MR 77-11

Sand Resources on the Inner Continental Shelf of the Cape Fear Region, North Carolina

by
Edward P. Meisburger

MISCELLANEOUS REPORT NO. 77-11
NOVEMBER 1977

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SECURITY CLASSIFICATION OF THIS PAGE (When Data Entered)

REPORT DOCUMENTATION PAGE

READ INSTRUCTIONS BEFORE COMPLETING FORM

1. REPORT NUMBER: MR 77-11	2. GOVT ACCESSION NO.
3. RECIPIENT'S CATALOG NUMBER	
4. TITLE (and Subtitle): SAND RESOURCES ON THE INNER CONTINENTAL SHELF OF THE CAPE FEAR REGION, NORTH CAROLINA	5. TYPE OF REPORT & PERIOD COVERED: Miscellaneous Report
	6. PERFORMING ORG. REPORT NUMBER
7. AUTHOR(s): Edward P. Meisburger	8. CONTRACT OR GRANT NUMBER(s)
9. PERFORMING ORGANIZATION NAME AND ADDRESS: Department of the Army, Coastal Engineering Research Center (CEREN-GE), Kingman Building, Fort Belvoir, Virginia 22060	10. PROGRAM ELEMENT, PROJECT, TASK AREA & WORK UNIT NUMBERS: B31466
11. CONTROLLING OFFICE NAME AND ADDRESS: Department of the Army, Coastal Engineering Research Center, Kingman Building, Fort Belvoir, Virginia 22060	12. REPORT DATE: November 1977
	13. NUMBER OF PAGES: 20 18p
14. MONITORING AGENCY NAME & ADDRESS(if different from Controlling Office)	15. SECURITY CLASS. (of this report): UNCLASSIFIED
	15a. DECLASSIFICATION/DOWNGRADING SCHEDULE

16. DISTRIBUTION STATEMENT (of this Report)

Approved for public release; distribution unlimited.

17. DISTRIBUTION STATEMENT (of the abstract entered in Block 20, if different from Report)

18. SUPPLEMENTARY NOTES

19. KEY WORDS (Continue on reverse side if necessary and identify by block number)

Beach nourishment
Borrow sites
Cape Fear, North Carolina
Inner Continental Shelf
Sand deposits
Sediment deposits
Seismic reflection profiles

20. ABSTRACT (Continue on reverse side if necessary and identify by block number)

The Inner Continental Shelf of North Carolina between the South Carolina border and Cape Lookout was investigated to obtain information on bottom and subbottom sediment deposits and geologic structure.

Primary survey coverage consists of 512 statute miles (824 kilometers) of high-resolution seismic reflection profiles and 124 cores ranging in length from 2 to 20 feet (0.6 to 6.1 meters).

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SECURITY CLASSIFICATION OF THIS PAGE (When Data Entered)

Sand suitable for restoration and nourishment of nearby beaches was located, described, and mapped for 27 potential offshore borrow sites. This sand occurs commonly in thin sheet deposits or as relict channel fill. However, extensive sand deposits exist in shoals off Cape Fear and Cape Lookout and in other low isolated shoals on the shelf floor and within the shoreface area.

PREFACE

This report is one of a series which describes results of the Inner Continental Shelf Sediment and Structure (ICONS) study. The primary objective of the ICONS study is locating and delineating offshore sand and gravel deposits suitable for beach nourishment and restoration (Duane, 1968). The work was carried out under the coastal processes program of the U.S. Army Coastal Engineering Research Center (CERC).

The report was prepared by Edward P. Meisburger, a CERC geologist, with the assistance of R. Rector and S.J. Williams, who served successively as Acting Chief, Geotechnical Engineering Branch, and Dr. C.H. Everts, the present Chief. As part of the research program of the Engineering Development Division, the ICONS study is under the general supervision of Mr. George Watts, Chief of the Division. The fieldwork (obtaining cores and continuous seismic reflection profile records) was accomplished under contract by Alpine Geophysical Associates, Inc. A preliminary study of the data was made by Dr. M.E. Field, a former geologist at CERC, and presently with the U.S. Geological Survey.

Microfilm copy of all seismic data is stored at the National Solar and Terrestrial Geophysical Data Center (NSTGDC), Rockville, Maryland 20852. Cores collected during the field survey program are in a repository at the University of Texas, Arlington, Texas 76010, under agreement with CERC. Requests for information relative to these items should be directed to NSTGDC or the University of Texas.

Comments on this publication are invited.

Approved for publication in accordance with Public Law 166, 79th Congress, approved 31 July 1945, as supplemented by Public Law 172, 88th Congress, approved 7 November 1963.

JOHN H. COUSINS
Colonel, Corps of Engineers
Commander and Director

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CONVERSION FACTORS, U.S. CUSTOMARY TO METRIC (SI) UNITS OF MEASUREMENT

U.S. customary units of measurement used in this report can be converted to metric (SI) units as follows:

Multiply	by	To obtain
inches	25.4	millimeters
	2.54	centimeters
square inches	6.452	square centimeters
cubic inches	16.39	cubic centimeters
feet	30.48	centimeters
	0.3048	meters
square feet	0.0929	square meters
cubic feet	0.0283	cubic meters
yards	0.9144	meters
square yards	0.836	square meters
cubic yards	0.7646	cubic meters
miles	1.6093	kilometers
square miles	259.0	hectares
knots	1.8532	kilometers per hour
acres	0.4047	hectares
foot-pounds	1.3558	newton meters
millibars	1.0197×10^{-3}	kilograms per square centimeter
ounces	28.35	grams
pounds	453.6	grams
	0.4536	kilograms
ton, long	1.0160	metric tons
ton, short	0.9072	metric tons
degrees (angle)	0.1745	radians
Fahrenheit degrees	5/9	Celsius degrees or Kelvins[1]

[1]To obtain Celsius (C) temperature readings from Fahrenheit (F) readings, use formula: $C = (5/9)(F - 32)$.

To obtain Kelvin (K) readings, use formula: $K = (5/9)(F - 32) + 273.15$.

SAND RESOURCES ON THE INNER CONTINENTAL SHELF OF THE CAPE FEAR REGION, NORTH CAROLINA

by

Edward P. Meisburger

I. INTRODUCTION

The construction, improvement, and periodic maintenance of beaches and dunes by placement of suitable sand along the shoreline is an important means of counteracting coastal erosion and of enhancing recreational facilities (U.S. Army, Corps of Engineers, Coastal Engineering Research Center, 1975). In recent years, it has become increasingly difficult to obtain large volumes of suitable sand from lagoons and inland sources for this purpose because of economic and ecological factors. Accordingly, the Coastal Engineering Research Center (CERC) initiated an Inner Continental Shelf Sediment and Structure (ICONS) study to locate offshore sand resources suitable for beach fill. This report, part of that effort, deals with the location and physical characteristics of offshore sand resources near Cape Fear, North Carolina.

The study area includes a zone adjacent to the shore about 14 nautical miles (26 kilometers) wide, extending from the South Carolina border through Long Bay, Frying Pan Shoals, and Onslow Bay to Cape Lookout (Fig. 1). More detailed coverage of the area is given in Figures 2, 3, and 4. Data consist of 512 statute miles (824 kilometers) of reflection profiles and 124 cores ranging from 2 to 20 feet (0.6 to 6.1 meters) in length. These data are supplemented by pertinent scientific and technical literature and National Ocean Survey (NOS) hydrographic data.

This report is primarily the result of a reconnaissance effort; seismic line spacing and core density, even in grid areas, are not suitably detailed for reliable delineation of borrow sites. Consequently, further study of promising locales is needed before selection or use in project design and construction. A separate report, largely from the same data base used here, covers general aspects of inner shelf geology in the Cape Fear region (Meisburger, in preparation, 1977). That report is aimed at providing a background for better understanding of the character, disposition, and origin of the inner shelf sediment bodies. It contains visual logs of all cores taken during the study and size data for those core samples composed essentially of sand.

II. POTENTIAL BORROW AREAS

1. Sand Requirements.

The suitability of sand for beach nourishment is largely dependent on grain-size characteristics (Krumbein and James, 1974; James, 1975). Size characteristics of beach sand within the region covered by this report have been obtained from unpublished size data held by CERC and the U.S. Army Engineer District, Wilmington (U.S. Army Engineer District, Wilmington,

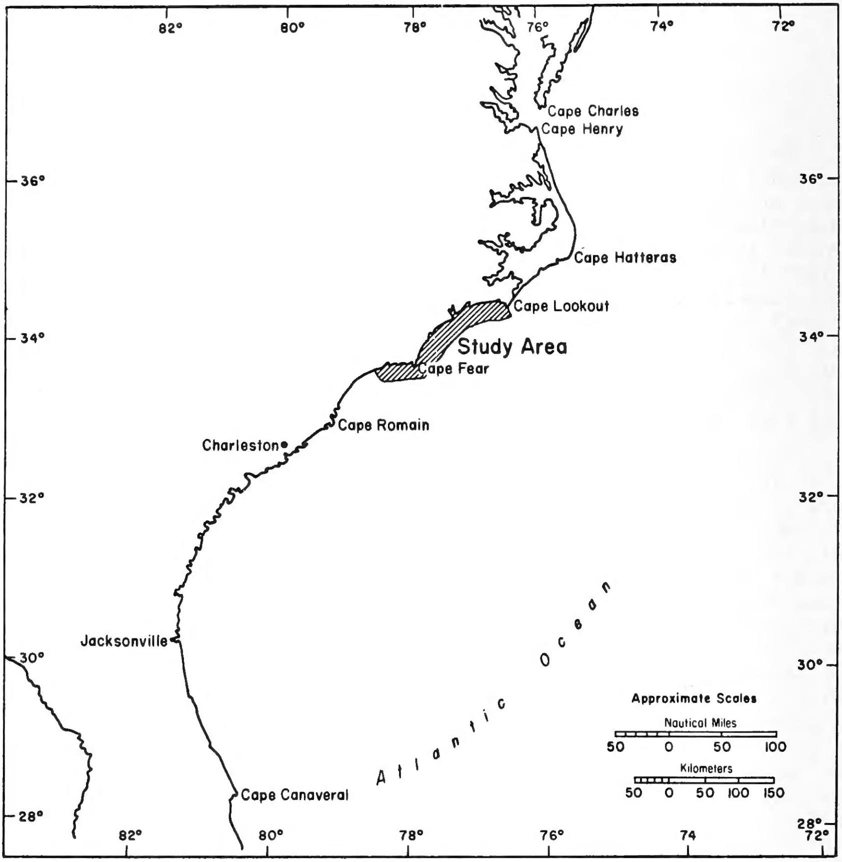

Figure 1. Location of the study area.

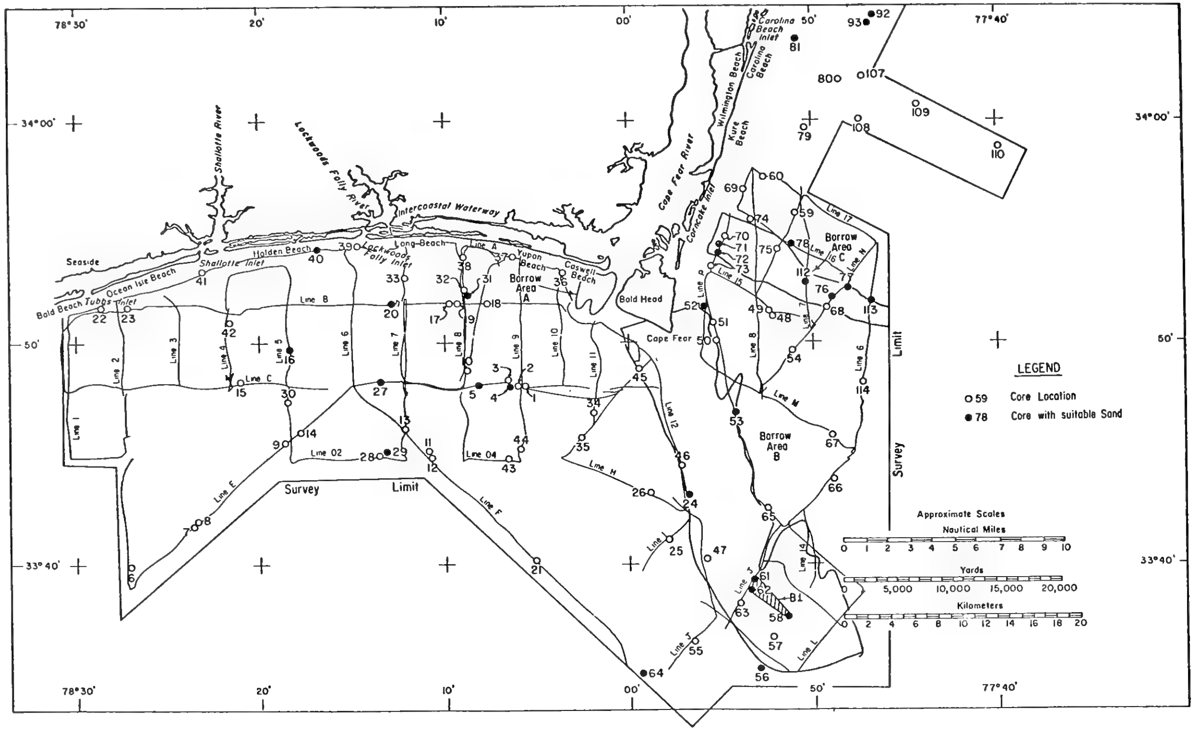

Figure 2. Western part of the study area showing survey limits, core locations, and borrow sites.

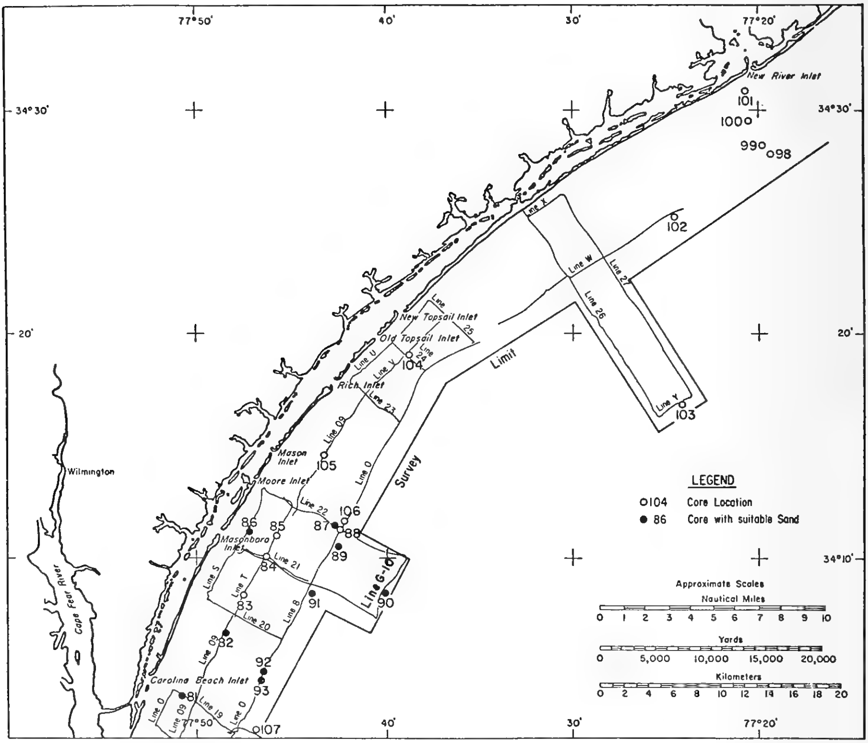

Figure 3. Central part of the survey area showing survey limits, core locations, and borrow sites.

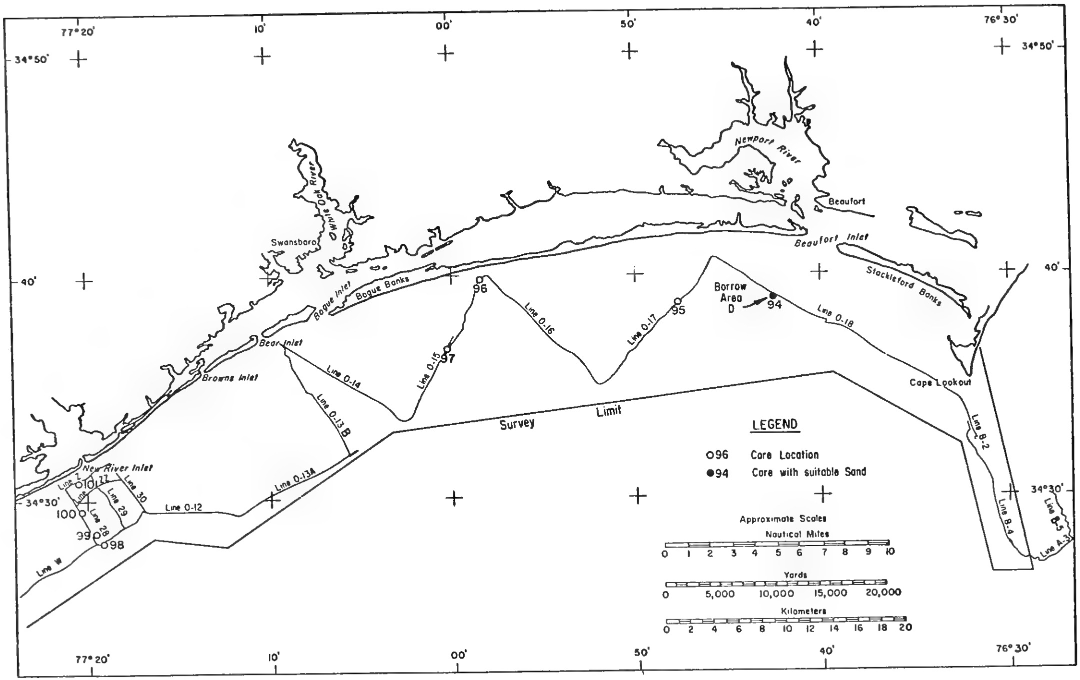

Figure 4. Northeastern part of the survey area showing survey limits, core locations, and borrow sites.

1973). These sources indicate that desirable borrow sand for beaches in this region should be in the medium to coarse sand range (0.250 to 1.00 millimeter, 2.0 to 0.0 phi). Selection of the borrow sites described below is based mainly on that size criterion.

2. Potential Borrow Areas.

Two groups of potential offshore borrow locations are: (a) Areas for which there are sufficient data to delineate the probable area extent and sand volume of the deposit (designated as borrow areas A, B, C, and D); and (b) potential borrow sites for which there are insufficient data to delineate the deposit or calculate volume, but which are shown by cores to contain suitable material (identified by core number). Borrow areas and core sites are described in the Table and plotted in Figures 2, 3, and 4.

a. Borrow Area A. Borrow area A (Fig. 2) consists of the larger part of Middle Ground Shoal lying immediately seaward of the Cape Fear River entrance; center coordinates are 33°52.7' N., 78°01.7' W.

Figure 5 is an isopach map of Middle Ground Shoal based on bathymetric data and cores. The volume of sediment within the zero isopach contour is 71 million cubic yards, the bulk of which is clean quartz sand in the fine to medium size range (0.125 to 0.250 millimeter, 3.0 to 1.0 phi). To minimize adverse effects of shoal removal on the shoreline, U.S. Army Engineer District, Wilmington (1973) indicated only so much of the shoal should be removed which would leave the resultant bottom profile equivalent to the shoreface slope of the open-coast beaches to the west. With this adjustment the potential volume of sand available in the borrow area is judged to be 50 million cubic yards (38 million cubic meters).

b. Borrow Area B. Borrow area B consists of that part of Frying Pan Shoals extending from Cape Fear to 16 nautical miles (29.7 kilometers) offshore (Fig. 2). Figure 6 is an isopach map of the borrow area drawn above a reflector that passes beneath the shoal at about the elevation of the surrounding shelf floor. Because of sparse reflection and core coverage of areas adjacent to the shoal, the zero isopach contour cannot be established with reliability. Therefore, volume calculations were made using the 10-foot isopach contour as the datum. These calculations show that approximately 1.4 billion cubic yards (1.1 billion cubic meters) of sediment is contained in the shoal. Cores indicate that most of the shoal sediment consists of quartz sand containing about 15-percent biogenic calcium carbonate derived chiefly from mollusks, echinoids, and Foraminifera. Most of the sand recovered in nine cores of the shoal area is in the fine size range (0.125 to 0.250 millimeter, 3.0 to 2.0 phi); however, four cores contain medium to coarse sand. Three of the cores (58, 61, and 62; Fig. 6) are in relatively close proximity and apparently lie within the bounds of the same deposit. The coarser texture of this material may be related to the relatively shallow water (<40 feet) of the shoal crest.

In terms of size distribution and quality, the best beach replenishment material in Frying Pan Shoals is in the general locale of cores 58, Table. Characteristics of potential borrow areas.

Designation	Center coordinates	Water depth (ft)	Composition	Mean diameter (mm)	Mean diameter (phi)	Phi standard deviation[1]	Area (10^6 yd^2)	Thickness (ft)	Est volume (10^6 yd^3)	Type deposit
Areas A	33°52.7 N., 78°01.7' W.	5 to 25	Quartz sand	0.344[2]	1.54	---[3]	17.01	0 to 27	71	Shoal
B	See Fig. 6		Quartz sand	0.125 to 0.250	3.0 to 2.00	0.22 to 1.08	270.6	5 to 50	1,400	Shoal
B1			Quartz sand	0.239 to 0.433	2.07 to 1.21	0.29 to 0.82	2.5	2.5	11.5	Shoal
C	See Fig. 7		Calcareous sand and gravel	Silt to gravel		---	59.3	20 to 100+	202	Channel fill
D	34°38.9' N., 76°42.3' W.	35 to 45	Quartz sand	0.266 to 0.379	1.91 to 1.40	0.39 to 0.82	1.45	6.0	2.1	Dredge spoil
Cores 4	33°48.1' N., 78°06.8' W.	48	Quartz sand	0.487 to 0.839	1.04 to 0.25	0.31 to 0.83	---	2.0	---	---
5	33°48.1' N., 78°08.3' W.	51	Quartz sand	0.237 to 0.273	2.08 to 1.87	0.58 to 0.95	---	8.0	---	Channel fill
16	33°49.6' N., 78°18.2' W.	45	Quartz sand	0.607	0.72	0.59	---	1.5	---	Sheet
20	33°51.7' N., 78°12.7' W.	37	Shelly sand	0.240 to 0.766	2.06 to 0.38	0.59 to 0.93	---	3.5	---	Sheet
27	33°48.3' N., 78°13.5' W.	50	Silty sand	0.255 to 0.493	1.97 to 1.02	0.63 to 1.13	---	5.0	---	Sheet
29	33°45.0' N., 78°13.4' W.	54	Quartz sand	0.262 to 0.362	1.93 to 1.46	1.05 to 1.30	---	6.0	---	Sheet
31	33°52.1' N., 78°08.9' W.	39	Quartz sand	0.293	1.77	0.94	---	1.0	---	Sheet
40	33°54.2' N., 78°16.6' W.	24	Shelly quartz sand	0.286 and 0.463	1.80 and 1.11	0.91 and 1.14	---	7.0	---	Shoreface
50	33°50.1' N., 77°55.1' W.	35	Silty quartz sand	0.393	1.35	1.10	---	1.5	---	Sheet
52	33°51.7' N., 77°55.9' W.	29	Silty quartz sand	0.264 and 0.436	1.92 and 1.20	0.44 and 1.05	---	1.5	---	Sheet
56	33°35.1' N., 77°53.8' W.	68	Quartz sand	0.345	1.53	0.71	---	1.5	---	Sheet
64	33°35.0' N., 77°59.5' W.	61	Quartz sand	0.446 and 0.609	1.17 to 0.72	0.42 and 0.67	6.4	8.0	10.4	Shoal
78	33°54.3' N., 77°51.2' W.	45	Quartz sand	0.326 and 0.386	1.62 and 1.37	0.94	---	3.5	---	Sheet
79	33°59.8' N., 77°50.0' W.	44	Quartz sand	0.226 to 0.262	2.14 to 1.93	0.37 to 0.57	---	6.0	---	Shoal
81	34°04.7' N., 77°50.8' W.	40	Quartz sand	0.302 to 0.558	1.73 to 0.84	0.66 to 0.80	---	6.0	---	Sheet
82	34°06.6' N., 77°48.7' W.	51	Quartz sand	0.253 and 0.319	1.98 and 1.65	0.73 and 0.81	---	2.0	---	Sheet
86	34°11.0' N., 77°47.5' W.	37	Quartz sand	0.200 to 0.416	2.32 and 1.26	0.91 and 1.23	---	1.0	---	Shoal
87	34°11.3' N., 77°42.0' W.	60	Shelly quartz sand	0.241 to 0.602	2.06 to 0.73	0.81 to 1.17	---	20.0	---	Channel
89	34°10.5' N., 77°42.8' W.	54	Quartz sand	0.348 to 0.443	1.52 and 1.17	1.18 and 1.32	---	3.0	---	Sheet
90	34°08.3' N., 77°40.3' W.	60	Quartz sand	0.469 and 0.632	1.09 and 0.66	0.66 and 0.85	---	3.0	---	Sheet
91	34°08.4' N., 77°44.1' W.	55	Quartz sand	0.345	1.54	0.97	---	4.0	---	Sheet
92	34°04.9' N., 77°46.5' W.	44	Quartz calcareous	0.263 and 0.276	1.93 and 1.86	0.21 and 0.95	---	19.0	---	Shoal
93	34°04.5' N., 77°46.6' W.	45	Quartz sand	0.265 and 0.295	1.92 and 1.76	0.42 to 0.89	1.45	6.0	2.1	Dredge spoil

[1]Calculated by the moment method.

[2]Composite average mean from U.S. Army Engineer District, Wilmington (1973).

[3]Unknown.

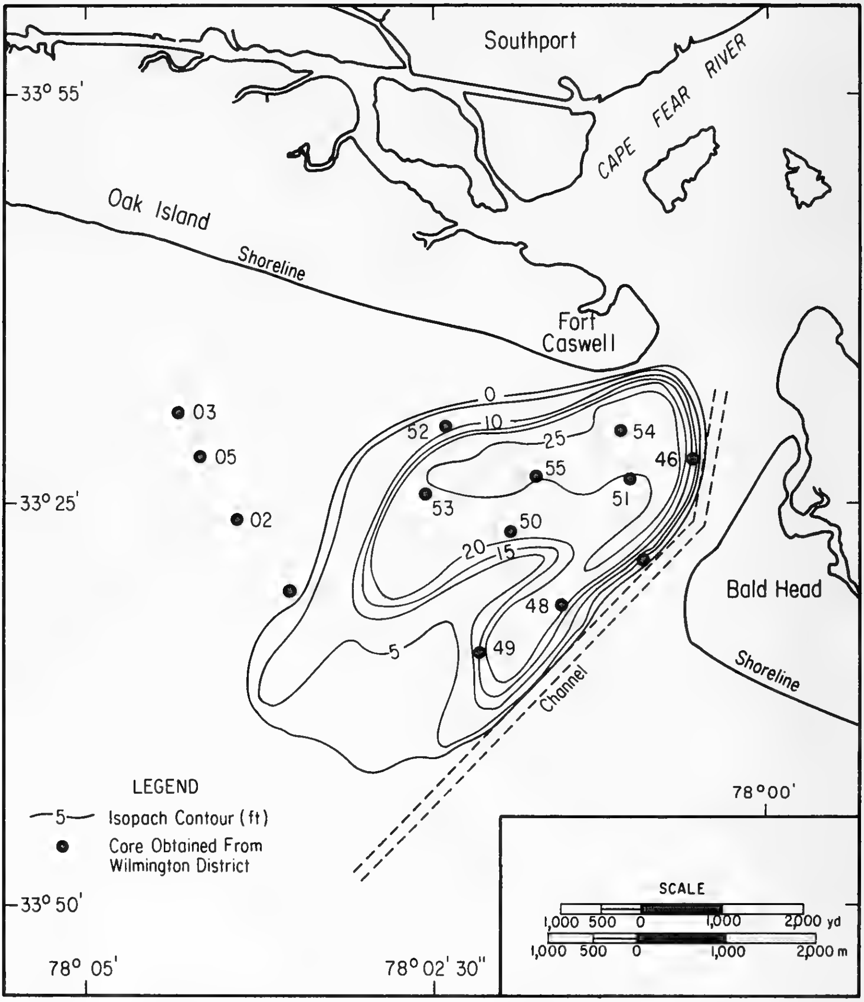

Figure 5. Sand isopach map of potential borrow area A. Core numbers refer to a group of cores obtained by Wilmington District and not to the CERC cores.

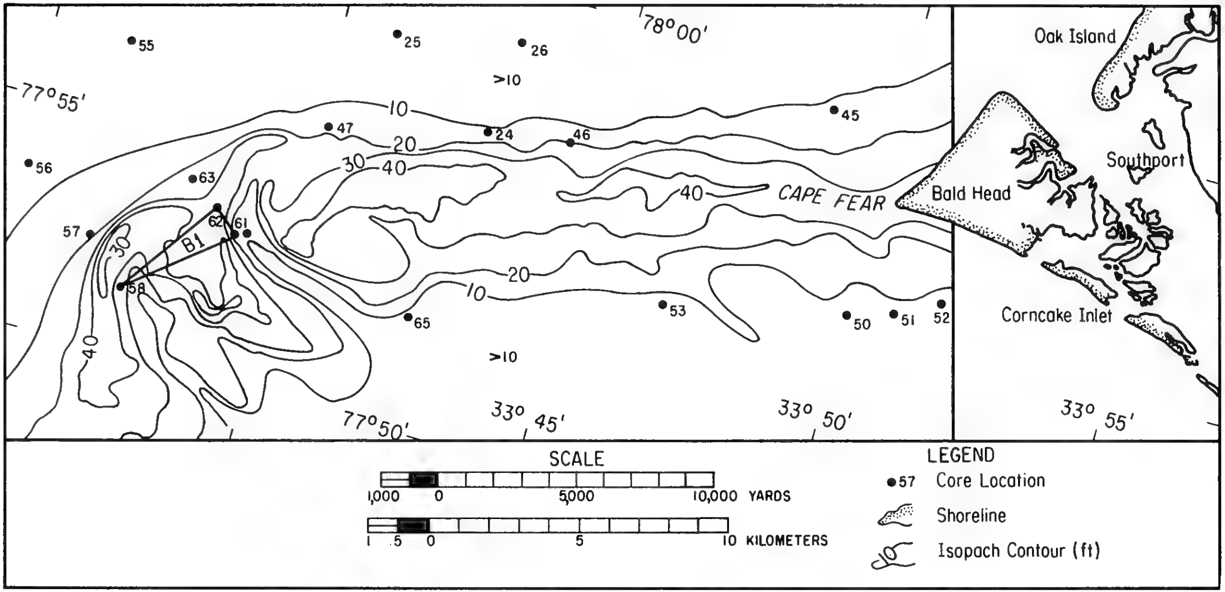

Figure 6. Sand isopach map of potential borrow area B.

61, and 62 (Fig. 6). A conservative estimate of the minimum volume of the material, based on the minimum area encompassed by lines connecting the cores sites (Fig. 6, area B1) and a minimum depth based on the average depth (13.8 feet, 4.2 meters) sampled in the cores is 11.5 million cubic yards (8.2 million cubic meters). Since much of the shoal mass was not sampled, other areas as suitable for borrow as area B1 may exist closer to shore.

c. Borrow Area C. This site comprises a large rectangular area within the boundaries of a prominent filled river channel (Figs. 2 and 7), which trends east-southeast from the vicinity of Kure Beach. Cores taken within this area contain biogenic calcareous sediment and rock with the upper 5 to 15 feet (1.5 to 4.6 meters) in a loose granular state. It is unclear whether the unconsolidated material represents a naturally unconsolidated facies or the product of disaggregation of poorly consolidated material during the coring process. In either event, it seems probable that large quantities of dredgable granular sediment are available from the area. Since well-consolidated ledges occur throughout the area, detailed surveys with a dense net of probe or drill holes would be required to further delineate the recoverable material. An isopach map of the channel area and similar channels to the north is shown in Figure 7. The volume of fill within the channel area, as delineated on seismic reflection profiles, is approximately 1.2 billion cubic yards (0.92 billion cubic meter). The nature of the fill is unknown below a depth of 20 feet (6.1 meters), the maximum penetration of cores. The calcareous facies fills the channel to this depth. Using 10 feet as an average depth for this material, the approximate volume in the channel area is 202 million cubic yards (154 million cubic meters).

The suitability of the calcareous granular sediment found in borrow area C for beach fill is questionable. Its coarseness and abundance of granule- and pebble-size fragments might make it undesirable on a recreational beach. In addition, being almost entirely composed of calcium carbonate, it is chemically and mechanically less durable than quartz and could degrade rapidly or form cemented crusts when placed in the beach environment. It would probably be quite suitable for purely protective beaches or as core material for beaches and armored structures.

Three similar channels north of borrow area C are shown in Figure 7. They appear to contain the same calcareous material as the southern channel but there are insufficient core data for further definition.

d. Borrow Area D. This borrow area is a previously used dredge spoil disposal area located 3 nautical miles (5.6 kilometers) southwest of Beaufort Inlet (Fig. 4). The borrow consists of a low mound, apparently composed of material dredged from the entrance channel of Beaufort Inlet. Core 94 in the central part of the mound contains 8 feet (2.4 meters) of clean, medium to coarse quartz sand overlying fine, shelly sand. Mean diameters of the quartz sand range from 0.266 to 0.379 millimeter (1.91 to 1.40 phi). The zero isopach reflector in Figure 8 is at about the level

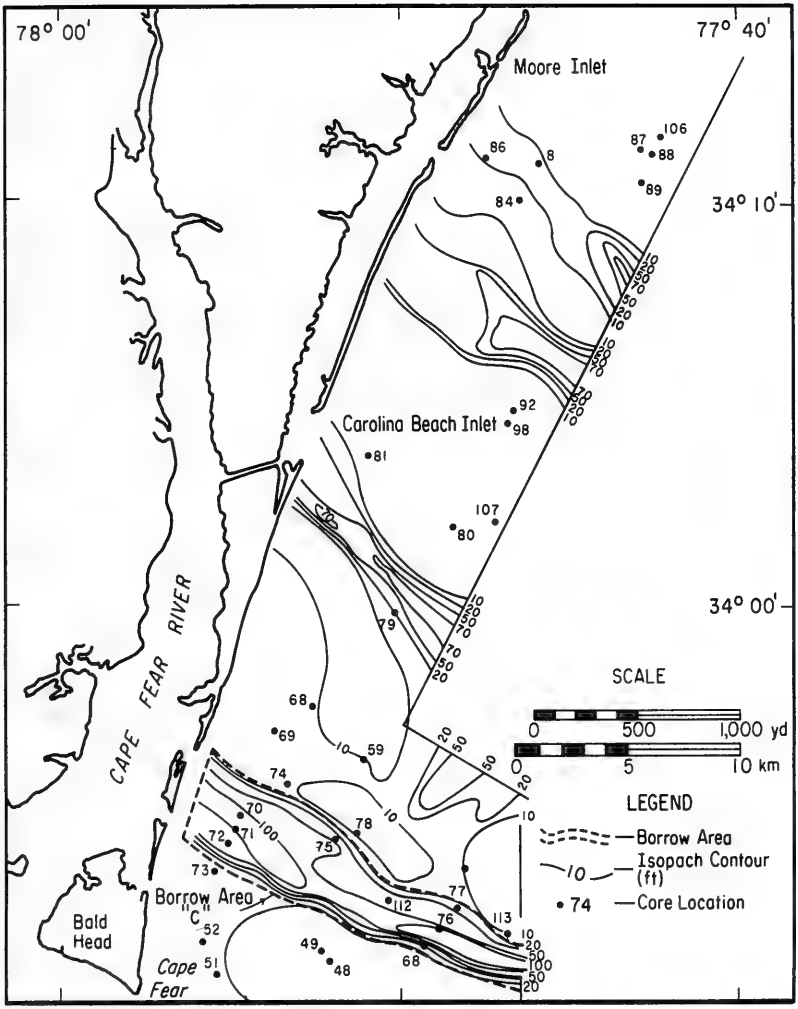

Figure 7. Isopach of channel fills in Onslow Bay showing potential borrow area C.

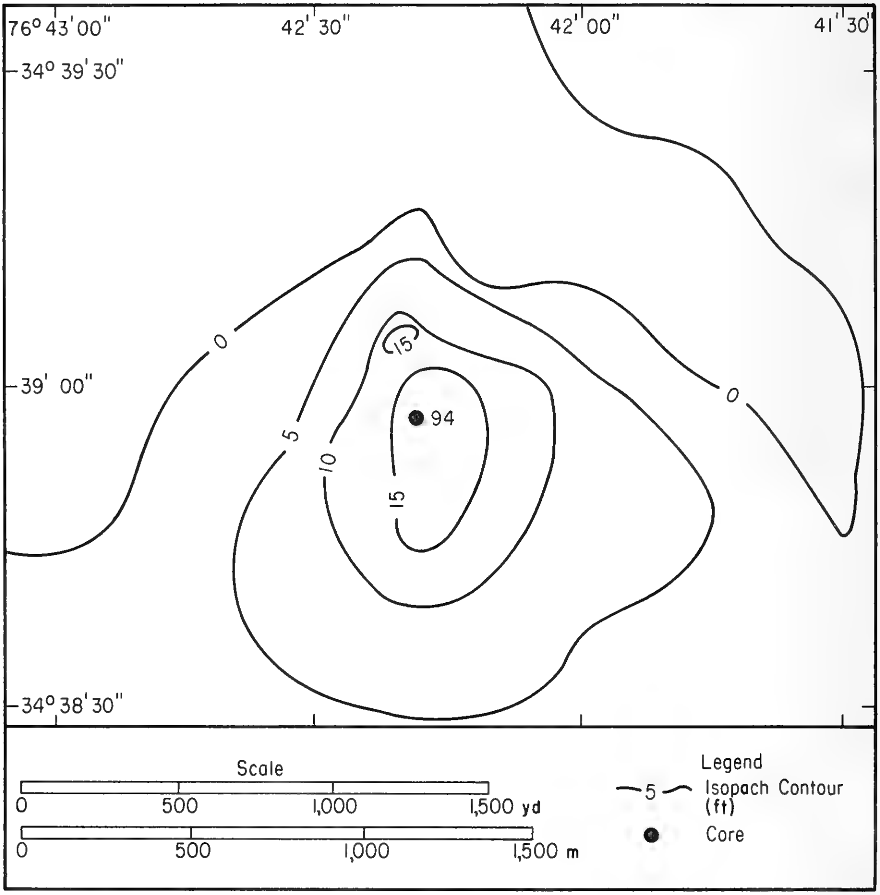

Figure 8. Isopach map of potential borrow area D.

of the surrounding shelf floor and probably represents the original bottom before dumping. The boundaries of the mound are best defined by the 5-foot isopach contour. Within this area there is approximately 2.1 million cubic yards (1.6 million cubic meters) of sediment. Additional data are needed to determine if all of this sediment is similar to the medium to coarse sand in core 94. The bottom topography of the spoil area outside the borrow site indicates that other mounds of spoil are also present within the general vicinity. These may contain sand usable for beach fill and warrant further investigation.

e. Core Sites. Suitable sediment for beach fill was found in cores from 23 other sites; however, there are insufficient data to determine the extent and thickness of these deposits. With the exception of borrow areas A to D, the cores are considered the most promising sites for further exploration. Pertinent data concerning the suitable material in these cores are contained in the table.

III. SUMMARY

1. The Inner Continental Shelf in the Cape Fear region of North Carolina was surveyed for sand deposits suitable for beach restoration and maintenance.

2. Data collected during the field survey consist of 512 statute miles (824 kilometers) of high-resolution seismic reflection profiles coverage and 124 cores of the sea floor ranging from 2 to 20 feet (0.6 to 6.1 meters) in length.

3. Desirable sand for restoration and maintenance of beaches in the study region should be in the Wentworth scale, medium to coarse size range (0.250 to 1.00 millimeter, 2.0 to 0.0 phi).

4. Twenty-seven sites where sand deposits were potentially suitable for offshore borrow were located and described (Figs. 2 to 8; Table).

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Meisburger, Edward P.
Sand resources on the Inner Continental Shelf of the Cape Fear region, North Carolina / by Edward P. Meisburger. – Fort Belvoir, Va. : U.S. Coastal Engineering Research Center ; Springfield, Va. : available from National Technical Information Service, 1977.
20 p. : ill. (Miscellaneous report - U.S. Coastal Engineering Research Center ; no. 77-11)
Bibliography: p. 20.
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TC203 .U581mr no. 77-11 627

Meisburger, Edward P.
Sand resources on the Inner Continental Shelf of the Cape Fear region, North Carolina / by Edward P. Meisburger. – Fort Belvoir, Va. : U.S. Coastal Engineering Research Center ; Springfield, Va. : available from National Technical Information Service, 1977.
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