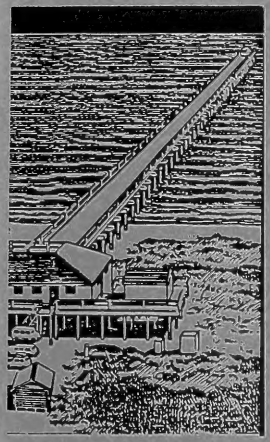
US Army Corps of Engineers



**REPAIR, EVALUATION, MAINTENANCE, AND REHABILITATION RESEARCH PROGRAM**

TECHNICAL REPORT REMR-CO-3

# CASE HISTORIES OF CORPS BREAKWATER AND JETTY STRUCTURES

## Report 5
## NORTH ATLANTIC DIVISION

by

Ernest R. Smith

Coastal Engineering Research Center

DEPARTMENT OF THE ARMY
Waterways Experiment Station, Corps of Engineers
PO Box 631, Vicksburg, Mississippi 39181-0631



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The following two letters used as part of the number designating technical reports of research published under the Repair, Evaluation, Maintenance, and Rehabilitation (REMR) Research Program identify the problem area under which the report was prepared:

| | Problem Area | | Problem Area |
|---|---|---|---|
| CS | Concrete and Steel Structures | EM | Electrical and Mechanical |
| GT | Geotechnical | EI | Environmental Impacts |
| HY | Hydraulics | OM | Operations Management |
| CO | Coastal | | |



COVER PHOTOS:

TOP — Field Research Facility, Duck, North Carolina.

BOTTOM — Photograph of Indian River Inlet jetties.

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This report is fifth in a series of case histories of US Army Corps of Engineers (Corps) breakwater and jetty structures at nine Corps divisions. Chronological histories are presented for 58 breakwater and jetty structures located within the US Army Engineer Division, North Atlantic (NAD), which includes the New York, Philadelphia, Baltimore, and Norfolk Districts. Presently, there are approximately 161,500 lin ft of breakwater and jetty structures managed by NAD. Structure cross sections of rubble-mound or stone-filled timber crib account for most of this total. Thirty-three of the project structures have been repaired since construction. Other construction materials that have been used include steel, dolosse, concrete cap, concrete block, and timber.

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A report of the Coastal Problem Area of the Repair, Evaluation, Maintenance, and Rehabilitation (REMR) Research Program. Available from National Technical Information Service, 5285 Port Royal Road, Springfield, VA 22161.

# PREFACE

This report was prepared as part of the Coastal Problem Area of the Repair, Evaluation, Maintenance, and Rehabilitation (REMR) Research Program. The work was carried out jointly under Work Unit 32278, "Rehabilitation of Rubble-Mound Structure Toes," of the REMR program and Work Unit 31269, "Stability of Breakwaters," of the Civil Works Coastal Area Program. For the REMR Program, Coastal Problem Area Monitor is Mr. John H. Lockhart, Jr., Office, Chief of Engineers (OCE), US Army Corps of Engineers (Corps). REMR Program Manager is Mr. William F. McCleese of the US Army Engineer Waterways Experiment Station's (WES's) Structures Laboratory, and Coastal Problem Area Leader is Mr. D. D. Davidson of WES's Coastal Engineering Research Center (CERC). Messrs. John G. Housley and Lockhart are Technical Monitors of the Civil Works Coastal Area Program.

This report is fifth in a series of case histories of Corps breakwater and jetty structures at nine Corps divisions. The case histories were written from information obtained from several sources (where available), including inspection correspondence, design memorandums, survey reports, and annual reports to the Chief of Engineers. Unless otherwise noted, any changes in prototype structures subsequent to 1985 are not included.

This work was conducted at WES during the period June 1985 to December 1986 under general direction of Dr. James R. Houston, Chief, CERC, and Mr. Charles C. Calhoun, Jr., Assistant Chief, CERC; and under direct supervision of Mr. C. Eugene Chatham, Jr., Chief, Wave Dynamics Division (CW), and Mr. D. D. Davidson, Chief, Wave Research Branch (CW-R). This report was prepared by Mr. Ernest R. Smith, Hydraulic Engineer, Wave Processes Branch (CW-P). Messrs. John P. Ahrens, Peter J. Grace, John M. Heggins, and Cornelius Lewis, CW-R, and Frances E. Sargent, CW-P, visited project sites and gathered information. Mr. Marvin G. Mize, CW-P, drafted figures, and Ms. Shirley A. J. Hanshaw, Information Products Division, Information Technology Laboratory, edited this report.

Commander and Director of WES during publication of this report was COL Dwayne G. Lee, EN. Technical Director was Dr. Robert W. Whalin.

CONTENTS

CONVERSION FACTORS, NON-SI TO SI (METRIC)
UNITS OF MEASUREMENT

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

| Multiply | By | To obtain |
|---|---|---|
| cubic yards | 0.76455549 | cubic metres |
| feet | 0.3048 | metres |
| inches | 2.54 | centimetres |
| miles (US statute) | 1.609347 | kilometres |
| pounds (force) | 4.448222 | newtons |
| square feet | 0.09290204 | square metres |
| tons (2,000 lb force) | 8896.443353 | newtons |

# CASE HISTORIES OF CORPS BREAKWATER AND JETTY STRUCTURES

## NORTH ATLANTIC DIVISION

## PART I: INTRODUCTION

### Background

1. The US Army Corps of Engineers (Corps) is responsible for a wide variety of coastal structures located on the Atlantic, Pacific, and gulf coasts, the Great Lakes, the Hawaiian Islands, other islands, and inland waterways. Coastal improvements such as breakwaters or jetties are necessary where safe harboring or passage of shipping is required. These structures are continuously subjected to wave and current forces, and they are usually constructed on top of movable-bed materials. Under these conditions structural deterioration can occur and, at some point, maintenance is required if the structure fails to serve the existing needs of the project. Some of these projects have been maintained for 150 years or more. Methods of construction (and repair) have varied significantly during this time, due principally to a better understanding of coastal processes, availability of construction materials, existing wave climates, regional construction practices, and economic considerations.

### Purpose

2. The purposes of this report are to lend insight into the scope, magnitude, and history of coastal breakwaters and jetties under Corps jurisdiction; determine their maintenance and repair history; determine their methods of construction; make this information available to Corps personnel; and address objectives of the Repair, Evaluation, Maintenance, and Rehabilitation (REMR) research program. To do this, case histories of Corps breakwater and jetty structures have been developed to quantify past and present problem areas (if any), to take steps to rectify these problems, and to subsequently evaluate the remedial measures. General design guidance can be obtained from those solutions that have been most successful. Information in this report should be of particular value to Corps personnel in the US Army Engineer Division, North Atlantic (NAD), and its coastal districts and possibly to non-Corps personnel. Where adequate solutions are lacking or where specific guidance is needed,

further research will be conducted to address these problems (e.g. general armor stability, toe protection, localized damage, use of dissimilar armor, wave runup and overtopping).

## PART II: SUMMARY OF CORPS BREAKWATER AND JETTY STRUCTURES IN NAD

3. NAD has 58 projects which contain breakwater and/or jetty structures that are located in four coastal districts as follows: New York (NAN), 21; Philadelphia (NAP), 17; Baltimore (NAB), 16; and Norfolk (NAO), 4. Case histories for these structures are included in Tables 1-58 which are ordered according to the preceding districts and coastal location. Twelve of the projects are located in an ocean environment, and the remainder are situated in bays, sounds, or rivers. Overall, there are approximately 161,500 lin ft* of breakwaters (22.6 percent) and jetties (77.4 percent). Most of the structures' cross sections are rubble mound (73.1 percent) or stone-filled timber crib (10.4 percent). Other construction materials that have been used include steel (Wilmington Harbor and Indian River Inlet), dolosse (Manasquan Inlet), concrete cap (Manasquan Inlet and Ocean City Inlet), concrete block (Cold Spring Inlet), and timber (Double Creek, Little Wicomico River, and Urbanna Creek). Thirty-three of the project structures have been repaired since construction.

4. Figures 1 through 4 are maps of NAN, NAP, NAB, AND NAO, respectively, showing project locations. Pertinent summary information on each project is presented in the following listing.

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* A table of factors for converting non-SI units of measurement to SI (metric) units is presented on page 3.

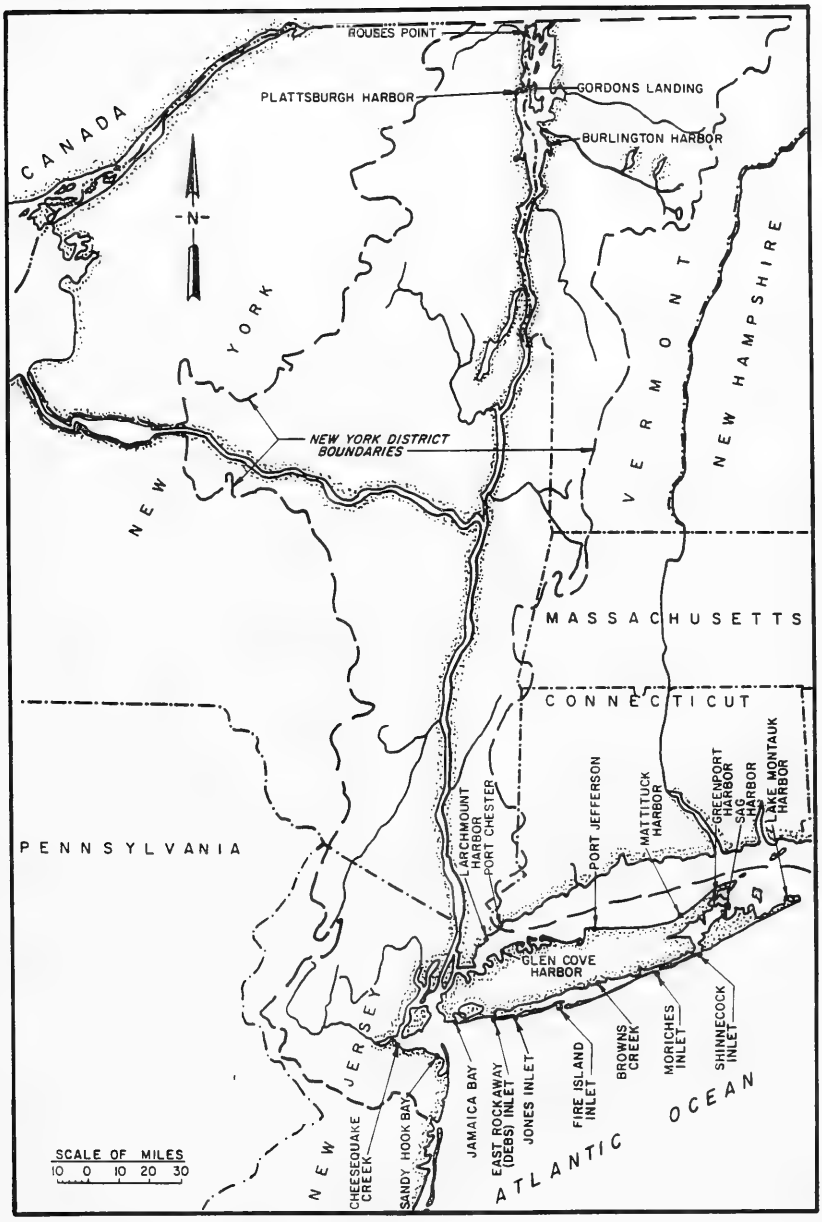



Figure 1. NAN breakwater and jetty project locations

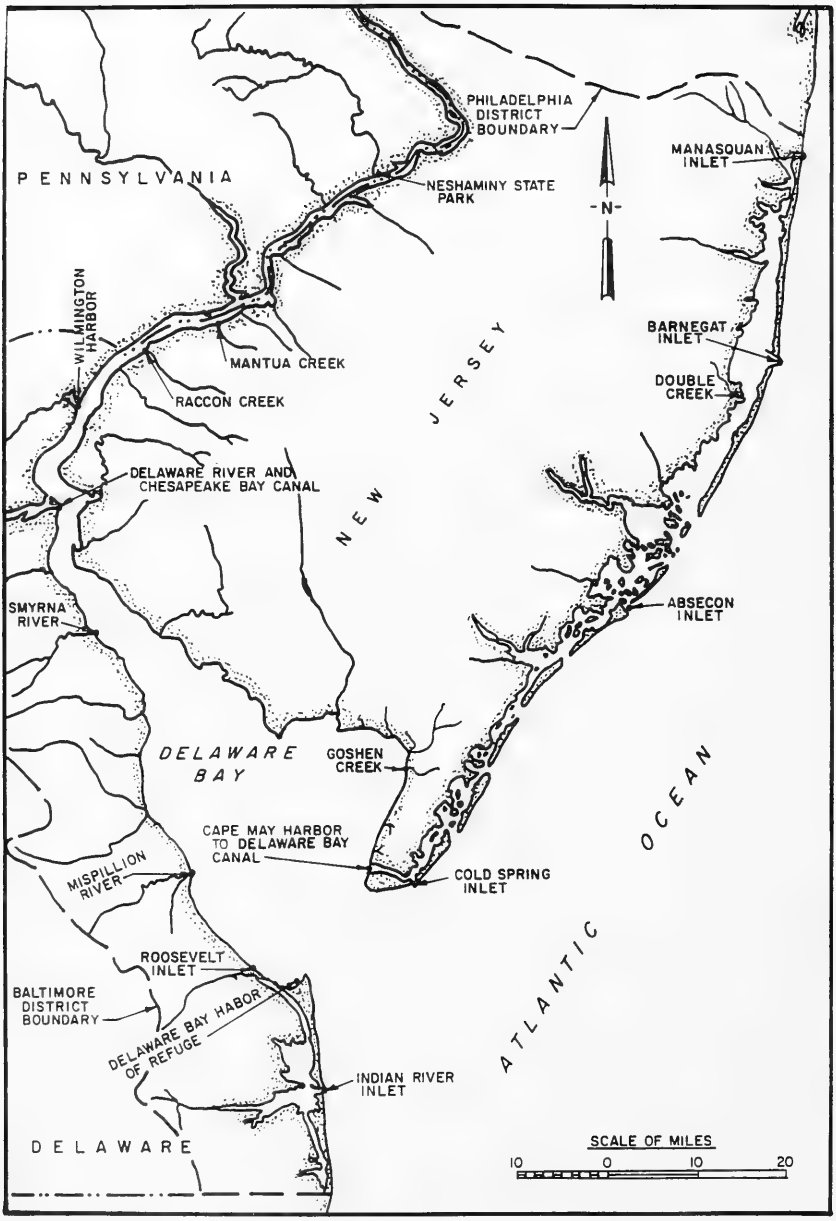



Figure 2. NAP breakwater and jetty project locations

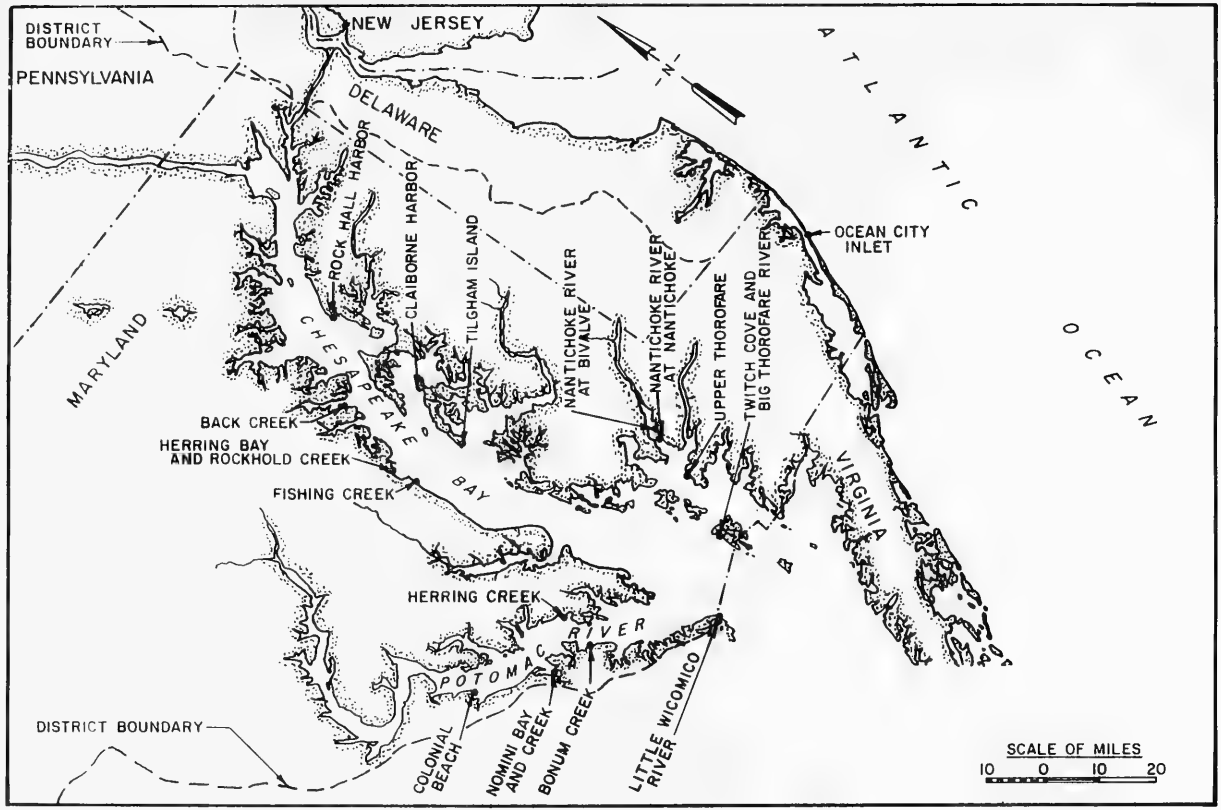



Figure 3. NAB breakwater and jetty project locations

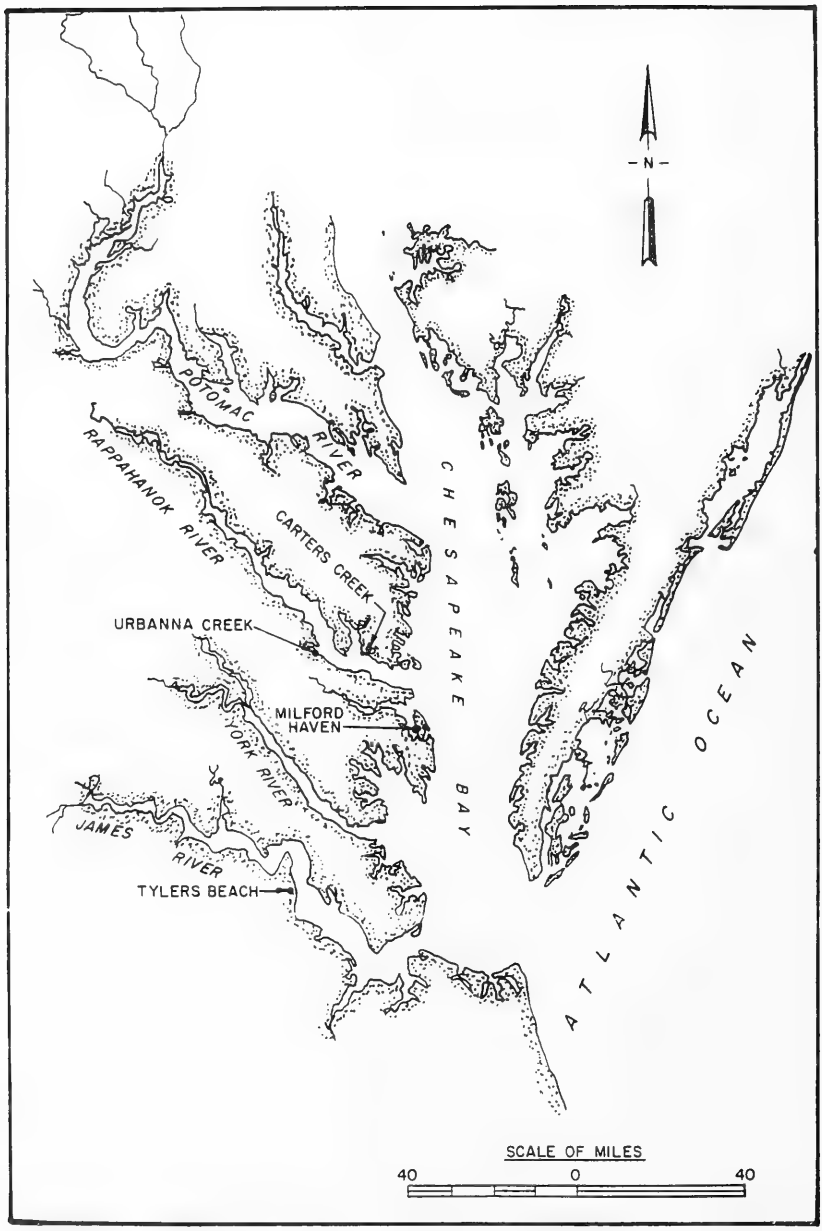



Figure 4. NAO breakwater and jetty project locations

| Location | Table | Structure Type & No.* | Armor Type** | Length ft | Date of Origin | Improvement† |
|---|---|---|---|---|---|---|
| Rouses Point | 1 | B | S | 1,835 | 1892 | N |
| Gordons Landing | 2 | B | S | 675 | 1891 | R |
| Plattsburgh Harbor | 3 | B | X,S | 1,565 | 1836 | R |
| Burlington Harbor | 4 | B(2) | X,S | 4,157 | 1836 | R |
| Port Chester | 5 | B | S | 783 | 1895 | R |
| Larchmont Harbor | 6 | B | S | 1,440 | 1906 | R |
| Glen Cove Harbor | 7 | B | S | 1,465 | 1906 | N |
| Port Jefferson | 8 | J(2) | S | 2,490 | 1871 | R |
| Mattituck Harbor | 9 | J(2) | S | 1,705 | 1906 | R |
| Greenport Harbor | 10 | B | - | 1,570 | 1883 | N |
| Sag Harbor | 11 | B | S | 3,180 | 1908 | R |
| Lake Montauk Harbor | 12 | J(2) | S | 1,962 | 1926 | R |
| Shinnecock Inlet | 13 | J(2) | S | 2,309 | 1953 | R |
| Moriches Inlet | 14 | J(2) | S | 2,302 | 1953 | R |
| Browns Creek | 15 | J(2) | S | 1,148 | 1892 | R |
| Fire Island Inlet | 16 | J | - | 4,950 | 1941 | N |
| Jones Inlet | 17 | J | S | 5,200 | 1959 | R |
| East Rockaway (Debs) Inlet | 18 | J | S | 3,750 | 1934 | R |
| Jamaica Bay | 19 | J | S | 8,400 | 1933 | R |
| Sandy Hook Bay | 20 | B | S | 4,000 | 1940 | N |
| Cheesequake Creek | 21 | J(2) | S | 1,920 | 1883 | N |
| Neshaminy State Park | 22 | J | S | 230 | 1968 | N |
| Mantua Creek | 23 | J(2) | S,X | 3,033 | 1907 | R |
| Raccoon Creek | 24 | J | X | 950 | 1922 | N |
| Wilmington Harbor | 25 | J(2) | St,X | 3,440 | 1936 | R |
| Delaware River and Chesapeake Bay Canal | 26 | J(2) | S | 4,190 | 1903 | R |
| Smyrna River | 27 | J(2) | X | 2,803 | 1939 | N |
| Mispillion River | 28 | J(2) | S,X | 11,442 | 1859 | R |

(Continued)

* Indicates type and number of structures (i.e. B-breakwater, J-jetty, B(2)-two breakwaters, J(2)-two jetties, etc.)

** Indicates amor types (i.e. S-stone, X-timber crib, St-steel, C-concrete cap, D-dolosse, T-timber, CB-concrete block.

† R-repair, N-none.

| Location | Table | Structure Type & No. | Armor Type | Length ft | Date of Origin | Improve-ment |
|---|---|---|---|---|---|---|
| Roosevelt Inlet | 29 | J(2) | St | 3,400 | 1908-1938 | R |
| Delaware Bay Harbor of Refuge | 30 | B(2) | S | 12,500 | 1898-1901 | N |
| Manasquan Inlet | 31 | J(2) | C,S,D | 2,260 | 1931 | R |
| Barnegat Inlet | 32 | J(2) | S | 7,495 | 1940 | R |
| Double Creek | 33 | J | T | 550 | 1912 | N |
| Absecon Inlet | 34 | J(2) | S | 4,527 | 1948 | N |
| Goshen Creek | 35 | J(2) | S | 2,480 | 1897 | R |
| Cold Spring Inlet | 36 | J(2) | CB,S | 8,958 | 1911 | R |
| Cape May Harbor to Delaware Bay Canal | 37 | J(2) | - | 1,300 | 1943 | R |
| Indian River Inlet | 38 | J(2) | S,St | 3,452 | 1939 | R |
| Rock Hall Harbor | 39 | B(2) | S | | 1939 | R |
| Claiborne Harbor | 40 | J | T | 1,000 | 1888 | R |
| Back Creek | 41 | J | S | 650 | 1938 | N |
| Herring Bay and Rockhold Creek | 42 | B | S | 900 | 1939 | N |
| Fishing Creek | 43 | J(2) | S | 2,150 | 1941 | R |
| Tilghman Island | 44 | B | S | 200 | 1981 | N |
| Nanticoke River at Bivalve | 45 | J(2) | S | 2,100 | 1960 | N |
| Nanticoke River at Nanticoke | 46 | J(2) | S | 1,600 | 1938 | N |
| Upper Thorofare | 47 | B(2) | S | 720 | 1934 | R |
| Twitch Cove and Big Thorofare River | 48 | J(2) | S | 3,870 | 1940 | R |
| Ocean City Inlet | 49 | J(2) | S,C | 3,480 | 1934 | R |
| Colonial Beach | 50 | B(7) | S | 1,500 | 1982 | N |
| Nomini Bay and Creek | 51 | J | S | 2,410 | 1912 | N |
| Bonum Creek | 52 | J(2) | S | 1,100 | 1967 | N |
| Herring Creek | 53 | J(2) | S | 1,450 | 1960 | N |
| Little Wicomico River | 54 | J(2) | S,T | 3,307 | 1937 | R |
| Urbanna Creek | 55 | J(2) | S,T | 2,612 | 1956 | N |
| Carters Creek | 56 | J | S | 742 | 1902 | N |
| Milford Haven | 57 | J | S | 1,183 | 1913 | N |
| Tylers Beach | 58 | J(2) | S | 740 | 1981 | N |

Table 1

Rouses Point Breakwater, Rouses Point, New York, New York District

| Date(s) | Construction and Rehabilitation History |
|---|---|
| 1892 | A 1,835-ft-long breakwater was completed for harbor protection (Figure 5). Construction was of rubble mound, faced with large stones. Cost of construction was $98,467. |
| 1986 | No further repair or maintenance information has been found. |

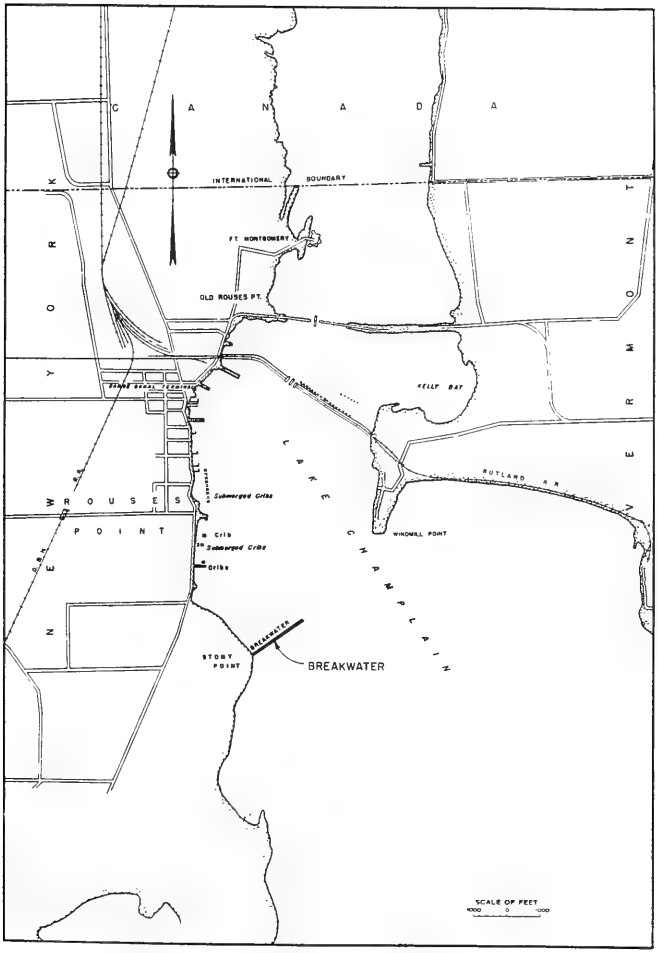



Figure 5. Rouses Point, New York

Table 2

Gordons Landing Breakwater, Gordons Landing, Vermont

New York District

| Date(s) | Construction and Rehabilitation History |
|---|---|
| 1891 | A 675-ft-long breakwater was constructed to provide dock protection (Figure 6). The structure was built of rubble and large stone. Cost of construction was $34,750. |
| 1893 | Core rubble and large facing stones were placed on the seaward 135 ft of the breakwater. |
| 1986 | No further repair or maintenance information has been found. |

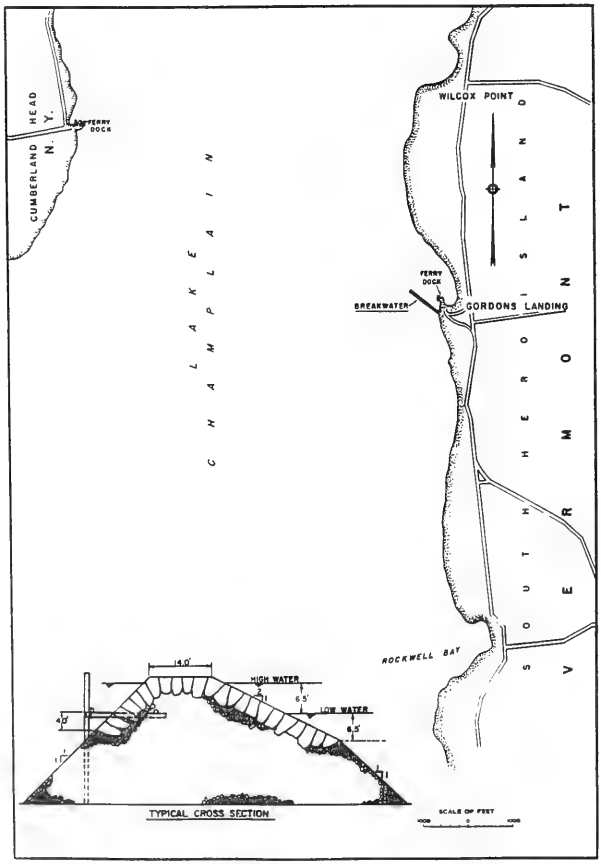



Figure 6. Gordons Landing, Vermont

Table 3

Plattsburgh Harbor Breakwater

Plattsburgh, New York

| Date(s) | Construction and Rehabilitation History |
|---|---|
| 1836-1875 | 1,250 ft of breakwater was constructed of timber cribs filled with rubblestone and capped with large stone. Slopes were 1:1, and the timber elevation was at low water level. |
| 1893 | The breakwater was extended to 1,565 ft (Figure 7). A total of $32,500 was spent on renewal of the old timber superstructure by one composed of large facing stones with rubblestone core. |
| 1949 | A survey indicated the breakwater was in good condition except at the ends. |
| 1971 | Repairs were made to the north end of the breakwater at a cost of $118,000. |
| 1986 | No further repair or maintenance information has been found. |

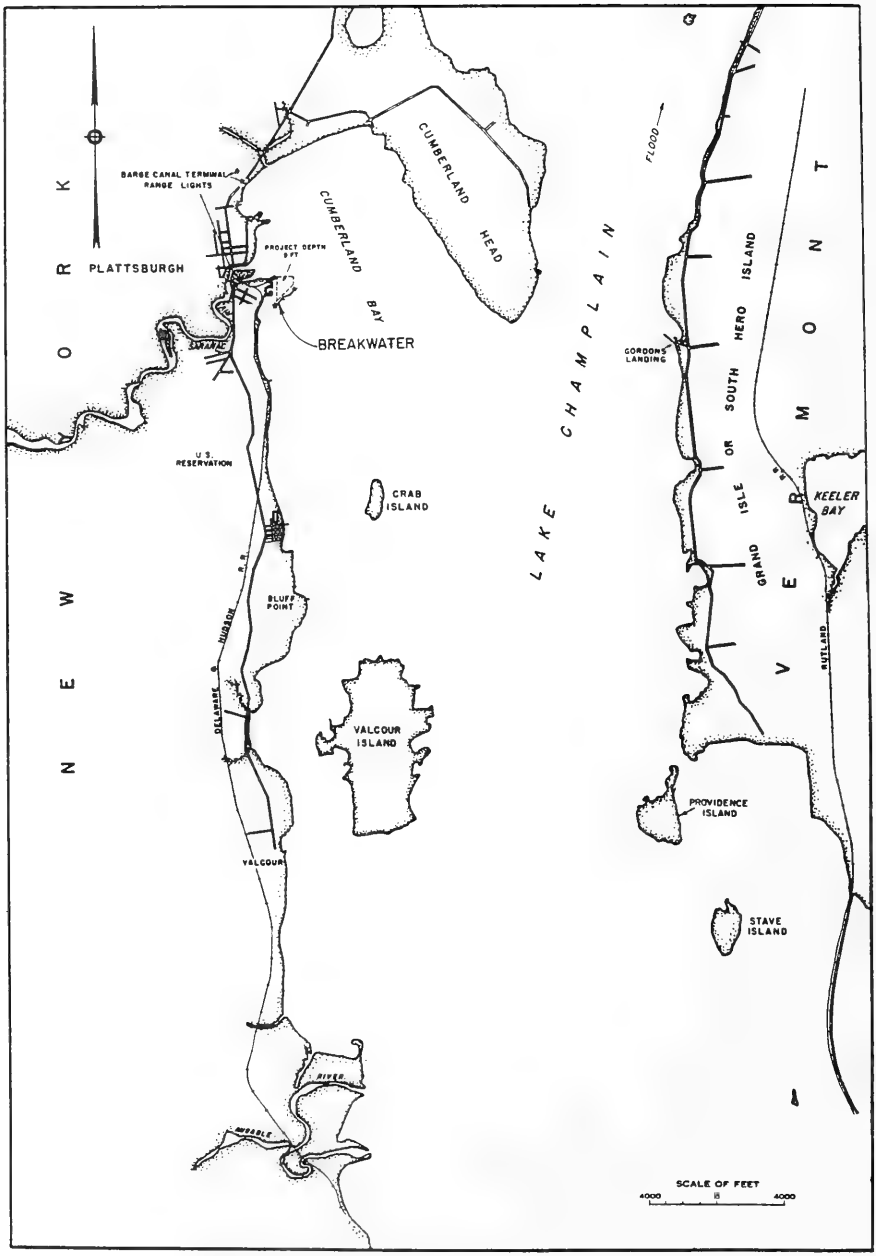



Figure 7. Plattsburgh Harbor, New York

Table 4

Burlington Harbor Breakwater

Burlington, Vermont

New York District

| Date(s) | Construction and Rehabilitation History |
|---|---|
| 1890 | A 4,157-ft breakwater was completed after 54 years of construction (Figure 8). The breakwater consisted of two segments at lengths of 364 ft (north) and 3,793 ft (south) which were separated by 250 ft. Construction was of rubble mound resting on rock-filled timber cribs capped by either concrete (2,457 ft), or rock (1,700 ft). The cribs rested on a sand and gravel bed and were fastened with dowels and tenons. Crest elevation was +8.0 ft low lake level (111), and crib width ranged from 24 to 34 ft. |
| 1948 | The breakwater was repaired. Stone was placed on the lakeside at weakened sections. |
| 1960 | A survey indicated the existing structure had settled 1.0 to 3.0 ft along the entire length. Deterioration of sections of the timber fasteners left unconnected sections and caused timber displacement and leaning of the structure lakeward. Deterioration was believed to be caused by wave action and ice conditions over long periods of time. Approximately 550 lin ft of the stone superstructure was undermined. Eighty feet of the structure was breached. |
| 1962-1965 | The breakwater was rehabilitated using 16,573 tons of stone at a cost of $381,000. |
| 1986 | No further repair or maintenance information has been found. |

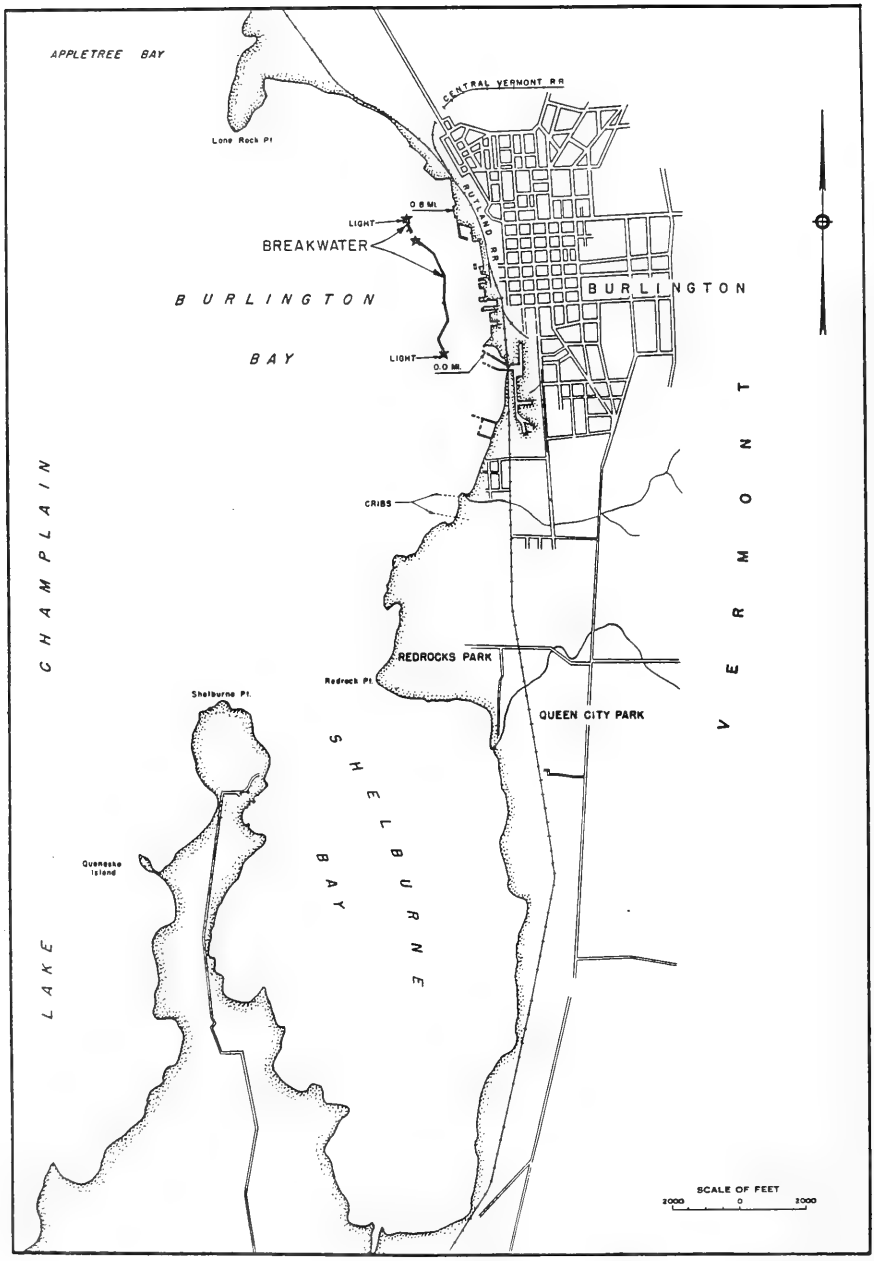



Figure 8. Burlington Harbor, Vermont

Table 5

Port Chester Breakwater, Port Chester, New York

New York District

| Date(s) | Construction and Rehabilitation History |
|---|---|
| 1895 | A 783-ft-long rubble-mound breakwater was completed from Byram Point to Sunken Rock (Figure 9). Crest elevation was +15 ft mlw. The estimated cost of breakwater construction was $25,000. |
| 1963 | The breakwater was repaired using 990 tons of stone. The cost of the repairs was $25,500. |
| 1986 | No further repair or maintenance information has been found. The project has been deauthorized. |

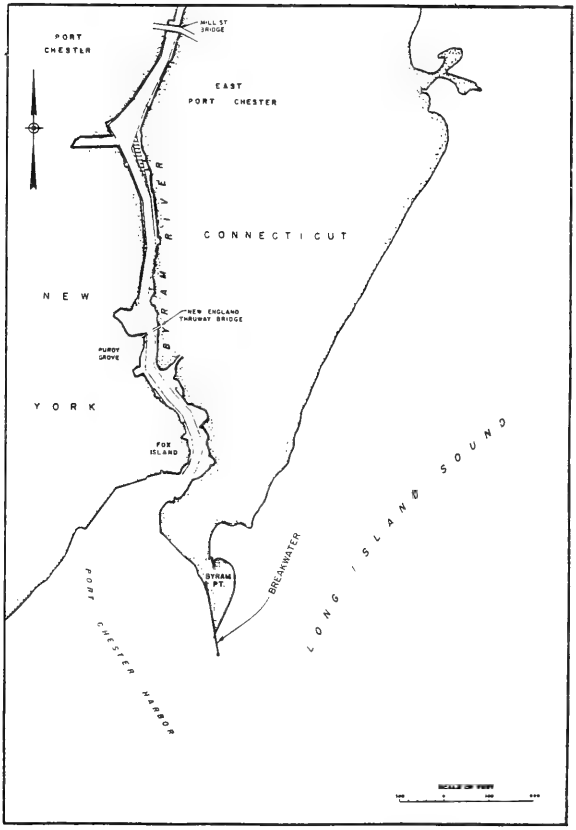



Figure 9. Port Chester Harbor, New York

Table 6

Larchmont Harbor Breakwater

Larchmont, New York

New York District

| Date(s) | Construction and Rehabilitation History |
|---|---|
| 1906 | Construction was completed on a 1,440-ft-long stone breakwater, (Figure 10). Crest elevation was +10.0 ft mlw, crown width was 5.0 ft, and side slopes were 1:1. Stone sizes 8.0 to 10.0 tons were placed in random fashion. Initial construction costs were $71,065. |
| 1967 | A survey of the breakwater indicated the entire length was below design elevation and varied from +4.0 to +8.0 ft mlw. A localized depression of +2.0 ft mlw was located approximately 1,300 ft from the shoreward end. The breakwater was submerged during high tides, which created danger areas and was only partially effective as a barrier to storm waves. The structure had no breaks and was considered stable. |
| 1969 | The entire breakwater was rehabilitated by adding 8.0- to 10.0-ton stone in pell mell fashion to raise the elevation up to original design. Crown width remained 5.0 ft, and side slopes were 1V:1.5H. Cost of rehabilitation was $215,500. A 12.5-ft, 4.9-sec design wave was used. |
| 1986 | No further repair or maintenance information has been found. |

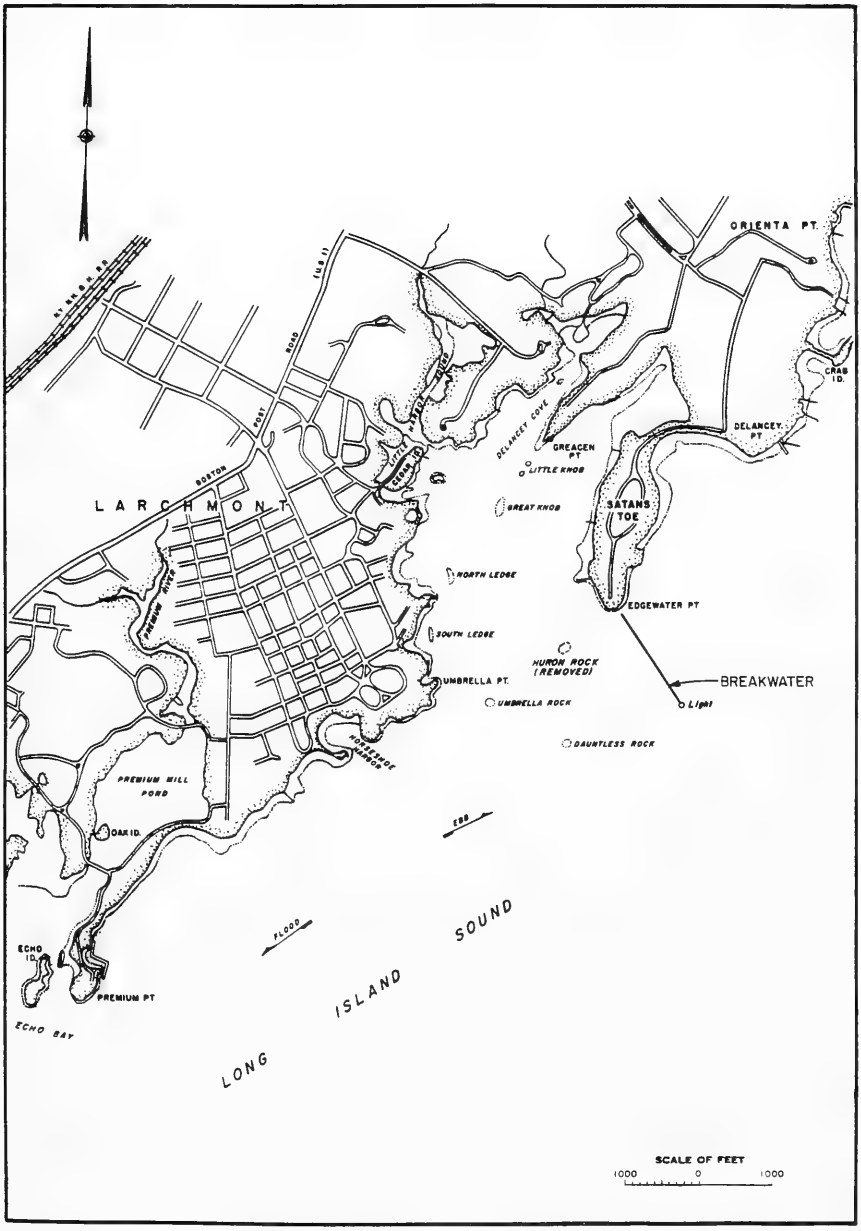



Figure 10. Larchmont Harbor, New York

Table 7

Glen Cove Breakwater

Glen Cove, New York

New York District

| Date(s) | Construction and Rehabilitation History |
|---|---|
| 1906 | A 1,465-ft-long stone breakwater was completed to provide shelter to anchorage (Figure 11). Crest elevation was +10.4 ft mlw, crown width was 5.0 ft, and side slopes were 1:1. Stone sizes of 1,500 lb to 2.0 ton were placed in pell mell fashion. Cost of initial construction was $71,830. |
| 1964 | A survey of the breakwater revealed that the offshore portion had deteriorated and the outer half had settled 3.0 ft. Crest elevation varied from +5.0 to +10.4 ft mlw, and side slopes varied from 1:1 to 1V:2H. Stones were displaced due to undersized stone. Over 50 percent of the breakwater was submerged at high tide. The breakwater was considered stable with no breach along the entire length. |
| 1986 | No further repair or maintenance information has been found. The project has been deauthorized. |

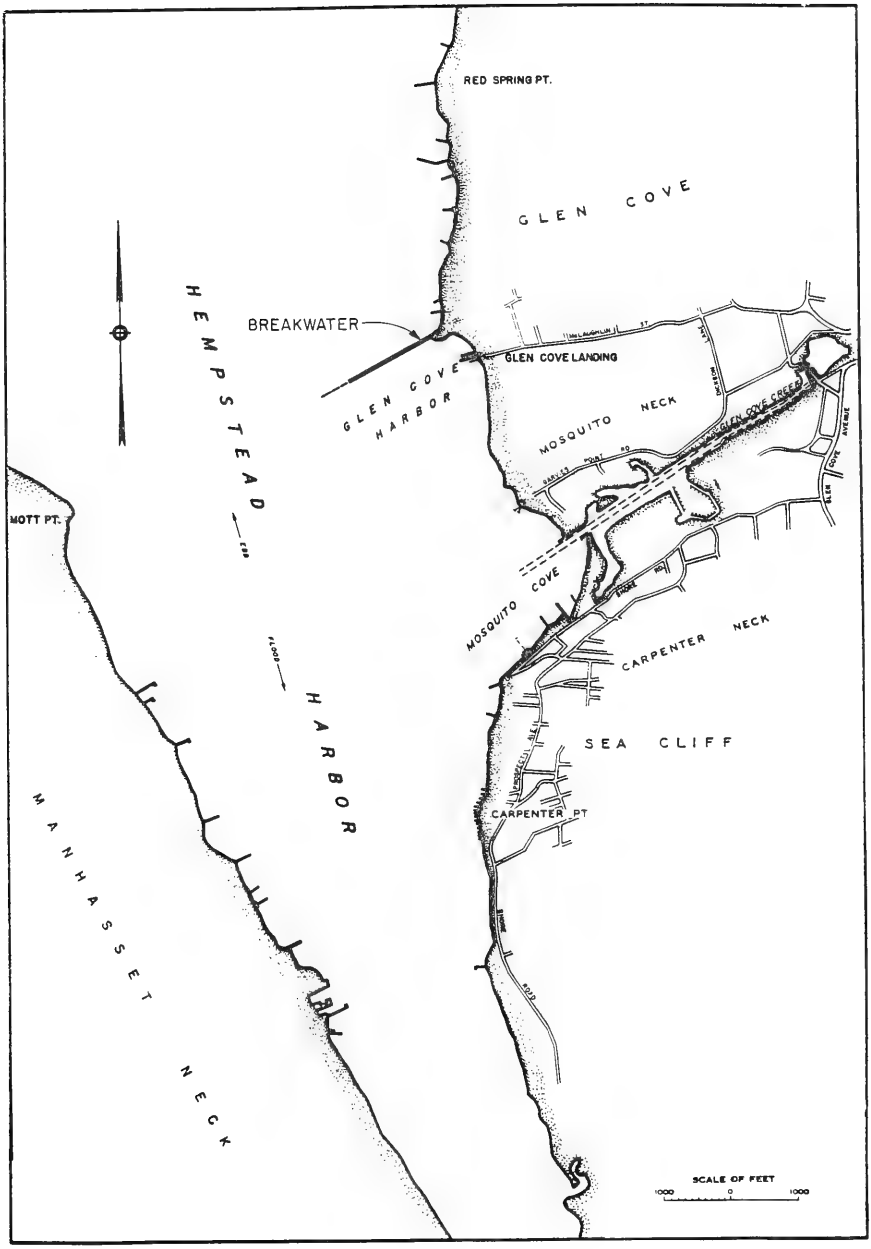



Figure 11. Glen Cove Harbor, New York

Table 8

Port Jefferson Jetties

Port Jefferson, New York

New York District

| Date(s) | Construction and Rehabilitation History |
|---|---|
| 1871 | A 600-ft-long riprap jetty was constructed east of the harbor entrance to prevent shoaling in the channel. Crest elevation was +6.5 ft mlw. |
| 1872 | The jetty was extended to 1,050 ft, maintaining the same crest elevation. |
| 1875 | A 475-ft-long riprap jetty was built west of the harbor using 3,933 tons of stone (Figure 12). Crest elevation was +11.0 ft mlw. |
| 1877 | The east jetty was extended 50 ft seaward, and the entire jetty was raised to +5.0 ft high water (hw). |
| 1878 | The west jetty was extended 450 ft with a crest elevation of +2.0 ft mlw, except the seaward end was +11.0 ft mlw. |
| 1879 | The east jetty was extended 70 ft using 1,437 tons of stone. |
| 1881 | Stone was placed on both jetties. |
| 1882 | The east jetty was extended 120 ft using 2,020 tons of stone. |
| 1883 | The west jetty was extended to 940 ft. Crest elevation of the jetty was +11.0 ft mlw over the shoreward 550 ft and +2.0 ft mlw seaward. The middle of the +2.0 ft mlw section was +11.0 ft mlw, and the seaard end was +14.0 ft mlw. Crown width was 4.0 ft at the seaward 250 ft, and side slopes were 1:1. The east jetty was extended to 1,390 ft at +5.0 ft hw, with a 4.0-ft crown width. The total cost of the jetties since 1871 was $79,000. |
| 1891 | The east jetty was repaired over 600 ft with 1,464 tons of stone. |
| 1908 | The east jetty was extended to 1,550 ft (Figure 12). |
| 1964 | A survey indicated the jetties were in poor condition. |
| 1986 | No further repair or maintenance information has been found. |

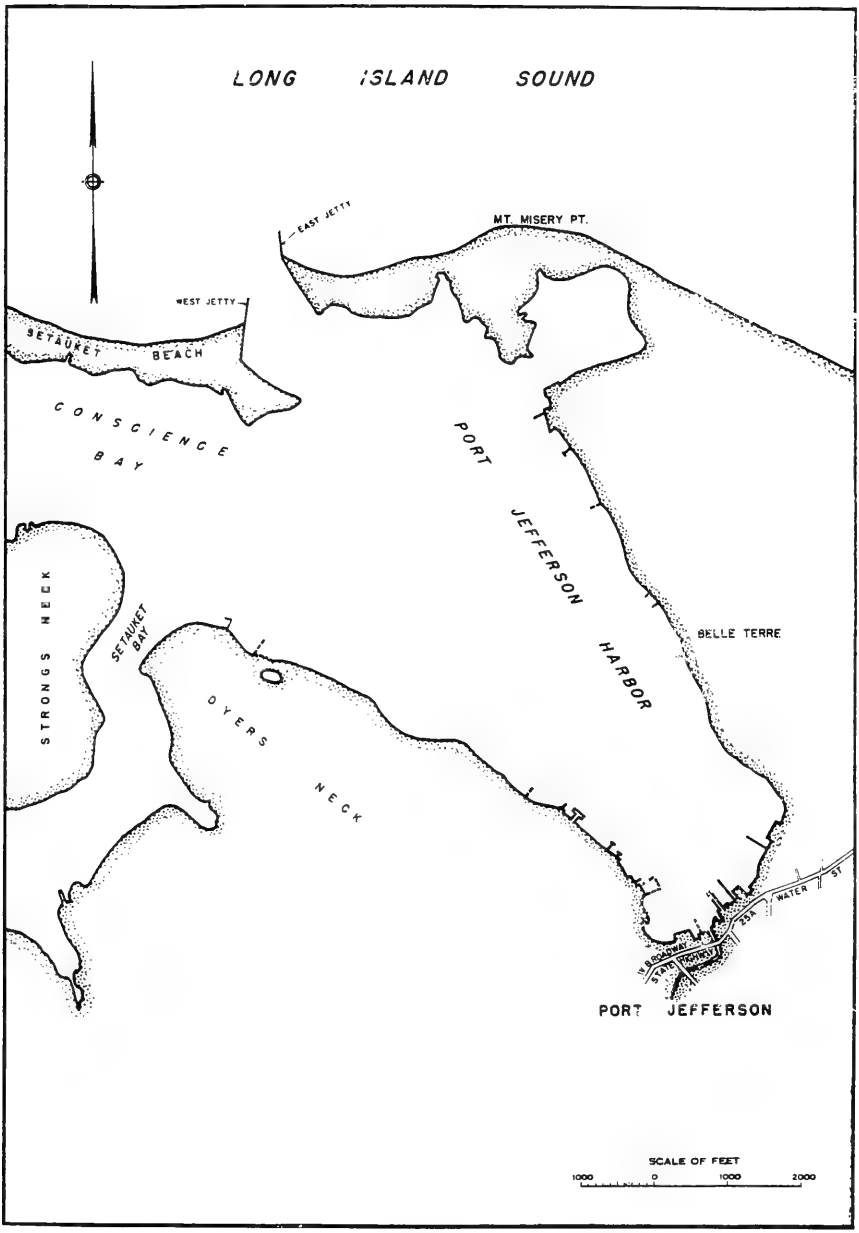



Figure 12. Port Jefferson Harbor, New York

Table 9

Mattituck Harbor Jetties

Mattituck, New York

New York District

| Date(s) | Construction and Rehabilitation History |
|---|---|
| 1906 | Two parallel jetties were constructed 400 ft apart at the harbor entrance. Lengths were 775 ft (east (Figure 13)), and 680 ft (west). The estimated cost of construction was $40,000. |
| 1910 | The landward 680 ft of the east jetty and 485 ft of the west jetty were repaired and made sand tight at a cost of $6,158. Seaward portions of the jetties were in need of repair and sand tightening. |
| 1938 | The west jetty was extended to 930 ft (Figure 13). The jetties were considered to be in good condition. |
| 1975 | Both jetties were repaired using $10,670 tons of stone. The cost of repairs was $385,000. |
| 1986 | No further repair or maintenance information has been found. |

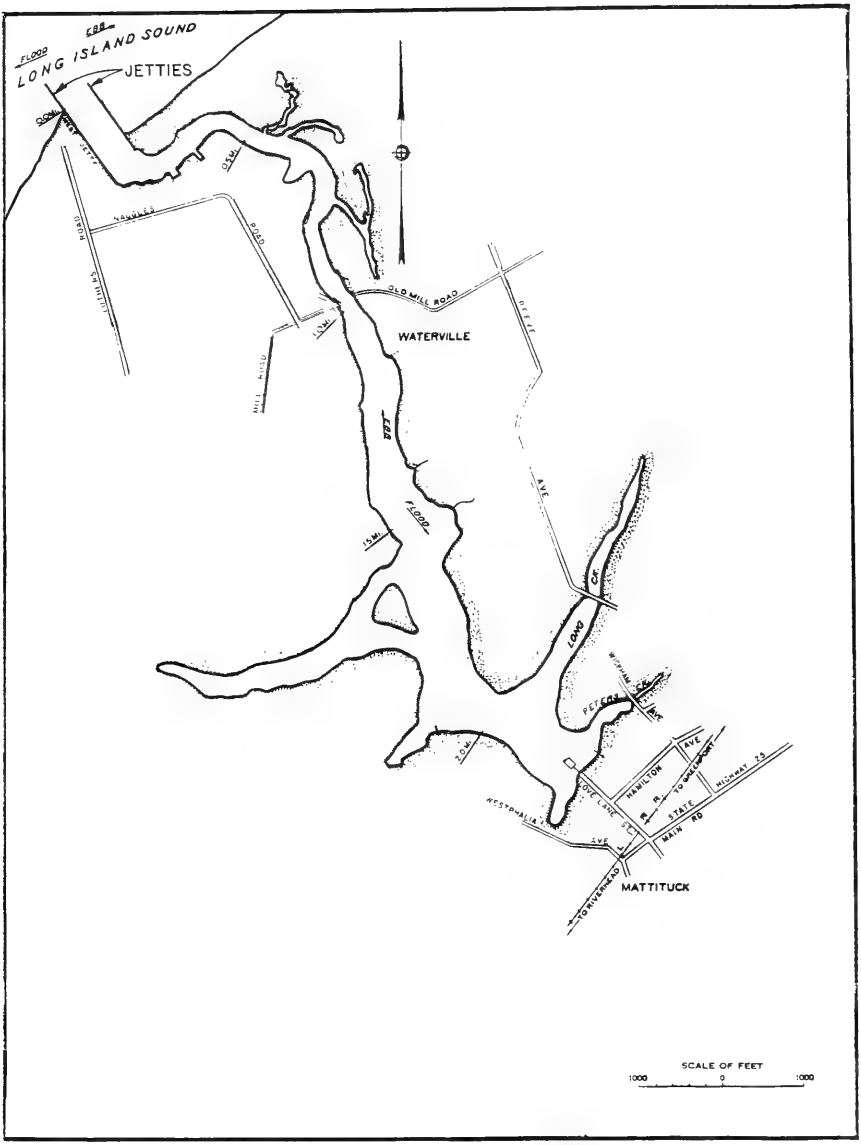



Figure 13. Mattituck Harbor, New York

Table 10

Greenport Harbor Breakwater

Greenport, New York

New York District

| Date(s) | Construction and Rehabilitation History |
|---|---|
| 1883 | A 1,570-ft-long breakwater was constructed to provide harbor protection from east and northeast storms (Figure 14). Crest elevation was +3.0 ft hw and allowed for 1.0-ft expected settlement. Crown width was 5.0 ft, and side slopes were 1:1. The estimated cost of construction was $22,000. |
| 1986 | No further repair or maintenance information has been found. |

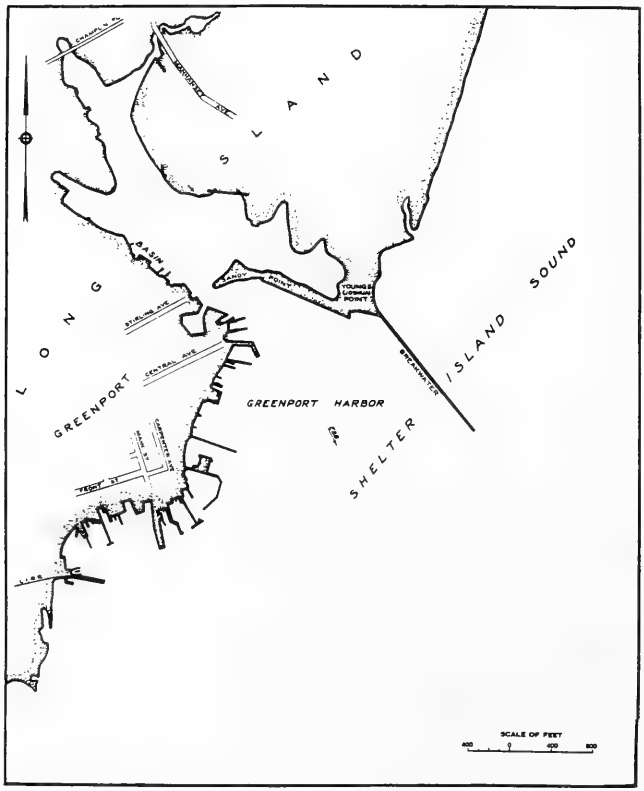



Figure 14. Greenport Harbor, New York

Table 11

Sag Harbor Breakwater, Sag Harbor, New York

New York District

| Date(s) | Construction and Rehabilitation History |
|---|---|
| 1908 | A two-section breakwater was constructed of stone to provide harbor protection (Figure 15). The total length of the breakwater was 3,180 ft. The inshore section extended 1,330 ft north-northwest from Conklin Point. The offshore and inshore sections overlapped and were separated by 100 ft. The offshore section extended 1,850 ft west-northwest. Crest elevations were +7.5 ft mlw, crown width was 5.0 ft, and side slopes were 1:1. The cost of construction was $59,800. |
| 1962 | Surveys indicated the breakwater had settled 0.5 to 1.0 ft for considerable lengths. The breakwater was considered stable. |
| 1963 | Repairs were made using 1,429 tons of stone at a cost of $15,150. |
| 1986 | No further repair or maintenance information has been found. |

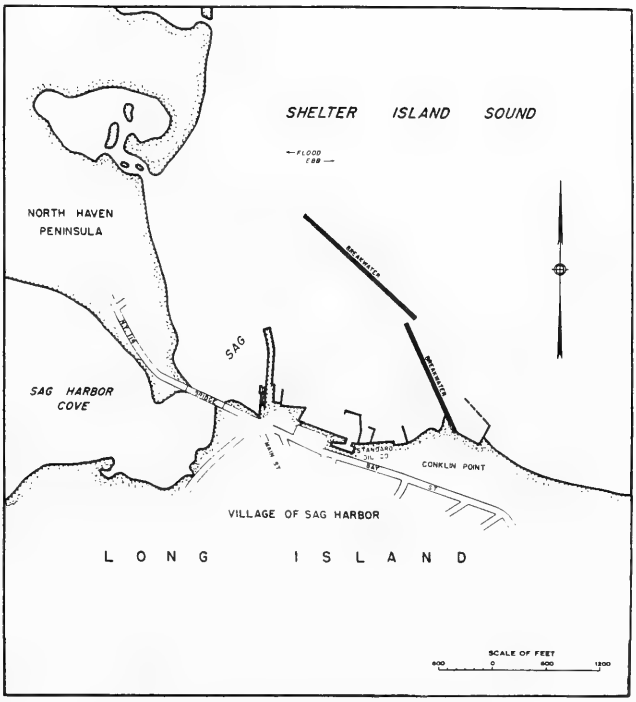



Figure 15. Sag Harbor, New York

Table 12

Lake Montauk Jetties

Star Island, New York

New York District

| Date(s) | Construction and Rehabilitation History |
|---|---|
| 1926 | Private interests constructed jetties east and west of the lake entrance. The east jetty was 750 ft long (Figure 16), and the west jetty was 981 ft long. Crest elevations were +6.0 ft and +8.0 ft mean low water (mlw) west and +8.0 ft mlw east. Crown width varied from 5.0 to 6.0 ft, and the side slopes were 1V:1.5H. One- to 4.0-ton stone was used and placed in random fashion. |
| 1942 | The west jetty was extended 231 ft shoreward at the request of the Department of the Navy using $82,738 of Navy funds (Figure 16). Crest elevation of the extension was +8.0 ft mlw, crown width was 6.0 ft, and side slopes were 1V:1.5H. Cover stone used was 4.0 to 6.0 tons, and core stone was 8.0 to 6,000 lb. |
| 1967 | A survey indicated the jetty was in poor condition. Proposals were made to repair and extend the jetties using a design wave of 16.0 ft and 5.8 sec. |
| 1968 | The jetties were repaired, and the east jetty was extended 350 ft. The cost of repairs and the extension was $526,600, and 18,400 tons of stone were used. |
| 1986 | No further repair or maintenance information has been found. |

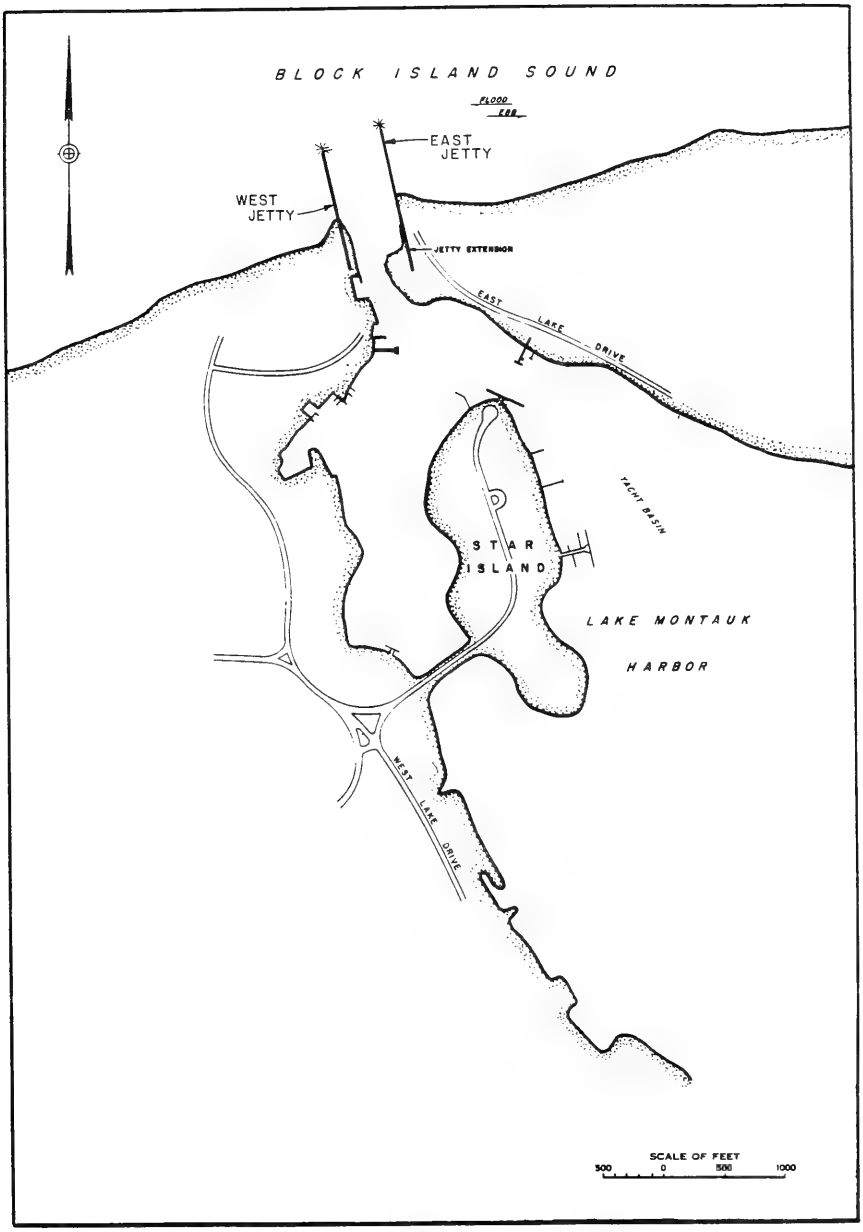



Figure 16. Lake Montauk Harbor, New York

Table 13

Shinnecock Inlet Jetties

Tiana Beach and Hampton Beach, New York

New York District

| Date(s) | Construction and Rehabilitation History |
|---|---|
| 1953 | Local interests constructed two jetties for inlet stabilization at lengths of 1,363 ft east (Figure 17) and 850 ft west. The cost of construction was $846,210 east and $376,000 west. The design geometry of both jetties consisted of +9.0-ft mlw crest elevations, 12.0-ft crown widths, and 1V:1.5H side slopes. The jetties were constructed of one layer capstone, 4.0- to 10-ton stone on the landward 1,163 ft of the east jetty, and 6.0- to 12-ton stone elsewhere. Core stone used on the east jetty was 5.0 lb to 1.0 ton on the landward 1,163 ft and 5.0 lb to 2.0 tons elsewhere. Core stone used on the west jetty was 50 lb to 1.0 ton. A 2.0-ft-thick blanket and apron stone were placed using 5.0- to 500-lb stone. |
| 1954 | Local interests extended the west jetty 96 ft (Figure 17) at a cost of $166,230. The extension was built at the same elevation and width as the original jetty. Side slopes were 1V:2H. Capstone was 6.0 to 12 tons, covering 10-lb to 2.0-ton core stone resting on a 2.0-ft-thick blanket and apron, consisting of 50- to 500-lb stone. |
| 1956 | A survey revealed that the east jetty had suffered severe damage. Capstones and slope stones had slipped and were disarranged in numerous spots. Core stones were washed out in several places. Capstones and core stones were washed out in four locations totaling 150 ft. The outer 250 ft of the jetty was partly washed out. Beach and dunes adjacent to the jetty eroded, and waves rode over the dunes and flanked the jetty. The west jetty was in fair condition with minor slips and disarrangement in five spots. The inlet was in a shoal condition. Most of the damage was due to a hurricane in 1954. |
| 1982 | The west jetty was reconstructed by resetting cap stones to original design geometry over 170 ft. A 1,470-ft-long pile crib revetment on the north end of the west jetty was replaced by a rubble-mound jetty. (Figure 18). |
| 1985 | A survey revealed that the reconstructed portion of the west jetty was in good condition. The seaward 200 ft of the west jetty had unraveled and capstones were scattered. The west jetty head had not maintained design configuration. Stones on the inlet side of the east jetty had sloughed in some sections, but stones on the beach side had retained their original position. Two areas on the northern end were completely deteriorated. Erosion of sand caused undermining of the east jetty with continual loss of sand undermining it further. |

(Continued)

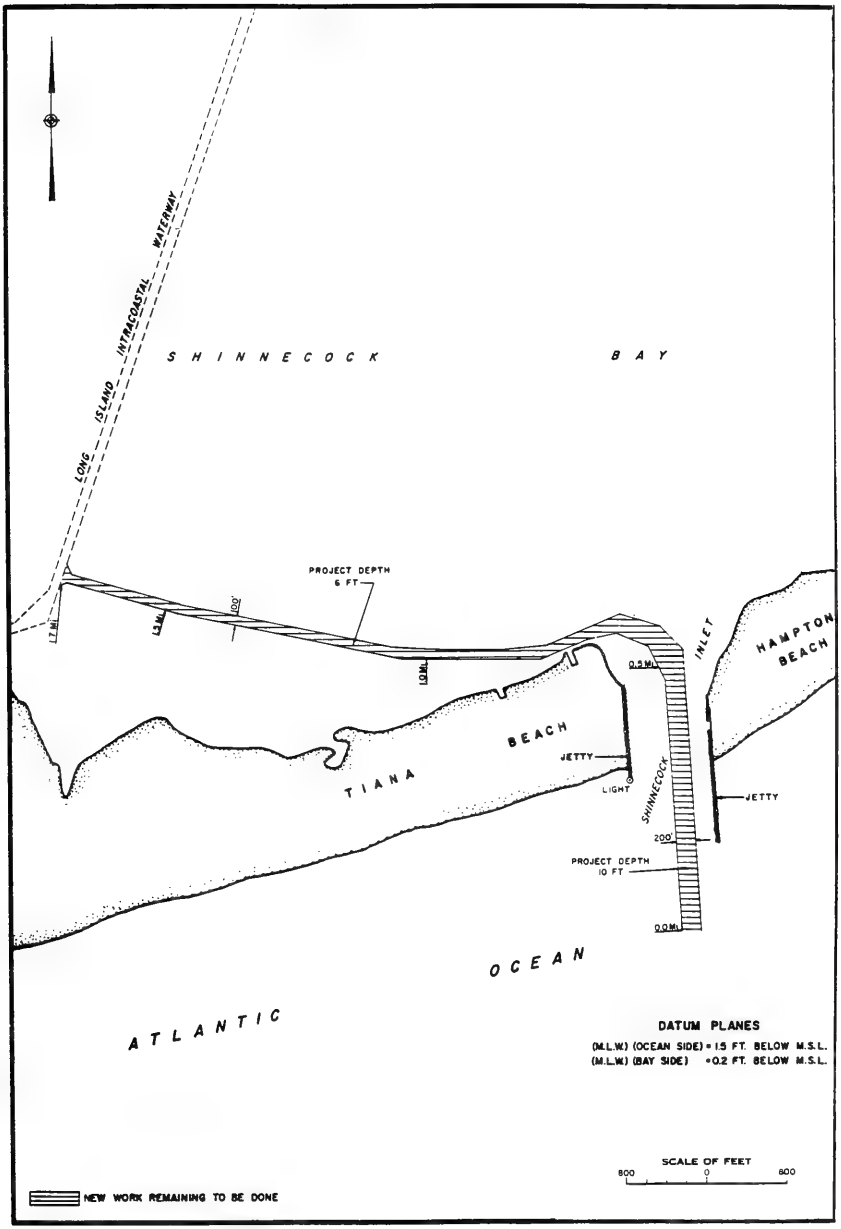



Figure 17. Shinnecock Inlet, New York

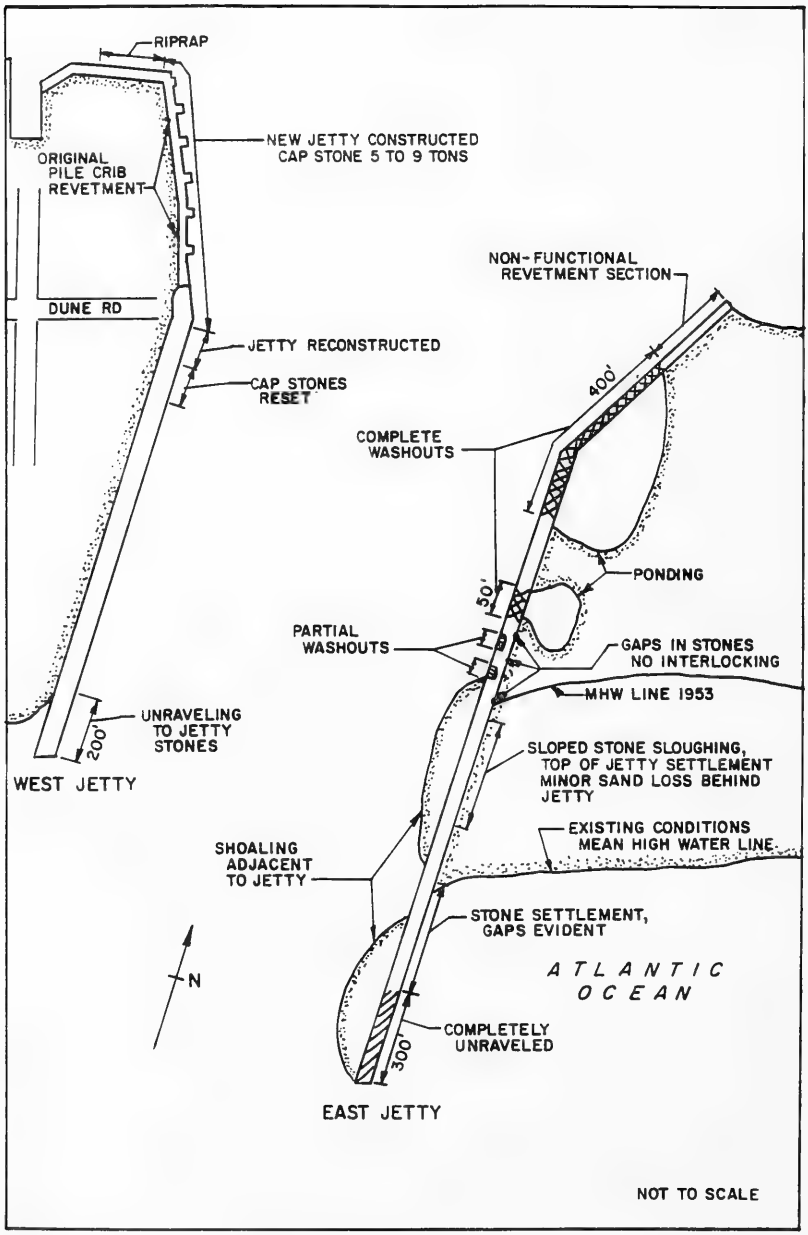



Figure 18. 1982 reconstruction of west jetty and 1985 existing conditions of east jetty, Shinnecock Inlet

Table 13 (Concluded)

| Date(s) | Construction and Rehabilitation History |
|---|---|
| 1985 (Cont.) | There were areas of partial washouts of stone, settlement, and non-interlocking capstones. The seaward 300 ft was completely unraveled, with all stones scattered (Figure 18). It was determined that the jetties had served their function of inlet stabilization and they were not leaking significant amounts of sand. |
| 1986 | Plans call for rehabilitation of the jetties. The east jetty will need new capstones and core stones where there are complete washouts, approximately 450 ft. Original stones will be removed and reset where settlement and sloughing has occurred, approximately 700 ft. The 300-ft east jetty head section will be completely rebuilt with new and original stone. A blanket will be placed for scour protection. A 5.0-ft-thick blanket using 1,000-lb stone will be laid on the existing bottom to prevent additional scouring of the west jetty toe. New capstone and core stone are needed to supplement the displaced stones of the west jetty head. The section will be rebuilt using existing stone but will consist of two layers of armor stone. |

Table 14

Moriches Inlet Jetties

Great South Beach and Pikes Beach, New York

New York District

| Date(s) | Construction and Rehabilitation History |
|---|---|
| 1953 | Construction of two jetties by local interests was completed at lengths of 750 ft east and 1,420 ft west. Elevations were +9.0 ft mlw, crown widths were 12.0 ft, and side slopes were 1V:1.5H. One layer of capstone was placed over core stone, which rested on a 2-ft-thick blanket. Stone sizes used on the east jetty were 4.0- to 10.0-ton capstone and 5.0-lb to 1.0-ton core stone on the shoreward 580 ft, and 6.0- to 12-ton capstone and 5.0-lb to 2.0-ton core stone on the remainder of the jetty. The west jetty consisted of 2.0- to 6.0-ton capstone and 10-lb to 1,000-lb core stone on the shoreward 1,280 ft and 6.0- to 12-ton capstone and 10-lb to 1.0-ton core stone elsewhere. Blanket and apron stone was 5.0 to 500 lb and 10 lb to 500 lb on the east and west jetties, respectively. Cost was $327,630 for the east jetty and $420,210 for the west jetty, all non-Federal funds. |
| 1954 | Local interests extended the jetties to 841 ft east and 1,461 ft west (Figure 19) using 6.0- to 12.0-ton capstone at 1V:2H side slopes. Core stone used was 15 lb to 5.0 ton, east jetty, and 10 lb to 2.0 tons west jetty. A 2.0-ft-thick blanket and apron was placed using 15- to 500-lb stone. Jetty ends were approximately 800 ft apart. Cost was $194,290 east and $142,260 west. |
| 1956 | An inspection of the jetties was conducted. Stone on the inlet side of both jetties had slipped at numerous locations. Slope stones and capstones had unraveled at the outer end of the east jetty. Approximately 300 ft of the west jetty had settled 2.0 to 3.0 ft. The jetties had undergone severe wave attack since their construction, and most of the damage was attributed to the hurricane of August 31, 1954. |
| 1983 | A survey indicated the jetties were in a good, stable condition. The jetties had settled approximately 2.0 ft over 65 ft on the east jetty and 130 ft on the west jetty. The jetties did not meet Corps of Engineers standards for armor stone layer thickness, weight, or elevation, and it was determined that it would be more economical to maintain the jetties on an annual basis than by rehabilitation. Potential damage was anticipated to increase. |
| 1986 | No further repair or maintenance information has been found. |

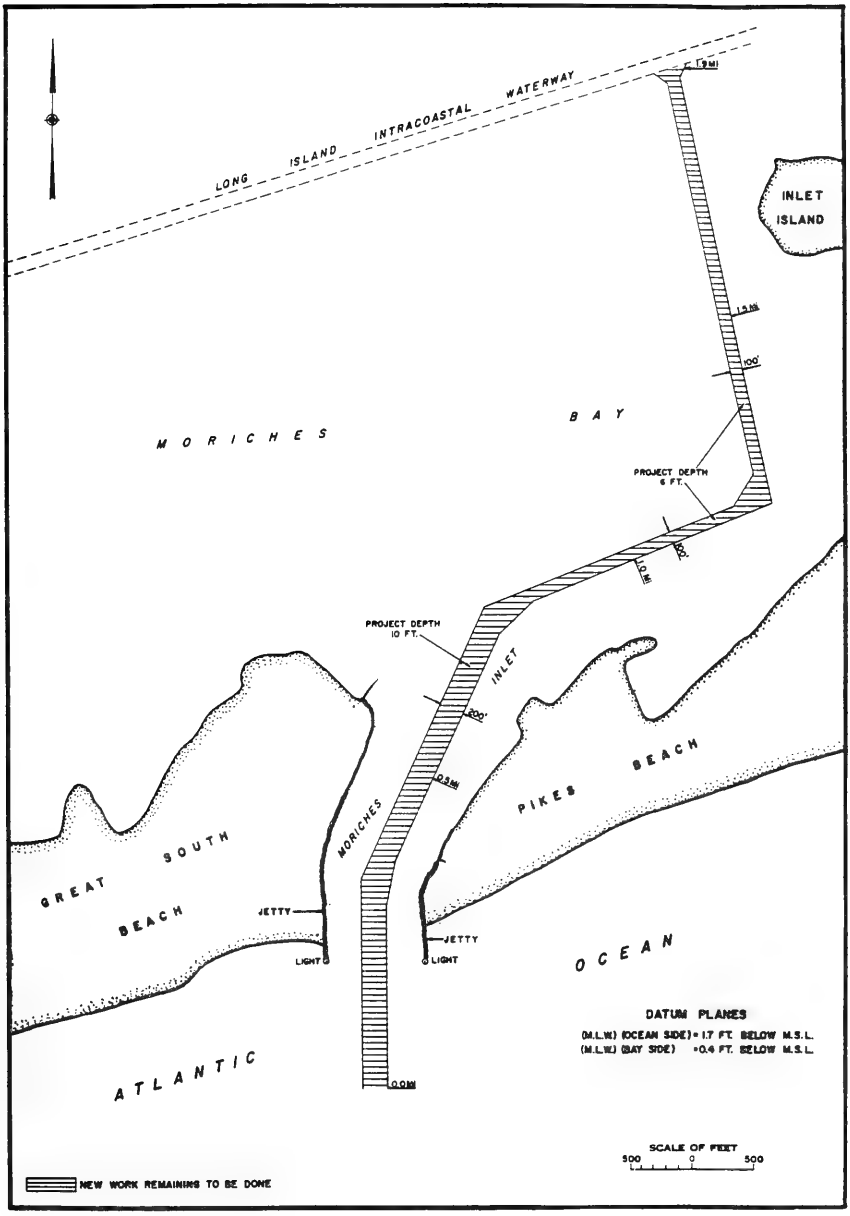



Figure 19. Moriches Inlet, New York

Table 15

Browns Creek Jetties

Sayville, New York

New York District

| Date(s) | Construction and Rehabilitation History |
|---|---|
| 1892 | Two riprap jetties were constructed east and west of the creek entrance. The east jetty was 448 ft long, and the west jetty was 492 ft long (Figure 20). Crest elevations were +1.0 ft hw, crown width was 3.0 ft, and side slopes were 1:1. The minimum stone used was 500 lb. |
| 1927 | The west jetty was repaired and extended 208 ft (Figure 20). Elevation of the extension was +3.0 ft hw. Nine hundred eighty one cubic yards of rock was used for repair and extension. |
| 1935 | The outer 213 ft of the west jetty was repaired. Minimum capstone and slope stone was 2.0 tons, and core stone was 15 lb to 1.5 tons. The crest elevation was raised over the entire jetty to +4.0 ft mlw, crown width was 4.0 ft, and side slopes were 1V:1.5H. |
| 1962-1963 | A survey indicated the jetties were deteriorated. Almost all stones were displaced on the west jetty, and there were numerous openings in the structure. Most of the stones were shifted out of place on the east jetty. Almost half of the jetty was breached and was not visible at mean low water. The jetties were rehabilitated over the entire lengths in 1963 using 4,000 tons of stone at a cost of $71,000. Crest elevations were +4.0 ft mlw, crown width was 6.0 ft, and side slopes were 1V:1.5H (Figure 20). Three-ton cap and slope stone, and 15-lb to 1.5-ton core stone was used. The design wave was 5.0 sec, 6.0 ft. |
| 1986 | No further repair or maintenance information has been found. The project has been deauthorized. |

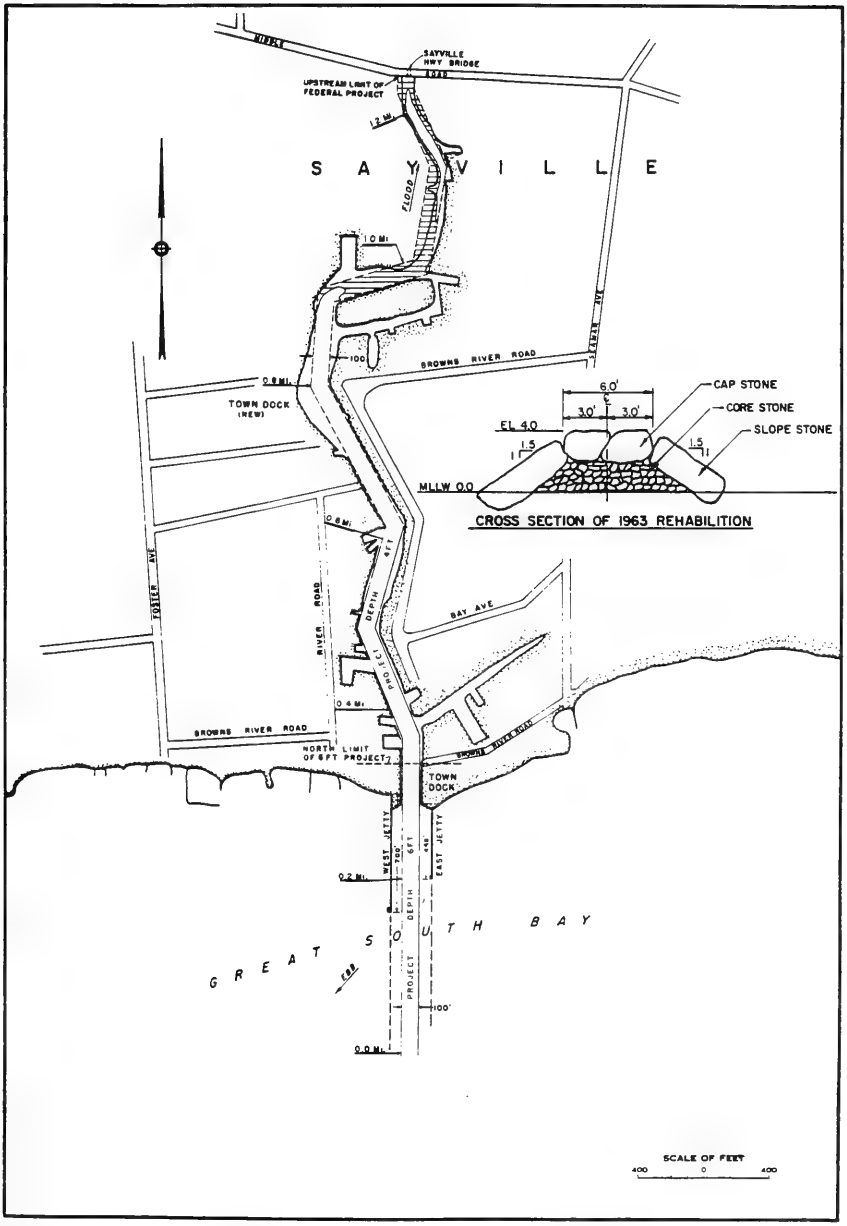



Figure 20. Browns Creek, New York

Table 16

Fire Island Jetty

Democrat Point, New York

New York District

| Date(s) | Construction and Rehabilitation History |
|---|---|
| 1941 | A 4,950-ft jetty was constructed to stabilize the inlet (Figure 21). Crest elevation was +8.0 ft mlw, crown width was 12.0 ft, and side slopes were 1V:2H. The jetty rested on a 3-ft-thick blanket which extended 50 ft seaward of the jetty toe. |
| 1950 | A survey indicated the sand trapping capacity of the jetty was reached, and the jetty was in fair condition. |
| 1986 | No further repair or maintenance information has been found. |

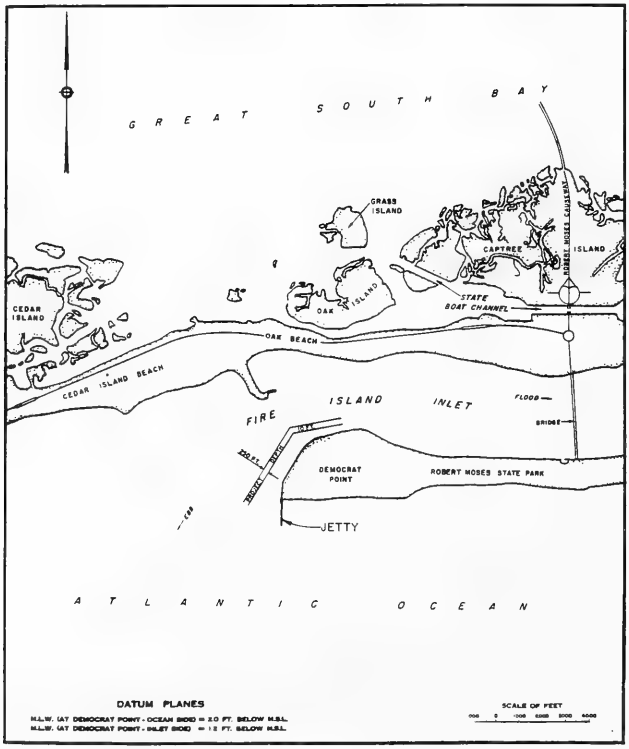



Figure 21. Fire Island Inlet, New York

Table 17

Jones Inlet Jetty

Jones Beach State Park, New York

New York District

| Date(s) | Construction and Rehabilitation History |
|---|---|
| 1959 | A 5,200-ft-long jetty was constructed to provide inlet stabilization, and a sand barrier was constructed to prevent shoaling of the inlet (Figure 22). The jetty was constructed in four sections. The landward section (Section 1) was 1,150 ft in length and had a crown width of 6.0 ft and side slopes of 1V:1.5H. Minimum capstone sizes were 5.0 tons, and core stone was 10 lb to 3.0 tons. Section 2 was 3,650 ft long and had a crown width of 8.0 ft and side slopes of 1V:2H, except the shoreward 1,850 ft on the western side, which was 1V:1.5H. Minimum capstone used was 5.0 tons, and core stone was 15 lb to 4.0 tons. Section 3 was 350 ft long and had a crown width of 12.0 ft and side slopes of 1V:2H. Capstone used was 8.0 ton minimum, and core stone was 15 lb to 5.0 ton. Section 4, the most seaward section, was 50 ft and had a crown width of 15 ft and side slopes of 1V:2.5H. Stone sizes were the same as those in Section 3. All crest elevations were +9.0 ft mlw. The jetty rested on a 2.0-ft-thick blanket that extended 20 ft west from the base of Sections 1 and 2 and extended 30 ft from both sides of the base of Section 3, except for 125 ft on the seaward west side. A 2.0-ft-thick apron extended 100 ft from the toe and curved to intersect the blanket in Section 3. The useful life of the jetty was expected to be 20 years. |
| 1962 | The Middle Atlantic coastal storm of 6-8 March 1962 damaged the jetty. The outer 200 ft was raveled and broken down to the high water level. A second layer of capstone was added to the outer 120 ft to restore the original design. The adjacent 1,080 ft shoreward was repaired by replacing armor stone and by adding stone. Armor stone was replaced on the adjacent 900 ft shoreward. |
| 1985 | The jetty had nearly reached impoundment. Sand was bypassing the jetty, mostly through large voids at the jetty-shoreline intersection. The apron had settled approximately 7.0 ft at the seaward end due to sand loss through voids in the apron. |
| 1986 | No further repair or maintenance information has been found. |

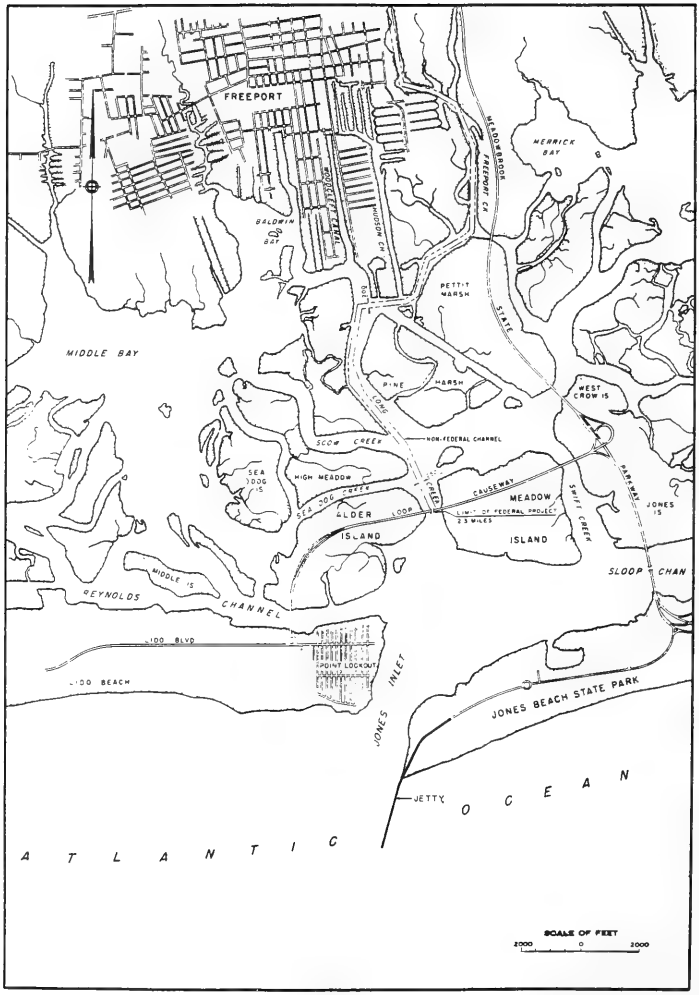



Figure 22. Jones Inlet, New York

Table 18

East Rockaway (Debs) Inlet Jetty

Long Beach, New York

New York District

| Date(s) | Construction and Rehabilitation History |
|---|---|
| 1934 | A 3,750-ft-long jetty was constructed on the east side of the inlet for stabilization (Figure 23). The jetty was constructed in three sections with lengths of 1,400 ft, 1,400 ft, and 950 ft, landward to seaward, respectively. The design geometry for each section was:<br><br>Section 1: Crest elevation of +8.0 ft mlw, 6.0-ft crown width, 1:1 side slopes, and one layer of cover and capstone.<br><br>Section 2: Crest elevation of +8.0 ft mlw, 8.0-ft crown width, 1:1 side slopes, and one layer of cover and capstone.<br><br>Section 3: Crest elevation of +10.0 ft mlw, 15.0-ft crown width, 1V:1.5H side slopes, and one layer cover and capstone.<br><br>The jetty rested on a 1.0-ft-thick blanket and a 1.0-ft-thick apron which extended seaward of the toe 500 ft. A jetty was to be built west of the inlet if necessary. |
| 1935 | Repairs were made to the jetty beginning 2,500 ft from the landward end, and extending seaward 250 ft. The cost of repairs was $14,426, and 1,926 tons of stone were used. |
| 1941 | Repairs were made by rearranging 212 tons of stone on the seaward 610 ft at a cost of $6,000. An additional 375 tons were placed on the east side of the seaward end at a cost of $1,670. |
| 1946 | Twenty-four hundred tons of stone were placed on the jetty at a cost of $78,000. The jetty was considered to be in good condition. |
| 1963 | Repairs were made using 800 tons of stone at a cost of $18,411, and the structure was in good condition with the exception of minor repairs. |
| 1986 | No further repair or maintenance information is available on the east jetty. The west jetty has not been built. The project has been deauthorized. |

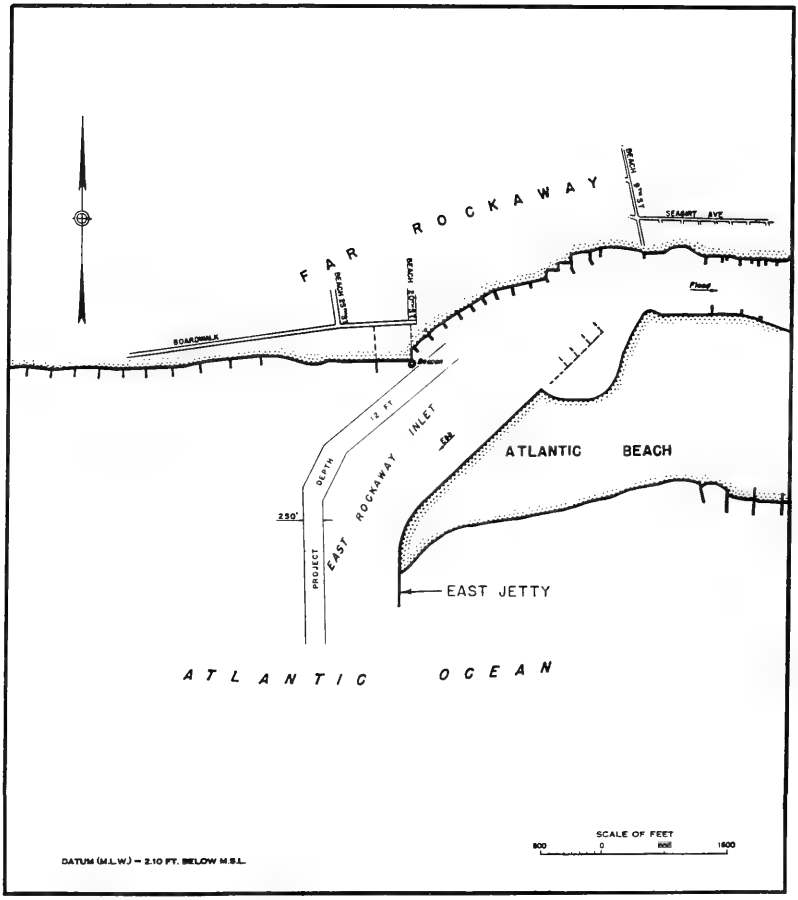



Figure 23. East Rockway (Debs) Inlet, New York

Table 19

Jamaica Bay Jetty, Rockaway Point, New York

New York District

| Date(s) | Construction and Rehabilitation History |
|---|---|
| 1933 | A jetty was constructed east of the bay entrance, 8,400 ft long, for channel protection (Figure 24). Plans called for construction of a west jetty. |
| 1949 | A survey of the jetty stated it was in fair condition. |
| 1953 | Repairs were made to 225 ft of the jetty using 580 tons of stone at a cost of $14,088. |
| 1963 | The jetty was rehabilitated to project dimensions. |
| 1986 | No further repair or maintenance information is available on the east jetty. The west jetty has not been constructed. |

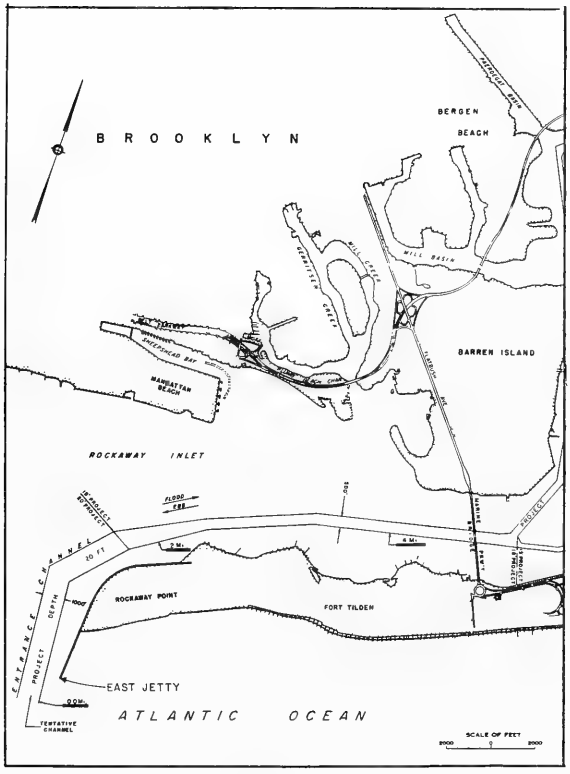



Figure 24. Jamaica Bay, New York

Table 20

Sandy Hook Bay Breakwater

Atlantic Highlands, New Jersey

New York District

| Date(s) | Construction and Rehabilitation History |
|---|---|
| 1940 | A 4,000-ft-long rubble-mound breakwater was completed (Figure 25). The breakwater extended east from the New Jersey Central Railroad steamboat dock. The cost of construction for the breakwater was $239,600, of which $158,334 were federal funds. A total of 93,548 tons of stone was used. |
| 1986 | No further repair or maintenance information has been found. |

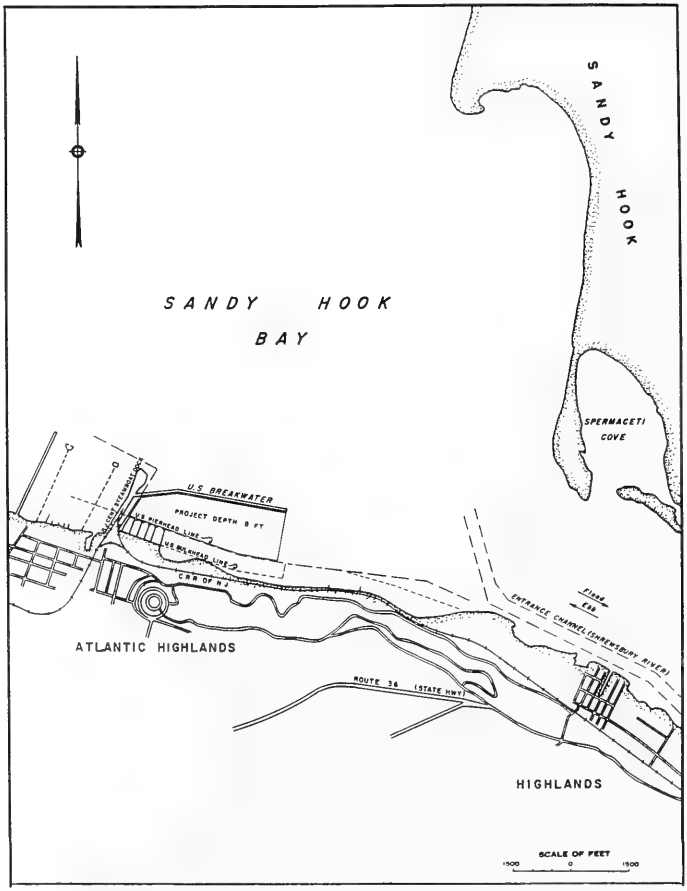



Figure 25. Sandy Hook Bay, New Jersey

Table 21

Cheesequake Creek Jetties, Morgan, New Jersey

New York District

| Date(s) | Construction and Rehabilitation History |
|---|---|
| 1883 | Two parallel jetties were constructed 200 ft apart for channel protection. Lengths were 925 ft east and 995 ft west (Figure 26). |
| 1986 | No further repair or maintenance information is available. The project has been deauthorized. |

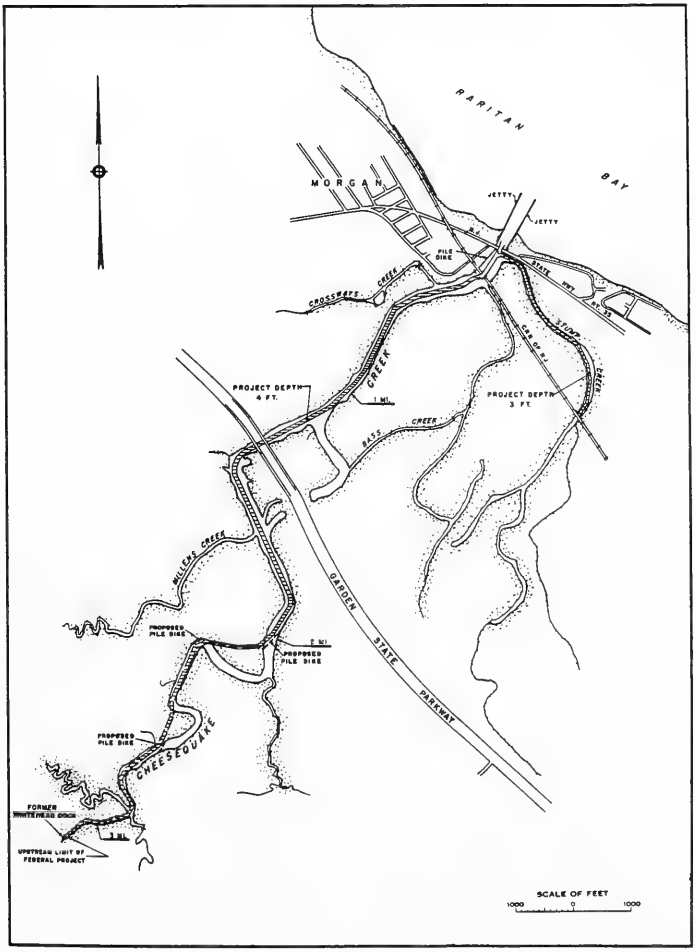



Figure 26. Cheesequake Creek, New Jersey

Table 22

Neshaminy State Park Jetty

Neshaminy State Park, Pennsylvania

Philadelphia District

| Date(s) | Construction and Rehabilitation History |
|---|---|
| 1968 | A 230-ft-long rubble-mound groin was built but has served as a jetty for channel control (Figure 27). |
| 1986 | No further repair or maintenance information has been found. |

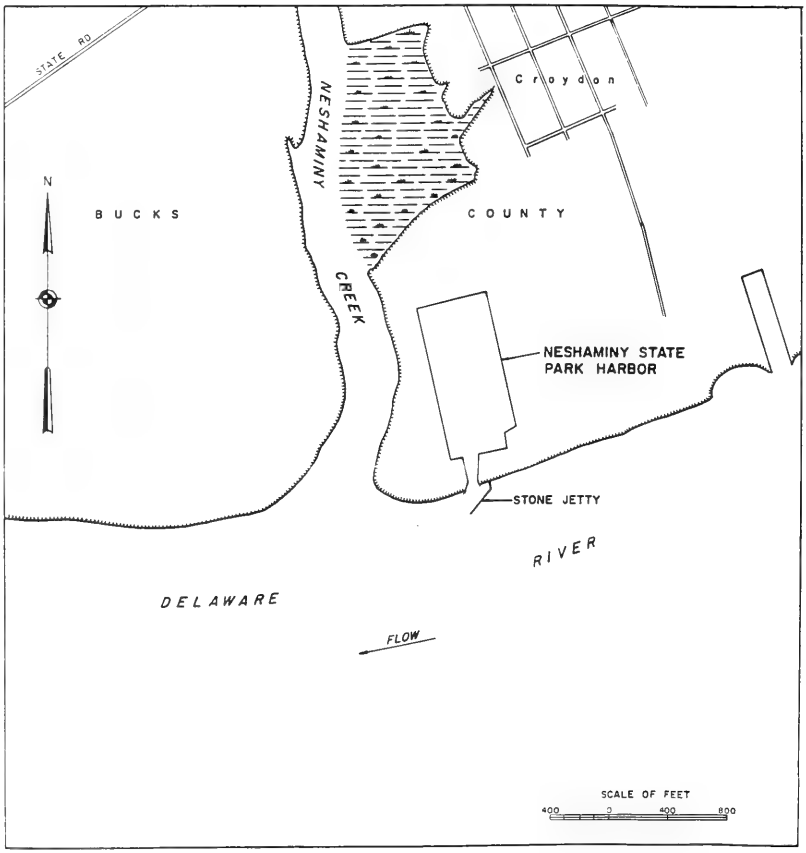



Figure 27. Neshaminy State Park Harbor, Pennsylvania

Table 23

Mantua Creek Jetties

Paulsboro, New Jersey

Philadelphia District

| Date(s) | Construction and Rehabilitation History |
|---|---|
| 1907 | Two jetties were constructed to provide channel protection. Lengths were 754 ft and 580 ft east and west, respectively. The jetties were constructed of stone-filled timber cribs, with mat brush placed to support the stone (Figure 28). Top width and elevation were 12.0 ft and +8.0 ft mlw, respectively, for each jetty. |
| 1912-1913 | The east jetty was extended to 1,577 ft, and the west jetty was extended to 1,456 ft (Figure 28). |
| 1918 | Repairs were made by the addition of stone. |
| 1962 | An investigation of the jetties revealed the jetties had settled an average of 2.0 ft. Approximately 100 ft of the offshore end of the east jetty had deteriorated, with most of the pilings gone, and stone had fallen out to below the waterline. Most of the walings had deteriorated and were missing. Piles were missing at intermediate locations along the jetties, but there was no significant loss of stone at those locations. Piles that remained were in good condition. |
| 1963 | The jetties were rehabilitated at a cost of $136,895. A new row of piles was placed over approximately 100 ft at the offshore ends. Piles were placed 7.5 ft on either side of the center line of the jetties. Corestone was dumped between the piles to an elevation of +8.0 ft mlw (Figure 29). Missing piles were replaced, and new wales were provided along the remainder of the jetties. One row of capstone was placed on the inner sides of both cribs on top of the existing stone to +8.0 ft mlw. Core stone was filled between the capstones in the center of the jetties to +8.0 ft mlw (Figure 29). Crown width was 16.0 ft at the offshore ends and 12.0 ft on the remainder of the jetty. Design wave height was 4.2 ft. |
| 1964 | Repairs were made to the seaward end of the east jetty at a cost of $4,864. The Corps was reimbursed later for this work. |
| 1986 | No further repair or maintenance information has been found. |

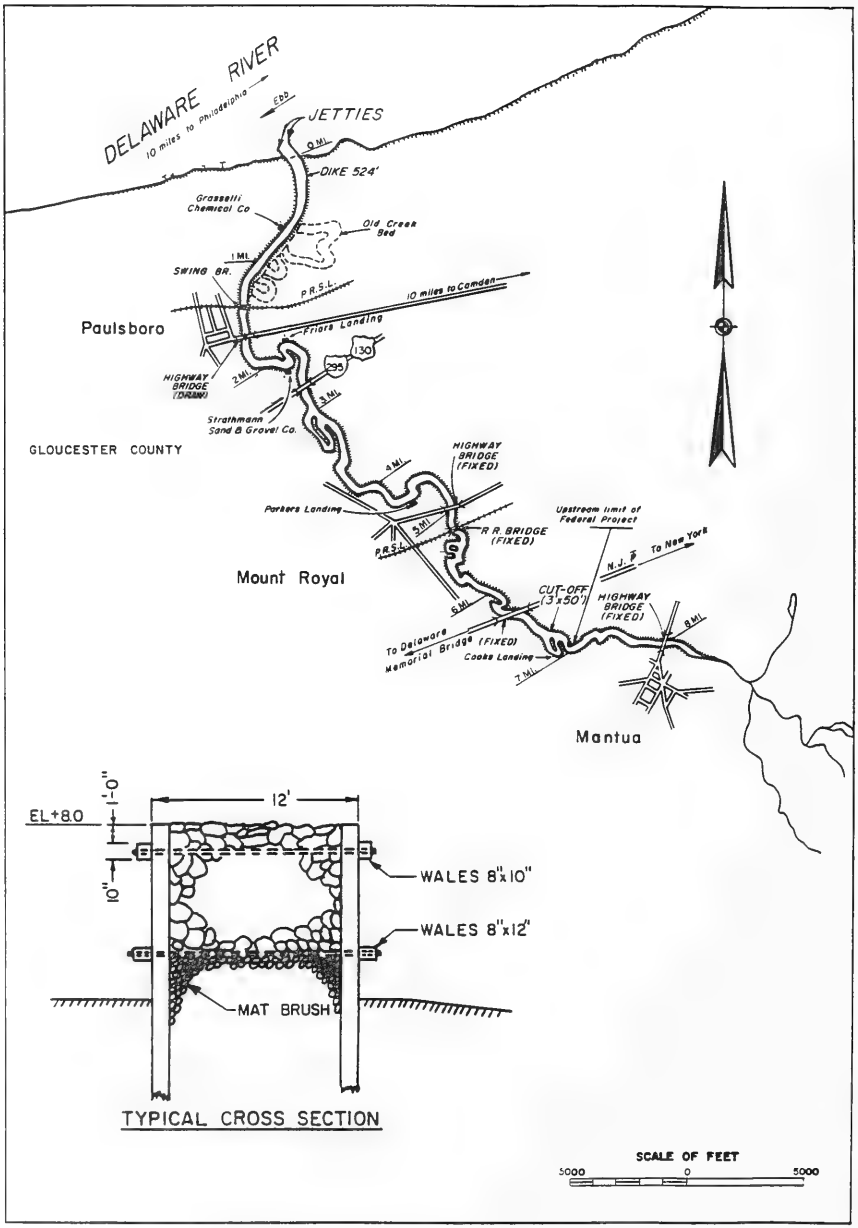



Figure 28. Mantua Creek, New Jersey

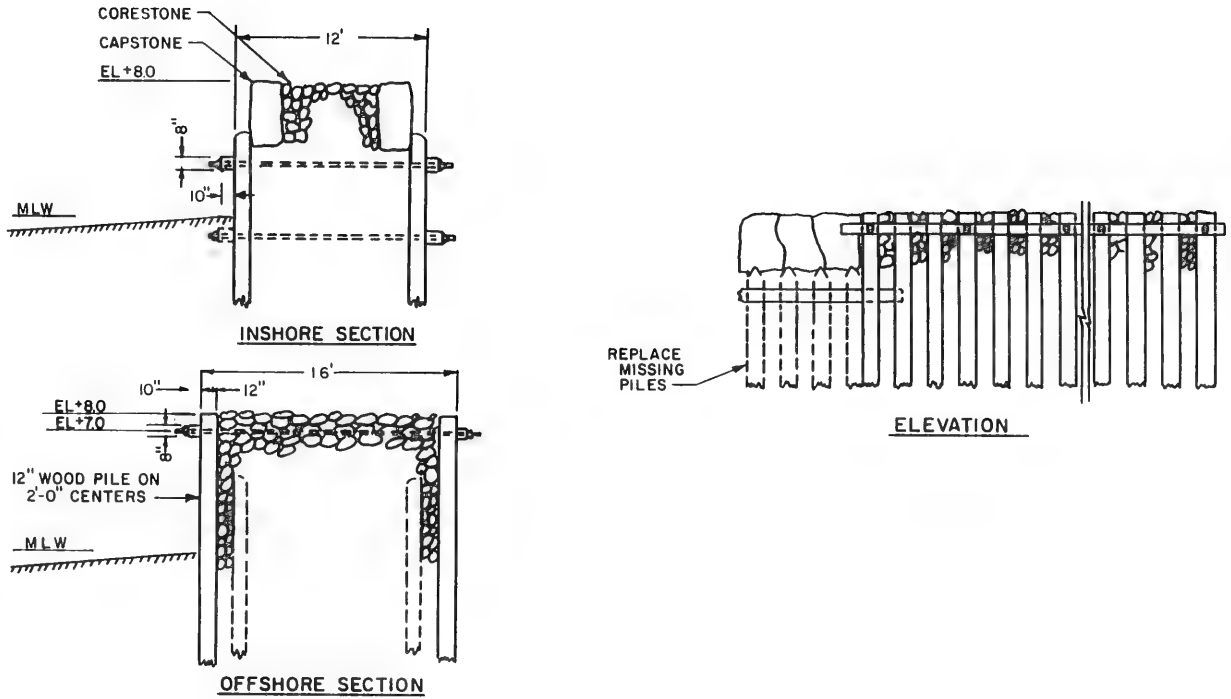



Figure 29. Rehabilitation of Mantua Creek jetties, 1963

Table 24

Raccoon Creek Jetty

Bridgeport, New Jersey

Philadelphia District

| Date(s) | Construction and Rehabilitation History |
|---|---|
| 1922 | A 950-ft-long timber pile, brush, and stone jetty was constructed south of the entrance to provide channel protection (Figure 30). The cost of construction was $29,159. |
| 1986 | No further repair or maintenance information has been found. |

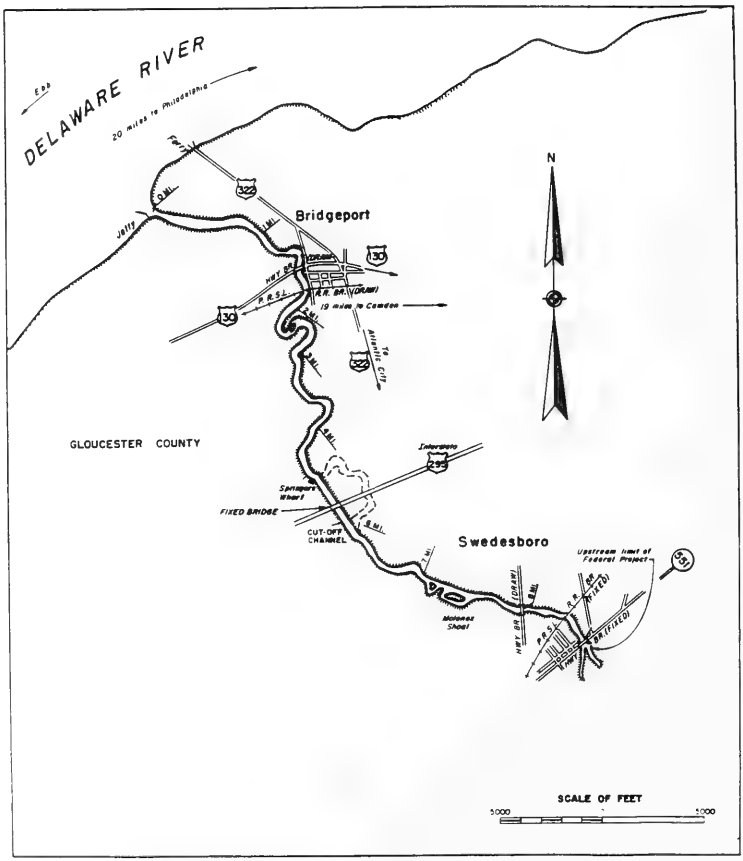



Figure 30. Racoon Creek, New Jersey

Table 25

Wilmington Harbor Jetties

Wilmington, Delaware

Philadelphia District

| Date(s) | Construction and Rehabilitation History |
|---|---|
| 1883 | A 1,740-ft-long curved stone-filled pile and timber crib jetty was constructed north of the Christina River mouth. |
| 1884 | The north jetty was raised 4.0 ft to a height above high water (no information on exact height). |
| 1900 | The north jetty was repaired and extended 313 ft. A terminal crib was also constructed. The total length of the north jetty was 2,150 ft. Jetties were constructed on the south side of the Christina River and at the mouth of the Brandywine River. The length of the south Christina River jetty was 1,515 ft and was built of pile and stone. A cross dike was built to connect the inner end of the jetty to the shore at high water. The Brandywine River jetty was V-shaped and was built of stone-filled pile and timber crib. The total length of this jetty was 690 ft, 430 ft on the Brandywine River side and 260 ft on the Christina River side (Figure 31). |
| 1905 | Repairs were made to the Brandywine River jetty and the north Christina River jetty. New wales were put on the Brandywine jetty, and face timber was replaced on the north Christina jetty. Stone was replaced where needed on both jetties. |
| 1916 | Repairs were made to the north Christina River jetty. Broken timber and piling was replaced with new material. Fender piles were placed along the channel face, and the interior of the crib was filled with stone where settling had occurred along the entire length of the jetty. |
| 1925 | The south jetty was removed, and a new jetty was to be built south of the Christina River. |
| 1931 | Approximately 1,200 ft of the north jetty was removed to improve the channel regime. The total length of the north jetty was 950 ft (Figure 31). |
| 1936 | A new jetty was completed south of the Christina River mouth. The jetty was 2,300 ft long (Figure 31) and consisted of 1,352 lin ft of steel sheet-pile wall, buttressed with 100-ft timber piles 12 ft on center, a 948-ft outboard section consisting of twelve 25.5-ft-diameter steel sheet-pile cells, and one 30.5-ft-diameter terminal cell with twelve 51-ft interconnecting fences. Crest elevation was +10 ft Corps of Engineers Datum (2.9 ft below mean sea level, 1929). The landward end of the jetty was connected to shore by a 120-ft steel sheet-pile anchor wall. The cost of construction was $205,000. |

(Continued)

Table 25 (Concluded)

| Date(s) | Construction and Rehabilitation History |
|---|---|
| 1937-1939, 1948 | Damages to the Christina south jetty, caused by ships colliding with it, were repaired each of these years at a total cost of $90,000. |
| 1961 | The landward 500 ft of the Christina south jetty was removed to accommodate marine terminal expansion. The total length of the jetty was 1,800 ft. |
| 1962 | 275 ft of buttressed steel sheet-pile wall failed during an extremely low tide and was eventually repaired. |
| 1985 | The Christina south jetty is in good condition. |

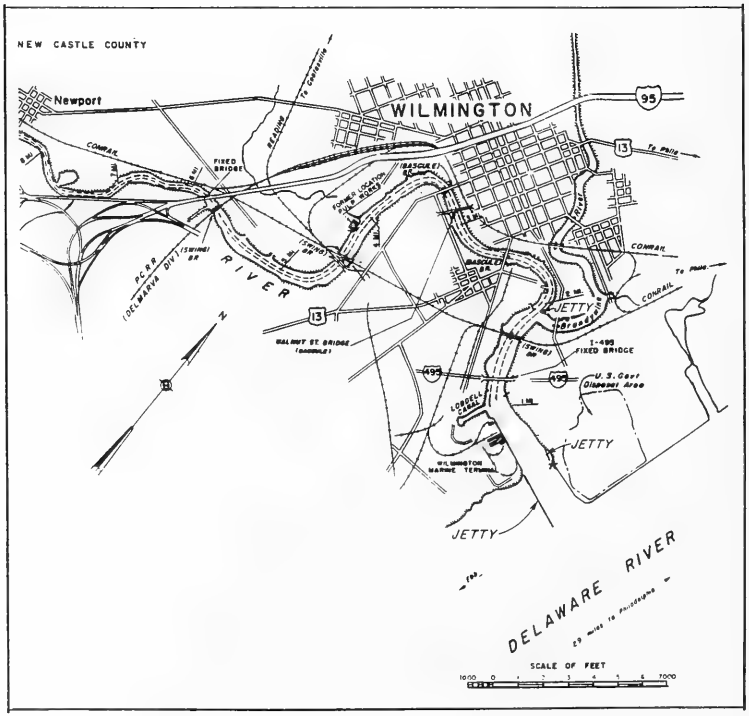



Figure 31. Wilmington Harbor, Delaware

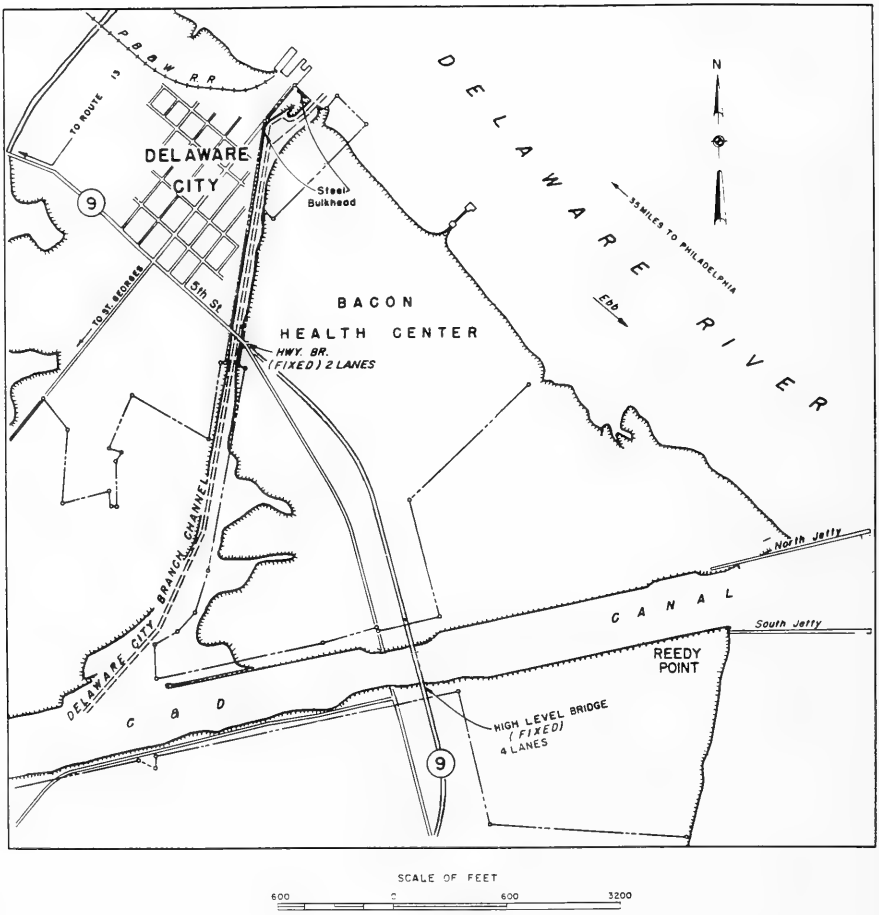
Table 26

Delaware River and Chesapeake Bay Canal Jetties

Reedy Point, Delaware

Philadelphia District

| Date(s) | Construction and Rehabilitation History |
|---|---|
| 1903 | Construction of two rubble-mound jetties, north and south of the canal, was completed to provide channel protection. The length of each jetty was 725 ft, crest elevations were +8.0 ft mlw, crown widths were 6.0 ft, and side slopes were 1:1 (Figure 32). |
| 1938 | Each jetty was extended to 2,095 ft (Figure 32). |
| 1960's | The south jetty was removed and replaced by a new jetty to increase the entrance size to accommodate larger vessels and to improve navigation safety. The new jetty had a crest elevation of +8.0 ft mlw and a 14.0-ft crown width (Figure 32). The design wave was 6.3 ft, 4.8 sec. |
| 1985 | The north jetty has subsided, lost stone, and the toe has scoured. |



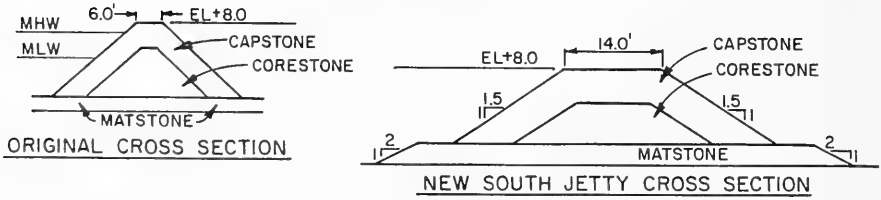




Figure 32. Delaware River and Chesapeake Bay Canal, Delaware

Table 27

Smyrna River Jetties, Kent County, Delaware

Philadelphia District

| Date(s) | Construction and Rehabilitation History |
|---|---|
| 1939 | Two parallel stone-filled timber crib jetties were constructed to provide channel protection. The north jetty was 803 ft, and original plans called for the south jetty to be 2,700 ft; however, project maps indicate it was approximately 2,000 ft (Figure 33). |
| 1986 | There is no records of repairs. The project has been deauthorized. |

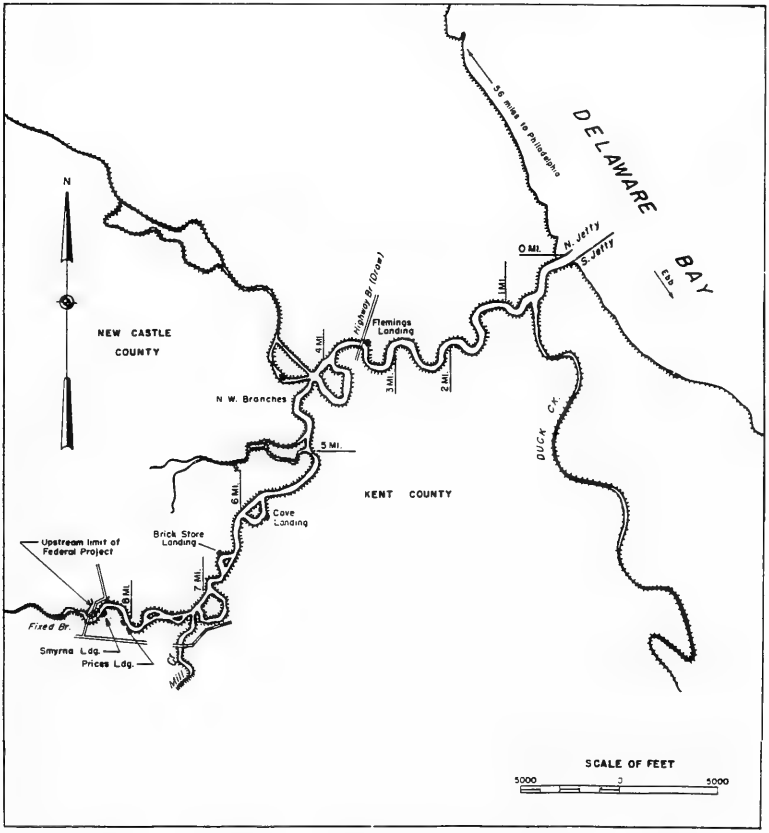



Figure 33. Smyrna River, Delaware

Table 28

Mispillion River Jetties

Kent and Sussex Counties, Delaware

Philadelphia District

| Date(s) | Construction and Rehabilitation History |
|---|---|
| 1859 | A 560-ft-long jetty was constructed by local interests north of the entrance. The jetty was installed by placing a row of close-fitting piling and brush. |
| 1879 | The jetty had deteriorated considerably, and the Federal government made repairs. |
| 1896 | A 350-ft-long stone-filled timber crib dike was constructed on the west side of the new channel. |
| 1897 | The jetty was extended shoreward 200 ft at a cost of $1,600. |
| 1899 | Repairs were made to 141 ft of the 1897 extension at the seaward end at a cost of $506. |
| 1901 | The stone-filled timber crib dike had become a channel obstruction and was removed. |
| 1904 | The jetty was extended 805 ft shoreward by placing stone over brush-filled pile and timber crib. The extension was 12.0 ft wide with pile elevations of +11.0 ft mlw and stone elevations of +8.0 ft mlw. The gap between the extension and the existing jetty ends was filled with 313 cu yd of stone. |
| 1907 | The jetty was extended 85 ft shoreward at a cost of $870, using 1904 construction geometry. The extension was classified as repairs. |
| 1908 | Repairs were made to 68 ft of the jetty damaged by a storm on January 11, 1908. A jetty was constructed south of the entrance and parallel to the north jetty. The south jetty was 3,300 ft long and was constructed by placing stone over brush-filled pile and timber crib for 2,200 ft, and over an existing 1,100-ft-long bulkhead. The jetty was 6.0 ft wide with pile elevations of +7.0 ft mlw and stone elevations of +5.5 ft mlw. The north and south jetties were separated by 210 ft. Costs of repairs and new construction were $22,770 and $350,000, respectively. The locations of the jetties are shown in Figure 34. |
| 1911 | The south jetty was extended 1,800 ft at a cost of $18,431 using 1904 construction geometry. Repairs were made to the south jetty by filling settled sections with 96 cu yd of stone. The cost was $18,431 for extension and $384 for repairs. |

(Continued)

Table 28 (Continued)

| Date(s) | Construction and Rehabilitation History |
|---|---|
| 1912, 1913, 1914 | The north jetty was extended 400 ft seaward in each of these years (1,200-ft total) at a cost of $4,940, $4,800, and $5,000, respectively. Extensions were 6.0 ft wide with +7.0-ft mlw pile elevations and +5.5-ft mlw stone elevations. |
| 1915 | Both jetties were repaired by adding or replacing broken and decayed timber or piling, and a preservative was applied to tops of piles. Stone was placed to fill settled sections. The cost of repairs was $6,312. |
| 1920 | The south jetty was extended 700 ft to a total length of 5,800 ft using the same type of construction and geometry as the existing jetty. Both jetties were repaired in the same manner as the 1915 repairs. Costs of repairs and the extension were $2,422 and $26,033, respectively. |
| 1939 | The north jetty was extended 3,500 ft seaward at a cost of $129,140, using 1912-1914 construction geometry. |
| 1944 | Tops of piles were coated with tar on the north jetty near the river mouth at a cost of $320. |
| 1948 | The north jetty was repaired beginning 708 ft from the shoreward end and extending 942 ft seaward. The original timber crib section was rehabilitated to a rubble-mound structure (Figure 34). The cost of repairs was $51,493, and 4,870 tons of stone were used. |
| 1963 | A survey of the north jetty indicated there was no visible trace of the shoreward 708 ft. The total length of the existing jetty was 5,642 ft. The shoreward, rubble-mound, end had an average height of +6.2 ft mlw. The 1,200-ft-long timber crib structure adjacent to the rubble-mound section had deteriorated. Upper crib work was virtually nonexistent, and tops of piles were rotted or broken off. Stone had settled an average of 2.8 ft from design, was displaced, and had spilled out between piles. Piles, tie rods, and wales in the most seaward 3,500 ft appeared to be in good condition. Stone had settled an average of 1.5 ft in this section. |
| 1964 | Minor rehabilitation was done on the north jetty at a cost of $377,848. The 1,200-ft-long deteriorated timber crib section was rehabilitated to a rubble-mound structure. The center line of the rubble-mound structure was placed north of the center line of the timber crib jetty to prevent failure of the jetty on the channel side due to lateral forces. The offset was 11.0 ft over a distance of 650 ft and 9.0 ft over a distance of 400 ft, shoreward and seaward ends of the section, respectively. Transition sections were on either end of the new structure and between the two offset sections. Crest elevation was +7.0 ft mlw, crown width was 10.0 ft, and side slopes were 1V:1.5H. Twenty-five ton minimum capstone was placed over 1- to 50-lb matstone. A layer of willow matting, compressed in |

(Continued)

Table 28 (Concluded)

| Date(s) | Construction and Rehabilitation History |
|---|---|
| 1964 (Cont.) | place to 1.5 ft thick, was provided as a filter. Core stone, 25 to 500 lb, was placed on the channel side of the existing jetty at a slope of 1V:1H to 1V:1.5H to ensure stability of the rubble-mound structure. The 3,500-ft-long timber crib on the seaward end of the jetty was filled with core stone, 150 to 300 lb, to the original design elevation of +5.5 ft mlw. Cross sections of the rehabilitation are shown in Figure 35. |
| 1985 | The jetties are in good condition and have been effective in providing safe navigation and preventing channel shoaling. |

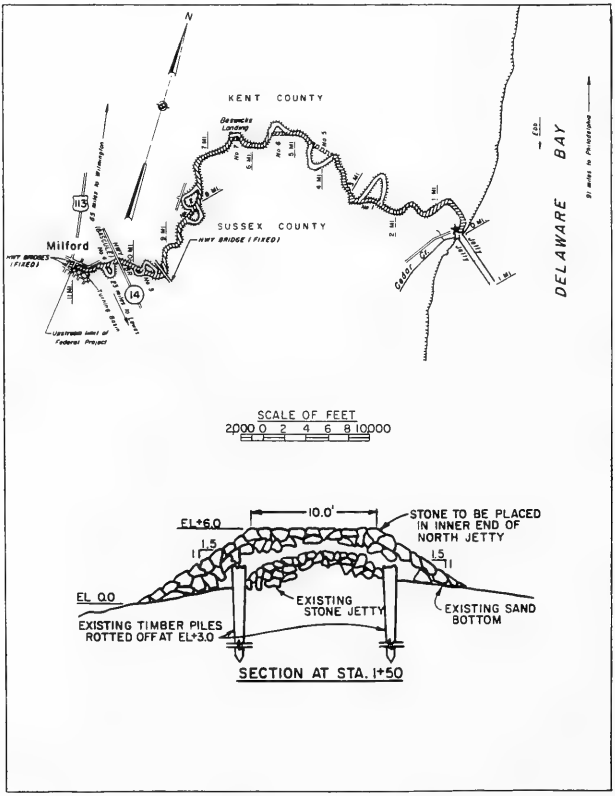



Figure 34. Mispillion River, Delaware

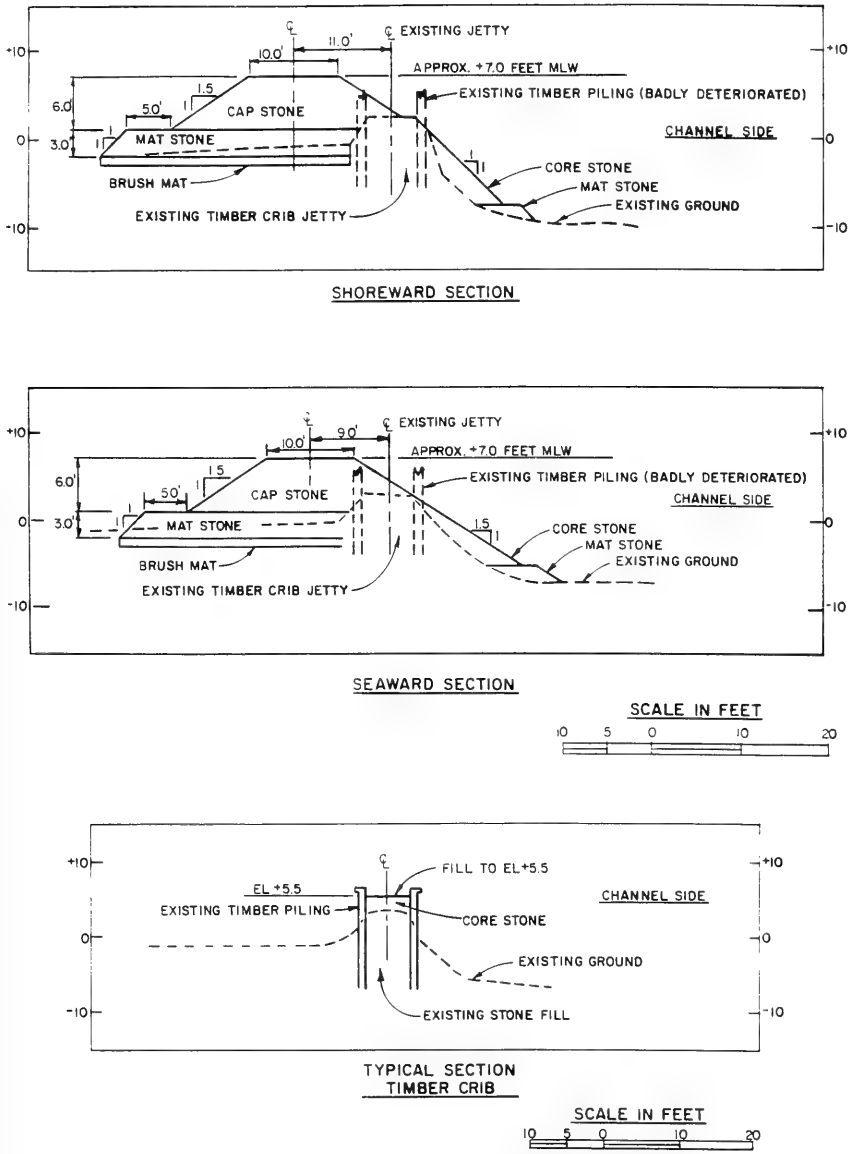



Figure 35. Cross sections of 1964 rehabilitation of Mispillion River jetties

Table 29

Roosevelt Inlet Jetty

Lewes, Delaware

Philadelphia District

| Date(s) | Construction and Rehabilitation History |
|---|---|
| 1908 | A 1,263-ft-long stone-filled timber crib jetty was constructed on the west side of the inlet. |
| 1911-1914, 1917, 1920, 1923 | Stone replacement repairs were made each of these years. Cause of damage was due to inadequate jetty design; waves easily damaged the timber cribs. The cribs were also permeable to sand. |
| 1937 | The timber crib jetty was replaced by two steel sheet-pile jetties, constructed 500 ft apart, on the east and west sides of the inlet. Both jetties were 1,700 ft long (Figure 36). Crest elevations were +8.0 ft mlw, except the shoreward ends which were +10.0 ft mlw. |
| 1939 | The jetties had deteriorated due to corrosion. |
| 1944 | The jetties were flanked and rubble was placed along the east bank. The additional rubble extended the east jetty shoreward 400 ft. The possibility of the west jetty becoming completely flanked was determined to be remote; therefore, no rubble was placed on the west bank. Seaward ends of both jetties were repaired due to deterioration by corrosion. |
| 1985 | The jetties are in poor condition and are ineffective. They are considered a navigation hazard and are to be removed. |

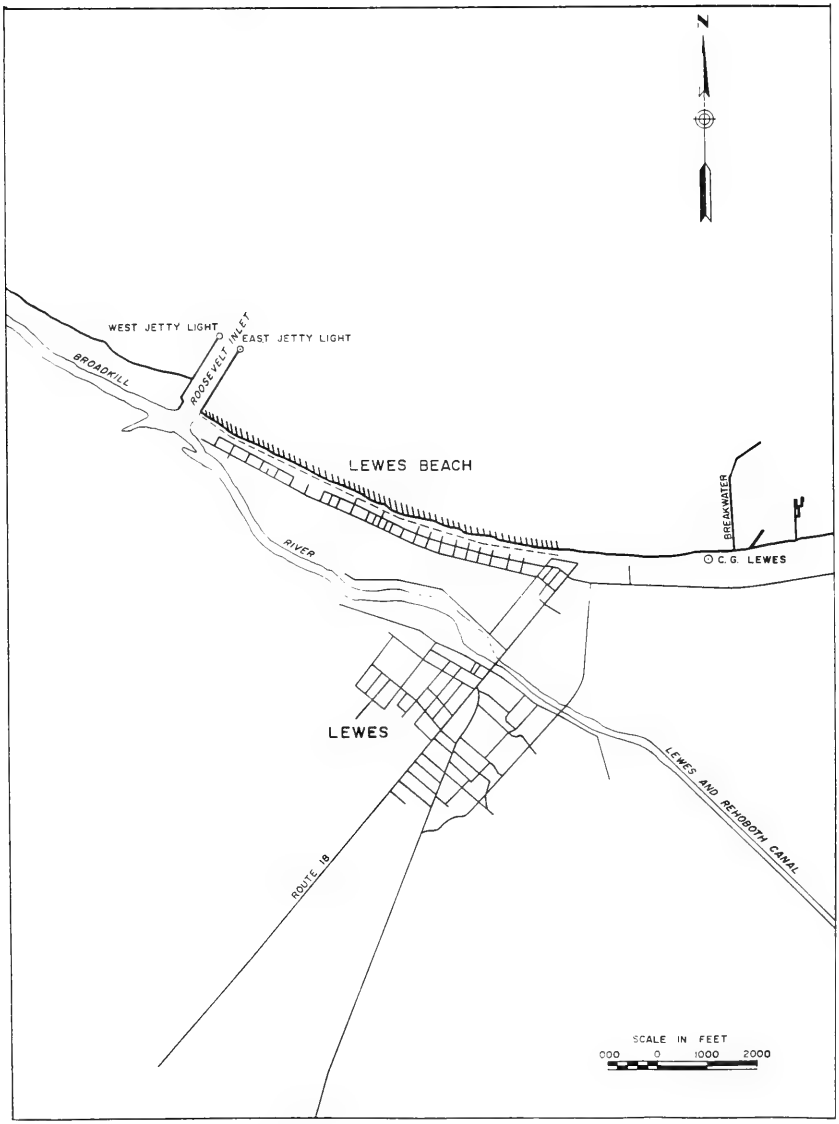



Figure 36. Roosevelt Inlet, Delaware

Table 30

Delaware Bay Harbor of Refuge Breakwaters

Fort Miles, Delaware

| Date(s) | Construction and Rehabilitation History |
|---|---|
| 1898 | A 5,000-ft-long detached breakwater was completed to offer harbor protection from east-northeast storms. The structure was located 2,800 ft west of Cape Henlopen and extended west-northwest (Figure 37). The cost of construction was $2,790,000. |
| 1901 | Construction was completed on a second detached breakwater to provide harbor protection from northwest storms (Figure 37). The structure began at a point 6,000 ft north of Cape Henlopen and extended northwest 7,500 ft. The rubble-mound breakwater was constructed with 1,475,276 tons of stone at a cost of $2,239,000. |
| 1985 | The breakwaters have no history of repairs and have survived remarkably well. The structures are outdated and would not be repaired if damaged. They no longer serve their intended purpose because of changes in the shipping industry. |

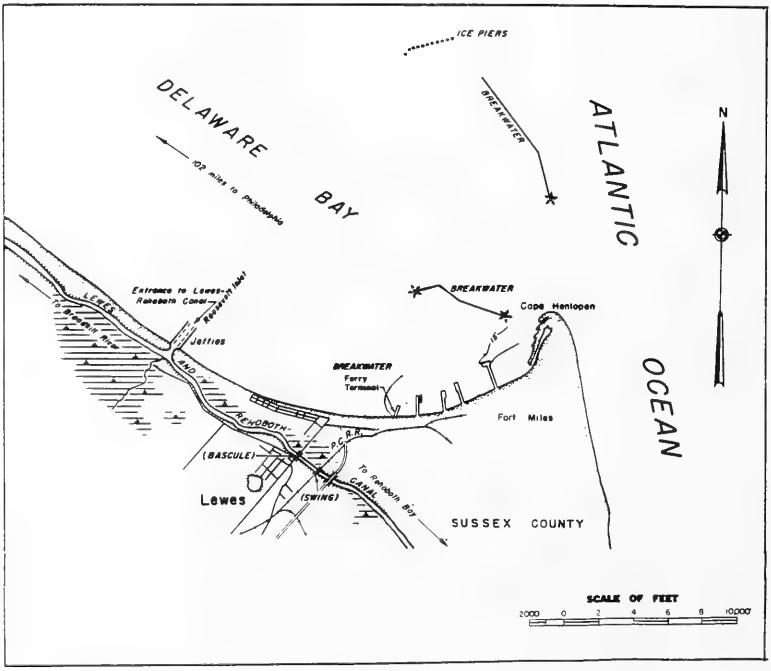



Figure 37. Delaware Bay Harbor of Refuge, Delaware

Table 31

Manasquan Inlet Jetties

Manasquan, New Jersey

Philadelphia District

| Date(s) | Construction and Rehabilitation History |
|---|---|
| 1882 | A 1,515-ft-long timber jetty and dike was constructed north of the inlet. |
| 1883 | A timber jetty was constructed south of the inlet to a length of approximately 500 ft. |
| 1886 | The south jetty was flanked, and use of the inlet was seriously impaired. |
| 1922 | New timber jetties were constructed. |
| 1924 | The jetties were in a state of disrepair. |
| 1930-1931 | Two rubble-mound jetties were constructed north and south of the inlet to replace the timber jetties and provide channel protection. The north jetty was 1,230 ft long, and the south jetty was 1,030 ft long. The jetties were spaced 400 ft apart and built to an elevation of +14 ft mlw, with a 12.0-ft crown width and side slopes of 1V:1.5H on the ocean side, and 1V:1H on the channel side (Figure 38). Capstone was 2.0 ton, and core stone ranged from 100 to 500 lb. |
| 1946 | Both jetties were rehabilitated using 5,190 tons of capstone, 2,886 tons of corestone, and 628 cu yd of grout. The cost of rehabilitation was $56,778. |
| 1955 | The north jetty was rehabilitated using 5,400 tons of stone at a cost of $128,597. |
| 1959 | The south jetty was rehabilitated using 12.0-ton capstone at a cost of $67,048. |
| 1977 | The seaward 100 ft and 60 ft of the north and south jetties, respectively, were destroyed through continued displacement of armor stone and loss of structural integrity. The south jetty was damaged from the seaward end to 700 ft shoreward. Sand passed from the south jetty fillet through and over the jetty into the inlet. |
| 1979-1982 | Both jetties were rehabilitated using dolosse. Sand and displaced stone were excavated and reshaped to design configuration before dolosse placement. Sixteen-ton dolosse were placed along the seaward 400 ft on the north side of the south jetty, around the jetty head, and along the seaward 50 ft on the south side. The dolosse extended to -10 ft mlw on the channel side, with side slopes of 1V:2H, and front slopes of 1V:3H. The seaward 400 ft was concrete capped, 20 ft wide, and was built at an elevation of +14 ft mlw. Sixteen-ton dolosse were placed along the seaward 250 ft on the north side of the north jetty, around the jetty head, and along the seaward 90 ft on |

(Continued)

Table 31 (Concluded)

| Date(s) | Construction and Rehabilitation History |
|---|---|
| 1979-1982 (Cont.) | the south side. The seaward 240 ft was concrete capped, 35 ft wide at the seaward end and 20 ft wide elsewhere. Capstone was placed shoreward of the dolosse section, 375 ft on the north side and crest, and 90 ft on the south side. Capstone size decreased in the shoreward direction from 12.0 to 3.0 to 5.0 tons. Design wave height was 25.0 ft. An aerial photograph of the rehabilitation is shown in Figure 39. |
| 1985 | The jetties were subjected to several storms after the 1982 rehabilitation, including a design level storm in March 1984. Photogrammetric monitoring of the structures under the Monitoring of Completed Coastal Projects (MCCP) Program indicated the last rehabilitation of the jetties has been fully successful to date. |

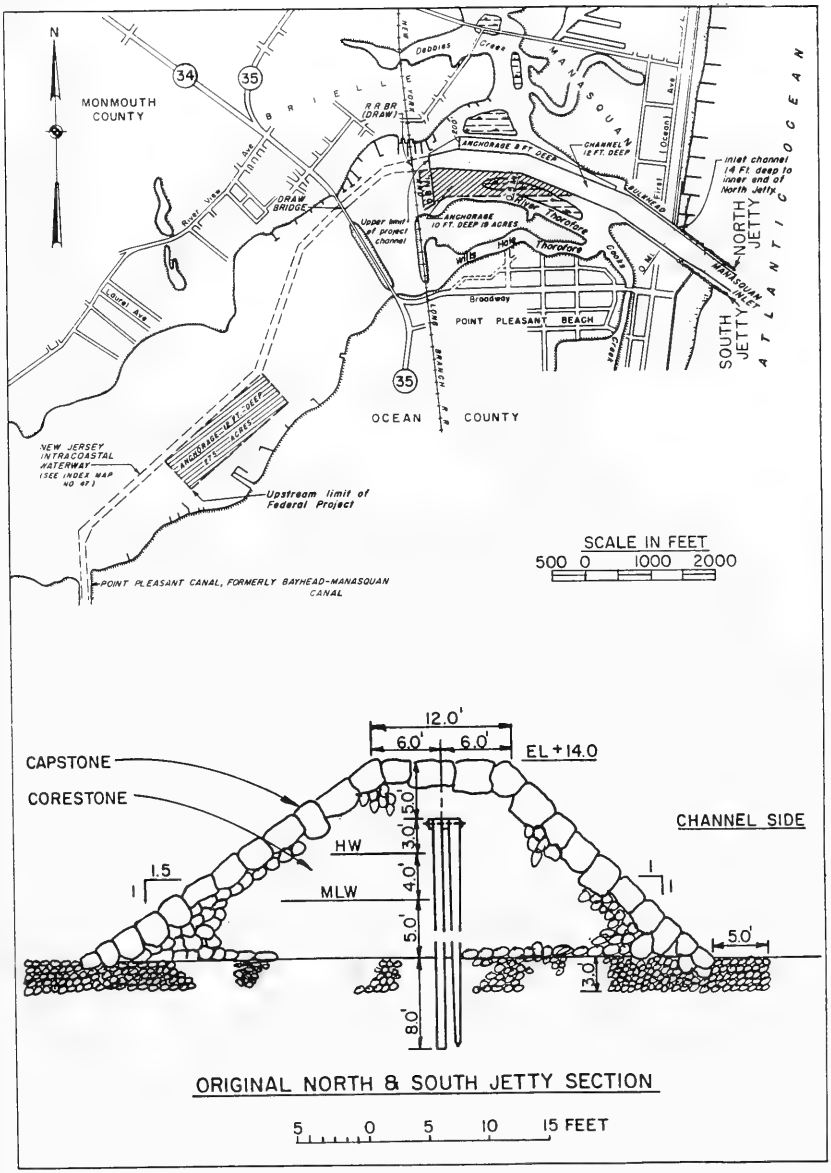



Figure 38. Manasquan River, New Jersey

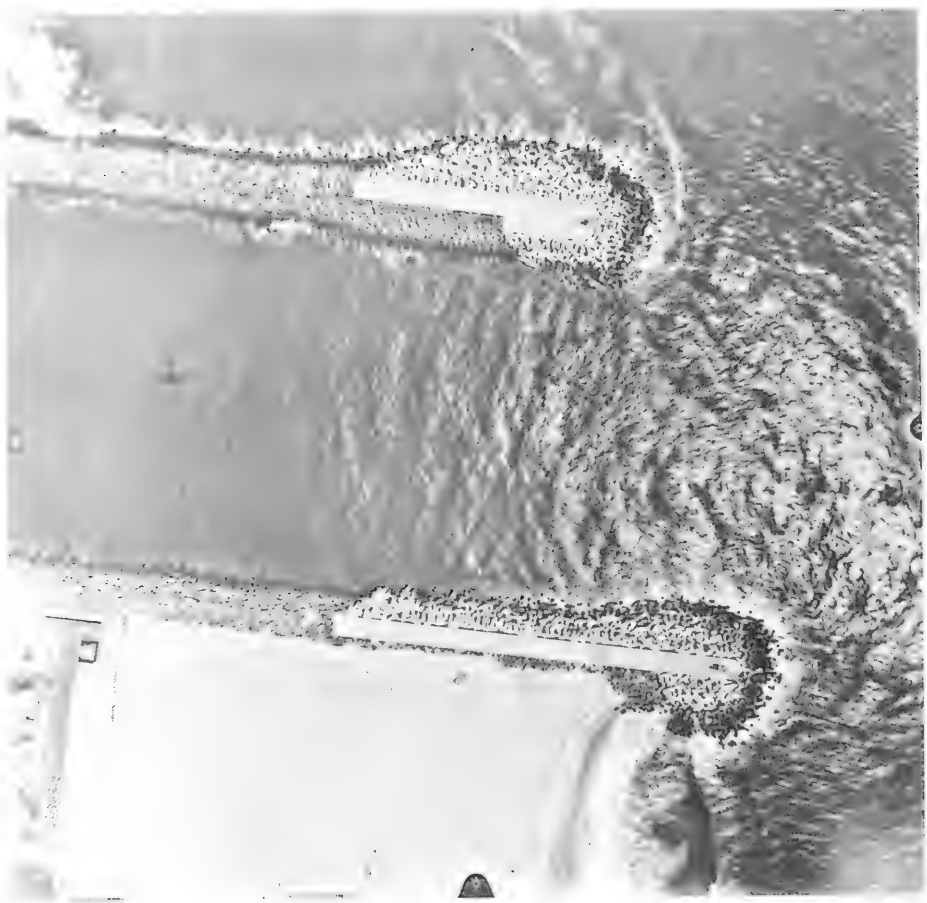


Figure 39. Photograph of Manasquan Inlet jetties after 1982 rehabilitation

Table 32

Barnegat Inlet Jetties

Barnegat, New Jersey

Philadelphia District

| Date(s) | Construction and Rehabilitation History |
|---|---|
| 1940 | Two converging stone jetties were constructed north and south of the inlet for channel protection. The north jetty was 4,675 ft long, and the south jetty was 2,820 ft long (Figure 40). Design crest elevation was +2.0 ft mlw. |
| 1944 | The shoreward 100 ft of the south jetty was lowered. |
| 1950 | Repairs were made to the seaward end of the north jetty. |
| 1954 | Repairs were made to the shoreward portion of the south jetty. |
| 1972-1974 | To prevent sand passing through and waves overtopping the north jetty, the shoreward 3,700 ft was raised to +8.0 ft mlw and made impermeable. The center line of the section repaired was offset 12.0 ft toward the inlet from the existing section (Figure 40). |
| 1985 | Due to instability and continuous shoaling of the navigation channel, proposals are being considered to construct a new south jetty. Portions of the jetties have crest elevations of +10.0 ft mlw. These sections were probably built as part of repair work conducted in 1950 and 1954. Figure 41 is an aerial photograph of the jetties in 1984. |

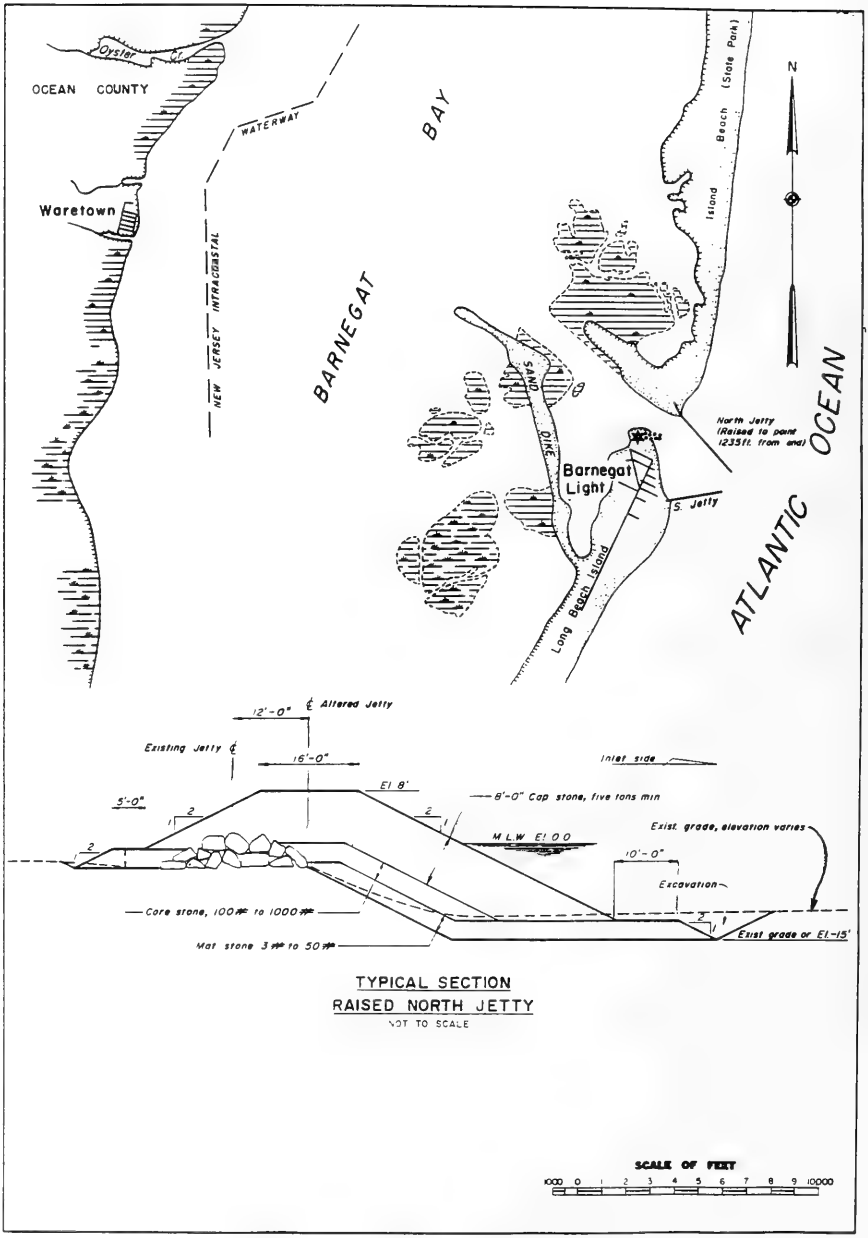



Figure 40. Barnegat Inlet, New Jersey

Figure 41. Photograph of Barnegat Inlet jetties

Table 33

Double Creek Jetty

Ocean County, New Jersey

Philadelphia District

| Date(s) | Construction and Rehabilitation History |
|---|---|
| 1912 | A 550-ft-long timber pile jetty was constructed to provide channel control (Figure 42). |
| 1986 | There is no repair history. |

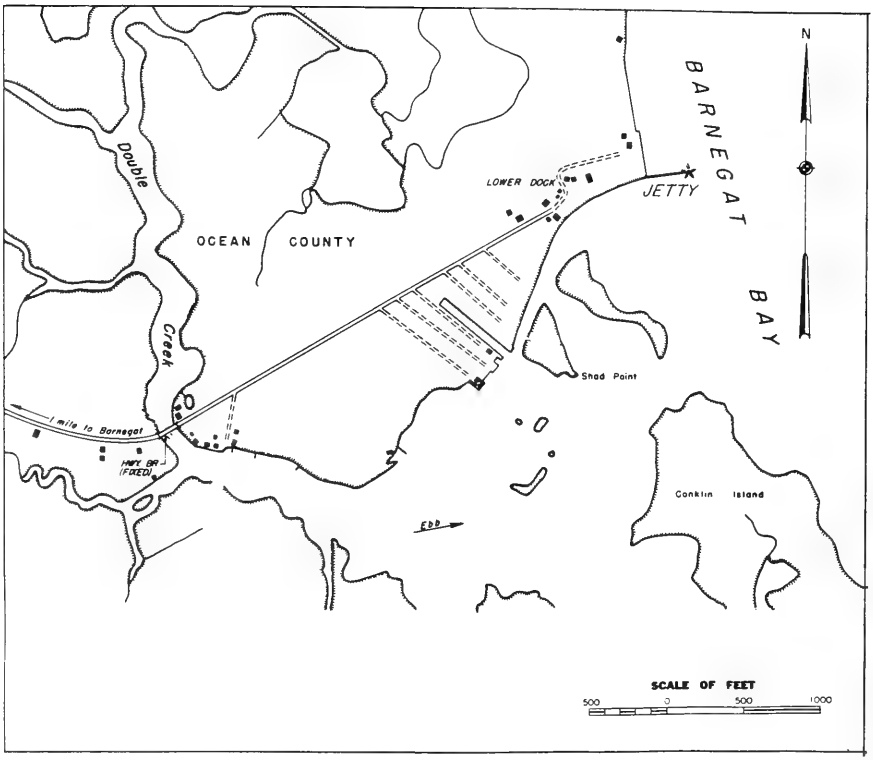



Figure 42. Double Creek, New Jersey

Table 34

Absecon Inlet Jetties

Atlantic City, New Jersey

Philadelphia District

| Date(s) | Construction and Rehabilitation History |
|---|---|
| 1948 | Construction began on a 3,727-ft-long jetty on the east side of the harbor for channel control. Crest elevation was +8.0 ft mlw. An 800-ft-long groin served as a jetty on the west side of the harbor (Figure 43). |
| 1986 | No repair or rehabilitation history is available. Figure 44 is an aerial photograph of the jetties in 1971. |

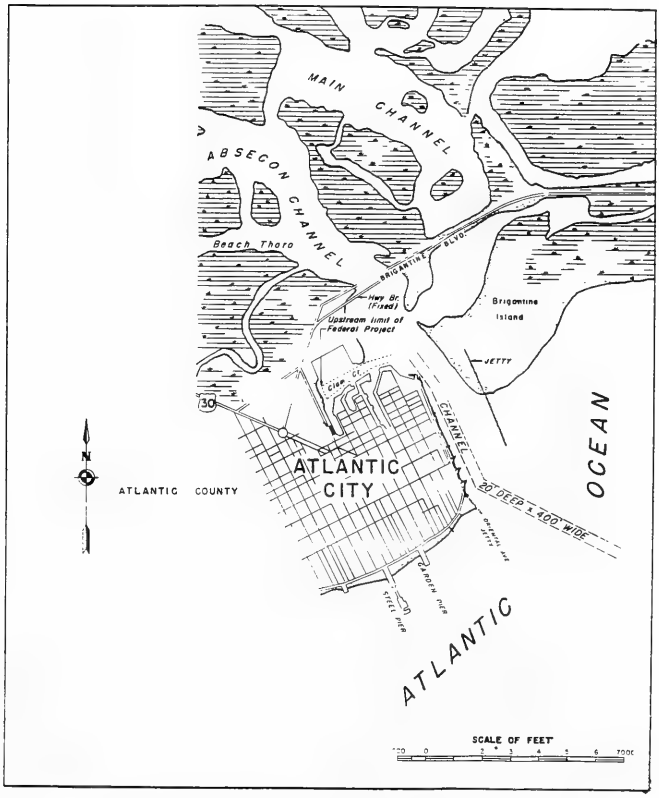



Figure 43. Absecon Inlet, New Jersey

Figure 44. Photograph of Absecon Inlet jetties

Table 35

Goshen Creek Jetties

Cape May County, New Jersey

Philadelphia District

| Date(s) | Construction and Rehabilitation History |
|---|---|
| 1897 | A 600-ft-long sheet-pile jetty was constructed south of the entrance to provide channel control. |
| 1898 | The south jetty was extended shoreward to maintain the dredged channel. |
| 1899 | The south jetty was repaired with brush and stone and extended to 680 ft. A jetty was constructed north of the entrance, parallel to the south jetty, at a length of 680 ft (Figure 45). |
| 1986 | The south jetty is now 1,800 ft long (Figure 45), but the date of the extension is unknown. No history is available on maintenance in this century, and the project is specified as inactive. |

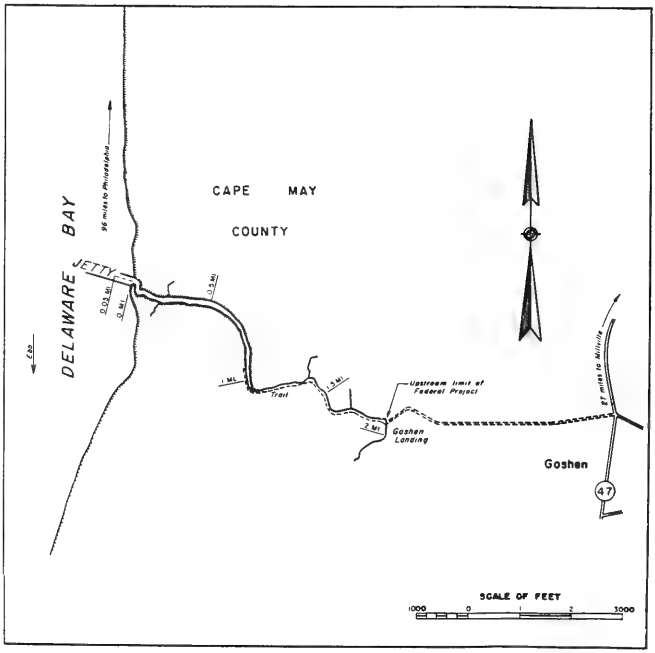



Figure 45. Goshen Creek, New Jersey

Table 36

Cold Spring Inlet Jetties

Cape May County, New Jersey

Philadelphia District

| Date(s) | Construction and Rehabilitation History |
|---|---|
| 1911 | Construction was completed on two parallel jetties 850 ft apart, on the east and west sides of the inlet. Lengths were approximately 4,548 ft and 4,410 ft east and west, respectively (Figure 46). Crest elevations were +10 ft mlw, crown widths varied from 6.0 to 15.0 ft, and side slopes were generally 1V:1.5H. A total of 326,049 tons of stone was used. Shoreward wing lengths were 750 ft and 297 ft east and west, respectively. Wings of both jetties and the shoreward 2,000 ft of the west jetty were constructed of stone-filled pile and timber. The remainder of the west jetty and the entire east jetty were rubble mound. |
| 1915 | Repairs were made by placing 8,497 tons of stone at a cost of $24,810. |
| 1916 | Repairs were made by placing 9,023 tons of stone at a cost of $31,816. |
| 1917 | Repairs were made by placing 1,500 tons of stone. |
| 1922 | An unknown quantity of stone was placed at a cost of $5,410. |
| 1923 | The seaward 368 ft of the west jetty was repaired with concrete blocks and stone. The shoreward 1,572 ft of the west jetty was grout-sealed. |
| 1927 | Repairs were made by placing 10,424 tons of stone at a cost of $63,884. |
| 1946 | Repairs were made by placing 519 tons of stone at a cost of $12,072. |
| 1948 | Dolphin and jetty repairs were made at a cost of $6,204. |
| 1949 | Repairs were made by placing 235 tons of stone at a cost of $3,416. |
| 1964 | Jetties were rehabilitated at a cost of $174,879. |
| 1979 | Jetties were rehabilitated at a cost of $197,891. |
| 1986 | No further repair information is available. Figure 47 is an aerial photograph of the jetties in 1982. |

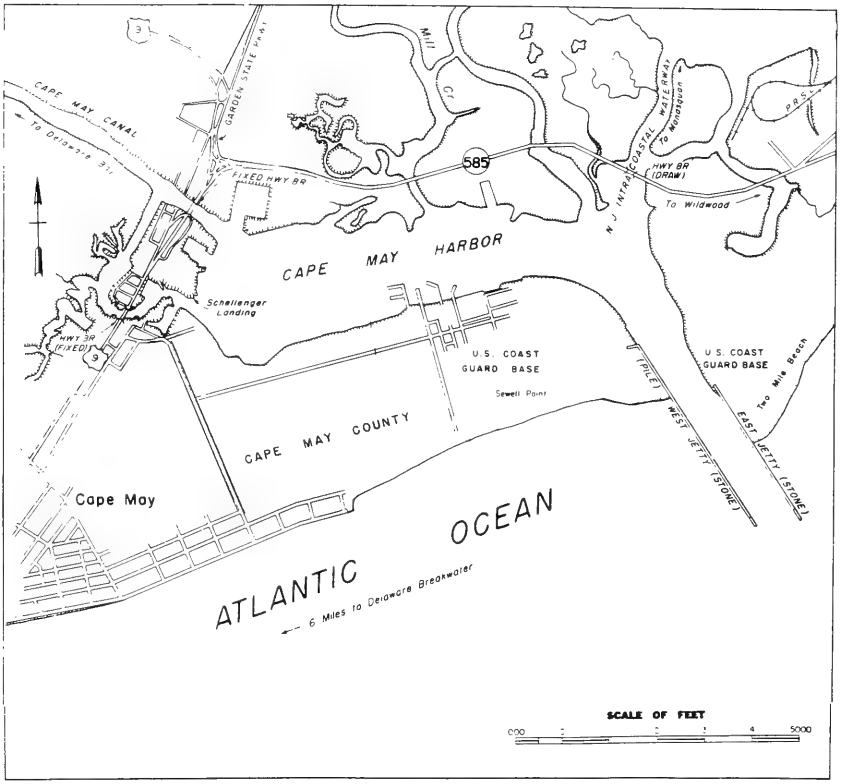



Figure 46. Cold Spring Inlet, New Jersey

Figure 47. Photograph of Cold Spring Inlet jetties

Table 37

Cape May Harbor to Delaware Bay Canal Jetties

Cape May, New Jersey, Philadelphia District

| Date(s) | Construction and Rehabilitation History |
|---|---|
| 1943 | Two parallel jetties were constructed on either side of the entrance for channel protection (Figure 48). |
| 1986 | No jetty repair information was found. Lengths of the jetties are approximately 600 ft and 700 ft north and south, respectively. |

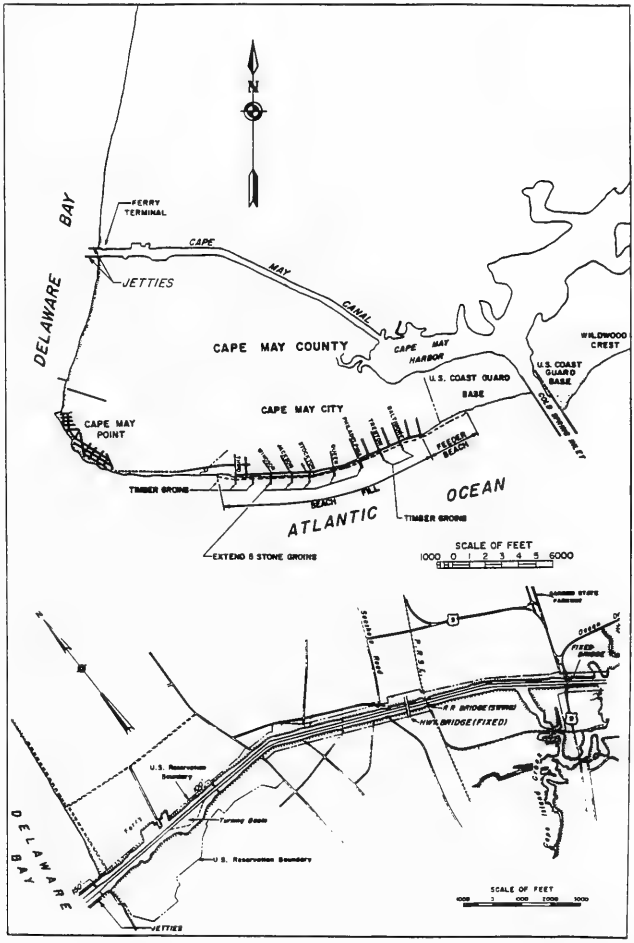



Figure 48. Cape May Harbor to Delaware Bay Canal, New Jersey

Table 38

Indian River Inlet Jetties

Indian River Inlet, Delaware

Philadelphia District

| Date(s) | Construction and Rehabilitation History |
|---|---|
| 1939 | Two parallel jetties were completed to provide inlet protection. The jetties were 1,566 ft long and 500 ft apart. The shoreward 904 ft and 890 ft of the north and south jetties, respectively, were constructed of steel sheet pile, and the seaward portions were constructed of stone. The stone jetties had a crest elevation of +6.0 ft mlw, a crown width of 10.0 ft, and side slopes of 1V:1.5H (Figure 49). |
| 1956 | Storm damages to the south jetty were repaired. |
| 1957 | The north jetty was repaired because of storm damages and was extended shoreward 320 ft because of shoreline recession and deterioration of the sheet pile (Figure 49). |
| 1985 | The jetty heads are in poor condition because of slope failure, subsidence, and toe scour. Repair alternatives have been proposed, and the use of dolosse has been suggested. Figure 50 is an aerial photograph of the jetties taken in 1985. |

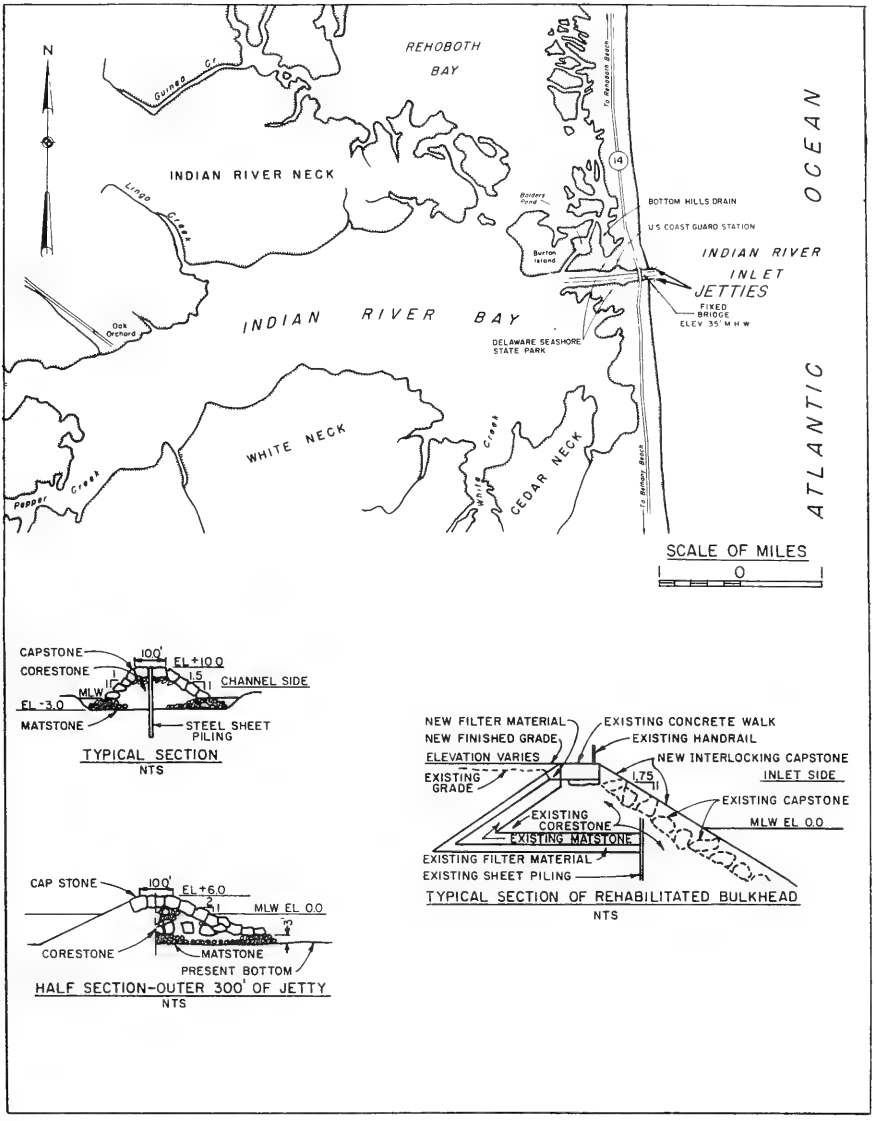



Figure 49. Indian River Inlet, Delaware

Figure 50. Photograph of Indian River Inlet jetties

Table 39

Rock Hall Harbor Breakwaters

Rock Hall, Maryland

Baltimore District

| Date(s) | Construction and Rehabilitation History |
|---|---|
| 1939 | Two breakwaters were constructed with 8,400 tons of stone. Lengths of the breakwaters were 850 ft and 700 ft east and west, respectively (Figure 51). Elevations of the breakwaters were +4.0 ft mlw, with a single capstone, crown width of 4.0 ft, and side slopes of 1V:1.5H. |
| 1964 | Repairs were made on both breakwaters to restore them to original design geometry. The east breakwater was in good condition with crest subsidence of less than 0.5 ft. The majority of the repairs were made on the west breakwater. The landward 80 ft had subsided up to 2.0 ft, the seaward 50 ft had subsided to mlw, and the adjacent 380 ft had subsided 1.0 to 2.5 ft. The landward ends of both breakwaters were repaired with 250- to 500-lb stone. A 40-ft extension was added to the west breakwater (Figure 51), and the outer 220 ft, including the extension, were repaired with 1,000 to 2,000-lb cover and core stone. The adjacent 260 ft were raised by filling the existing section with additional core stone. |
| 1982 | Extensive rehabilitation was done to both breakwaters due to wave transmission and overtopping causing excessive wave heights (greater than 4.0 ft) in the inner harbor. Estimated cost of the rehabilitation was $1,800,000 and required over 27,000 tons of stone. Crown elevation was raised to +7.0 ft mlw, crown width was widened to 8.0 ft with three capstones, and side slopes remained 1V:1.5H requiring 12,400 tons of stone. The west breakwater was extended to 1,100 ft requiring 14,800 tons of stone. Cover stone used for rehabilitation ranged from 2,300 lb at the trunk to 2,800 lb at the head. Cross sections and location of the rehabilitation are shown in Figure 52. |
| 1986 | No further repair or maintenance information has been found. |

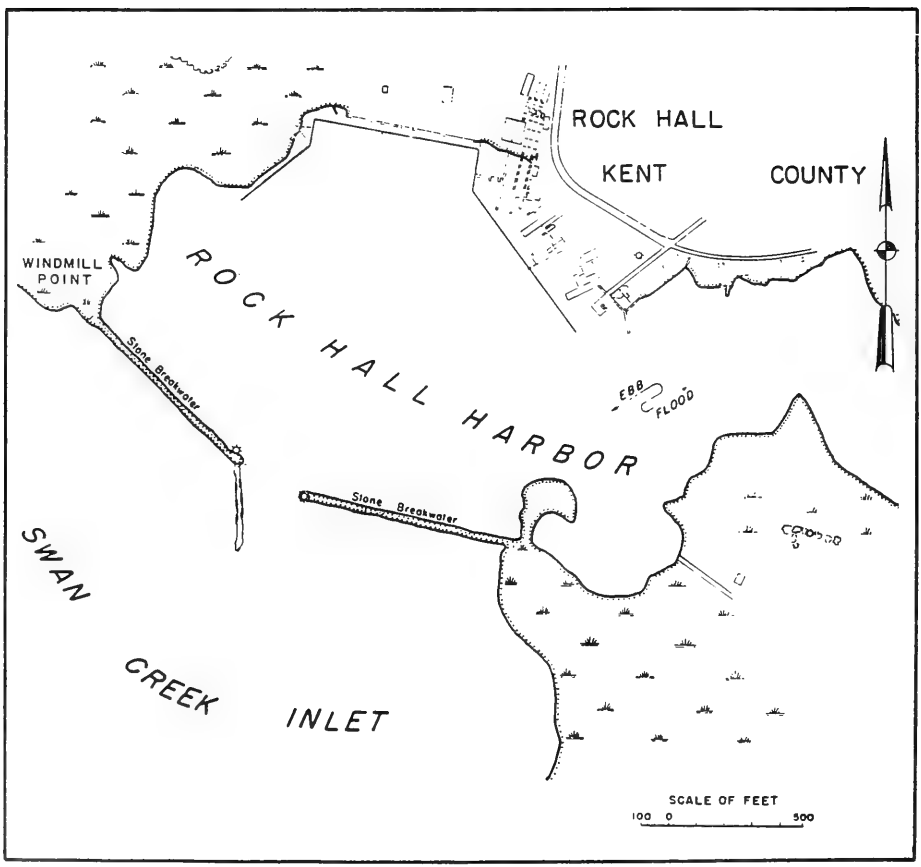



Figure 51. Rock Hall Harbor, Maryland

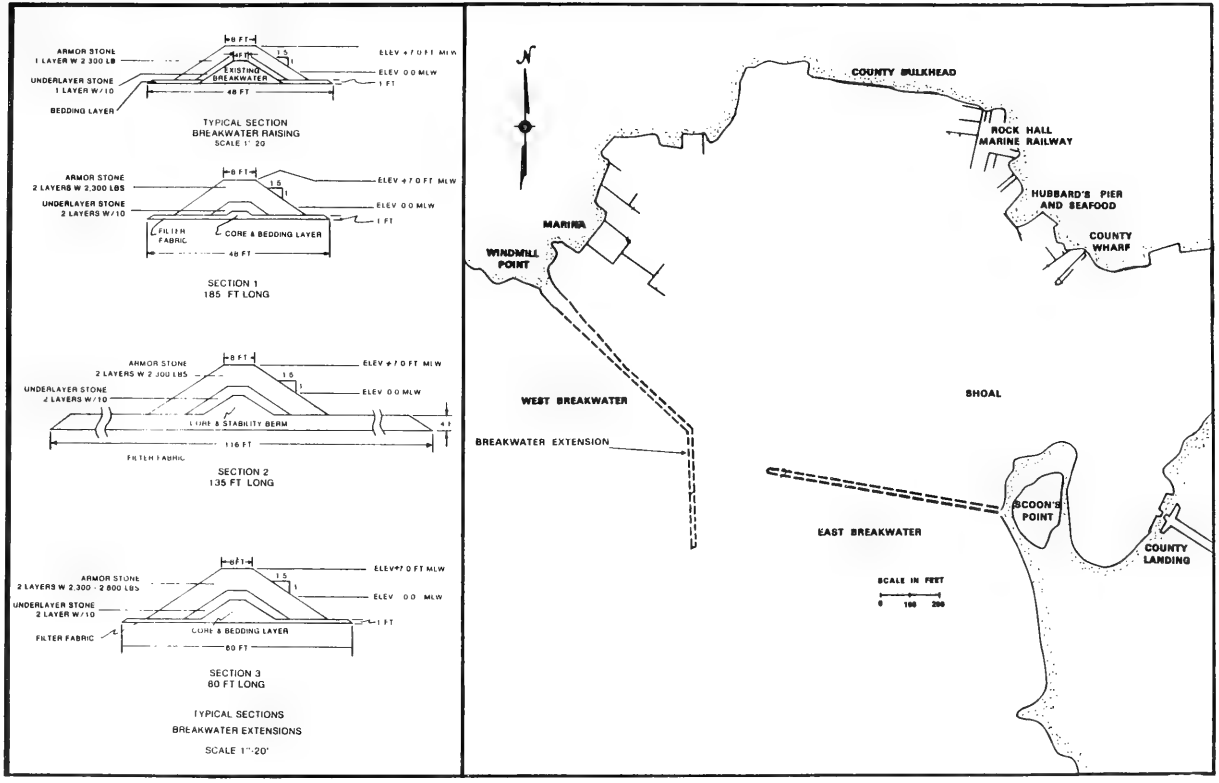



Figure 52. Plan view and cross sections of 1982 rehabilitation, Rock Hall Harbor

Table 40

Claiborne Harbor Jetty

Claiborne, Maryland

Baltimore District

| Date(s) | Construction and Rehabilitation History |
|---|---|
| 1888 | A 750-ft-long slag jetty was constructed by a railway company at Claiborne Harbor. |
| 1912 | The jetty was extended 250 ft seaward as part of the federal project and was constructed of timber piles (Figure 53). |
| 1928 | The timber pile extension was in poor condition and was missing a seaward section. |
| 1970's | The jetty was repaired, and revetment was placed around the jetty and wharf area of the harbor by non-Federal interests. |
| 1978 | A report recommended removal of deteriorated timber piles. |
| 1981 | A survey indicated the jetty was in excellent condition. |
| 1986 | Plans are complete for jetty rehabilitation. No details are available. |

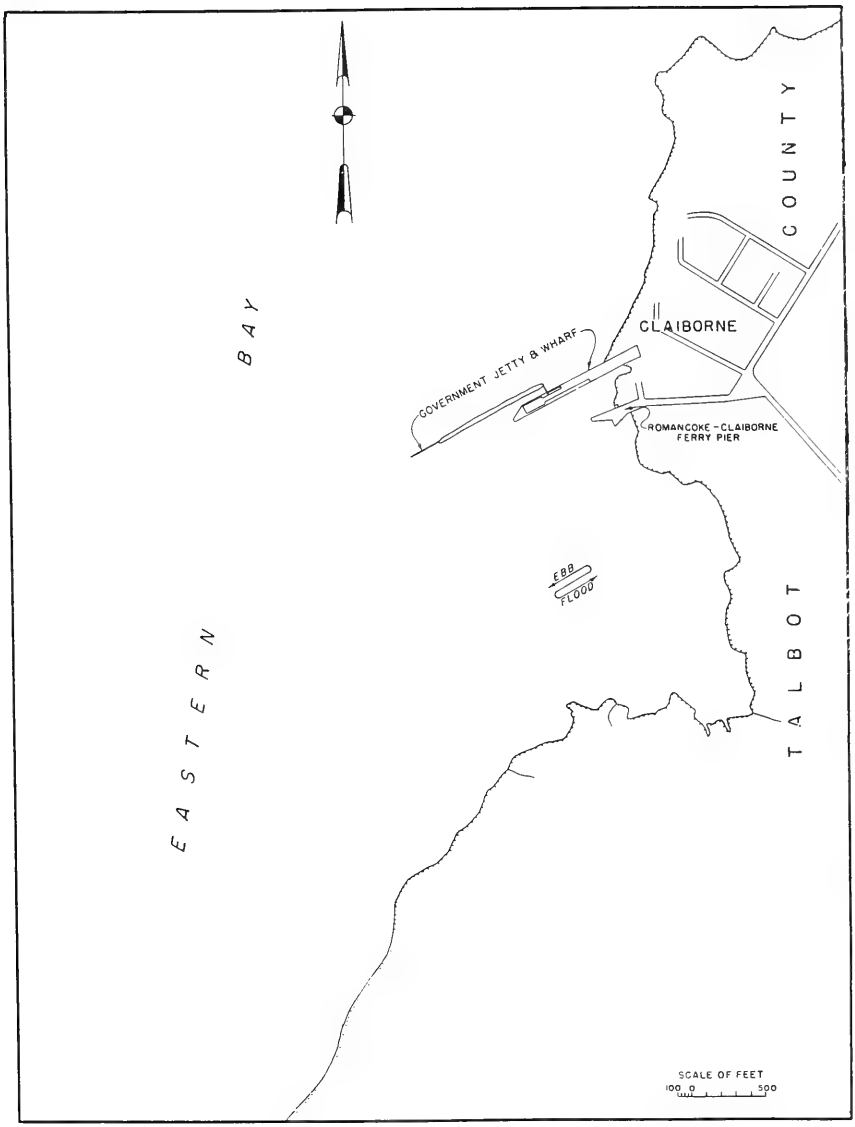



Figure 53. Claiborne Harbor, Maryland

Table 41

Back Creek Jetty, Anne Arundel County, Maryland

Baltimore District

| Date(s) | Construction and Rehabilitation History |
|---|---|
| 1938-1939 | A 650-ft-long jetty was constructed to a crest elevation of +4.0 ft mlw (Figure 54). Crown width was 4.0 ft with a single capstone, and side slopes were 1V:2H. |
| 1981 | A survey indicated the jetty was in very good condition. |
| 1986 | No further repair or maintenance information has been found. |

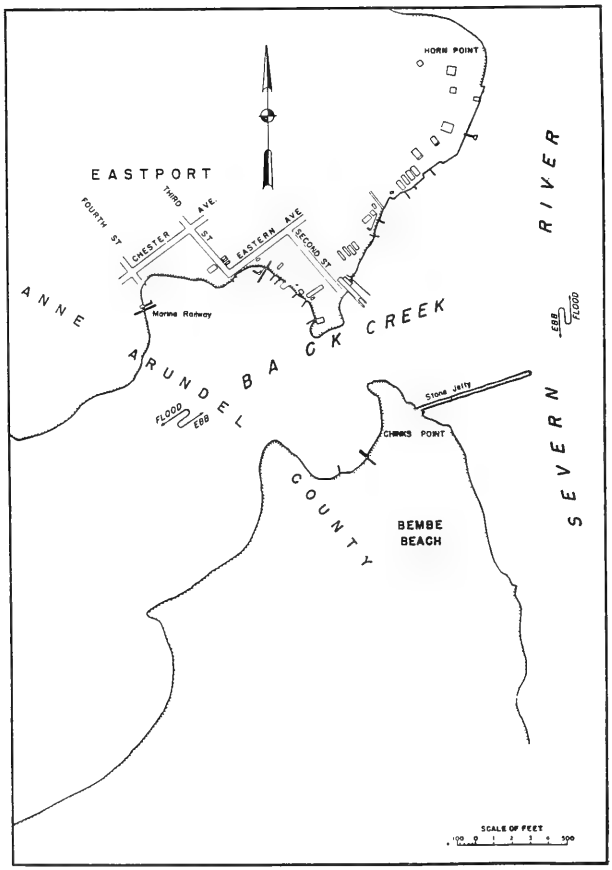



Figure 54. Back Creek, Maryland

Table 42

Herring Bay and Rockhold Creek Breakwater

Anne Arundel County, Maryland

Baltimore District

| Date(s) | Construction and Rehabilitation History |
|---|---|
| 1939-1940 | A 900-ft-long stone breakwater was constructed to a crown elevation of +4.0 ft mlw (Figure 55). Crown width was 4.0 ft, and side slopes were 1V:1.5H. |
| 1981 | A survey indicated that the structure was in good condition with very little subsidence. |
| 1986 | No further repair or maintenance information has been found. |

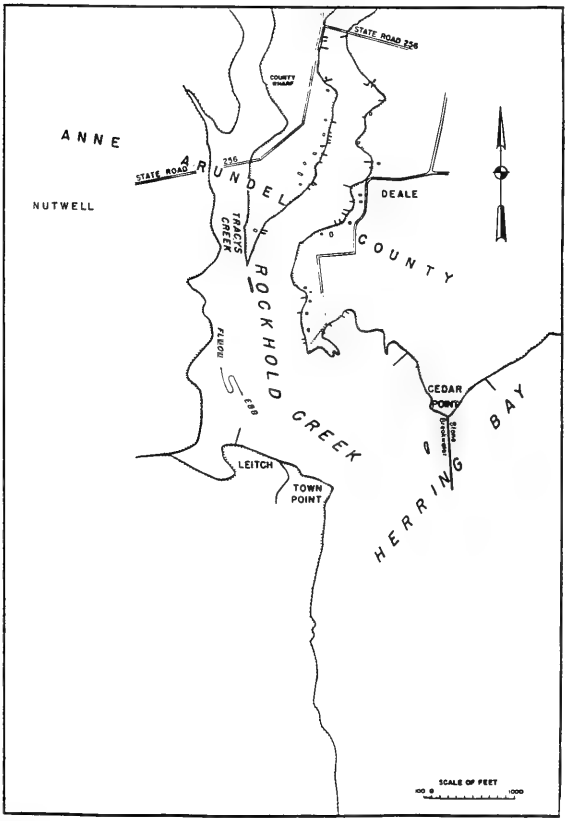



Figure 55. Herring Bay and Rockhold Creek, Maryland

Table 43

Fishing Creek Jetties, Calvert County, Maryland

Baltimore District

| Date(s) | Construction and Rehabilitation History |
|---|---|
| 1941-1942 | Two converging stone jetties were constructed to lengths of 1,050 and 1,100 ft north and south, respectively (Figure 56). Crown elevation was +4.0 ft mlw, crown width was 4.0 ft, and side slopes were 1V:1.5H. |
| 1981 | A survey revealed that both jetties were in good condition with minor settlement and some displaced stone. |
| 1985 | Plans call for sand tightening of the jetties with 2,100 to 3,500 lb of cover stone, 20 to 100 lb of core stone, and 1.0 to 20 lb of bedding stone. |

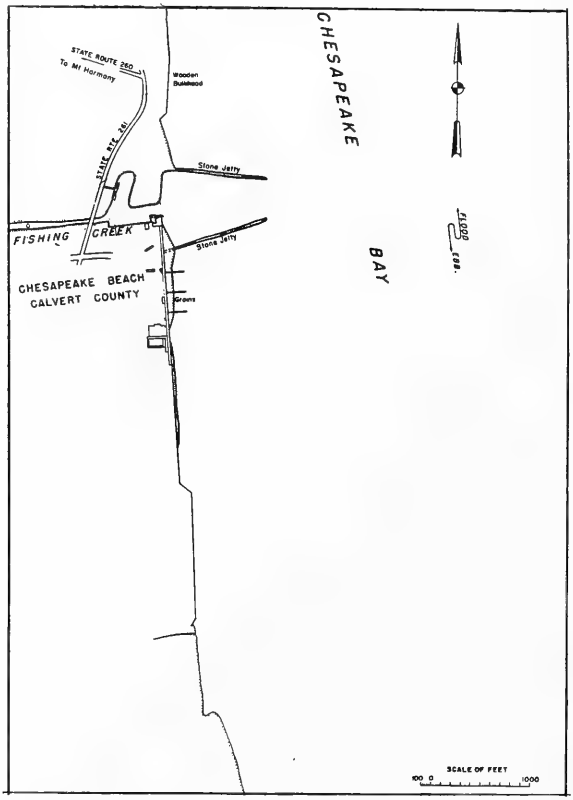



Figure 56. Fishing Creek, Maryland

Table 44

Tilghman Island Breakwater

Talbot County, Maryland

Baltimore District

| Date(s) | Construction and Rehabilitation History |
|---|---|
| 1981 | A 200-ft-long breakwater was constructed at an estimated cost of $140,000 with 1,750 tons of stone to reduce wave action in the inner harbor area (Figure 57). Crown elevation was +6.0 ft mlw and allowed for expected settling to +5.0 ft mlw. Crown width was 6.0 ft, and side slopes were 1V:1.5H. The structure consisted of two layers of armor stone, 750 to 1,200 lb and 70 to 130 lb, and a 1- to 50-lb core and bedding layer. Design wave height and period were 2.3 ft and 4.0 sec. |
| 1986 | No further repair or maintenance information has been found. |

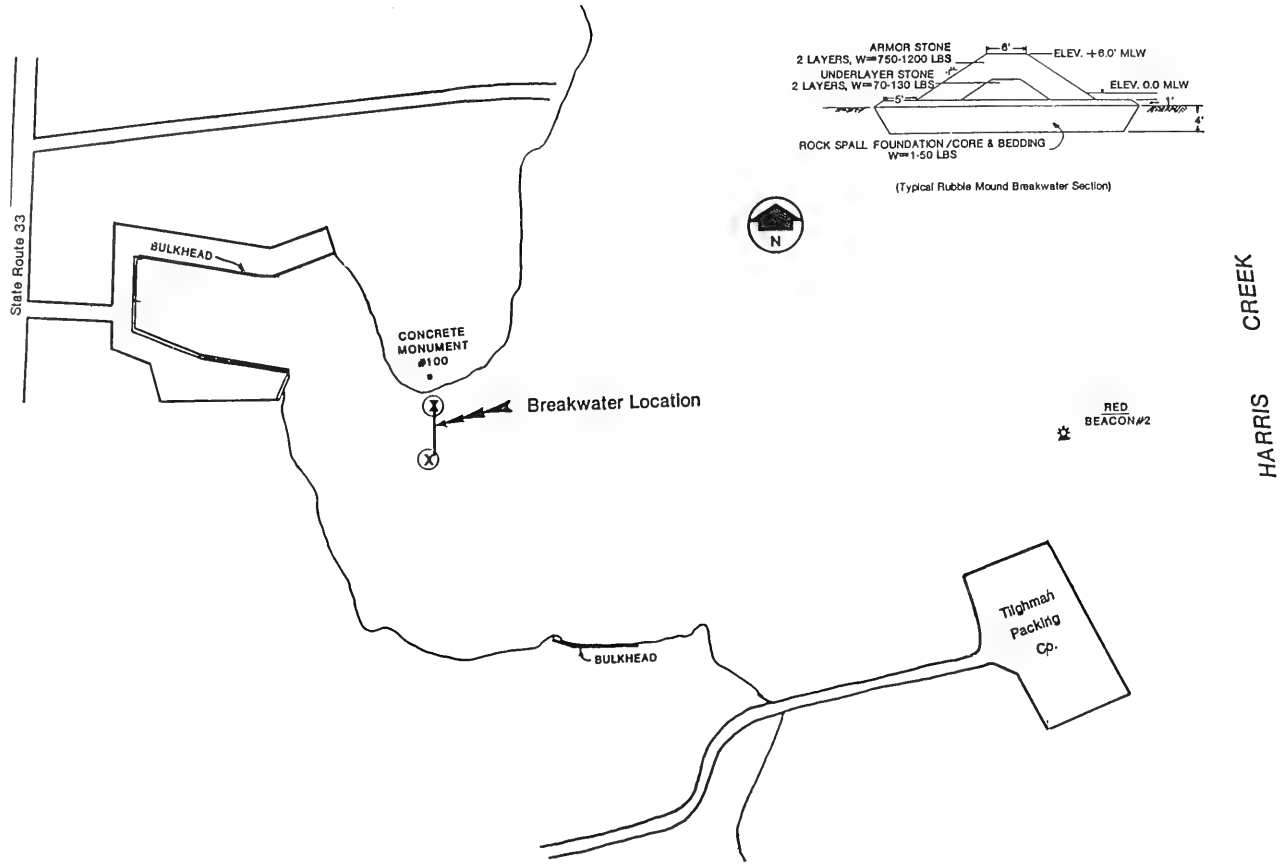



Figure 57. Tilghman Island, Maryland

Table 45

Nanticoke River at Bivalve Jetties

Wicomico County, Maryland

Baltimore District

| Date(s) | Construction and Rehabilitation History |
|---|---|
| 1960 | Two jetties were constructed at lengths of 1,050 ft each and spaced 400 ft apart (Figure 58). Crown elevation was +4.0 ft mlw, crown width was 4.0 ft with a single capstone, and side slopes were 1V:2H. Minimum coverstone weight was 1.5 tons, and corestone ranged from 15 to 500 lb with a 1.0-ft-thick bedding layer. Design wave height was 7.0 ft. |
| 1985 | Both jetties are in excellent condition; however, present shoaling in the channel may be due to sand passing through the jetties. |

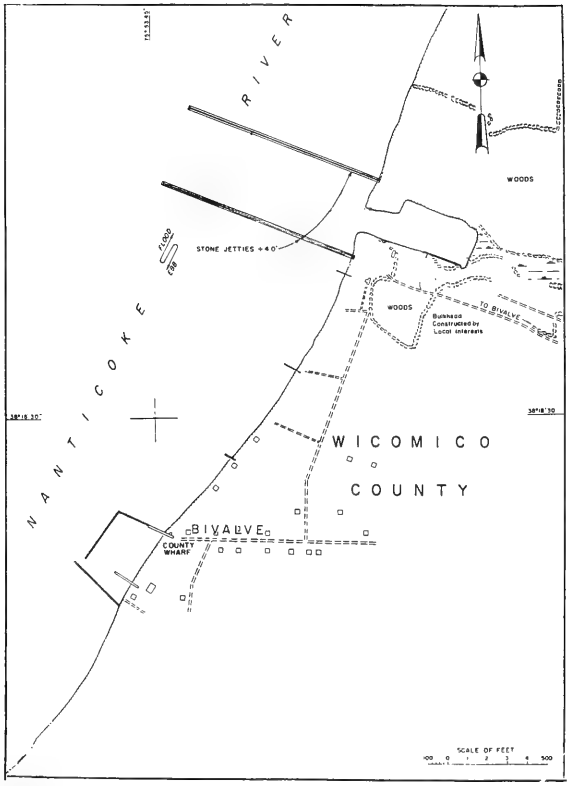



Figure 58. Nanticoke River at Bivalve, Maryland

Table 46

Nanticoke River at Nanticoke Jetties

Nanticoke, Maryland

Baltimore District

| Date(s) | Construction and Rehabilitation History |
|---|---|
| 1938 | Two converging stone jetties were constructed at lengths of 850 ft and 750 ft north and south, respectively (Figure 59). Crown elevation was +5.0 ft mlw, crown width was 4.0 ft, with a single capstone, and side slopes were 1V:1.5H. A post-construction survey showed little deviation from the design elevation. |
| 1944 | A survey of the jetties indicated little change in crown elevation. |
| 1981 | A survey indicated both jetties were in excellent condition. |
| 1986 | No further repair or maintenance information has been found. |

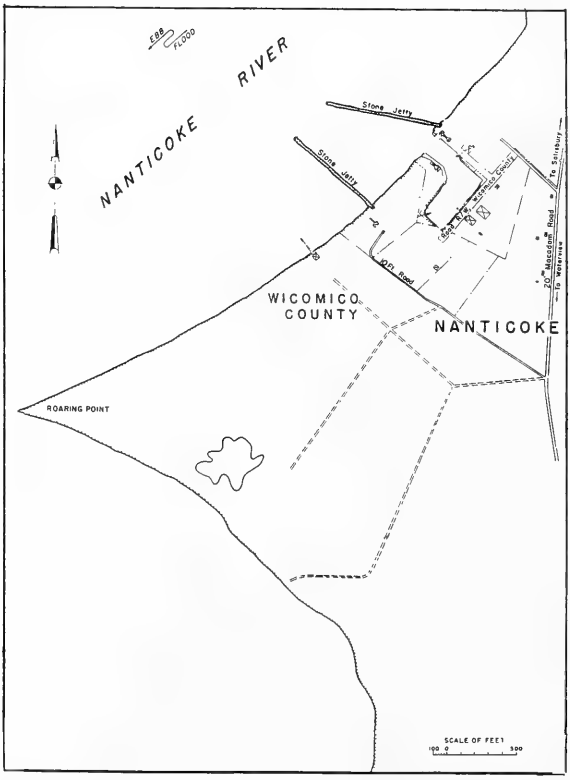



Figure 59. Nanticoke River at Nanticoke, Maryland

Table 47

Upper Thorofare Breakwaters

Deal Island, Maryland

Baltimore District

| Date(s) | Construction and Rehabilitation History |
|---|---|
| 1934 | Two stone breakwaters were constructed with 3,650 tons of stone at an estimated cost of $9,000. The north breakwater was 410 ft long. The south breakwater was 310 ft long. The seaward ends were 180 ft apart (Figure 60). Crest elevations were +7.0 ft mlw, except the landward 142 ft of the south breakwater which was from +5.0 to +6.5 mlw. Crown width was 4.0 ft, and side slopes were 1:1. |
| 1966 | Sand had accumulated around one-half to two-thirds of the landward end of the north breakwater. The south breakwater had an average subsidence of 2.0 ft and was repaired to raise the elevation to +7.0 ft mlw. Crown width was 4.0 ft, and side slopes were 1V:1.5H. |
| 1981 | A survey indicated the south breakwater was in excellent condition, although the midsection appeared to have subsided 1.0 ft. The north breakwater was almost completely surrounded by sand, and future shoaling of the channel was foreseen. The north breakwater appeared to have subsided 1.0 ft from the original design elevation. |
| 1986 | No further repair or maintenance information has been found. |

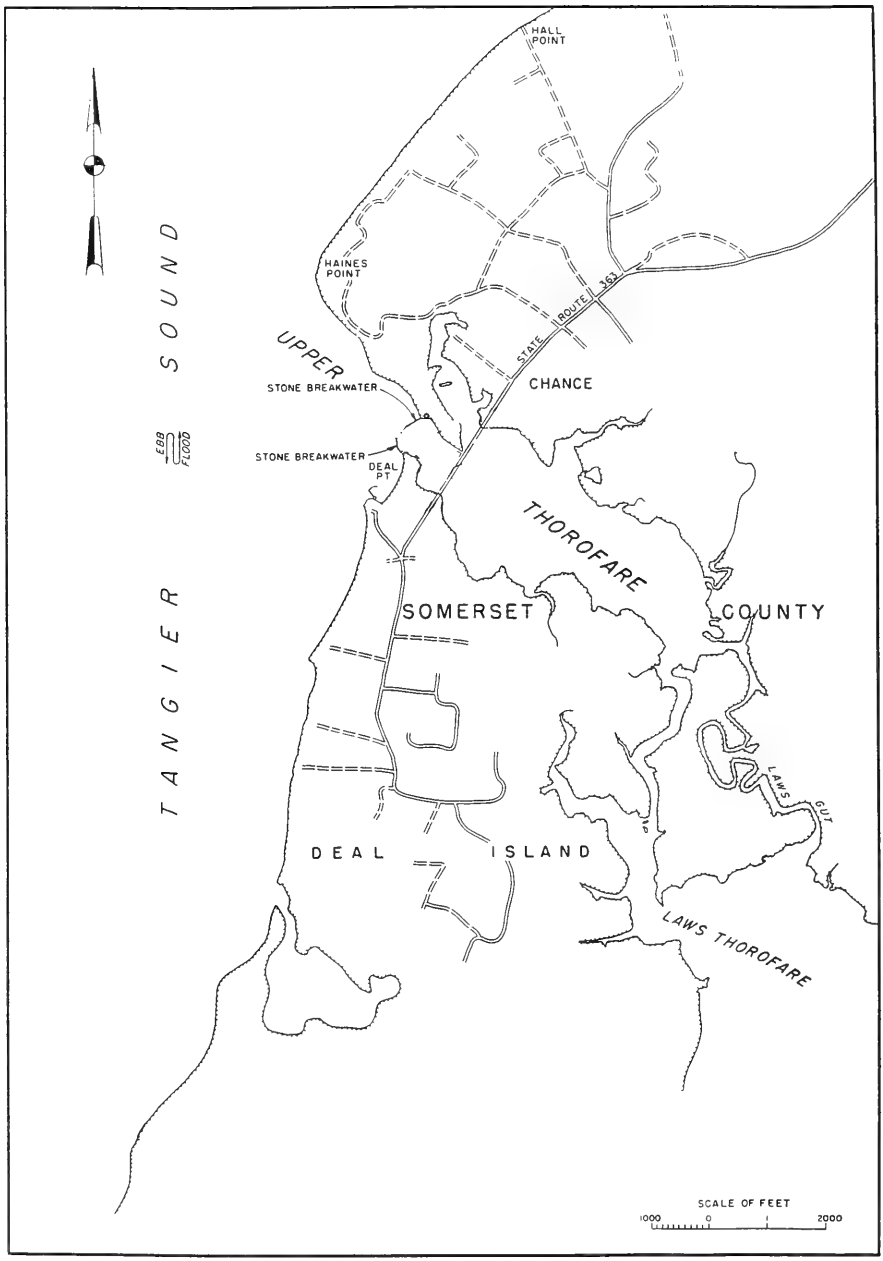



Figure 60. Upper Thorofare, Maryland

Table 48

Twitch Cove and Big Thorofare River Jetties

Somerset County, Maryland

Baltimore District

| Date(s) | Construction and Rehabilitation History |
|---|---|
| 1940 | Two converging stone jetties were constructed with 23,000 tons of stone at a cost of $112,000 (Figure 61). The north jetty was 2,070 ft long, and the south jetty was 1,800 ft long. The design section included a crown elevation of +4.0 ft mlw, a crown width of 2.0 ft with the exception of the seaward 120 ft of the north jetty which was 4.0 ft, and side slopes of 1V:2H, except for the bay side of the north jetty which was designed for 1:1 along the landward 1,950 ft. No stone size details were given; however, a 1981 survey indicated the side slope stone was approximately 1.5 tons, and the core was of similar stone. The survey also revealed the single cap-stone ranged from 2.0 to 3.0 tons. No apron or bedding was placed during construction or subsequent repairs. |
| 1945 | A condition survey was performed which indicated the north jetty was in a severe state of deterioration. The seaward 1,300 ft of this jetty had a typical subsidence of 0.5 ft below the original elevation, and the seaward 300 ft of this section had a range of subsidence of 2.0 to 4.0 ft. The south jetty was flanked, and the seaward 400 ft of the south jetty had subsided 0.5 to 1.5 ft. The seaward end of this section had subsided below mlw. Toe areas had scoured from -5.0 to -7.0 ft mlw. |
| 1952 | A condition survey was made on the north jetty. The seaward 570 ft had a range of subsidence from 2.0 to 5.0 ft, and 700 ft landward of this section had subsided 1.0 to 2.0 ft. Jetty cross sections indicated most of the subsidence occurred on the bay side. Repairs were made to the seaward 1,030 ft of the north jetty using original design geometry to raise the crest elevation to +3.0 ft mlw. The cost of the repairs and dredging was $33,000. |
| 1955-1956 | A condition survey performed on the south jetty indicated an average subsidence of 0.5 ft over the entire length. The seaward 300 ft had subsided 2.0 to 4.0 ft, and a length of 80 ft had subsided near the landward end. Areas of subsidence were typically 1.0 to 2.0 ft below adjacent sections. Repair work began in 1956 to raise the crest elevation to +3.5 ft mlw using original design geometry. Approximately 1,000 tons of stone were used at a cost of about $35,000 which included dredging. Toe areas had scoured to -9.0 ft mlw. |
| 1962 | Both jetties were surveyed and repaired with 2,200 tons of stone for approximately $64,500. The north jetty had been flanked on the landward end, and elevations of the seaward 520 ft ranged from +1.0 to +3.0 ft mlw. The seaward 180 ft of the south jetty had elevations ranging from 0.0 to +4.0 ft mlw. The above sections were repaired to |

(Continued)

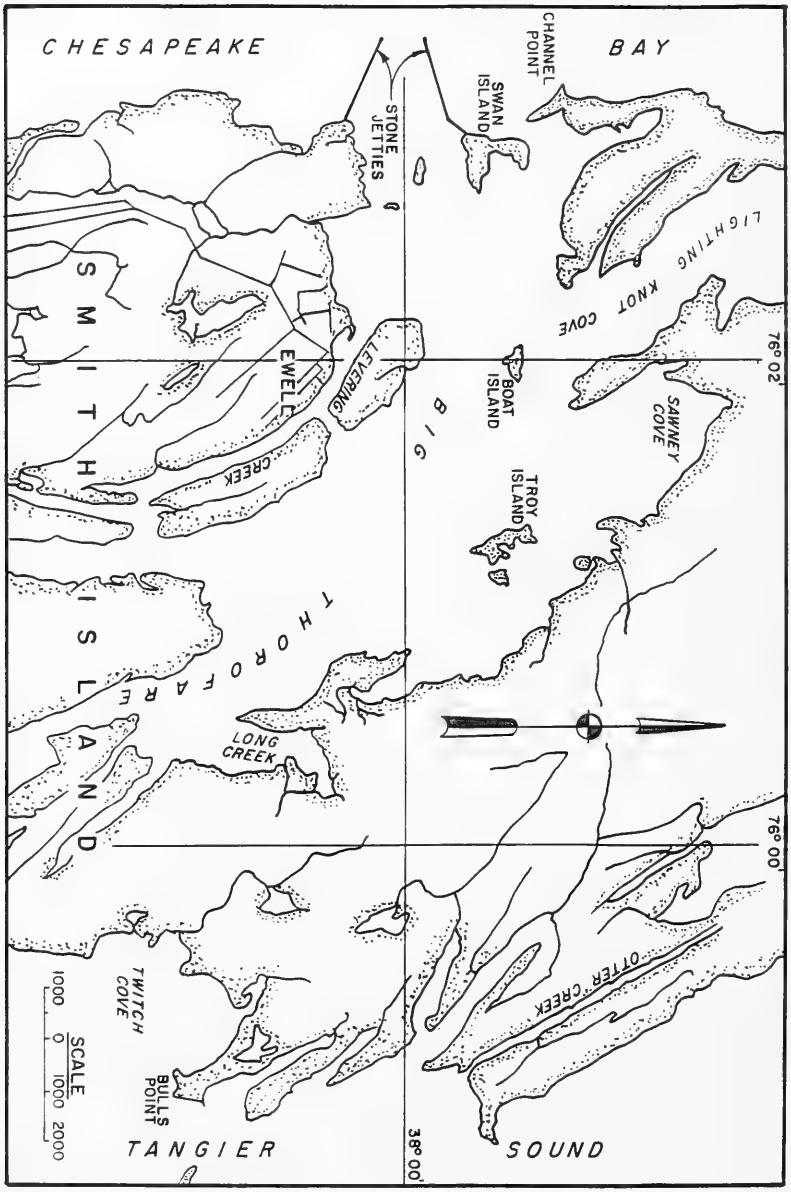



Figure 61. Twitch Cove and Big Thorofare River, Maryland

Table 48 (Concluded)

| Date(s) | Construction and Rehabilitation History |
|---|---|
| 1962 (Cont.) | a crown elevation of +4.0 ft mlw, with a 2.0-ft crown width, except the seaward 70 ft of the north jetty was 4.0 ft. The side slopes were 1V:2H. The landward end of the north jetty was extended 120 ft. Voids along the remainder of the jetties were repaired by placing and resetting existing stone at existing section elevations. The depth at the toes of the jetties ranged from 10.0 to 12.0 ft mlw. |
| 1981 | A survey report indicates both jetties are in "poor" condition. The seaward end of the north jetty and the landward ends of both jetties were flanked, and there were numerous areas of subsidence along their lengths. It is believed that scour is the reason for their deterioration for the following reasons:<br>-- Existence of a homogeneous cross section (no smaller core placed).<br>-- No bedding stone or apron stone being placed during original construction or during repairs.<br>-- Increase in depth from a range of 5.0 to 6.0 ft to a range of 10.0 to 12.0 ft mlw at the seaward ends.<br>-- Landward ends of the jetties being flanked at present. Each has been flanked once and repaired since original construction.<br>-- General susidence along the entire lengths of the jetties of 0.5 to 1.0 ft.<br>-- Numerous voids or gaps where capstones were missing. |
| 1986 | No further repair or maintenance information has been found. |

Table 49

Ocean City Inlet Jetties

Ocean City, Maryland

Baltimore District

| Date(s) | Construction and Rehabilitation History |
|---|---|
| 1934 | A 1,100-ft-long jetty was constructed on the north side of a newly formed inlet at Ocean City (Figure 62). Crest elevation was +4.0 mlw, crown width was 12.0 ft, and side slopes were 1V:2H from the crest to -4.0 mlw and 1V:1.5H from -4.0 mlw to the bottom. |
| 1935 | Construction was completed on a jetty on the south side of the inlet. Crest elevation was +6.0 ft mlw, and crown width was 12.0 ft. The landward 750 ft of the jetty was 1,100 ft south of the north jetty. The south jetty angled north 1,100 ft to a point 600 ft from the north jetty. The final 530 ft of the south jetty was parallel to that of the north jetty. The crest elevation decreased from +6.0 ft mlw to the apron elevation beginning 170 ft seaward of this final section. The apron extended 200 ft farther seaward. The total length of the jetty was 2,380 ft, including the apron. A total of 39,500 tons of stone was used for core; 17,300 tons were used for capstone on the south jetty. |
| 1937 | Sand on the north side of the north jetty had reached the top of the jetty and was depositing in the inlet. A concrete superstructure was built to raise the jetty elevation. The first 100 ft from the boardwalk was raised to +12.0 ft mlw, the next 254 ft was raised to +9.0 ft, and the next 170 ft was raised to +7.0 ft mlw. |
| 1956 | Repairs were made on the seaward 750 ft of the north jetty because of slope failures on the channel side from toe scour. The existing concrete cap was repaired and raised to +9.0 ft. Armor stone was placed on the seaward 575 ft. The armor stone section was placed 26 ft north of the center line to use existing stone as toe protection and to minimize the stone required. The landward end of the south jetty was repaired to maintain integrity with the shoreline. |
| 1963 | Approximately 720 ft of the south jetty was rehabilitated due to slope failures caused by a scour hole that had an elevation of -37 ft mlw. Armor stone was placed 25 ft seaward of the center line for the same reasons stated above in positioning the north jetty. The landward end of the south jetty was again repaired to maintain integrity with the shoreline. |
| 1984 | The seaward 1,100 ft of the south jetty was rehabilitated due to slope failures. The section repaired in 1963 had deteriorated. The scour hole had a maximum depth of -54 ft mlw. Repairs consisted of filling the scour hole with dredged material to -20 ft mlw, covering the hole with 18 in. of blanket stone, and placing stone berm quarry run and armor stone along the toe on the channel side of the |

(Continued)

Table 49 (Concluded)

| Date(s) | Construction and Rehabilitation History |
|---|---|
| 1984 (Cont.) | existing jetty. The landward end of the south jetty was sand tightened to prevent material from passing through the jetty and shoaling into the channel. Three rubble mound breakwaters were constructed landward of the jetty to prevent expected erosion from occurring as a result of sand tightening. |
| 1986 | No further repair or maintenance information has been found. |

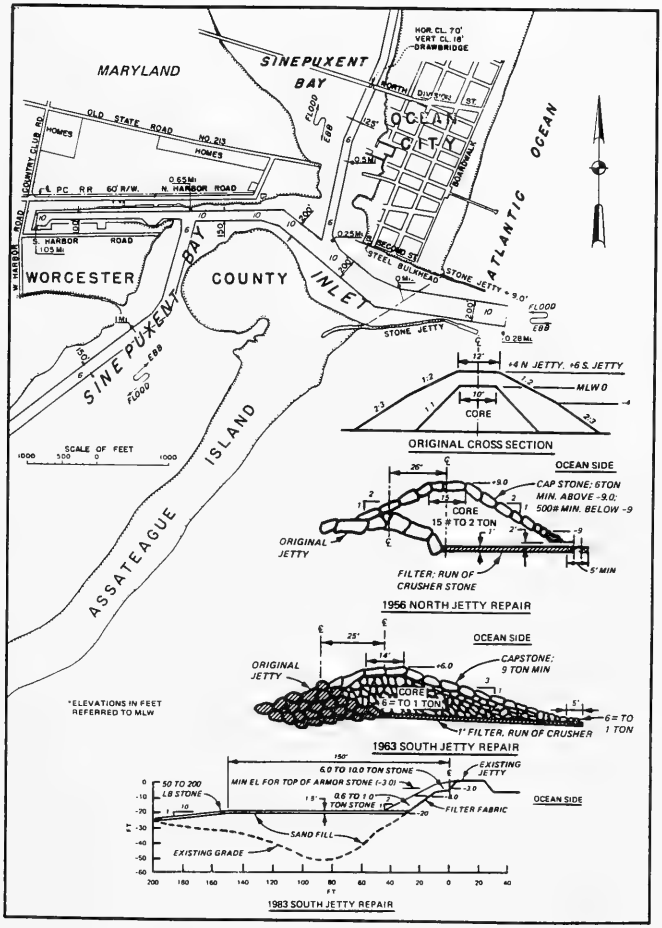



Figure 62. Ocean City Inlet, Maryland

Table 50

Colonial Beach Breakwaters

Colonial Beach, Virginia

Baltimore District

| Date(s) | Construction and Rehabilitation History |
|---|---|
| 1982 | Seven offshore breakwaters were constructed as part of a beach restoration project for approximately $447,000, using over 9,000 tons of stone (Figure 63). One 300-ft breakwater and two 200-ft breakwaters were placed at Castlewood Beach, and four 200-ft breakwaters were placed at Central Beach. All were placed parallel to the shoreline and approximately 100 ft offshore, and they were separated by 150-ft gaps. Crest elevations were +3.0 ft mlw but allowed for settlement to +2.0 ft mlw. Crown widths were 6.0 ft, and side slopes were 1V:1.5H. One layer of 2,000-lb cover stone was placed over one layer of 500-lb underlayer resting on a core and 1 ft bedding layer. Design wave height was 6.0 ft. |
| 1985 | The breakwaters are in excellent condition and serving their intended function. |

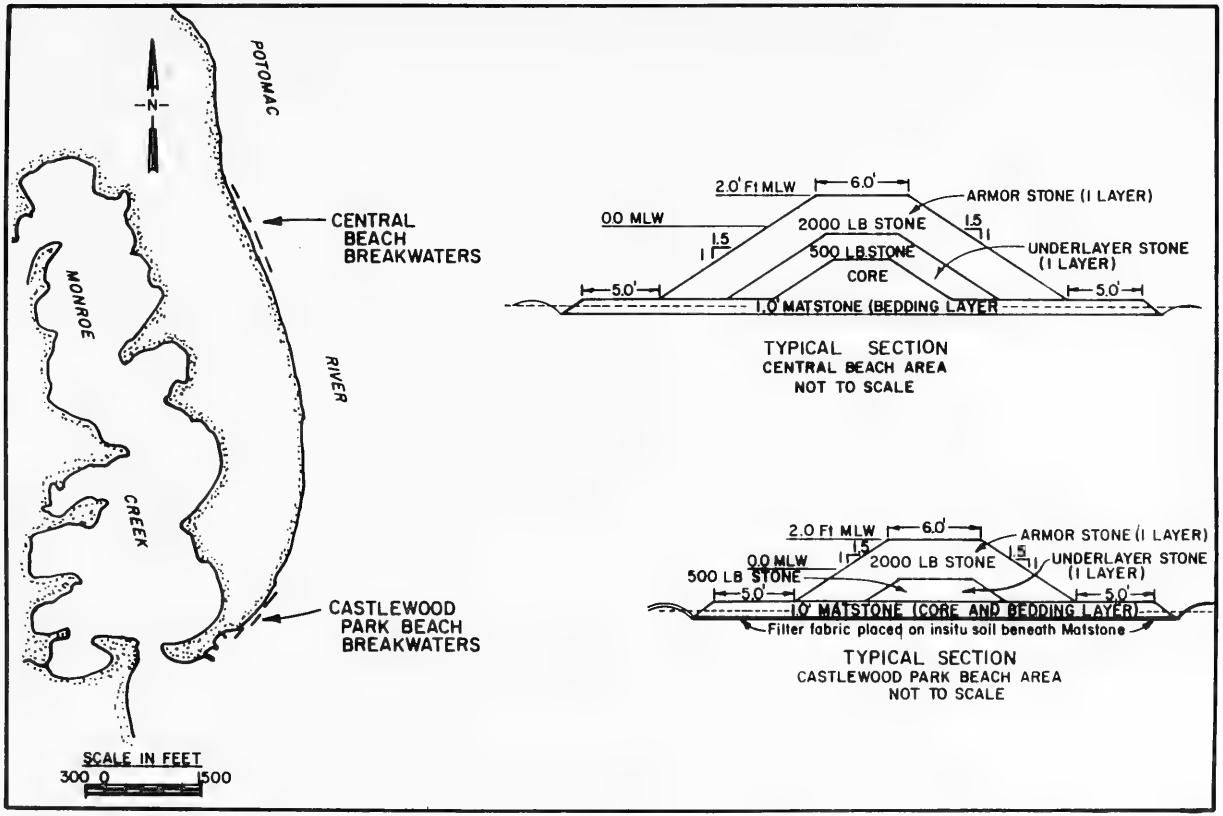



Figure 63. Colonial Beach, Virginia

Table 51

Nomini Bay and Creek Jetty

Westmoreland County, Virginia

Baltimore District

| Date(s) | Construction and Rehabilitation History |
|---|---|
| 1912 | A 2,410-ft-long stone jetty was completed (Figure 64). |
| 1981 | A survey indicated the jetty was in good condition. |
| 1986 | No further repair or maintenance information has been found. |

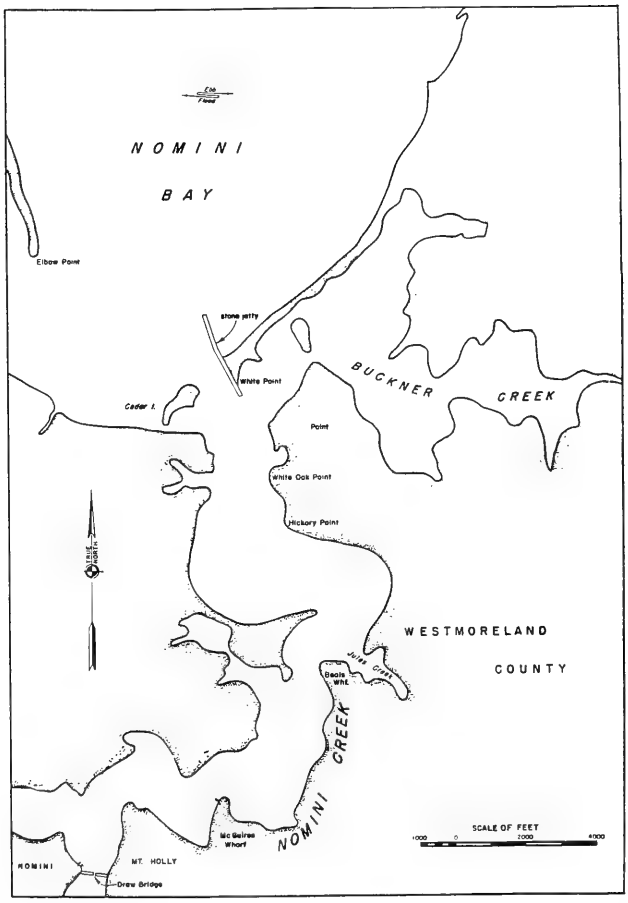



Figure 64. Nomini Bay and Creek, Virginia

Table 52

Bonum Creek Jetties

Westmoreland County, Virginia

Baltimore District

| Date(s) | Construction and Rehabilitation History |
|---|---|
| 1968 | Construction was completed on two stone jetties at an estimated cost of $221,000 using 8,000 tons of stone. The north jetty was 800 ft long, and the south jetty was 300 ft long (Figure 65). Crown elevation was +4.0 ft mlw, crown width was 4.0 ft with a single capstone, and side slopes were 1V:2H. Cover stone used was 2.5 tons, and core stone ranged from 25 to 500 lb. Design wave height was 9.0 ft. |
| 1981 | A condition survey revealed that the jetties had undergone some settlement but were in good condition. |
| 1986 | No further repair or maintenance information has been found. |

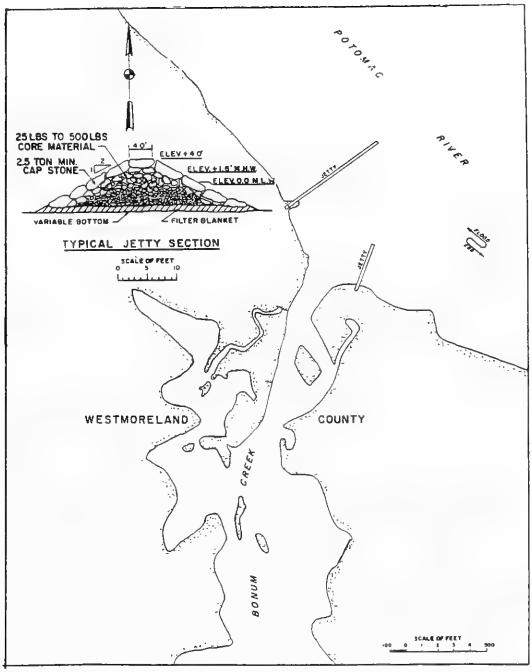



Figure 65. Bonum Creek, Virginia

Table 53

Herring Creek Jetties

St. Marys County, Maryland

Baltimore District

| Date(s) | Construction and Rehabilitation History |
|---|---|
| 1960-1961 | Two jetties were constructed to 750- and 700-ft lengths north and south, respectively (Figure 66). Crown elevation was +4.5 ft mlw, crown width was 4.0 ft, and side slopes were 1V:2.5H. A 1.0-ft-thick bedding layer was placed, and a 1.0-ft-thick by 10.0-ft-wide apron was placed along both jetty toes. |
| 1981 | A survey indicated the jetties were in good condition with only minor settlement. |
| 1986 | No further repair or maintenance information has been found. |

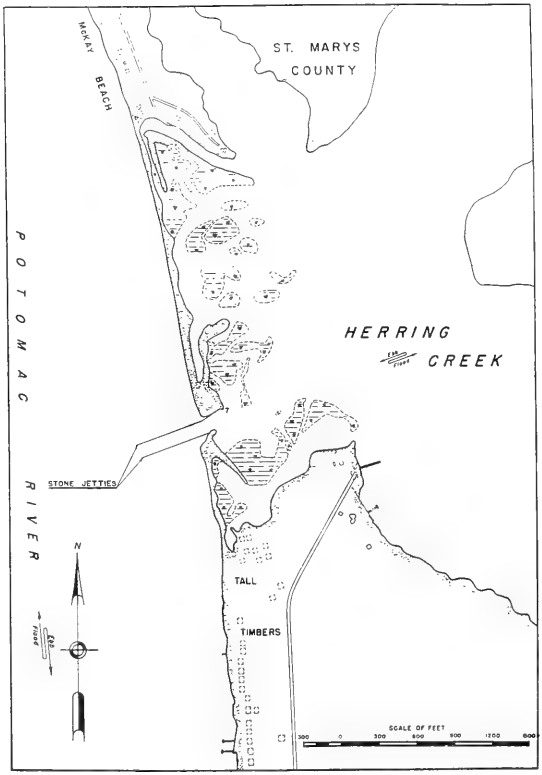



Figure 66. Herring Creek, Maryland

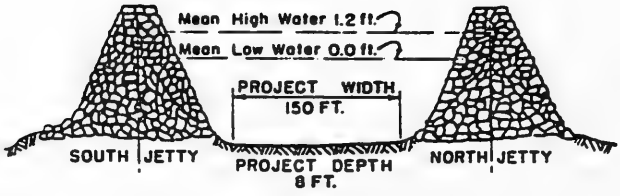
Table 54

Little Wicomico River Jetties

Norththumberland County, Virginia

Baltimore District

| Date(s) | Construction and Rehabilitation History |
|---|---|
| 1937 | Two stone jetties were constructed to lengths of 1,000 and 1,300 ft north and south, respectively (Figure 67). Timber pile jetties were also placed at the landward ends of the stone jetties. Lengths of the timber piles were 357 ft north and 650 ft south. |
| 1970 | The north timber pile jetty was repaired at a cost of $51,822. |
| 1981 | Survey of the jetties indicated the seaward 300 ft of each jetty had crown elevations ranging from -2.0 to +6.0 ft and no semblance of a crown width. |
| 1985 | The jetties were to be rehabilitated to minimize shoaling of the federal channel. The seaward 290 ft of each jetty was to be made sand tight by placing core stone and cover stone on the outer face at a 1-V:1.5-H slope. Crown elevation was to be +4.0 ft mlw, with a crown width up to 15.0 ft along the sections with crown elevations below +4.0 ft mlw. Toe protection was to be provided by a 2.0-ft-thick by 5.0-ft-wide extension of the core stone. A double layer of 1.0-ton cover stone was to be used. It is not known if the work was done. |




TYPICAL SECTION THROUGH JETTIES
AND CHANNEL
(NOT TO SCALE)

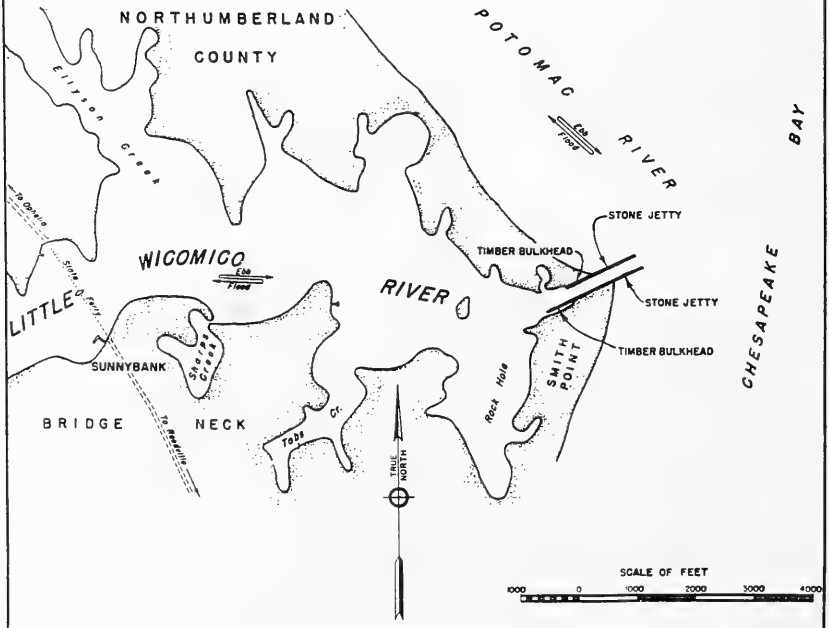



Figure 67. Little Wicomico River, Virginia

Table 55

Urbanna Creek Jetties

Urbanna, Virginia

Norfolk District

| Date(s) | Construction and Rehabilitation History |
|---|---|
| 1956 | Two jetties were constructed for channel control. The north jetty, 1,895 ft long, was rubble mound. The 717-ft-long south jetty was built of timber (Figure 68). |
| 1962 | The north jetty was rehabilitated. |
| 1986 | No further repair or maintenance information has been found. |

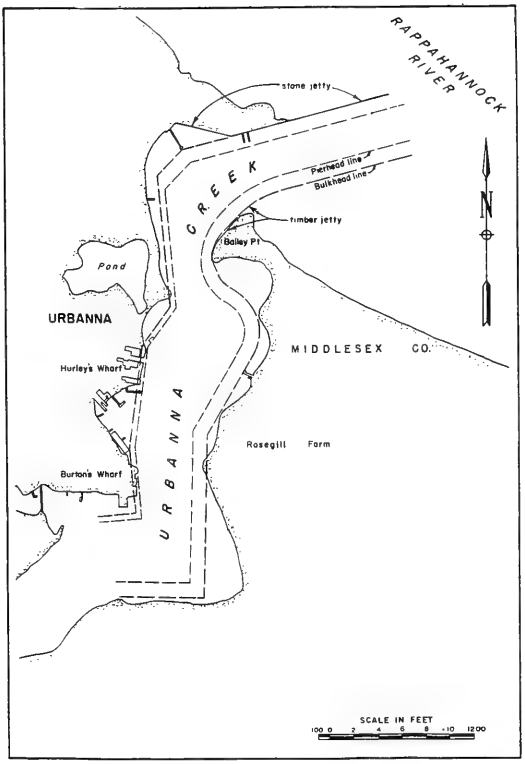



Figure 68. Urbanna Creek, Virginia

Table 56

Carters Creek Jetty, Crab Point, Virginia

Norfolk District

| Date(s) | Construction and Rehabilitation History |
|---|---|
| 1902-1906 | A 742-ft-long rubble-mound jetty was built to provide channel control (Figure 69). |
| 1986 | No further repair or maintenance information has been found. |

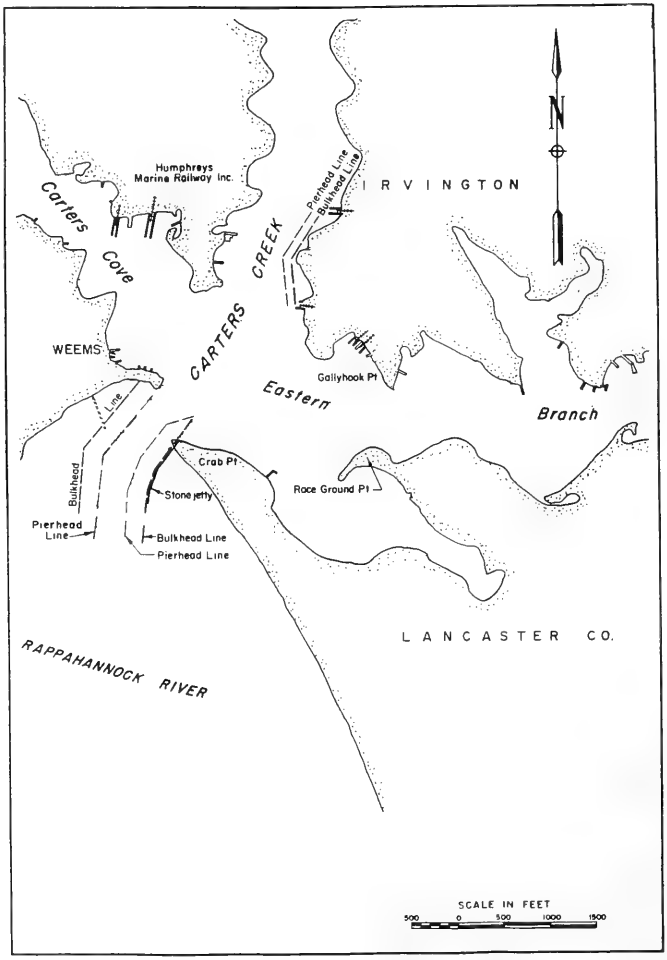



Figure 69. Carters Creek, Virginia

Table 57

Milford Haven Jetty

Narrows Point, Virginia

Norfolk District

| Date(s) | Construction and Rehabilitation History |
|---|---|
| 1913 | A 1,183-ft-long rubble-mound jetty was constructed to provide channel control (Figure 70). |
| 1986 | No further repair or maintenance information has been found. |

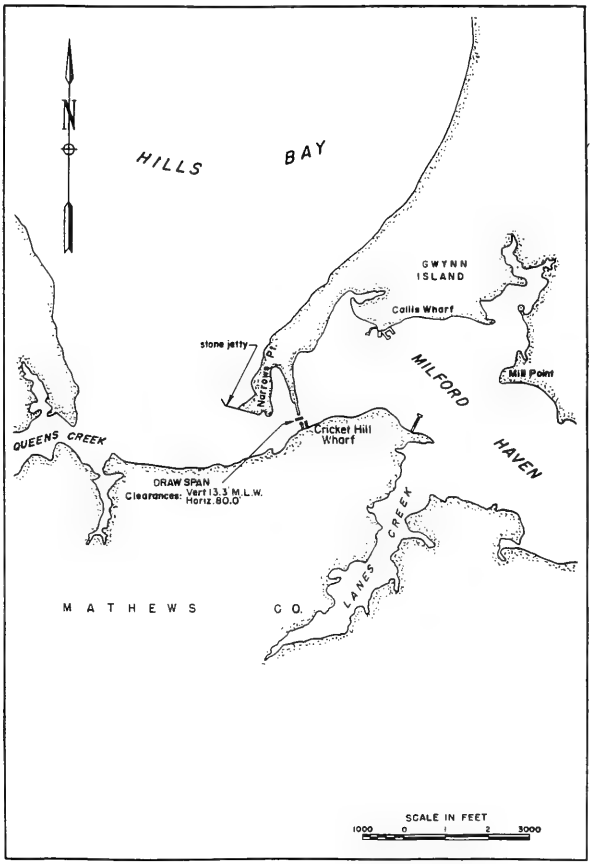



Figure 70. Milford Haven, Virginia

Table 58

Tylers Beach Jetties

Isle of Wight County, Virginia

Norfolk District

| Date(s) | Construction and Rehabilitation History |
|---|---|
| 1981 | Two parallel rubble-mound jetties were constructed to provide channel control. Both jetties were 370 ft in length and spaced 120 ft apart (Figure 71). Crest elevation was +5.0 ft mlw but allowed for 0.5 to 1.0 settlement; crown width was 5.0 ft; and side slopes were 1V:2H. One layer of armor stone, 300 to 500 lb, was placed over one layer of core stone, 3.0 to 40 lb. The jetties rested on a 2.0-ft-thick sand blanket. The sand was encased by filter fabric. A 5.0-ft-wide, 1.5-ft-thick apron and a 5.0-ft-wide, 3.0-ft-thick apron were placed on the shore and channel sides, respectively (Figure 71). A 6.0-sec, 4.1-ft design wave was used. Estimated cost of construction was $245,000. |
| 1986 | No further repair or maintenance information has been found. |

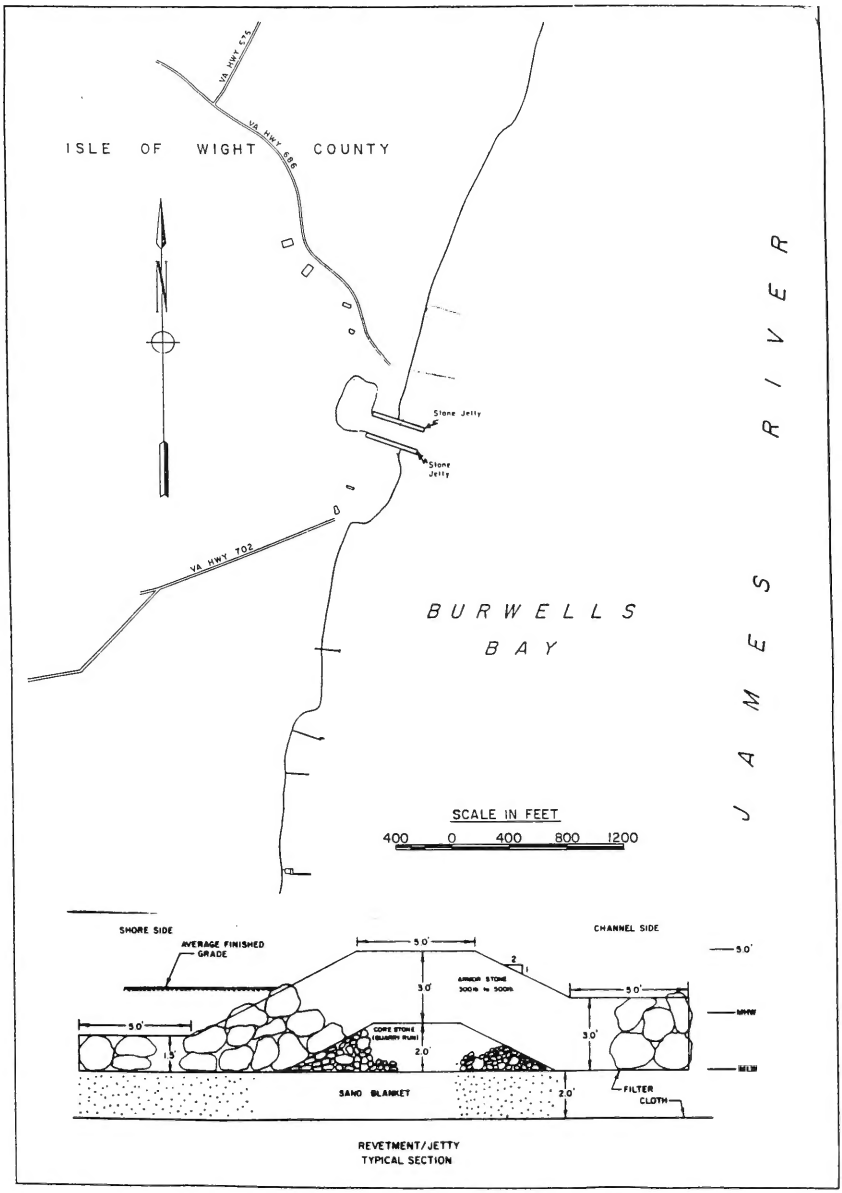



Figure 71. Tylers Beach, Virginia