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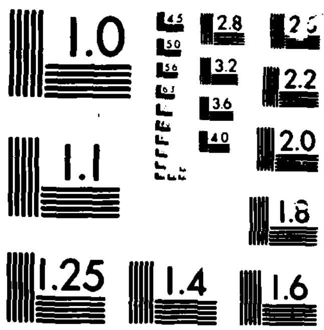

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MOORING PLAN FOR THE U.S. ARMY POWER BARGE "IMPEDANCE" TO THE CARIBBEAN CEMENT CO. WHARF, JAMAICA

FPO-1-82(19)

Ocean Engineering

CHESAPEAKE DIVISION
NAVAL FACILITIES ENGINEERING COMMAND
WASHINGTON NAVY YARD
WASHINGTON, DC 20374

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MOORING PLAN FOR THE U.S. ARMY POWER BARGE "IMPEDANCE" TO THE CARIBBEAN CEMENT CO. WHARF, JAMAICA

FPO-1-82(19)

by

William N. Seelig

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1. Introduction

The purpose of this mooring plan is to give guidance and provide information useful to mooring the U.S. Army power barge "Impedance" to the concrete wharf at the Caribbean Cement Co. on the eastern end of Kingston Harbor, Jamaica. This report condenses and summarizes information obtained by the Ocean Engineering and Construction Project Office (FPO-1), Chesapeake Division, Naval Facilities Engineering Command, Washington Navy Yard 20374 (202) 433-3881, in support to the U.S. Army. Reports in addition to this mooring plan include:

Title	Number
Underwater Facilities Inspection and Assessments at Caribbean Cement Company, Kingston West Indies	FPO-1-82-(16)
Structural Calculations for Caribbean Cement Company Wharf and Mooring Plan for U.S. Army Power Barge "Impedance"	FPO-1-82-(18)
Jamaican Power Barge Mooring at Kingston Harbor, Jamaica	Plans and specifications for bollards, marine fenders and mooring lines NAVFAC Drawing Nos. 3026162, 3026163, 3026164, 3026165

1.1 Report Content

This report includes a brief environmental summary of conditions at the site, general characteristics of the wharf and associated mooring hardware and gives guidance on mooring the "Impedance".

2. Environmental Conditions

Kingston Harbor is a natural deepwater harbor with good access (Figure 1). The mooring wharf is located on the eastern end of the harbor where mountains to the east and north provide protection from winds and the barrier island to the south affords limited sheltering from ocean waves.

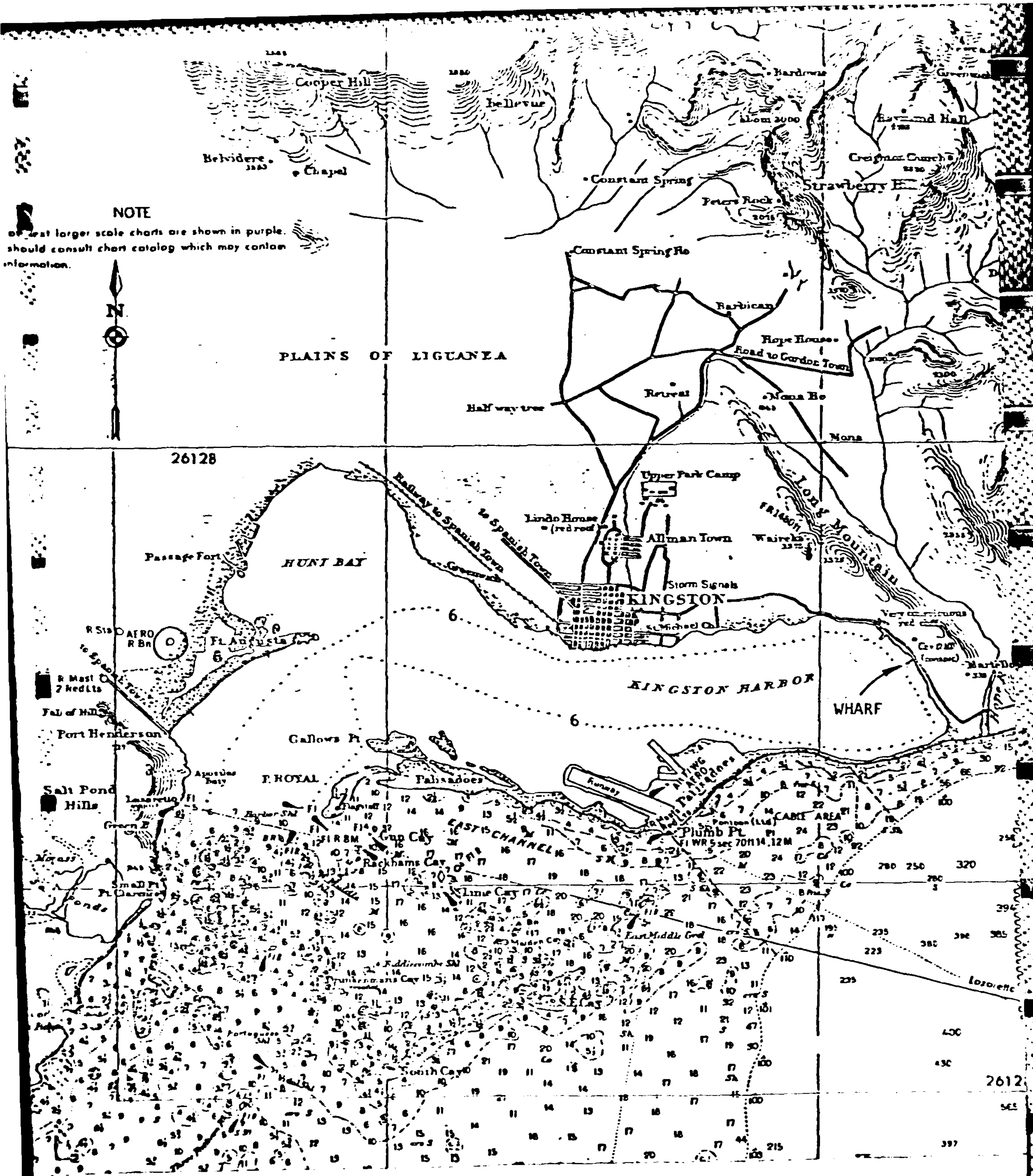

Figure 1. Kingston Harbor

Calculations show that winds from the west cause the most severe waves at the wharf with waves of Sea State 4 to 5 produced by a hurricane with 125 mph winds from the west (Figure 2). Winds from the west also produce the longest period waves in the range of 4 to 5 seconds, which have wave lengths of 80 to 120 feet at the wharf (Figure 3).

Calculations were also made for storm surge levels in Kingston Harbor and west wind induced set-up was found to be the primary factor producing large water level fluctuations at the mooring site (Figure 4). Additional water level changes may be produced by the astronomical tide, which has a one-foot diurnal range, open coast storm surge (may be as high as two feet) and pressure set-up, which could be as high as two feet near the eye of a severe hurricane. These factors give a design storm surge of 8.4 feet.

2.1 Hurricanes

Hurricanes provide the major threat to vessels moored in Kingston Harbor. Records from 1670 through 1981 reveal that a hurricane strikes Jamaica on the average of once every 6.7 years and in the worst times several hurricanes have influenced the island in one year. Extremely severe damage occurs due to major hurricane landfalls that have been observed to occur approximately once every 25 years during the past three centuries.

2.2 Earthquakes

It is worth noting that Kingston experienced a major earthquake once in the past three centuries. Eyewitnesses reported that a number of shocks occurred in the mountains to the north. These vibrations caused a "slip fault" in the soil and a major portion of Port Royal slid into the harbor producing a tidal wave or tsumani that destroyed most vessels and buildings in the harbor area.

CHESAPEAKE DIVISION	PROJECT: JAMAICA
Naval Facilities Engineering Command NDW	Station: East end of Kingston Harbor
DISCIPLINE	E S R: ______ Contract: ______
Calcs made by: SEELIC date: 6/25/82	Calculations for: Wave Heights (significant)
Calcs ck'd by: ______ date: ______	

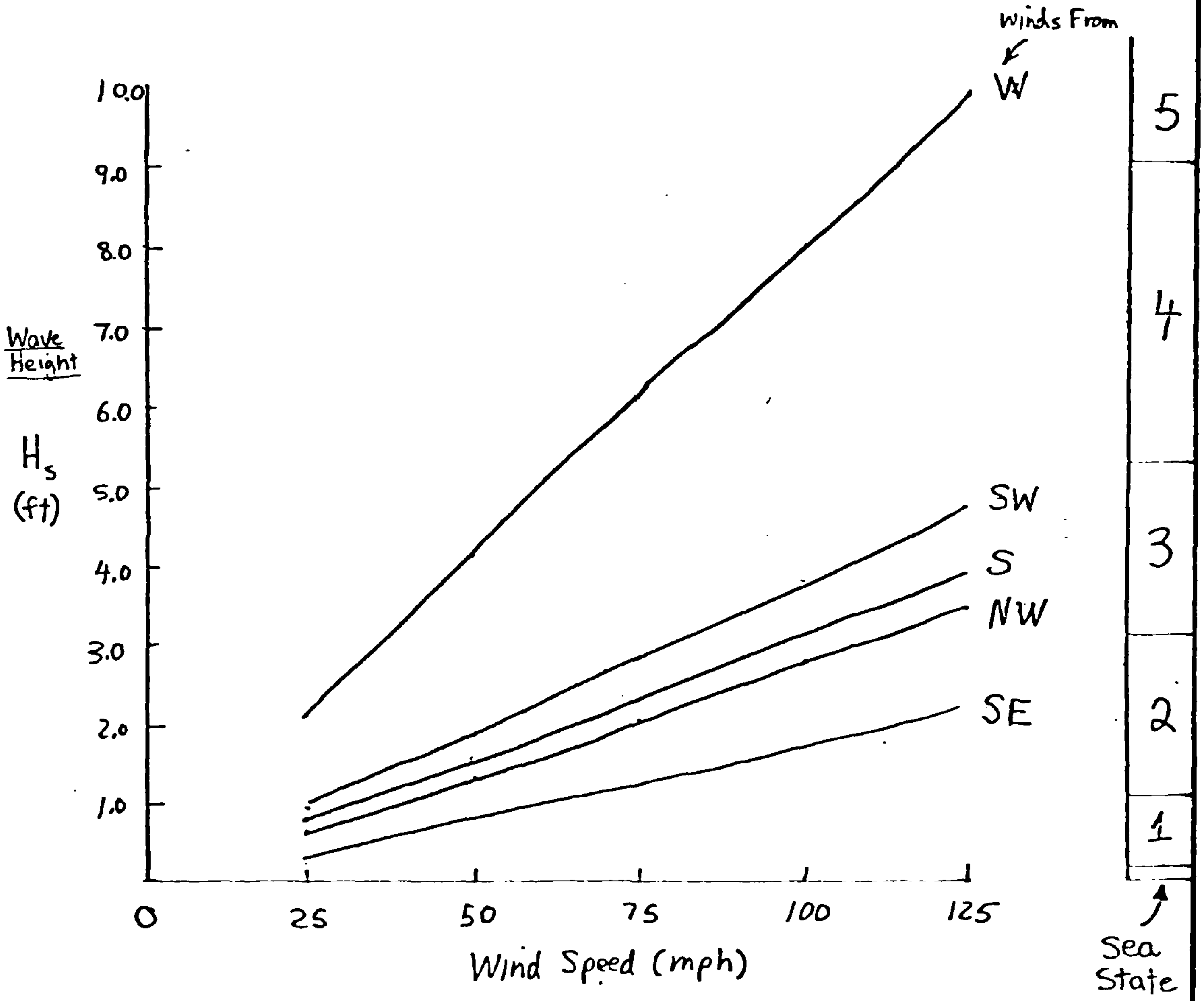

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Figure 2. Predicted Wave Heights in Kingston Harbor at the Wharf

CHESAPEAKE DIVISION Naval Facilities Engineering Command NDW DISCIPLINE	PROJECT: JAMAICA Station: East End of Kingston Harbor E S R: ____ Contract: ____ Calculations for: Wave Periods (Tp)
Calcs made by: SEELIG date: 6/25/82 Calcs ck'd by: ____ date: ____	

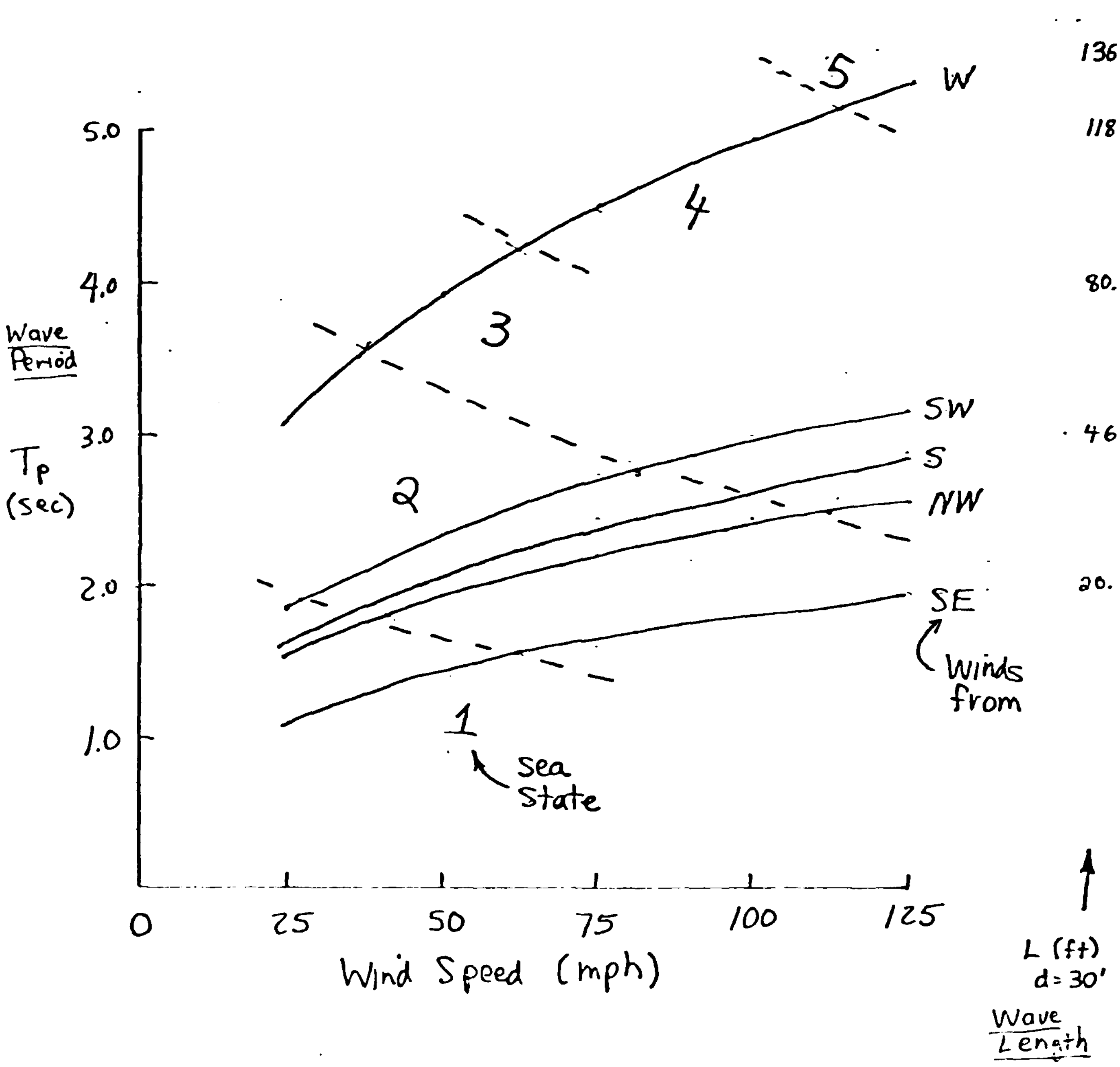

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Figure 3. Predicted Wave Periods and Lengths at the Wharf

CHESAPEAKE DIVISION
Naval Facilities Engineering Command NDW
DISCIPLINE

Calcs made by: SEELIG date: 6/25/82
Calcs ck'd by: ______ date: ______

PROJECT: JAMAICA
Station: Pier Location
E S R: ______ Contract: ______
Calculations for: Wind Setup

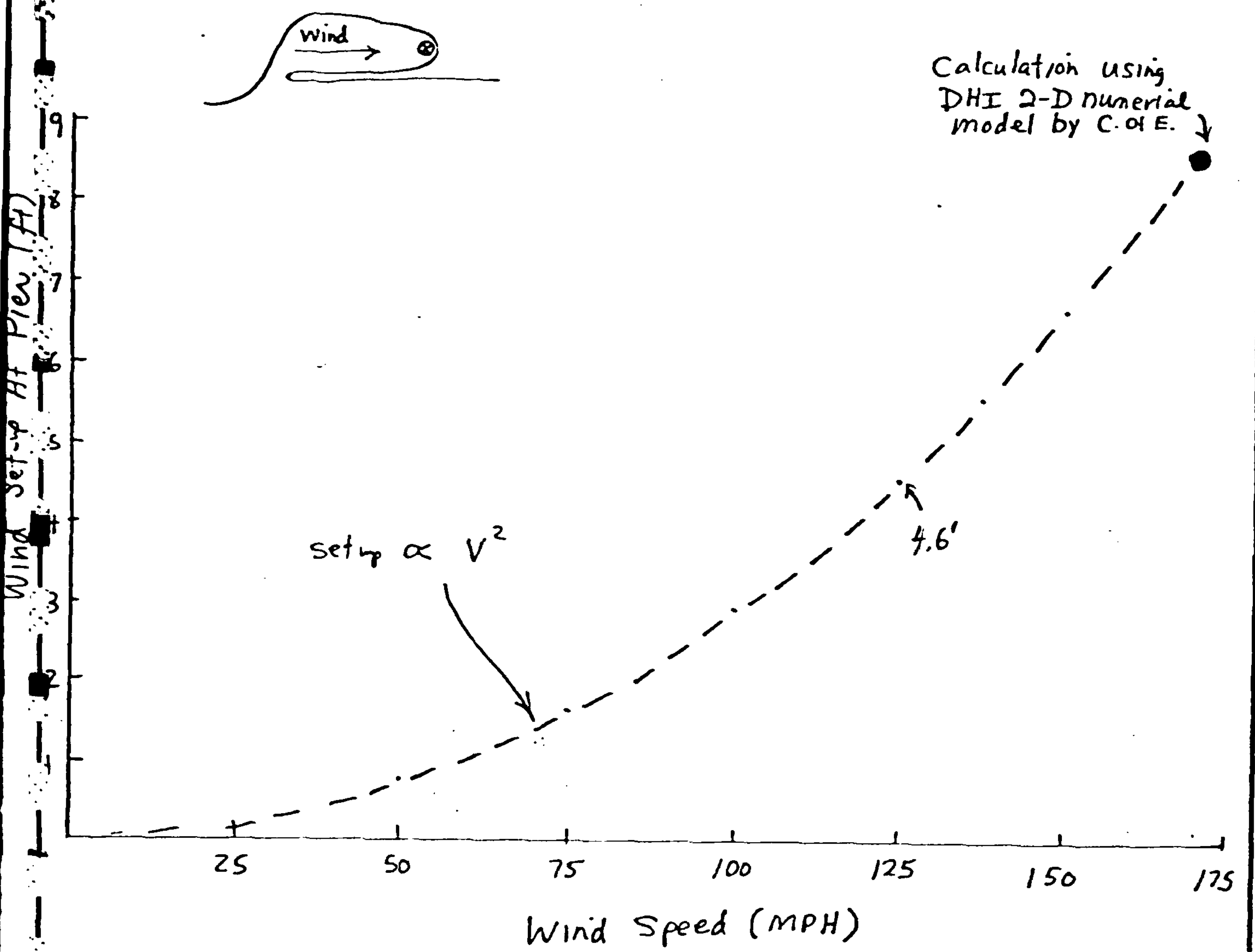

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Figure 4. Predicted Wind Setup at the Eastern End of Kingston Harbor

3.0 Barge Mooring: General

The barge mooring system consists of the wharf (including newly installed marine fenders and two new bollards), mooring lines (including bow and stern, spring and breasting lines) and mooring equipment on the barge. All components have been designed for mooring the barge during fair and foul weather at the site. Two mooring configurations have been designed: one for "normal" operation consisting of wire rope mooring lines; and a second "hurricane" mooring including a combination of wire and nylon ropes. Descriptions of these mooring components and their use are detailed in the following paragraphs.

3.1 The Wharf

The 20 year old concrete wharf owned by the Caribbean Cement Co. is 281 feet long, 45 feet wide, has a deck that is approximately 5 feet above the normal water level. Water depth at the seaward wharf edge is approximately 30 feet. A detailed U.S. Navy inspection was conducted on the wharf in July 1982 both above and below the water and the wharf found to be in "extremely good shape" with only one of the 145 piles showing significant structural damage. Most of the "damage" to the wharf is loss of concrete cover at bottom of pile caps/deck beams that has only superficial influence on the structural function of the wharf.

The seaward face of the pier is provided with seven Sea Guard marine fenders (Figure 5), three feet in diameter and 18 feet long arranged to transfer the lateral mooring forces into the batter piles. These fenders were selected to absorb the predicted energy and reaction force associated with expected vessel motions, while producing low hull pressures (26 psi). The fenders are designed to roll during heave motion of the barge, even when being compressed.

Four bollards are available on the landward edge of the wharf, including two newly installed units, for attaching breasting lines (Figure 5). Four additional bollards are on the seaward face of the wharf.

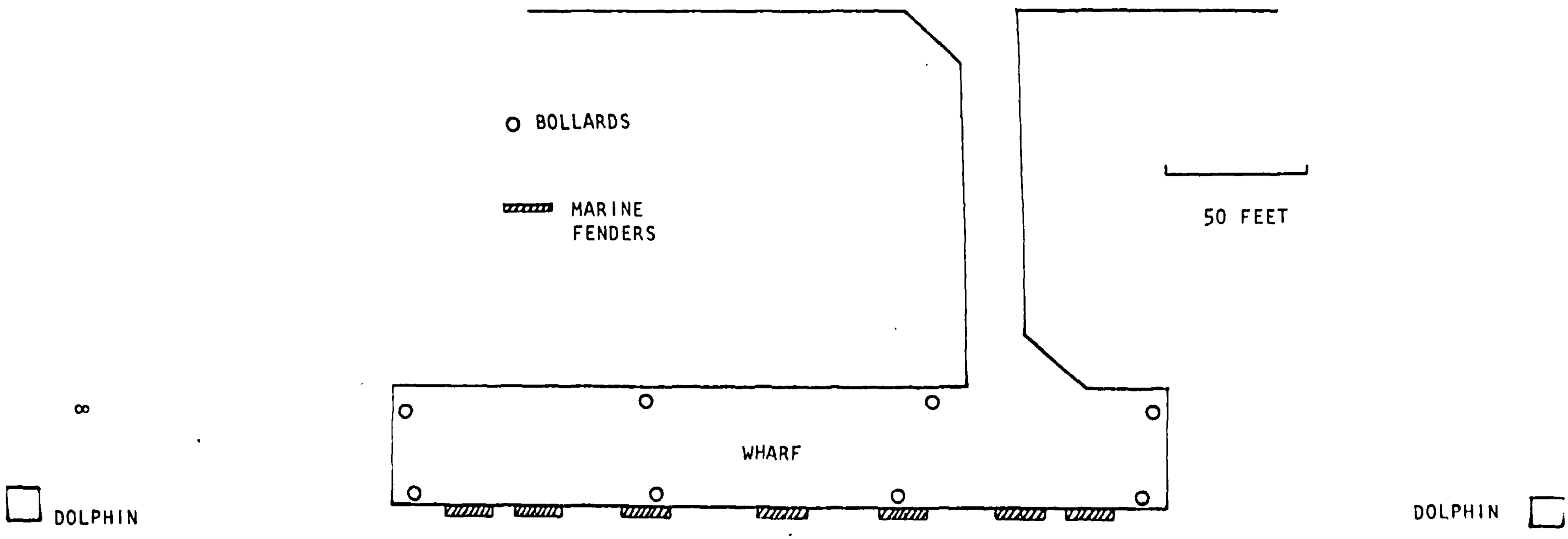

Figure 5. Locations of the Bollards, Marine Fenders and Dolphins

3.2 Dolphins

Two mooring dolphins, approximately 120 feet from the wharf, are available for fore and aft mooring (Figure 5).

3.3 Normal Mooring Plan

Wire rope was selected as the mooring material for normal operation. This mooring consists of six 1" diameter 6x37 bow and stern lines 200 feet long (two for the bow, two for the stern and two spares) and six 180 long lines (two breasting lines, two spring lines and two spares, see Figure 6). A single length of wire rope will be used for each of these lines with pretension applied to meet local conditions.

3.4 Hurricane Mooring Plan

The hurricane mooring configuration consists of a combination of wire rope and nylon mooring lines as illustrated in Figure 7. The bow and stern lines for normal operation (see 3.3 above) should be left in place; wire breasting and spring lines removed; and nylon breasting and spring lines installed (see Figure 7). Ten 180 feet long 2-3/4" diameter nylon lines have been provided that includes six breasting lines, two spring lines and two spares. Nylon was selected for the hurricane mooring because it is elastic, will allow adjustment of the barge to changing water levels and will absorb some energy of the barge motions. However, nylon may degrade with exposure, so these lines should not be used for extended time intervals. The nylon lines should be stored when not in use.

Adequate line has been provided so that each nylon line can be attached to the barge, run to the pier and wrapped around the bollard and returned to the barge to be tied off.

The nylon lines should be installed any time a tracked hurricane is headed toward Jamaica or has a path to the south of the island. All the nylon lines should be replaced if the barge rides through a hurricane or severe storm with the hurricane mooring lines.

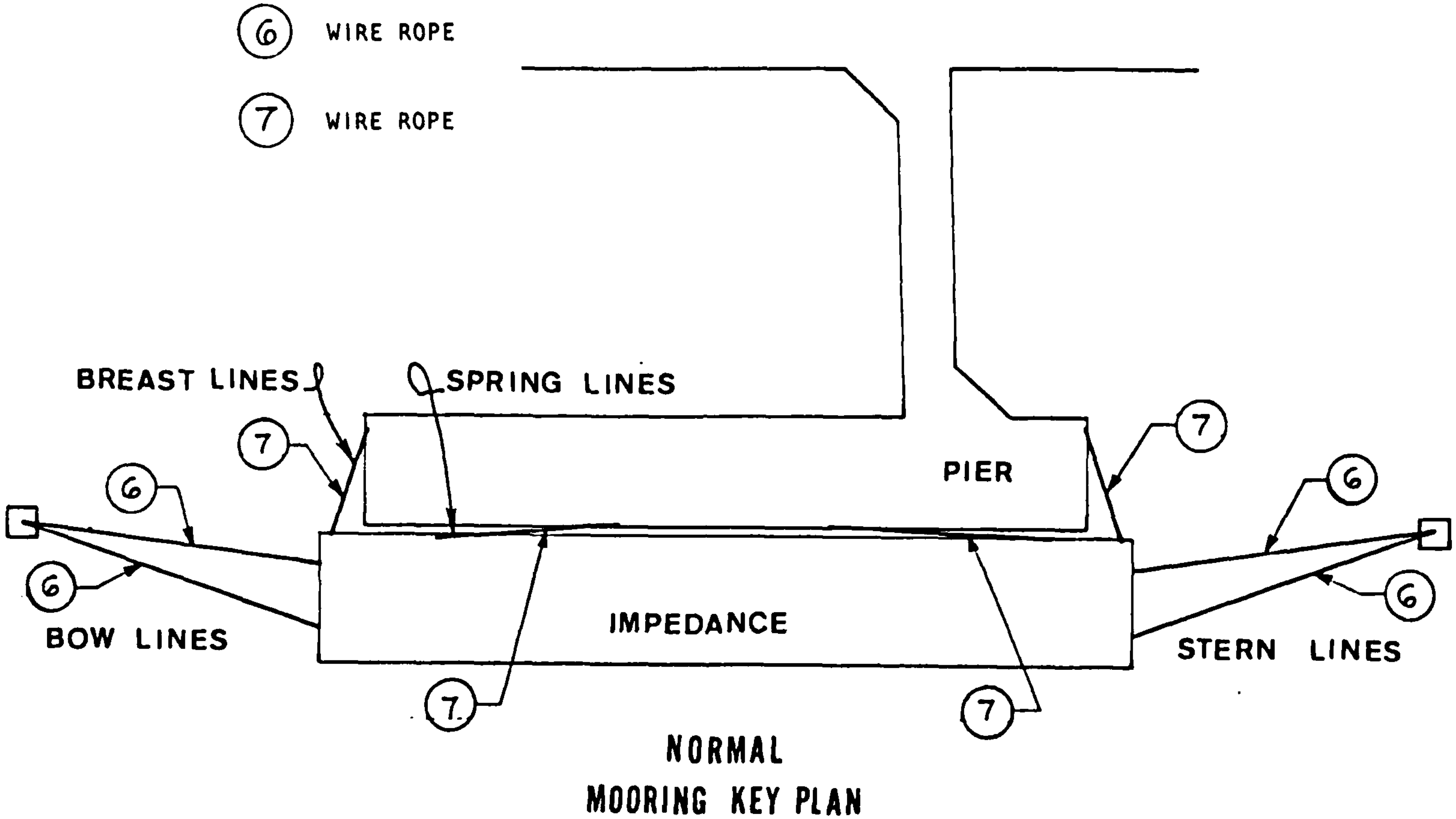

Figure 6. Normal Mooring Plan

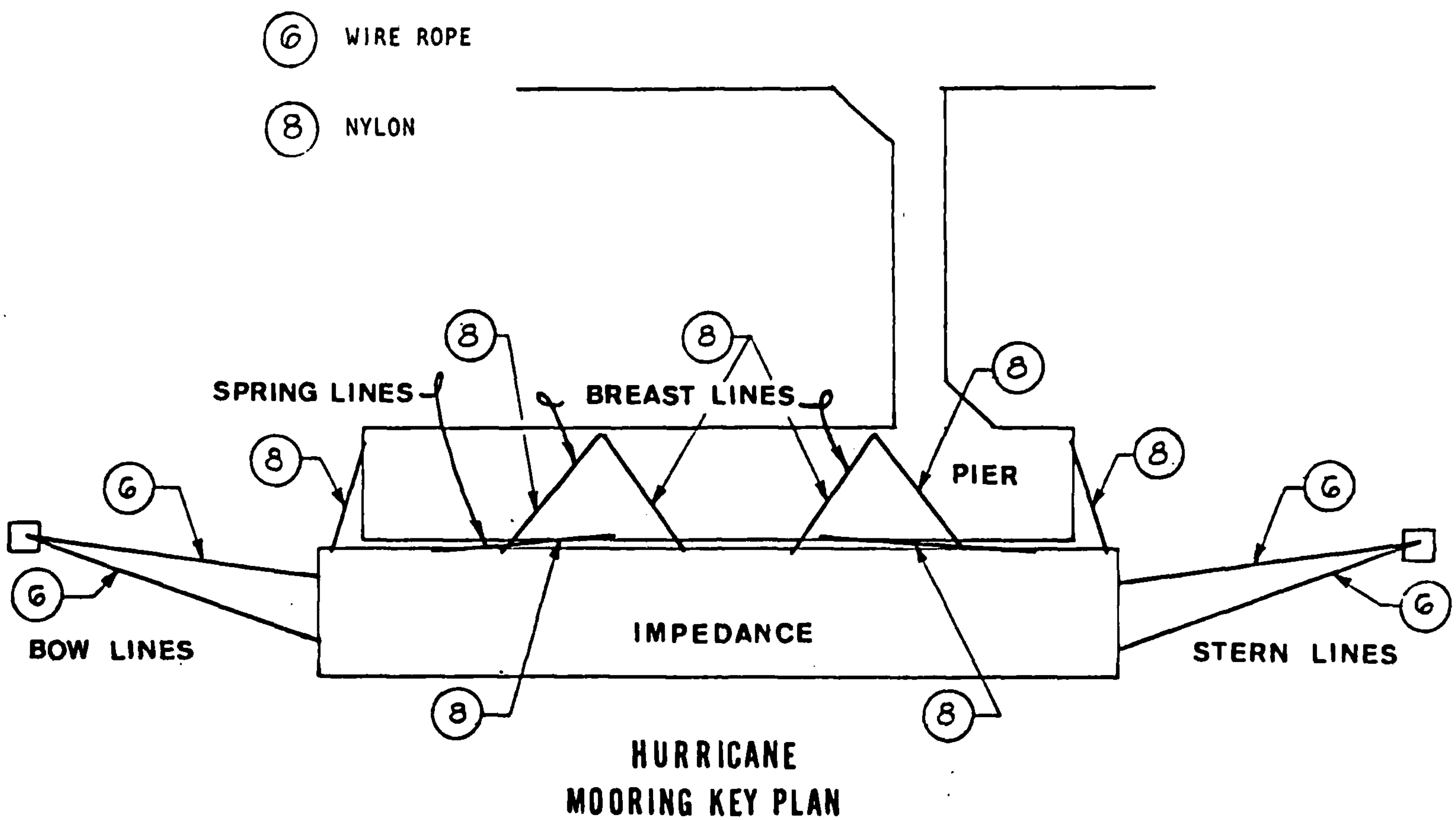

Figure 7. Hurricane Mooring Plan

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