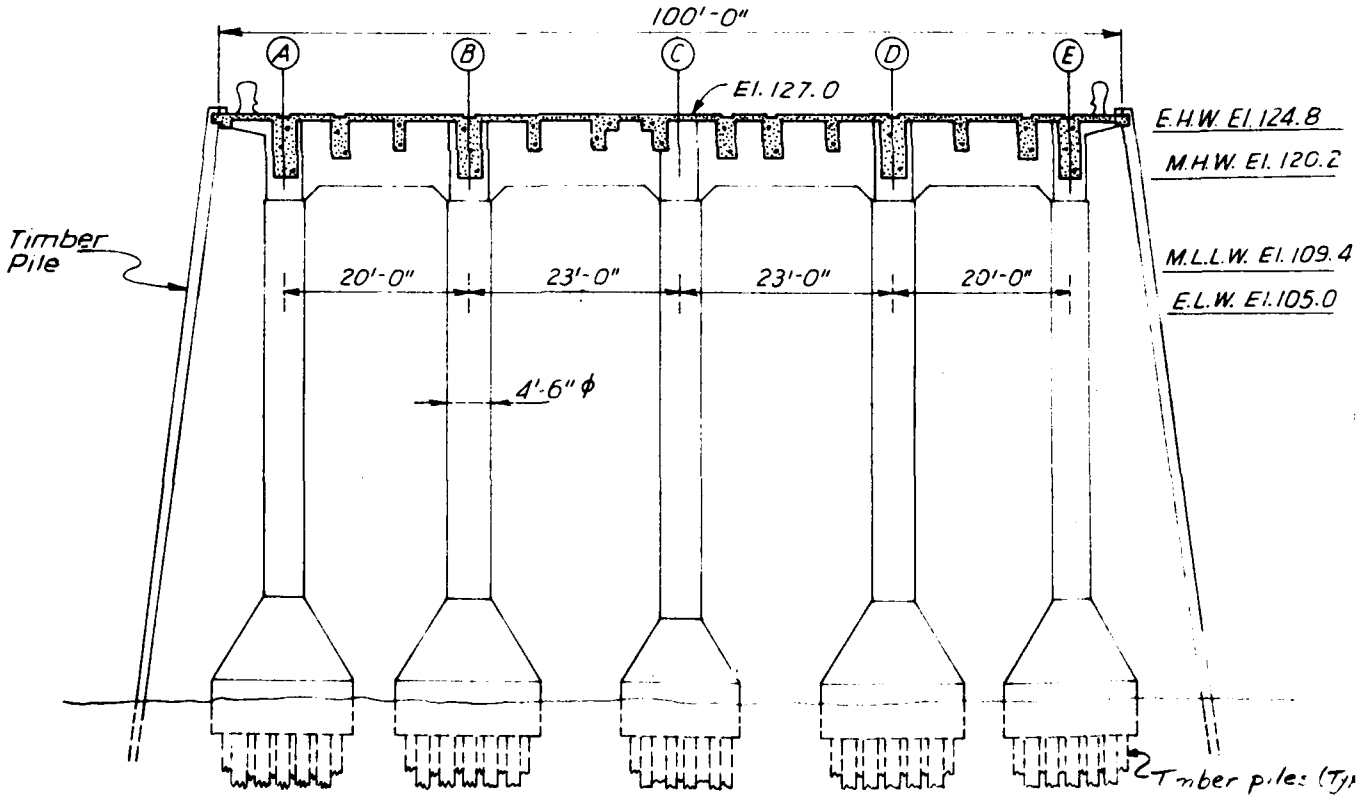
Note:
This drawing developed in part from N.Y.P.S. Drwgs. 6303, 6304, 6347 & 6348

2

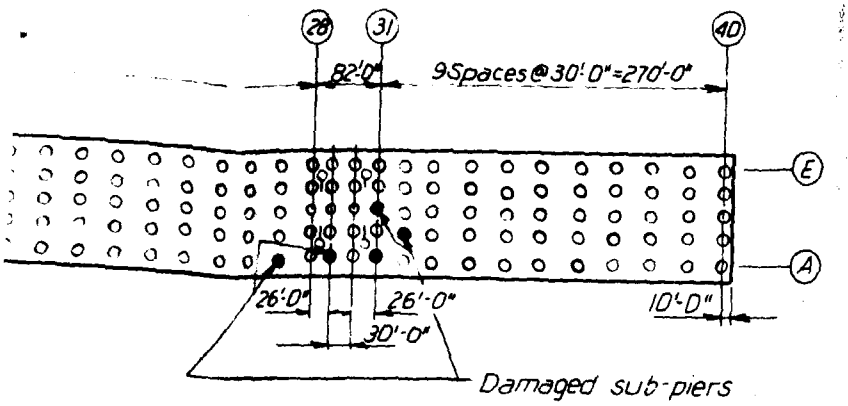
PUGET SOUND NAVAL SHIPYARD	
PIER 5	
CHESAPEAKE DIVISION NAVAL FACILITIES ENGINEERING COMMAND WASHINGTON, D.C.	
COLLINS ENGINEERS, INC.	FIGURE 19

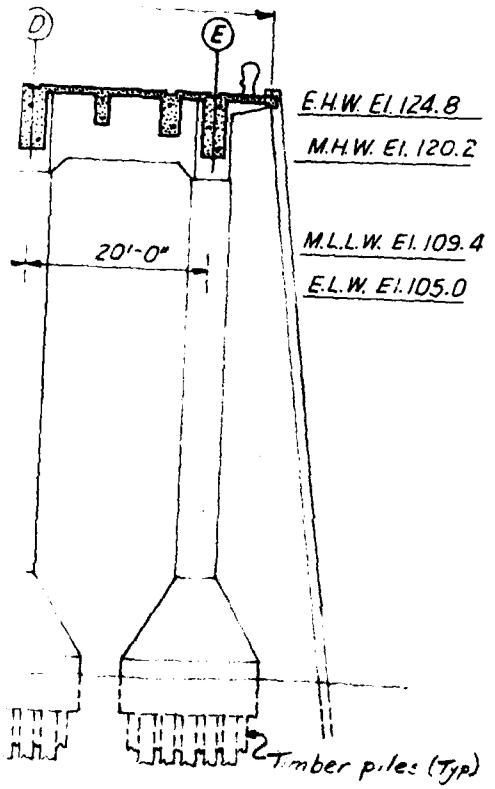


PLAN



TYPICAL SECTION





DESIGN:
Deck Live Load = 900 psf

Note:
This drawing developed in part from NYPS Drwgs. 7086, 7089 & 7090

● Subpiers receiving Level II inspection

2

PUGET SOUND NAVAL SHIPYARD	
PIER 6	
CHESAPEAKE DIVISION NAVAL FACILITIES ENGINEERING COMMAND WASHINGTON, D. C.	
COLLINS ENGINEERS, INC.	FIGURE 20

The water depth along the pier varies from approximately 15 ft at the inboard end to approximately 40 ft at the outboard end. Generally, the water is 35 to 40 ft deep.

Refer to Figure 21 for a plan of the pier and a typical section showing the general configuration of the structure.

3.2.19 Pier 8

Pier 8 is approximately 500 ft long by 62 ft wide. The pier consists of an inboard section and an outboard section.

The outboard section consists of eight rows of 2 ft square precast concrete piles, supporting a concrete beam and slab deck.

The inboard section consists of four rows of 3 ft diameter subpiers with belled bases supporting a concrete girder, beam and slab deck system.

The water depth at the outboard end of the pier is approximately 30 ft. Generally, the water depth varies from 25 to 30 ft.

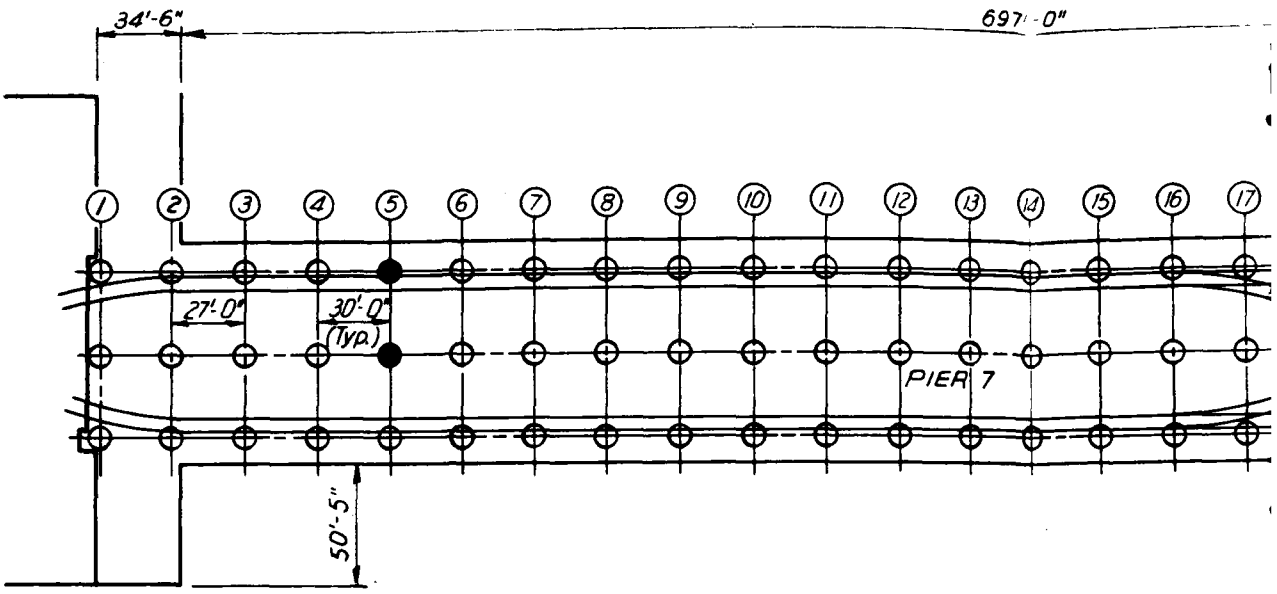
Refer to Figure 22 for a plan of the pier and typical sections showing the configuration of the structure.

3.3 Inspection Level

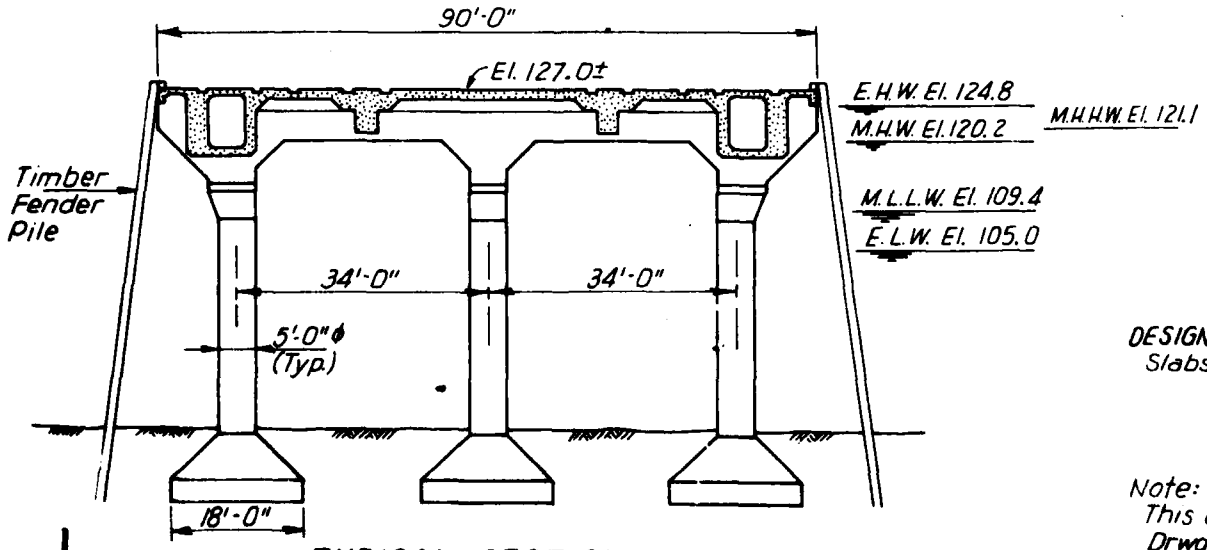
A Level I inspection was conducted of all accessible underwater structural elements.

A Level II inspection was conducted in areas of apparent damage or deterioration, and at selected locations. The following is a summary of the extent of detailed inspection conducted at each facility:

Quaywall Structure 730:	Cleaning and scraping of 20 piles
Pier D:	Cleaning and scraping of 6 piles; ultrasonic measurement of 1 steel pipe pile shell
Supply Pier:	Cleaning and scraping of 3 - 5 ft diameter subpiers
	Cleaning and scraping of 3 - 1 ft square piles
Quaywall Structure 729:	Cleaning and scraping of 2 concrete sheet piles
Pier B:	Cleaning and scraping of 6 piles
Pier 9; Structure 823:	Cleaning and scraping of 3 piles
Small Boat Pier; Structure 825:	Cleaning and scraping of 3 steel H-piles Ultrasonic measurement of 3 H-piles near bottom
Mooring A:	Cleaning and scraping of 3 piles Ultrasonic measurement of 2 steel sheet pile cells at 5 ft intervals from waterline to bottom



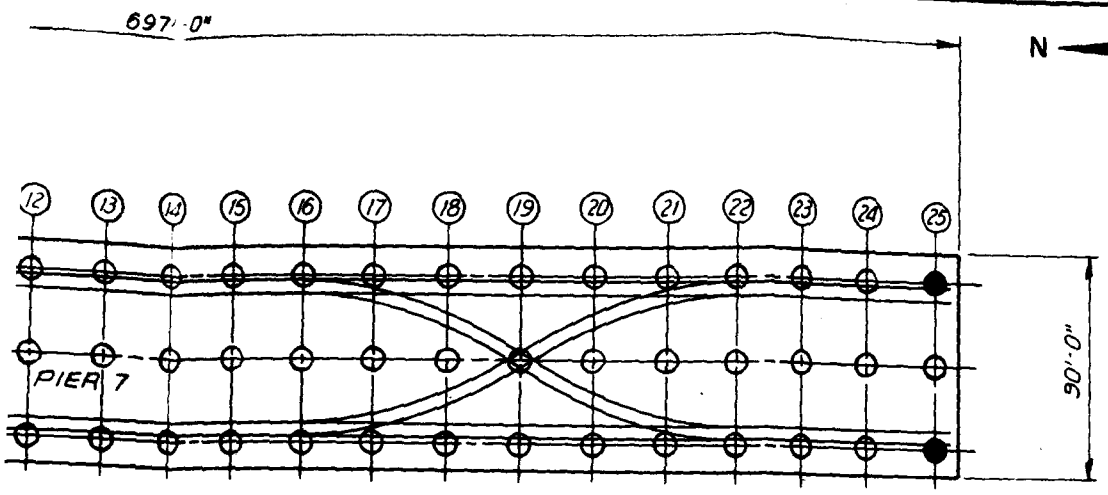
PLAN



TYPICAL SECTION

DESIGN LIVE LOAD
Slabs: 900 psf

Note:
This drawing dev
Drwg. No. 158, 730
● Indicates Le



PLAN

24.8
0.2 M.H.H.W. El. 121.1

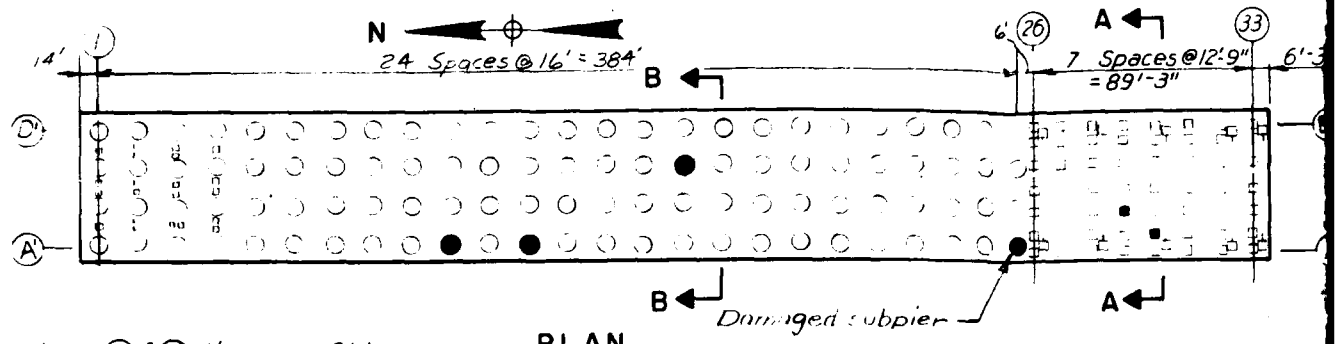
109.4
105.0

DESIGN LIVE LOAD
Slabs: 900 psf

2

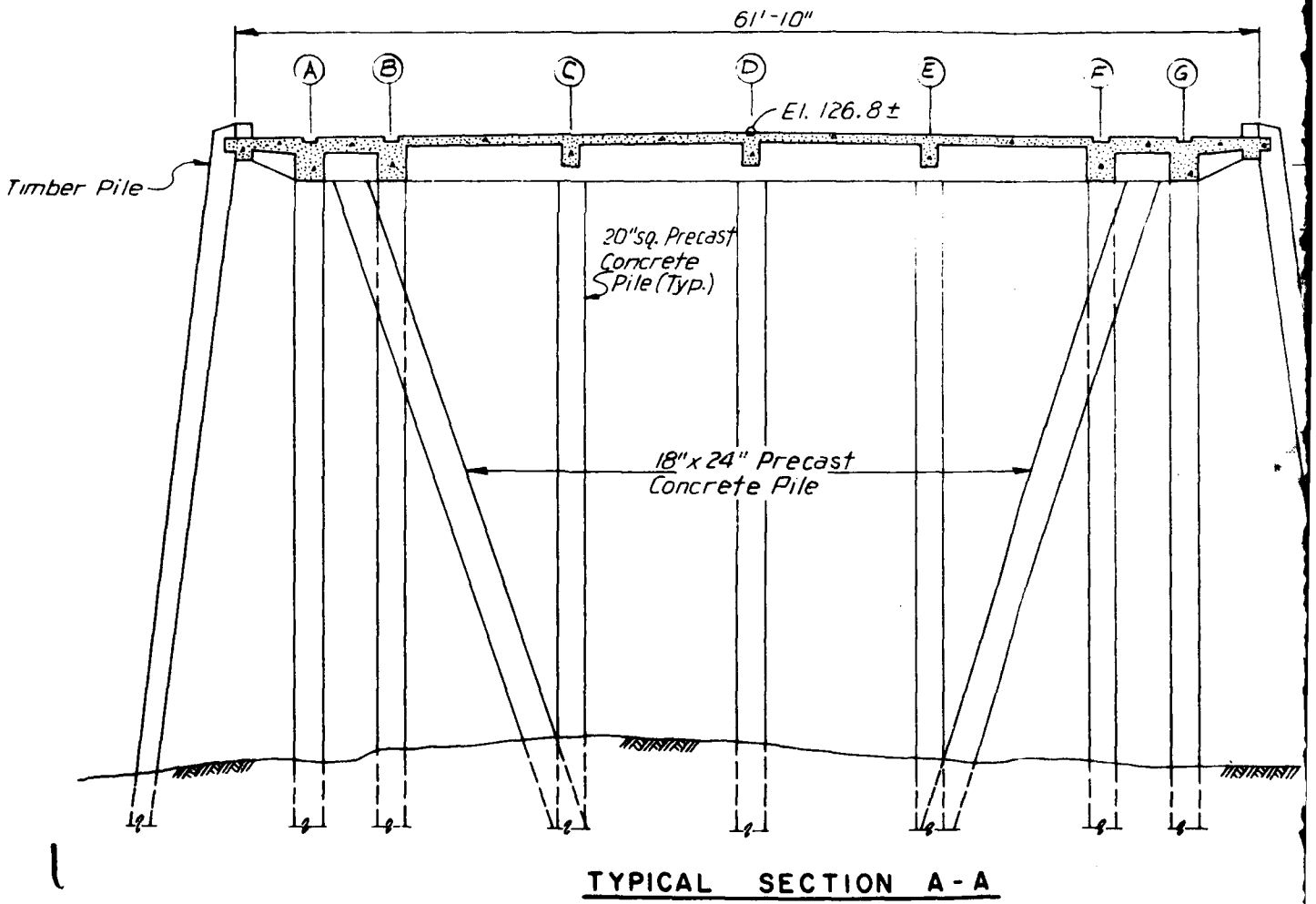
Note:
This drawing developed in part from Y.&D. Drwg. No. 158,730 ; P.W. Drwg. No. 19,251
● Indicates Level II Inspection

PUGET SOUND NAVAL SHIPYARD	
PIER 7	
CHESAPEAKE DIVISION NAVAL FACILITIES ENGINEERING COMMAND WASHINGTON, D. C.	
COLLINS ENGINEERS, INC.	FIGURE 21

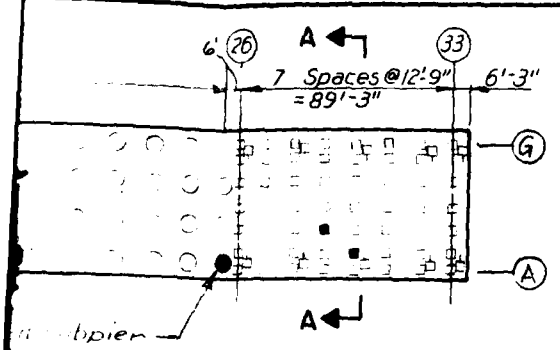


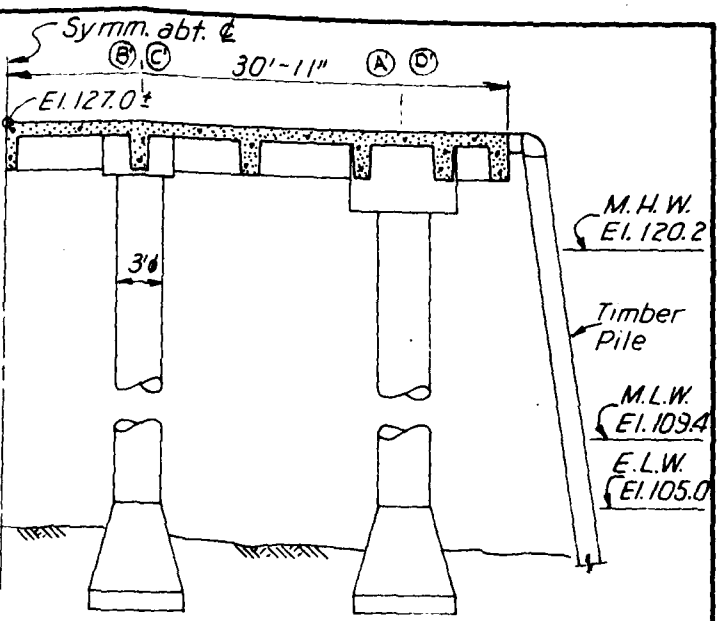
Note:
Between Lines ① & ④ there are 2'ϕ piles and 4'ϕ subpiers.

PLAN

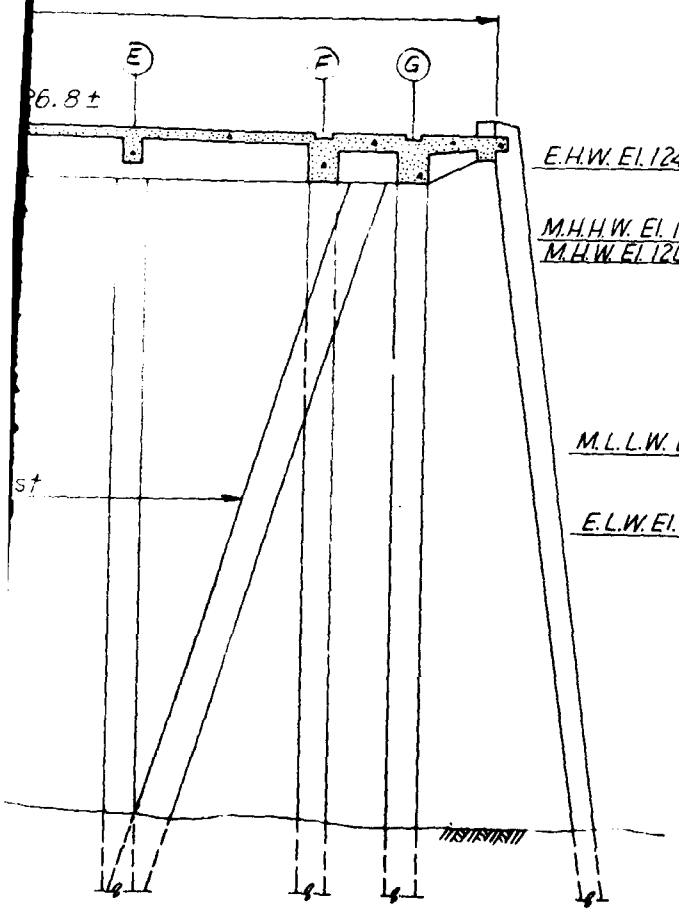


TYPICAL SECTION A-A





TYPICAL HALF SECTION B-B



TION A-A

DESIGN:
Deck Live Load: Bents (26) - (33) = 400 psf

Note:
This drawing developed in part from P.W. Drwg. No. 10311, 10312; Y & D. Drwg. No. 56805 & 56806
- Piles and Subpiers receiving Level II
- inspection

PUGET SOUND NAVAL SHIPYARD	
PIER 8	
CHESAPEAKE DIVISION NAVAL FACILITIES ENGINEERING COMMAND WASHINGTON, D.C.	
COLLINS ENGINEERS, INC.	FIGURE 22

Pier 3:	Cleaning and scraping of 2-5 ft dia. subpiers
	Cleaning and scraping of 4-2 ft square piles
Quaywall Structure 694:	Cleaning and scraping of 2 piles
	Ultrasonic measurements of steel sheet pile wall
Quaywall Structure 693:	Cleaning and scraping of 3 piles
	Ultrasonic measurements of steel sheet pile wall
Pier 4:	Cleaning and scraping of 3 - 2 ft square piles
	Cleaning and scraping of 2 - 5 ft dia. subpiers
	Cleaning and scraping of 2 - 4 ft dia. subpiers
Pier 5:	Cleaning and scraping of 3 subpiers
Pier 6:	Cleaning and scraping of 3 - 4-1/2 ft dia. subpiers
	Cleaning and scraping of 1 - 5-1/2 ft dia. subpier
Pier 7:	Cleaning and scraping of 3 subpiers
Pier 8:	Cleaning and scraping of 3 subpiers

Representative conditions observed during the Level I and Level II inspections were documented with underwater color photographs.

3.4 Method of Investigation

In September, 1981, a detailed underwater inspection was made of the accessible portions of the facilities described above. The inspection included the concrete walls, concrete bearing piles, concrete subpiers, concrete sheet piling, steel bearing piles and steel sheet piling of these facilities from the area near the waterline at the time of the inspection to the channel bottom.

A visual inspection was made of all accessible foundation elements below the waterline, followed by detailed scraping, cleaning, probing and sounding to determine the presence and extent of distress.

The underwater inspection was conducted by a five-person team, including a structural engineer-diver and technician-divers. The diving and tending duties were rotated among the team members. The divers, using scuba equipment, worked from a small boat supplied and operated by Shipyard personnel.

In making the "swim-by" inspection, at least two divers were in the water near each other. Tenders in the boat observed and coordinated the divers' work. The swim-by inspection generally consisted of a diver descending individual piles, circling around the pile while inspecting it. Upon reaching the bottom, the diver swam to the next pile and ascended while circling and inspecting it.

After reporting the general condition of the piles just inspected to a notetaker in the boat, the diver swam to the next set of piles and the process was repeated. When significant distress or deterioration was found the diver immediately surfaced and reported the specific conditions in detail.

At each facility, the diver scraped and cleaned representative areas to conduct Level II inspections during the Level I inspection. The Level I and Level II inspections were generally conducted at the same time because of the problems of scheduling access in the active shipyard. Some of the photography was completed at a later time.

Dive operations were scheduled on a daily basis, and coordinated with the Ship Movement Office and ships in the immediate area of the diving operations. The dive team was in constant radio contact with the Ship Movement Office.

4. STRUCTURAL CONDITION ASSESSMENT

4.1 Existing Conditions

Generally, the underwater inspection indicated that the submerged portion of the waterfront facilities are in good to excellent condition. Only a few localized areas of deterioration or damage were detected.

There is an abundance of sea life in the area, and underwater structural components, particularly in the tidal zone, are generally encrusted with barnacles and other sea growth from one to two inches thick. Sea anemones, starfish, crabs and sea cucumbers generally cover from half to almost the entire surface of the members. Refer to Photographs 1 through 4 on the following page for views of typical marine growth at and below the tidal zone.

The channel bottom near these facilities is generally sandy, silty, and covered with marine growth, although stone riprap and broken concrete have been placed beneath many structures.

In the following sections, distress locations are referenced to the plans shown on Figures 5 through 22, where appropriate.

4.1.1 Moorings E, F and G

The piling of Moorings E, F and G are in good condition. Generally, the precast concrete piles are approximately 50 percent covered by sea anemones.

The steel sheet piles were visually inspected and appeared to have experienced little or no loss of section. Ultrasonic thickness measurements, made by shipyard divers in 1979 and 1980, near the tidal zone, generally indicated losses of 5 to 10 percent. Copies of those reports are included in the Appendix.

4.1.2 Quaywall Structure 730

The piling of Quaywall Structure 730 is in good condition. The concrete piling is generally covered with barnacles approximately 2 inches thick.

At Mean Lower Low Water, the top of the riprap and the steel sheet pile wall above the riprap is exposed. It was noted that riprap partially fills the north-south leg of the quaywall at the west end of the facility. This north-south leg is located in a storage area, and because it is not readily apparent from the surface that it is a quaywall structure, it could be inadvertently overloaded.

4.1.3 Pier D

The Pier D piles are in good to excellent condition.

PHOTOGRAPH 1 TYPICAL MARINE GROWTH IN TIDAL ZONE

PHOTOGRAPH 2 TYPICAL MARINE GROWTH ON STRUCTURES

PHOTOGRAPH 3 TYPICAL MARINE GROWTH ON STRUCTURES

PHOTOGRAPH 4 TYPICAL MARINE GROWTH ON STRUCTURES

Seagrowth on the piles in the tidal zone consists of barnacles approximately 1 to 2 inches thick. Below the tidal zone the barnacles are 1/2 to 1 inch thick and sea anemones cover approximately 90 percent of the pile surfaces.

Refer to photographs 5 and 6 following this page for views of typical piles in the tidal zone. It was noted that pipe piles, not shown on available drawings, are located in approximately Bents 3 through 5.

4.1.4 Supply Pier

The Supply Pier piling and subpiers are generally in good condition.

Approximately one-fourth of the subpiers have irregular surface indentations which cover an area approximately 4 inches square and extend into the subpiers about 2 inches. Many subpiers also have irregularly formed surfaces which appear to be patches used to correct the condition described above. It appears that this patching may have been done at the time of the original construction.

In the west subpier of Bent 2, a 4 ft long horizontal crack extending approximately 2 inches into the concrete was found about 3 ft from the channel bottom. No reinforcing steel was observed.

Seagrowth on the subpiers in the tidal zone consist of barnacles generally 1 to 2 inches thick. Below the tidal zone the barnacles are 1/2 to 1 inch thick, and sea anemones cover approximately 50 percent of the subpier surfaces.

4.1.5 Quaywall Structure 729

The submerged portions of Quaywall Structure 729 are in good condition.

The concrete columns supporting the top slab are generally covered with barnacles 1 to 2 inches thick.

The concrete sheet piling cutoff wall is covered with a thin film of seagrowth. Refer to Photograph 7, on Page 4-7 for a typical view of these piling.

4.1.6 Pier B

The piles of Pier B are generally in good condition.

This pier has been damaged and repaired in the past. Within the repaired area, there are minor cracks at the top of four piles on the east side of the facility between Bents 95 and 100.

PHOTOGRAPH 5 TYPICAL CONCRETE PILE, PIER D

PHOTOGRAPH 6 TYPICAL PIPE PILE, PIER D

Seagrowth on the piles in the tidal zone consists of barnacles approximately 1 to 2 inches thick. Below the tidal zone, the barnacles are generally about 1/2 thick and sea anemone cover approximately 50 percent of the pile surfaces.

4.1.7 Pier 9; Structure 823

The piles of Pier 9; Structure 823 are in good condition. Repairs have been made to one of the piles above water using corrugated metal pipe as a form.

Seagrowth on the piles in the tidal zone consists of barnacles generally 1 to 2 inches thick. Below the tidal zone, the barnacles are approximately 1/2 inch thick, and sea anemones cover approximately 50 percent of the pile surfaces.

Refer to Photograph 8 on the following page for a typical view of these piles at the channel bottom.

4.1.8 Small Boat Pier; Structure 852

The steel H-piles and concrete encasement of this facility are in good to excellent condition.

The concrete encasement of one pile near the north end of Row B has a damaged area approximately 2 ft. long horizontally by 4 in. high extending into the concrete a maximum of 2 in. as Shown in Photograph 9 on Page 4-8.

The remaining thickness of the steel H-pile section of the southernmost two piles of the east row was ultrasonically measured at the channel bottom. The measurements, which are shown below, indicate an average reduction from the original thicknesses in the order of 5 percent, or less than one mil per year.

	Section Measurements (in.)	
	t_{web}	t_{flange}
Original Theoretical Thickness	0.436	0.436
Average Measured Thickness		
Pile A1	0.426	0.422
Pile A2	0.418	0.406

Seagrowth on the piles and encasement consists of barnacles approximately 1/2 inch thick and a few anemones.

Refer to Photographs 10 and 11 on Pages 4-8 and 4-9 for typical views of the H-piles

PHOTOGRAPH 7 TYPICAL CONCRETE SHEET PILES, QUAYWALL STRUCTURE 729

PHOTOGRAPH 8 TYPICAL OCTAGONAL PILE AT CHANNEL BOTTOM, PIER 9, STRUCTURE 823

PHOTOGRAPH 9 DAMAGED CONCRETE ENCASEMENT, NORTH END ROW B, SMALL BOAT PIER, STRUCTURE 852

PHOTOGRAPH 10 H-PILE, A2, AND CONCRETE ENCASEMENT, SMALL BOAT PIER, STRUCTURE 852

PHOTOGRAPH 11 H-PILE, A1, AND CONCRETE ENCASEMENT, SMALL BOAT PIER, STRUCTURE 852

PHOTOGRAPH 12 STEEL SHEET PILING INTERLOCK, MOORING A, SOUTH SIDE OF NORTH CELL

4.1.9 Mooring A

The precast concrete piles, and steel sheet piling of Mooring A are in good condition. At the north end of the mooring platform, seven battered steel H-piles are separated from the concrete deck. Near and below the waterline, however, these piles, which are not noted on available drawings, are in good condition.

At each of the cellular cofferdams, the remaining section of one steel sheet pile was measured ultrasonically at approximately 5 ft. intervals from the waterline to the channel bottom. The measurements, which are listed below, indicate generally that no significant losses have occurred. Measurements made in 1979 and 1980 by Shipyard personnel are included in the Appendix.

Section Measurements (in.)

Elevation (N.O.S.)	North Cell, t	South Cell, t
+ 5	.522	.524
0	.526	.530
- 5		.530
-10	.503	.496
-15	.496	.467
-20	.478	.315
-25	.508	.464
-30	.458	.468
-35	.512	.521
-40	.515	
-45	.497	

Original theoretical thickness, t = 0.50 in.
Refer to Figure 15 for the location of the ultrasonic measurements.
See Photograph 12 for a typical view of the steel sheet piles.

These cells are about 35 years old, and the losses of section are extremely small. The most severe loss occurred in what appears to be an isolated area. General rates of loss are significantly less than one mil per year. Measurements in excess of the original theoretical thickness may be due to the variations in fabrication tolerances and the normal accuracy of the thickness measuring device.

Observation of the surface of the mooring platform indicates that differential settlement may have occurred as shown in Photograph 13 on the following page, but no related distress was found below water.

Sea growth on the piles and subpiers consists of barnacles approximately 1 to 2 inches thick, and sea anemones cover approximately 50 percent of their surface area.

4.1.10 Pier 3

The subpiers and piles of Pier 3 are in good condition. No evidence of significant distress was found.

Sea growth on the subpiers and piles consists of barnacles 1/2 inch to 2 inches thick and sea anemones covering approximately 50 percent of their surface area.

4.1.11 Quaywall Structures 694 and 693

Quaywall Structures 694 and 693 are in good condition. The concrete piling is generally covered with barnacles 1 to 2 inches thick, and sea anemones cover approximately 30 percent of pile surfaces.

At Mean Lower Low Water, the top of the riprap is at the waterline along the steel sheet pile wall. The thickness of the sheet piling measured near Mean Lower Low Water, as shown below generally indicated no significant losses.

Elevation± (N.O.S.)	Section Measurements, t (in.) Quaywall 694		Quaywall 693	
+5	.544	.454	.562	.482
+2	.454	.500	.531	.422
+0	.492		.496	

Original theoretical thickness, t = 0.500 in.

Measurements in excess of the original theoretical thickness may be due to variations in fabrication and the normal accuracy of the thickness measuring device. The quaywalls are approximately 40 years old and losses are extremely low. General rates of loss are significantly less than 1 mil per year.

4.1.12 Pier 4

The piles and subpiers of Pier 4 are generally in good condition. There are, however, a number of areas of local minor damage or deterioration, especially in the Bents A1 through A19.

PHOTOGRAPH 13 MOORING A, LOOKING SOUTH

PHOTOGRAPH 14 TYPICAL PRECAST CONCRETE PILE, PIER 4

Many of the precast piles in this area have been repaired by encasing with concrete. One pile that has not been repaired in Bent 2, Row A, as shown in Figure 15, is severely cracked at the channel bottom, with concrete broken off and reinforcing steel exposed.

Sea growth on the piles and subpiers consists of barnacles approximately 1/2 to 1-1/2 inches thick, and sea anemones cover approximately 25 percent of their surface area.

Refer to Photographs 14 through 17 on pages 4-12, 4-14 and 4-15 for views of typical piles and subpiers.

4.1.13 Pier 5

The subpiers of Pier 5 are in good condition. No evidence of significant distress or damage was found.

Sea growth on the subpiers consists of barnacles approximately 1 to 2 inches thick, and sea anemones cover approximately 30 percent of their surface area.

Refer to Photograph 18 on Page 4-15 for a view of a typical subpier.

4.1.14 Pier 6

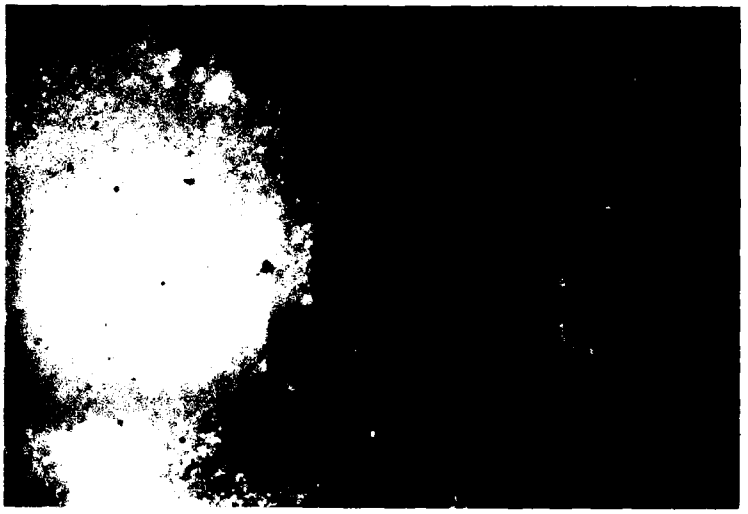
The subpiers of Pier 6 are generally in good condition. There are, however, damaged areas on the concrete shafts of Subpiers 27A, 29A, 31C, and 32B near the channel bottom, with voids extending into the subpier from 3 to 9 inches. In some cases there is also exposed and corroded reinforcement. These conditions were also reported in the Shipyard's 1977 inspection, a copy of which may be found in the Appendix.

Seagrowth on the subpiers consist of barnacles approximately 1 to 2 inches thick, and sea anemones covering approximately forty percent of their surface.

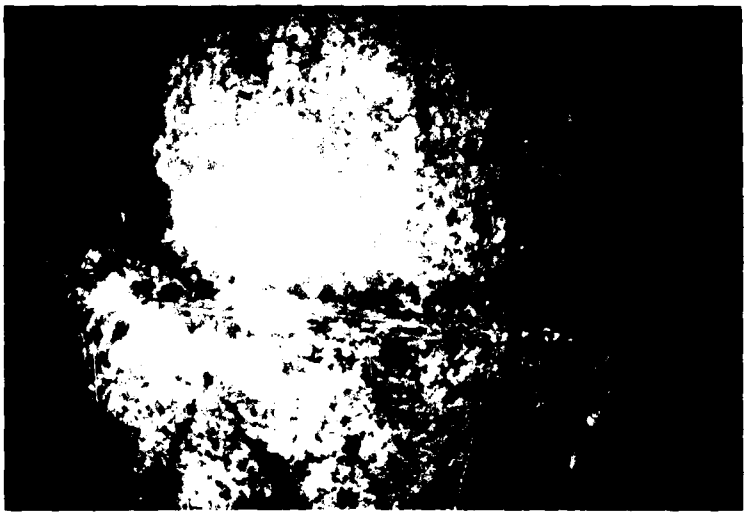
4.1.15 Pier 7

The subpiers of Pier 7 are in good condition. No evidence of significant distress were found.

Sea growth on the subpiers consists of barnacles 1/2 to 2 inches thick and sea anemones covering approximately 50 percent of their surface area.



PHOTOGRAPH 15 CRACKED CONCRETE PILE, BENT 2, Row A



PHOTOGRAPH 16 TYPICAL 4 FT-6 IN DIAMETER SUBPIER SHAFT, PIER 4

PHOTOGRAPH 17 TYPICAL SUBPIER BELL, PIER 4

PHOTOGRAPH 18 TYPICAL SUBPIER, PIER 5

4.1.16 Pier 8

The piles and subpiers of Pier 8 are generally in good condition. There are, however, a few areas of minor deterioration below the waterline. One subpier, the west subpier of Bent 25, has also been damaged above the waterline exposing reinforcing steel.

Sea growth on the piles and subpiers consists of barnacles approximately 1 to 2 inches thick, and sea anemones cover approximately 50 percent of their surface area.

4.2 Condition Assessment

The underwater inspection indicated that the facilities inspected as part of this project are generally in good to excellent condition, and are performing satisfactorily

There are areas of minor deterioration and damage, but review of previous inspection reports does not indicate that this distress is new or actively progressing.

There is no evidence of structural failure or significant reduction of structural capacity. Design loads for each structure are indicated on Figures 5 through 22, and no reduction from these values is indicated as necessary at this time.

Conditions noted at three structures, Mooring A, Pier 4, and Pier 6, warrant further discussion.

Mooring A generally appears to be in good condition at and below the waterline, but there are damaged steel H-piles at the north end of the structure, and the deck appears to have suffered damage as the result of differential settlement. The connection of the piles to the deck should be repaired, and the structure should be inspected periodically to insure that the movement has ceased.

In the notheastern part of Pier 4, there are a number of repaired piles. One pile in that area is damaged at the channel bottom and was not repaired. The distress does not appear to be recent, and may have existed at the time the other piles in the area were repaired. Detailed plans of the piles in this area are not available to permit an analytical evaluation of the loss of capacity of this pile. There is no evidence of related damage to the structure, however.

The subpiers of Pier 6 have a number of areas of local concrete distress and exposed reinforcing steel near the channel bottom. This damage was reported in previous inspections, and the present inspection generally confirmed the damage. In a

few instances, however, this inspection indicated depths of distress slightly greater than those previously reported. The depth of distress reported during the current inspection does not significantly reduce the capacity of the piers, and the distressed areas do not appear to have freshly exposed surfaces. It is believed, therefore, that the difference between the reports is to due differences in the inspectors' estimates, rather than actively progressing deterioration.

5. CONCLUSIONS AND RECOMMENDATIONS

The underwater investigation of the submerged portions of the waterfront structures included in this project indicated that generally these structures are performing satisfactorily, and no immediate repairs are required. There are, however, areas of distress and deterioration that should be repaired. With accomplishment of these repairs and routine inspection and maintenance, all the structures inspected in this project can be expected to provide long term serviceability.

Pier B has four concrete piles which are cracked near the underside of the deck, above the waterline. Adjacent piles have been repaired, and it was probably decided that the damage to these four piles was not significant. The structural capacity of the pier does not appear reduced by these cracks, but the cracks may provide a path for future deterioration. It is recommended that these piles be repaired in the future as part of other maintenance and repair operations so that they may be accomplished most economically. The estimated cost of these repairs is $8,000.

The Small Boat Pier, Structure 852 has one minor area of damaged concrete encasement. The damage is not structurally significant, and the repair should only be made when other work is also needed. The estimated cost of this repair is $500.

The north end of Mooring A, where the mooring meets the shoreline, is supported on steel H-piles which are not shown on available drawings of the structure. These piles are broken loose from the underside of the pier, and have been bent. These piles should be repaired by cutting off the damaged piles above the waterline, casting new concrete pile sections above the H-pile, and recasting the concrete pier deck at the damaged area. The estimated cost of this repair is $12,000.

One concrete pile of Pier 4 is cracked at the channel bottom and reinforcing steel is exposed. This pile is adjacent to a number of other piles which have been repaired by concrete encasement. This pile should be repaired in the same manner. Although there is no evidence of settlement or overstressing of adjacent structural members at this time, this repair should be scheduled for early accomplishment. The estimated cost of the repair is $5,000.

Except for the repairs indicated above, no other repairs are recommended at this time. These structures should be periodically inspected in the future. This inspection has established a "base line" condition for the structures. It is recommended that this information form the basis for evaluating the conditions encountered in subsequent inspections of these facilities to determine if deterioration is progressing.

Because the facilities inspected were generally found to be in good condition, it is recommended that the normal interval between underwater visual inspections be 5 years. For those structures in which reportable distress was found, the Supply Pier, Pier 6, and Pier, 8 it is recommended that the interval for underwater visual inspections be reduced to 3 years. The areas recommended for repair should be inspected annually until the repairs are accomplished.

Because the rate of loss for steel structures is very low, it is recommended that ultrasonic thickness measurements of remaining thickness be made every 10 years.

Interim inspections should be made of any facility that is damaged by external forces.

UNDER WATER PIER INSPECTION
MOORING "G" 1980
STRUCTURE NO. 728

THE CONSTRUCTION OF MOORING "G" IS SIMILAR TO THAT OF MOORING "F". ALL CONCRETE PILINGS ARE APPROXIMATELY 2 FEET SQUARE AND APPEAR TO BE IN SATISFACTORY CONDITION.

WITH THE AID OF CODE 135 DIVERS PERFORMED ULTRA-SONIC TESTS ON SHEET PILINGS ON MOORING "G". THE RESULTS OF THE TEST ARE PROVIDED IN THE TABLE BELOW. READING WERE TAKEN AT TIDAL ZONE & BELOW TIDAL ZONE.

	(MIDDLE OF PIER) CELL 1	(SOUTH) CELL 2
	TIDAL ZONE / BELOW TIDEL ZONE	TIDAL ZONE/ BELOW TIDAL ZONE
NORTH	.470" / .430"	.460"/.470"
EAST	.480" / .475"	.450" / .465"
SOUTH	.500" / .482"	.430"/ .472"
WEST	.495" / .445	.495"/ .470"

NOTE: SHEET PILING WAS .500" WHEN NEW.

SEA GROWTH ON ALL CONCRETE AND SHEET PILINGS UNDER MOORING "G" CONSISTS OF SMALL BARNACLES AND SEA ANEMONES COVERING APPROXIMATELY 20 % OF THEIR TOTAL AREA.

UNDERWATER PIER INSPECTION
MOORING "F" 1980
STRUCTURE NO. 727

THE CONCRETE PILING UNDER MOORING "F" CONSISTS OF FOUR ROWS LETTERED "A" THROUGH "D" FROM WEST TO EAST AND PILINGS NUMBERED FROM SOUTH TO NORTH. ALL CONCRETE PILINGS UNDER MOORING "F" ARE APPROXIMATELY 2 FEET SQUARE AND APPEAR TO BE IN SATISFACTORY CONDITION.

DIVERS TOOK ULTRA-SONIC MEASUREMENTS OF THE TWO SHEET PILING CELLS UNDER MOORING "F". THESE CELLS ARE CONSTRUCTED IDENTICALLY TO THOSE CELLS UNDER MOORING "E". MEASUREMENTS WERE TAKEN AT EIGHT DIFFERENT LOCATIONS ON EACH SHEET PILING. FOUR AT TIDAL ZONE AND FOUR BELOW TIDAL ZONE AT THE NORTH, EAST, SOUTH & WEST SIDES. RESULTS CONTAINED IN TABLE BELOW.

	(MIDDLE OF PIER) CELL 1	(SOUTH) CELL 2
	TIDAL ZONE / BELOW TIDAL ZONE	TIDAL ZONE / BELOW TIDAL ZONE
NORTH	.490" / .485"	.475" / .480"
EAST	.470" / .480"	.475" / .475"
SOUTH	.490" / .480"	.460" / .465"
WEST	.485" / .440"	.480" / .440"

NOTE: SHEET PILING WAS .500" WHEN NEW.

OVER

SEA GROWTH ON CONCRETE AND SHEET PILINGS UNDER MOORING "F" CONSISTS OF SMALL BARNACLES AND SEA ANENOMIES COVERING APPROXIMATELY 15% OF THIER TOTAL AREA.

UNDERWATER PIER INSPECTION
MOORING "E" 1980
STRUCTURE NO. 726

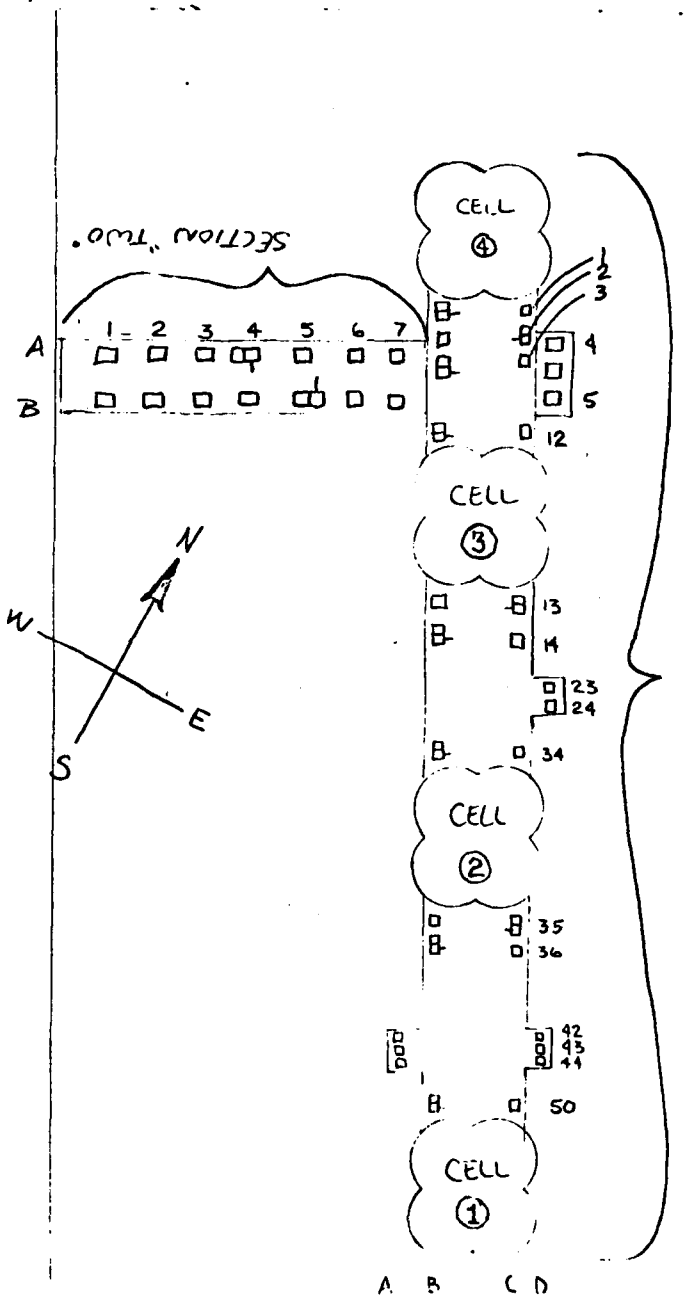
MOORING "E" IS CONSTRUCTED IN TWO SECTIONS. SECTION ONE IS THE MAIN MOORING PIER AND SECTION TWO IS THAT PART WHICH COMES FROM WYCOFF WAY TO SECTION ONE. THE CONCRETE UNDER SECTION ONE CONSISTS OF FOUR ROWS LETTERED A through D FROM WEST TO EAST WITH the PILINGS IN EACH ROW NUMBERED FROM SOUTH TO NORTH. THE PILINGS UNDER SECTION TWO CONSISTS OF TWO ROWS LETTERED A AND B from SOUTH TO NORTH AND NUMBERED FROM ONE to SEVEN WEST TO EAST. ALL CONCRETE PILINGS IN SECTION ONE # AND TWO APPEAR TO BE IN SATISFACTORY CONDITION.

SECTION ONE ALSO CONTAINS FOUR CLOVERLEAF SHAPED CELLS CONSTRUCTED OF SHEET PILINGS. DIVERS TOOK EIGHT ULTRA-SONIC MEASURMENTS ON EACH CELL. THESE MEASUREMENTS WERE TAKEN ON WEST, SOUTH, EAST, NORTH AT HIGH AND LOW TIDE ZONES AS EVENLY AS POSSIBILE

	CELL #1 HIGH/LOW	CELL #2 HIGH/LOW	CELL #3 HIGH/LOW	CELL #4 HIGH/LOW
SOUTH	.470"/.480"	.460/.475	.500/.475	.470/.465
EAST	.440"/.475"	.475/.420	.500/.490	.465/.475
NORTH	.450"/.450"	.430/.440	.460/.465	.480/.480
WEST	.450"/.450"	.450/.450	.460/.470	.475/.475

NOTE: SHEET PILING WAS .500" WHEN NEW.

(OVER)


SECTION "TWO"
A
B
1 2 3 4 5 6 7
CELL ④
CELL ③
CELL ②
CELL ①
1
2
3
4
5
12
13
14
23
24
34
35
36
42
43
44
50
N
W
E
S
SECTION "ONE"
A B C D

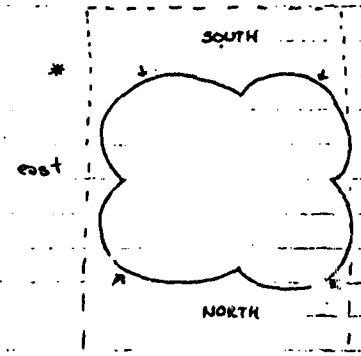
Note: all external piling is ½" thk per PW Dwg #32025
all interior piling is ⅜" thk

Ultra-Sonic test of Sheet Piling on Moorings A, E, F, & G

During the period of 7/19 thru 7/23 the shipyard divers, in conjunction with C/135, conducted ultra-sonic thickness tests of metal sheet piling on moorings Alpha, Echo, Foxtrot, and Golf.

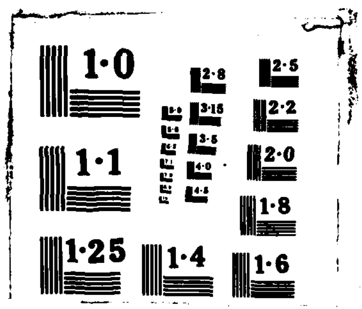
Readings were taken at three depth locations for each test site. (ie. Above water line - approx. 1ft. below bottom of pier, inter-tidal zone - approx. 15ft. below high water mark and 17ft. below bottom of pier, and below tidal zone - approx. 30ft. below high water mark and 32ft. below bottom of pier.) The sheet piling were formed in a cloverleaf configuration* (as per figure) and readings were taken at the north (east & west) and south (east & west) extremities of each set of sheet piling.

The attached sheets are the thickness readings for the various sets of sheet piling on each mooring



AD-A167 477 UNDERWATER FACILITIES INSPECTION AND ASSESSMENT AT PUGET SOUND NAVAL SHIP..(U) COLLINS ENGINEERS INC CHICAGO IL SEP 81 CHES/NAVFAC-FPO-1-82(00) 2/2

UNCLASSIFIED N62477-81-C-0161 F/G 13/2 NL


1·0
2·8
2·5
3·15
2·2
3·5
2·0
4·0
1·1
4·5
1·8
1·25
1·4
1·6

U. T. INSPECTION OF MOORING "G" 7-24-79

South SET OF Pilings

Tidal Zone	Below Tidal Zone
South	South
1. .470	1. .470
EAST	EAST
1. .470	1. .480
WEST	WEST
1. .450	1. .480
NORTH	NORTH
1. .470	1. .470

NOTE: DUE TO THE STRUCTURE OF THIS SET OF Pilings THERE ARE NO READINGS FOR ABOVE WATER LINE.

NORTH SET OF Pilings

Above w/l		Tidal Zone	Below Tidal Z
South	WEST	South	South
1. .500	1. .500	1. .480	1. .460
2. .500	2. .500	EAST	EAST
3. .500	3. .500	1. .490	1. .490
4. .500	4. .500	WEST	WEST
EAST	NORTH	1. .480	1. .480
1. .500	1. .500	NORTH	NORTH
2. .500	2. .500	1. .450	1. .480
3. .500	3 .500		
4. .500	4. .500		

U. T. READINGS BY

DATE 7-24-79

ACCURACY ± .01"

U.T. INSPECTIONS OF MOORING "F" 7-2.

South SET OF Pilings

Above w/l		Tidal Zone	Below Tidal Zone
South	West	South side	South side
1. .500	1. .500	1. .460	1. .460
2. .500	2. .500	East side	East side
3. .500	3. .500	1. .480	1. .460
4. .500	4. .500	West side	West side
East	North	1. .470	1. .480
1. .500	1. .500	North side	North side
2. .500	2. .500	1. .460	1. .460
3. .500	3. .500		
4. .500	4. .500		

North SET OF Pilings

Above w/l		Tidal Zone	Below Tidal Z
South	West	South side	South side
1. .500	1. .500	1. .480	1. .480
2. .500	2. .500	East side	East side
3. .500	3. .500	1. .480	1. .450
4. .500	4. .500	West side	West side
East	North	1. .470	1. .460
1. .500	1. .500	North side	North side
2. .500	2. .500	1. .490	1. .460
3. .500	3. .500		
4. .500	4. .500		

U. T. READINGS BY

J E Klaus

DATE 2-24-79

ACCURACY ± .012"

U. T. INSPECTION OF MOORING "E" 7-20

#1 SET FROM SOUTH END OF PIER

Tidal Zone		Below Tidal Zone
South side		South side
1. .500		1. .500
EAST side		EAST side
1. .400	.1	1. .480
WEST side		WEST side
1. .490		1. .460
NORTH side		NORTH side
1. .500		1. .470

#2 SET FROM South END OF PIER

Above w/l		Tidal Zone	Below Tidal
South	WEST	South side	South sid
1. .500	1. .500	1. .480	1. .480
2. .500	2. .500	EAST side	EAST sid
3. .500	3. .500	1. .480	1. .480
4. .500	4. .500	WEST side	WEST SID
EAST	NORTH	1. .500	1. .480
1. .500	1. .500	NORTH side	NORTH sid
2. .500	2. .500	1. .500	1. .480
3. .500	3. .500		
4. .500	4. .500		

NOTE: Due to the structure of #1 set of Pilings. There are no Above w/l Readings For These pilings.

U. T. READINGS BY

DATE 7-24-79

ACCURACY ±.01"

U. T. INSPECTION OF MOORING "E" 7-20

#3 SET FROM SOUTH END OF PIER

ABOVE W/L		TIDAL ZONE	BELOW TIDAL Z
SOUTH	WEST	SOUTH SIDE	SOUTH SIDE
1. .500	1. .500	1. .500	1. .470
2. .500	2. .500	EAST SIDE	EAST SIDE
3. .500	3. .500	1. .500	1. .500
4. .500	4. .500	WEST SIDE	WEST SIDE
EAST	NORTH	1. .490	1. .490
1. .500	1. .500	NORTH SIDE	NORTH SIDE
2. .500	2. .500	1. .490	1. .490
3 .500	3. .500		
4. .500	4. .500		

#4 SET FROM SOUTH END OF PIER

ABOVE W/L		TIDAL ZONE	BELOW TIDAL
SOUTH	WEST	SOUTH SIDE	SOUTH SIDE
1. .500	1. .500	1. .500	1. .500
2. .500	2. .500	EAST SIDE	EAST SIDE
3. .500	3. .500	1. .500	1. .500
4. .500	4. .500	WEST SIDE	WEST SIDE
EAST	NORTH	1. .490	1. .470
1. .500	1. .500	NORTH SIDE	NORTH SIDE
2. .500	2 .500	1. .490	1. .500
3. .500	3. .500		
4. .500	4. .500		

U. T. READINGS BY

DATE 7-24-79

ACCURACY ± .012"

1

U. T. INSPESTION OF MOORING "A"

7-19-79

South SET OF Pilings

Above w/l		Tidal Zone	Below Tidal Zone
South side	West side	South side	South side
1. .500	1. .500	1. .470	1. .460
2. .500	2. .500	2. .440	2. .470
3. .500	3. .500	East side	East side
4. .500	4. .500	1. .420	1. .420
East side	North side	2. .450	2. .470
1. .500	1. .500	West side	West side
2. .500	2. .500	1. .460	1. .460
3. .500	3. .500	2. .450	2. .440
4. .500	4. .500	North side	North side
		1. .470	1. .460
		2. .460	2. .450

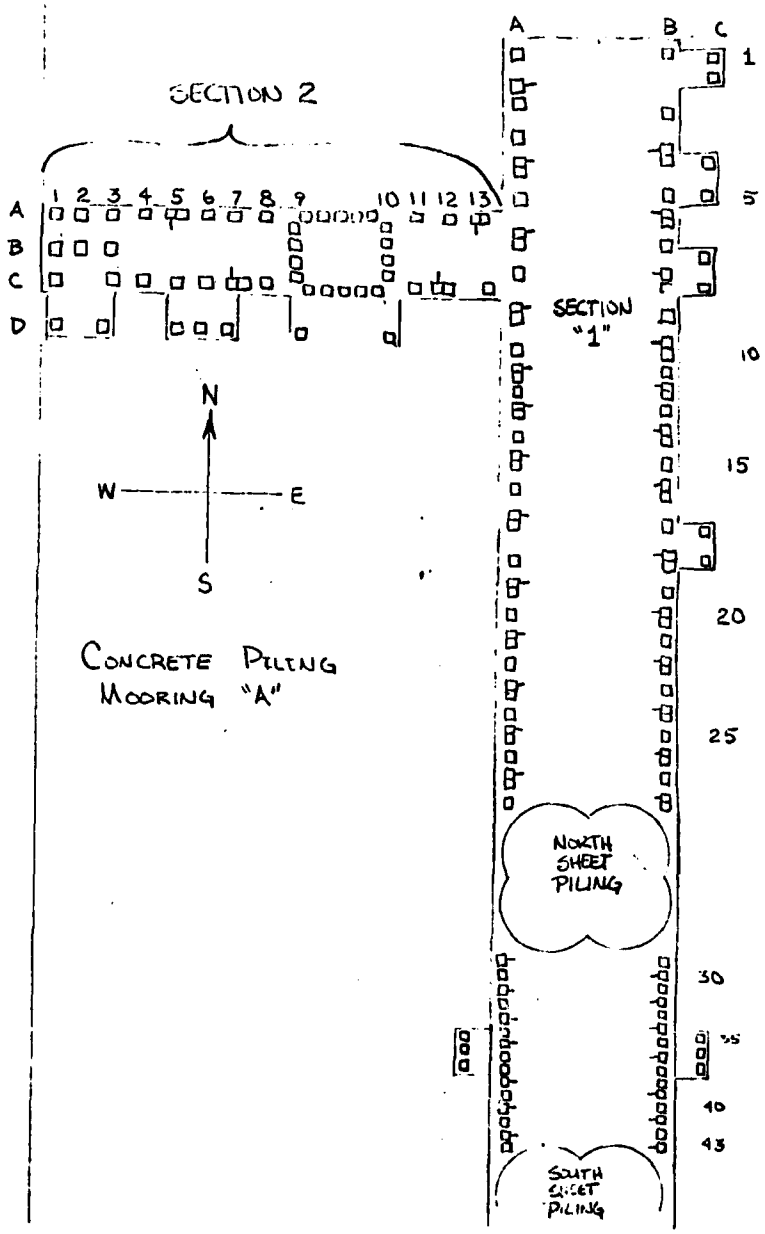
North SET OF Pilings

Above w/l		Tidal Zone	Below Tidal Zone
South side	West side	South side	South side
1. .500	1. .500	1. .460	1. .420
2. .500	2. .500	2. .480	2. .480
3. .500	3. .500	East side	East side
4. .500	4. .500	1. .470	1. .450
East side	North side	2. .460	2. .460
1. .500	1. .500	West side	West side
2. .500	2. .500	1. .450	1. .480
3. .500	3. .500	2. .480	2. .460
4. .500	4. .500	North side	North side
		1. .480	1. .470
		2. .470	2. .460

U. T. READINGS BY

DATE 7-24-79

ACCURACY ± .012"


SECTION 2
A
B
C
D
1 2 3 4 5 6 7 8 9 10 11 12 13
N
W
E
S
CONCRETE PILING
MOORING "A"
A
B C
1
5
SECTION "1"
10
15
20
25
NORTH SHEET PILING
30
35
40
43
SOUTH SHEET PILING

Ultra-Sonic Test were performed on both sets of sheet pilings in section one at high & low tide zones, at four different locations (ie; West, South, East, North).

South set of sheet Pilings

	Low Tide Mark	High Tide Mark
West	.490"	.450"
South	.440"	.460"
East	.420"	.420"
North	.495"	.500"

Note: sheet pile material was .500" when new.

North set of sheet Pilings

	Low Tide Mark	High Tide Mark
West	.400"	.395"
South	.460"	.465"
East	.440"	.480"
North	.460"	.350"

See attached sketch of all numbered and lettered concrete pilings.

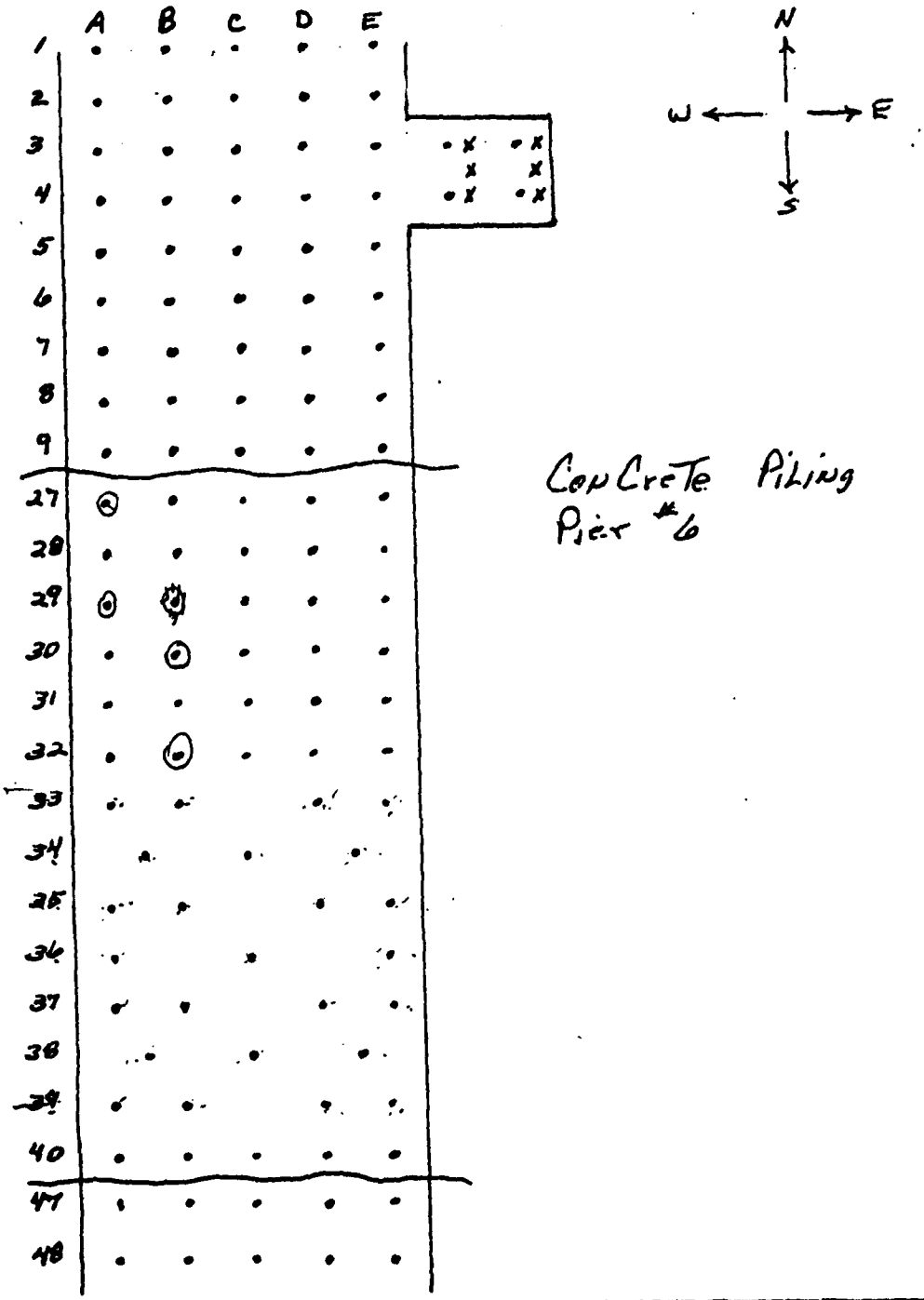
UNDERWATER PIER INSPECTION
PIER #6 1977
STRUCTURE NO. 716

The concrete piling under pier #6 consists of five rows lettered A through E from west to east with forty-eight piling in each row numbered one through forty-eight from north to south. This pattern changes between piling number thirty-three and thirty-nine because of reinforcement beneath the hammerhead crane. The pattern change is shown in the attached sketch. In line with piling numbers three and four and on the east side of the pier there are four large piling and six small piling. These six small piling are approximately two feet square. The remainder of piling under pier #6 are approximately four feet in diameter. Divers found five large piling with chipped or flaking areas on them. These areas are located at the top of the bell-shaped base of each piling. The chipped area in piling number twenty-seven A is approximately five feet long, two and one-half feet from top to bottom and six inches deep at its center. The chipped area in piling number twenty-nine A is approximately three and one-half feet long, three feet from top to bottom and four inches deep at its center. The chipped area in piling number thirty B is approximately two feet in diameter and four inches deep at its center. The chipped area in piling number thirty-one C is the entire circumference of the piling, two feet from top to bottom and six inches deep. The chipped area in piling number thirty-two B is approximately three feet in diameter and six inches deep at its center.

The fender piling around pier #6 are numbered with metal tags. On the west side of the pier, fender piling numbers four and five have rotten centers, number seven is split and outboard of number seventy, there is an old piling approximately thirty feet long coming within ten feet of the surface at low tide. On the east side of the pier, fender piling numbers thirty-one and forty-one have rotten centers, number sixty-eight is split at the top and numbers eighty-five, one hundred nine and one hundred fifty-three are not attached to the pier.

Seagrowth on all piling is heaviest between high and low tide levels with sea anemones covering approximately thirty percent of each piling.

See attached sketch for location of all numbered and lettered piling.


A
B
C
D
E
1
2
3
4
5
6
7
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27
28
29
30
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32
33
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N
W
E
S
Concrete Piling
Pier #6

END

DATE
FILMED

6-86