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Evolution of Popponesset Beach and Its Effect on Popponesset Bay

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WES

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Evolution of Popponesset Beach and Its Effect on Popponesset Bay

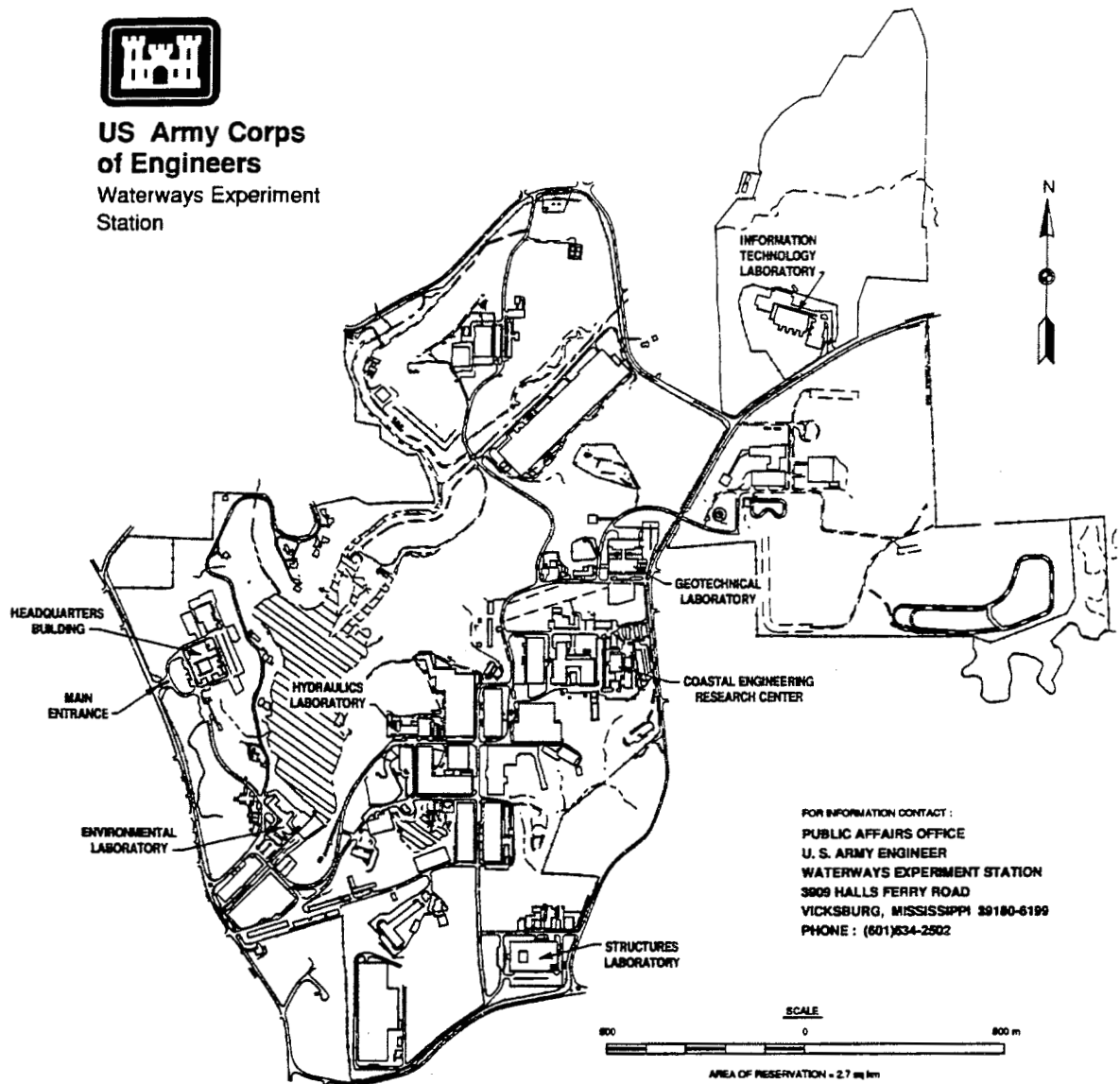
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Preface

This study was authorized by the U.S. Army Engineer Division, New England, and conducted at the Coastal Engineering Research Center (CERC) of the U.S. Army Engineer Waterways Experiment Station (WES). The study was conducted and this report was prepared during the period September-December 1992 by Ms. Mary A. Cialone, Research Division (RD), CERC, under the supervision of Mr. Bruce A. Ebersole, Chief, Coastal Processes Branch, and Mr. H. Lee Butler, Chief, RD. General supervision was provided by Dr. James R. Houston, Director, CERC, and Mr. Charles C. Calhoun, Jr., Assistant Director, CERC.

The main purpose of the study was to determine the likelihood of a breach of Popponesset Spit and the impact (in terms of water quality, storm protection, and navigation) of breaching and/or slow degradation of the spit on Popponesset Bay. A review of historical information pertaining to the Popponesset Beach area and an analytical/empirical "desktop" analysis were performed.

At the time of publication of this report Dr. Robert W. Whalin was Director of WES. COL Bruce K. Howard, EN, was Commander.

Conversion Factors, Non-SI to SI Units of Measurement

Non-SI units of measurement used in this report can be converted to SI units as follows:

Multiply	By	To Obtain
acres	4046.873	square meters
cubic feet	0.02831685	cubic meters
cubic yards	0.7646	cubic meters
feet	0.3048	meters
miles (U.S. statute)	1.6093	kilometers
square feet	0.09290304	square meters

1 Introduction

The purpose of this study is to answer the following questions: (a) will a major breach of Popponeset Beach occur, and if so, under what conditions, and (b) how will breaching and/or slow degradation of the entire barrier beach affect water quality, storm protection, and navigation in the bay? The findings in this report are based on review of historical information pertaining to the Popponeset Beach area, and subsequent analytical/empirical "desktop" analyses.

This report is organized in the following fashion: Chapter 1 introduces the study area and reviews available historical data; Chapter 2 discusses the evolution of Popponeset Beach and storm hydraulics; Chapter 3 covers an analysis of inlet stability; Chapter 4 discusses modes of deterioration of Popponeset Spit and the impacts on navigation, storm protection, and water quality in Popponeset Bay; Chapter 5 discusses possible solutions to the problem of deterioration of Popponeset Beach; Chapter 6 suggests additional information needed to further define the situation at Popponeset Beach and addresses studies which could be conducted to evaluate various solution schemes; and Chapter 7 provides conclusions drawn from the study.

Study Area

Popponeset Beach is an approximately 1-mile-long¹ barrier beach (or spit) fronting Popponeset Bay located on Nantucket Sound in Mashpee, Cape Cod, Massachusetts (Figure 1). Net longshore transport is to the northeast in the Popponeset Spit littoral cell, which extends from Succunneset Point (to the west) to the tip of the spit and offshore to Succunneset Shoals. A series of groins west of the spit were constructed in the 1950's to stabilize the shoreline. The groins have probably limited sediment supply to Popponeset Spit to some degree; however, most of the groins are short and sediment is likely to bypass them under storm conditions because of the wider surf zone. The spit extends in a northeasterly direction from the town of Popponeset to its terminus at the inlet entrance near Meadow Point (Figure 2). The inlet leads

¹ A table of factors for converting non-SI units of measurement to SI units is presented on page vi.

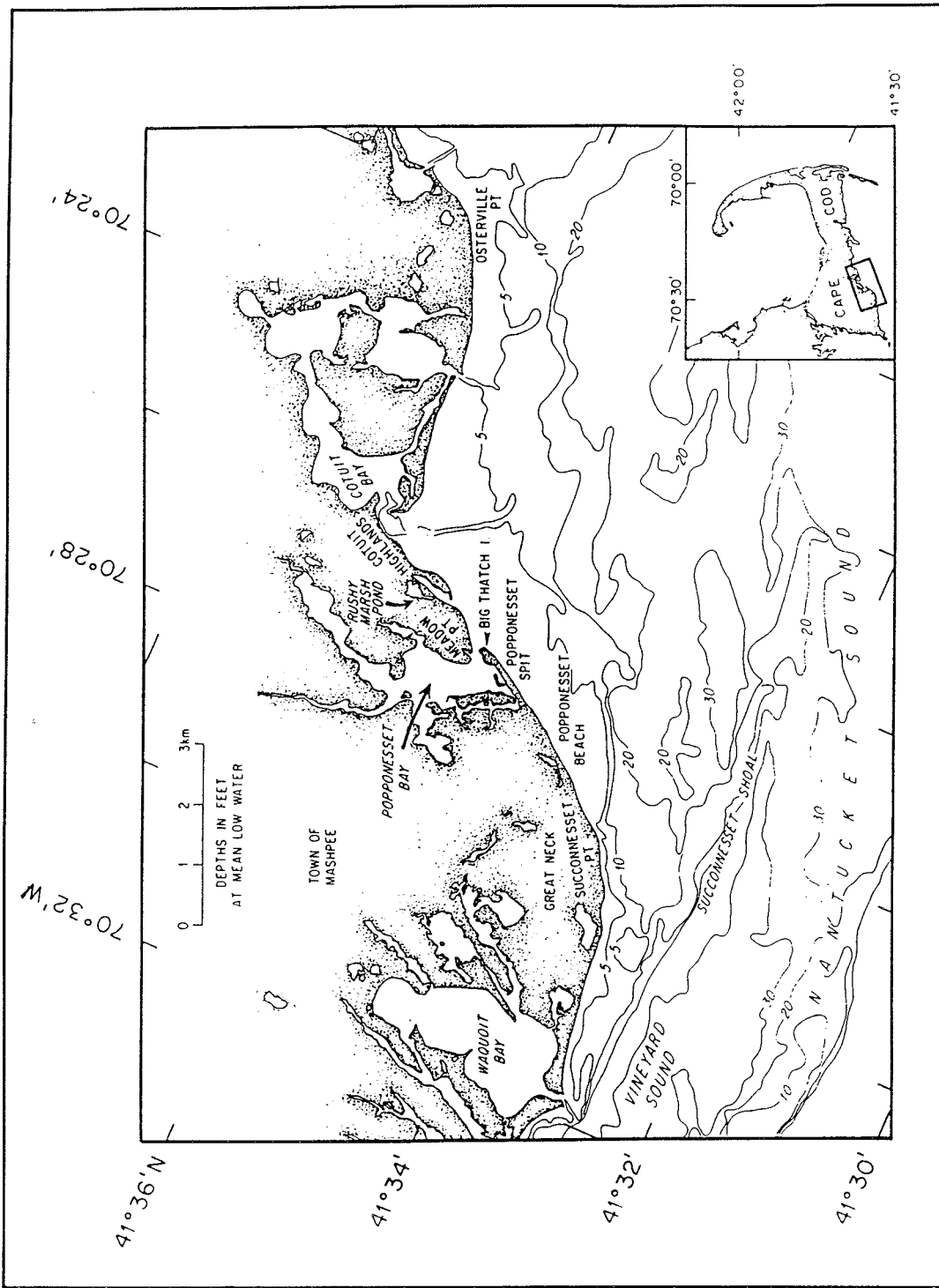


Figure 1. Location map from Aubrey and Gaines (1982b)

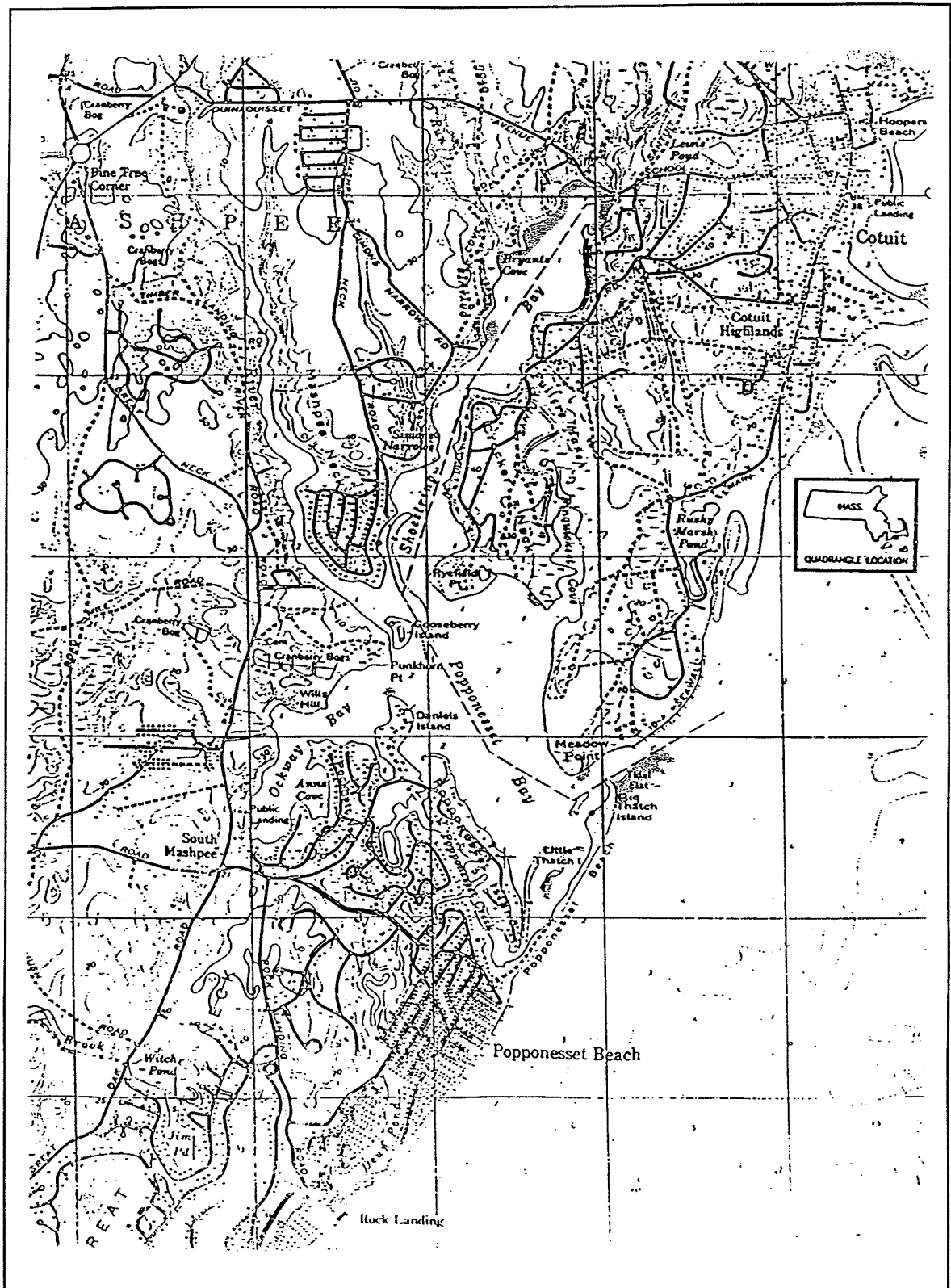


Figure 2. The study area

to Popponeset Bay, which is a shallow, saltwater lagoon covering approximately 665 acres. The mean tide range in the bay is 2.3 ft and the spring tide range is 2.8 ft. The bay is usually sheltered from direct wave and storm attack by the barrier beach and is used for shellfishing and recreational boating. However, the decreasing elevation along the entire length of the barrier spit and the decreasing width near its base are limiting the spit's ability to shelter the area behind it from more frequent (less severe) storm events. Popponeset Island (Figure 2), located directly behind the base of the spit, is a critical factor in the study from a storm protection standpoint as well as a navigation standpoint. Washover during storms tends to constrict the navigation channel around the southern tip of Popponeset Island, limiting or blocking navigation, and homes on Popponeset Island have been flooded during severe storms. Three major dredging projects were conducted in 1916, 1936, and 1961, as well as minor dredging projects in 1986 and 1991 to improve navigation in the bay and in the approach to Popponeset Creek.

Available Historical Data

Maps, charts, and aerial photographs of Popponeset Beach were used to assemble a picture of spit evolution from 1787 to the present (Aubrey and Gaines 1982a) (Figures 3-6). Aubrey and Gaines analyzed 92 charts and maps (1670-1979) and 43 aerial photographs (1938-1981); however, representation of coastal features is not rigorous in the early maps (1670-1857). More recent aerial photographs (1984 and 1991) provided additional information on spit evolution. It is interesting to note that the early shoreline illustration (1831) is similar in length and inlet configuration to present conditions.

Cross-section views (or profiles) of Popponeset Spit are available for 1966 and 1991 (Figure 7). The source of this information is the Director of Engineering for the New Seabury Company Ltd., Michael H. Grotzke. From this figure one observes that the peak elevation has diminished from 13.5 to 6 ft National Geodetic Vertical Datum (NGVD) (mean low water (mlw) = -0.7 NGVD), the spit has migrated landward, and the width of the spit has been reduced dramatically.

Water levels for several storms (Hurricane Carol ('54), Hurricane Donna ('60), Hurricane Bob ('91), 1938, 1944, and 1956 hurricanes, the Blizzard of '78 and the Halloween northeaster ('91)) as well as predicted water levels for 1-, 10-, 50-, and 100-year storms are given in Figure 8 (U.S. Army Engineer Division, New England 1988). Most of the recorded water levels for these storms indicate that they are approximately 5- to 10-year events, with the exceptions of Hurricane Carol (35- or 40-year event), and the 1944 hurricane (nearly a 100-year event).

Two islands, Martha's Vineyard and Nantucket Island, and shallow shoals are located offshore from the spit and serve to limit wave energy in the study area. Wave measurements in Nantucket Sound are not available; however,

