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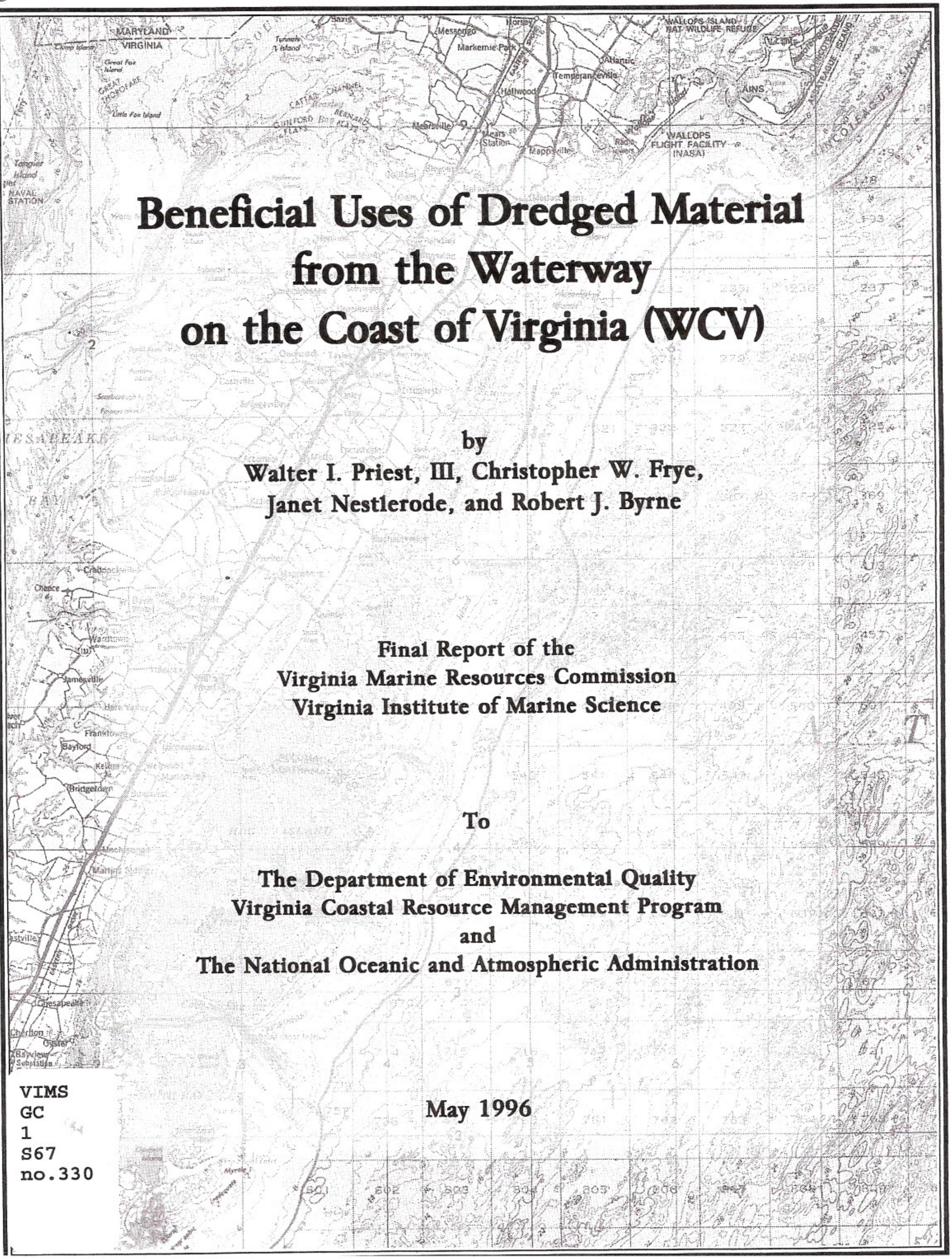

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Final Report of the
Virginia Marine Resources Commission
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To

The Department of Environmental Quality
Virginia Coastal Resource Management Program
and
The National Oceanic and Atmospheric Administration

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I. Introduction

The Waterway on the Coast of Virginia (WCV) is an inland waterway along the Atlantic coast between Virginia's barrier islands and the Eastern Shore mainland, extending from Cape Charles to Chincoteague Bay. Segments of the WCV were originally designated under the Intracoastal Waterway and provided a protective navigational route along the eastern seaboard. The quiescent waters found within the marsh/lagoon complex behind the barrier islands provided this protection, but the depositional nature of the area made maintaining a navigational channel difficult. The current project is maintained by the Norfolk District of the U. S. Army Corps of Engineers (Corps) as a Federal Project channel (Plate 1). Since 1962, an average of 275,000 cubic yards of material per year have been dredged from the channel of the WCV and placed within a variety of nearby estuarine habitats.

Traditionally the Corps has held the responsibility of evaluating each dredging project and identifying the potential placement sites within the seaside lagoons that would adhere to a 50-year dredging plan. Once the Corps identified their preferred placement sites, a Joint Permit Application was submitted to the State depicting the site locations and the estimated amount of material to be dredged. As a result, it sometimes was difficult to realize the effort expended by the Corps during their internal assessment and what environmental considerations were made.

A more comprehensive approach proposed by this plan, would be to involve a broader based interest group during the preliminary site selection process. The result would be a group decision over the proposed dredged material placement sites that incorporates beneficial uses, lessens the environmental impacts, and considers value engineering.

There is increased acknowledgment that dredged materials can have environmentally beneficial uses. For several decades the Corps has utilized the concept of beneficial uses of dredged material throughout the United States. Examples of beneficial uses vary from shoreline stabilization and erosion control to marsh creation, oyster reefs, and upland sites suited for bird and wildlife use. Several beneficial use-type projects have been accomplished within the Chesapeake Bay region. They include Barren Island (1981), Smith Island (1987), Slaughter Creek (1987), Eastern Neck National Wildlife Refuge (1993), and Kenilworth Marsh (1991)[1]. Within Virginia beneficial uses of dredged material have mostly centered on beach nourishment (e.g Virginia Beach, Willoughby Spit, Queens Creek, and others).

The Barren Island project is an example of how sandy dredged material can be placed along a shoreline to abate erosion as well as creating vegetated wetlands and high marsh habitat capable of sustaining avian wildlife. In the Slaughter Creek project fine-grained dredged material was placed overboard in a mound configuration and planted with oyster cultch to mimic a natural oyster reef. The Eastern Neck National Wildlife Refuge project is another example of placing dredged material along an eroding shoreline, in conjunction with offshore breakwaters, to abate erosion. The intertidal portion of that placement area was also sprigged with smooth and saltmeadow cordgrass, creating a vegetated wetland.

Although a fair number of these projects may have been designed with a single goal in mind such as marsh creation, oyster reef creation, shoreline protection, and development of upland wildlife habitat, the end product benefits a wide range of communities and organisms. For example, an overboard placement area that is mounded and planted with oyster cultch not only provides a more desirous habitat for oyster spat to attach and flourish, but the new substrate provides a similar structural habitat for other organisms. Many valuable fish species, as well as the very important blue crab, are known to orient and feed around oyster reefs. In addition, oysters are filter feeders that remove algae and suspended solids from suspension, thereby having a positive influence on water quality.

Intertidal wetlands created from dredged material can protect an eroding headland, but the wetlands also provide foraging areas for wildlife and refuge for juvenile finfish and crabs. The vegetated wetlands also serve as a natural filter by removing sediments, nutrients, and other matter transported by upland runoff into the adjacent waterways.

Since each dredged material placement practice has a host of potential benefits which are intertwined with estuarine ecology, it is difficult to singularly define a placement project with respect to a targeted beneficial use. It might be more appropriate to refer to beneficial uses in broader terms, such as habitat creation or modification. It should be noted, however, that at each placement site one targeted habitat may be more appropriate than another. Selecting the best placement option will depend on the physical characteristics of the site, nature of the material to be dredged, and the resource tradeoffs especially associated with benthic habitats (see Chapter V). For the purposes of this report, beneficial uses will be described as they have been in the past (i.e. oyster reef habitat, marsh creation and protection, beach nourishment, etc.).

The primary factors to be considered when determining what type of structure or habitat can be constructed from dredged material are the geotechnical properties and the method by which it will be dredged. Hydraulically dredged, unconfined, coarse-grained material (sand and gravel) will stack more quickly and steeper than fine-grained material such as silt and clay. Coarse-grained materials are also more resistant to erosion processes, making them desirable for beach nourishment, marsh erosion control, and basement substrate for oyster habitat. The beneficial uses or habitat options are somewhat limited within the Eastern Shore barrier island system due to the fine-grained nature of the dredged material and the remoteness of the dredging sites. There are, however, slight variances in the character of the dredged material along the entire WCV which improve the pool of potential placement options.

Most of the material dredged from the WCV is a mixture of silt, clay, and some sand. There are a number of potential beneficial uses, according to the particle size, for these types of sediments: upland uses, oyster habitat creation, avian nesting and foraging habitat, wetland creation, and beach nourishment. The dredged materials generated from the WCV navigation project have traditionally been placed in open water sites, intertidal mudflats, contained upland sites, and along eroding marshes and beaches. Although Virginia's resource agencies and navigation experts have realized that incidental benefits could accrue from these placement practices, there has been little effort to develop a comprehensive plan that would exploit the material generated from the WCV.

The goal of this project is to develop a long-range management plan for the placement of dredged material from the WCV. This management plan will provide a set of goals, objectives, and mechanisms upon which long-term planning and the appropriate beneficial use options can be based. Furthermore, this report focuses intensively on assessing the environmental impacts to the Eastern Shore's benthic community since this is the habitat most often disturbed by the maintenance of the WCV. This and other information was collected, compiled, and included in this report to support the management plan.

II. Historical Dredging and Placement

Background

The Waterway on the Coast of Virginia (WCV) was authorized in the River and Harbor Act of 1910 with modifications in the River and Harbor Act of 1945. The project, completed by 1959, provides for a waterway channel of six foot depth and sixty foot width between Chincoteague Bay and the Chesapeake Bay at Cape Charles. Similar sectional waterways were authorized and realized along the Maryland and Delaware coastal embayments. In 1970 Congress authorized development of a continuous Delaware Bay-Chesapeake Bay Waterway which would connect and enhance the sectional projects. Due to prohibitive cost, the project was not engaged [2,3]. Maintenance of the Virginia waterway, however, continues under authorization of the WCV.

Dredging History

Of the total length of approximately 85 miles much of the WCV waterway follows channels with natural depths exceeding project depths. Some 15 sections do require periodic maintenance dredging (Plate 1). For the most part, the areas that shoal transit shallow bays exposed to wind wave agitation as well as tidal currents that contribute to sedimentation in the channels. Since 1962 the total maintenance dredging (Table 1) amounts to approximately 9 million cubic yards(MCY) [4].

Dredge Material Placement Sites

During initial construction and subsequent maintenance a large number of placement sites have been utilized. Some sites have been used on a continuing basis but many have been used on a periodic basis. The geographic distribution of placement sites is shown in Plates 2 through 13 which is keyed, in Table 2, to the dredging dates and sites utilized.

Virtually all dredging is effected using hydraulic methods with disposal achieved via pipeline to overboard or upland sites. Table 3 indicates the site characteristics as:

- Overboard
- Marsh, diked
- Marsh, unconfined
- Upland
- Beach Nourishment

The locations of all the dredged sections of the WCV channel and any corresponding overboard placement sites shown in Plates 2 through 13 have been entered into the VMRC mapping system. By integrating the survey data collected by the Corps with the survey information found in the VMRC mapping system, a highly useful tool is now available that will assist in the process of selecting dredged material placement sites and beneficial use options.

The following provides a brief description of each of the project areas and a summary of the dredging history.

Chesapeake Bay to Magothy Bay (Plate 2)

The southern reach of the WCV begins by connecting the Chesapeake Bay to Magothy Bay through Fishermans Inlet and a man-made canal between Raccoon Island and the mainland. The total length of this reach is approximately 23,000 linear feet and at least one million cubic yards of material have been maintenance dredged from this reach over a 30-year period. The maintenance material generated from this section of the WCV has a high concentration of sand and has typically been placed along eroding shorelines (CBMB1, 2, 6 and 7). Some of these placement sites have provided positive benefits to the avian community. However, a large amount of material was placed on marsh during the initial construction and now harbors

Table 1. Summary of Maintenance Dredging

Channel Segment	Total Maintenance Dredging - CY	Time Period	Approximate Dredging Frequency (Years)
Chesapeake Bay to Magothy Bay	1,029,792	1962 to 1993	5
Magothy Bay (north)	369,508	1977 to 1993	4
Eckichy Marsh Channel	68,406	1991	
Gull Marsh Flats	1,427,409	1962-1994	4
North Channel	943,346	1963-1992	4
Sloop Channel	804,156	1962-1992	4
Swash Bay & White Trout Creek	1,215,081	1962-1993	5
Bradford Bay	358,382	1962-1991	7
Burtons Bay and Cedar Island Bay	1,110,613	1962-1994	4
Metompkin Bay	1,308,675	1963-1993	6
Gargathy Inlet	67,490	1961-1974	
Kegotank Bay & Northern Narrows	280,914	1964-1983	6
Bogues Bay	20,189	1978	
Hog Creek	178,133	1974-1991	8
Lewis Creek	113,662	1972-1992	
TOTAL	9,295,756		

Table 2. Placement Sites Utilized for Channel Maintenance. See Plates 1 through 13 for Locations

DELAWARE BAY - CHESAPEAKE BAY WATERWAY
(Previous Project - Waterway on the Coast of Virginia)
Accomack - Northampton County

Chesapeake Bay to Magothy Bay

Date Dredged	C.Y. Dredged	Placement Sites (CBMB)							
		1	2	3	4	5	6	7	8
June-September 1958	NW	✓		✓	✓	✓		✓	
July 1960	Maintenance & Widening	✓	✓						
January-May 1962	114,160	✓	✓					✓	
April-May 1964	86,450				✓?				
July 1964	39,263							✓?	
March-April 1965	78,694	✓	✓						
May 1966	63,195	✓							
May-June 1967	133,636	✓		✓					✓
October-November 1967	90,010								
June-July 1969	72,901								
June-July 1970	24,116	✓							
March-May 1972	91,239	✓							
October 1976	43,495	✓							
April-May 1982	108,607								
February 1988	51,896	✓							
April 1993	32,130						✓?		

Table 2 (continued)

DELAWARE BAY - CHESAPEAKE BAY WATERWAY
(Previous Project - Waterway on the Coast of Virginia)
Accomack - Northampton County

Magothy Bay

Date Dredged	C.Y. Dredged	Placement Sites (MB)			
		1	2		
October-November 1977	144,257	✓?			
1982	?				
March-April 1987	102,852		✓?		
February 1990	50,635		✓?		
December 1993	71,764		✓?		

Table 2 (continued)

DELAWARE BAY - CHESAPEAKE BAY WATERWAY
(Previous Project - Waterway on the Coast of Virginia)
Accomack - Northampton County

Eckichy Marsh Channel

Date Dredged	C.Y. Dredged	Placement Sites (ECM)			
		1	2		
June 1969	24,484(NW)	✓			
October 1991	68,406		✓		

Gull Marsh Flats

Date Dredged	C.Y. Dredged	Placement Sites (GMF)			
		1	2	3	
September 1958	(NW)	✓			
September 1962	150,980		✓		
March 1965	133,203		✓		
June-July 1969	185,991	?			
March-May 1976	231,191			✓	
March-April 1982	274,805			✓	
March 1986	204,871			✓	
July 1991	120,586			✓	
January-February 1994	125,782			✓	

Table 2 (continued)

DELAWARE BAY - CHESAPEAKE BAY WATERWAY
(Previous Project - Waterway on the Coast of Virginia)
Accomack - Northampton County

North Channel

Date Dredged	C.Y. Dredged	Placement Sites (NC)			
		1	2	3	
August 1957	(NW)	✓	✓		
February 1963	97,990	✓	✓		
June 1967	115,161			✓	
January-March 1972	120,278			✓	
March 1975	139,574			✓	
April 1982	114,868			✓	
February 1986	101,914			✓	
May 1989	110,626			✓	
June 1992	142,935			✓	

Sloop Channel

Date Dredged	C.Y. Dredged	Placement Sites (SC)			
		1	2	3	4
August 1957	(NW)	✓	✓	✓	
October 1962	106,900	✓	✓	✓	
July 1967	161,890	✓	✓	✓	
January 1974	113,580				✓
November 1977	92,565	✓	✓	✓	
May 1982	97,189	✓	✓	✓	
March 1986	82,303	✓	✓	✓	
May 1989	62,247	✓	✓	✓	
June-July 1992	87,482		✓		

Table 2 (continued)

DELAWARE BAY - CHESAPEAKE BAY WATERWAY
(Previous Project - Waterway on the Coast of Virginia)
Accomack - Northampton County

Swash Bay & White Trout Creek

Date Dredged	C.Y. Dredged	Placement Sites (SBWT)						
		1	2	3	4	5	6	7
August 1957	(NW)	✓	✓	✓				
October 1962	178,645	✓	✓	✓				
July 1967	208,822	✓	✓	✓				
January-February 1974	239,990				✓	✓		
October 77-January 1978	157,589	✓	✓	✓				
September - November 1983	187,100 (SB)			✓				✓
September -November 1983	83,500 (WT)	✓			✓			
March 1988	47,886							✓?
March-April 1993	111,519						✓	

Table 2 (continued)

DELAWARE BAY - CHESAPEAKE BAY WATERWAY
(Previous Project - Waterway on the Coast of Virginia)
Accomack - Northampton County

Bradford Bay

Date Dredged	C.Y. Dredged	Placement Sites (BB)			
		1	2	3	4
July 1957	(NW)	✓			
October 1962	65,566	✓			
July-August 1967	47,150	✓			
March 1977	101,802	✓			
November 1983	37,000			✓	
November 1983	41,000		✓		
October 1991	65,850				✓

Table 2 (continued)

DELAWARE BAY - CHESAPEAKE BAY WATERWAY
(Previous Project - Waterway on he Coast of Virginia)
Accomack - Northampton County

Burtons Bay and Cedar Island Bay

Date Dredged	C.Y. Dredged	Placement Sites (BBCIB)			
		1	2	3	4
June 1957	(NW)	✓	✓		
November 1962	139,776	✓	✓		
September 1967	193,276	✓	✓		
July 1969	21,752	✓			
December 1973	194,186	✓			
December 77 - January 1978	176,618	✓			
April-September 1983	198,635	?	?		
April-June 1987	95,326			✓	✓
November-December 1992	39,250			✓	✓
February 1994	51,794			?	?

Table 2 (continued)

DELAWARE BAY - CHESAPEAKE BAY WATERWAY
(Previous Project - Waterway on the Coast of Virginia)
Accomack - Northampton County

Metompkin Bay

Date Dredged	C.Y. Dredged	Placement Sites (MTB)								
		1	2	3	4	5	6	7	8	9
November 62-February 1963	699,350(NW)	✓	✓	✓	✓	✓	✓			
September 1967	217,853						✓			
February-September 1973	498,851	✓			✓				✓	
October-November 1986	465,375							✓		✓
1990	?									
January-February 1993	126,596							✓		✓

Table 2 (continued)

DELAWARE BAY - CHESAPEAKE BAY WATERWAY
(Previous Project - Waterway on the Coast of Virginia)
Accomack - Northampton County

Gargathy Inlet

Date Dredged	C.Y. Dredged	Placement Sites (GI)			
		1	2		
September 1957	(NW)	✓	✓		
November-December 1961	18,730	✓	✓		
July 1964	4,313	✓			
March 1965	7,930	✓			
August 1967	3,832	✓			
August 1969	5,660	✓			
June 1970	9,128	✓			
January 1972	7,551	✓			
February 1974	10,346	✓			

Table 2 (continued)

DELAWARE BAY - CHESAPEAKE BAY WATERWAY
(Previous Project - Waterway on the Coast of Virginia)
Accomack - Northampton County

Kegotank Bay & Northam Narrows

Date Dredged	C.Y. Dredged	Placement Sites(KBNN)			
		1	2	3	4
October-November 1958	(NW)	✓	✓		
June-July 1964	108,194	✓		✓	
May-June 1970	133,756	✓		✓	✓
February-March 1978	27,542			✓	
August-October 1983	11,422	✓			

Bogues Bay

Date Dredged	C.Y. Dredged	Placement Sites (BB)			
		1	2	3	4
January-February 1978	20,189	✓?			

Table 2 (continued)

DELAWARE BAY - CHESAPEAKE BAY WATERWAY
(Previous Project - Waterway on the Coast of Virginia)
Accomack - Northampton County

Hog Creek

Date Dredged	C.Y. Dredged	Placement Sites (HC)			
		1	2	3	4
February 1974	55,121	✓			
October 1983	64,077	✓			
August 1991	58,935	✓			

Lewis Creek

Date Dredged	C.Y. Dredged	Placement Sites (LC)			
		1	2	3	4
August-October 1963	80,255 (NW)	✓	✓	✓	
February-May 1972	34,415		✓		
August 1992	79,247				✓

Table 3. Character of Dredge Material Placement Sites

	Chesapeake Bay to Magothy Bay (CBMB)								Magothy Bay (MB)		Eckichy Marsh (ECM)		Gull Marsh Flats (GMF)			North Channel (NC)			Sloop Channel (SC)				Swash Bay/White Trout (SBWT)						
	1	2	3	4	5	6	7	8	1	2	1	2	1	2	3	1	2	3	1	2	3	4	1	2	3	4	5	6	7
Overboard	✓	✓					✓	✓	✓	✓		✓	✓	✓	✓	✓	✓	✓	✓	✓		✓			✓		✓	✓	✓
Marsh, Diked					✓	✓					✓												✓	✓		✓			
Marsh, Unconfined			✓	✓																	✓								
Upland																													
Beach Nourishment	✓					✓	✓																						

	Bradford Bay (BB)				Burtons Bay/Cedar Island Bay (BBCIB)					Metompkin Bay (MTB)									Gargathy (GI)		Kegotank Bay/ Northern Narrows(KBNN)				Bogues Bay/ Hog Creek (BB) (HC)	
	1	2	3	4	1	2	3	4	5	1	2	3	4	5	6	7	8	9	1	2	1	2	3	4	1	1
Overboard	✓	✓	✓	✓		✓	✓	✓	✓					✓	✓	✓	✓	✓			✓					
Marsh, Diked										✓	✓															
Marsh, Unconfined												✓	✓									✓	✓	✓	✓	
Upland					✓																					✓
Beach Nourishment																			✓	✓						

large stands of *Phragmites australis* (CBMB3, 4, and 5).

Magothy Bay (Plate 3)

The WCV extends northward from lower Magothy Bay through upper Magothy Bay and into Mockhorn Channel. The shallowest section of the WCV in this area occurs in upper Magothy Bay where approximately 7,800 linear feet of channel requires maintenance dredging. The amount of material maintenance dredged since 1977 is approximately 370,000 cubic yards. According to historical records, all of this material has been placed overboard on subaqueous bottom (Table 3).

Eckichy Marsh Channel and Gull Marsh Channel (Plate 4)

The WCV follows Mockhorn Channel northward to Sand Shoal Channel, where it then turns to the east and continues towards Sand Shoal Inlet. As the WCV approaches the oceanside, it turns northwest into Eckichy Channel at channel marker 224. A short section of the WCV channel near Eckichy Marsh has experienced minor sedimentation, therefore, requiring maintenance dredging on two separate occasions. The dredged material resulting from these episodes has been placed on marsh (ECM1) and in an overboard site (ECM 2). The material placed against and upon the vegetated marsh at ECM1 has provided some erosion protection and possible benefits to colonial waterbirds.

From Eckichy Marsh the WCV continues through Spidercrab Bay in a northeasterly direction within Gull Marsh Channel. Gull Marsh Channel contains approximately 7,200 linear feet of shoal. Table 1 indicates that this section of the WCV has had over 1.4 million cubic yards of material removed over a 32-year period, the greatest amount of all of the WCV shoals. The entire 1.4 million cubic yards of dredged material has been placed overboard onto subaqueous bottom (GMF1, 2, and 3). Several intertidal hummocks emerged from subaqueous bottom as a result of the successive placement of dredged material within those same areas.

North Channel (Plate 5)

Where Gull Marsh Channel merges with Great Machipongo Channel, the WCV turns north through Hog Island Bay. At channel marker 186, the WCV then turns northeast into North Channel. A 5,100 linear foot section of North Channel has yielded 943,000 cubic yards of maintenance material over a 29-year period. All of the material has been placed overboard on subaqueous bottom (NC1, 2, and 3). Based on surface grab samples, the material appears to be a mixture of sand, silt, and clay. Records indicate that several areas within the above-referenced placement sites were subsequently leased by seaside waterman. Apparently the placement sites became suitable habitat for oysters to set and grow.

Sloop Channel (Plate 6)

The WCV follows North Channel to Cunjer Channel where it traverses the northern end of Hog Island Bay, heading towards Sloop Channel. The southern portion of Sloop Channel, approximately 5,100 linear feet, has required the removal of approximately 840,000 cubic yards of material over a 30-year period. The majority of the fine-grained dredged material has been placed overboard and adjacent to an eroding marsh fringe (SC1, 2, and 4), but in 1974 113,580 cubic yards were placed unconfined on an intertidal marsh site (SC3). Several of these placement sites have been utilized as nesting habitat by colonial waterbirds.

Swash Bay and White Trout Creek (Plate 7)

The WCV follows Sloop Channel to the northeast until it crosses Sandy Island Channel, and then enters Little Sloop Channel along the western side of Revel Island Bay. These areas remain naturally deep and do not require any maintenance dredging. Little Sloop Channel converges with White Trout Creek at the head of The Swash, where the WCV then turns north into White Trout Creek and towards the southern end of Swash Bay.

Approximately 4,500 linear feet of White Trout Creek and 8,400 linear feet of Swash Bay require maintenance dredging. It is difficult to determine the volume of maintenance material that has been removed from each of the two projects, since they are usually accomplished under the same contract. A combined total of 1.2 million cubic yards of maintenance material has been dredged over a 31-year period. The fine-grained material has been placed in confined marsh sites (SBWT1, 2, and 4), as well as overboard on subaqueous bottoms (SBWT3, 5, 6, and 7).

Records indicate that dredged material was initially placed near SBWT2 in an unconfined manner, the area subsequently became a heron rookery. Moreover, dredged material placed on subaqueous bottoms along the western side of Swash Bay Channel created well developed intertidal mounds that became suitable oyster habitat. SBWT2 is no longer used as a rookery, but the intertidal mounds on the west side of Swash Bay remain under private lease by watermen.

Bradford Bay (Plate 8)

The WCV enters Seal Creek at the northern end of Swash Bay and continues northeasterly until reaching Millstone Creek. Once into Millstone Creek the WCV turns northwest towards Bradford Bay. Within Bradford Bay there is a 7,200 linear foot section of the WCV that requires maintenance dredging. Approximately 358,000 cubic yards of dredged material has been removed from this section of the WCV since 1962 and placed in overboard sites (BB1, 2, 3 and 4). Site BB3 was located near an eroding marsh fringe and may have provided some erosional protection for the high marsh. It should also be noted that material placed along the southwestern side of the dredged channel (BB1 and 2) created intertidal mounds that became productive oyster habitat.

Burtons Bay and Cedar Island Bay (Plate 9)

Upon exiting Bradford Bay, the WCV continues easterly within Wachapreague Channel until reaching Custis Channel. Custis Channel takes the WCV in a more northerly direction into Burtons Bay. There is approximately 21,500 linear feet of channel within Burtons Bay and Cedar Island Bay that requires maintenance dredging. The total amount of material maintenance dredged from these two bays since 1962 is approximately 1.1 million cubic yards. A large portion of the dredged material was hydraulically placed on upland (BBCIB1) and into an overboard site (BBCIB2). Areas of the overboard site have been leased due to the oyster habitat created. More recently, the material has been placed into other overboard sites (BBCIB3, 4, and 5).

Metomkin Bay (Plate 10)

The WCV exits Cedar Island Bay via Longboat Creek, follows Longboat Creek to a man-made passage connected with Folly Creek, and then exits Folly Creek through another man-made passage into lower Metomkin Bay.

The WCV channel through Metomkin Bay is approximately 26,400 linear feet long. Due to high sedimentation and rapid barrier island migration rates in this area, a 16,000 linear foot section of the channel was relocated during the late 1980's. Approximately 1.1 million cubic yards of material have been dredged over a 30-year period. Placement sites have varied from diked marsh (MTB1), unconfined marsh (MTB2, 3 and 4), overboard, subaqueous bottoms (MTB5 and 6), and along the oceanside of Metomkin Island (MTB7, 8, and 9). Several beneficial uses have resulted from these placement activities: portions of the previously used overboard sites have been leased by watermen for oyster cultivation, and the material pumped to the Atlantic side of Metomkin Island may have provided some erosion protection.

Gargathy Inlet, Kegotank Bay, Northam Narrows and Hog Creek (Plate 11)

Wire Passage provides a naturally deep course for the WCV to exit Metomkin Bay and continues in a northerly direction to Gargathy Inlet. Gargathy Inlet is a highly dynamic ocean inlet where sand is continuously shifting and depositing into the nearby WCV. Early records indicate that over 67,000 cubic yards of material were dredged between 1961 and 1974 with a dredging frequency of less than two years (Table 1). All of the sandy material has been placed along the oceanside of southern Assawoman Island and northern Metomkin Island (GI1 and 2) as beach nourishment material. It has also enhanced existing shorebird habitat.

From Gargathy Inlet, the WCV orignally follwed First Creek into Kegotank Bay. Due to the continued migration of southern Assawoman Island, however, First Creek has been filled entirely with sandy deposits. As a result the WCV has been relocated through Kegotank Creek into Kegotank Bay. Historically there has been a 4,800 foot section of channel through Kegotank Bay and other short channel segments within Northam Narrows that have yielded over 280,000 cubic yards of maintenance material. The material was placed unconfined on tidal marsh (KBNN2, 3, and 4) and at an overboard site (KBNN1).

Bogues Bay (Plate 12)

The WCV follows Northam Narrows to Assawoman Creek and continues through Hog Creek, Little Cat Creek, and Cat Creek into Bogues Bay. Approximately 2,000 linear feet of channel through Bogues Bay requires maintenance dredging. Over 20,000 cubic yards of material were dredged in 1978 and placed unconfined on marsh and intertidal flats (BB1). Portions of these areas have been leased by local watermen.

Lewis Creek (Plate 13)

The WCV exits Bogues Bay and follows Island Hole Narrows towards Chincoteague Inlet and Chincoteague Channel. The northern stretch of the WCV follows Chincoteague Channel into Lewis Creek, then enters Chincoteague Bay and continues into Maryland waters. Approximately 6,500 linear feet of channel has yielded 113,000 cubic yards of dredged material over a 29-year period. The material has been placed along the shoreline of Chincoteague Island (LC2 and 3), overboard in Chincoteague Bay (LC4), and on marsh (LC1).

Plate 1. Index Map

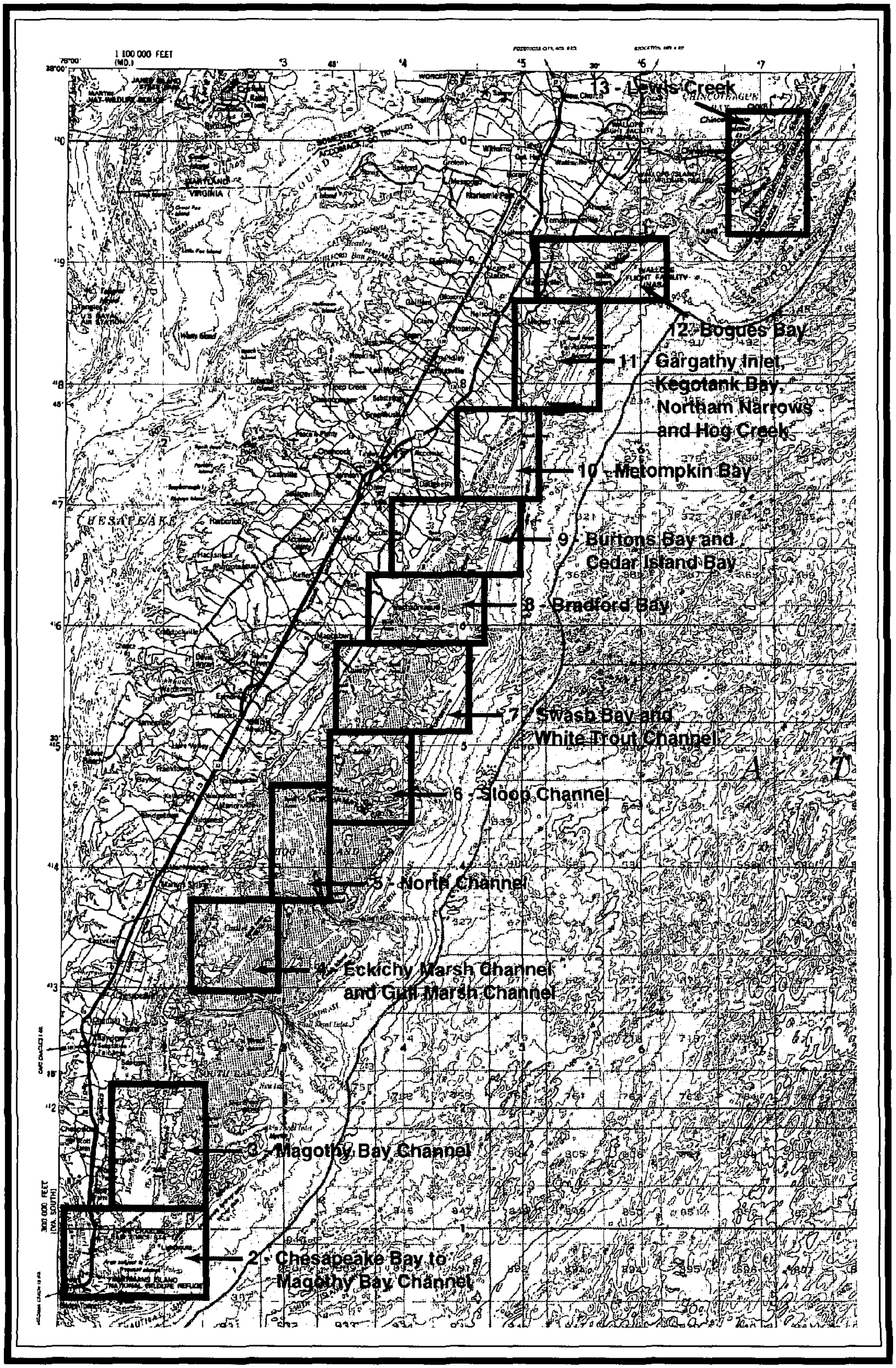


Plate 2. Chesapeake Bay to Magothy Bay Channel

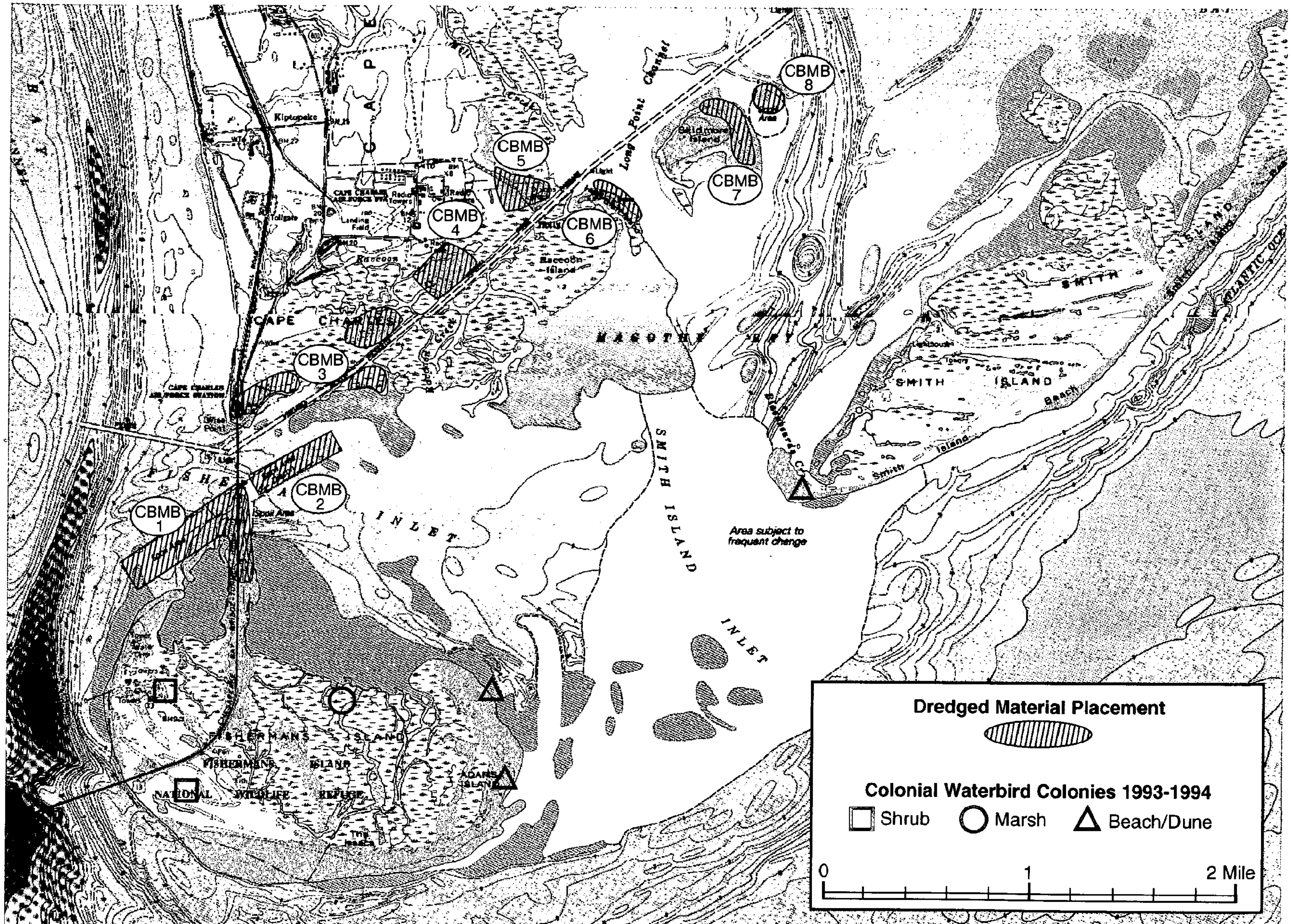


Plate 3. Magothy Bay Channel

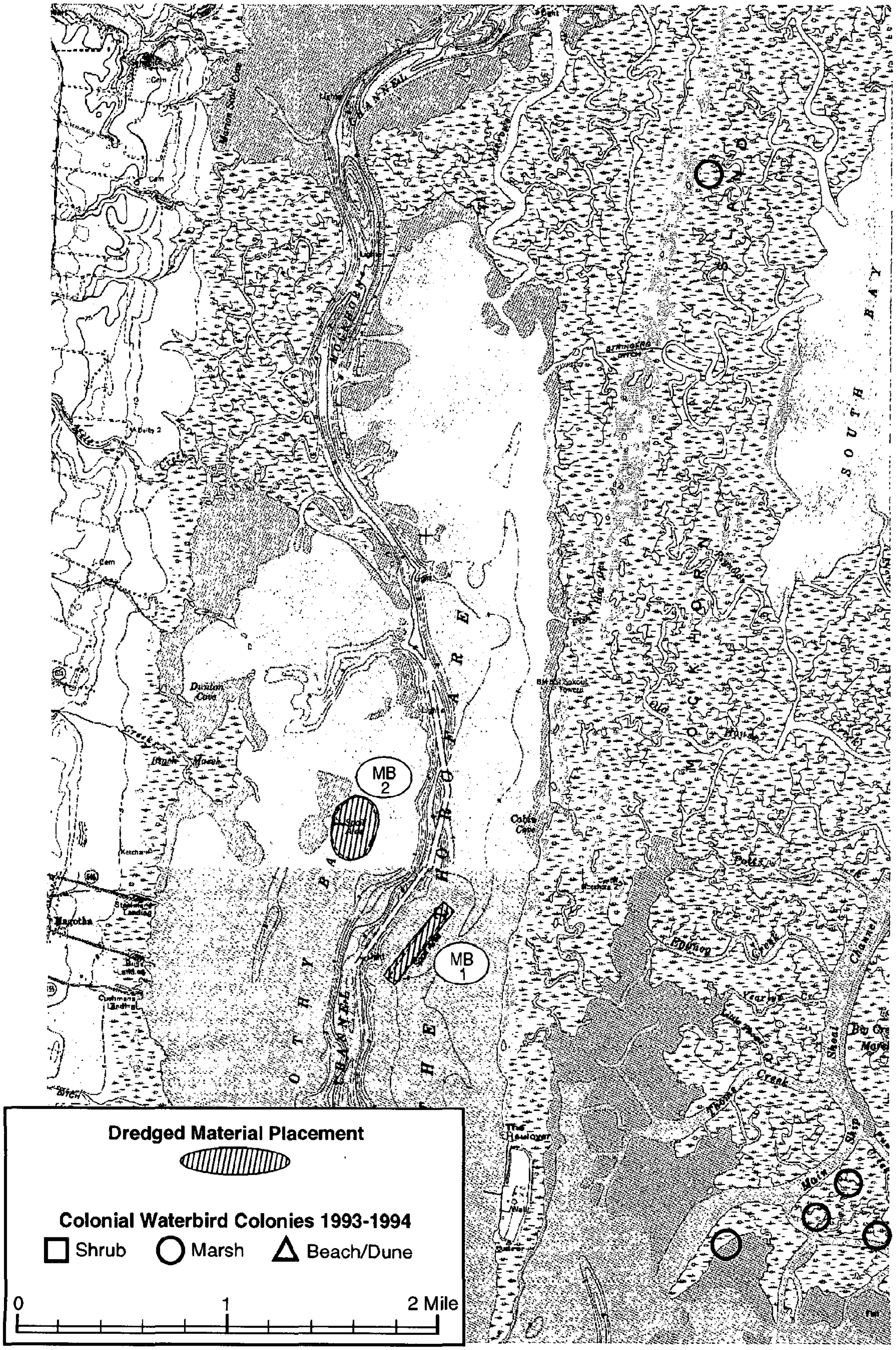


Plate 4. Eckichy Marsh Channel and Gull Marsh Channel

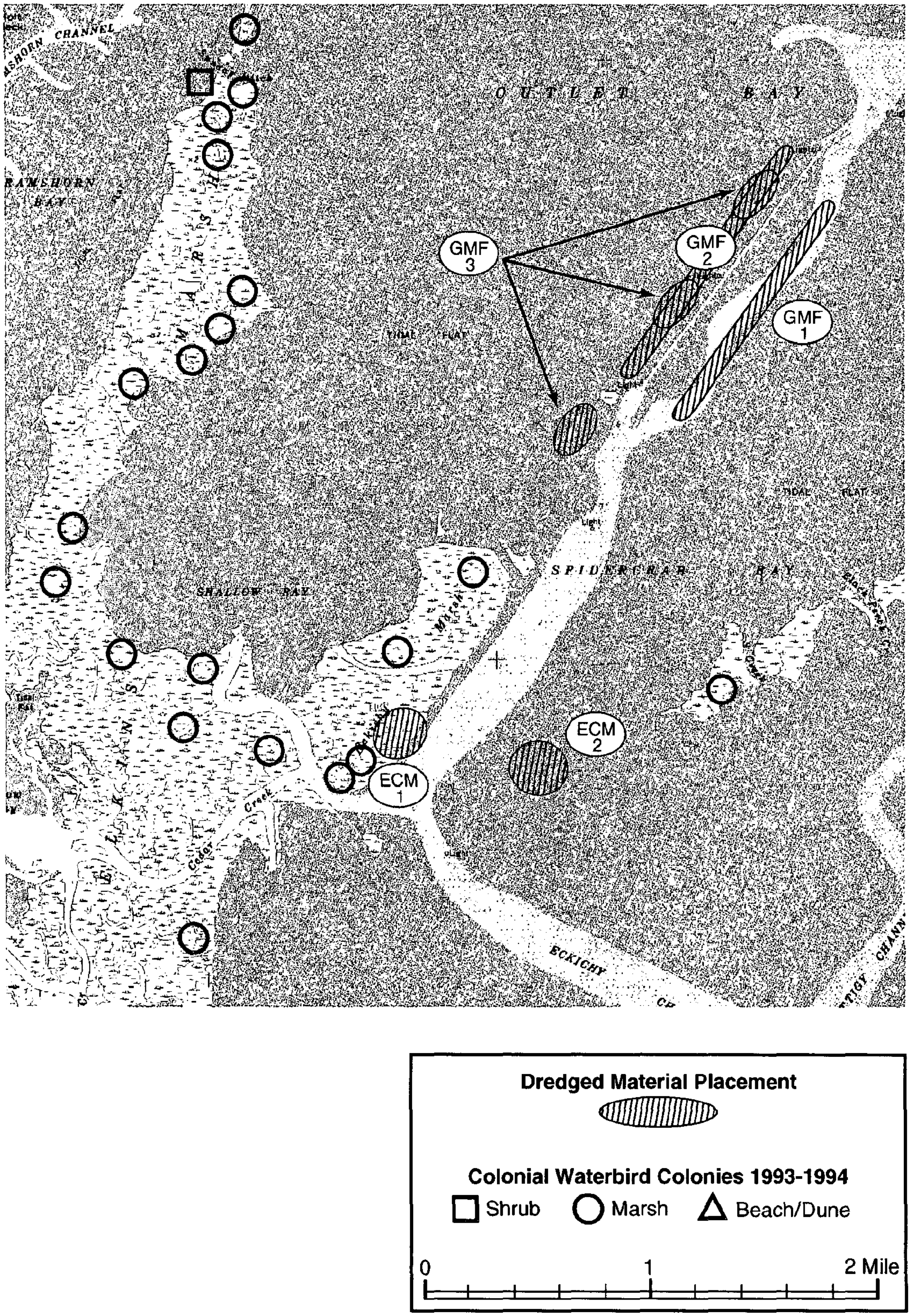


Plate 5. North Channel

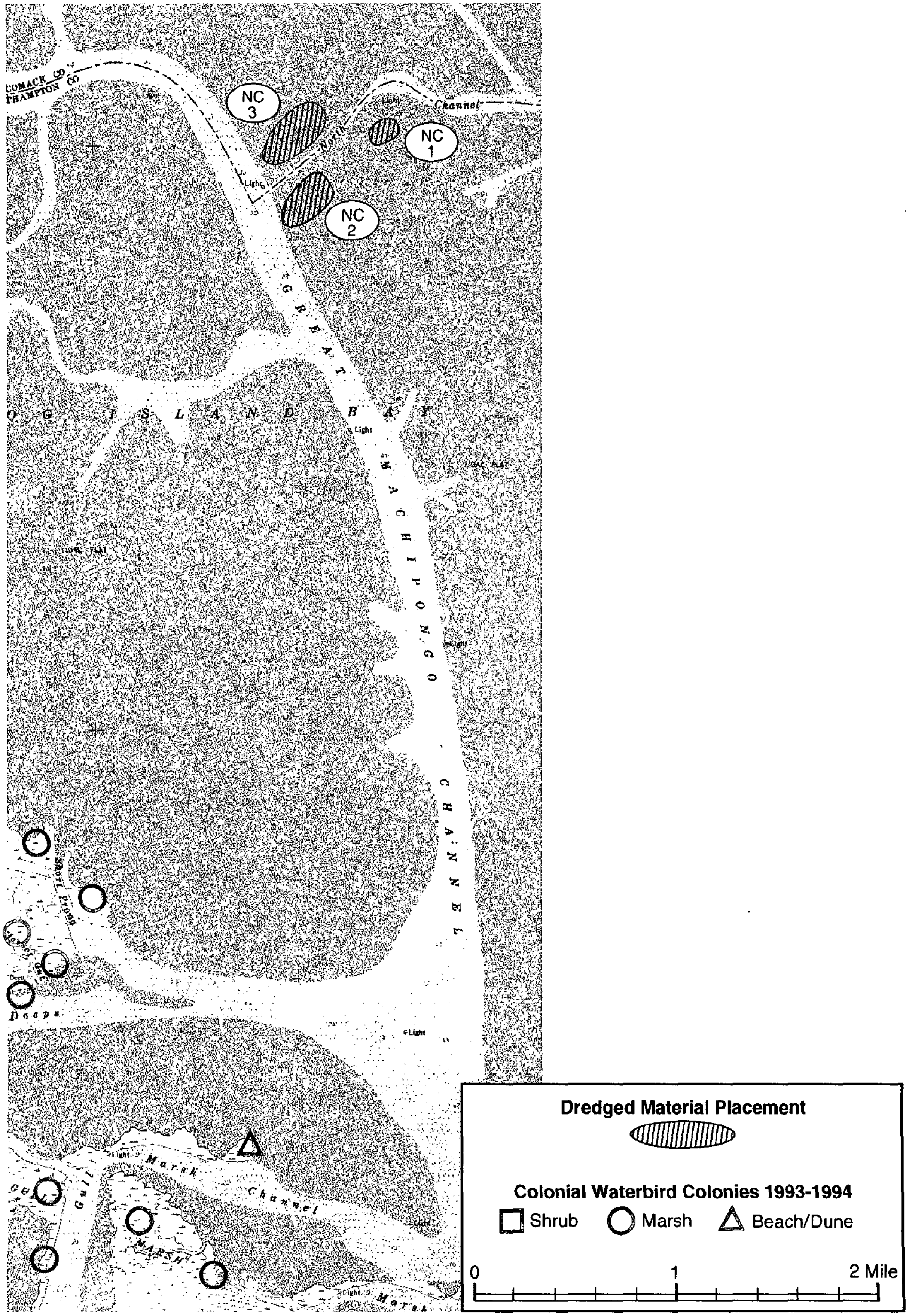


Plate 6. Sloop Channel

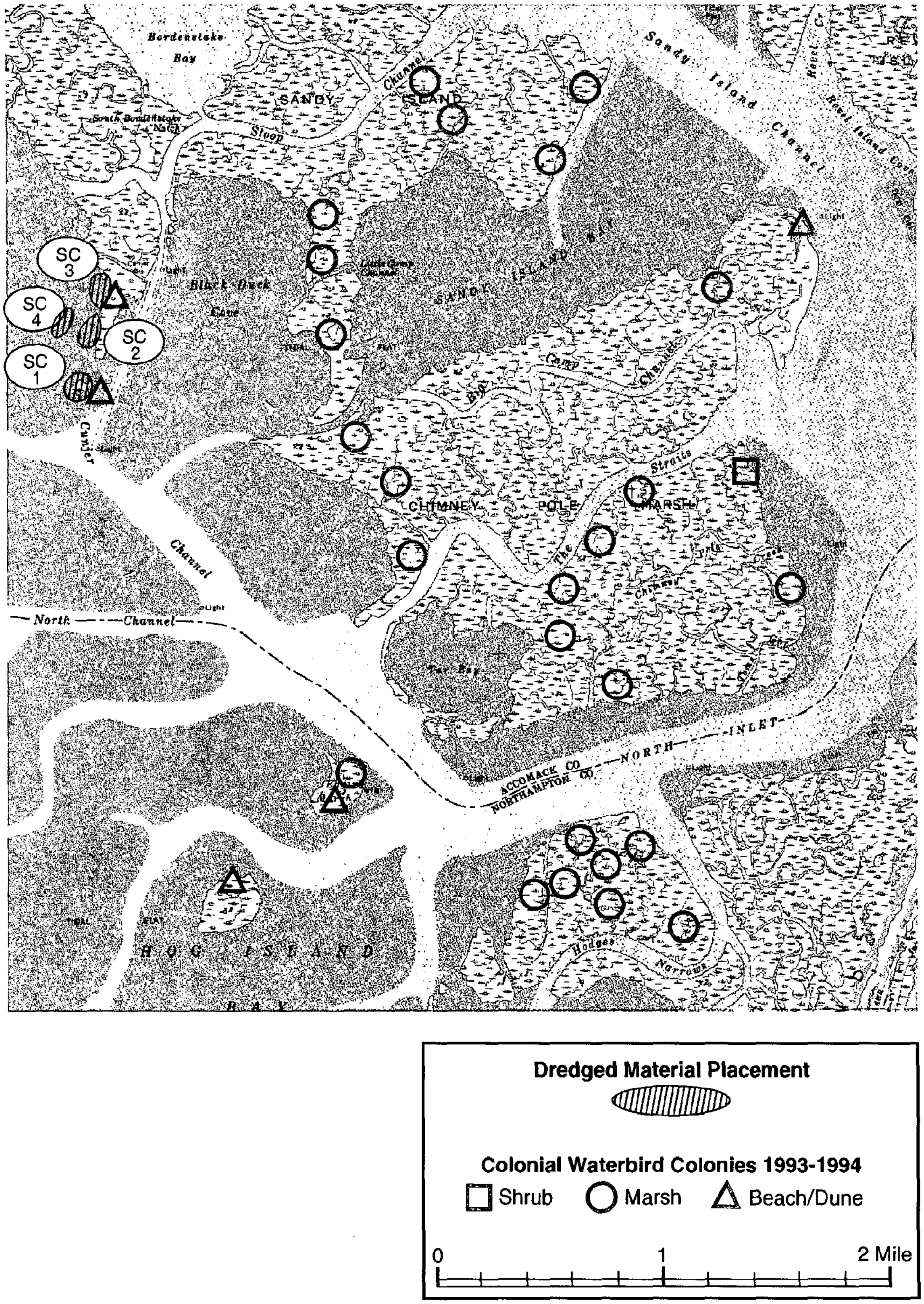


Plate 7. Swash Bay and White Trout Channel

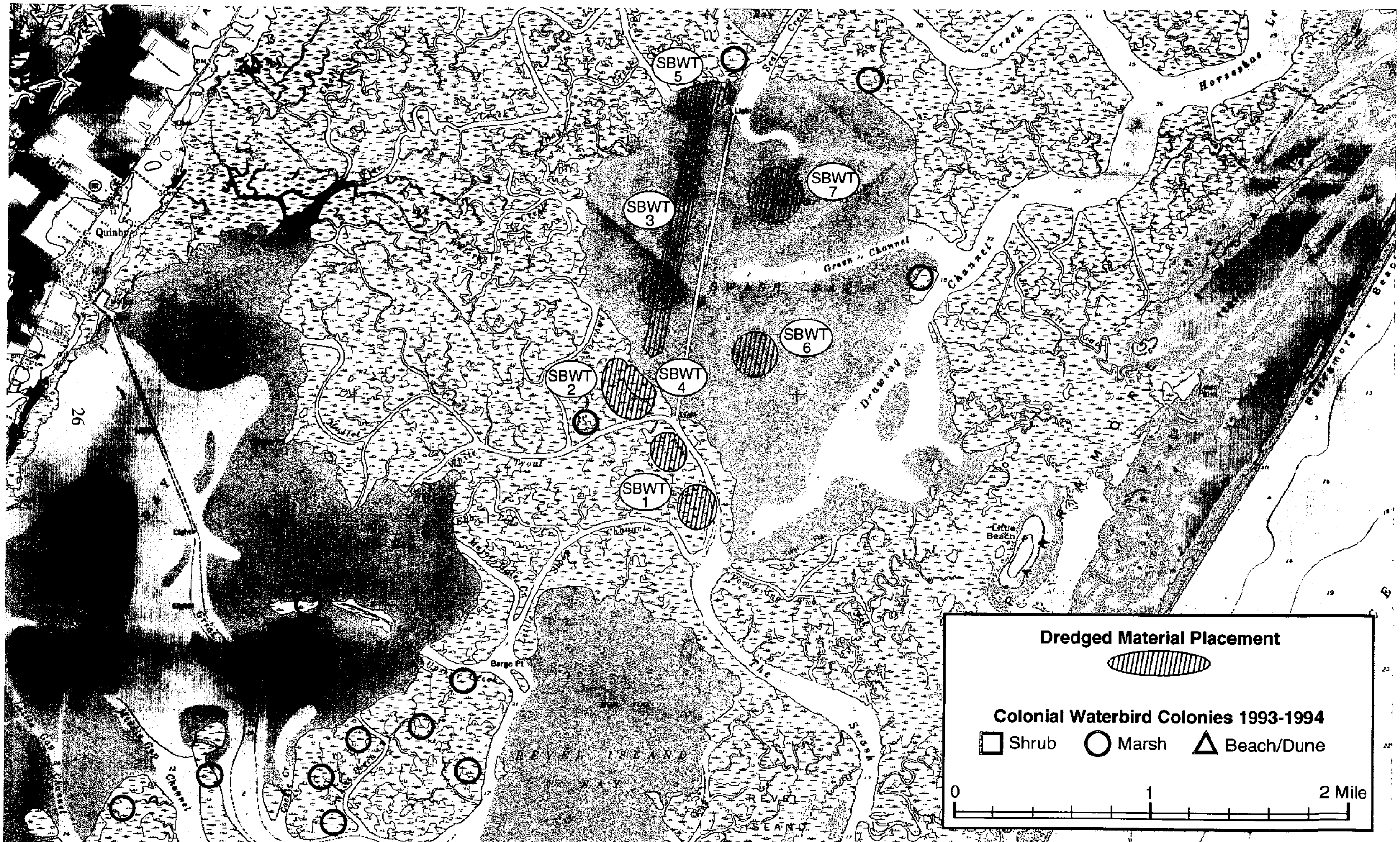


Plate 8. Bradford Bay

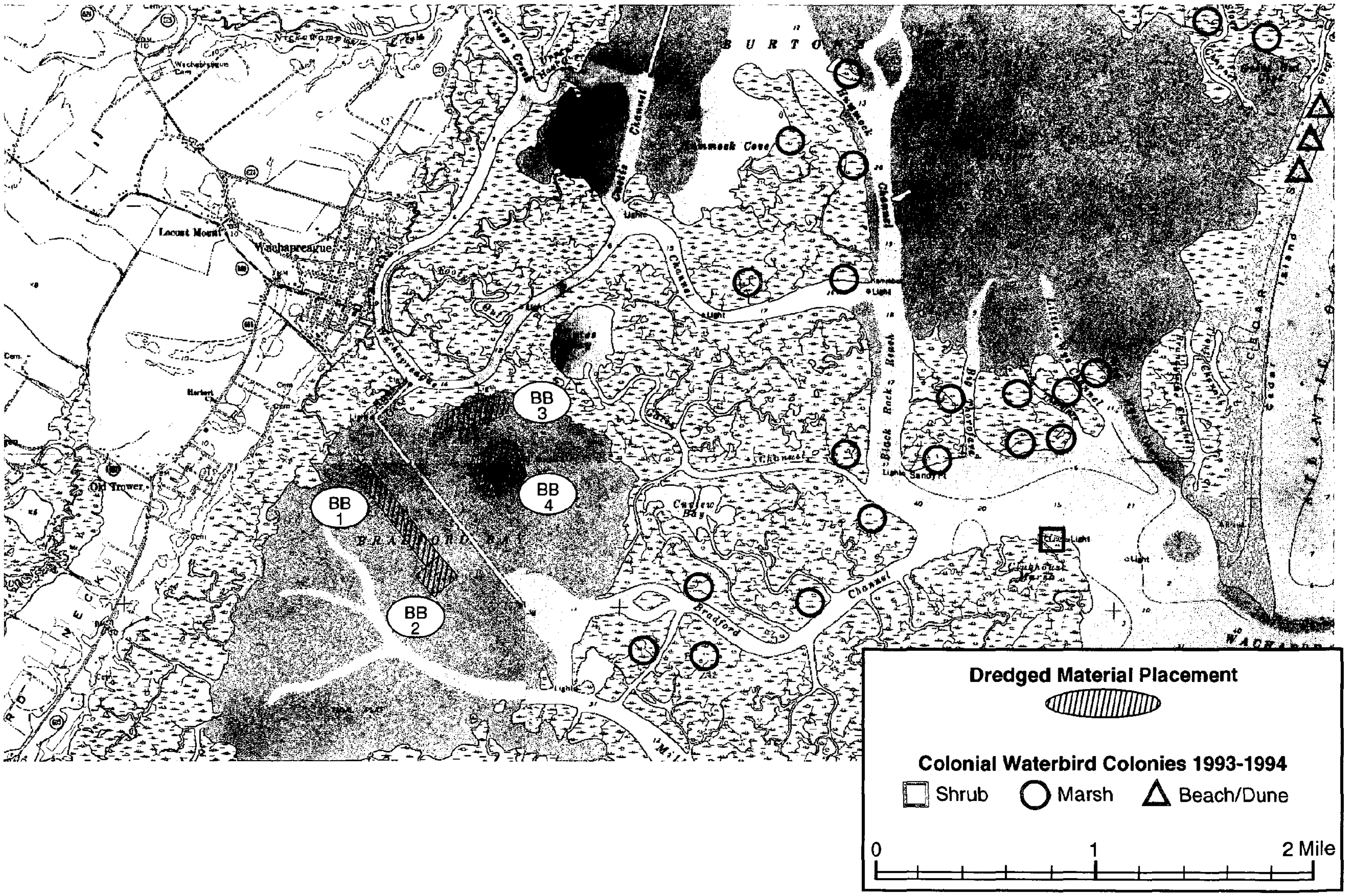


Plate 9. Burtons Bay and Cedar Island Bay

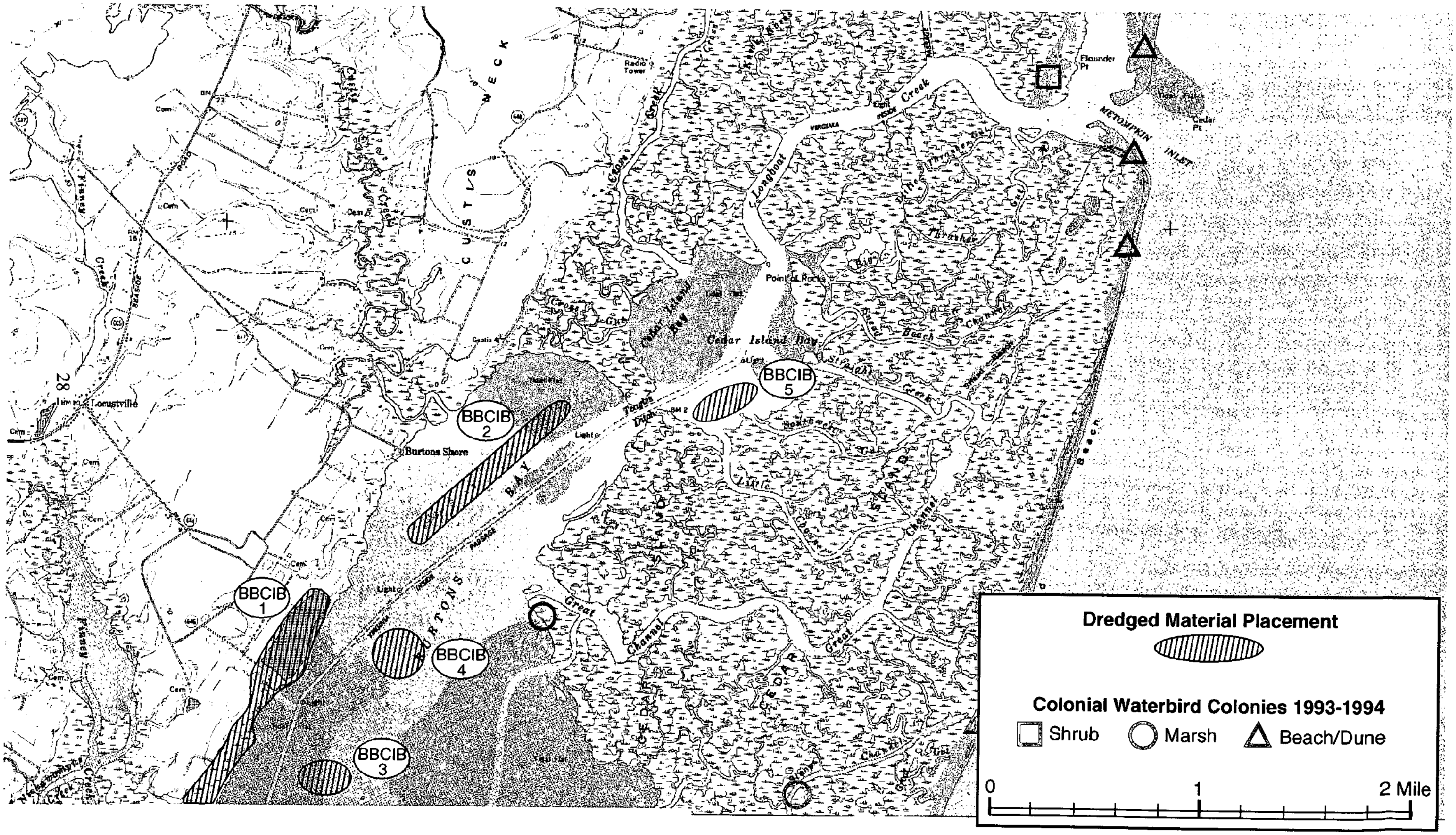


Plate 10. Metompkin Bay

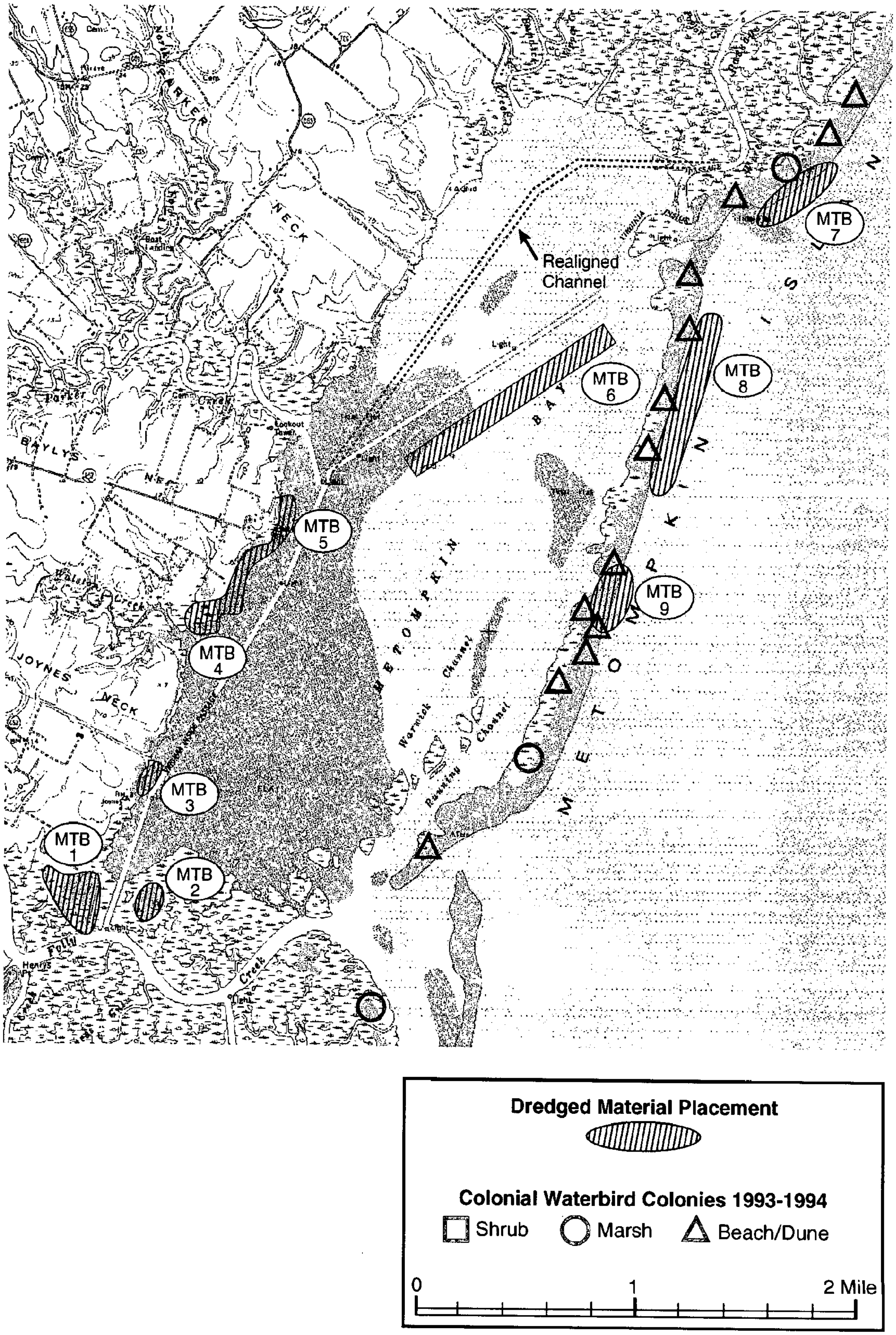


Plate 11. Gargathy Inlet, Kegotank Bay, Northam Narrows and Hog Creek

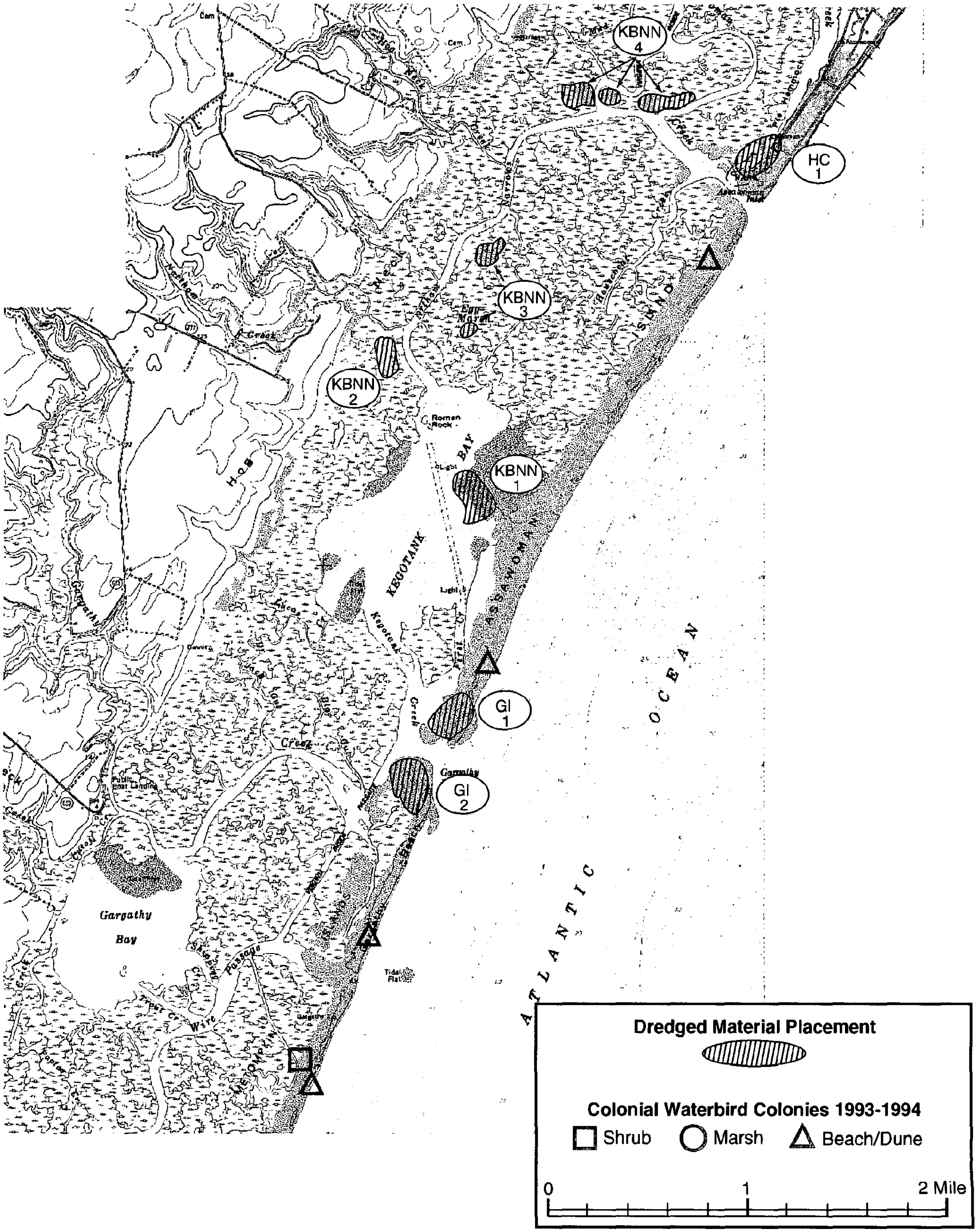


Plate 12. Bogues Bay

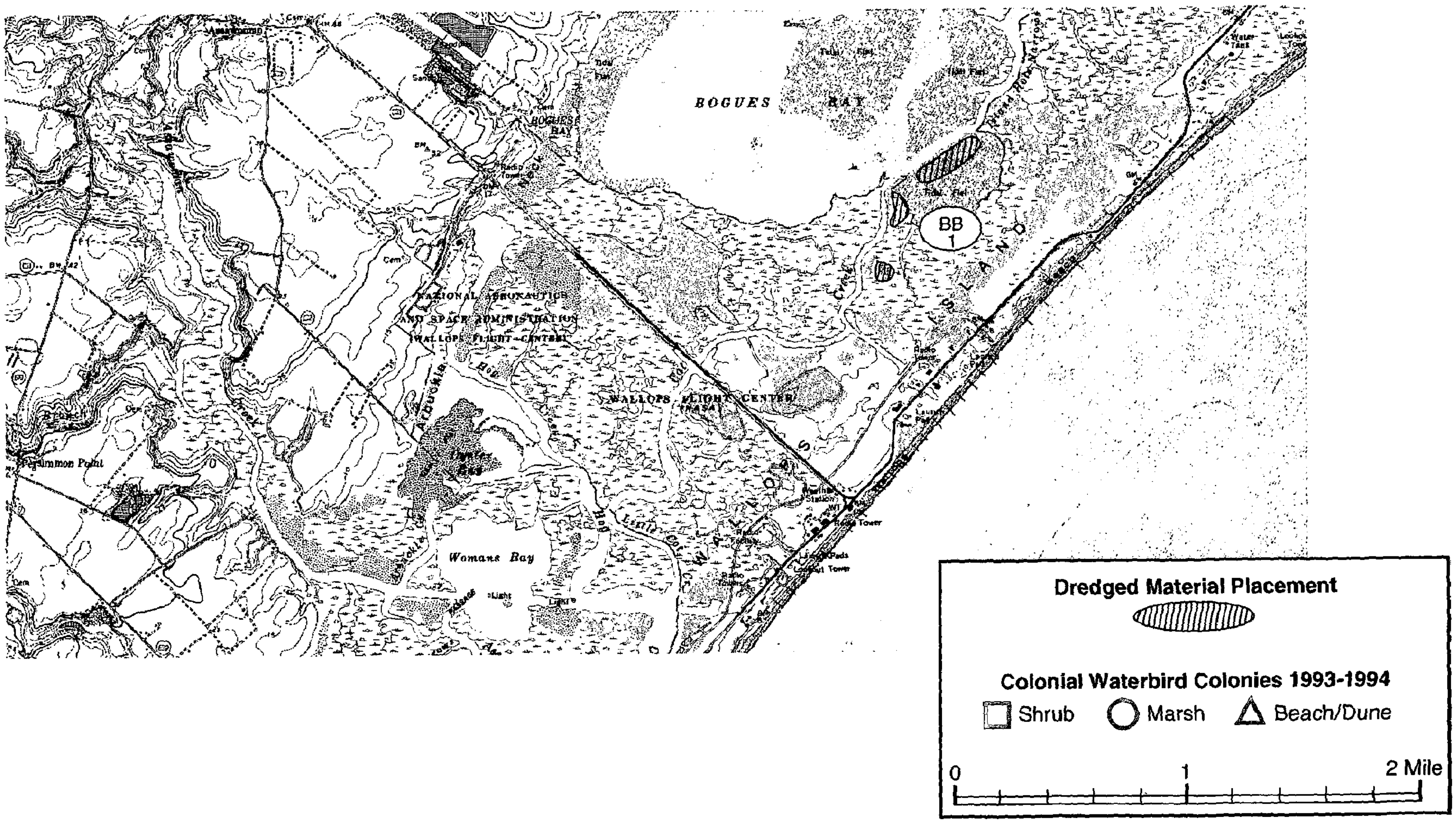
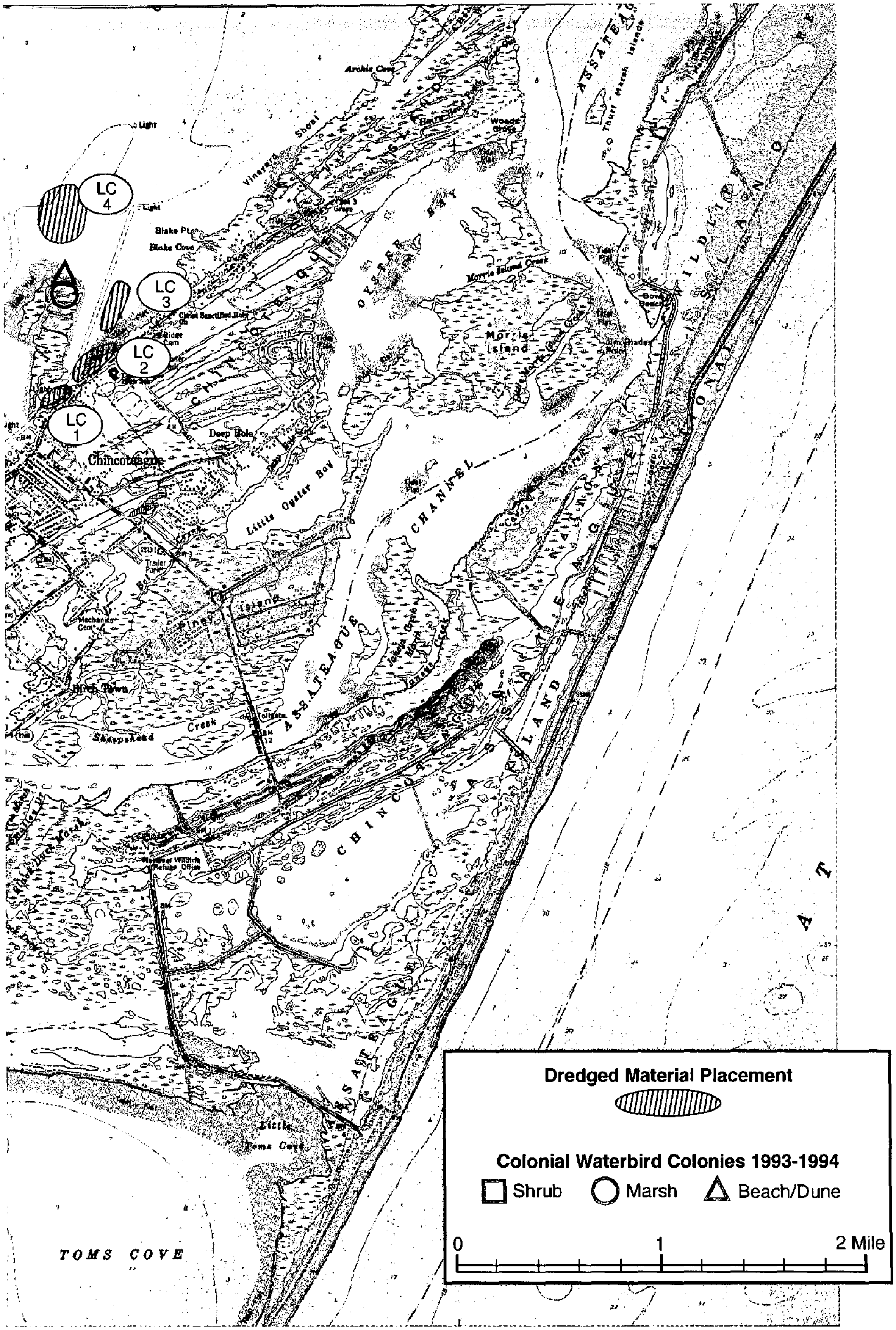


Plate 13. Lewis Creek



III. Natural Resources

The WCV stretches along the seaside of the Eastern Shore of Virginia between the barrier islands and the mainland (Plate 1). The lagoon and marsh complex through which the WCV passes is one of the most pristine environments remaining along the Atlantic Coast of the United States. The beaches of the barrier islands are used as nurseries by both endangered and non-endangered species of turtles and shorebirds, and the entire area supports a large assemblage of colonial waterbirds, shorebirds, and waterfowl. The lagoon and marsh system also provide important nursery habitat for many important finfish which are harvested both commercially and recreationally. In addition, the seaside of the Eastern Shore has historically been an area of very high shellfish productivity.

As a result of the great abundance of natural resources found along the WCV, and the lack of nearby inland or upland disposal sites, the placement of dredged material has the potential to impact a wide variety of environments and natural resources. Therefore, it is essential to identify the areas of high resource value so that any impacts from dredge material placement can be minimized, while possibly enhancing various components of the habitat surrounding the WCV.

Shellfish/Aquaculture

The seaside of the Eastern Shore has the largest extent of public shellfish grounds in any one area of Virginia. In a study conducted during the late 1970's [5] it was determined that approximately 7,226 acres of public shellfish grounds had moderate to high potential for oyster growth, primarily based on substrate composition (Appendix D). Most of these oysters (*Crassostrea virginica*) on the seaside of the Eastern Shore are found on intertidal flats. They have adapted to intertidal elevations, which lessens their exposure to aquatic predators and diseases [6]. These shallow intertidal reef systems are numerous throughout the seaside, but small in size - less than one to two acres [7]. Consequently, there is relatively little information about the exact location and productivity of individual oyster reefs or bars.

The VMRC's Oyster Grounds Leasing and Surveying Department is responsible for surveying subaqueous ground for public and private shellfish cultivation, leasing private shellfish grounds, and maintaining oyster ground lease records. All of the existing public grounds and private leases are surveyed and entered into the VMRC mapping system. VMRC's survey and lease records of the entire Eastern Shore are contained in Appendix C. The VMRC survey and mapping data do not indicate, however, the presence or value of any particular resource within mapped grounds.

As a result of this study, the VMRC mapping system has been updated to include the locations of all the sections of the WCV requiring maintenance dredging, as well as the historical overboard placement sites. This will enable a desktop review that quickly and accurately locates a dredging project relative to public and private shellfish grounds. Site specific information about the presence of shellfish resources will still have to be garnered from the leaseholders, local waterman, and Marine Patrol Officers familiar with the sites in question.

The Virginia Marine Resources Commission's Oyster Conservation and Repletion Department manages public shellfish grounds for the conservation and promotion of oyster resources. As a part of their responsibilities, public oyster grounds on the seaside are improved by shell planting and the turning of old beds to increase setting substrate in spawning areas. During the years of 1992-94 approximately 31 individual sites were shell planted and/or experienced "turnover", a process whereby buried shell is brought up to the surface. A 1995 survey of those sites showed relatively good numbers (100-300 oysters per square meter) of small oysters. There is some encouragement that further reef rehabilitation and creation may have some success on the seaside [7]. All of the oyster repletion sites have been surveyed and entered into the VMRC mapping system, and can be readily identified (Appendix C).

The intertidal oyster reef habitat found on the seaside of the Eastern Shore represent an ecologically valuable resource. Hopefully, future dredged material placement activities can be accomplished in a manner to benefit this habitat. It is interesting to note that many small intertidal sand and shell mounds were created along the WCV as a result of dredged material being repeatedly placed in the same areas over a 30-year period. Some of the mounds became colonized by oysters naturally and were eventually leased by watermen because of their economic viability [6].

Other valuable shellfish resources found along the seaside of the Eastern Shore include the quahog (*Mercenaria mercenaria*) and surf clam (*Spisula solidissima*). Both the surf clam and large quahog clams are commonly used in clam chowder and as clam strips. Small quahogs, or cherrystones, are valued by restauranteurs for their half shell market. The surf clams are found along the Atlantic beaches and offshore of the barrier islands, while the quahog clam can found throughout the barrier island system. There is, however, little quantitative information about the abundance or location of naturally occurring clams on the seaside. A review of the VMRC commercial landings data for the seaside of the Eastern Shore indicate that clam harvests have fluctuated between 75,000 and 620,000 pounds (meat weight only) from 1973 to 1992. The trend, however, appears to show a severe drop in landings during the 1990's.

While the harvest of natural clam stocks has decreased, aquaculture of clams has shown solid growth trends in Virginia. There has been an 8 to 14 percent annual growth rate for much of the last ten years [9]. In 1993 approximately 72.2 million clams were produced in Virginia, valued at over 11 million dollars. The state's largest clam producer is located on the bayside of the Eastern Shore. There are, however, other operations working on the seaside that utilize private leases as clam growout areas, as well as withdrawing seawater from the creeks and channels for their hatcheries.

A hatchery can be extremely sensitive to changes in water quality, especially during warm water months when productivity is high within the hatchery. A time-of-year restriction of March 15 to October 31 may be appropriate for maintenance dredging or material placement activities that are in the vicinity of a shellfish hatchery. Additionally, select areas along the seaside have proven to be more productive as clam growout areas due to water quality, tidal hydrodynamics, nutrient flux, and other variables. These areas may be more sensitive to dredged material placement activities, and should be considered during the evaluation of placement options.

Submerged Aquatic Vegetation (SAV)

There are little to no aquatic grasses within the barrier island complex from Fishermans Island to Chincoteague Inlet. At the northern extent of the WCV, however, within Chincoteague Bay behind Assateague Island, aquatic grasses occur quite extensively[10]. *Zostera marina* and *Ruppia maritima* have been depicted in very high densities all along the eastern shore of Chincoteague Bay, north of the Town of Chincoteague. The Lewis Creek project is the only maintenance dredging project on the Eastern Shore that has the potential to impact submerged aquatic vegetation. SAV is very sensitive to changes in water clarity and light penetration through the water column. Further investigations may be necessary in order to develop best management practices for dredged material placement near known SAV resources.

Fishes\Blue Crabs

The Eastern Shore seaside inlets and associated lagoons, or estuaries, provide important nursery habitat for commercially and recreationally important fishes [11,12,25]. Specifically, juvenile summer flounder, croaker, and spot have been found to utilize the seaside barrier island lagoons. Summer flounder, one of the more commercially and recreationally valued fishes, migrate seasonally from ocean beaches and estuaries to continental shelf waters. Adults migrate during late fall and winter from their inshore grounds to offshore shelf waters where they will remain until April to June. During the summer months the adults return to shallow coastal waters having salinities greater than 28 o/oo, sandy substrate, and situated in areas having swift flowing waters [13]. Excellent recreational fishing opportunities exist along the seaside inlets and main channels. Chincoteague and Wachapreague are both very popular destinations for flounder fishermen.

Although eggs and larval stages are found exclusively in shelf waters, juvenile flounder are found only in the estuarine/coastal environment. Recruitment of juvenile summer flounder begins as early as the fall and continues through spring and into the summer [12]. Furthermore, some studies have indicated that juvenile summer flounder associate with shallow mud bottom habitats during their first months of life [14]. The backbay lagoon and inlet environments of seaside provide excellent habitat for both adult and juvenile summer flounder.

Other researchers [15,16] have collected 38 and 99 different species of fishes from Magothy and Chincoteague Bays, respectively. Sharks, rays, and skates have also been reported to have a considerable presence within the Eastern Shore barrier island complex for use as both a nursery and foraging habitat [17]. These studies have also shown that adult or juvenile anadromous fishes are generally not present within the barrier island complex, possibly due to the high and stable salinities found within the seaside estuaries.

Due to the highly dynamic and complex seaside inlets and lagoons, there is little, if any, site specific information pertaining to the geographic distribution of certain species and their preferred habitat (i.e. inlets, creeks, lagoons, mud bottom, sandy bottom, etc.). It does appear, however, that the majority of commercial harvesting of finfish occurs within the inlets and along the shallow waters offshore of the barrier islands. Conversely, the majority of recreational fisherman concentrate within the protected waters behind the barrier islands, but near the oceanic inlets. Norcross [12] reported capturing juvenile flounder exclusively from along the edges of the sandy inlets and main channels on the seaside, but also recognized that extremely young flounder may associate with silty/clay substrate near salt marshes within the lagoons.

During her 1986-88 study [12], Norcross found that the number of species sampled on the seaside showed a strong seasonal component with the diversity lowest in February and highest in October. The most abundant group of fish was sciaenids (silver perch, spot, croaker, weakfish, kingfish, red drum and black drum). Croaker were of the greatest abundance during the fall of 1986, but were infrequently captured in the winter and spring. Spot abundance was high during the spring and summer, while newly recruited silver perch and weakfish appeared in late summer and fall.

The blue crab can be found throughout the barrier island system, but fishing or potting pressure generally occurs during the summer and fall within the waters immediately adjacent to the navigational channels and naturally occurring inlets and channels. The water in which the pots are placed needs to be deep enough so that at low tide the crabs remain submerged, and also so that the waterman can easily navigate and fish the pots.

Approximately 4.5 million pounds of hard blue crabs were commercially harvested from the seaside of the Eastern Shore in 1983. This represents a peak in the landings data for the period of 1973 through 1991. In 1989 approximately 2.9 million pounds were reportedly landed, but the total poundage fell to 26,500 by 1991.

It is not clear what impacts, if any, the placement of dredged material onto intertidal and subtidal habitats has on adult and juvenile finfish, and blue crabs of the Eastern Shore. It is known, however, that overboard placement of dredged materials does result in short term increases in turbidity and nutrient levels, and decreased oxygen levels. The depletion of oxygen levels, however, during dredging operations is localized and of short duration [18,19]. Studies by Schubel et al. [20] and Masters [21] have both found that high concentrations of suspended, fine-grained sediments did not have significant, adverse impacts on the survival of eggs and larvae of the blueback herring, alewife, American shad, yellow perch, white perch, striped bass, and spot. High suspended solids levels can , however, adversely impact the hatching success, larval development and settlement of oysters [18].

The conversion of subaqueous habitat to intertidal and emergent habitat through dredged material placement may have, however, a longer-term impact on the abundance of fishes and crabs. The bays and lagoons of the lower Eastern Shore (Northampton County) contain greater areas of subaqueous habitat than the bays behind Metomkin, Assawoman, and Wallops Island. Therefore, productivity of the lower bays may be less impacted than the more subaqueous-limited bays within Accomack County. Spatial limits of existing habitat need to be considered during the site by site analysis of dredged material placement options.

The majority of the sediments dredged from the WCV are fine-grained and susceptible to resuspension after placement from tidal currents and waves. Waves are capable of resuspending bottom sediments in the shallow water environment in which the majority of the dredged materials from the WCV are placed. For some of the smaller bays, sediments resuspended from dredged material placement areas may contribute substantially to the overall increased turbidity during a storm event. Conversely, resuspended sediments in a large bay such as Hog Island mostly originate from natural bottom deposits. In either case, the shallow water bays can reach very high water temperatures during the summer months and potentially enter periods of low dissolved oxygen. Therefore, it may be prudent to further limit dredging and placement activities within small bays and lagoons to the months of low water temperature.

Colonial Waterbirds

The marsh/lagoon complex through which much of the WCV traverses contains hundreds of breeding colonies of waterbirds. The Virginia Department of Game and Inland Fisheries was subcontracted through this grant to provide an inventory of the bird colonies adjacent to the WCV, and their preferred habitats [22].

During a 1993-94 survey [22], 270 waterbird colonies were identified within the Eastern Shore barrier island/marsh/lagoon complex. An estimated 62,979 pairs from 23 species were surveyed, accounting for 72% of the colonial waterbirds known to breed in the coastal plain of Virginia. Large numbers of pairs are found within Cobb Bay, Hog Island Bay, and adjacent to the causeway leading to Chincoteague Island.

The species identified in the bird survey [22] can be categorized into three groups: 1) wading birds, 2) terns and skimmers, and 3) gulls, pelicans, and Forster's terns. The wading birds prefer to nest within island and lagoon shrub habitat, dominated by wax myrtle and saltbush, respectively. The majority of the wading birds identified in the 1993-94 study were found to nest in patches or ridges of saltbush associated with the marsh/lagoon complex. Only a fraction of the available habitat, however, is used by waders for nesting. The waders mostly forage within intertidal mudflats and along the edges of the shallow, open water areas.

Terns and skimmers are found to nest on sandy foredune areas along the Atlantic side of the barrier islands and on isolated sandy/shell ridges within the lagoon complex. This type of nesting habitat is also very prevalent and only a portion of it is utilized by the terns and skimmers for nesting. Open water lagoons behind the barrier islands are the preferred foraging areas for terns and skimmers.

The third group of birds - gulls, pelicans, and Forster's terns can be found nesting in two separate areas. The gulls and pelicans nest in vegetated dunes and swales found mostly along the oceanside, while the Forster's terns nest in low saltmarsh and elevated marsh ridges in the backbay regions. This group of birds will forage in the surf zone, beach, ocean waters, lagoonal bays and mudflats.

It should be noted that not all of the identified nesting sites are occupied on a yearly basis, some colonial nesters move from year to year to new sites. This will have an impact on the restrictions that might be imposed on a particular dredging project within the vicinity of a nest site. In general, projects should be accomplished during the late fall and winter months to avoid the breeding period. For projects that may occur during spring and summer, however, a site by site analysis will be necessary to further document any colonial nesting sites within the project area.

Watts [22], provides several general and specific recommendations on how dredged material placement along the WCV can positively impact colonial waterbirds and/or shorebirds. In summary:

- Existing habitat could be enhanced to better facilitate breeding and/or foraging by 1) placing sandy material near the ends of barrier islands to maintain elevation of breeding grounds, and 2) placing dredged materials on low elevation tidal flats to increase their frequency of subaerial exposure, and thereby, improve foraging opportunities, especially within intertidal-limited lagoons
- Create new habitat by placing sandy dredged material within open water lagoons as emergent islands with a minimum surface area of 0.25 ha

All of the 270 nesting sites identified in the 1993-94 study have been entered into the VMRC mapping system. This will provide a quick and accurate method for identification and location of the nesting sites found during the 1993-94 assessment, and assist in the process of selecting placement options and beneficial uses of dredged materials.

IV. Sediment Evaluation

One of the most important factors in determining the feasibility of a particular placement option, is evaluating the type of sediment being dredged. The grain size of the sediments to be dredged needs to be mapped both horizontally and vertically so that the type and amounts of material available can be accurately determined. This will dictate, in large measure, how the dredged material will behave once it is deposited in the marine environment. Grain size, nominal side slopes, and mound stability will have a tremendous influence on the size and shape of the deposit and, consequently, its usefulness as a habitat modifier.

Since the nature of the sediment is so important, this study attempted to characterize the sediments involved in dredging the WCV by systematically sampling each of the shoals that are routinely dredged by the Corps. However, due to the large area routinely maintenance dredged and the limitations of this study, only the horizontal variations in sediment size were investigated. For more detailed analysis, it will be necessary to map the sediments of a severely shoaled channel both horizontally and vertically. For the purposes of this study, however, the sampling scheme provided enough information to support the proposed evaluation process.

Surface sediment samples were collected with a grab sampler at regular intervals along each section of the dredged channels. The distance between each sample varied with the length of the channel and ranged between 1000 and 2000 feet. The location of each sample was determined using a hand held Loran C receiver. The samples were returned to the VIMS Sediment Laboratory where they were analyzed for percent sand, silt, and clay. The sand fraction was then run through a Rapid Sediment Analyzer to determine the sand grain size distribution. The data are summarized in Table 4. Results from the sediment analysis of the entire sample set can be found in Appendix B.

A review of the channel sediment data indicate that a number of channels have substantial amounts of sand that could potentially have beneficial uses. The highest sand percentages (>75%) were Wise Point and Kegotank Bay. Channels with mid-range sand percentages (25%-75%) included: Magothy Bay, Eckichy Marsh, Gull Marsh, North Channel, portions of Sloop Channel, Metomkin Bay, portions of Northam Narrows, Bogues Bay, and Lewis Creek. The remainder of the channels, White Trout Creek, Swash Bay, Bradford Bay, and Burtons Bay averaged <25% sand (Table 4).

Table 4. Mean Grain Size of WCV Channel Sediments* From Frequently Dredged Areas

Channel (Shoal)	Percent (%) Sand	Silt	Clay
Wise Point	78.1	10.5	11.4
Magothy Bay	39.4	34.6	26.0
Eckichy Marsh	57.2	27.8	15.1
Gull Marsh	52.3	29.8	17.9
North Channel	43.1	34.9	22.1
Sloop Channel	31.9	42.8	25.3
White Trout Ck	11.6	55.6	32.8
Swash Bay	5.7	55.4	38.9
Bradford Bay	18.0	50.2	31.8
Burtons Bay	9.8	52.0	38.2
Metomkin Bay	41.9	32.9	25.2
Kegotank Bay	80.1	11.8	8.2
Northam Narrows	50.0	26.1	23.8
Bogues Bay	65.5	18.4	16.1
Lewis Creek	26.2	40.3	33.2

*** Based on surface grab samples**

V. Benthic Evaluation

Introduction

The impact of a project on existing communities is always a major concern whenever any type of habitat modification is undertaken. In this regard, a number of questions need to be asked during the evaluation of each construction project. Is the habitat that is being affected of greater value than the one replacing it? Are the acute short-term impacts outweighed by the potential long-term benefits? Is there going to be a net benefit to the ecosystem due to this modification? These questions and others concerning the long- and short-term impacts of a project need to be addressed regardless of the type of project in order to ensure the benefits of a proposed project exceed the potential detriments.

In the case of the WCV, a number of habitat types, including vegetated wetlands, intertidal mudflats, beaches, subtidal bottoms and uplands, can potentially be affected by dredging projects. Each of these habitat types has its own inherent set of environmental values that will be either lost or significantly changed if used as a dredged material placement site. Since most of the dredging on the WCV involves overboard placement on subtidal bottoms, it was decided to look at these impacts in some detail. In particular, there was concern about the value of the existing benthic habitat both as a commercial shellfish resource and as an ecological resource which provides foraging and nursery areas for numerous species of finfish. Of interest were the types of conversions that occur when these habitats are used as placement areas including both community responses in the short-term and also the long-term recovery prospects.

The overboard placement of dredged material physically impacts the benthic community in two different ways. First, it smothers the existing benthos with sediment which can destroy portions of the population. Second, it changes the physical structure of the site, i.e. elevation or depth and sediment grain size.

Recovery from the smothering occurs in a number of ways including: vertical migration of the existing benthos, migration of adults from undisturbed areas, reproduction and recruitment from undisturbed areas and residual populations in portions of the placement area [23].

The physical changes in the site indirectly affect recolonization by influencing the types of organisms capable of repopulating the area. Changes in elevation from subtidal to intertidal, for example, can significantly affect the nature of the benthic community that colonizes the site. Similarly, the sediment composition will strongly influence the kinds of organisms that can be recruited to the placement area.

The difficulty comes in assessing the nature and extent of these impacts on the habitats because the resulting changes in the communities can be very subtle and, consequently, difficult to distinguish from natural variability. In addition, benthic studies of this type can be very costly and time consuming. What this study sought was a methodology that was reasonably sensitive to changes in the environment and not too laborious or time consuming. The method selected was the Benthic Assessment Methodology (BAM), recently developed at VIMS [24]. It was chosen because it is comparatively easy to implement, does not require extensive taxonomic identification, is responsive in a timely manner, is not particularly expensive, and is sensitive to the anticipated level of impact. This was, however, the first use of this method in a marsh/lagoon complex like the Seaside of the Eastern Shore.

The BAM is unique in that it looks at the long-term stability of the benthic community as a measure of its value or importance. This evaluation is based on a number of factors including the depth at which the organisms live, their functional life style, the size of the organisms and the percentage of the biomass found at depth. All of these factors imply that large, long-lived, deep living organisms are indicators of a degree of equilibrium and long-term stability in the community. Recently reestablished or stressed benthic communities tend to be dominated by small, shallow-living, short-lived organisms that might have very high densities, yet are not really indicative of a stable community.

The BAM technique was utilized in two different ways in this study. First, it was used to evaluate short- and long-term impacts of overboard dredged material placement on the benthic community at three maintenance dredged channels along the WCV, Magothy Bay (Figure 1), Swash Bay (Figure 2), and Lewis Creek in Chincoteague Bay (Figure 3). At each of the channels three stations were selected to represent the most recently used placement area, an older placement area that has not been used in at least ten years, and an undisturbed area that has never been used as a placement area. The purpose of this sampling regime was to investigate the short- and long-term differences in benthic communities among the sites at each channel as measured by the BAM technique.

It was also used as a planning tool to compare and evaluate potential new placement sites at Ramshorn Bay (Figure 4), the site of a proposed channel relocation. Here, it was used to help determine the relative value of the benthic community at several sites to see if any significant differences existed that might direct the placement away from or towards a particular area as a means of minimizing the impacts.

Methods

The Magothy Bay sites (Figure 1) were sampled in May 1995. The new placement area had last been used in December 1993. The old placement area had last been used in 1977. The Swash Bay sites (Figure 2) were sampled in June 1994. The new placement area had last been used in April 1993. The old placement area had last been used in 1983. The Lewis Creek sites (Figure 3) were sampled in July 1995. The new placement area had last been used in August 1992. The old placement area had last been used in the late 1940's. Two potential placement areas, a control site and a channel station at Ramshorn Bay (Figure 4) were sampled in July 1995.

The sites at each channel were sampled three times with a 225cm^2 (15cm x 15cm) box corer to a depth of at least 15cm. The top 5cm of each core were removed and bagged separately from the rest of the core. Both sections were stored on ice in transit. Upon return to the laboratory both sections were sieved through a 0.5mm screen. The animals in each core section were enumerated, sized, and weighed and their life history determined. These data were then used to score each core according to the BAM outlined in Appendix B to determine its numerical rating.

In addition, sediment cores were taken at each site for analysis of sand, silt, and clay content.

Results

The mean scores for the BAM technique and the sediment grain size analyses for each site at the three dredged channels have been compiled in

Figure 1. Magothy Bay Benthic Assessment Methodology (BAM) Sites.

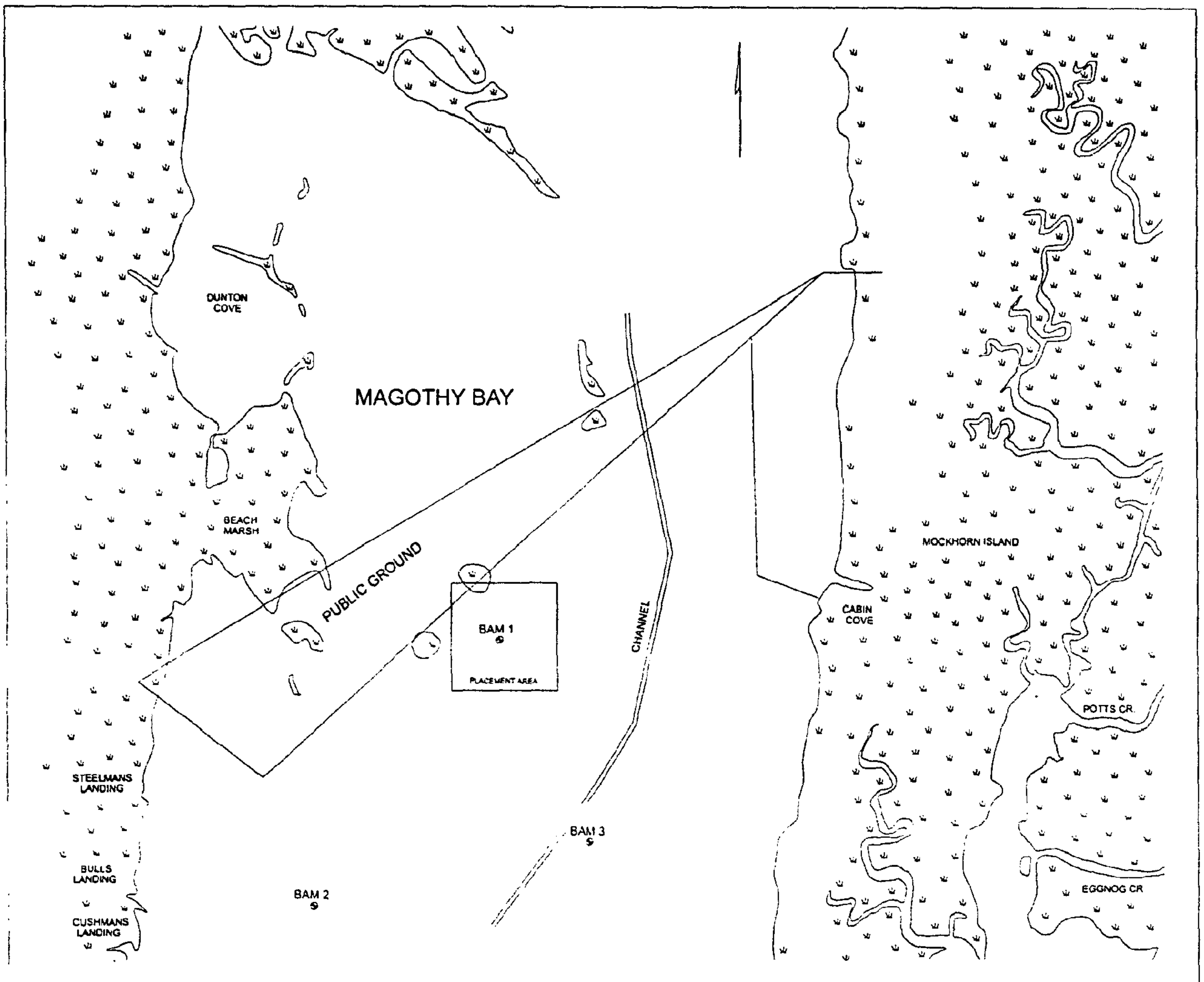


Figure 2. Swash Bay Benthic Assessment Methodology (BAM) Sites.

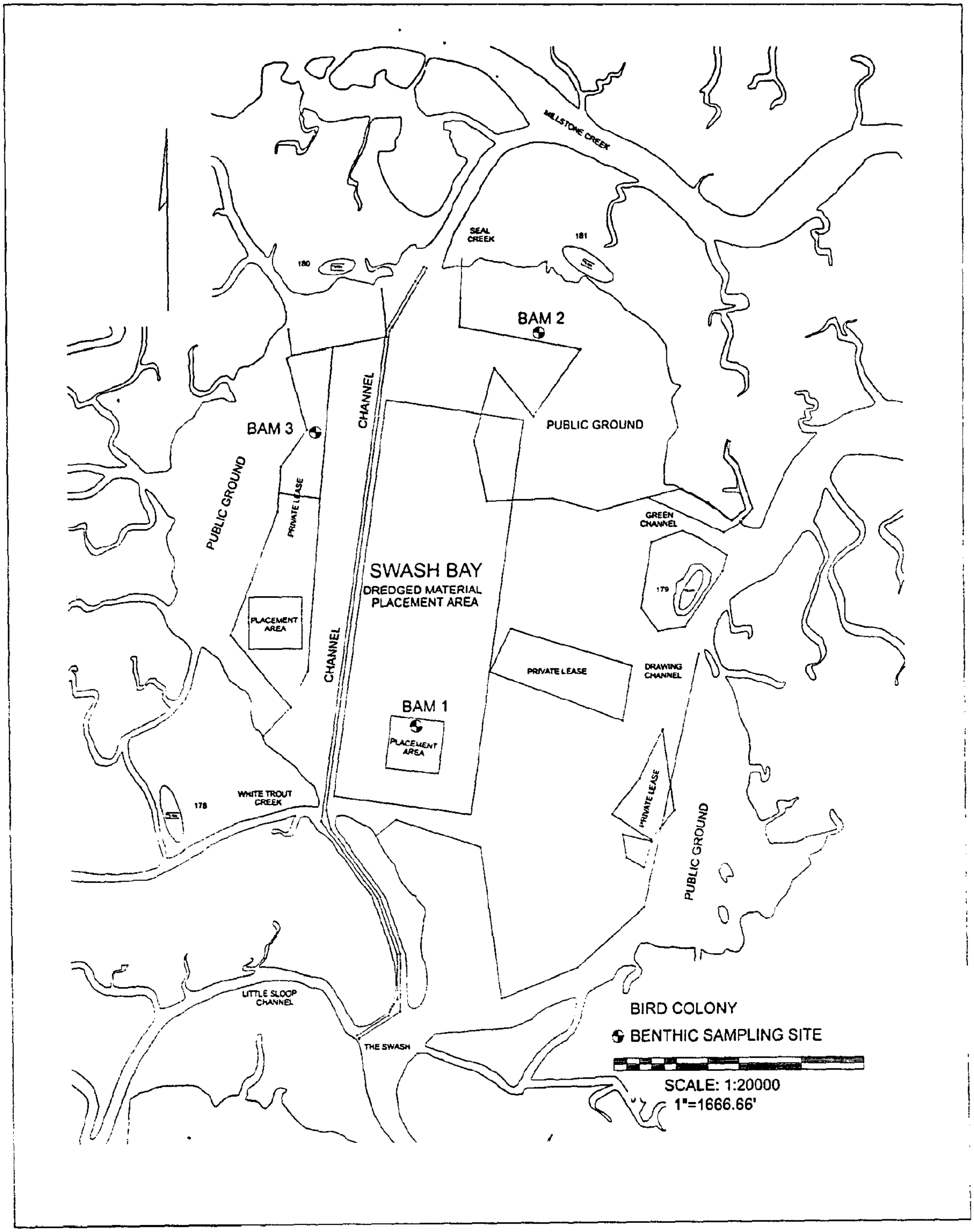


Figure 3. Lewis Creek Benthic Assessment Methodology (BAM) Sites.

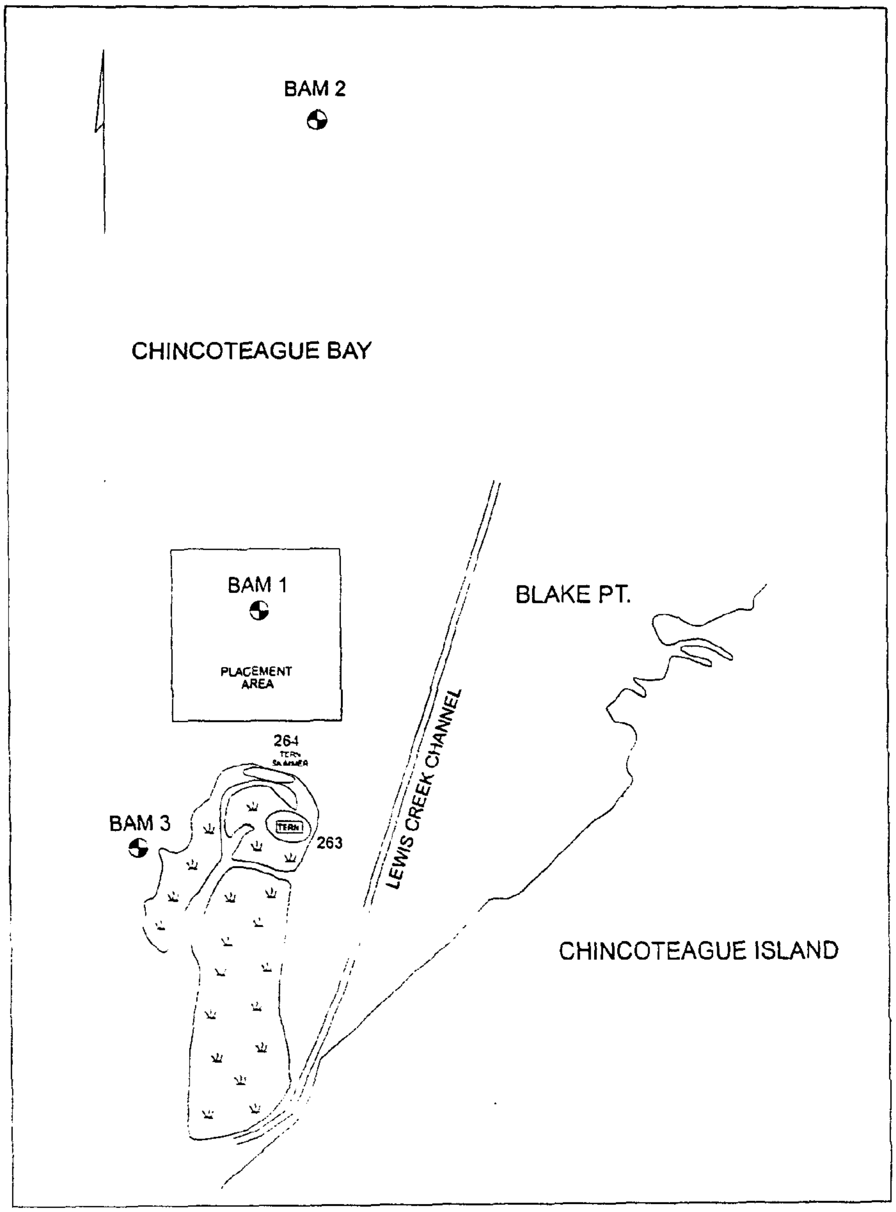


Figure 4. Ramshorn Bay Assessment Methodology (BAM) Sites.

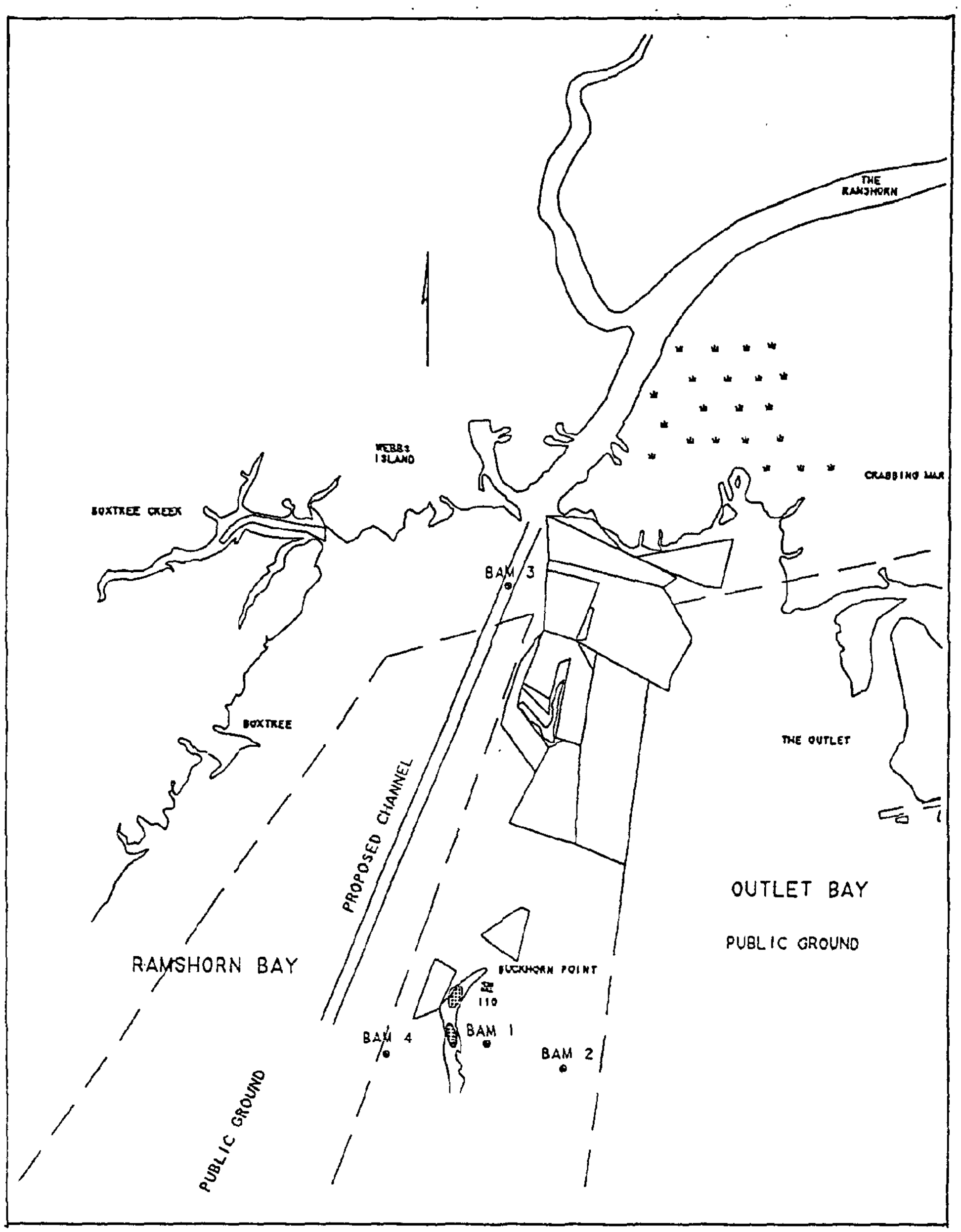


Table 5. The raw data and BAM evaluation scores for each site are provided in Appendix B along with the explanation of the methodology.

Several sample sections from Magothy Bay were lost. Consequently, there were only two complete replicates at the new and old placement sites and only one complete replicate at the undisturbed site.

The BAM scores were, with one exception at Magothy Bay, uniformly highest at the undisturbed site and lowest at the recently used site at each channel with intermediate values at the old placement areas. The percent sand in the sediment varied considerably among the sites at each channel with no apparent trends.

The results from Ramshorn Bay are compared in Table 6. The two proposed placement areas and the control site showed very little difference. The station in the proposed channel appeared to be somewhat lower in value according to the BAM technique. With the exception of the inshore placement site, the surface sediments were also similar.

Discussion

The average BAM scores follow a fairly consistent pattern at each of the maintenance dredged channels, with the highest values at the undisturbed site, intermediate values at the old placement area, and the lowest values at the most recently used site. The observed pattern in the BAM scores is most likely related to natural recovery processes following placement but might also reflect changes in the habitat not related to recovery.

Following a disturbance the habitat may or may not be degraded but the community is shifted to some other configuration. The recovery process (or movement towards the original configuration) may be affected by habitat changes or biotic processes (recruitment, competition and predation).

The BAM method was designed to be used in soft-bottom communities and changes in the physical structure of sediment such as increased amounts of sand and shell might influence the results. The trend in these data, however, appears to indicate that the placement areas recover with time.

While the trend remains the same, the absolute scores are different at each channel. The highest scores, 8.0, 7.7, and 7.0, indicating good habitats, were found at the Lewis Creek and Swash Bay undisturbed sites and the Swash Bay old placement sites, respectively. With the exception of the recently used site in Magothy Bay, all the other scores, 4.0, 4.0, 5.0, 5.0, and 5.7, fell in the slightly to moderately disturbed habitat range. The lowest score, 1.5, indicating a poor or seriously disturbed habitat was found at the recently used site in Magothy Bay. This channel also had the lowest score, 4.0, for the undisturbed site. These scores were likely influenced by the lost core sections and lack of replication at each of the sites. Additionally, the sediments at the undisturbed and old placement sites in Magothy Bay were very dense, well-consolidated clays that were difficult to penetrate with the box corer.

At Swash Bay, the major differences appear to be between the recently used site and the older site and the unused site. The values of 7.0 and 7.7 at the latter sites are probably not substantially different and are indicative of well-developed habitats according to the BAM. The recently used site scored somewhat lower in the slightly to moderately disturbed habitat category. The basic difference in the data is the percentage of biomass below 5cm which is considerably lower in the recently used site. This score, 5.7, could be taken as an indication that the community is recovering from the disturbance but has not had sufficient time for the deep living biomass to reach undisturbed levels. According to the score of 7.0 for the old site, this appears to be achievable over time.

Table 5.
BENTHIC ASSESSMENT METHODOLOGY (B.A.M.) AND SEDIMENT GRAIN-SIZE SUMMARY

	Swash Bay				Chincoteague Bay				Magothy Bay			
Station Type	**B.A.M.**	**% Sand**	**% Silt**	**% Clay**	**B.A.M.**	**% Sand**	**% Silt**	**% Clay**	**B.A.M.**	**% Sand**	**% Silt**	**% Clay**
Undisturbed	7.7	9.6	57.5	32.9	8.0	30.4	47.9	21.7	4.0	14.1	47.7	37.9
Old Disposal	7.0	24.8	43.1	32.2	5.0	86.6	10.1	0.3	5.0	13.0	42.5	44.5
New Disposal	5.7	9.5	53.7	36.7	4.0	94.8	0.9	4.4	1.5	36.5	44.1	19.4

Total BAM score interpretation:

- 0 - 1 : Poor habitat, seriously disturbed
- 2 - 3 : Moderately disturbed or stressed habitat
- 4 - 5 : Slightly disturbed to moderately disturbed habitat
- 6 - 8 : Good habitat

Table 6
RAMSHORN CHANNEL DATA SUMMARY

	B.A.M.	SEDIMENTS		
Station	**Mean Score**	**% Sand**	**% Silt**	**% Clay**
BAM1 - Inshore placement area	7.7	26	57	17
BAM2 - Offshore placement area	6.7	13	47	40
BAM3 - Channel near day marker	4.7	18	45	37
BAM4 - Control west of marsh	7.0	13	53	34

BAM score interpretation:
0-1 : Poor habitat, seriously disturbed
2-3 : Moderately disturbed or stressed habitat
4-5 : Slightly disturbed to moderately disturbed habitat
6-8 : Good habitat

At Lewis Creek in Chincoteague Bay, the major differences in the cores were the lack of large, long-lived animals living deeper than 5cm in both the new and old placement areas. This may have been influenced by the significantly higher percentages of sand found at these sites, 94.8% and 86.6%, as compared to the 30.4% sand at the undisturbed site which is the site that scored a perfect average score of 8.0. Perhaps these sandier sediments were no longer suitable for colonization by deep dwelling, large, long-lived organisms.

The BAM scores at the recently used placement areas at Swash Bay, 5.7, and Lewis Creek, 4.0, both indicate only slightly to moderately disturbed habitat values. This indicates a substantial amount of short-term recovery considering that the dredged material had been in place only 14 months at Swash Bay and only 36 months at Lewis Creek.

The data from Ramshorn Bay indicate that the benthic communities at the proposed placement locations and the control site are not appreciably different. Hence, because the values are similar, the impacts to the benthic community would be similar and, therefore, would not be a deciding factor in the selection of the placement area.

Based on the data to date it appears that this method is capable of discerning differences among similar habitats at a particular channel in a simple, comparatively inexpensive and timely manner. The differences observed may be related, in part, to the differences in the sediments found among the sites at each channel and differences in the communities at the different channels as well as differences in recovery time. All of these factors, however, would combine to make comparisons between channels very difficult.

Aside from the direct impacts to the benthos and from a broader landscape perspective, the physical structure of these mounds, i.e. the elevation and coarser-grained sediments found near the discharge, produces pronounced physiographic differences in otherwise homogeneous, shallow, soft-bottom communities typical of bays in the barrier island lagoon system. This structure creates an "edge effect" that may increase diversity within the benthic community resulting from a variety of sediment types, fine to coarse-grained, and elevational exposures, subtidal to supratidal. The amount of "edge" and diversity within the habitat would increase with increasing elevation. Increased community productivity is often associated with increasingly diverse habitats. Enhanced community productivity can, in turn, attract mobile organisms such as blue crabs, fishes, and shorebirds to forage in the area thereby increasing its ecological value.

VI. Beneficial Use Options Evaluation

Introduction

Beneficial uses for dredged material can often be realized by exercising selected options during its placement. The feasibility of these options depends on a number of factors associated with a particular dredging project and the environmental setting of the site. Engineering factors influencing the selection of a placement option include the pumping distance, volume of material, type of sediments, placement area capacity and cost. The environmental factors include the proximity to existing living resources, spawning periods, nesting habitats, water quality concerns and habitat modification or destruction. Physical factors, such as tides, currents, fetch and bathymetry are also important because they influence the behavior of the dredged material during and after deposition. If all of these considerations can be evaluated and allowances made in the plans to accommodate these restraints, avenues can become available to make beneficial use of the material.

Because of the variety of habitats and resources found along the WCV, there are numerous options to make beneficial use of the dredged materials from the waterway. Table 7 lists a number of dredged material placement options that could have beneficial impacts. Even with this range of options, situations may occur where circumstances prevent the incorporation of any of these beneficial uses into a dredging plan. In these instances, the aim of the dredging process becomes, simply, to dispose of the dredged material in the least environmentally damaging method.

Table 7. Beneficial Uses of Dredged Material

PLACEMENT OPTION	BENEFICIAL USE
Beach Nourishment	Erosion Control/Avian Habitat
Marsh Toe/Intertidal	Erosion Control/Avian Habitat
Overboard	Fish Structure/Avian Habitat Oyster & Avian Habitat
Marsh Island	Wetland Habitat Avian Habitat
Unconfined Marsh	Avian Nesting Habitat

Beach nourishment is the placement of reasonably compatible sandy sediments along a high energy shoreline to supplement the sediment supply to that reach and help stabilize the location of the shoreline.

Colonial waterbird habitat can be developed in a number of ways using dredged material. One method is ancillary to beach nourishment projects where the beaches created are high enough and wide enough to provide suitable habitat for terns and skimmers. The creation of island habitats, either shelly subaerial sand, sparsely vegetated transition zone areas, or shrub communities, can provide habitat capable of accommodating the nesting requirements of terns, skimmers, gulls, pelicans or herons. These isolated marsh islands also provide a competitive advantage or increased likelihood of nesting success because of the lack of mammalian predators. Islands in the sense of an isolated habitat type can also be produced by the unconfined placement of dredged material in a monospecific stand of marsh grass. These areas provide increased elevation as protection against flooding, shrub habitat for heron nesting, low ridges for gull nesting, and some measure of predator protection through its remoteness.

Oyster reef development on the WCV involves the construction of an intertidal platform from dredged material that can then be planted with cultch and seed oysters to initiate the reef. The advantages of this type of habitat are that the oysters are not exposed to as much predation and disease because they are not submerged as often. This elevation also helps to increase growth rates. If quantities of sand are available in the dredged material the appropriate intertidal elevations can usually be achieved during a single placement. If, however, there is only a small amount of sand, it may take several dredging cycles and a number of years to produce a stable platform of sufficient elevation to provide the foundation for a new reef.

Marsh creation can be achieved by either island formation or by the augmentation of an existing shoreline. It involves building the material to elevations above mean tide level where the appropriate grasses can be planted and survive. Intertidal wetlands of this type have considerable habitat value and can also provide some measure of protection to eroding shorelines.

The concept of island creation inherently incorporates the production of all of these habitats: intertidal mudflats, intertidal oyster reefs, vegetated wetlands, and sandy subaerial transition zones and beach/dune grasses because the lower elevation habitats must be developed in order to produce the higher elevation ones (Figure 5). These concepts also apply to situations where the dredged material may be placed along an existing shoreline for the development of additional habitat or shoreline protection.. It only remains to capitalize on the availability of these areas by fostering the development of all of the potential habitats at a particular site by placing oyster cultch in the intertidal areas and planting the vegetation appropriate to the existing elevations.

All of these community types and attributes contribute to the complexity of the environment around one of these dredged material islands. This complexity allows for the integration and interaction of these communities so that the maximum ecological benefit can accrue to the system.

Evaluation Process

In determining the viability of any of these options for beneficial use, the net environmental impact of the proposal must be considered. The value of the option in terms of increased productivity, improved habitat diversity, shoreline protection or economic benefit must be weighed against the potential adverse impacts of the proposal. In the final analysis, the placement option needs to be the most advantageous, least damaging and most efficient. This analysis involves value judgements by project managers and decision makers that should endeavor to maximize the public and private benefits while minimizing the public and private detriments. It is hoped that this report provides the baseline information and a framework or process whereby these types of decisions can be reached.

When planning a particular dredging project it will be helpful to follow a specific process to evaluate which of the placement options are potentially viable and which are not. Figure 6 provides a flow chart that follows a process whereby placement options can be identified, evaluated, and selected for implementation. Each of the elements in the chart are described in some detail in the following paragraphs.

The initial step in identifying potential placement options and associated beneficial uses for dredged material according to the process outlined in Figure 6 is to characterize the material to be dredged. Contaminated sediments would <u>not</u> be available for use in the marine environment, but this situation rarely occurs on the seaside of the Eastern Shore due to the pristine nature of the area. However, there are several harbors and creeks (e.g. Oyster

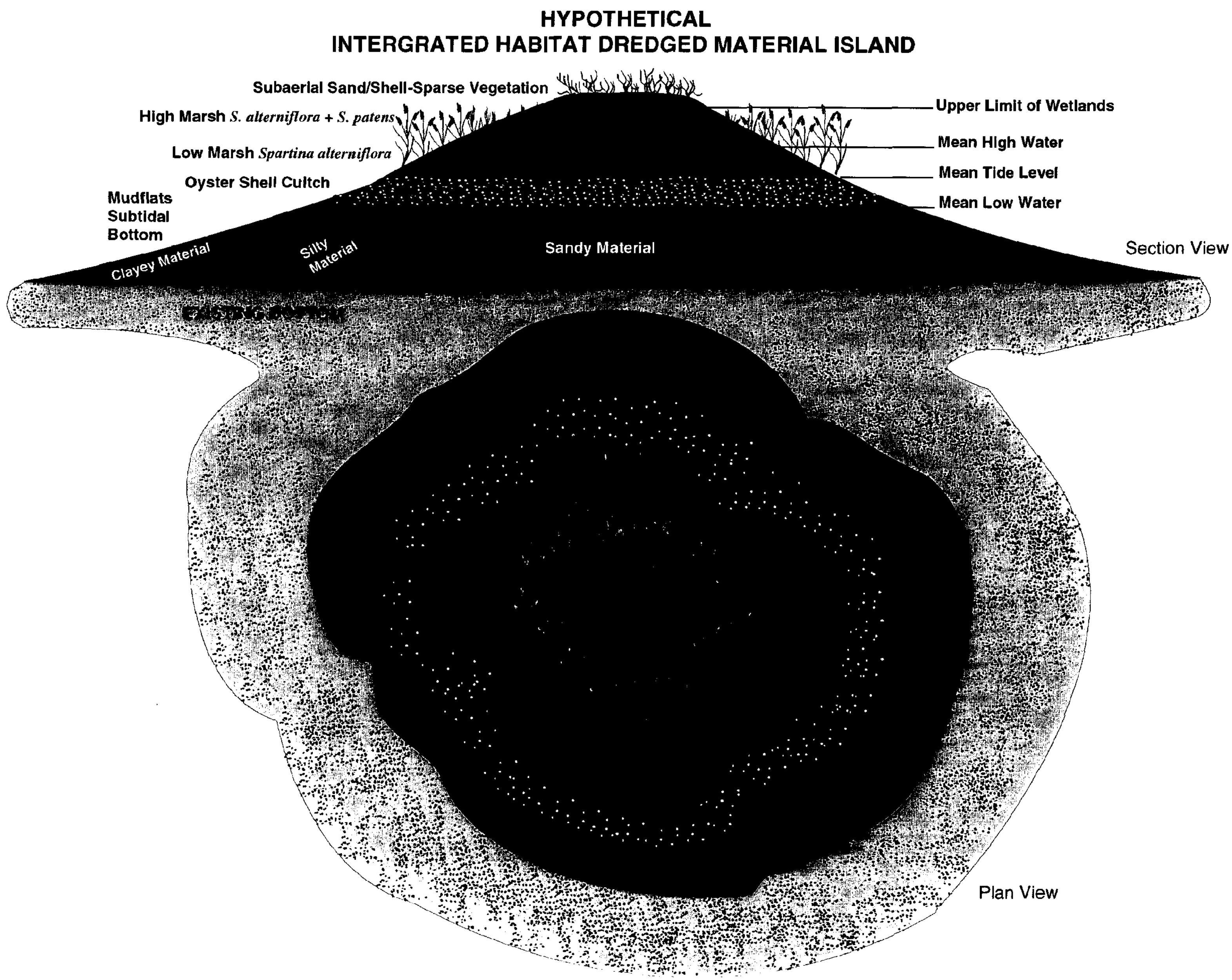


Figure 5. Dredged material island.

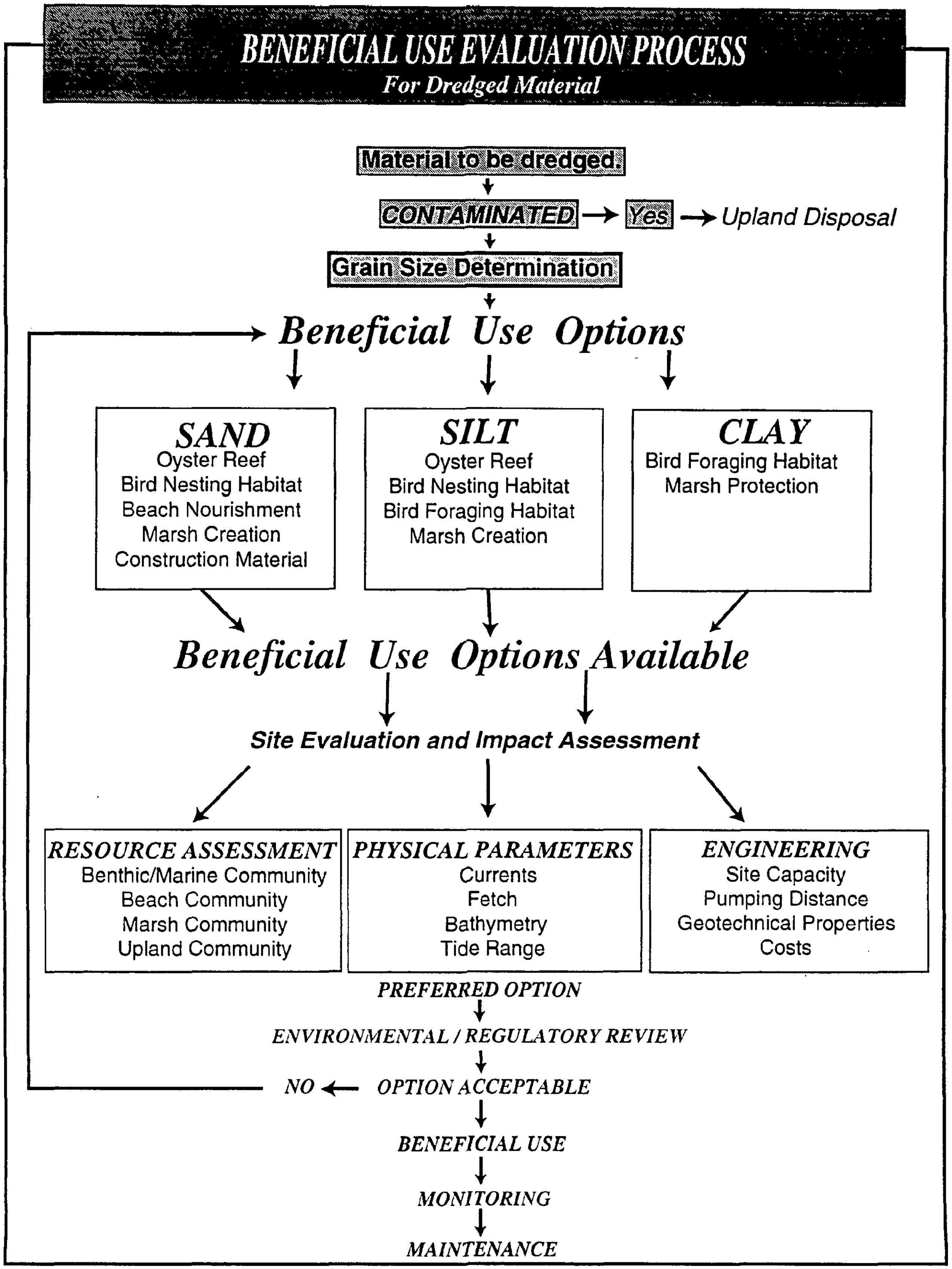


Figure 6. Beneficial use evaluation process.

Harbor, upper Parkers Creek) that are known to have undesirable deposits that should not be placed within the barrier island complex. Upland placement would be the preferred alternative in this type of situation.

A list of beneficial use options appears below the grain size determination that is distinguished by the dominant grain size of the dredged material (Figure 6). Each of the listed grain sizes (sand, silt, and clay) respond differently to the physical processes within the marine environment. As a result, tide range, fetch, currents, and bathymetry, may limit placement options at a given location. The listed beneficial uses below each grain size are not definitive, but represent the types of projects that we feel have the greatest potential along the WCV.

Once grain size has been determined and a list of beneficial use options is formulated, a series of concurrent assessments need to be made of the living resources, physical parameters, and engineering factors (Figure 6). The resource assessment should focus on the areas determined to be potential placement sites as well as the adjacent areas that could be indirectly impacted. The previously-discussed benthic assessment method (B.A.M.) is recommended for assessing the benthic community in and around potential placement areas located on subaqueous bottoms. Other recommended resource assessments would include colonial waterbirds and shorebirds; evaluating public grounds/private leases and shellfish repletion sites, as well as other marine flora and fauna; and evaluating potential impacts to adjacent marshes and uplands.

All of the potential community types - benthic, marsh, beach and upland, have ecological values that will be affected. These impacts need to be quantified and factored into the decision-making process. If a specific type of habitat is being proposed as a beneficial use, the proximity of similar habitats and the diversity of adjacent habitats also need to be determined.

A concurrent assessment should also be made of the physical nature of the site because this will dictate the stability of the material once it is placed in the area. For example, if fine-grained sediments are placed in areas of high currents or wave action, the likelihood that they will migrate out of the placement area would be high. The tide range and bathymetry or elevations at the placement area are also important because they will help dictate the capacity of the site as well as the amount of material needed to achieve a specific change.

The final concurrent assessment involves the engineering feasibility and project costs associated with each potential beneficial use option. After all of the pertinent information described above has been obtained and interdependently evaluated, a preferred placement site and beneficial use can be selected based on the positive and negative aspects of that option.

The preferred beneficial use option would then be introduced to the regulatory and environmental review process that is facilitated by the joint permit application. If approved, the dredged material would be placed in a manner consistent with the decision rendered during the evaluation process depicted in Figure 6. Monitoring and possible maintenance of a placement site may be necessary in order to sustain the intended beneficial use.

The one aspect of the management process for the beneficial use of dredged material that has been neglected the most is monitoring. This is an important consideration in dynamic systems like Seaside's barrier islands. The complex physical and biological processes that define this type of system can often modify the value of once productive placement areas through erosion or vegetative succession, for example. It is vital to the continued success of beneficial use projects that monitoring be incorporated into the construction plan so that its success can be evaluated and also to identify future measures that might be necessary to maintain or even enhance the beneficial use of a particular project.

Application of the Evaluation Process Oyster Reef Development

A previous effort that produced the Swash Bay Dredged Material Placement Area Management Plan is an example of how this type of process can be used to optimize benefits. It was developed as a joint effort by the Corps, the Virginia Marine Resources Commission, and the Virginia Institute of Marine Science. It involved the development of a new dredged material placement area using beneficial uses because the old area had been leased for oyster production.

Swash Bay is one of the shallow bays along the WCV that is routinely dredged by the Corps (See Plate 7). Since its construction in 1957, the Corps has used a combination of overboard, unconfined marsh and diked marsh disposal sites for the dredged material.

Oysters on the Seaside of the Eastern Shore grow almost exclusively in the intertidal zone where they are less susceptible to diseases and predators. The previous placement episodes had created a large number of intertidal hummocks covered with shell that began to support populations of oysters. In 1985, the entire placement area was leased from the State for shellfish cultivation (See Figure 2). As a consequence, it was no longer available for dredged material placement. This precipitated the need to develop a new overboard placement site.

Because of the potential for oyster habitat creation demonstrated by the past practices, the Corps decided to pursue oyster reef development in Swash Bay as a beneficial use. Unfortunately, the analysis of the sediments to be dredged indicated they were very fine-grained (approximately 6% sand). This would require several placement cycles to accumulate enough material to reach the intertidal elevations necessary for oyster reef development. This would also require long-term commitments from all three parties for the eventual success of the project.

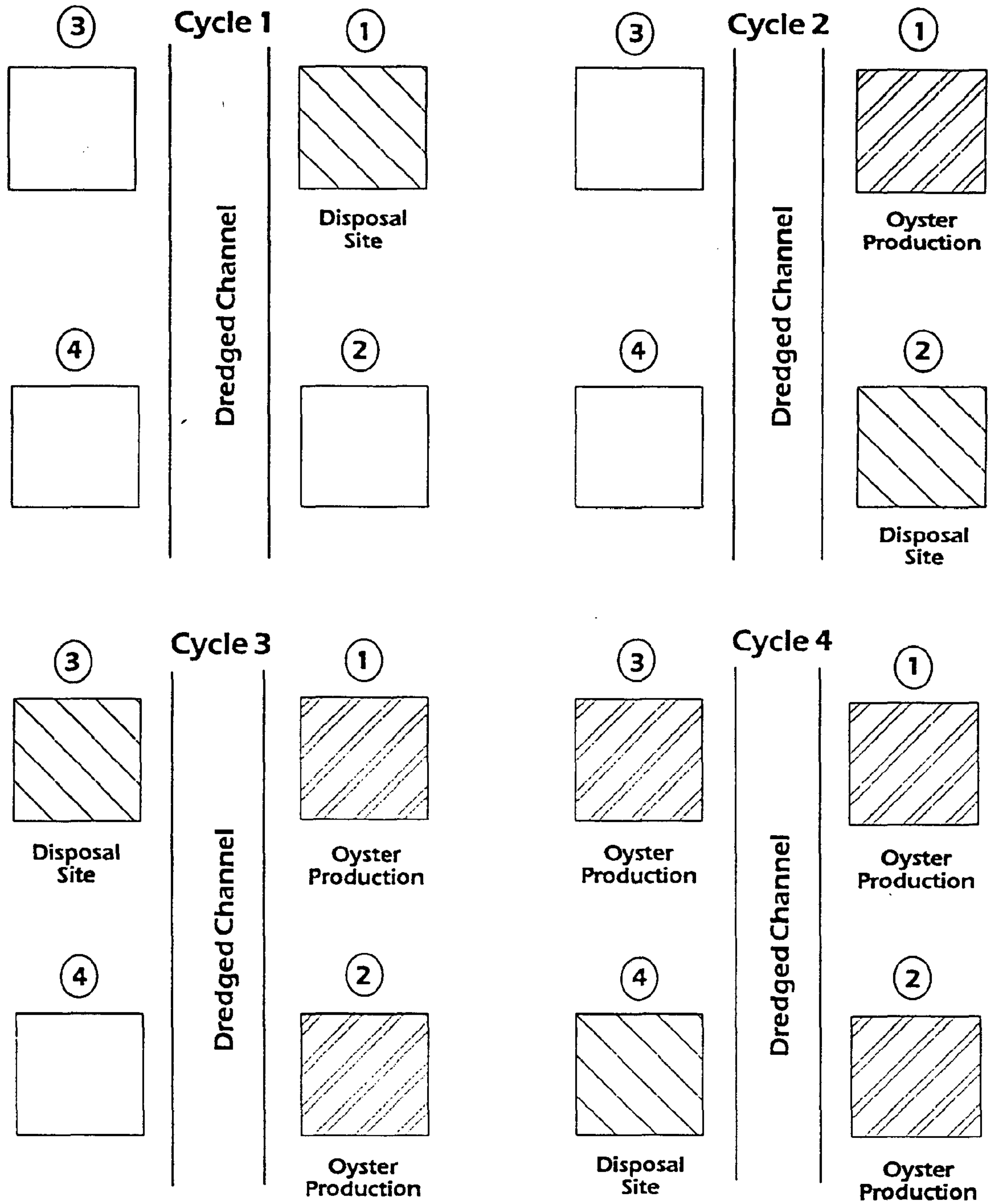
The Corps agreed to continue to place the dredged material at the same location to allow the material to accumulate in the highest profile possible and to make every effort to provide cultch for the area once a sufficient intertidal area had been built. They also agreed to periodically survey the placement area to document its behavior between placement episodes. VMRC agreed not to lease the area for oyster production as long as it is actively being used as a placement area by the Corps. VIMS agreed to provide monitoring with funding from the Corps.

The monitoring of the first placement episode in 1993 has produced a substantial amount of information on the recovery of the benthic community, the distribution of surface sediment types, and the behavior of the sediment mound as it responds to the physical environment of Swash Bay.

Preliminary results from that study indicate that the intertidal area of the mound created from dredged materials decreased in size from 1.93 acres to 0.41 acres over a 14-month period [6]. This type of geophysical information will prove useful when attempting to design and build a dredged material placement site with specific goals in mind. Other results of the study indicate a relatively short-term recovery of the benthic community that was covered by the dredged material [19].

The material from the next dredging cycle will be placed on top of the existing mound in the continuing effort to develop a stable platform within the intertidal zone that can serve as the foundation for an oyster reef. Once future placements produce an intertidal area of roughly ten acres, the plan calls for the area to be cultched to initiate the reef development.

Dredged Material Placement for Oyster Reef Management



Cycle 5 - Strip Site (1) and Repeat Rotation,

Stripping Each Successive Site of Shell.

At this point the placement area would be moved to a new area and the process begun again.

This process would be repeated as necessary to accommodate the volume of material that needed to be dredged. Once all of the area available for reef development has been utilized, it becomes necessary to reuse the original sites in the order they were developed. Existing oyster and shell resources would be stripped from the reef and additional dredged material pumped into place. This additional material would help maintain the required intertidal elevations by offsetting the long-term consolidation and erosion processes that would tend to lower the elevation of the reef. After the appropriate elevations and area have been reestablished the reef would then be replanted with cultch and seed. A schematic of this process is presented in Figure 7.

Planning Process

The recommended beneficial use evaluation process and dredged material placement site selection utilizes a team approach. Moreover, we recommend a two phase evaluation for each WCV dredging project, as each project comes up for review. The first phase or "public review" would invite non-regulatory groups such as working watermen, wildlife conservation organizations, recreational and commercial fishing associations, local government, and any other party that might have an interest in the seaside. Conducted on the shore, this initial step would allow groups the opportunity to review a given project and make recommendations on potential beneficial uses of the dredged material. VMRC would oversee these proceedings.

Phase two of the evaluation process would involve a "Beneficial Use Development Team" comprised of regulatory and advisory individuals that would normally participate in the Norfolk District dredging management process. The team would follow the procedures outlined in this project in an effort to identify the best possible use of dredged materials. The comments and recommendations obtained during the public review phase would be considered during this process. Final site selections for the placement of dredged material would then be subjected to the existing regulatory/environmental review process.

VII. Summary

This project has centered on developing a beneficial use evaluation process whereby each project could be reviewed on a individual basis, its benefits and detriments assessed, resource tradeoffs evaluated, and placement option(s) agreed upon through a consensus process. The beneficial use evaluation process has been presented in Chapter VI. It is the recommendation of this study that the described process, or a similiar version, be adopted by the Corps and collectively exercised by the various regulatory, environmental, and advisory groups within Virginia.

As part of this process, future dredging and dredged material placement projects that are designed to provide specific beneficial uses should be formally designated as construction projects. This would emphasize the positive aspects of the beneficial use and connote the fact that something is being built. As such, it is imperative that the design be properly engineered and the placement plan be specifically followed by the dredging contractor. Oversight by members of the Beneficial Use Development Team would also be helpful to address unforseen contingencies that might arise during construction.

The placement of dredged material can be specifically managed in a number of ways to produce important habitat features such as oyster reefs and colonial waterbird nesting habitat. Additionally, the construction of islands from dredged material placement, regardless of the intended purpose, can contribute to the ecology of the landscape in numerous ways due to the structure and "edge effect" it creates in the landscape. Other types of placement areas produce similar impacts to a greater or lesser extent. This structure fosters a diversity that would not otherwise occur at the site because any island is necessarily made up of a number of habitat components such as shallow subtidal bottom, intertidal flats, vegetated wetlands, and subaerial sand and shell. This structural complexity and habitat diversity allow ecological processes to integrate and interact producing a habitat complex with an ecological value greater than that of the individual habitats.

The Benthic Assessment Method (BAM) selected to monitor the recovery of the benthic communities at the placement sites appeared to be capable of discerning differences among the sites at each of the dredged channels. The assessment scores with one exception followed the same pattern where the highest values were found at the undisturbed sites, the lowest values at the most recently used sites, and intermediate values for the older placement sites. The absolute values of the BAM scores, however, varied considerably among the channels and were not necessarily comparable. The scores indicated both short and long term recovery at all of the channels except one. The differences observed appeared, for the most part, to be attributable to differences in sediment grain size, benthic community type and age of the placement area.

Acknowledgment: Virtually all the documentation on dredging and material placement in the WCV is either U.S. Army Corps of Engineers reports or reports prepared for the Corps. In addition to providing documentation, the project has been specifically assisted by T. D. Woodward, Elizabeth Grey Waring, Roger Pruhs, and Ronald G. Vann of the Norfolk District.

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APPENDIX A

Channel Sediment Grain Size Composition

Channel sediment composition from the WCV.

Channel	Sample #	% Gravel	% Sand	% Silt	% Clay
Wise Point	WCV 2	0.2%	83.6%	5.0%	11.2%
	WCV 4	0.8%	93.4%	1.5%	4.3%
	WCV 6	0.0%	94.7%	0.1%	5.2%
	WCV 8	2.0%	92.7%	0.3%	5.0%
	WCV 10	2.7%	92.1%	0.5%	4.7%
	WCV 12	0.0%	92.9%	1.7%	5.4%
	WCV 14	0.4%	95.4%	0.2%	4.0%
	WCV 16	0.0%	83.7%	7.5%	8.8%
	WCV 18	3.3%	91.9%	0.4%	4.4%
	WCV 20	1.4%	69.2%	13.0%	16.4%
	WCV 22	1.5%	46.1%	31.3%	21.1%
	WCV 24	0.2%	42.6%	30.1%	27.1%
	WCV 26	0.0%	23.9%	45.2%	30.9%
Magothy Bay	WCV 28	0.0%	58.3%	24.2%	17.5%
	WCV 30	0.2%	53.8%	28.0%	18.0%
	WCV 32	0.1%	77.0%	11.7%	11.2%
	WCV 34	0.0%	63.4%	22.3%	14.3%
	WCV 36	0.0%	3.4%	54.5%	42.1%
	WCV 38	0.1%	11.6%	50.6%	37.7%
	WCV 40	0.1%	7.4%	51.1%	41.4%
Eckichy Marsh	WCV 42	0.0%	50.8%	28.8%	20.4%
	WCV 44	0.0%	69.5%	17.5%	13.0%
	WCV 46	0.0%	64.4%	22.6%	13.0%
	WCV 48	0.0%	50.5%	34.9%	14.6%
	WCV 50	0.0%	56.9%	31.6%	11.5%
	WCV 52	0.0%	56.9%	26.1%	17.0%
	WCV 54	0.0%	41.6%	40.9%	17.5%
	WCV 56	0.0%	66.6%	19.8%	13.6%
Gull Marsh	WCV 58	0.0%	40.4%	37.5%	22.1%
	WCV 60	0.0%	76.5%	12.4%	11.1%
	WCV 62	0.0%	32.3%	43.7%	24.0%
	WCV 64	0.0%	69.9%	19.0%	11.1%
	WCV 66	0.0%	43.1%	36.2%	20.7%
	WCV 68	0.0%	60.4%	26.4%	13.2%
	WCV 70	0.0%	43.2%	33.5%	23.3%
North Channel	WCV 72	0.0%	32.5%	42.6%	24.9%
	WCV 74	0.2%	33.3%	40.1%	26.4%
	WCV 76	0.1%	44.1%	34.2%	21.6%
	WCV 78	0.0%	40.8%	35.5%	23.7%
	WCV 80	0.0%	46.6%	31.7%	21.7%
	WCV 82	0.0%	60.7%	25.0%	14.3%

Appendix A - Page 2

Channel	Sample #	% Gravel	% Sand	% Silt	% Clay
Sloop Channel	WCV 84	0.0%	67.0%	21.2%	11.8%
	WCV 85	0.0%	48.0%	33.6%	18.4%
	WCV 86	0.1%	51.6%	31.4%	16.9%
	WCV 87	0.0%	45.1%	36.7%	18.2%
	WCV 88	0.0%	20.6%	46.1%	33.3%
	WCV 89	0.0%	13.8%	55.5%	30.7%
	WCV 90	0.0%	10.2%	54.5%	35.3%
	WCV 91	0.0%	10.8%	55.6%	33.6%
	WCV 92	0.0%	19.9%	50.5%	29.6%
White Trout Ck	WCV 114	0.0%	27.9%	43.8%	28.3%
	WCV 115	0.0%	4.0%	52.9%	43.1%
	WCV 116	0.0%	4.9%	63.2%	31.9%
	WCV 117	0.0%	9.4%	62.6%	28.0%
Swash Bay	WCV 118	0.0%	3.3%	57.3%	39.4%
	WCV 119	0.0%	7.5%	59.4%	33.1%
	WCV 120	0.0%	3.6%	53.8%	42.6%
	WCV 121	0.0%	4.6%	56.5%	38.9%
	WCV 122	0.0%	9.4%	50.2%	40.4%
Bradford Bay	WCV 123	0.0%	33.9%	40.6%	25.5%
	WCV 124	0.0%	11.7%	56.6%	31.7%
	WCV 125	0.0%	3.0%	57.4%	39.6%
	WCV 126	1.2%	32.9%	40.9%	25.0%
	WCV 127	0.0%	7.3%	55.7%	37.0%
Burtons Bay	WCV 128	0.0%	3.4%	51.5%	45.1%
	WCV 129	0.0%	7.8%	56.6%	35.6%
	WCV 130	0.0%	2.1%	56.3%	41.6%
	WCV 131	0.0%	0.5%	50.0%	49.5%
	WCV 132	0.0%	4.2%	53.1%	42.7%
	WCV 133	0.0%	8.9%	54.7%	36.4%
	WCV 134	6.9%	12.6%	53.6%	26.9%
	WCV 135	0.0%	31.4%	40.5%	28.1%
Teagles Ditch	WCV 136	0.0%	14.9%	54.0%	31.1%
Cedar Island Bay	WCV 137	0.9%	37.3%	31.4%	30.4%
Metomkin Bay	WCV 138	0.6%	93.4%	3.0%	3.0%
	WCV 139	0.0%	34.8%	39.7%	25.5%
	WCV 140	0.0%	19.3%	47.0%	33.7%
	WCV 141	0.0%	1.2%	46.3%	52.5%
	WCV 142	0.0%	1.6%	50.1%	48.3%
	WCV 143	0.0%	15.2%	56.8%	28.0%
	WCV 144	0.0%	88.5%	9.3%	2.2%
	WCV 145	0.0%	80.3%	11.3%	8.4%

Appendix A - Page 3

Channel	Sample #	% Gravel	% Sand	% Silt	% Clay
Kegotank Bay	WCV 146	0.0%	93.4%	3.3%	3.3%
	WCV 147	0.0%	72.8%	16.7%	10.5%
	WCV 148	0.5%	65.0%	21.9%	12.6%
	WCV 149	8.1%	80.4%	5.2%	6.3%
Northam Narrows	WCV 150	0.0%	95.4%	2.1%	2.5%
	WCV 151	1.3%	94.8%	1.3%	2.6%
	WCV 152	5.3%	88.3%	2.4%	4.0%
	WCV 153	0.2%	11.2%	52.0%	36.6%
	WCV 154	0.0%	1.2%	52.5%	46.3%
	WCV 155	0.0%	2.7%	46.4%	50.9%
Bogues Bay	WCV 156	2.4%	85.8%	5.9%	5.9%
	WCV 157	0.0%	57.8%	23.8%	18.4%
	WCV 158	0.0%	50.6%	25.5%	23.9%
Lewis Creek	WCV 159	0.0%	84.4%	6.8%	8.8%
	WCV 160	0.2%	57.0%	21.9%	20.9%
	WCV 161	0.0%	5.6%	52.2%	42.2%
	WCV 162	0.0%	16.8%	46.7%	36.5%

APPENDIX B

Benthic Assessment Method (B. A. M.)

Benthic Assessment Method (BAM)

Rapid bioassessment needs to be:
1. Reliable at telling impact from non-impact
2. Able to identify impacts from the same disturbance in different communities
3. Affordable, minimize the need for special equipment and taxonomic expertise
4. Rapid return of data and answer
5. Understandable by non-expert

Approach to calibration of BAM:
1. Select known impacted sites
2. Select natural undisturbed areas as reference points
3. Establish range of variability in time and space
4. Determine influence of salinity, sediment, and other special environmental conditions that could modify the method
5. Set maximum value for the index in different habitats

The Benthic Assessment Method:
1. Developed for use in soft bottom estuarine habitats
2. Is a stepped approach with three levels:
    1. Evaluation
    2. Identification
    3. Biomass determination
3. Is based on the premise that healthy areas contain well developed and diversely-functioning communities
4. Disturbed areas have communities with altered functions

The BAM needs the following data:
1. Benthic samples, anywhere from 0.02 to 1.0 m^2
2. Sampler can be a diver core, box core, or grab with an opening top that can be sub-cored
3. Depth of sample needs to be about 15 cm; sample needs to be sectioned into a 0-5 cm layer and a >5 cm layer
4. Sieve size should be 0.5 mm, standard in estuarine work, for the 0-5 cm layer; A 1.0 mm sieve can be used for the >5 cm layer
5. Replicate samples are needed at a site to assess the average condition.

Application of the Benthic Assessment Procedure

Phase I - BAM - Evaluation

Sieve, Look, and Score:

Is the fauna in the >5 cm section?	yes - 1	no - 0
Is fauna in the >5 cm section large? (>2 cm long)	yes - 1	no - 0

Phase II - BAM - Identification

From the same samples, identify to major group and determine functional life style.

If present, then score:

Only surface dwellers	0
Small burrowers	1
long-lived large fauna	2

Phase III - BAM - Biomass determination

From the same samples determine the biomass of each layer.

0-5 cm layer + >5 cm layer = 100% of biomass

Score percentage of biomass in the >5 cm layer as:

0 - 10 %	0
10 - 20 %	1
20 - 50 %	2
50 - 80 %	3
80 - 100 %	4

Add scores from all three phases to get BAM assessment value.

For Virginia estuaries the operational range of scores can be from 0 to 8.

In general, scores indicate:

0 - 1	Poor habitat, seriously disturbed
2 - 3	Moderately disturbed or stressed habitat
4 - 5	Slightly disturbed to moderately good habitat
6 - 8	Good habitat

Interpretation needs to be based on the possible range of BAM conditions within the system being studied.

MAGOTHY BAY B.A.M. DATA - 4 MAY 1995

Site	Core section	Fauna present in >5cm?	Is fauna in >5 cm large?	Fauna life stule	Section biomass (g)	Total Biomass (g)	% biomass in >5 cm	Total BAM Score*	Comments:
New Placement Area	0 - 5 cm	yes (1)	no (0)	small burrowers (1)	0.911	0.951	4.2 % (0)	(2)	sfc biomass does not include Nassarius (9.043g with 6 Nassarius)
	>5 cm				0.040				
	0 - 5 cm	no (0)		small burrowers (1)	0.293	0.293	0 % (0)	(1)	
	>5 cm				0.000				
	0 - 5 cm	yes (1)	no (0)	small burrowers (1)					top section of sample missing
	>5 cm				0.246				
Undisturbed Area	0 - 5 cm	yes (1)	no (0)	small burrowers (1)	2.385	4.131	42.3 % (2)	(4)	
	>5 cm				1.746				
	0 - 5 cm	yes (1)	no (0)	small burrowers (1)	0.701				bottom section of sample missing
	>5 cm								
	0 - 5 cm	yes (1)	no (0)	small burrowers (1)					top section of sample missing
	>5 cm				0.227				
Old Placement Area	0 - 5 cm	yes (1)	no (0)	small burrowers (1)	0.530	2.452	78.4 % (3)	(5)	sfc biomass does not include Nassarius (3.707g with 2 Nassarius)
	>5 cm				1.922				
	0 - 5 cm	yes (1)	no (0)	small burrowers (1)					top section of sample missing
	>5 cm				1.878				
	0 - 5 cm	yes (1)	no (0)	small burrowers (1)	0.195	0.373	47.7 % (3)	(5)	
	>5 cm				0.178				

* Total BAM score interpretation:
- 0 - 1 : Poor habitat, seriously disturbed
- 2 - 3 : Moderately disturbed or stressed habitat
- 4 - 5 : Slightly disturbed to moderately disturbed habitat
- 6 - 8 : Good habitat

SWASH BAY B.A.M. RESULTS - JUNE 1994

Site	Replicate	Core Section	Is fauna present in>5cm?	Is fauna in >5cm large?	Fauna lifestyle	Section biomass (g)	Total biomass (g)	% biomass in >5 cm	Total BAM score *	Comments:
New Placement Area	1	0 - 5 cm	yes (1)	yes (1)	small burrowers	1.3330	2.0137	34%	(5)	
		> 5 cm			(1)	0.6807		(2)		
	2	0 - 5 cm	yes (1)	yes (1)	long-lived large fauna	0.5582	1.9984	72%	(7)	large *Nereis*
		> 5 cm			(2)	1.4402		(3)		
	3	0 - 5 cm	yes (1)	yes (1)	small burrowers	0.5613	1.0661	47%	(5)	
		> 5 cm			(1)	0.5048		(2)		
Undisturbed Area	1	0 - 5 cm	yes (1)	yes (1)	long-lived large fauna	0.4827	7.0717	93%	(8)	large *Nereis*
		> 5 cm			(2)	6.5890		(4)		
	2	0 - 5 cm	yes (1)	yes (1)	long-lived large fauna	0.6338	3.9136	83%	(8)	large *Nereis*
		> 5 cm			(2)	3.2798		(4)		
	3	0 - 5 cm	yes (1)	yes (1)	small burrowers	0.2770	2.1408	87%	(7)	
		> 5 cm			(1)	1.8638		(4)		
Old Placement Area	1	0 - 5 cm	yes (1)	yes (1)	small burrowers	0.6379	4.2831	85%	(7)	
		> 5 cm			(1)	3.6452		(4)		
	2	0 - 5 cm	yes (1)	yes (1)	long-lived large fauna	10.5559	14.7868	29%	(6)	large *Nereis*.
		> 5 cm			(2)	4.2309		(2)		holothuroidea
	3	0 - 5 cm	yes (1)	yes (1)	long-lived large fauna	0.4273	13.1988	97%	(8)	large *Nereis*
		> 5 cm			(2)	12.7715		(4)		small *Mercenaria*

* Total BAM score interpretation:

- 0 - 1 : Poor habitat, seriously disturbed
- 2 - 3 : Moderately disturbed or stressed habitat
- 4 - 5 : Slightly disturbed to moderately disturbed habitat
- 6 - 8 : Good habitat

CHINCOTEAGUE B.A.M. DATA - 18 July 1995

Site	Core section	Fauna present in >5cm?	Is fauna in >5 cm large?	Fauna life stule	Section biomass (g)	Total Biomass (g)	% biomass in >5 cm	Total BAM Score*	Comments:
Undisturbed Area	0 - 5 cm >5 cm	yes (1)	yes (1)	long lived (2)	0.314 3.333	3.647	91.4 % (4)	(8)	small burrowers in sfc; large Nereis and Glycera in bottom
	0 - 5 cm >5 cm	yes (1)	yes (1)	long lived (2)	0.183 2.667	2.85	93.6 % (4)	(8)	small burrowers in sfc; large Nereis and Glycera in bottom
	0 - 5 cm >5 cm	yes (1)	yes (1)	long lived (2)	0.161 2.949	3.11	94.8 % (4)	(8)	small burrowers in sfc; large Nereis and Glycera in bottom
New Placement Area	0 - 5 cm >5 cm	yes (1)	no (0)	small burrowers (1)	0.126 0.157	0.33	47.6 % (2)	(4)	
	0 - 5 cm >5 cm	yes (1)	no (0)	small burrowers (1)	0.256 0.123	0.356	34.6 % (2)	(4)	
	0 - 5 cm >5 cm	yes (1)	no (0)	small burrowers (1)	0.266 0.158	0.446	35.4 % (2)	(4)	
Old Placement Area	0 - 5 cm >5 cm	yes (1)	no (0)	small burrowers (1)	0.132 0.497	0.629	79.0 % (3)	(5)	sfc biomass does not include Nassarius (7.126g with Nassarius)
	0 - 5 cm >5 cm	yes (1)	no (0)	small burrowers (1)	0.231 0.655	0.886	73.9 % (3)	(5)	sfc biomass does not include 6 Nassarius (12.266g with Nassarius)
	0 - 5 cm >5 cm	yes (1)	no (0)	small burrowers (1)	0.255 0.366	0.621	58.9 % (3)	(5)	sfc biomass does not include 5 Nassarius (10.682g with Nassarius)

* Total BAM score interpretation:

- 0 - 1 : Poor habitat, seriously disturbed
- 2 - 3 : Moderately disturbed or stressed habitat
- 4 - 5 : Slightly disturbed to moderately disturbed habitat
- 6 - 8 : Good habitat

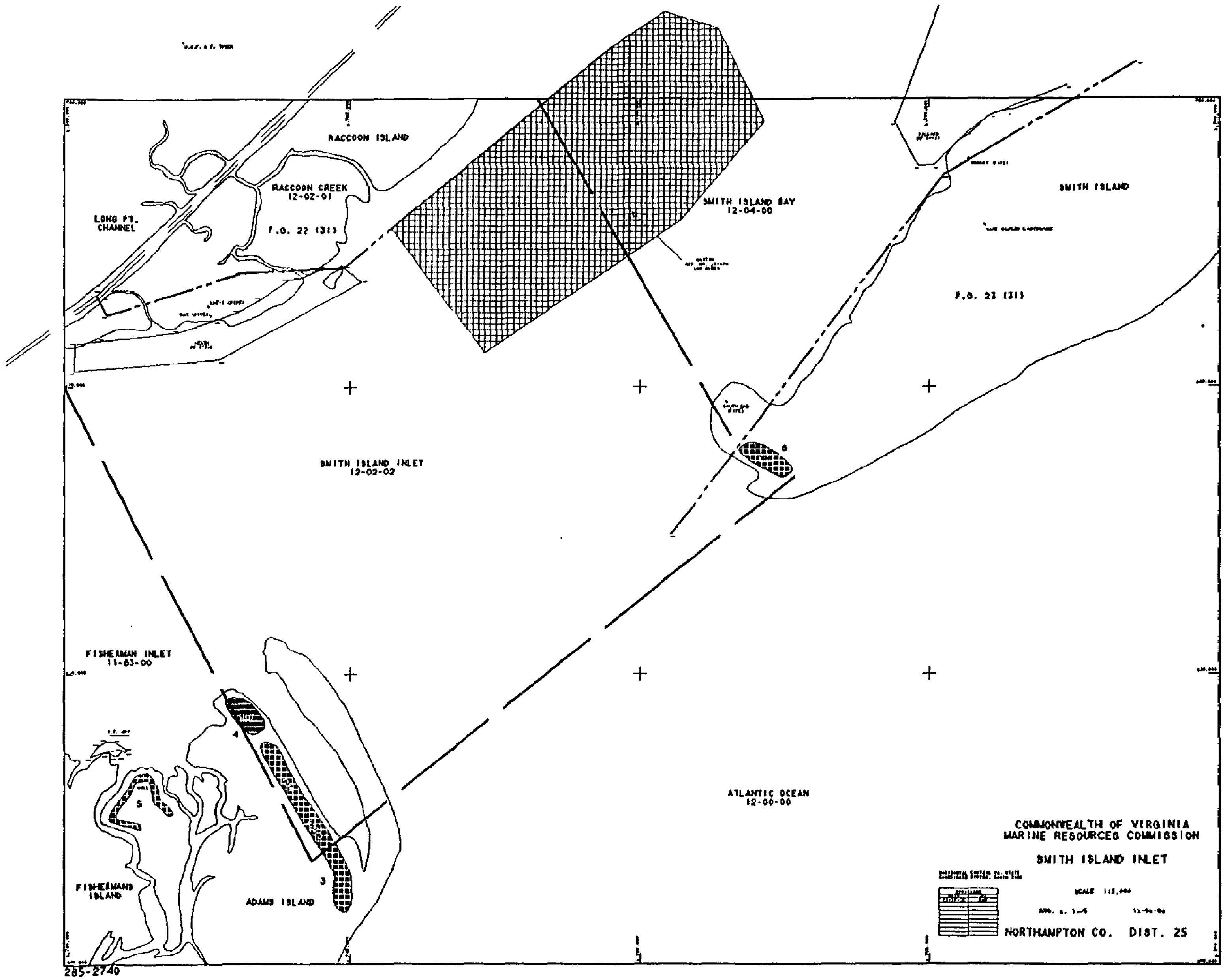
RAMSHORN B.A.M. DATA - 17 July 1995

Site	Core section	Fauna present in >5cm?	Is fauna in >5 cm large?	Fauna life stule	Section biomass (g)	Total Biomass (g)	% biomass in >5 cm	Total BAM Score*	Comments:
Site # 1 Inshore East Side of Marsh	0 - 5 cm	yes (1)	yes (1)	long lived (2)	1.532	3.749	59%	(7)	
	>5 cm				2.217		(3)		
	0 - 5 cm	yes (1)	yes (1)	long lived (2)	0.069	2.209	97%	(8)	
	>5 cm				2.140		(4)		
	0 - 5 cm	yes (1)	yes (1)	long lived (2)	0.006	1.265	99%	(8)	
	>5 cm				1.259		(4)		
Site #2 Offshore East Side of Marsh	0 - 5 cm	yes (1)	no (0)	sm burr (1)	0.167	0.934	82%	(6)	
	>5 cm				0.767		(4)		
	0 - 5 cm	yes (1)	yes (1)	long lived (2)	0.018	2.347	99%	(8)	
	>5 cm				2.329		(4)		
	0 - 5 cm	yes (1)	no (0)	sm burr (1)	0.063	0.512	88%	(6)	
	>5 cm				0.449		(4)		
Site # 3 Channel Station Near Day Marker	0 - 5 cm	yes (1)	yes (1)	long lived (2)	3.828	7.485	49%	(6)	
	>5 cm				3.657		(2)		
	0 - 5 cm	yes (1)	no (0)	sm burr (1)	0.198	1.384	86%	(6)	
	>5 cm				1.186		(4)		
	0 - 5 cm	yes (1)	no (0)	sm burr (1)	1.359	1.452	6%	(2)	
	>5 cm				0.093		(0)		
Site # 4 Westside of Marsh	0 - 5 cm	yes (1)	yes (1)	long lived (2)	0.306	1.71	82%	(8)	
	>5 cm				1.404		(4)		
	0 - 5 cm	yes (1)	yes (1)	long lived (2)	0.272	1.826	85%	(8)	
	>5 cm				1.554		(4)		
	0 - 5 cm	yes (1)	yes (1)	sm burr (1)	1.849	2.663	31%	(5)	
	>5 cm				0.814		(2)		

* Total BAM score interpretation:
- 0 - 1 : Poor habitat, seriously disturbed
- 2 - 3 : Moderately disturbed or stressed habitat
- 4 - 5 : Slightly disturbed to moderately disturbed habitat
- 6 - 8 : Good habitat

APPENDIX C

VMRC Oyster Lease Ground Maps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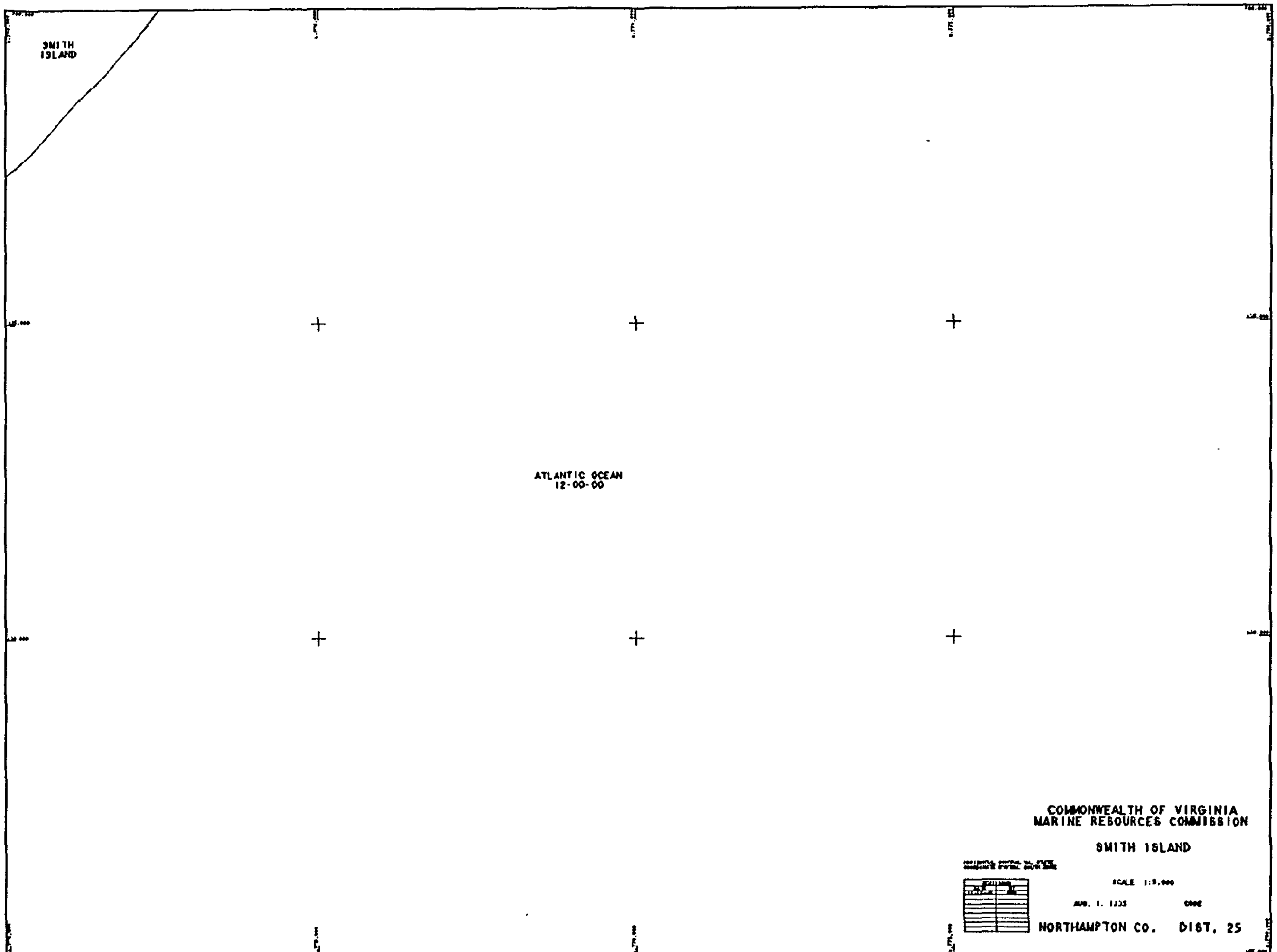
SMITH ISLAND BAY
12-04-00
SMITH ISLAND
F.O. 23 (31)
SMITH ISLAND INLET
12-02-02
FISHERMAN INLET
11-03-00
FISHERMANS
ISLAND
ADAMS ISLAND
ATLANTIC OCEAN
12-00-00
6
5
4
3
COMMONWEALTH OF VIRGINIA
MARINE RESOURCES COMMISSION
SMITH ISLAND INLET
NORTHAMPTON CO. DIST. 25
285-2740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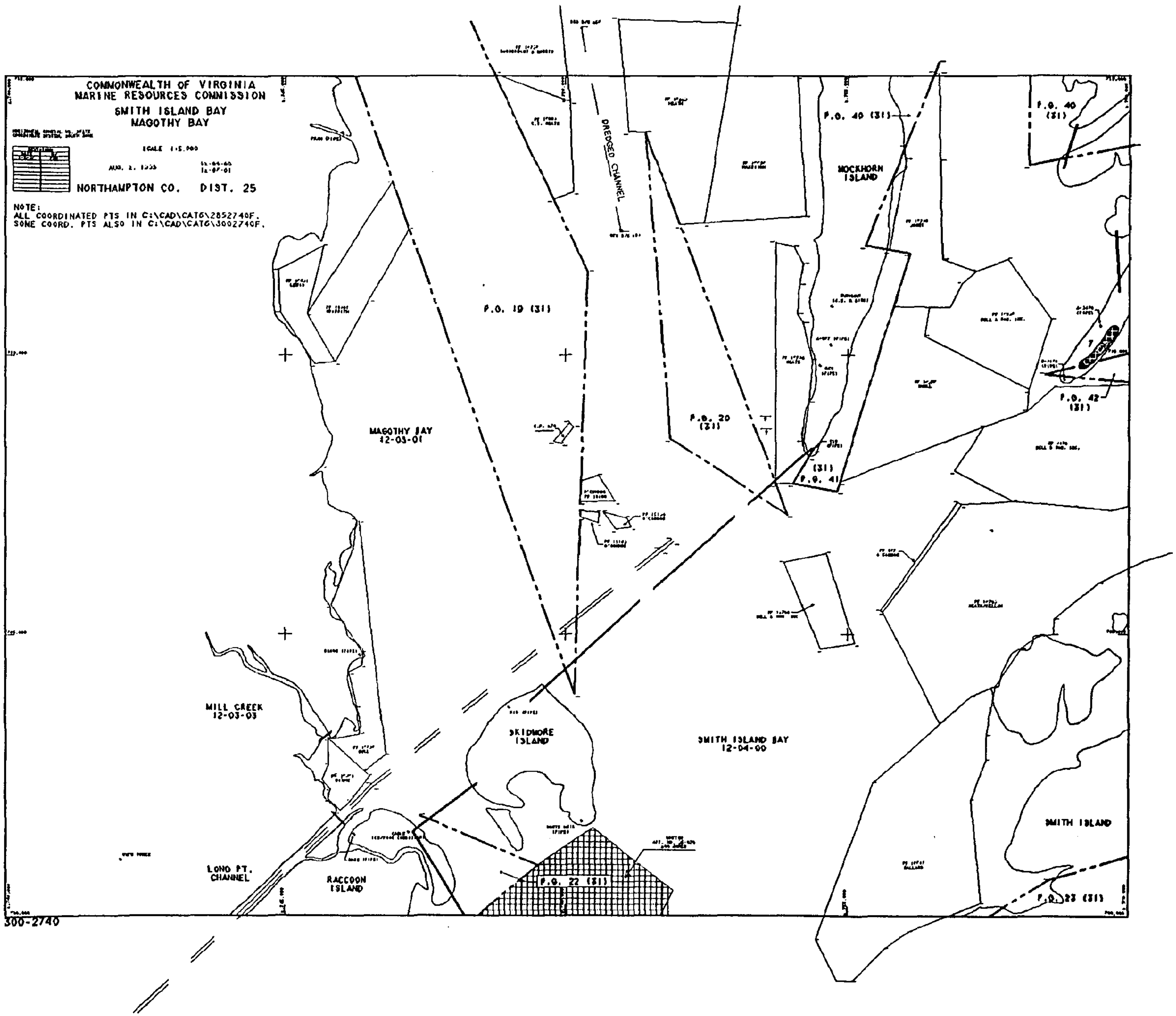
285-2760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SONE COORD. PTS ALSO IN C:\CAD\CATG\3002740F.
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P.O. 19 (31)
P.O. 20 (31)
(31) P.O. 41
P.O. 42 (31)
MAGOTHY BAY 12-03-01
MILL CREEK 12-03-03
SKIDMORE ISLAND
SMITH ISLAND BAY 12-04-00
SMITH ISLAND
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RACCOON ISLAND
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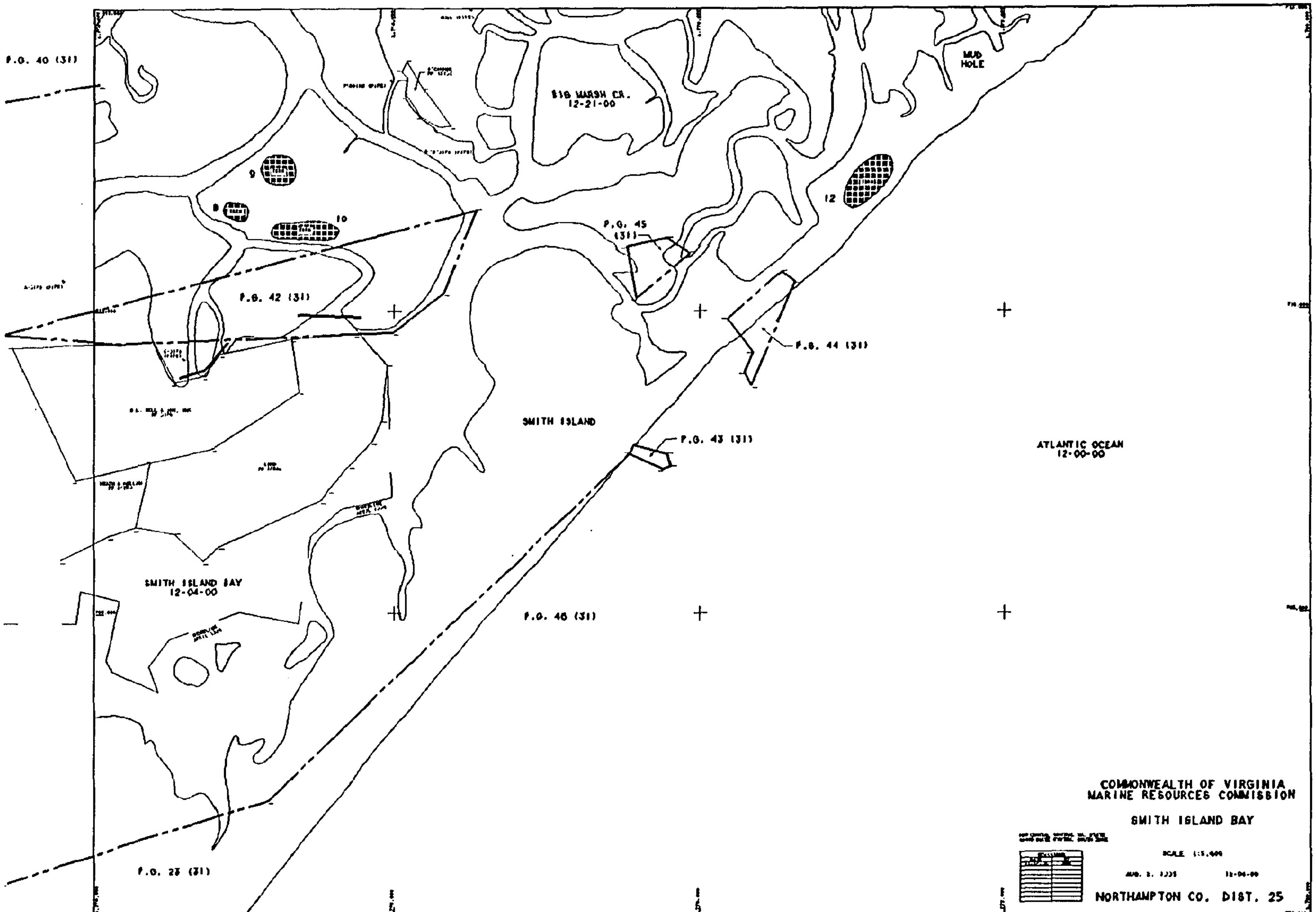
300-2740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12-04-00
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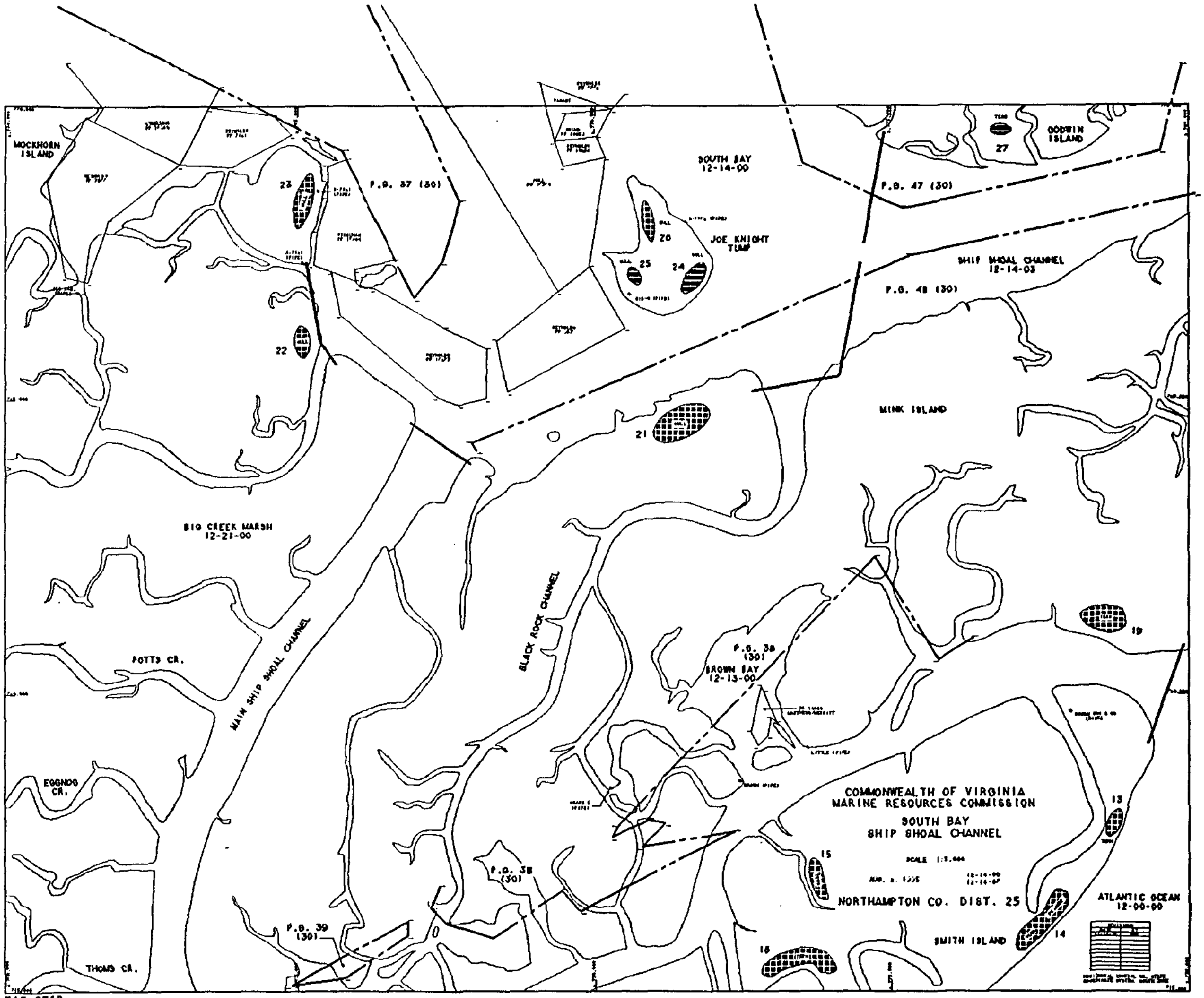
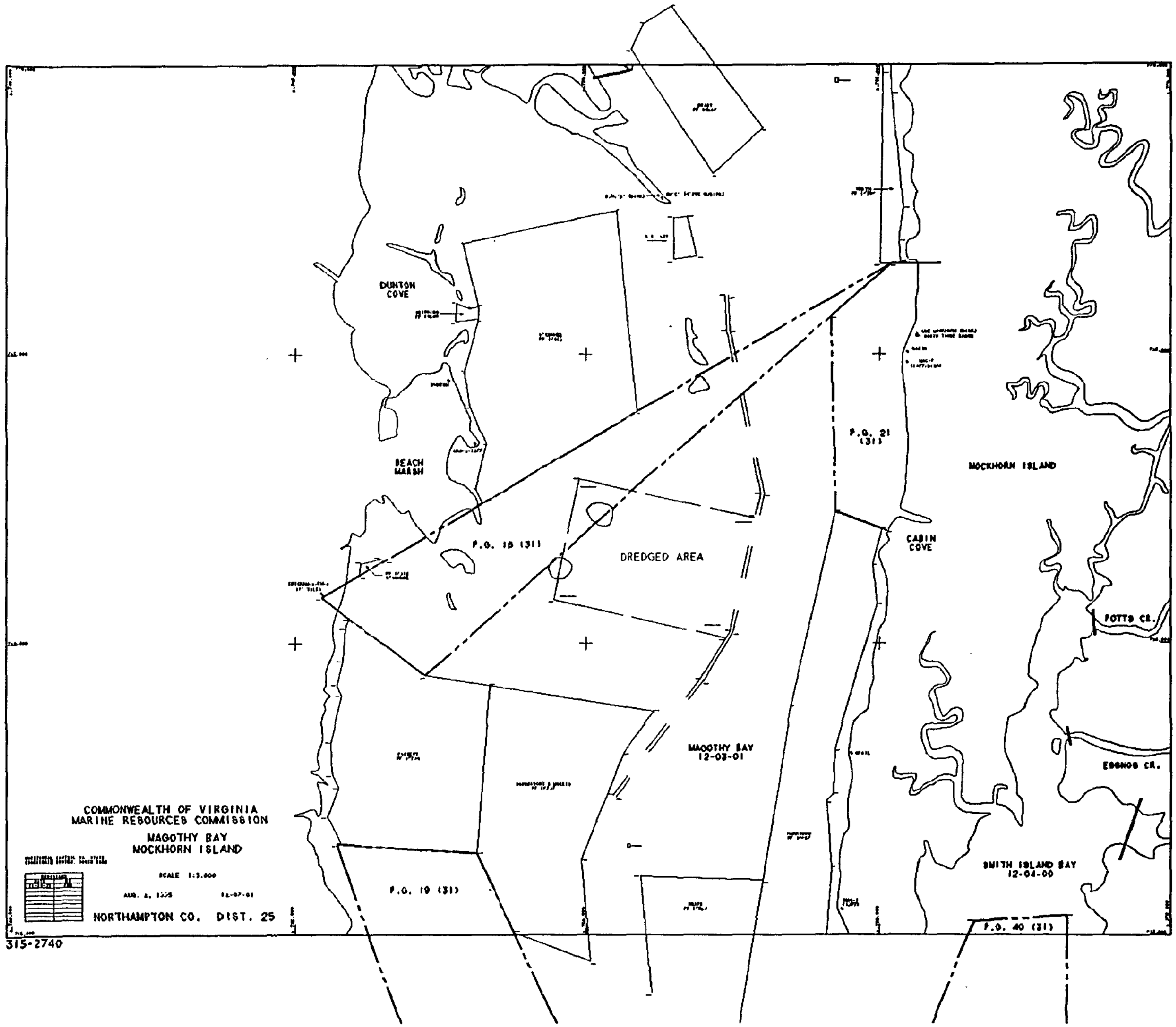
COMMONWEALTH OF VIRGINIA
MARINE RESOURCES COMMISSION
SMITH ISLAND BAY
NORTHAMPTON CO. DIST. 25

300-2760



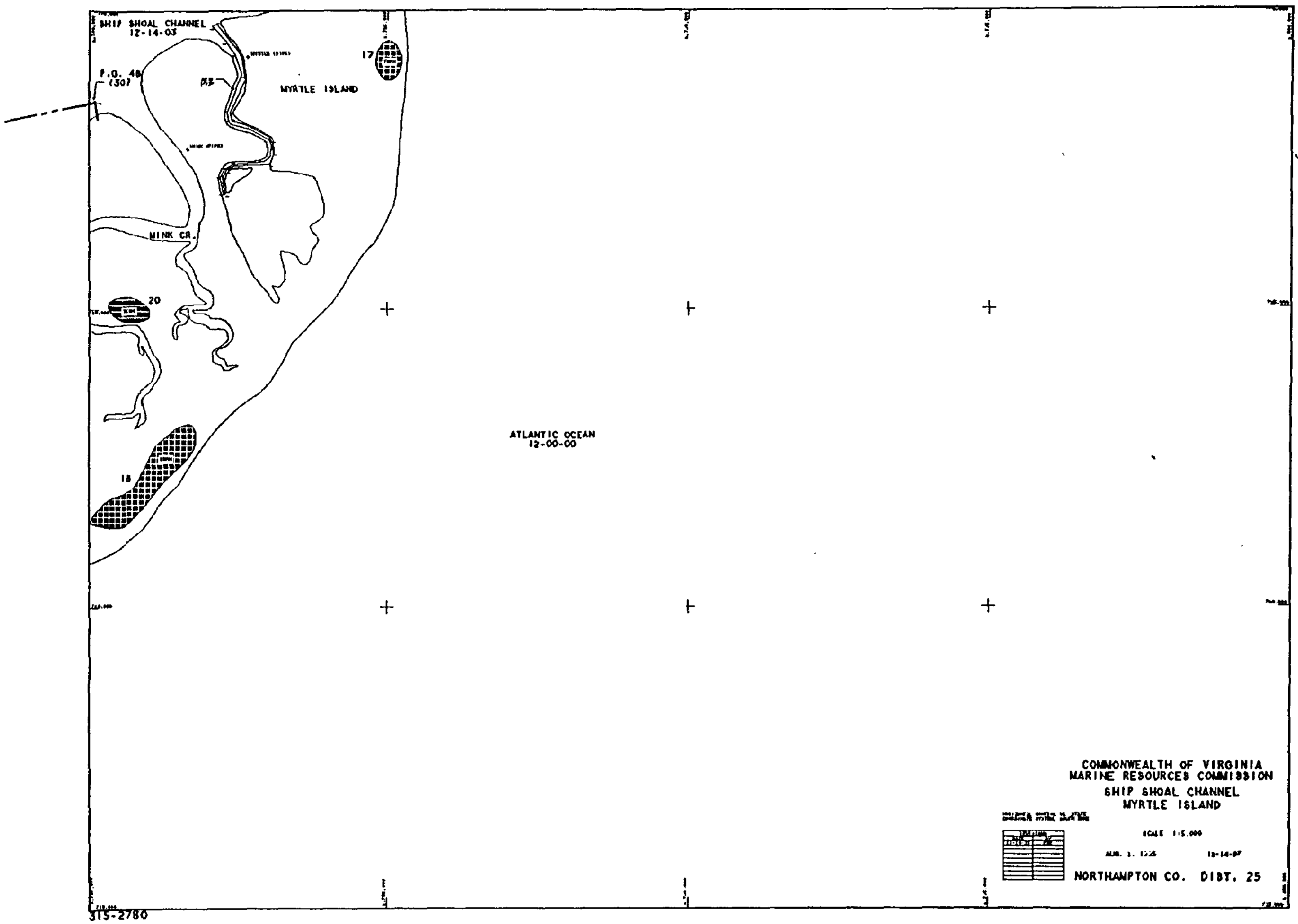
COMMONWEALTH OF VIRGINIA
MARINE RESOURCES COMMISSION
SOUTH BAY
SHIP SHOAL CHANNEL
NORTHAMPTON CO. DIST. 25
MOCKHORN ISLAND
GODWIN ISLAND
SOUTH BAY 12-14-00
JOE KNIGHT TUMP
F.G. 37 (30)
F.G. 47 (30)
F.G. 48 (30)
SHIP SHOAL CHANNEL 12-14-03
MINK ISLAND
BIG CREEK MARSH 12-21-00
MAIN SHIP SHOAL CHANNEL
BLACK ROCK CHANNEL
POTTS CR.
EGGNOG CR.
THOMS CR.
F.G. 38 (30)
BROWN BAY 12-13-00
F.G. 39 (30)
SMITH ISLAND
ATLANTIC OCEAN 12-00-00
13
14
15
16
19
20
21
22
23
24
25
27

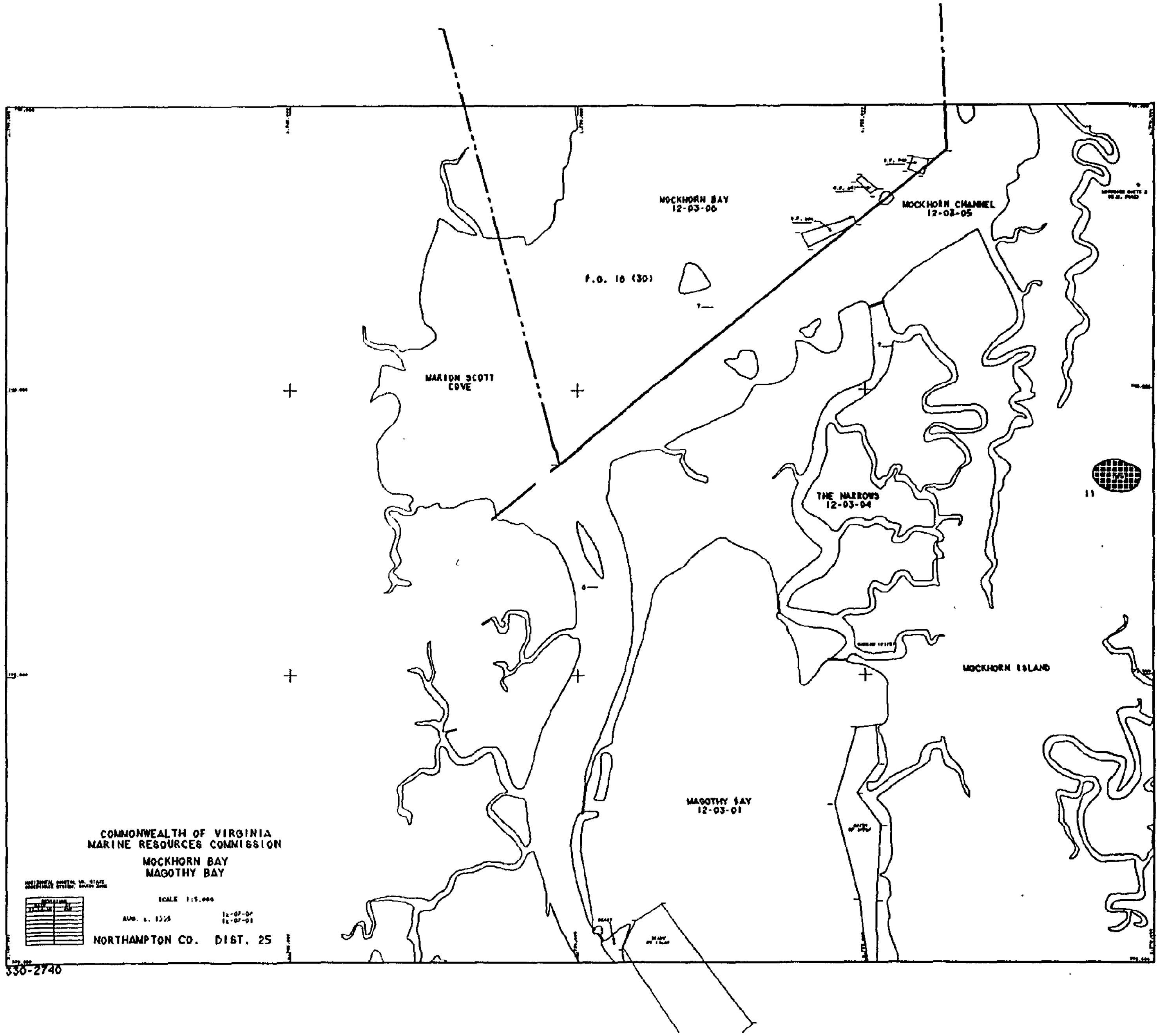
315-2760



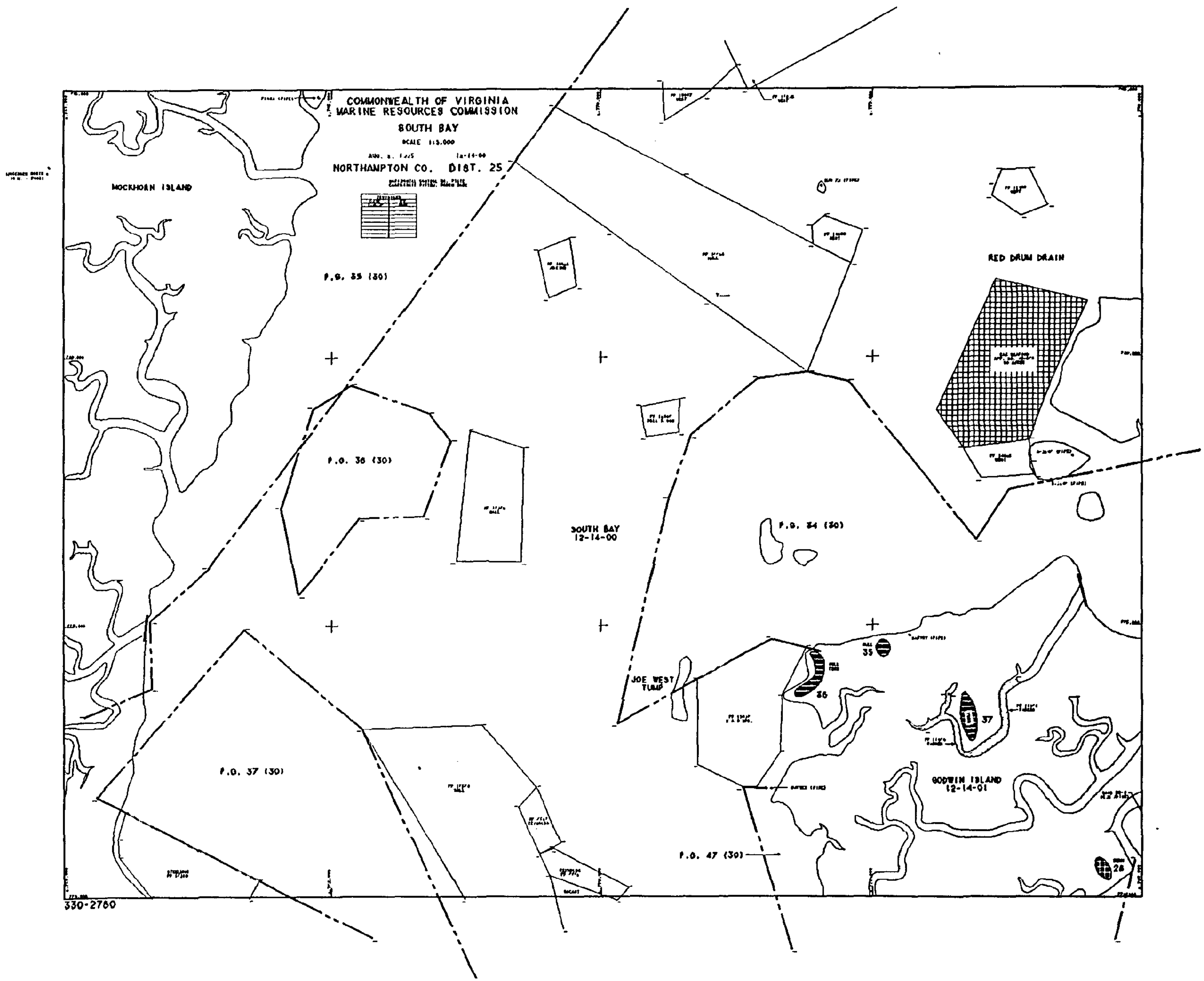
DUNTON COVE
BEACH MARSH
P.G. 18 (31)
DREDGED AREA
P.G. 21 (31)
MOCKHORN ISLAND
CABIN COVE
POTTS CR.
MAGOTHY BAY
12-03-01
EGGNOG CR.
SMITH ISLAND BAY
12-04-00
P.G. 19 (31)
P.G. 40 (31)
COMMONWEALTH OF VIRGINIA
MARINE RESOURCES COMMISSION
MAGOTHY BAY
MOCKHORN ISLAND
NORTHAMPTON CO. DIST. 25

315-2740

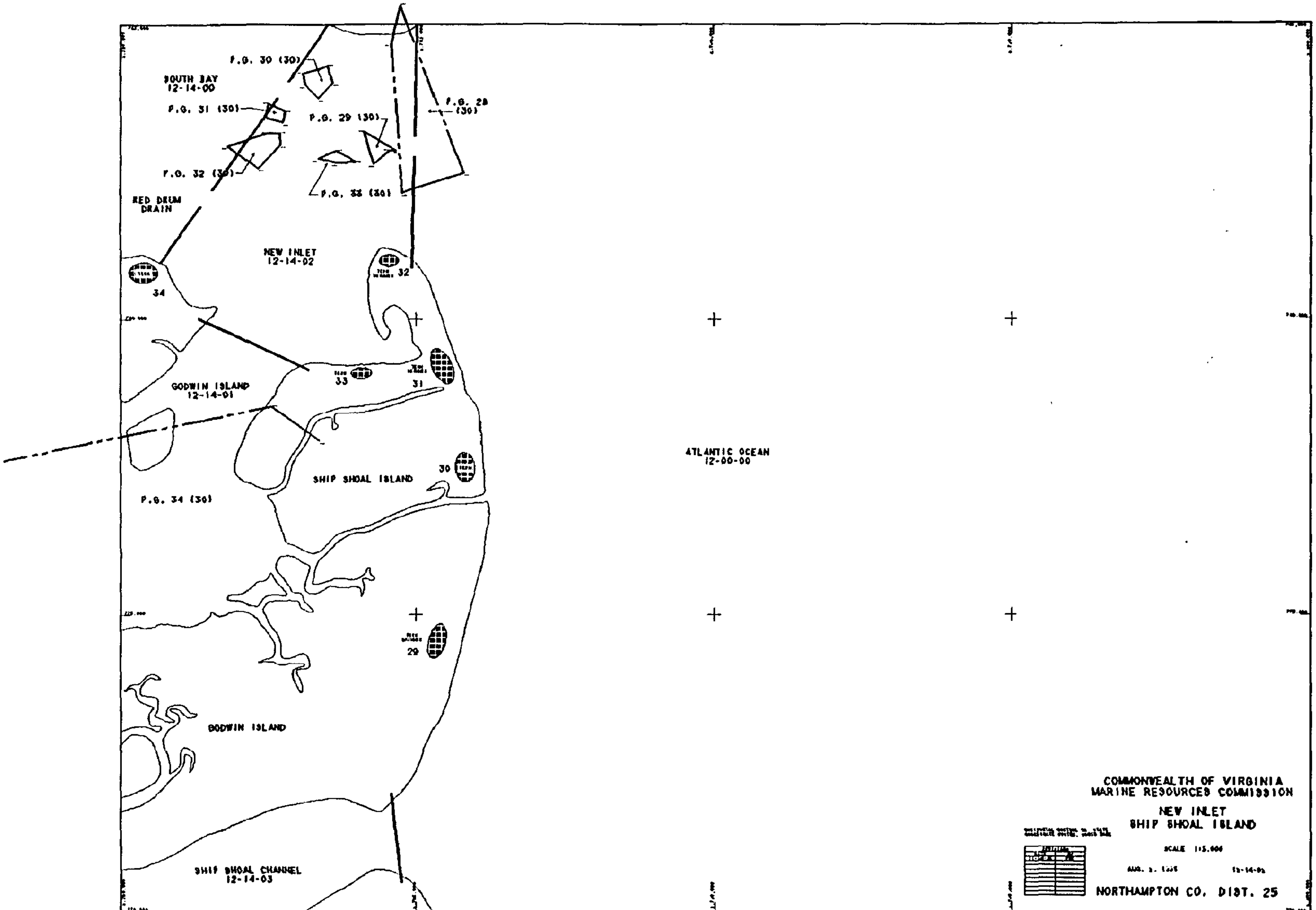

SHIP SHOAL CHANNEL
12-14-03
P.O. 48
(30)
MYRTLE ISLAND
17
MINK CR.
20
18
ATLANTIC OCEAN
12-00-00
COMMONWEALTH OF VIRGINIA
MARINE RESOURCES COMMISSION
SHIP SHOAL CHANNEL
MYRTLE ISLAND
NORTHAMPTON CO. DIST. 25
315-2780



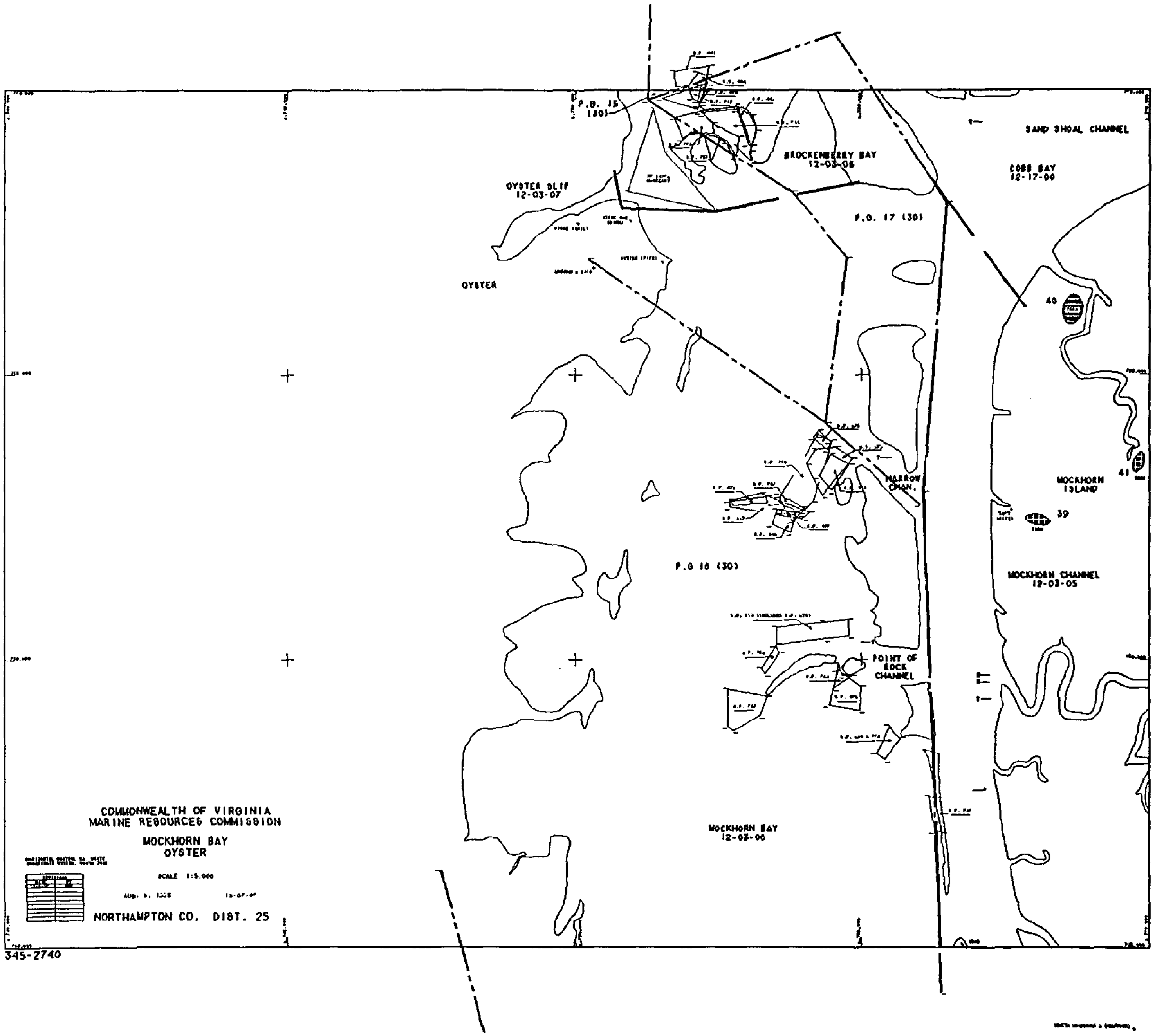
MOCKHORN BAY
12-03-06
MOCKHORN CHANNEL
12-03-05
F.O. 16 (30)
MARION SCOTT
COVE
THE NARROWS
12-03-04
MOCKHORN ISLAND
MAGOTHY BAY
12-03-01
COMMONWEALTH OF VIRGINIA
MARINE RESOURCES COMMISSION
MOCKHORN BAY
MAGOTHY BAY
NORTHAMPTON CO. DIST. 25
330-2740

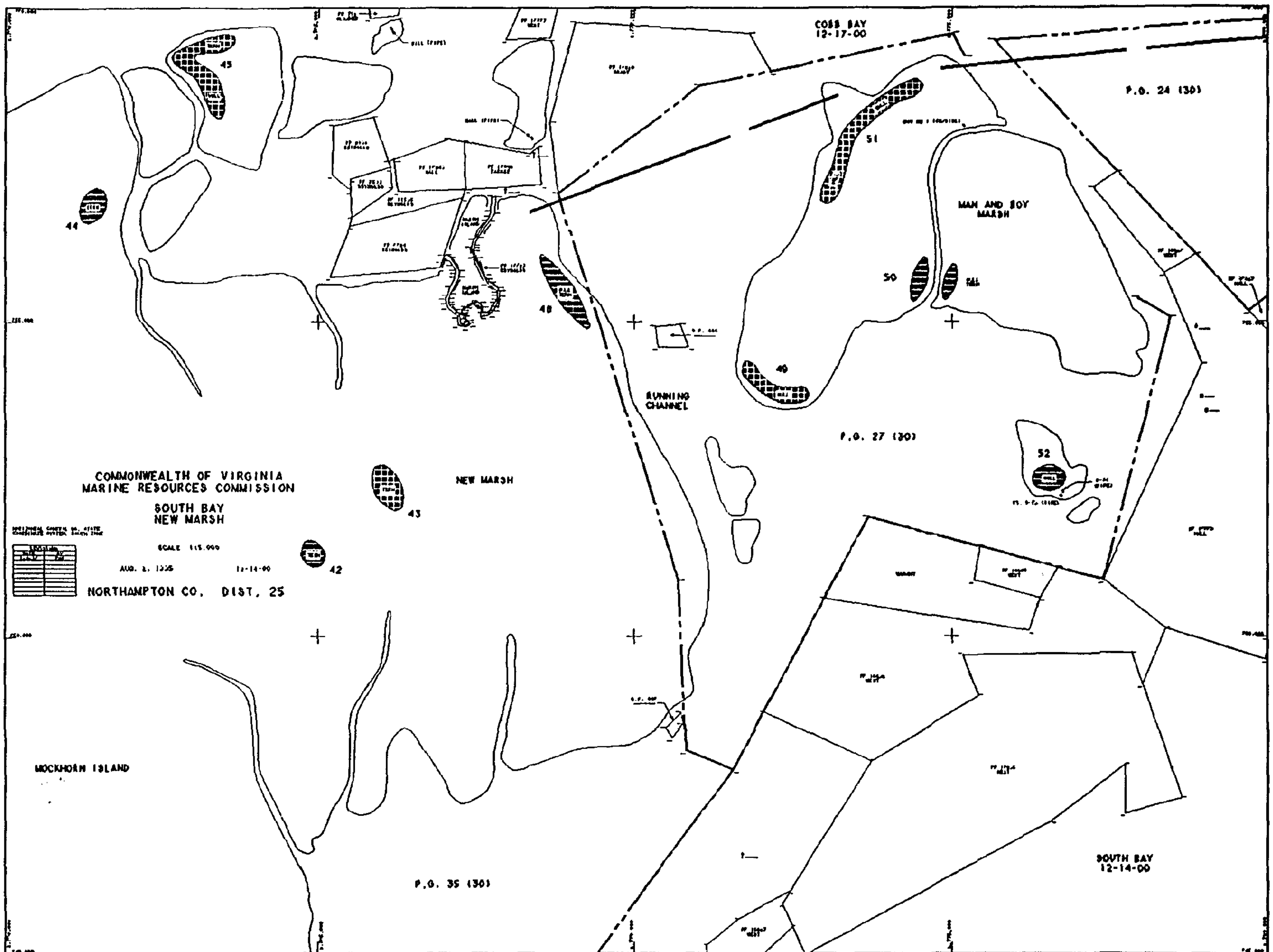

COMMONWEALTH OF VIRGINIA
MARINE RESOURCES COMMISSION
SOUTH BAY
NORTHAMPTON CO. DIST. 25
MOCKHORN ISLAND
P.O. 35 (30)
P.O. 36 (30)
SOUTH BAY
12-14-00
P.O. 34 (30)
RED DRUM DRAIN
JOE WEST
TUMP
P.O. 37 (30)
P.O. 47 (30)
GODWIN ISLAND
12-14-01
35
36
37
28

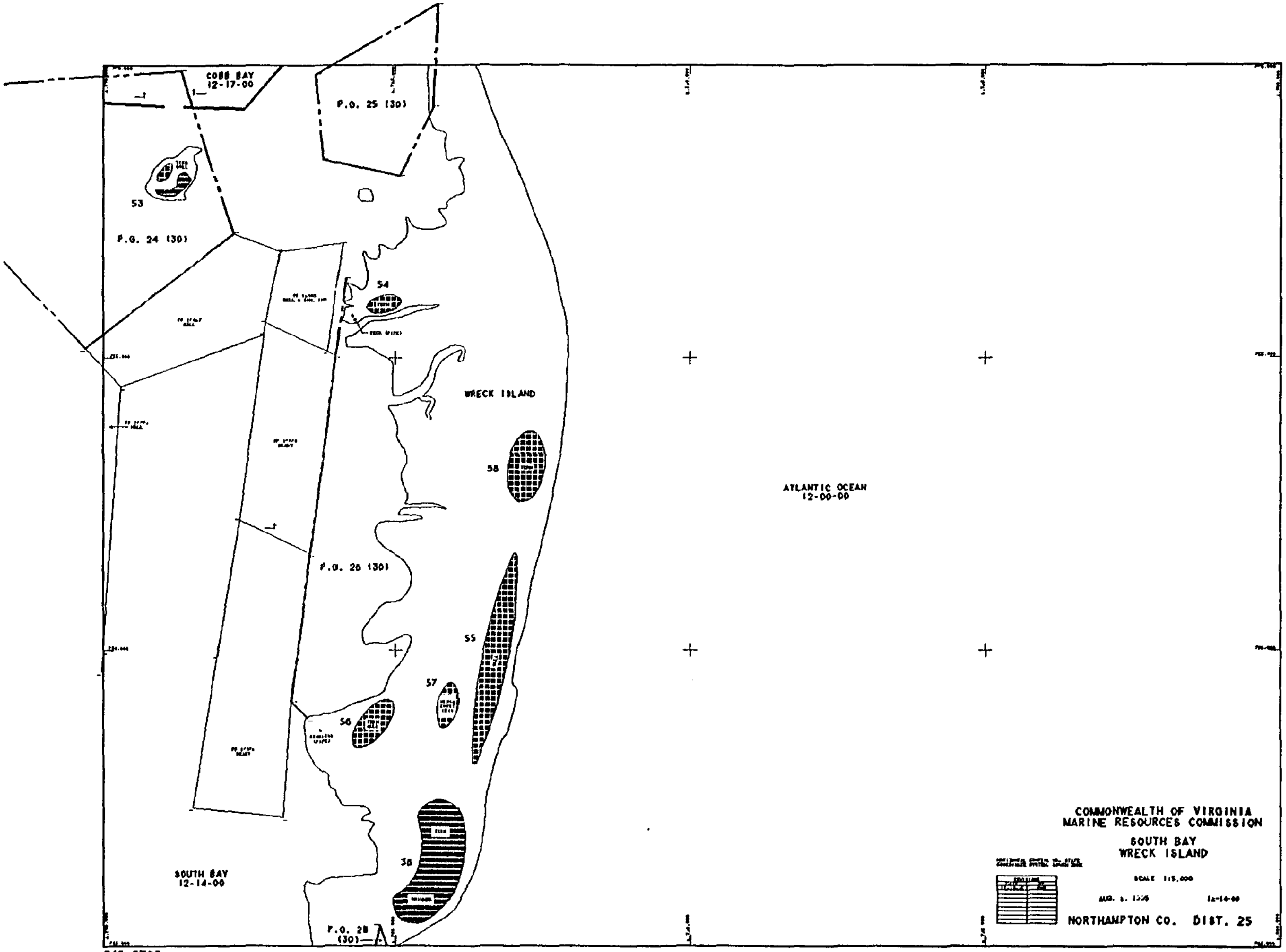
330-2780


P.G. 30 (30)
SOUTH BAY
12-14-00
P.G. 31 (30)
P.G. 29 (30)
P.G. 28
(30)
P.G. 32 (30)
P.G. 33 (30)
RED DRUM
DRAIN
NEW INLET
12-14-02
32
34
33
31
GODWIN ISLAND
12-14-01
30
SHIP SHOAL ISLAND
P.G. 34 (30)
ATLANTIC OCEAN
12-00-00
29
GODWIN ISLAND
SHIP SHOAL CHANNEL
12-14-03
COMMONWEALTH OF VIRGINIA
MARINE RESOURCES COMMISSION
NEW INLET
SHIP SHOAL ISLAND
NORTHAMPTON CO. DIST. 25

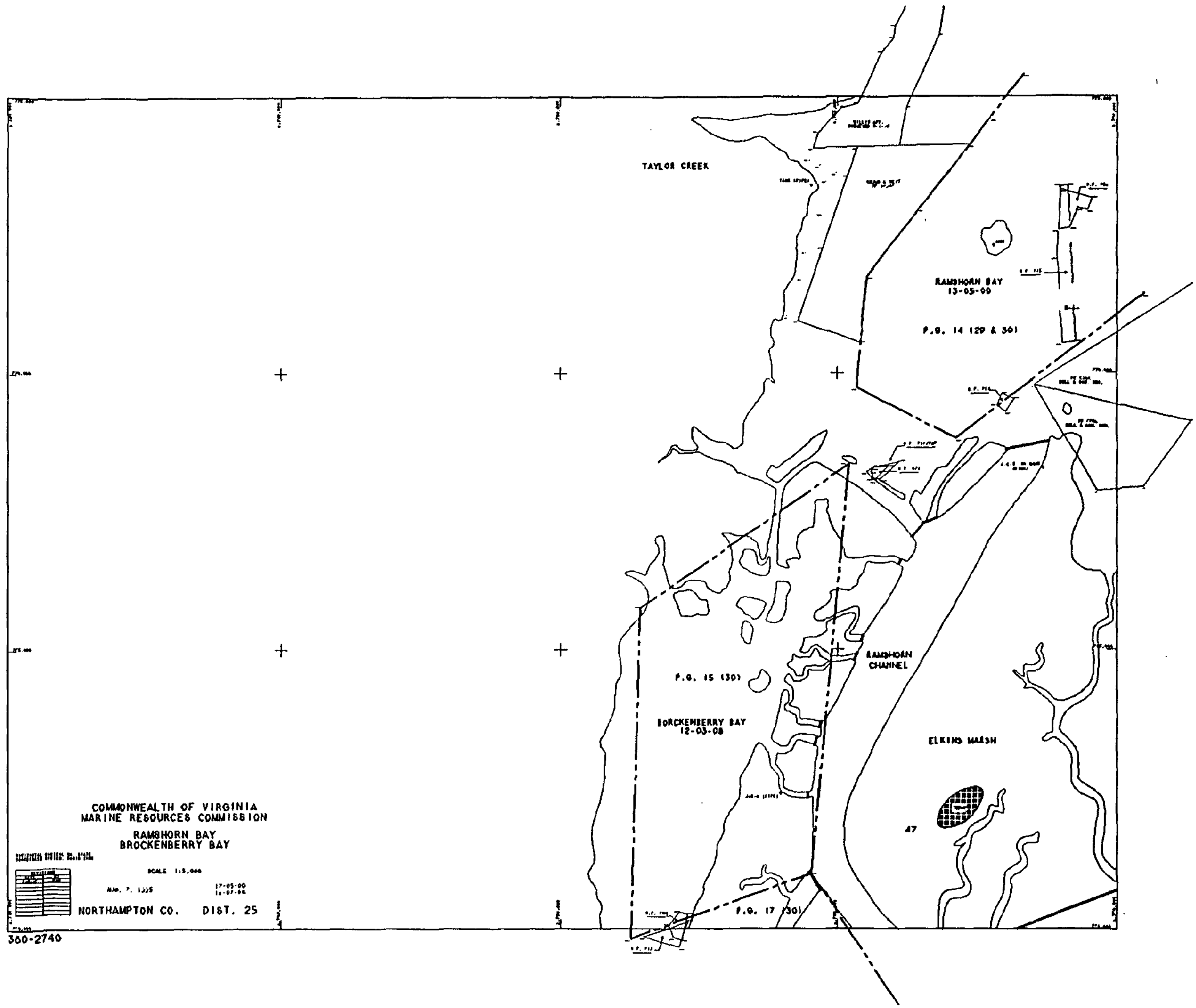
330-2780

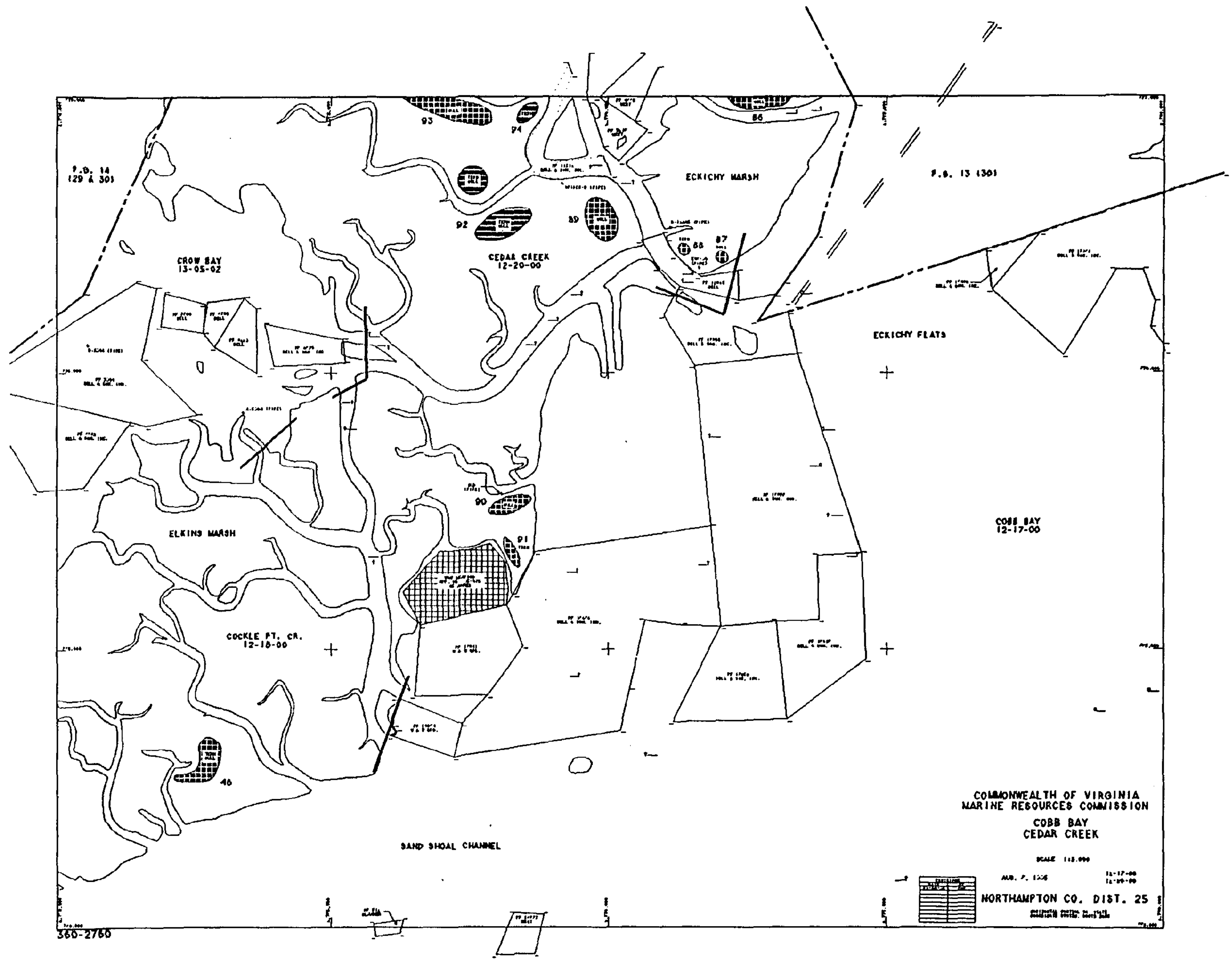

SAND SHOAL CHANNEL
COBB BAY
12-17-09
P.O. 15
(30)
BROCKENBERRY BAY
12-03-06
OYSTER SLIP
12-03-07
P.O. 17 (30)
OYSTER
40
MOCKHORN
ISLAND
41
39
NARROW
CHAN.
P.O 16 (30)
MOCKHORN CHANNEL
12-03-05
POINT OF
ROCK
CHANNEL
MOCKHORN BAY
12-03-06
COMMONWEALTH OF VIRGINIA
MARINE RESOURCES COMMISSION
MOCKHORN BAY
OYSTER
NORTHAMPTON CO. DIST. 25
345-2740

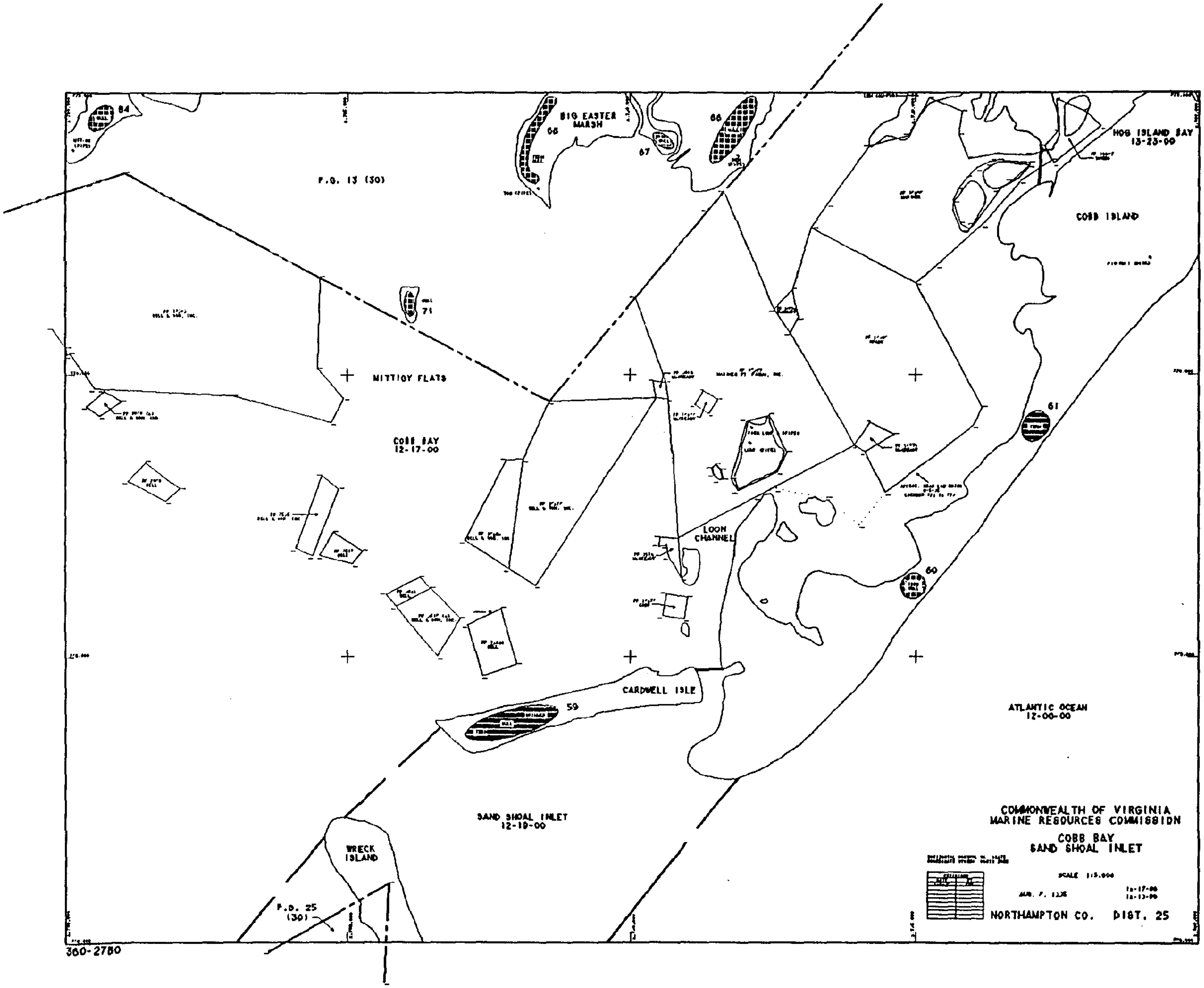

COBB BAY
12-17-00
P.O. 24 (30)
MAN AND BOY
MARSH
51
50
49
52
48
45
44
43
42
RUNNING
CHANNEL
P.O. 27 (30)
NEW MARSH
COMMONWEALTH OF VIRGINIA
MARINE RESOURCES COMMISSION
SOUTH BAY
NEW MARSH
NORTHAMPTON CO. DIST. 25
MOCKHORN ISLAND
P.O. 35 (30)
SOUTH BAY
12-14-00
345-2760


COBB BAY
12-17-00
P.O. 25 (30)
53
P.O. 24 (30)
54
WRECK ISLAND
58
ATLANTIC OCEAN
12-00-00
P.O. 26 (30)
55
57
56
38
SOUTH BAY
12-14-00
P.O. 28
(30)
COMMONWEALTH OF VIRGINIA
MARINE RESOURCES COMMISSION
SOUTH BAY
WRECK ISLAND
NORTHAMPTON CO. DIST. 25

345-2760

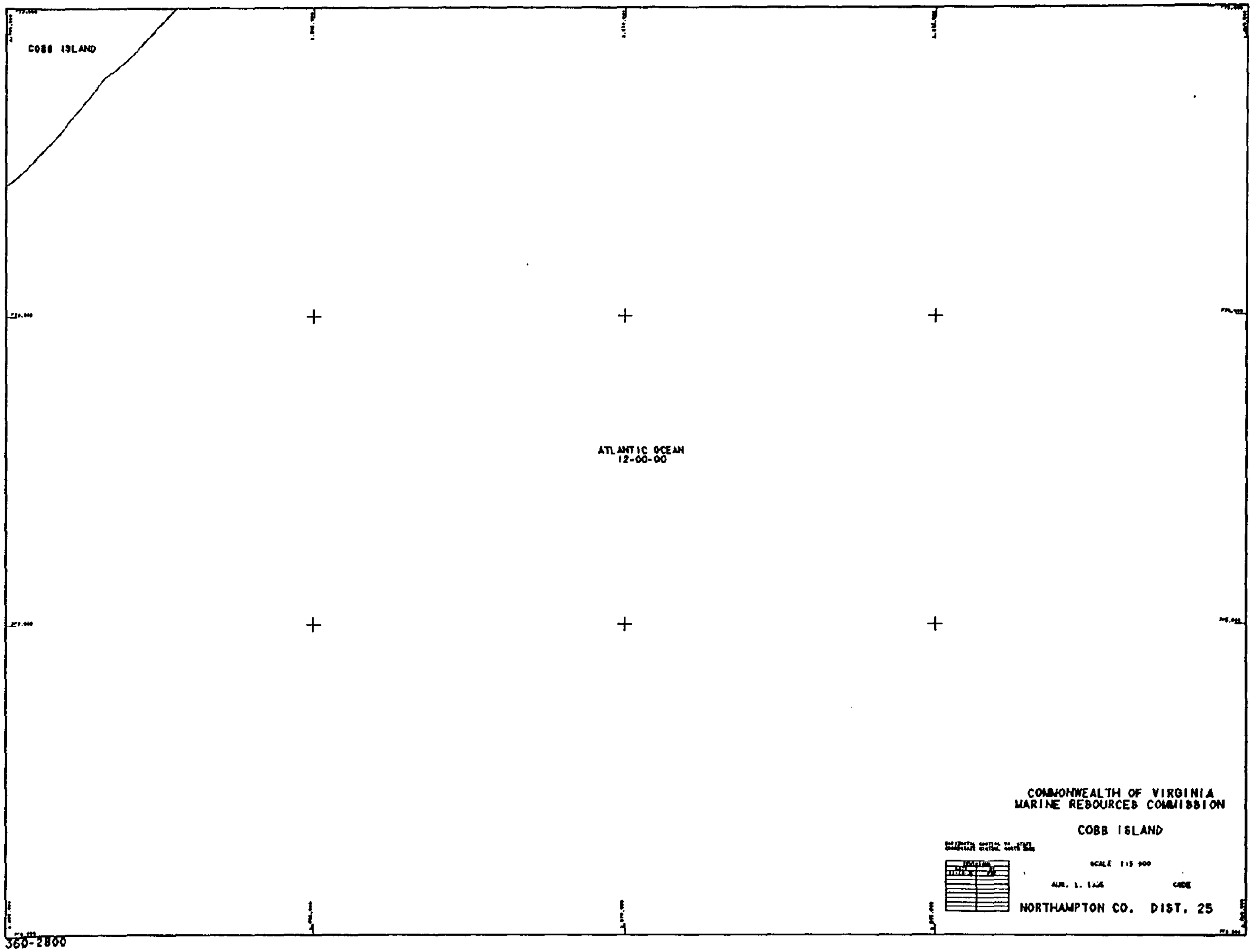

TAYLOR CREEK
RAMSHORN BAY
13-05-09
P.G. 14 (29 & 30)
P.G. 15 (30)
BORCKENBERRY BAY
12-03-08
RAMSHORN
CHANNEL
ELKINS MARSH
47
P.G. 17 (30)
COMMONWEALTH OF VIRGINIA
MARINE RESOURCES COMMISSION
RAMSHORN BAY
BROCKENBERRY BAY
NORTHAMPTON CO. DIST. 25
360-2740

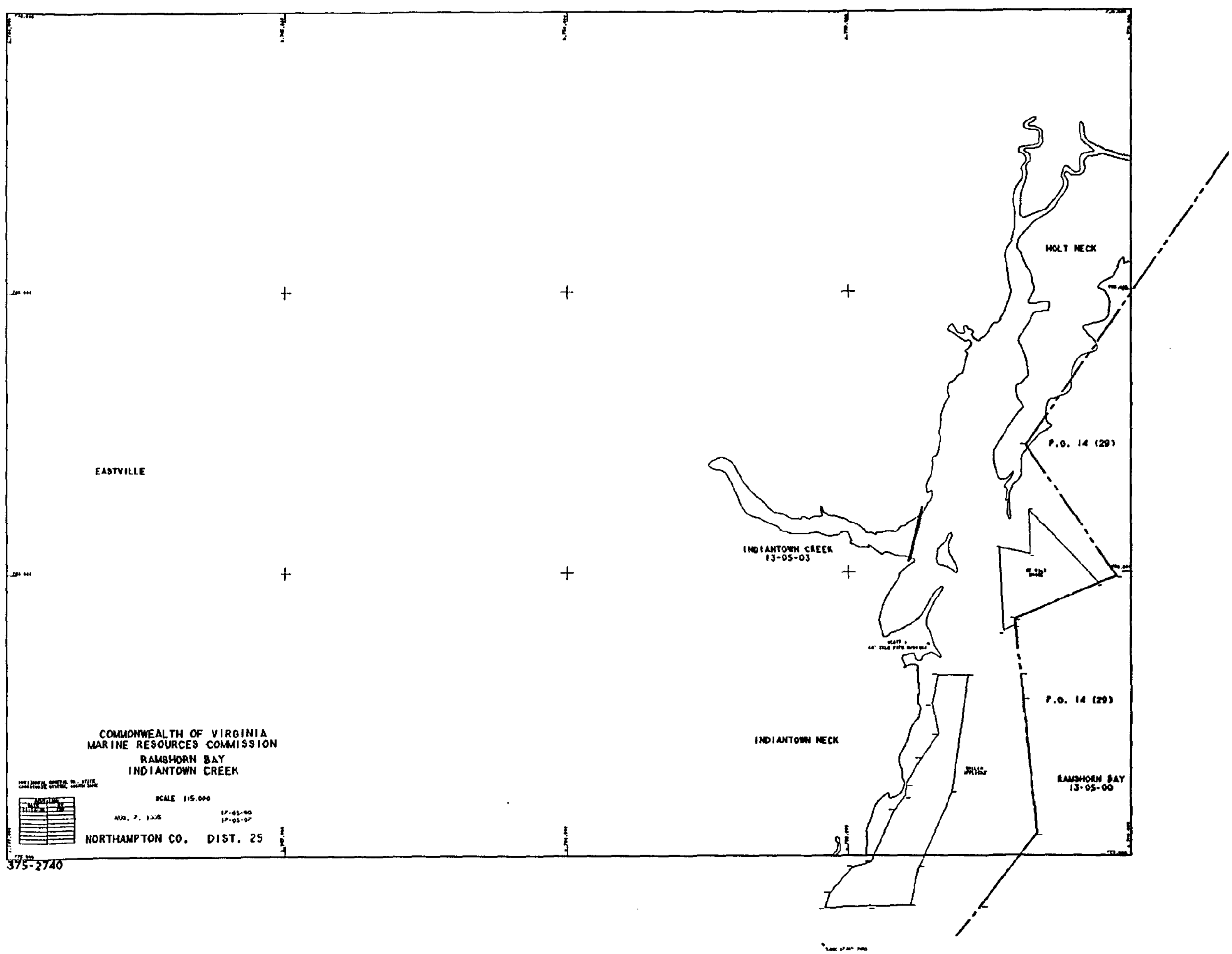

F.D. 14
(29 & 30)
CROW BAY
13-05-02
CEDAR CREEK
12-20-00
ECKICHY MARSH
F.D. 13 (30)
ECKICHY FLATS
COBB BAY
12-17-00
ELKINS MARSH
COCKLE PT. CR.
12-18-00
SAND SHOAL CHANNEL
93
94
92
89
88
87
86
90
91
46
COMMONWEALTH OF VIRGINIA
MARINE RESOURCES COMMISSION
COBB BAY
CEDAR CREEK
NORTHAMPTON CO. DIST. 25
360-2760



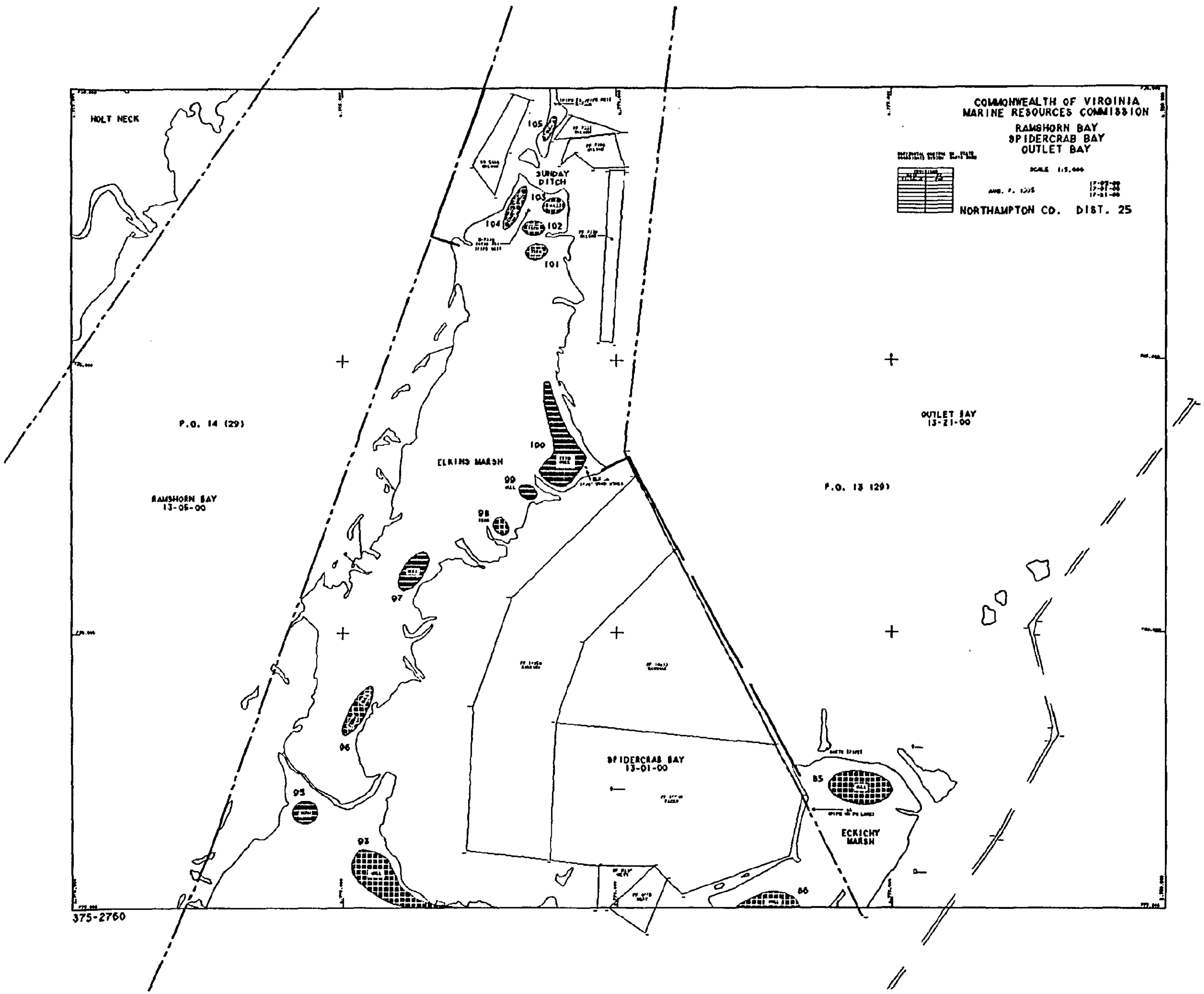
BIG EASTER MARSH
HOG ISLAND BAY 13-23-00
COBB ISLAND
P.O. 13 (30)
MITTIOY FLATS
COBB BAY 12-17-00
LOON CHANNEL
CARDWELL ISLE
ATLANTIC OCEAN 12-00-00
SAND SHOAL INLET 12-19-00
WRECK ISLAND
P.O. 25 (30)
84
66
68
67
71
61
60
59
COMMONWEALTH OF VIRGINIA
MARINE RESOURCES COMMISSION
COBB BAY
SAND SHOAL INLET
NORTHAMPTON CO. DIST. 25

360-2780

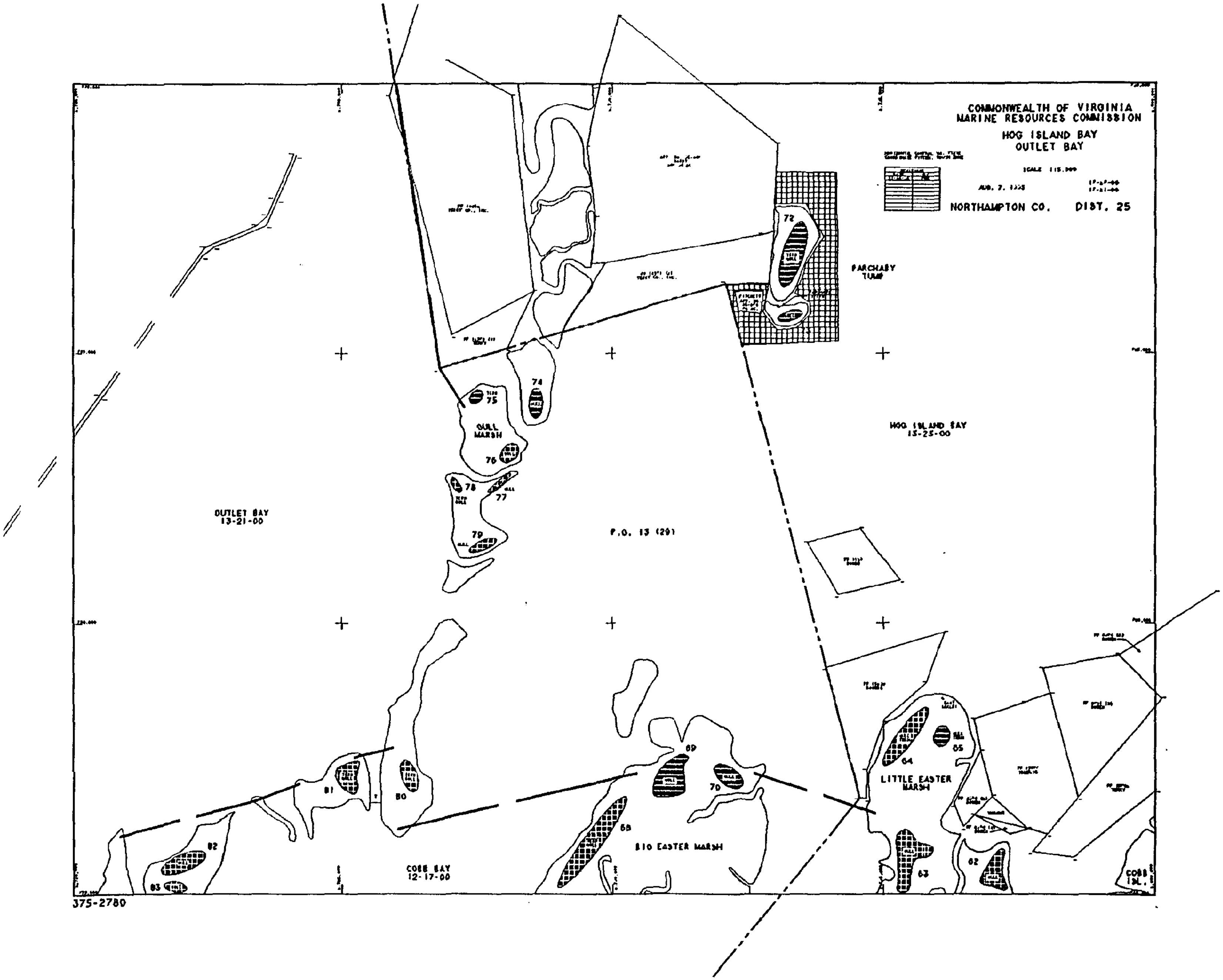

COBB ISLAND
ATLANTIC OCEAN
12-00-00
COMMONWEALTH OF VIRGINIA
MARINE RESOURCES COMMISSION
COBB ISLAND
NORTHAMPTON CO. DIST. 25
360-2800



HOLT NECK
P.O. 14 (29)
P.O. 14 (29)
RAMSHORN BAY
13-05-00
INDIANTOWN CREEK
13-05-03
INDIANTOWN NECK
EASTVILLE
COMMONWEALTH OF VIRGINIA
MARINE RESOURCES COMMISSION
RAMSHORN BAY
INDIANTOWN CREEK
SCALE 1:5,000
NORTHAMPTON CO. DIST. 25
375-2740

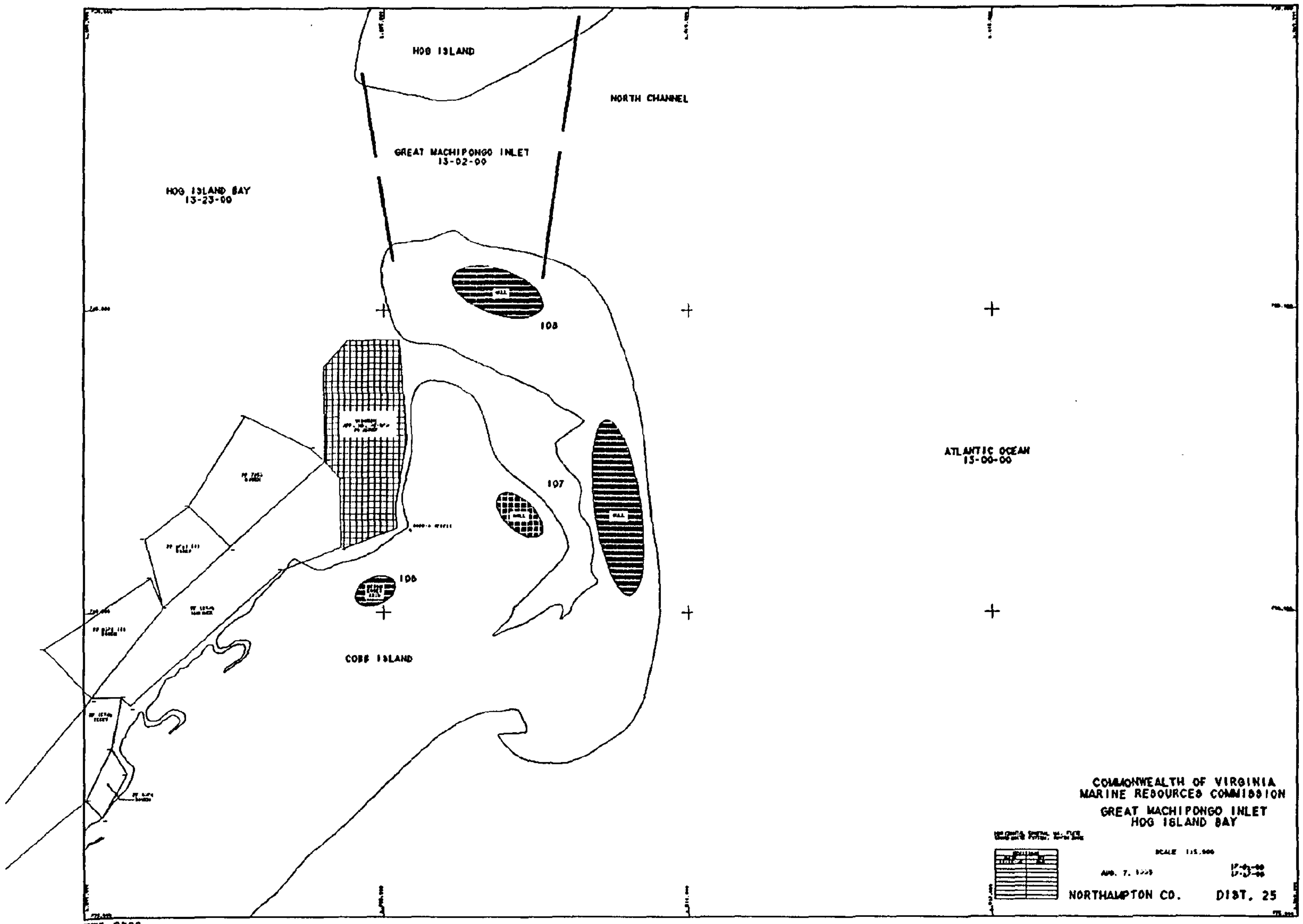

COMMONWEALTH OF VIRGINIA
MARINE RESOURCES COMMISSION
RAMSHORN BAY
SPIDERCRAB BAY
OUTLET BAY
NORTHAMPTON CO. DIST. 25
HOLT NECK
SUNDAY DITCH
ELKINS MARSH
P.O. 14 (29)
RAMSHORN BAY
13-05-00
OUTLET BAY
13-21-00
P.O. 13 (29)
SPIDERCRAB BAY
13-01-00
ECKICHY MARSH
105
104
103
102
101
100
99
98
97
96
95
93
85
86

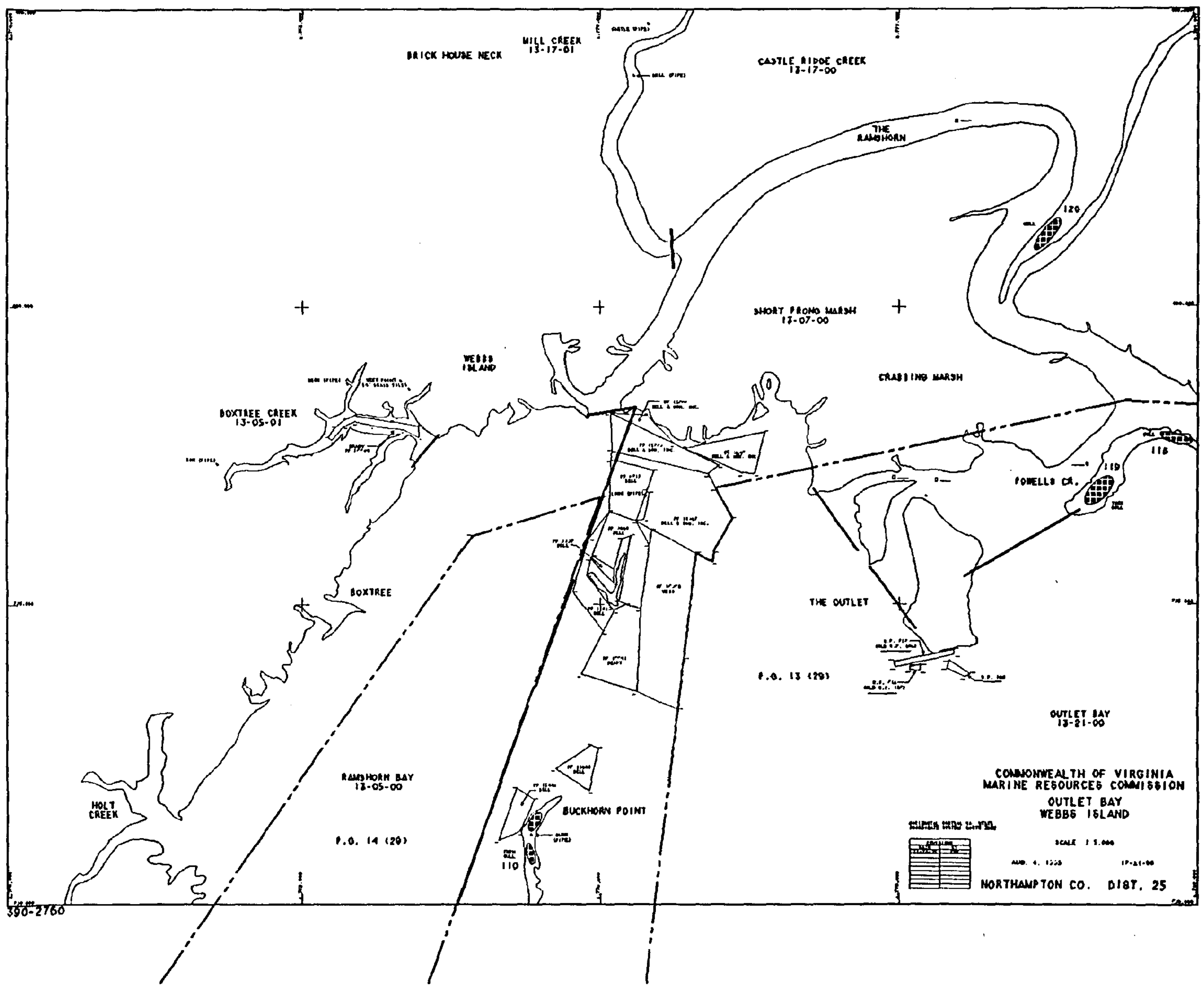
375-2760

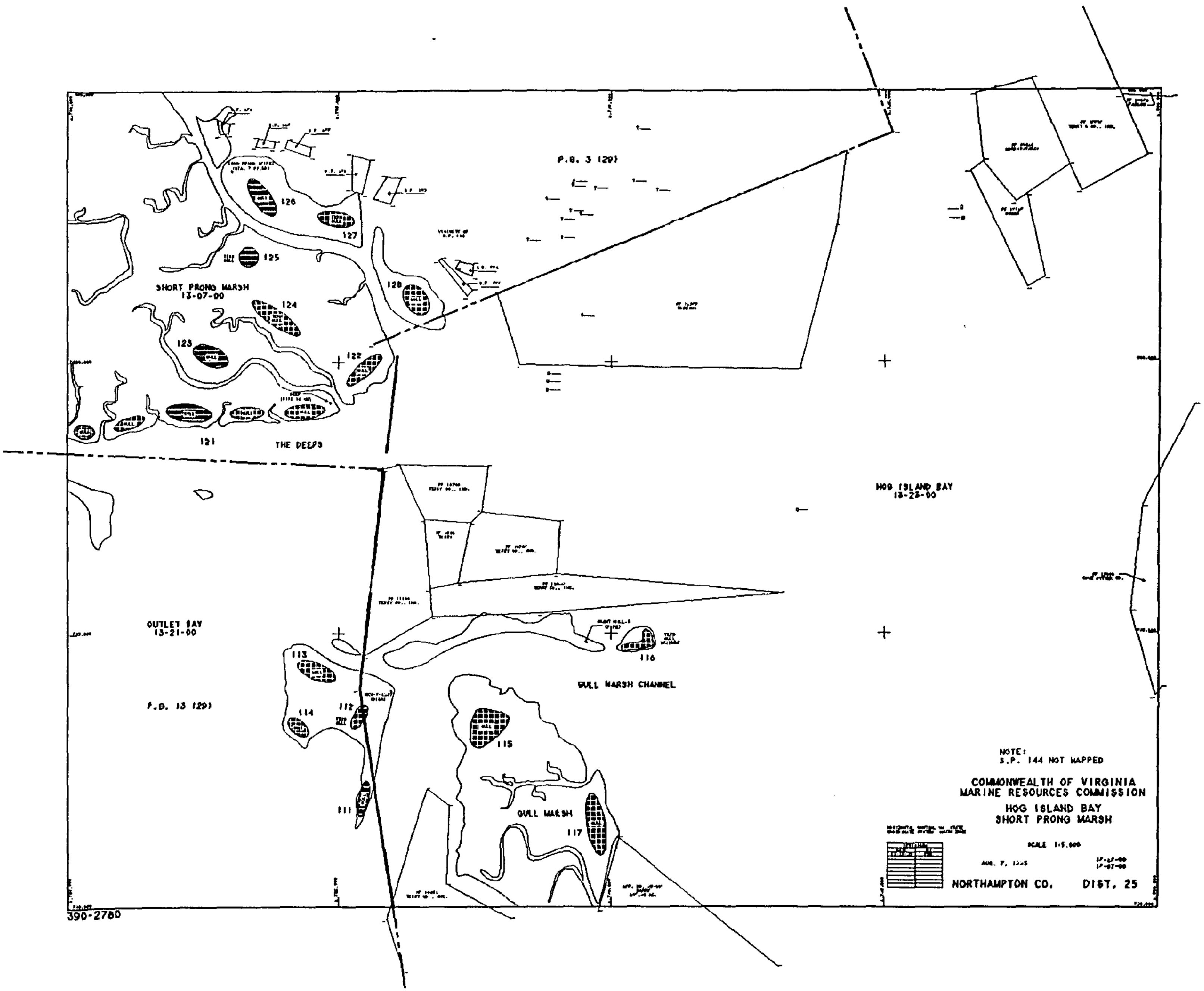


COMMONWEALTH OF VIRGINIA
MARINE RESOURCES COMMISSION
HOG ISLAND BAY
OUTLET BAY
NORTHAMPTON CO.
DIST. 25
PARCHABY TUMP
HOG ISLAND BAY
13-25-00
72
74
75
GULL MARSH
76
77
78
79
OUTLET BAY
13-21-00
P.O. 13 (29)
COBB BAY
12-17-00
80
81
82
83
68
69
70
BIG EASTER MARSH
LITTLE EASTER MARSH
64
65
63
62
COBB ISL.

375-2780

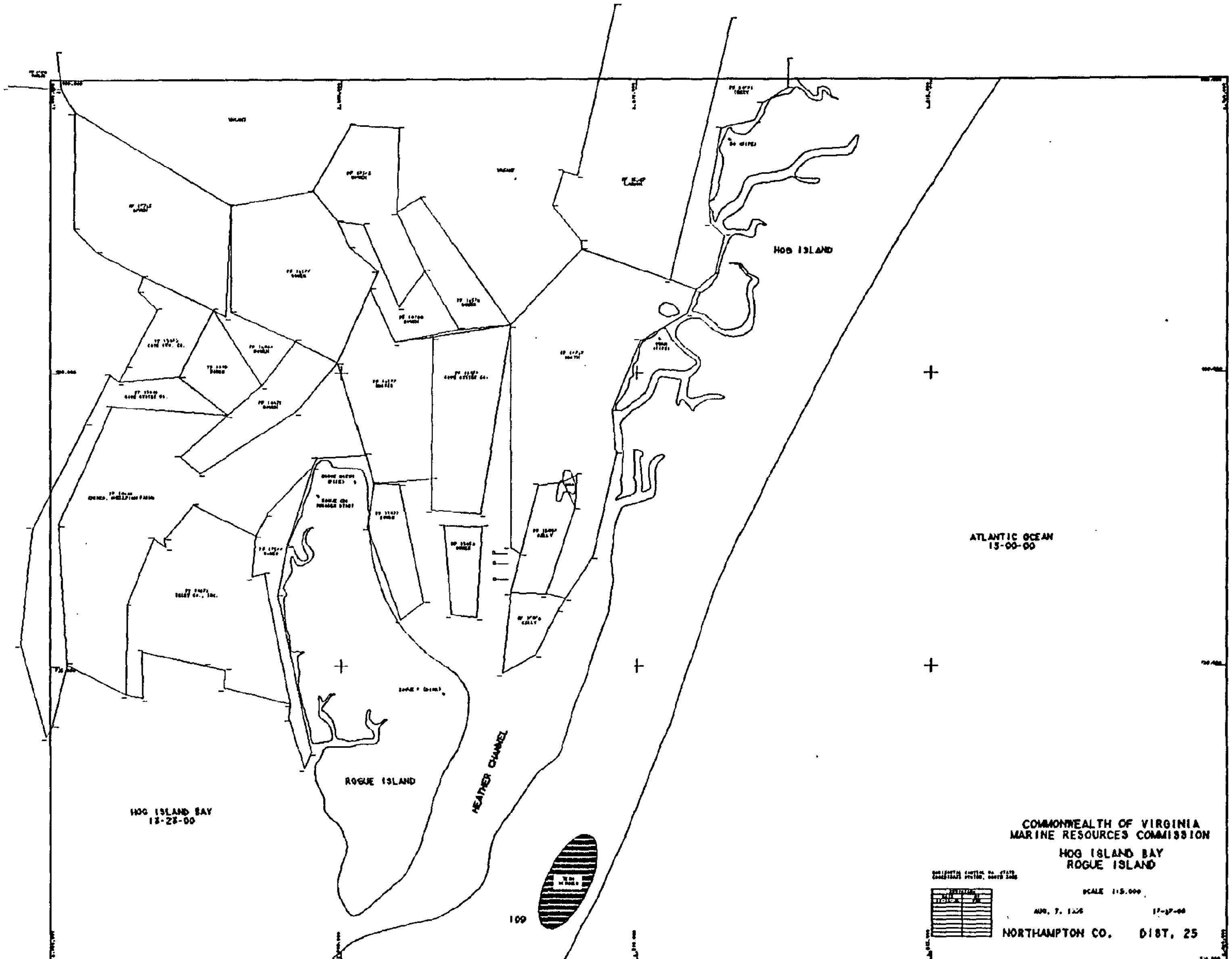

HOG ISLAND
NORTH CHANNEL
GREAT MACHIPONGO INLET
13-02-00
HOG ISLAND BAY
13-23-00
108
107
106
COBB ISLAND
ATLANTIC OCEAN
13-00-00
COMMONWEALTH OF VIRGINIA
MARINE RESOURCES COMMISSION
GREAT MACHIPONGO INLET
HOG ISLAND BAY
NORTHAMPTON CO.
DIST. 25
375-2800


BRICK HOUSE NECK
MILL CREEK
13-17-01
CASTLE RIDGE CREEK
13-17-00
THE RAMSHORN
120
SHORT PRONG MARSH
13-07-00
CRABBING MARSH
WEBBS ISLAND
BOXTREE CREEK
13-05-01
118
119
POWELLS CR.
BOXTREE
THE OUTLET
P.O. 13 (29)
OUTLET BAY
13-21-00
RAMSHORN BAY
13-05-00
BUCKHORN POINT
HOLT CREEK
P.O. 14 (29)
110
COMMONWEALTH OF VIRGINIA
MARINE RESOURCES COMMISSION
OUTLET BAY
WEBBS ISLAND
NORTHAMPTON CO. DIST. 25
390-2760

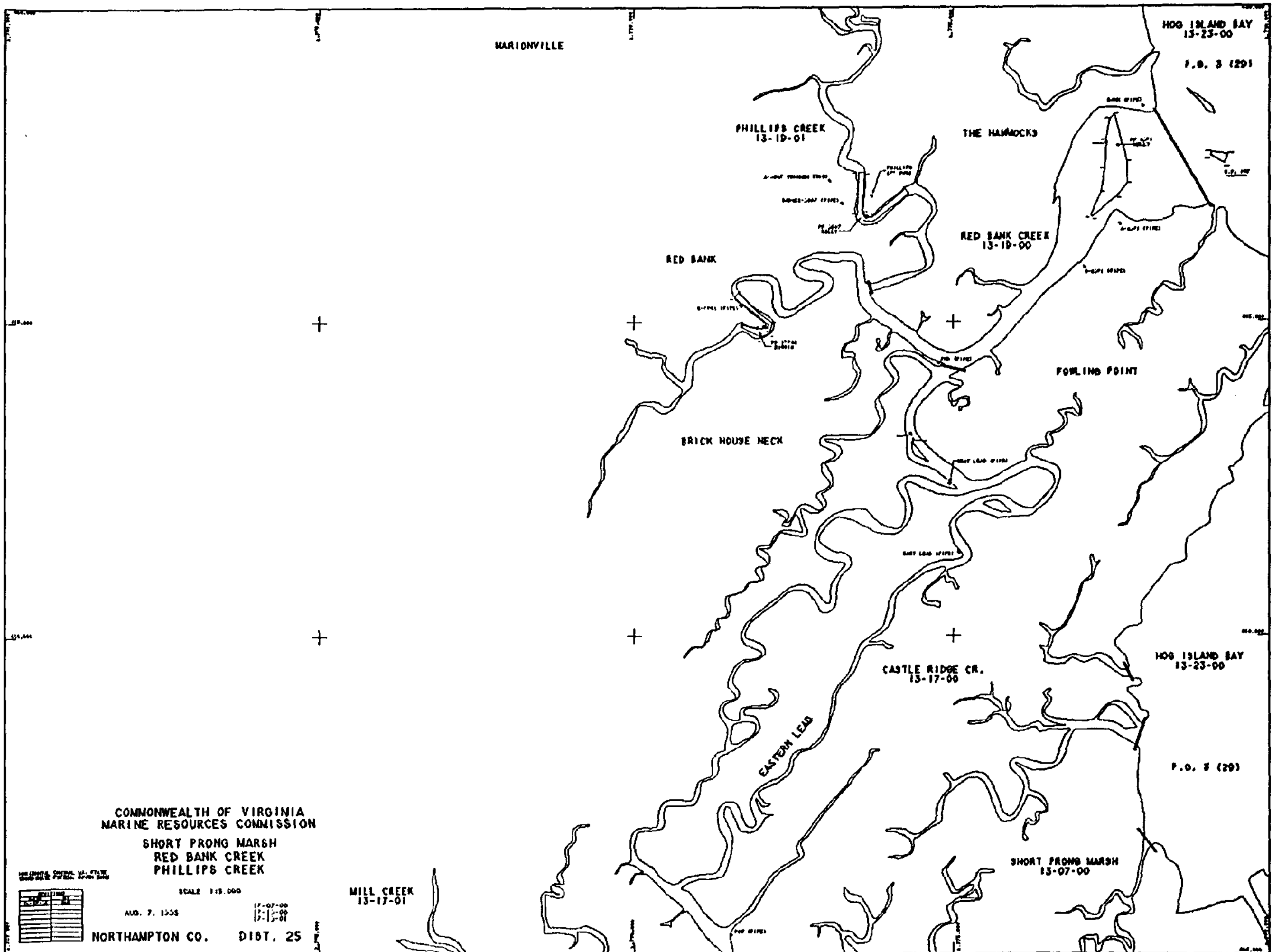


P.B. 3 (29)
SHORT PRONG MARSH
13-07-00
THE DEEPS
HOG ISLAND BAY
13-28-00
OUTLET BAY
13-21-00
P.B. 13 (29)
GULL MARSH CHANNEL
GULL MARSH
121
122
123
124
125
126
127
128
111
112
113
114
115
116
117
NOTE:
S.P. 144 NOT MAPPED
COMMONWEALTH OF VIRGINIA
MARINE RESOURCES COMMISSION
HOG ISLAND BAY
SHORT PRONG MARSH
NORTHAMPTON CO.
DIST. 25

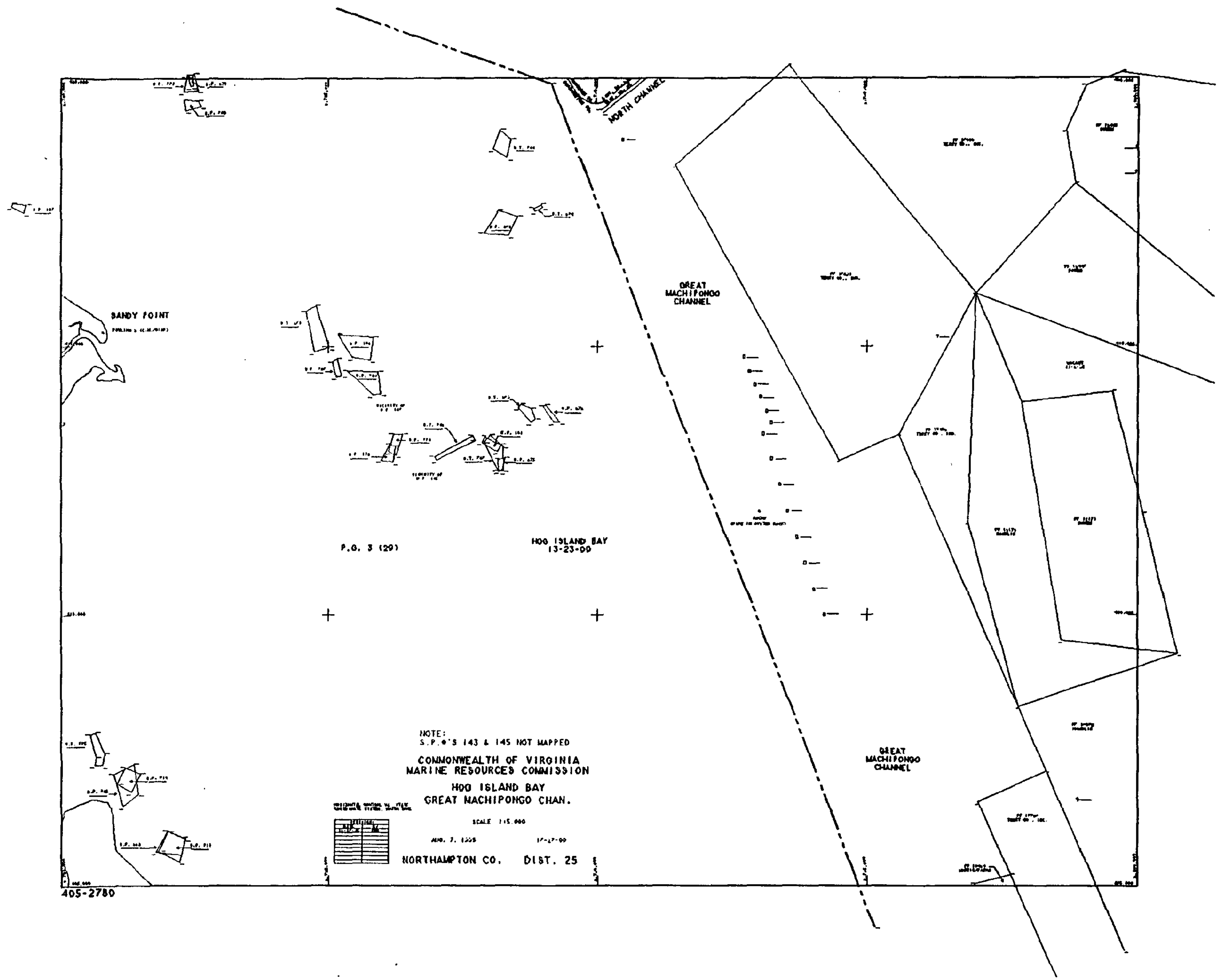
390-2780

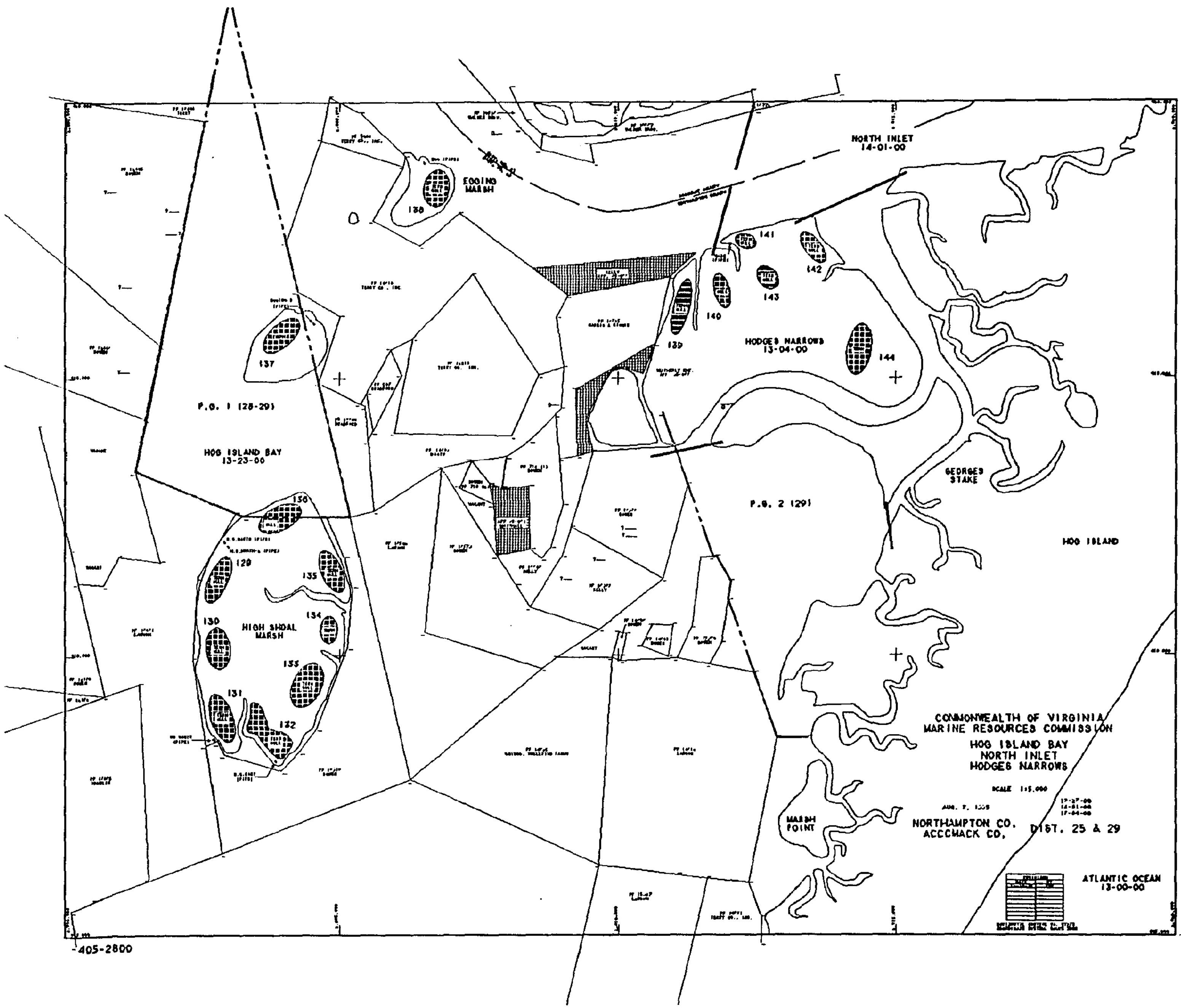

HOG ISLAND
ATLANTIC OCEAN
13-00-00
HEATHER CHANNEL
ROGUE ISLAND
HOG ISLAND BAY
13-23-00
109
COMMONWEALTH OF VIRGINIA
MARINE RESOURCES COMMISSION
HOG ISLAND BAY
ROGUE ISLAND
NORTHAMPTON CO.
DIST. 25

390-2600

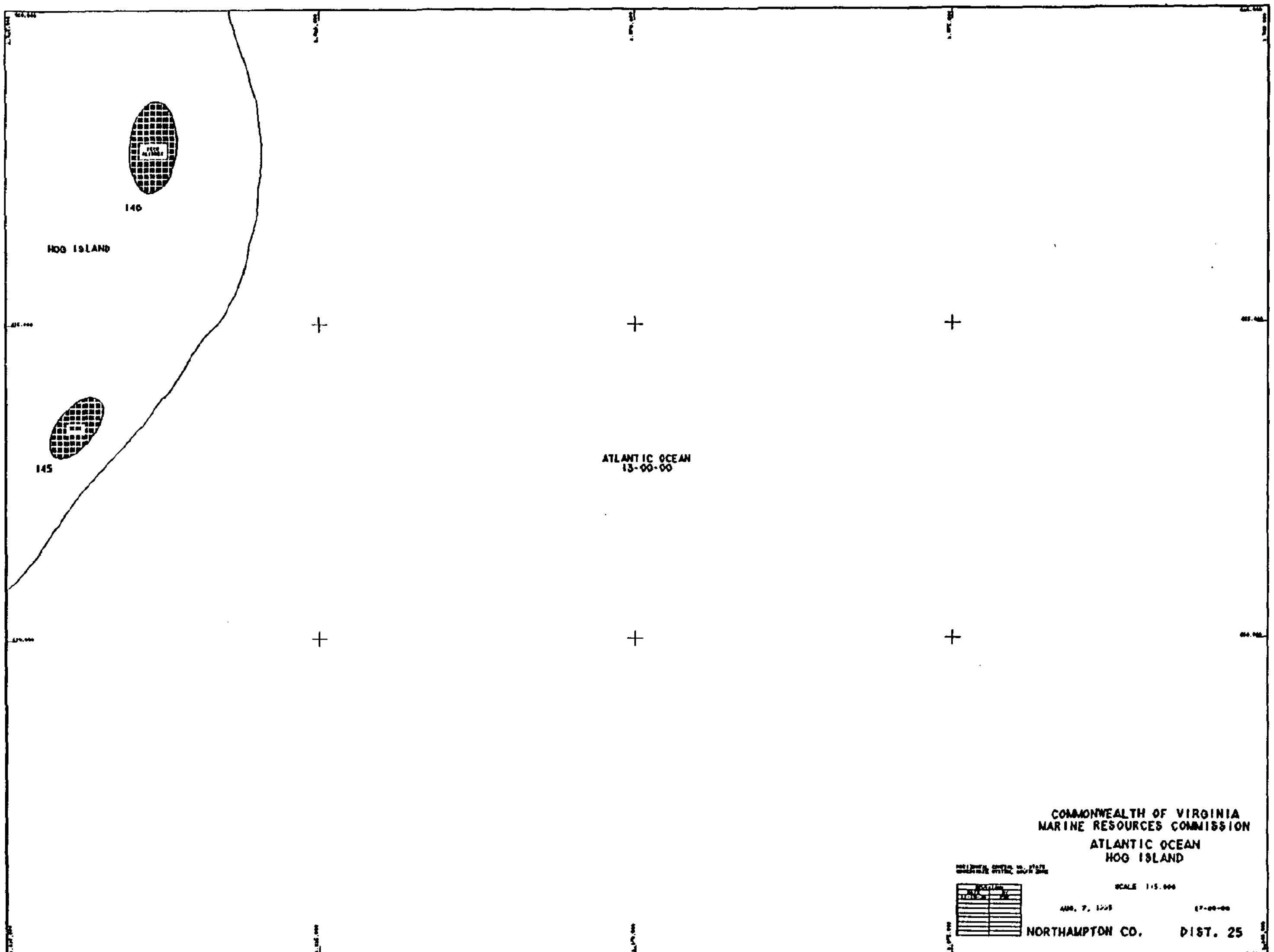

MARIONVILLE
PHILLIPS CREEK
13-19-01
THE HAMMOCKS
HOG ISLAND BAY
13-23-00
P.O. 3 (29)
RED BANK CREEK
13-19-00
RED BANK
FOWLING POINT
BRICK HOUSE NECK
CASTLE RIDGE CR.
13-17-00
HOG ISLAND BAY
13-23-00
EASTERN LEAD
P.O. 3 (29)
SHORT PRONG MARSH
13-07-00
MILL CREEK
13-17-01
COMMONWEALTH OF VIRGINIA
MARINE RESOURCES COMMISSION
SHORT PRONG MARSH
RED BANK CREEK
PHILLIPS CREEK
NORTHAMPTON CO.
DIST. 25

405-2760

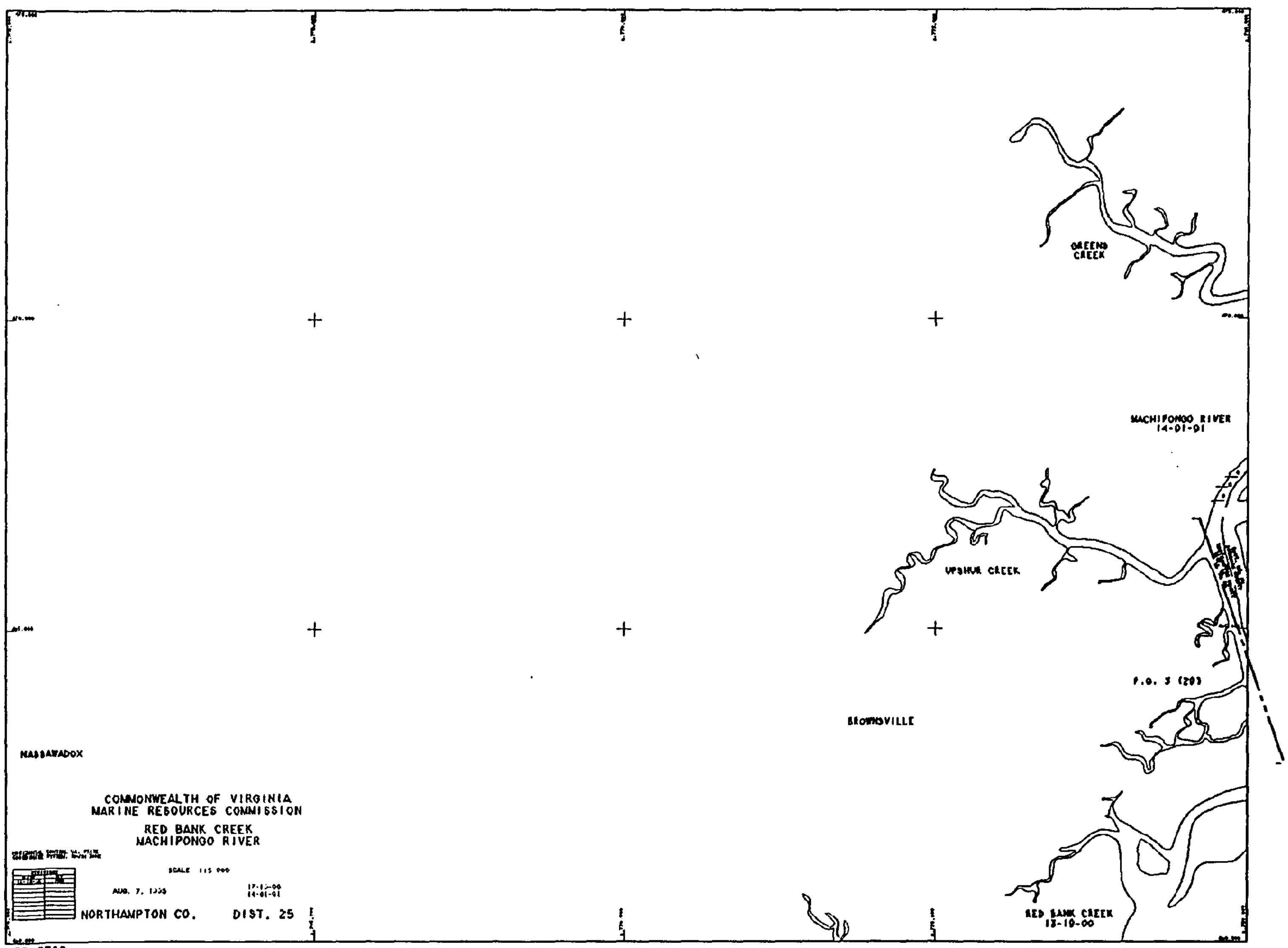

NORTH CHANNEL
GREAT MACHIPONGO CHANNEL
SANDY POINT
P.O. 3 (29)
HOG ISLAND BAY 13-23-00
GREAT MACHIPONGO CHANNEL
NOTE:
S.P.#'S 143 & 145 NOT MAPPED
COMMONWEALTH OF VIRGINIA
MARINE RESOURCES COMMISSION
HOG ISLAND BAY
GREAT MACHIPONGO CHAN.
NORTHAMPTON CO. DIST. 25
405-2780


COMMONWEALTH OF VIRGINIA
MARINE RESOURCES COMMISSION
HOG ISLAND BAY
NORTH INLET
HODGES NARROWS
NORTHAMPTON CO.
ACCOMACK CO.
DIST. 25 & 29
ATLANTIC OCEAN
13-00-00
NORTH INLET
14-01-00
HODGES NARROWS
13-04-00
HOG ISLAND BAY
13-23-00
P.G. 1 (28-29)
P.G. 2 (29)
HOG ISLAND
GEORGES STAKE
MARSH POINT
EGGING MARSH
HIGH SHOAL MARSH
129
130
131
132
133
134
135
136
137
138
139
140
141
142
143
144

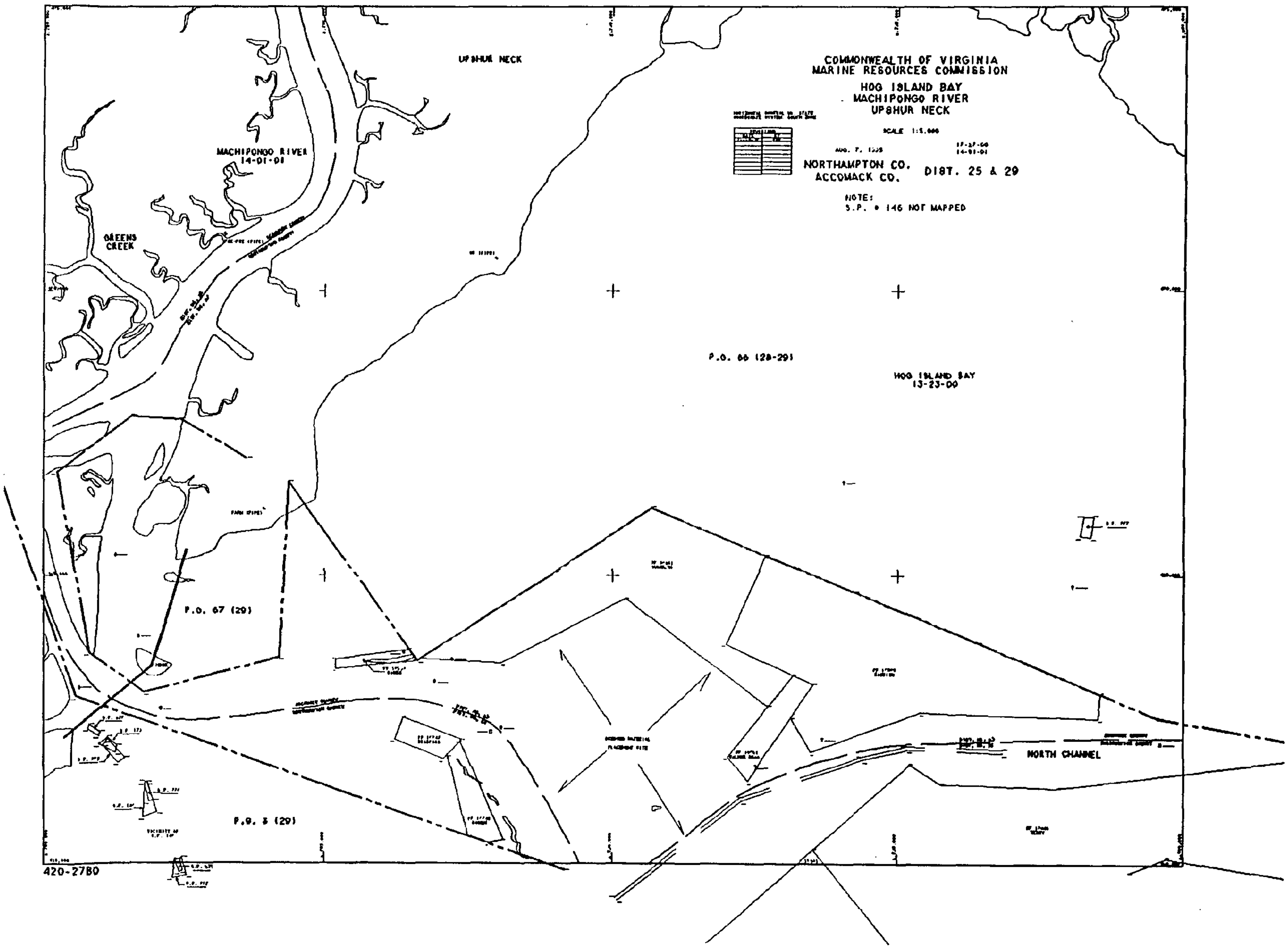
-405-2800


HOG ISLAND
140
145
ATLANTIC OCEAN
13-00-00
COMMONWEALTH OF VIRGINIA
MARINE RESOURCES COMMISSION
ATLANTIC OCEAN
HOG ISLAND
NORTHAMPTON CO.
DIST. 25

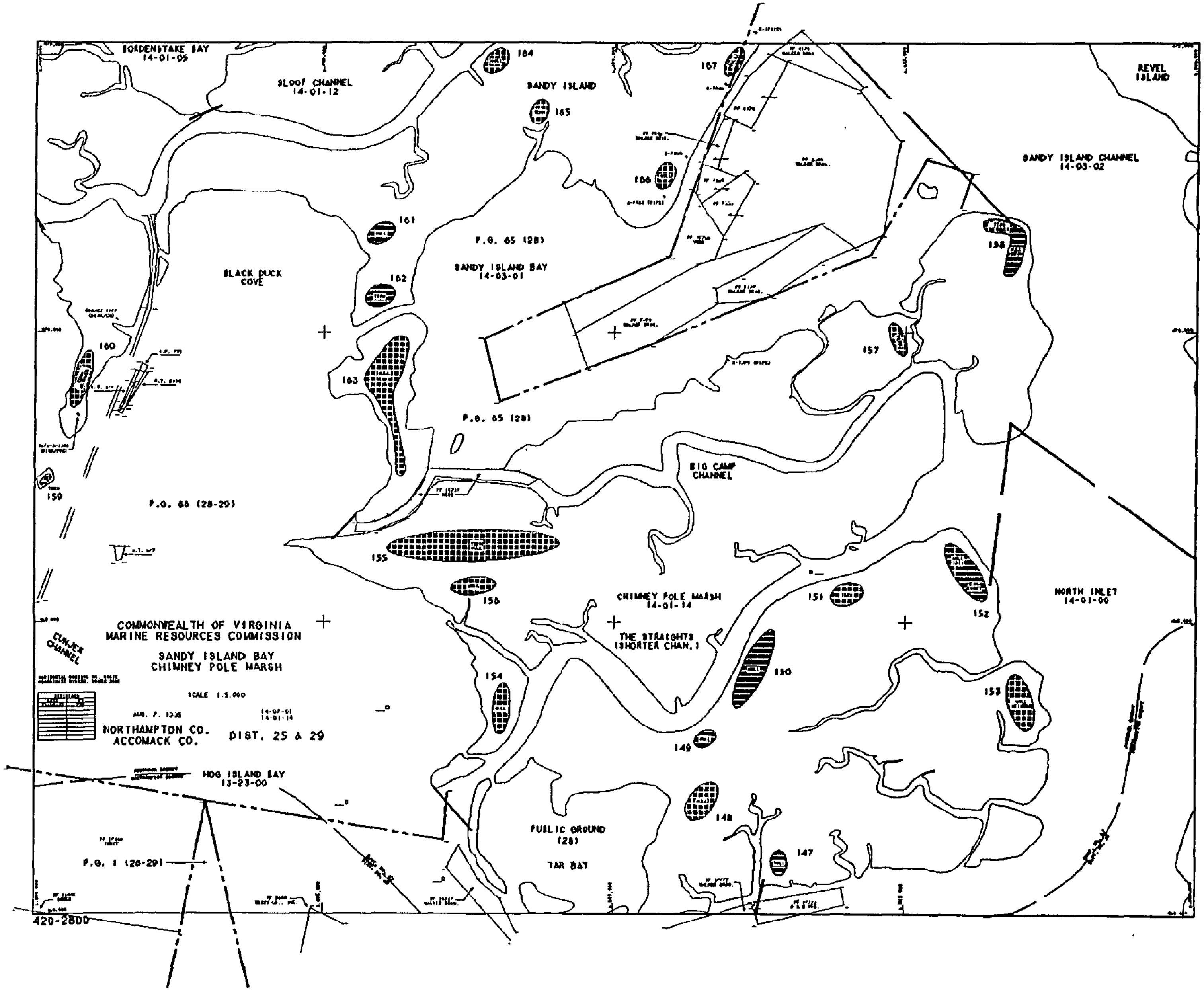
405-2820


GREENS CREEK
MACHIPONGO RIVER
14-01-01
UPSHUR CREEK
BROWNSVILLE
RED BANK CREEK
13-10-00
NASSAWADOX
COMMONWEALTH OF VIRGINIA
MARINE RESOURCES COMMISSION
RED BANK CREEK
MACHIPONGO RIVER
NORTHAMPTON CO.
DIST. 25

420-2760


COMMONWEALTH OF VIRGINIA
MARINE RESOURCES COMMISSION
HOG ISLAND BAY
MACHIPONGO RIVER
UPSHUR NECK
NORTHAMPTON CO.
ACCOMACK CO.
DIST. 25 & 29
NOTE:
S.P. # 146 NOT MAPPED
UPSHUR NECK
MACHIPONGO RIVER
14-01-01
GREENS
CREEK
P.O. 66 (28-29)
HOG ISLAND BAY
13-23-00
P.O. 67 (29)
P.O. 8 (29)
NORTH CHANNEL

420-2780


BORDENSTAKE BAY
14-01-05
SLOOP CHANNEL
14-01-12
SANDY ISLAND
REVEL ISLAND
SANDY ISLAND CHANNEL
14-03-02
BLACK DUCK COVE
P.G. 65 (28)
SANDY ISLAND BAY
14-03-01
P.G. 66 (28-29)
BIG CAMP CHANNEL
CHIMNEY POLE MARSH
14-01-14
THE STRAIGHTS
(SHORTER CHAN.)
NORTH INLET
14-01-00
PUBLIC GROUND
(28)
TAR BAY
HOG ISLAND BAY
13-23-00
P.G. 1 (28-29)
CUNJER CHANNEL
COMMONWEALTH OF VIRGINIA
MARINE RESOURCES COMMISSION
SANDY ISLAND BAY
CHIMNEY POLE MARSH
SCALE 1:5,000
NORTHAMPTON CO.
ACCOMACK CO.
DIST. 25 & 29
14-03-01
14-01-14
147
148
149
150
151
152
153
154
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156
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158
159
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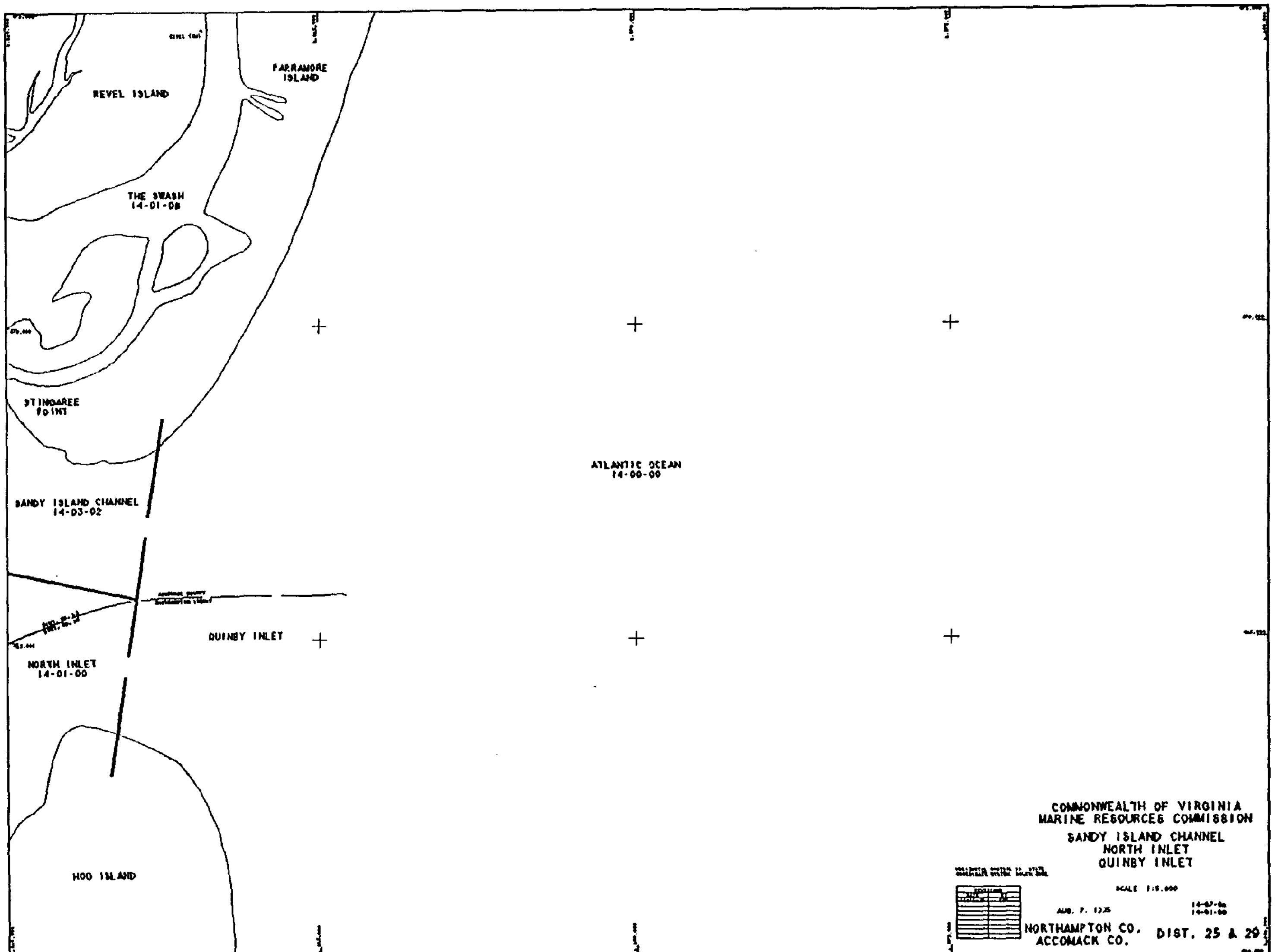
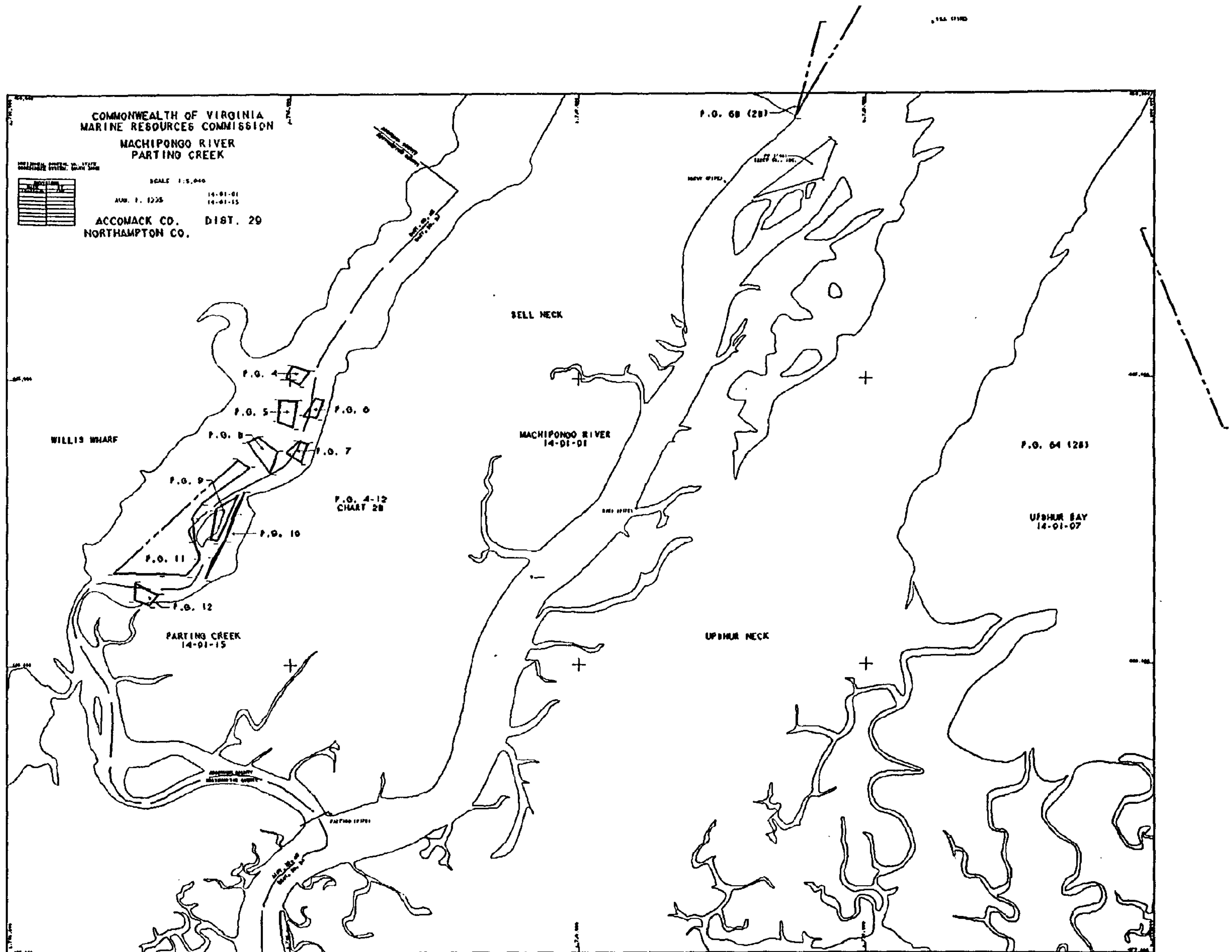
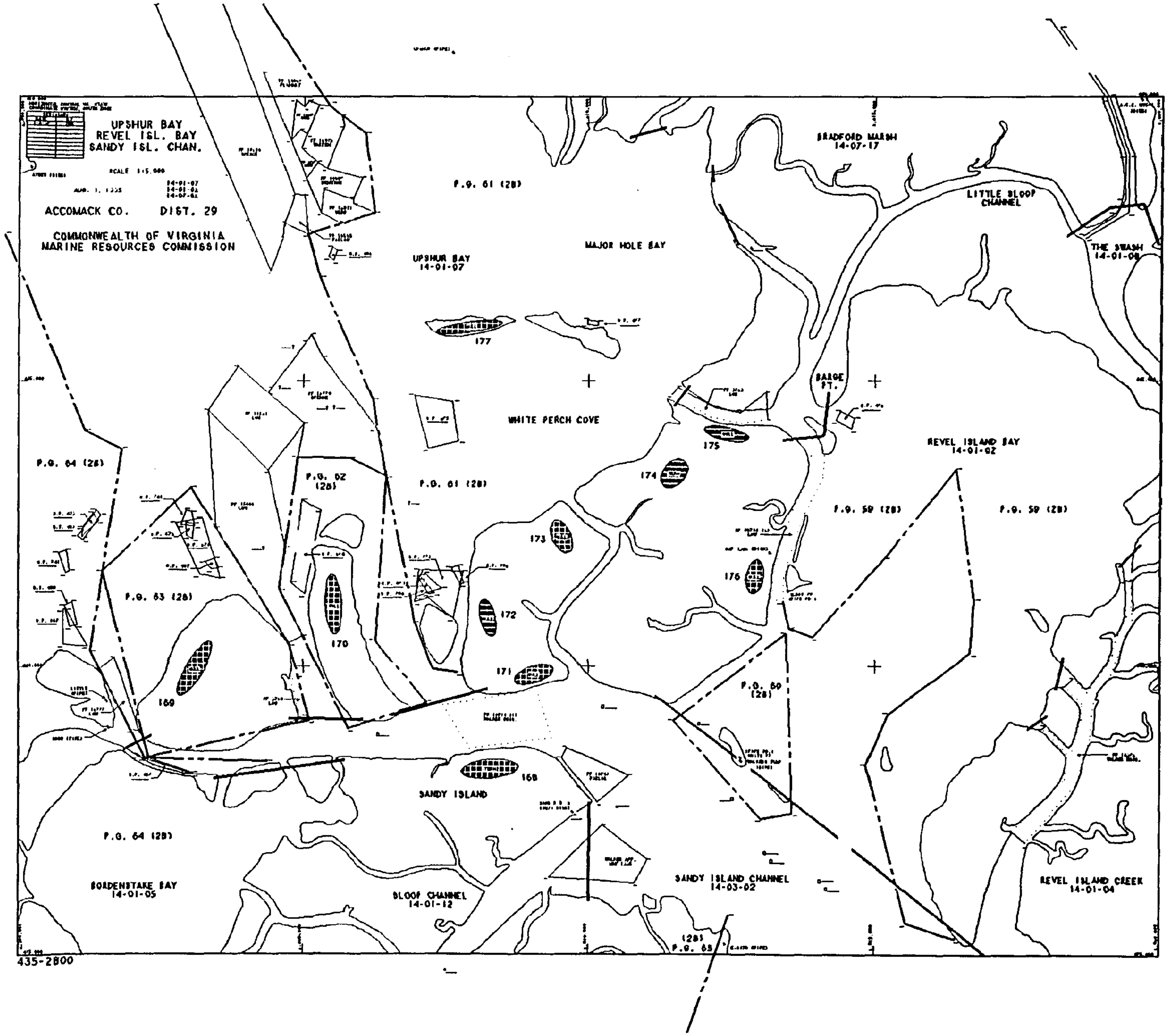
161
162
163
164
165
166
167
420-2800

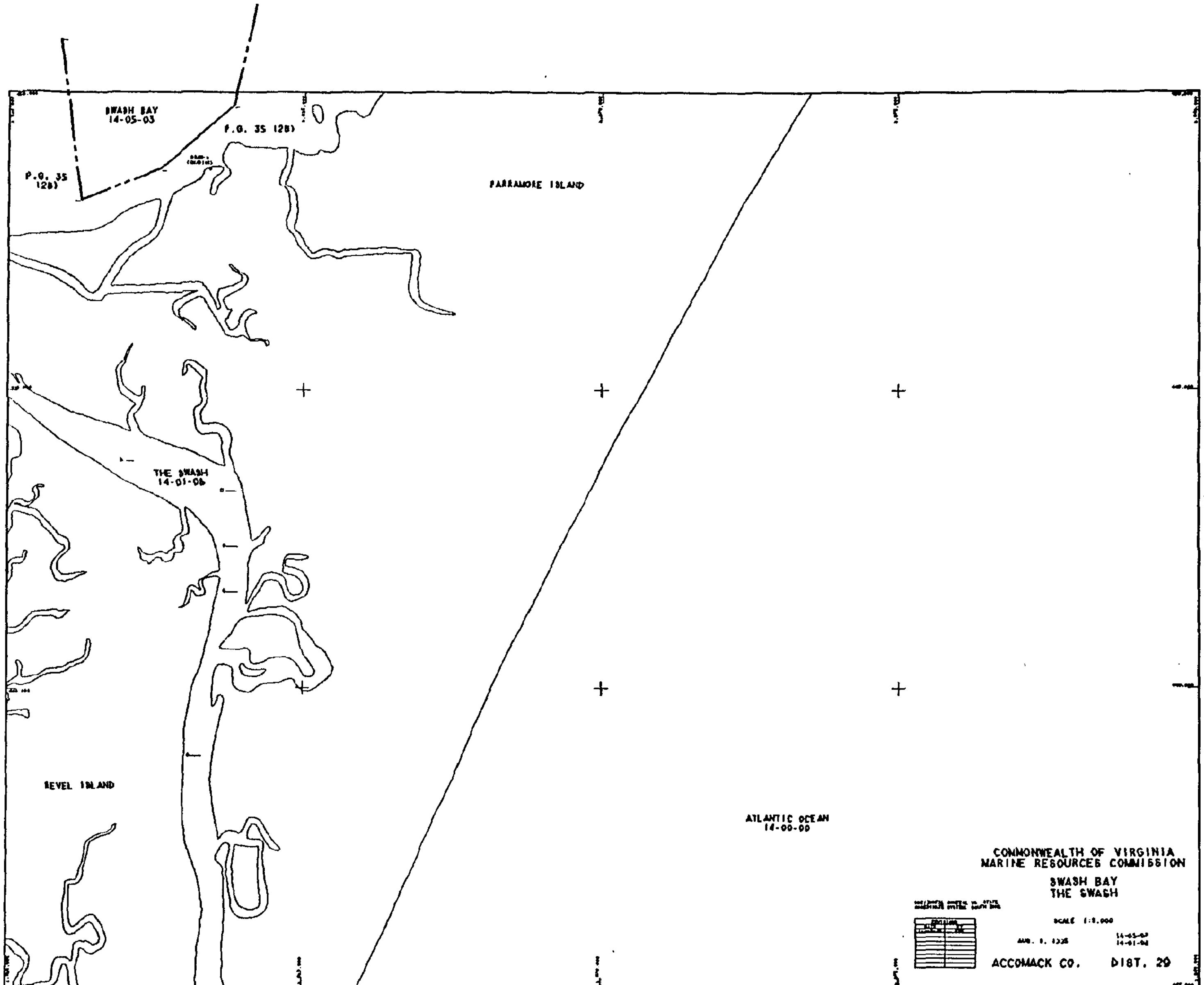

REVEL ISLAND
FARRAMORE ISLAND
THE SWASH
14-01-08
STINGAREE POINT
SANDY ISLAND CHANNEL
14-03-02
ATLANTIC OCEAN
14-00-00
QUINBY INLET
NORTH INLET
14-01-00
HOG ISLAND
COMMONWEALTH OF VIRGINIA
MARINE RESOURCES COMMISSION
SANDY ISLAND CHANNEL
NORTH INLET
QUINBY INLET
NORTHAMPTON CO.
ACCOMACK CO.
DIST. 25 & 29

420-2820

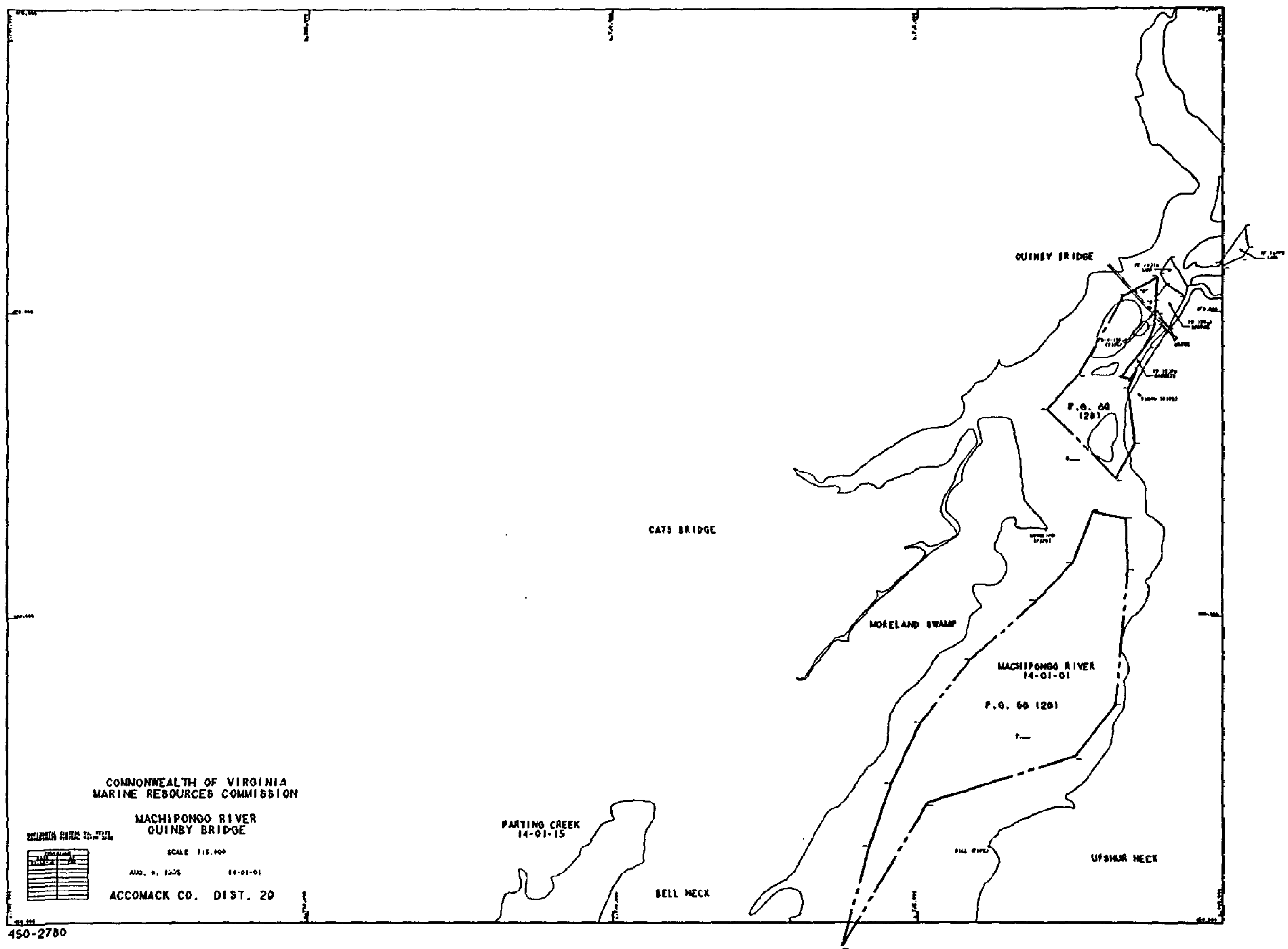

COMMONWEALTH OF VIRGINIA
MARINE RESOURCES COMMISSION
MACHIPONGO RIVER
PARTING CREEK
SCALE 1:5,000
14-01-01
14-01-15
ACCOMACK CO.
NORTHAMPTON CO.
DIST. 29
P.O. 68 (28)
P.O. 64 (28)
UPSHUR BAY
14-01-07
BELL NECK
MACHIPONGO RIVER
14-01-01
UPSHUR NECK
WILLIS WHARF
P.O. 4
P.O. 5
P.O. 6
P.O. 7
P.O. 8
P.O. 9
P.O. 10
P.O. 11
P.O. 12
P.O. 4-12
CHART 28
PARTING CREEK
14-01-15

435-2780

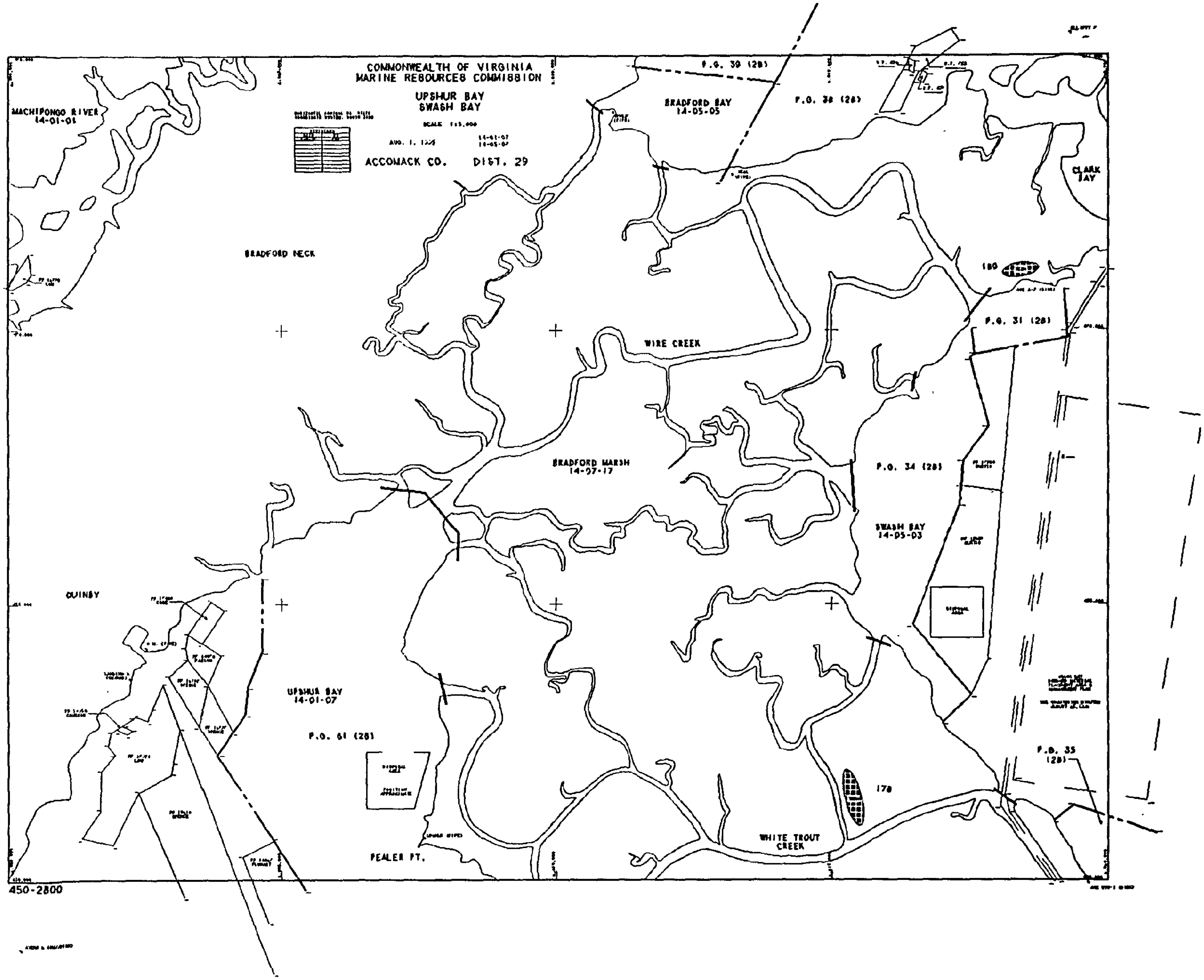

UPSHUR BAY
REVEL ISL. BAY
SANDY ISL. CHAN.
ACCOMACK CO. DIST. 29
COMMONWEALTH OF VIRGINIA
MARINE RESOURCES COMMISSION
P.G. 61 (28)
MAJOR HOLE BAY
UPSHUR BAY
14-01-07
BRADFORD MARSH
14-07-17
LITTLE SLOOP
CHANNEL
THE SWASH
14-01-08
177
WHITE PERCH COVE
BARGE
PT.
REVEL ISLAND BAY
14-01-02
175
174
P.G. 02
(28)
P.G. 61 (28)
P.G. 64 (28)
P.G. 59 (28)
P.G. 59 (28)
173
176
P.G. 63 (28)
170
172
171
169
P.G. 60
(28)
168
SANDY ISLAND
P.G. 64 (28)
BORDENSTAKE BAY
14-01-05
SLOOP CHANNEL
14-01-12
SANDY ISLAND CHANNEL
14-03-02
REVEL ISLAND CREEK
14-01-04
(28)
P.G. 65
435-2800

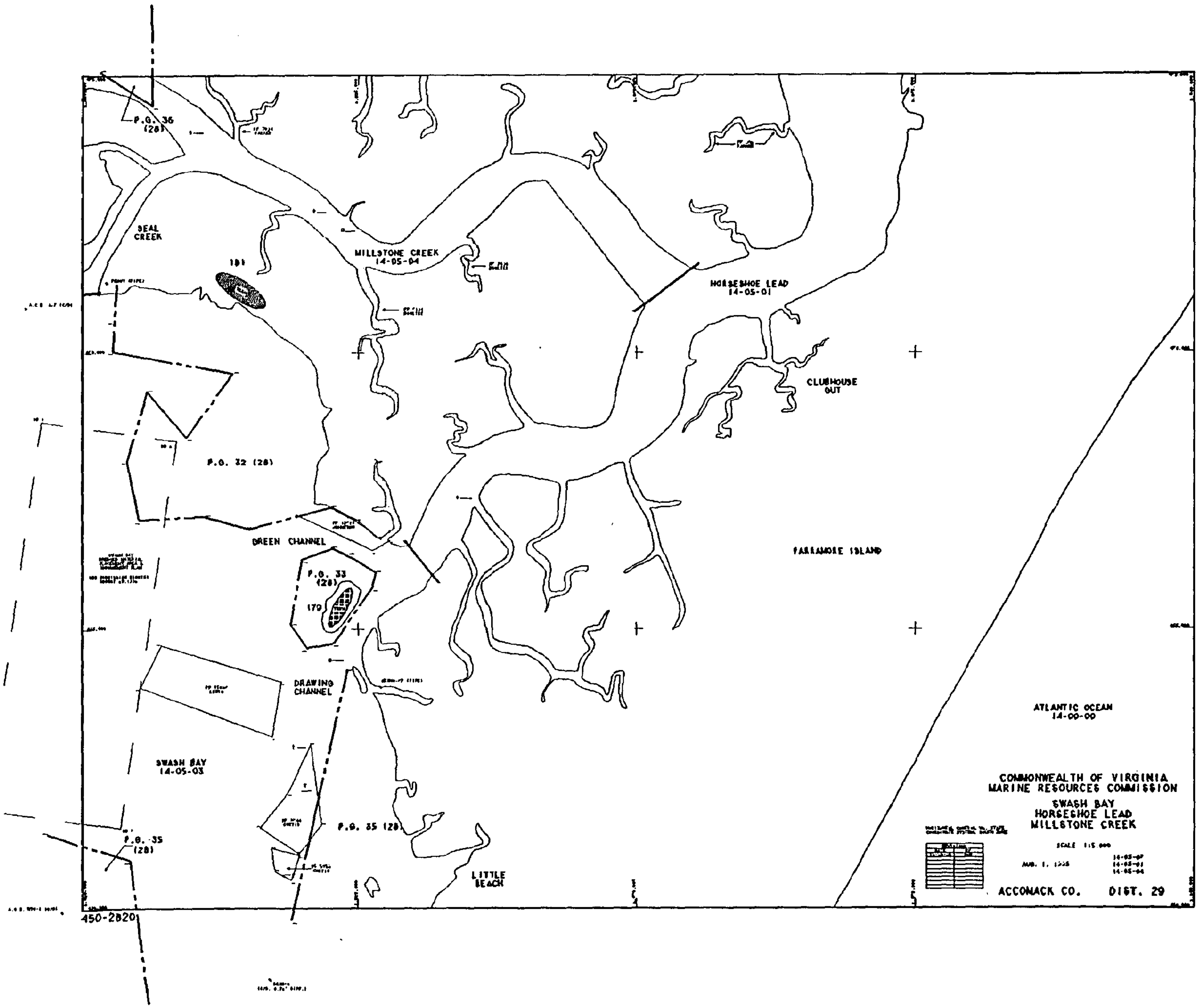

SWASH BAY
14-05-03
P.G. 35 (28)
P.G. 35
(28)
PARRAMORE ISLAND
THE SWASH
14-01-06
REVEL ISLAND
ATLANTIC OCEAN
14-00-00
COMMONWEALTH OF VIRGINIA
MARINE RESOURCES COMMISSION
SWASH BAY
THE SWASH
ACCOMACK CO.
DIST. 29

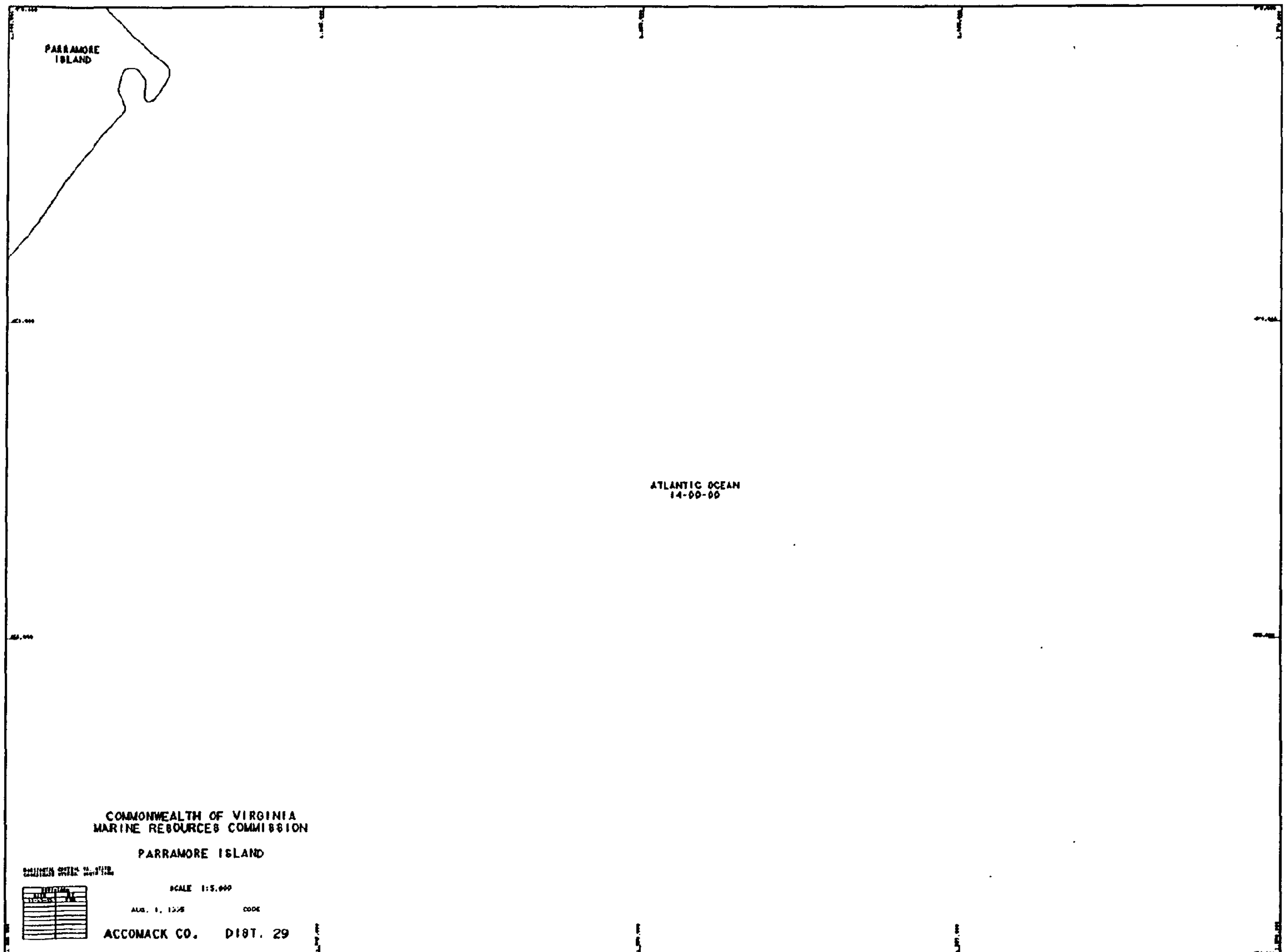
435-2820


QUINBY BRIDGE
P.G. 68
(28)
CATS BRIDGE
MOSELAND SWAMP
MACHIPONGO RIVER
14-01-01
P.G. 68 (28)
UPSHUR NECK
BELL NECK
PARTING CREEK
14-01-15
COMMONWEALTH OF VIRGINIA
MARINE RESOURCES COMMISSION
MACHIPONGO RIVER
QUINBY BRIDGE
ACCOMACK CO. DIST. 20

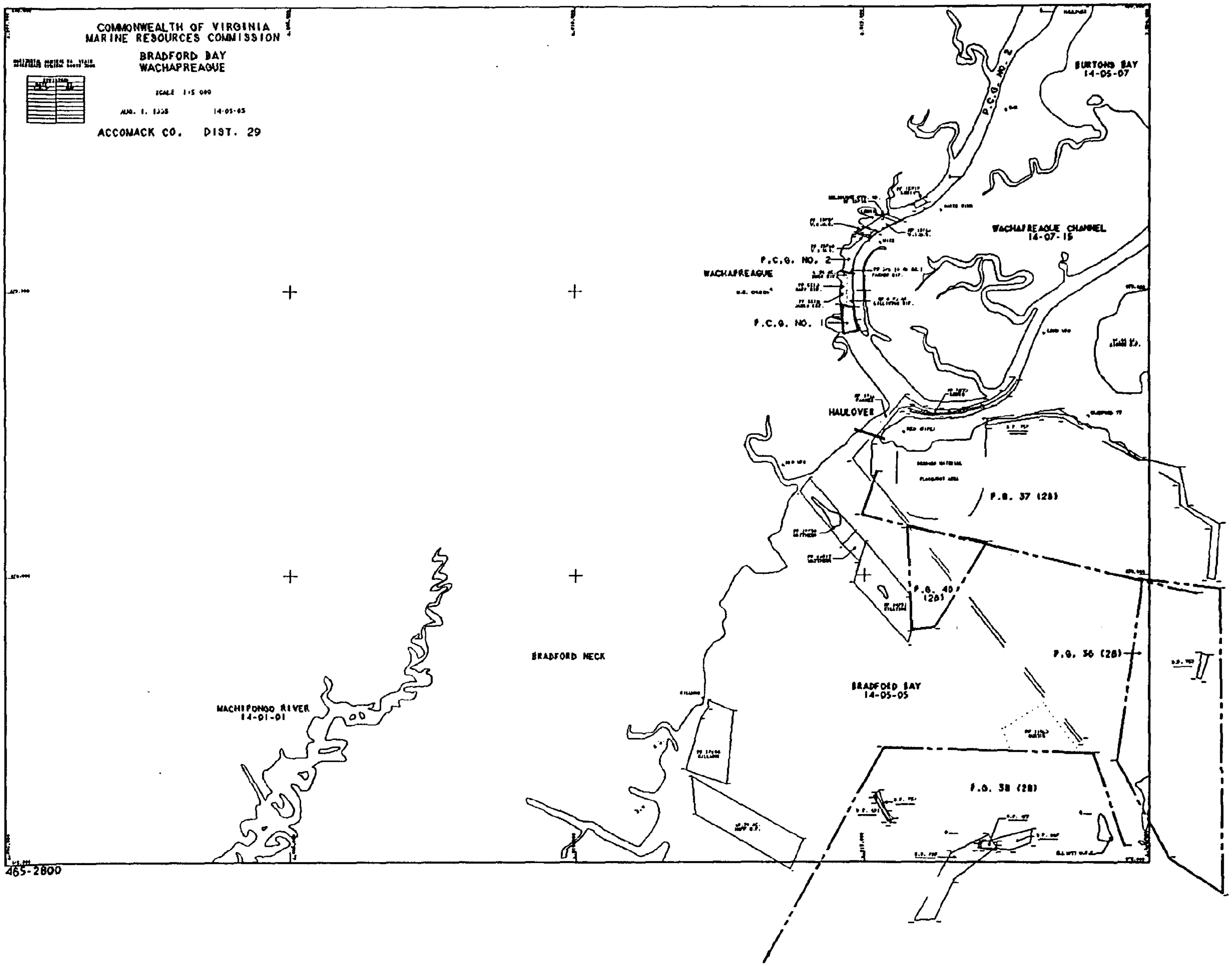
450-2780

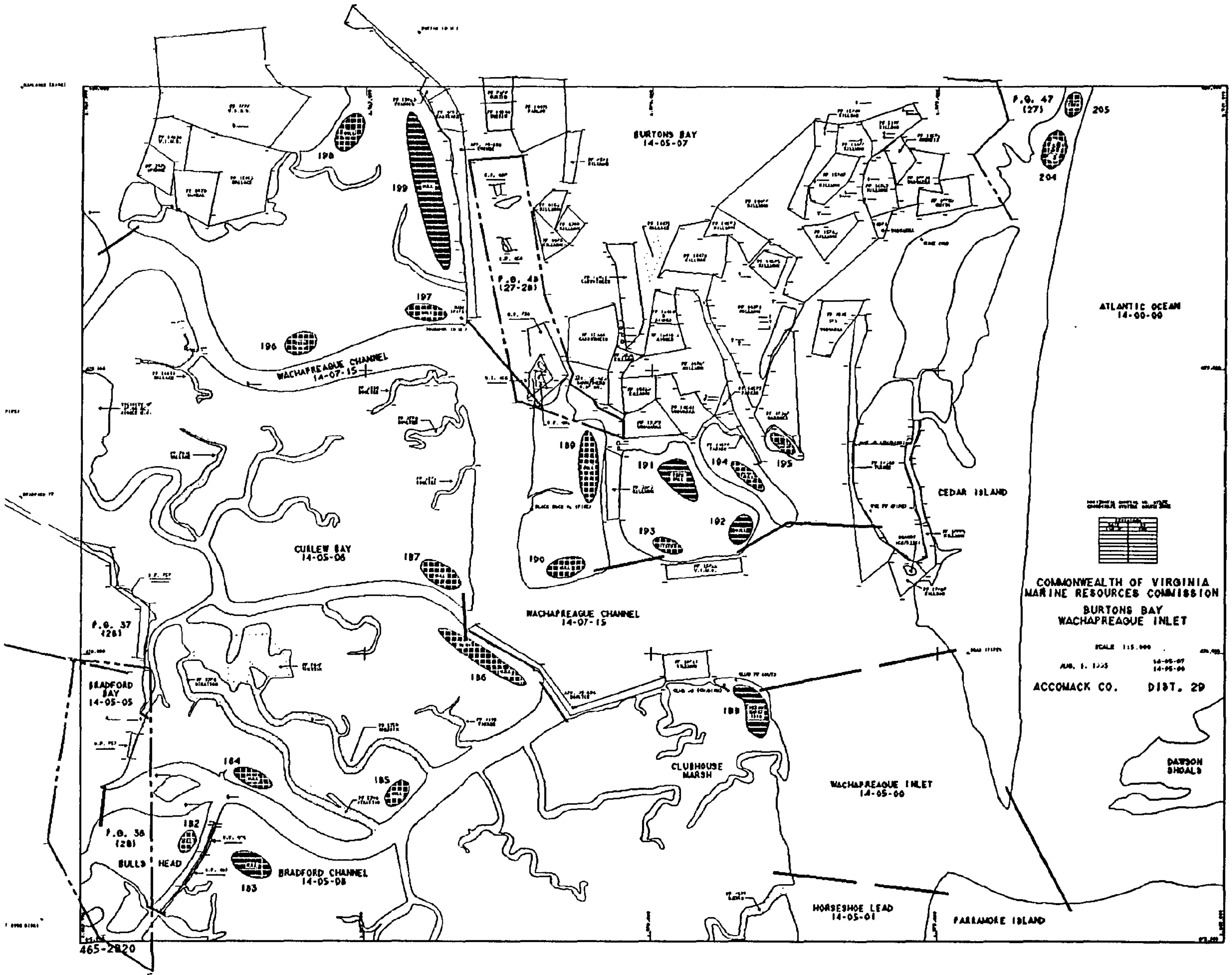

COMMONWEALTH OF VIRGINIA
MARINE RESOURCES COMMISSION
UPSHUR BAY
SWASH BAY
ACCOMACK CO. DIST. 29
MACHIPONGO RIVER
14-01-01
BRADFORD NECK
BRADFORD BAY
14-05-05
P.O. 39 (28)
P.O. 38 (28)
CLARK BAY
180
P.O. 31 (28)
WIRE CREEK
BRADFORD MARSH
14-97-17
P.O. 34 (28)
SWASH BAY
14-05-03
QUINBY
UPSHUR BAY
14-01-07
P.O. 61 (28)
PEALER PT.
WHITE TROUT CREEK
178
P.O. 35
(28)
450-2800


P.O. 36
(28)
SEAL
CREEK
181
MILLSTONE CREEK
14-05-04
HORSESHOE LEAD
14-05-01
CLUBHOUSE
GUT
P.O. 32 (28)
GREEN CHANNEL
P.O. 33
(28)
179
PARRAMORE ISLAND
DRAWING
CHANNEL
SWASH BAY
14-05-03
P.O. 35 (28)
P.O. 35
(28)
LITTLE
BEACH
ATLANTIC OCEAN
14-00-00
COMMONWEALTH OF VIRGINIA
MARINE RESOURCES COMMISSION
SWASH BAY
HORSESHOE LEAD
MILLSTONE CREEK
ACCOMACK CO.
DIST. 29
450-2820


PARRAMORE
ISLAND
ATLANTIC OCEAN
14-00-00
COMMONWEALTH OF VIRGINIA
MARINE RESOURCES COMMISSION
PARRAMORE ISLAND
SCALE 1:5,000
CODE
ACCOMACK CO.
DIST. 29

450-2840


COMMONWEALTH OF VIRGINIA
MARINE RESOURCES COMMISSION
BRADFORD BAY
WACHAPREAGUE
ACCOMACK CO. DIST. 29
BURTONS BAY
14-05-07
P.C.G. NO. 2
WACHAPREAGUE CHANNEL
14-07-15
WACHAPREAGUE
P.C.G. NO. 1
HAULOVER
P.G. 37 (28)
P.G. 40
(28)
P.G. 36 (28)
BRADFORD BAY
14-05-05
BRADFORD NECK
MACHIPONGO RIVER
14-01-01
P.G. 38 (28)
465-2800


COMMONWEALTH OF VIRGINIA
MARINE RESOURCES COMMISSION
BURTONS BAY
WACHAPREAGUE INLET
ACCOMACK CO. DIST. 29
ATLANTIC OCEAN
14-00-00
BURTONS BAY
14-05-07
CEDAR ISLAND
WACHAPREAGUE CHANNEL
14-07-15
CURLEW BAY
14-05-06
CLUBHOUSE MARSH
WACHAPREAGUE INLET
14-05-00
DAWSON SHOALS
HORSESHOE LEAD
14-05-01
PARRAMORE ISLAND
BRADFORD CHANNEL
14-05-08
BRADFORD BAY
14-05-05
BULLS HEAD
F.G. 47
(27)
F.G. 48
(27-28)
F.G. 37
(28)
F.G. 38
(28)
182
183
184
185
186
187
188
189
190
191
192
193
194
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196
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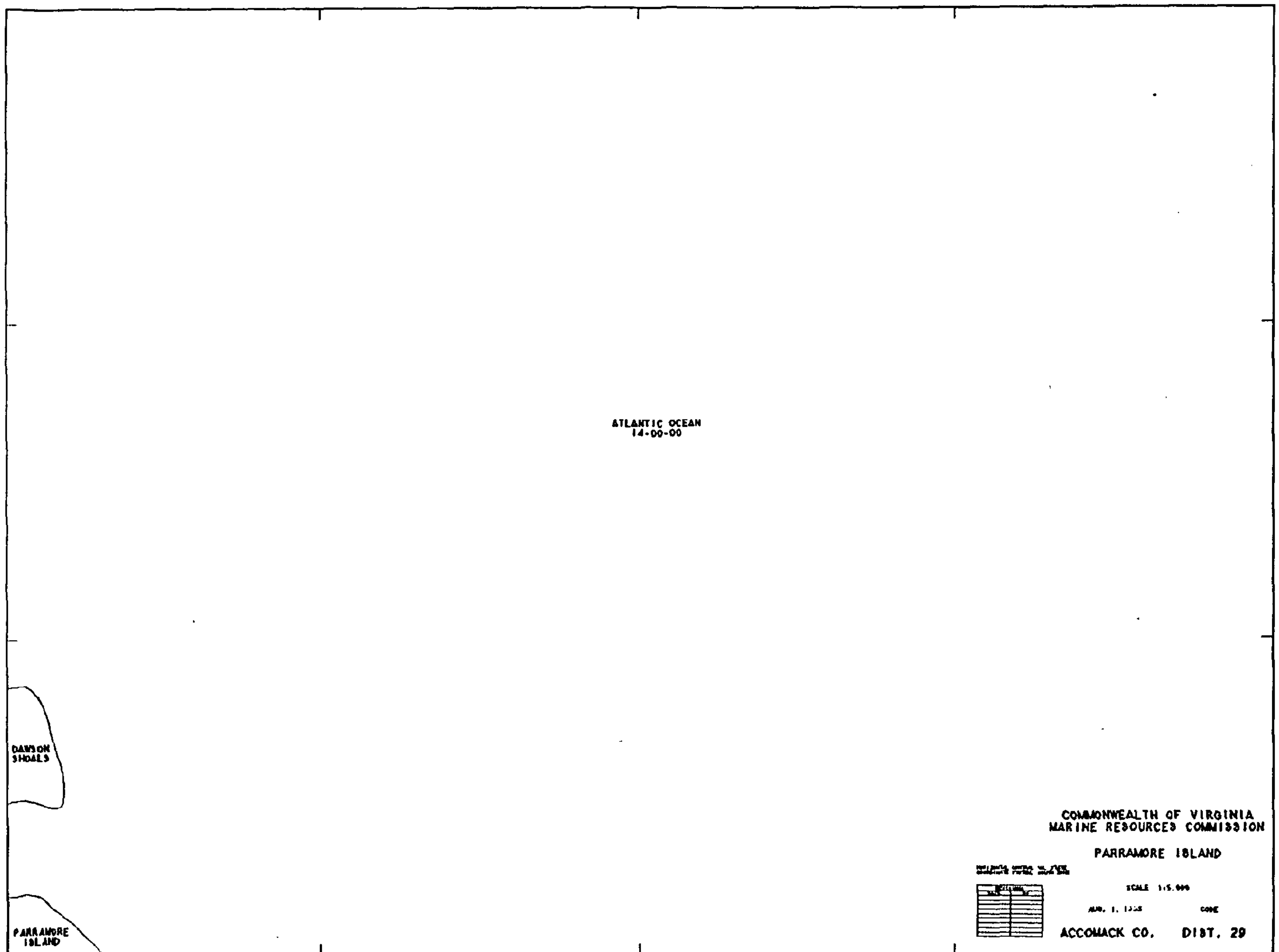
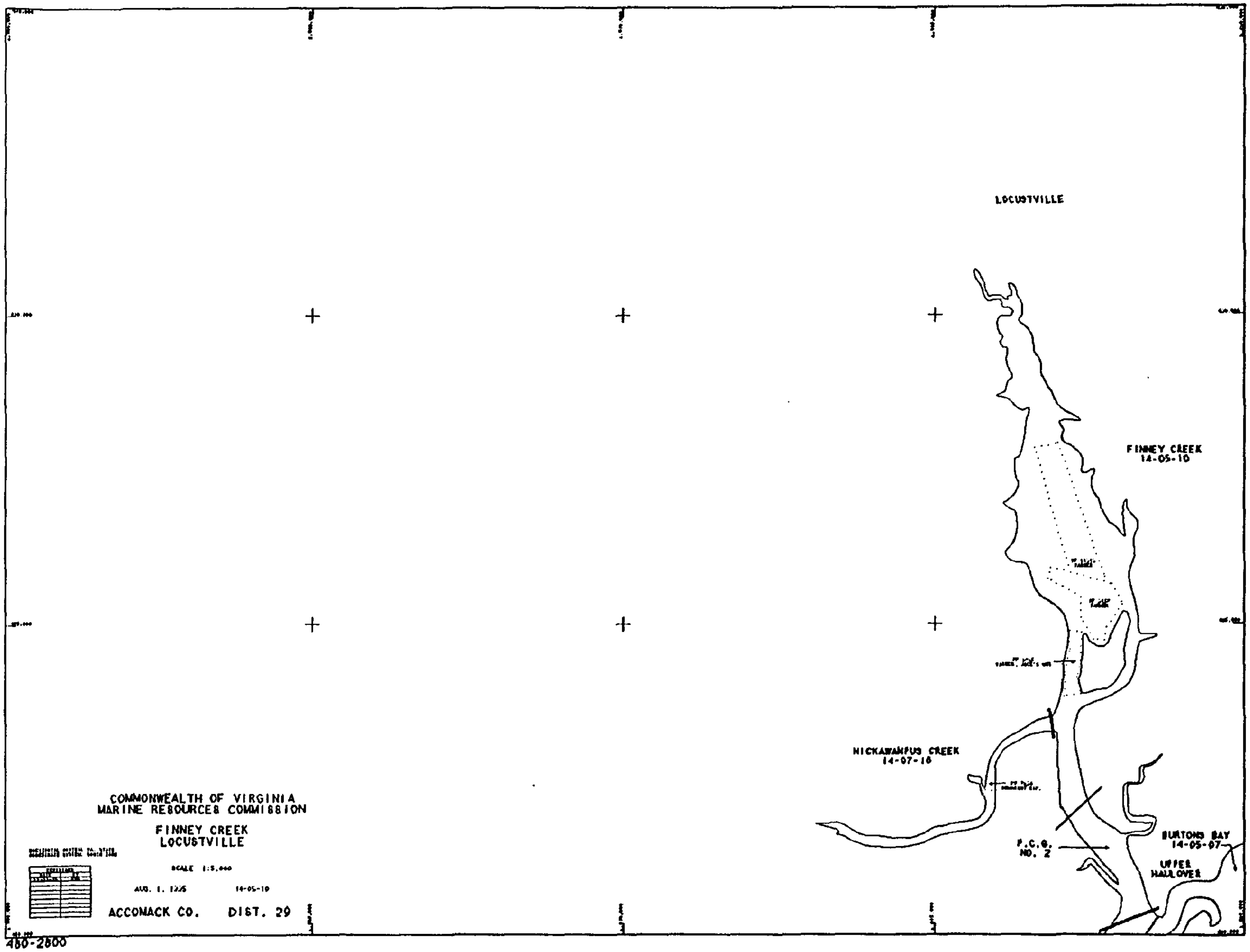
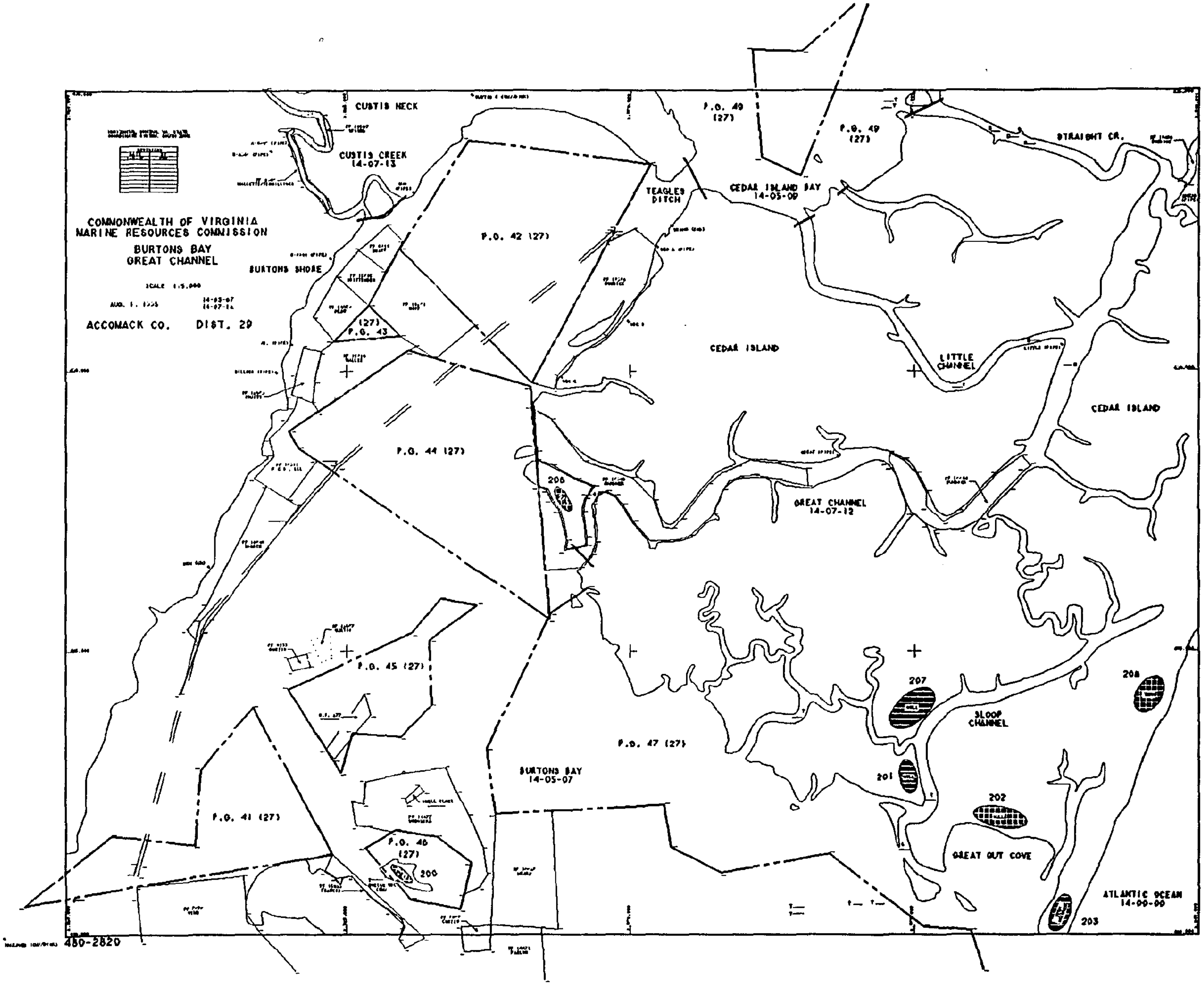
198
199
204
205
465-2820

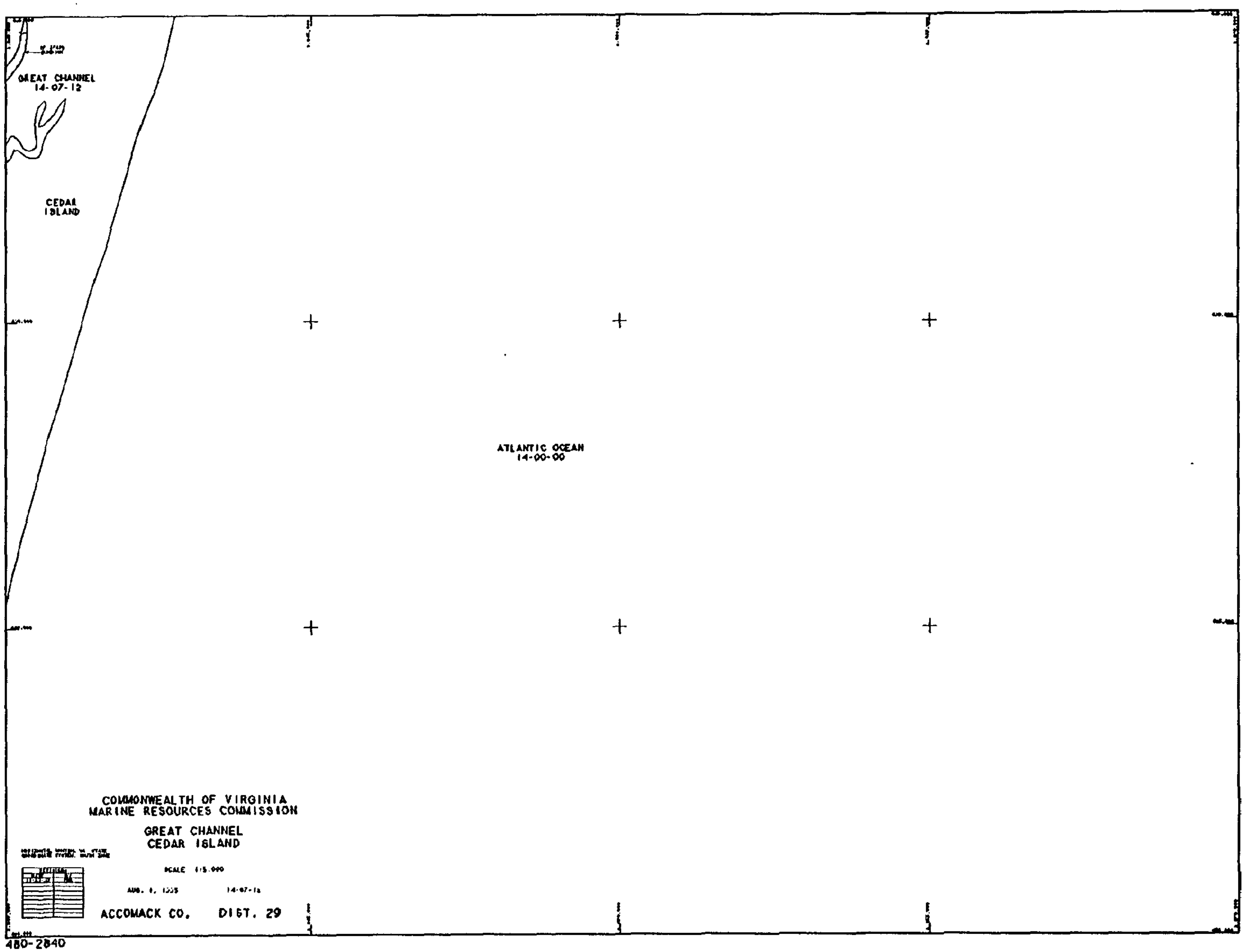


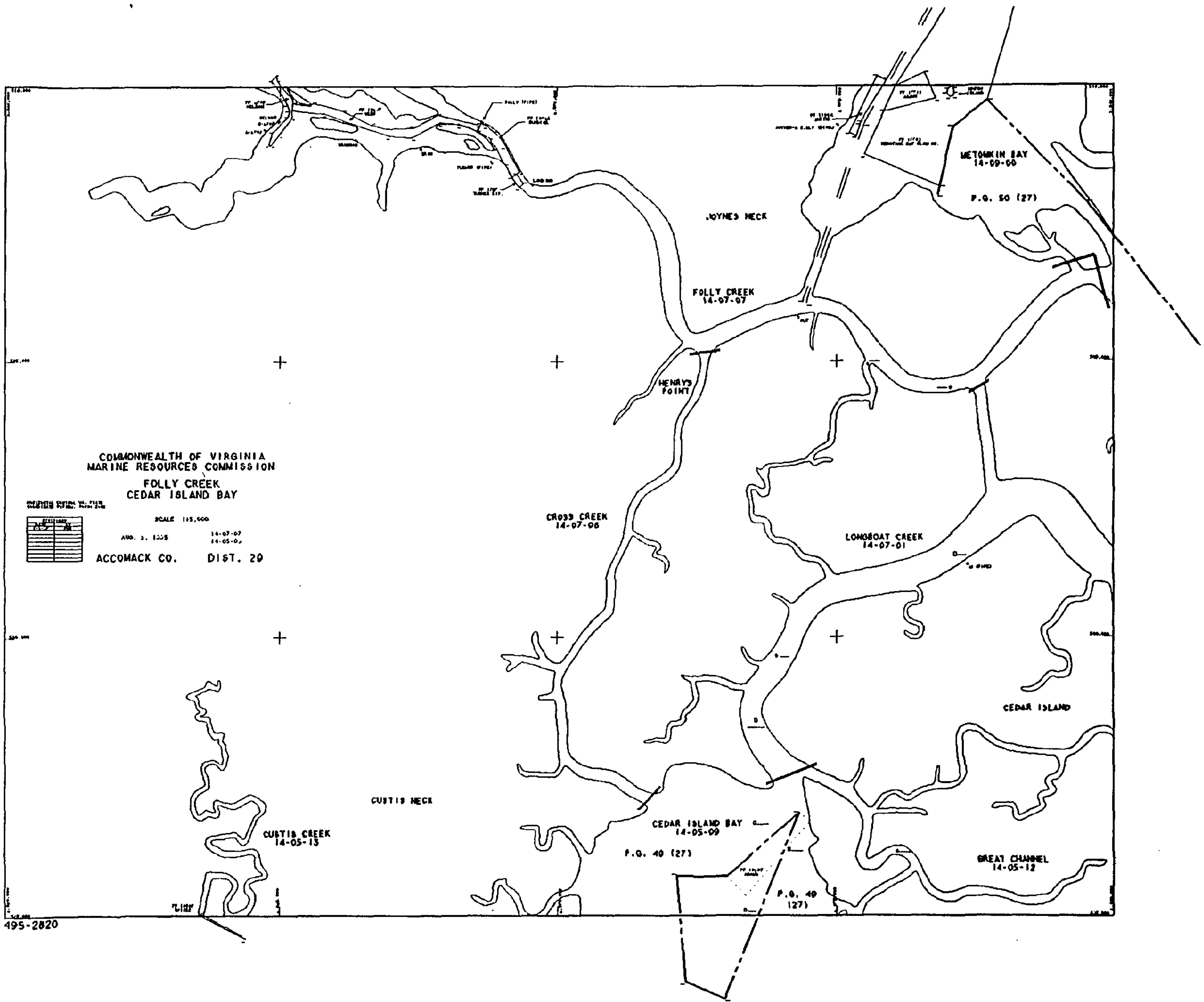
MAP NO. 465-2840


LOCUSTVILLE
FINNEY CREEK
14-05-10
HICKAWAMPUS CREEK
14-07-10
P.C.G. NO. 2
BURTONS BAY
14-05-07
UPPER HAULOVER
COMMONWEALTH OF VIRGINIA
MARINE RESOURCES COMMISSION
FINNEY CREEK
LOCUSTVILLE
ACCOMACK CO. DIST. 29
480-2800

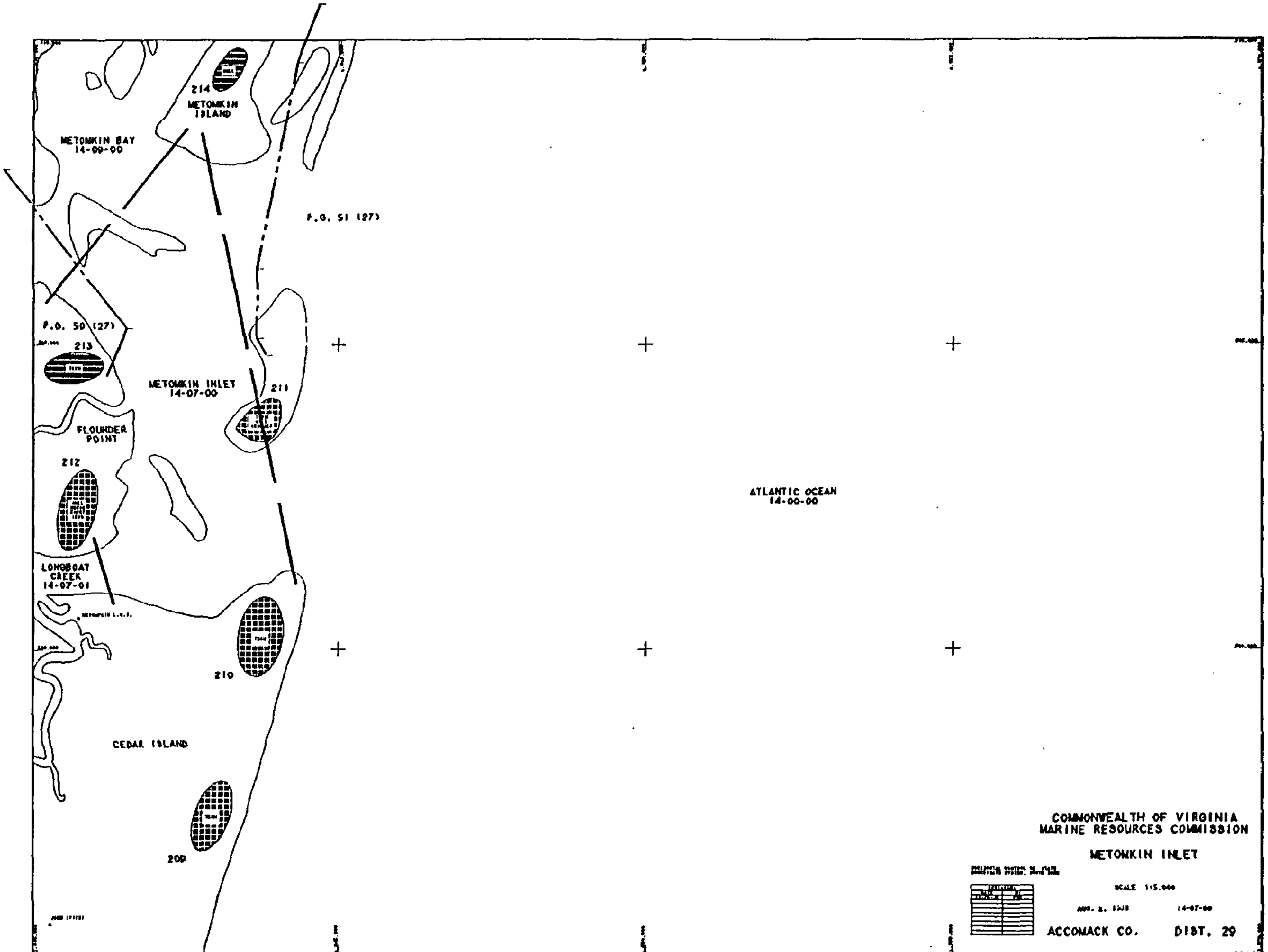


COMMONWEALTH OF VIRGINIA
MARINE RESOURCES COMMISSION
BURTONS BAY
GREAT CHANNEL
ACCOMACK CO. DIST. 29
CUSTIS NECK
CUSTIS CREEK
14-07-13
BURTONS SHORE
P.O. 42 (27)
P.O. 43
(27)
P.O. 44 (27)
P.O. 45 (27)
P.O. 41 (27)
P.O. 46
(27)
P.O. 47 (27)
P.O. 49
(27)
TEAGLES DITCH
CEDAR ISLAND BAY
14-05-09
CEDAR ISLAND
LITTLE CHANNEL
STRAIGHT CR.
GREAT CHANNEL
14-07-12
BURTONS BAY
14-05-07
SLOOP CHANNEL
GREAT OUT COVE
ATLANTIC OCEAN
14-00-00
200
201
202
203
206
207
208
480-2820


GREAT CHANNEL
14-07-12
CEDAR
ISLAND
ATLANTIC OCEAN
14-00-00
COMMONWEALTH OF VIRGINIA
MARINE RESOURCES COMMISSION
GREAT CHANNEL
CEDAR ISLAND
ACCOMACK CO. DIST. 29
480-2840

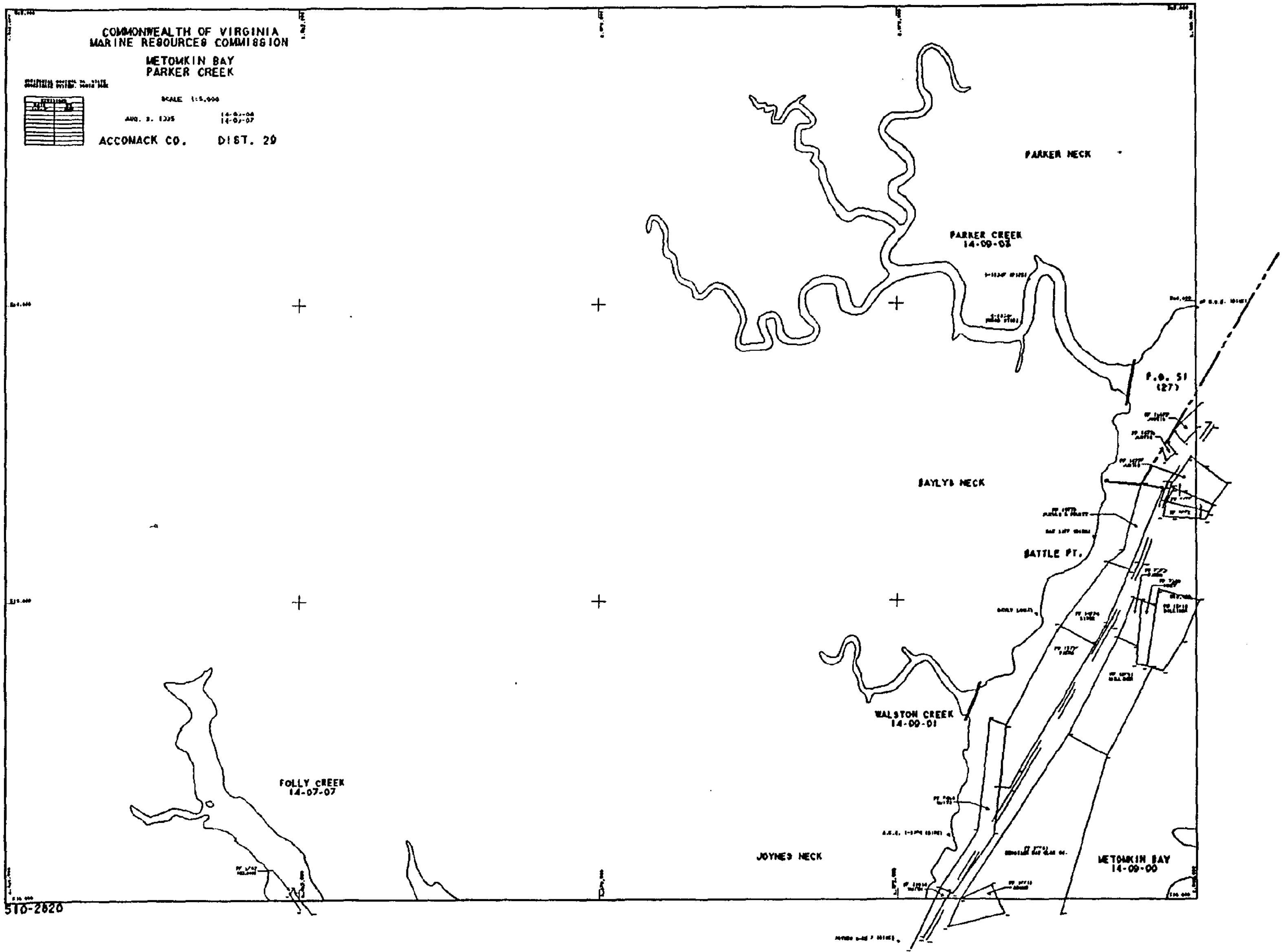

COMMONWEALTH OF VIRGINIA
MARINE RESOURCES COMMISSION
FOLLY CREEK
CEDAR ISLAND BAY
ACCOMACK CO. DIST. 29
METOMKIN BAY
14-09-00
P.G. 50 (27)
JOYNES NECK
FOLLY CREEK
14-07-07
HENRYS POINT
CROSS CREEK
14-07-06
LONGBOAT CREEK
14-07-01
CEDAR ISLAND
CEDAR ISLAND BAY
14-05-09
P.G. 49 (27)
P.G. 49
(27)
GREAT CHANNEL
14-05-12
CURTIS NECK
CURTIS CREEK
14-05-13

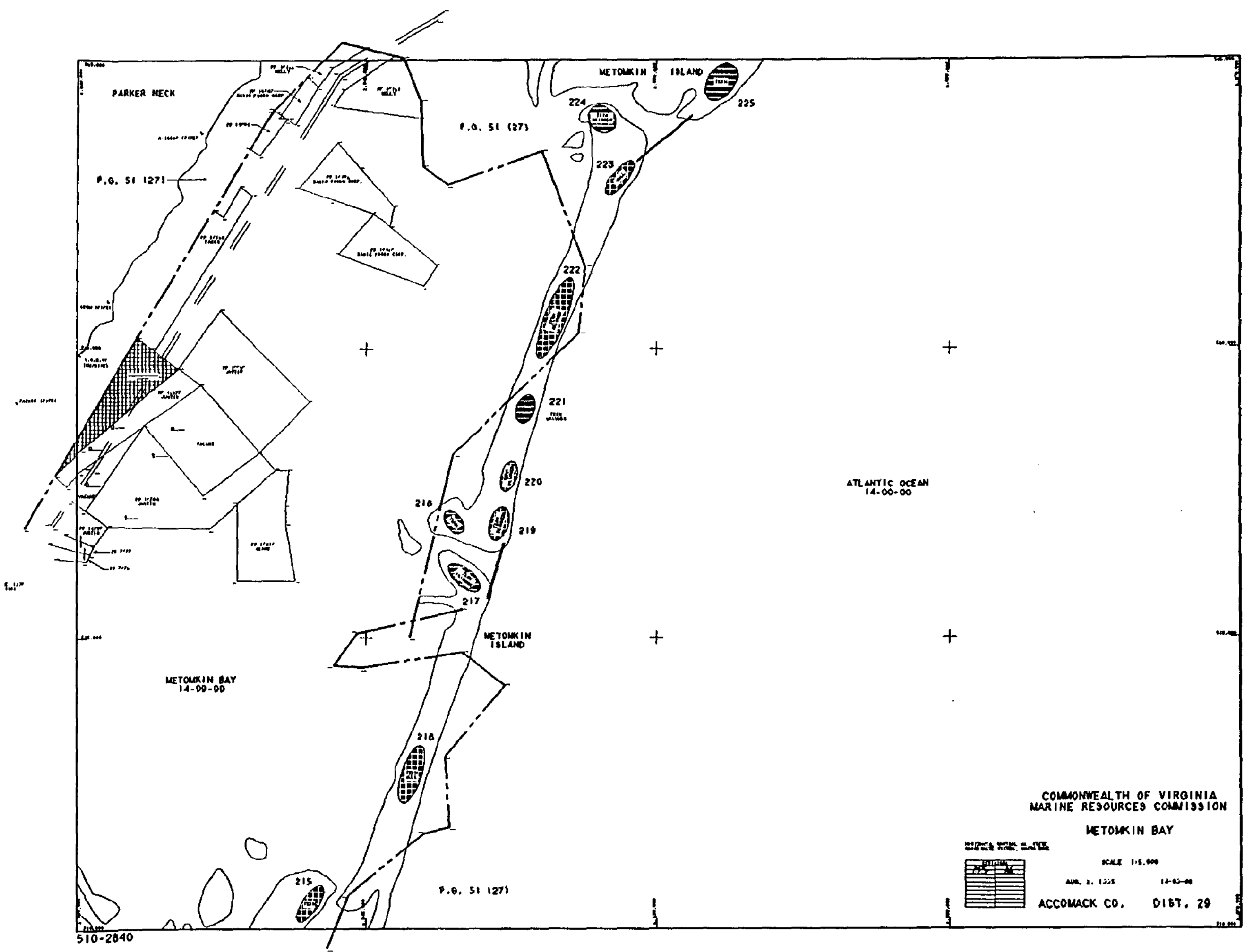
495-2820

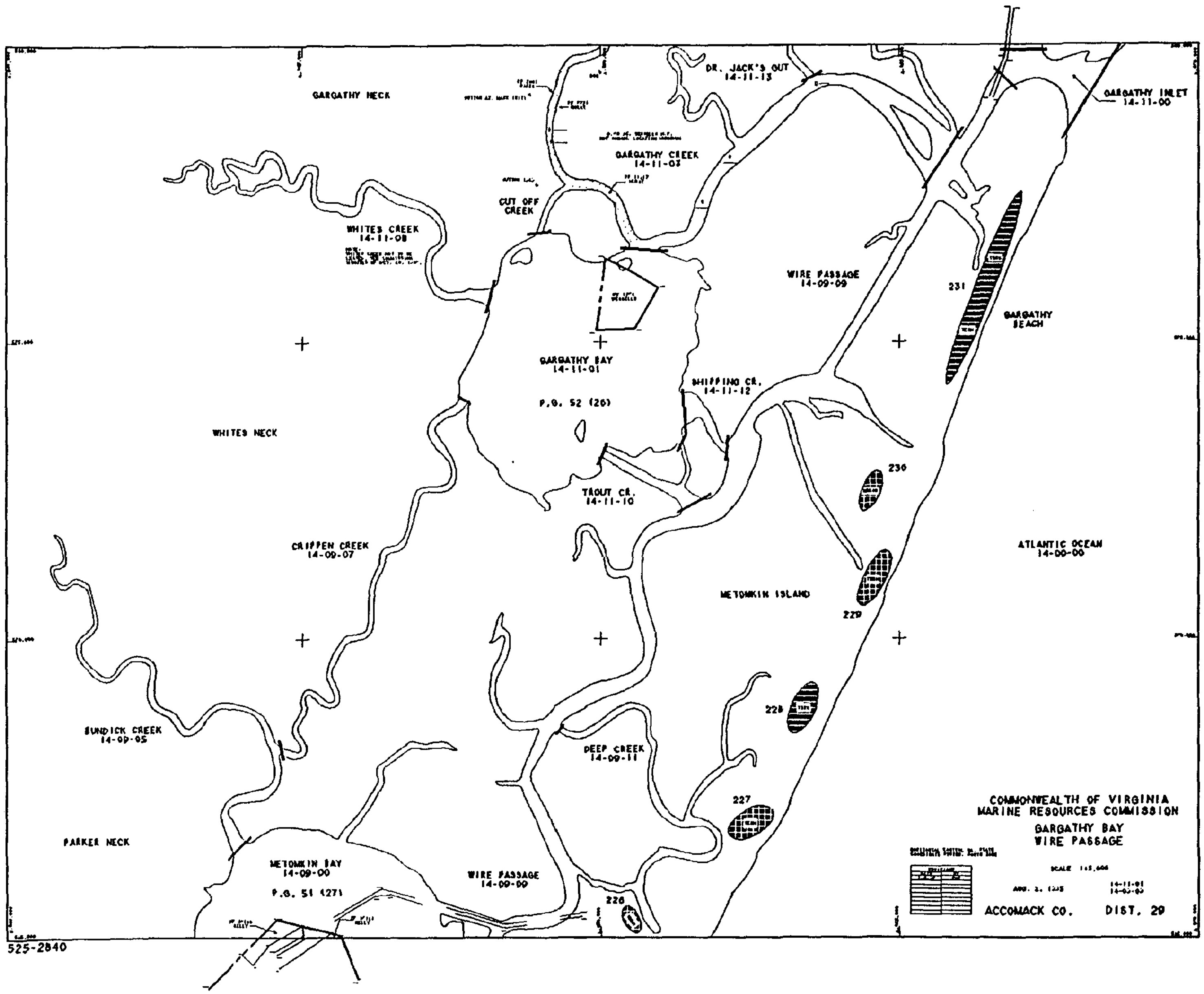


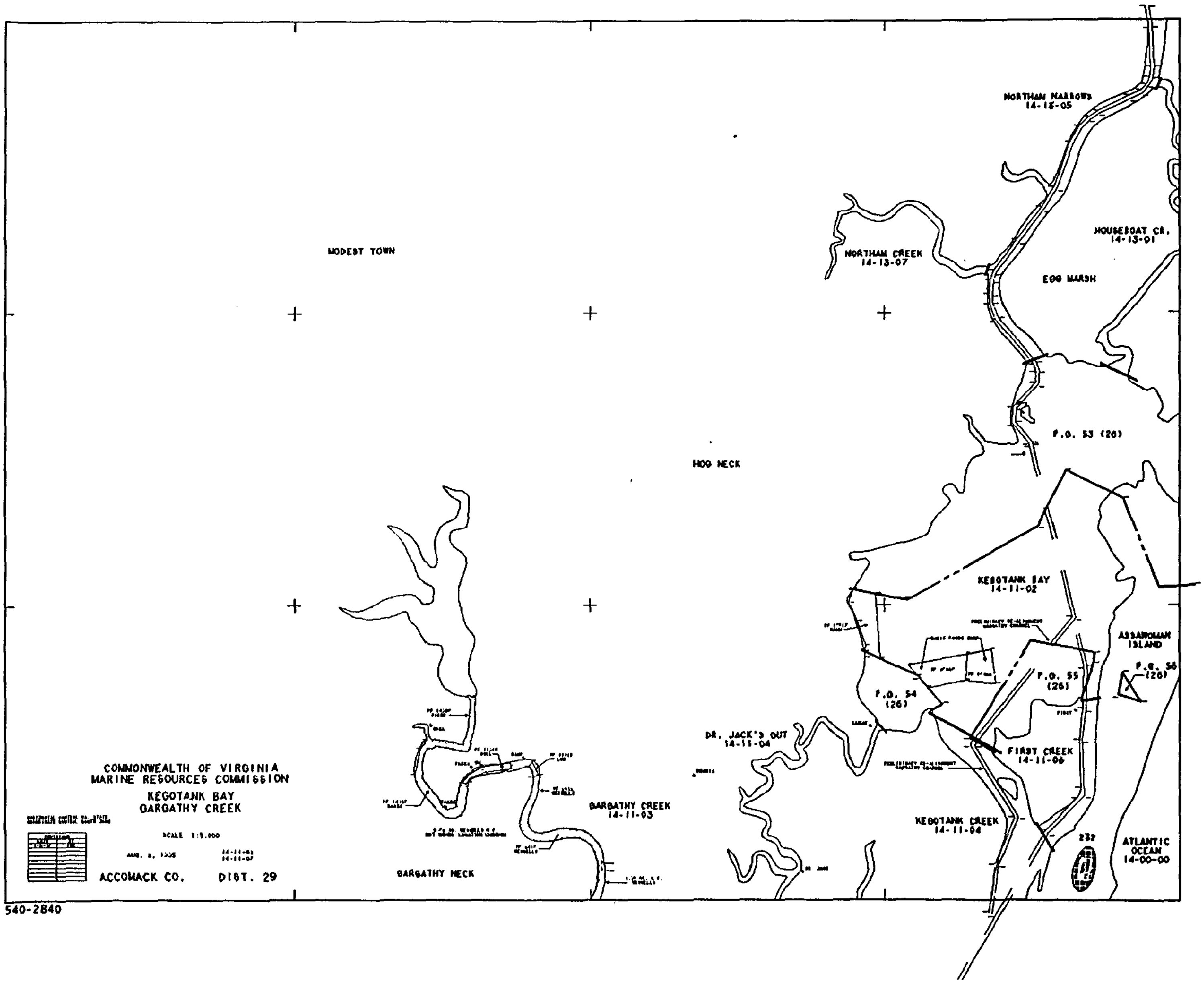
214
METOMKIN ISLAND
METOMKIN BAY 14-09-00
F.O. 51 (27)
F.O. 50 (27)
213
METOMKIN INLET 14-07-00
211
FLOUNDER POINT
212
LONGBOAT CREEK 14-07-01
210
CEDAR ISLAND
209
ATLANTIC OCEAN 14-00-00
COMMONWEALTH OF VIRGINIA
MARINE RESOURCES COMMISSION
METOMKIN INLET
ACCOMACK CO.
DIST. 29

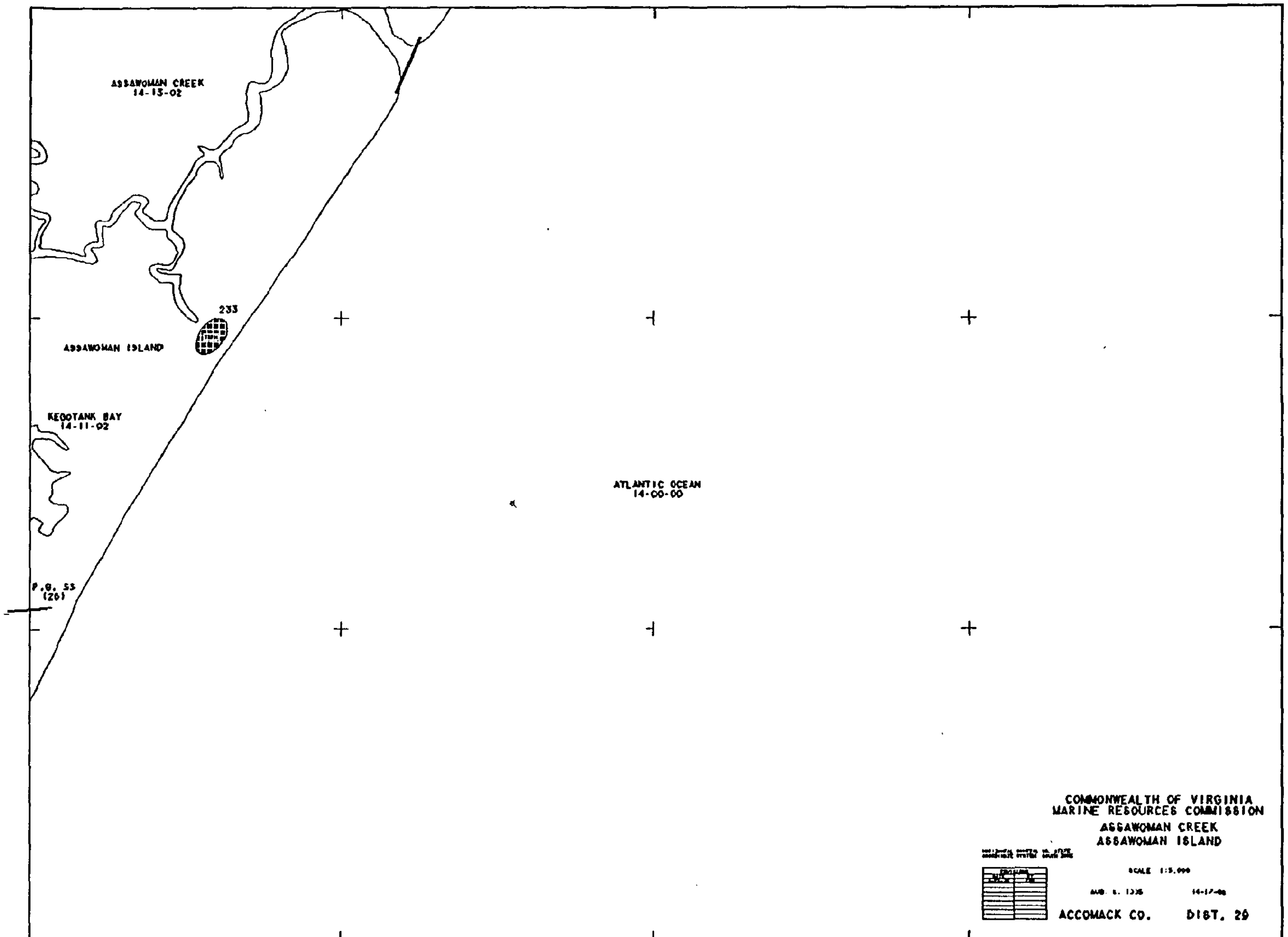
495-2840


COMMONWEALTH OF VIRGINIA
MARINE RESOURCES COMMISSION
METOMKIN BAY
PARKER CREEK
ACCOMACK CO.
DIST. 29
PARKER NECK
PARKER CREEK
14-09-03
P.O. 51
(27)
BAYLYS NECK
BATTLE PT.
WALSTON CREEK
14-09-01
FOLLY CREEK
14-07-07
JOYNES NECK
METOMKIN BAY
14-09-00
510-2820

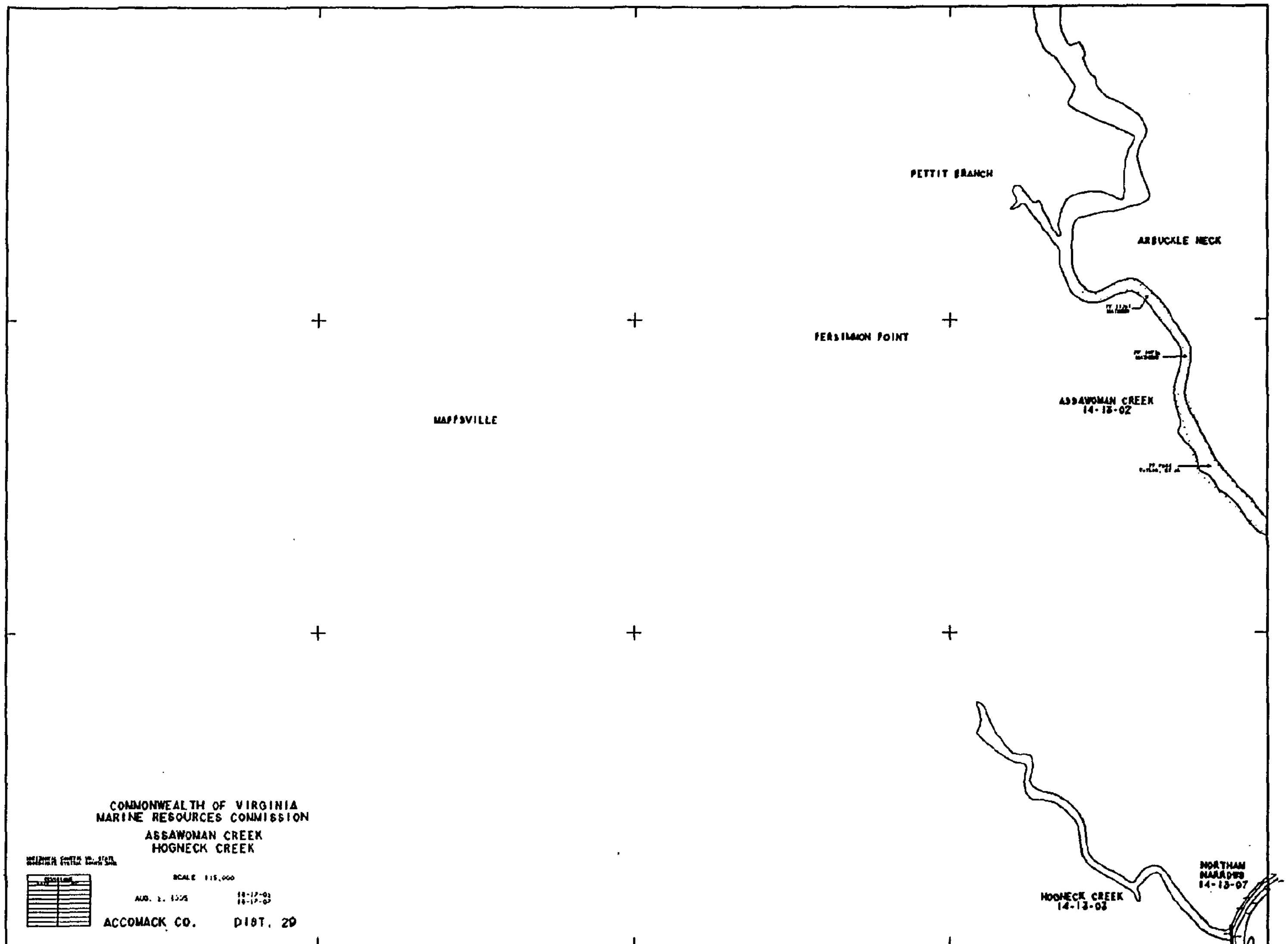

PARKER NECK
METOMKIN ISLAND
P.G. 51 (27)
224
225
223
222
221
220
219
218
217
216
215
ATLANTIC OCEAN
14-00-00
METOMKIN
ISLAND
METOMKIN BAY
14-09-00
COMMONWEALTH OF VIRGINIA
MARINE RESOURCES COMMISSION
METOMKIN BAY
ACCOMACK CO.
DIST. 29
510-2840

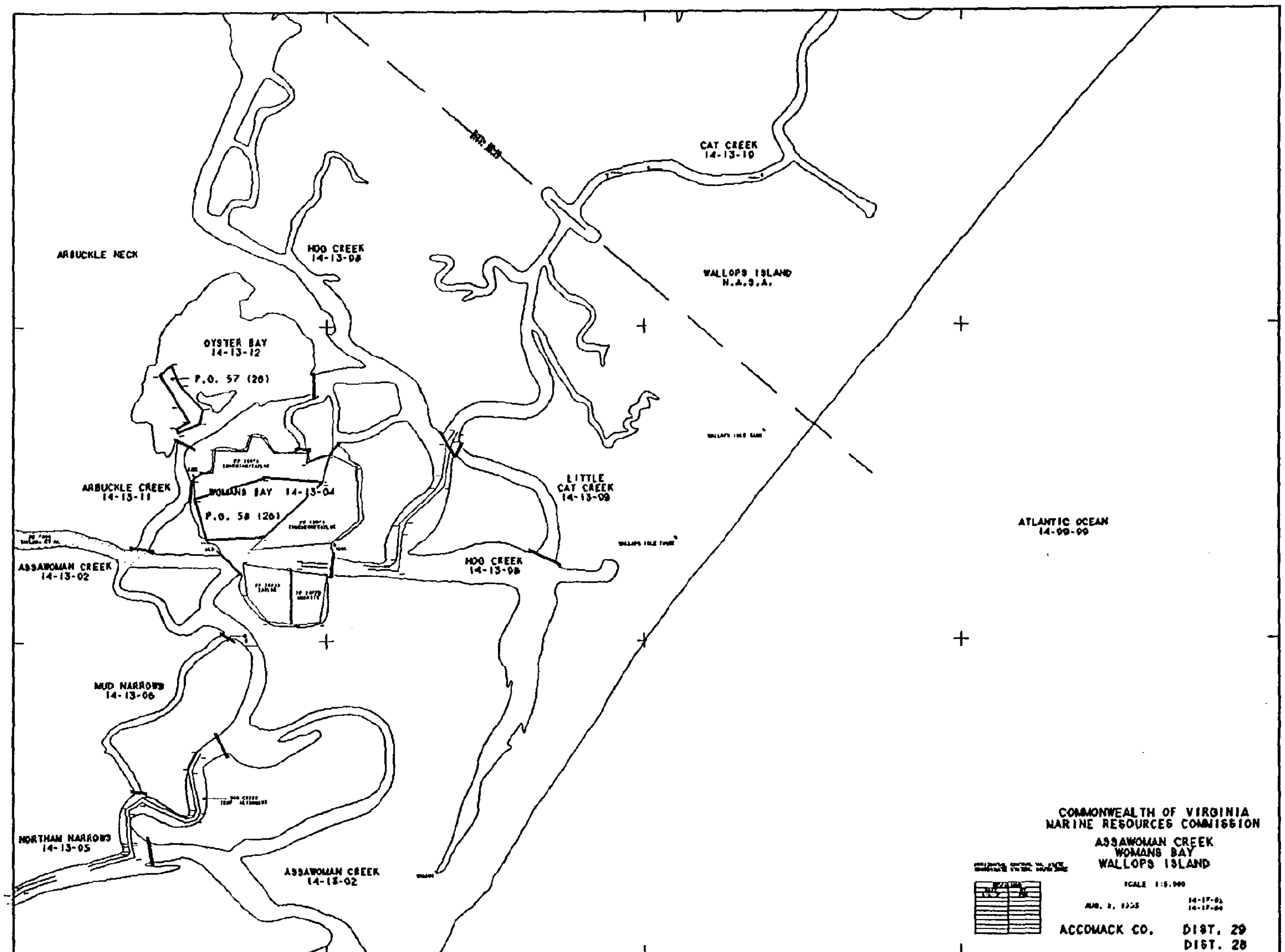

COMMONWEALTH OF VIRGINIA
MARINE RESOURCES COMMISSION
GARGATHY BAY
WIRE PASSAGE
ACCOMACK CO.
DIST. 29
GARGATHY INLET
14-11-00
DR. JACK'S OUT
14-11-13
GARGATHY NECK
GARGATHY CREEK
14-11-03
CUT OFF
CREEK
WHITES CREEK
14-11-08
WIRE PASSAGE
14-09-09
231
GARGATHY
BEACH
GARGATHY BAY
14-11-01
P.G. 52 (26)
SHIPPING CR.
14-11-12
WHITES NECK
TROUT CR.
14-11-10
230
ATLANTIC OCEAN
14-00-00
CRIPPEN CREEK
14-09-07
METOMKIN ISLAND
229
228
SUNDICK CREEK
14-09-05
DEEP CREEK
14-09-11
227
PARKER NECK
METOMKIN BAY
14-09-00
P.G. 51 (27)
WIRE PASSAGE
14-09-00
226
525-2840

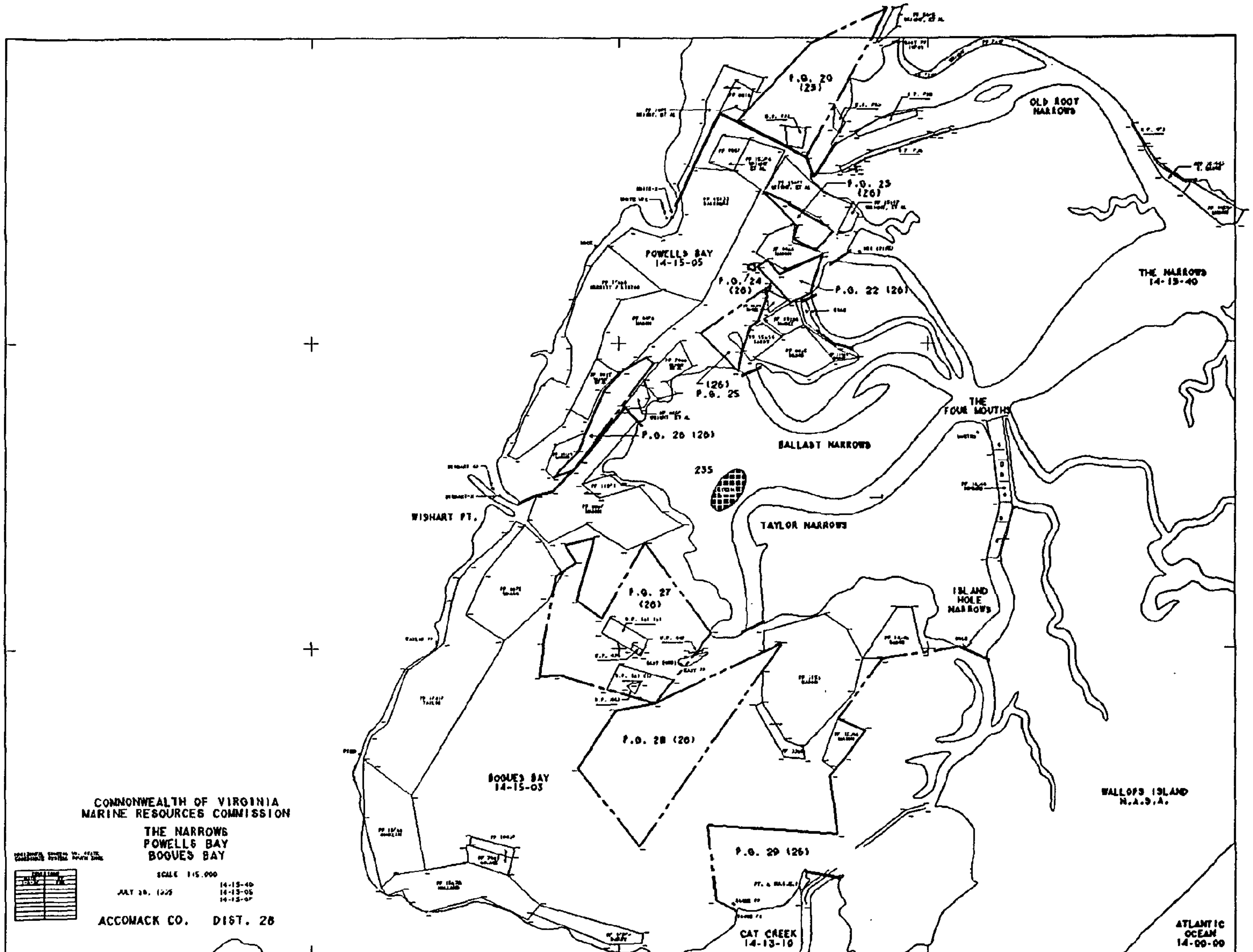

NORTHAM NARROWS
14-13-05
HOUSEBOAT CR.
14-13-01
NORTHAM CREEK
14-13-07
EGG MARSH
MODEST TOWN
P.O. 53 (20)
HOG NECK
KEGOTANK BAY
14-11-02
ASSAWOMAN
ISLAND
P.G. 56
(20)
P.O. 55
(26)
P.O. 54
(26)
DR. JACK'S OUT
14-11-04
FIRST CREEK
14-11-06
GARGATHY CREEK
14-11-03
KEGOTANK CREEK
14-11-04
232
ATLANTIC
OCEAN
14-00-00
GARGATHY NECK
COMMONWEALTH OF VIRGINIA
MARINE RESOURCES COMMISSION
KEGOTANK BAY
GARGATHY CREEK
ACCOMACK CO.
DIST. 29
540-2840


ASSAWOMAN CREEK
14-13-02
233
ASSAWOMAN ISLAND
KEGOTANK BAY
14-11-02
P.G. 53
(26)
ATLANTIC OCEAN
14-00-00
COMMONWEALTH OF VIRGINIA
MARINE RESOURCES COMMISSION
ASSAWOMAN CREEK
ASSAWOMAN ISLAND
ACCOMACK CO.
DIST. 29

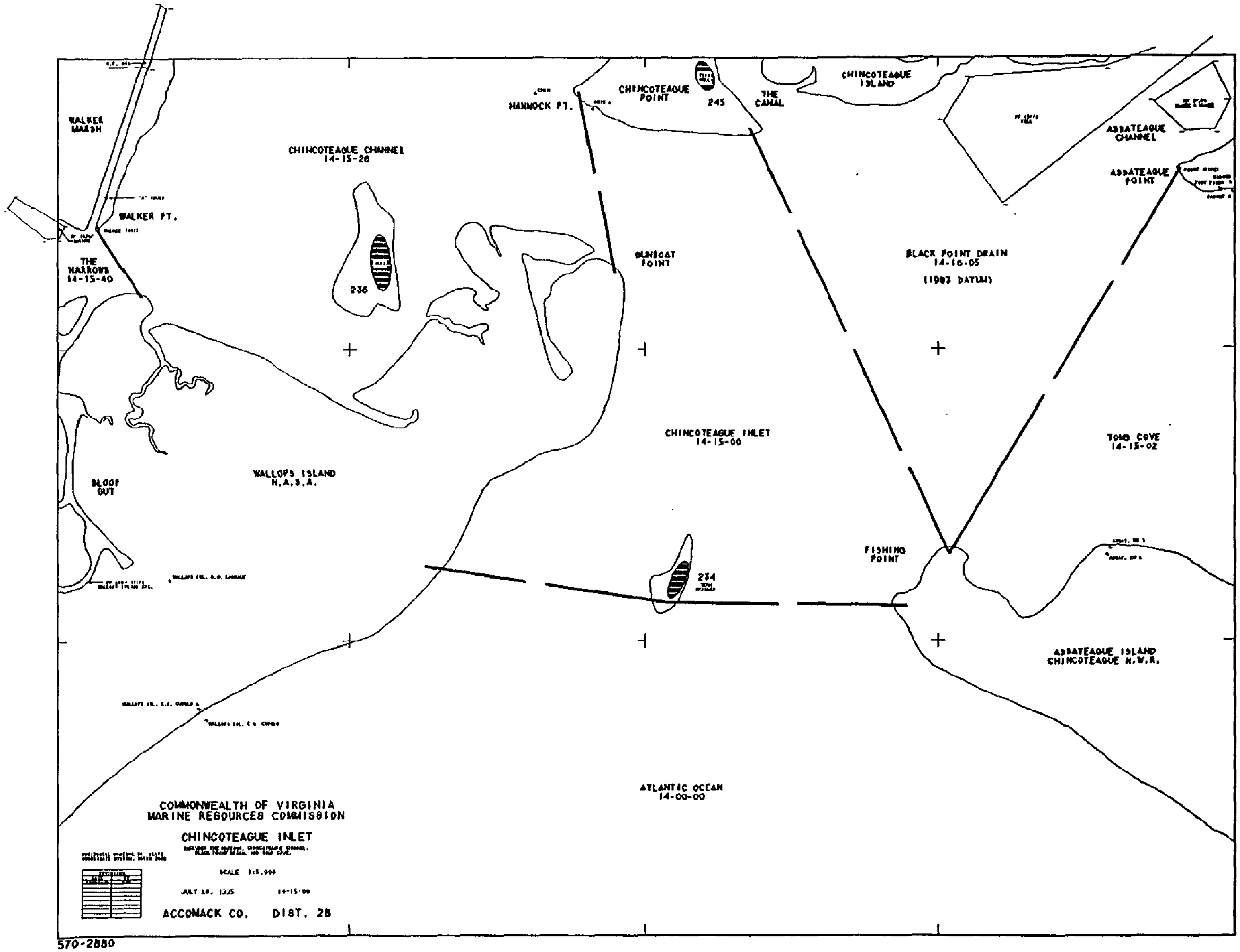
540-2860

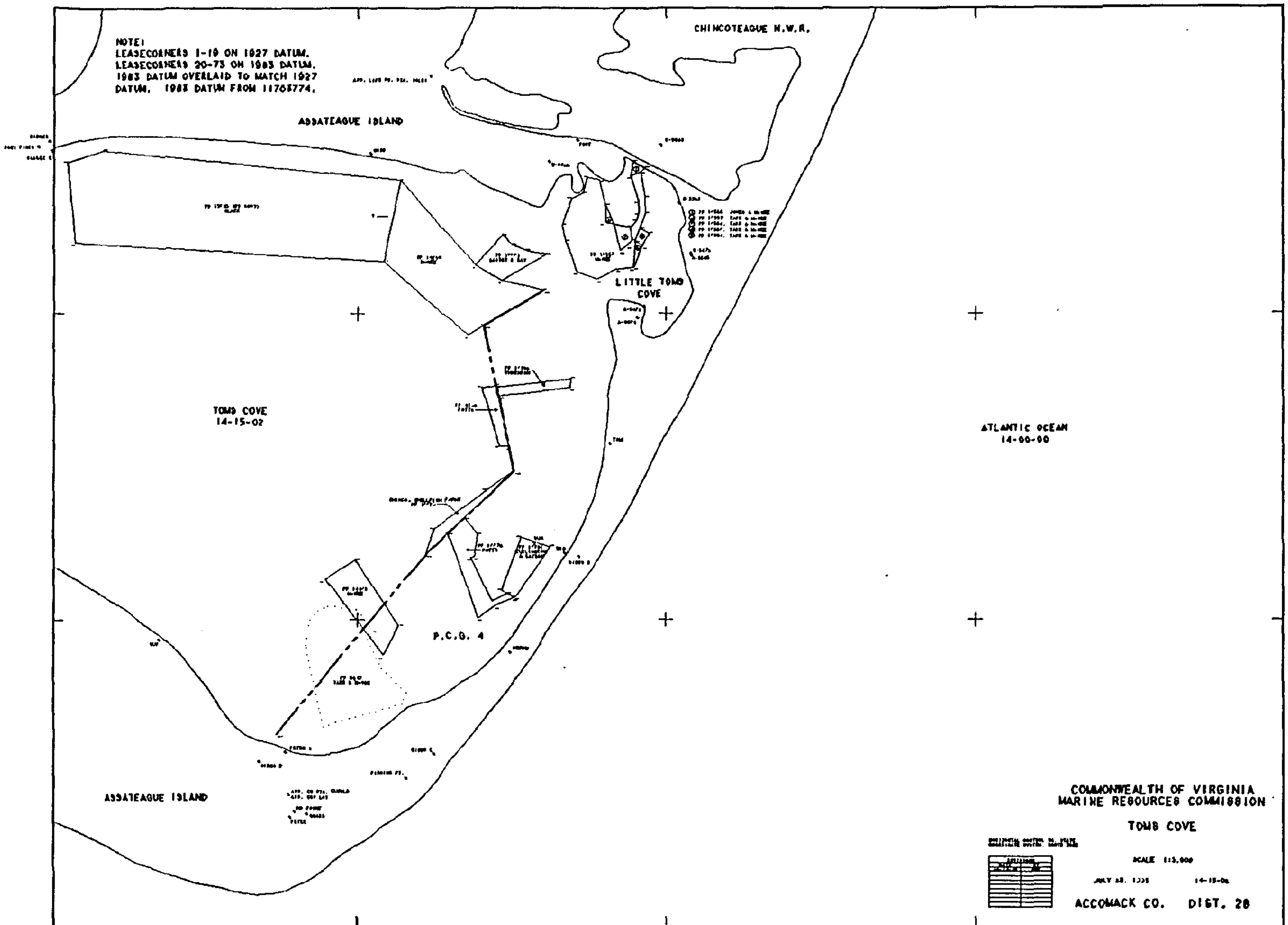

PETTIT BRANCH
ARBUCKLE NECK
PERSIMMON POINT
ASSAWOMAN CREEK
14-13-02
MAPPSVILLE
HOGNECK CREEK
14-13-03
NORTHAM NARROWS
14-13-07
COMMONWEALTH OF VIRGINIA
MARINE RESOURCES COMMISSION
ASSAWOMAN CREEK
HOGNECK CREEK
ACCOMACK CO. DIST. 29
555-2840

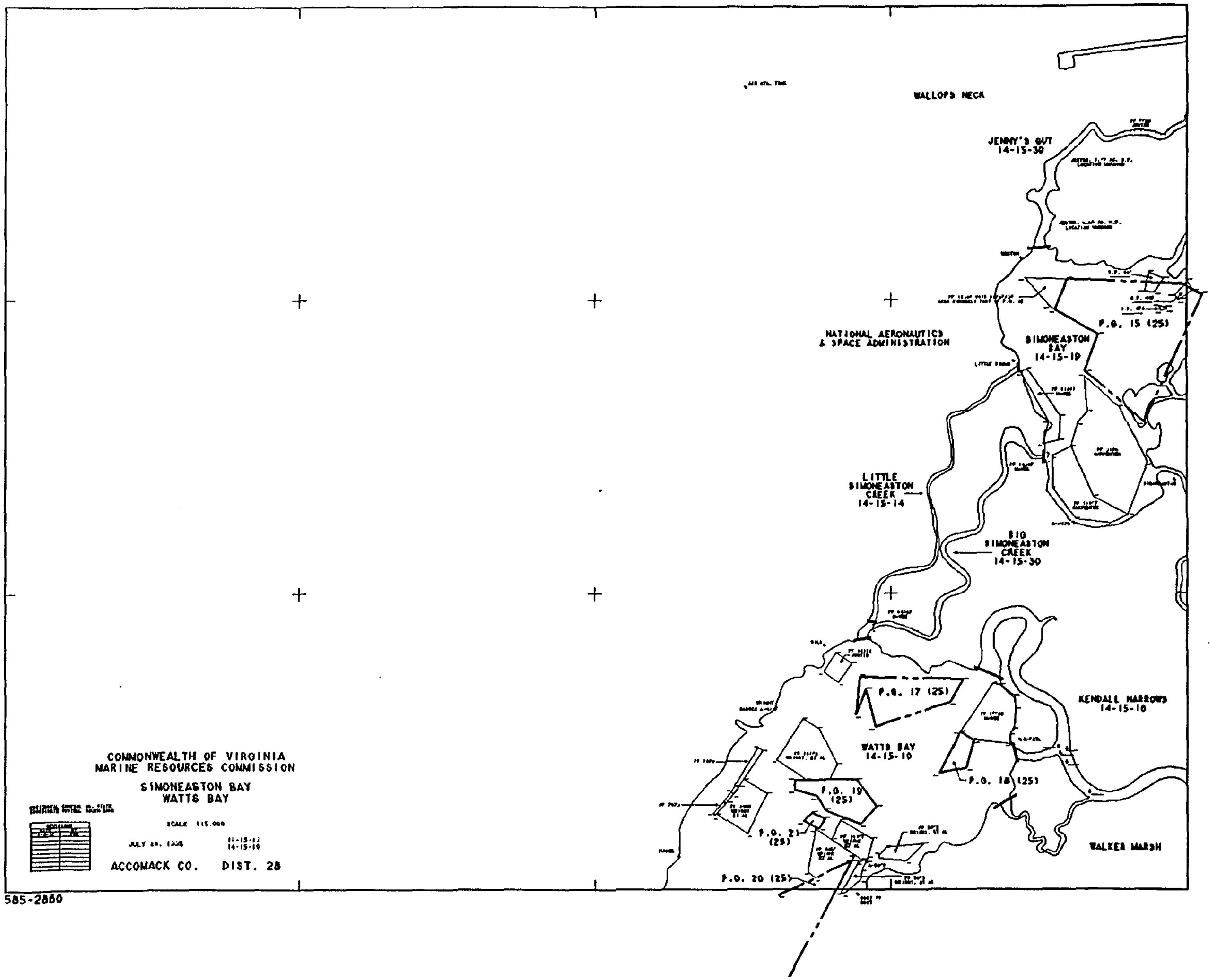

CAT CREEK
14-13-10
HOG CREEK
14-13-08
ARBUCKLE NECK
WALLOPS ISLAND
N.A.S.A.
OYSTER BAY
14-13-12
P.O. 57 (26)
ARBUCKLE CREEK
14-13-11
WOMANS BAY 14-13-04
P.O. 58 (26)
LITTLE
CAT CREEK
14-13-09
ASSAWOMAN CREEK
14-13-02
HOG CREEK
14-13-08
ATLANTIC OCEAN
14-09-99
MUD NARROWS
14-13-06
NORTHAM NARROWS
14-13-05
ASSAWOMAN CREEK
14-13-02
COMMONWEALTH OF VIRGINIA
MARINE RESOURCES COMMISSION
ASSAWOMAN CREEK
WOMANS BAY
WALLOPS ISLAND
ACCOMACK CO.
DIST. 29
DIST. 28


P.G. 20
(23)
OLD ROOT
NARROWS
P.G. 23
(26)
POWELLS BAY
14-15-05
P.G. 24
(26)
P.G. 22 (26)
THE NARROWS
14-13-40
(26)
P.G. 25
THE
FOUR MOUTHS
P.G. 26 (26)
BALLAST NARROWS
235
WISHART PT.
TAYLOR NARROWS
P.G. 27
(26)
ISLAND
HOLE
NARROWS
P.G. 28 (26)
BOGUES BAY
14-15-03
WALLOPS ISLAND
N.A.S.A.
P.G. 29 (26)
CAT CREEK
14-13-10
ATLANTIC
OCEAN
14-00-00
COMMONWEALTH OF VIRGINIA
MARINE RESOURCES COMMISSION
THE NARROWS
POWELLS BAY
BOGUES BAY
ACCOMACK CO. DIST. 28

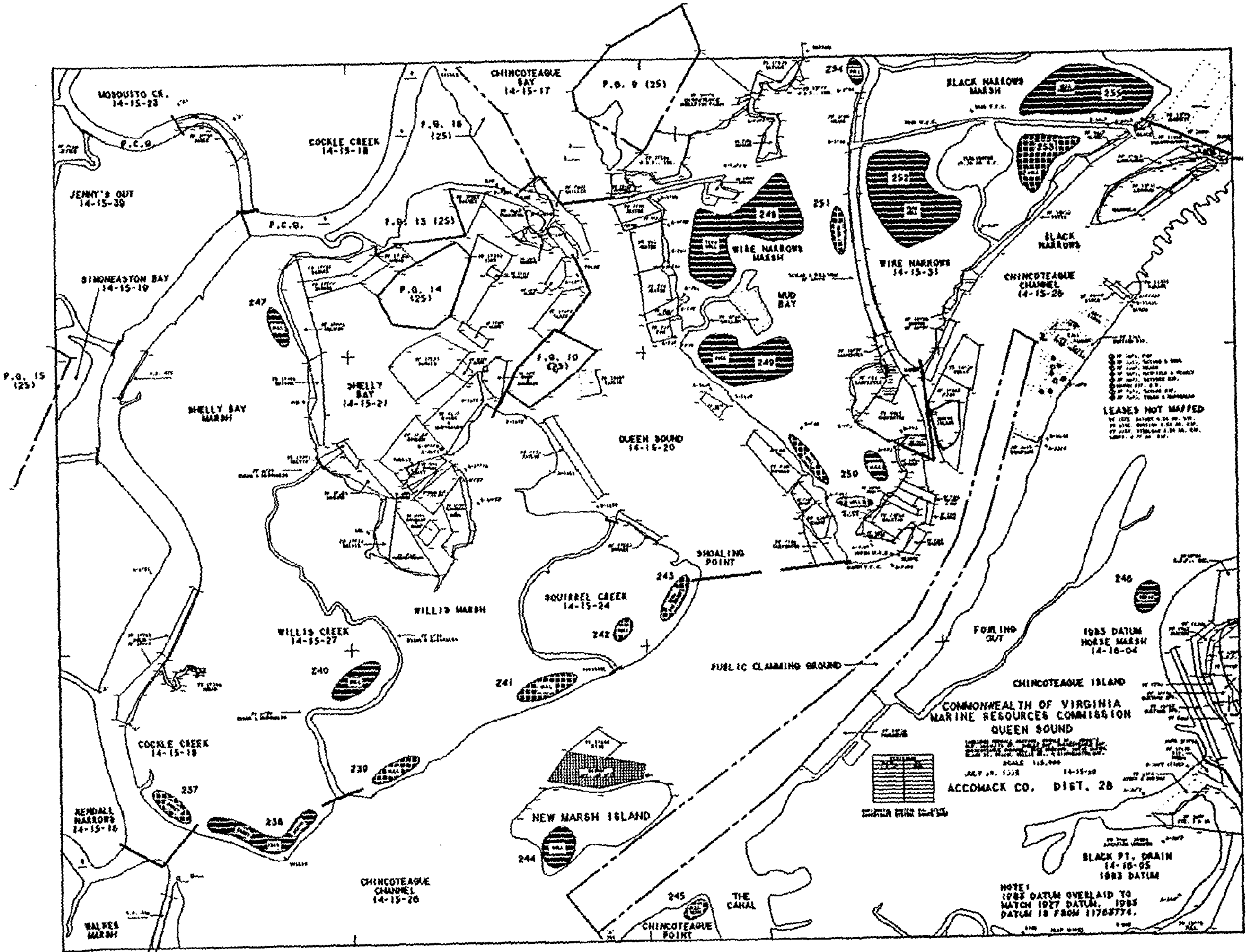
570-2860


WALKER MARSH
CHINCOTEAGUE CHANNEL 14-15-26
WALKER PT.
THE NARROWS 14-15-40
236
HAMMOCK PT.
CHINCOTEAGUE POINT
245
THE CANAL
CHINCOTEAGUE ISLAND
ASSATEAGUE CHANNEL
ASSATEAGUE POINT
GUNBOAT POINT
BLACK POINT DRAIN 14-16-05
(1983 DATUM)
CHINCOTEAGUE INLET 14-15-00
TOMS COVE 14-15-02
WALLOPS ISLAND N.A.S.A.
SLOOP GUT
FISHING POINT
234
ASSATEAGUE ISLAND CHINCOTEAGUE N.W.R.
ATLANTIC OCEAN 14-00-00
COMMONWEALTH OF VIRGINIA
MARINE RESOURCES COMMISSION
CHINCOTEAGUE INLET
ACCOMACK CO. DIST. 2B
570-2880


NOTE:
LEASECORNERS 1-19 ON 1927 DATUM.
LEASECORNERS 20-73 ON 1983 DATUM.
1983 DATUM OVERLAID TO MATCH 1927
DATUM. 1983 DATUM FROM 11763774.
CHINCOTEAGUE N.W.R.
ASSATEAGUE ISLAND
LITTLE TOMS
COVE
TOMS COVE
14-15-02
ATLANTIC OCEAN
14-00-00
P.C.G. 4
ASSATEAGUE ISLAND
COMMONWEALTH OF VIRGINIA
MARINE RESOURCES COMMISSION
TOMS COVE
ACCOMACK CO. DIST. 28
570-2000

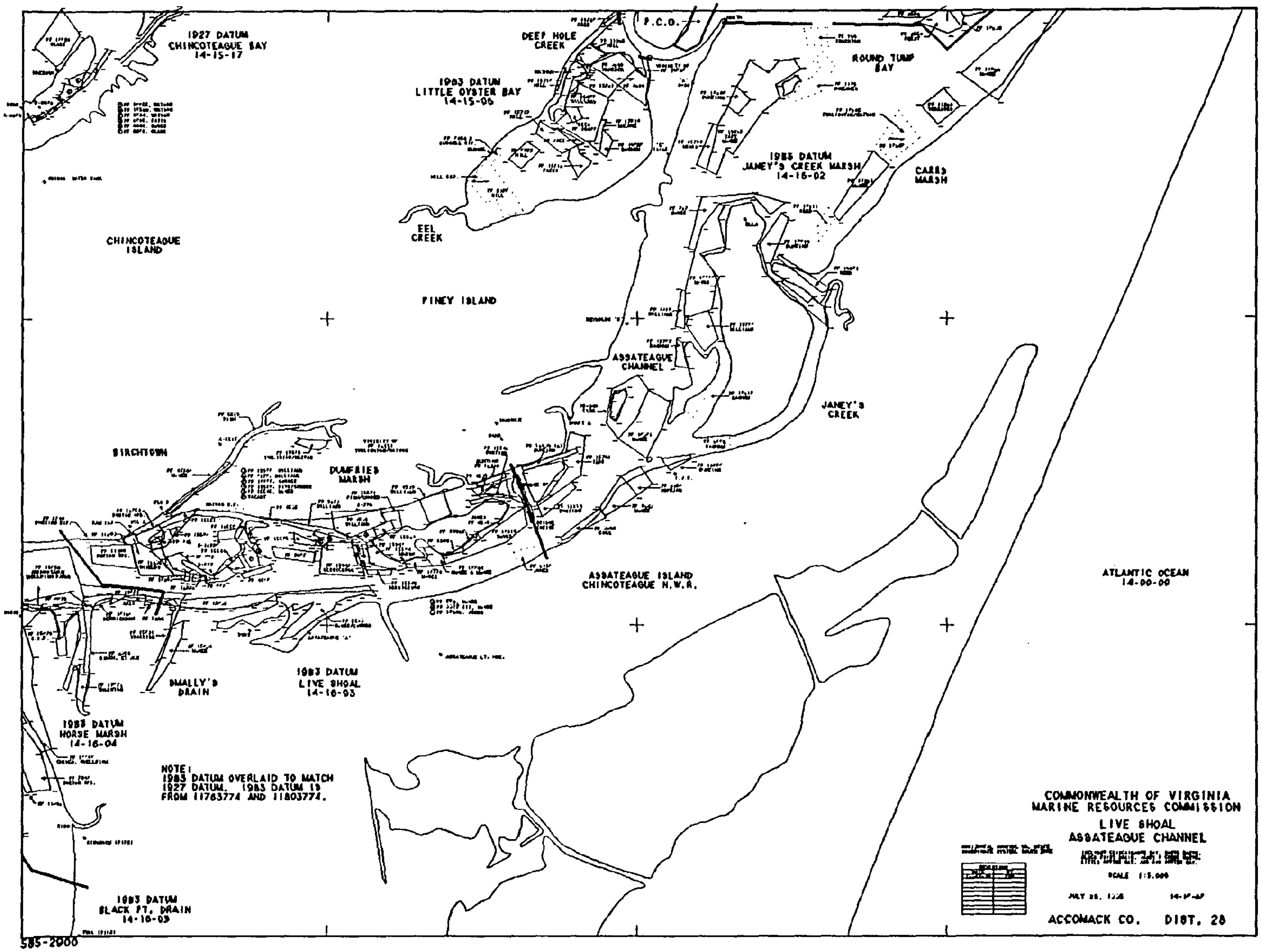

WALLOPS NECK
JENNY'S GUT
14-15-30
NATIONAL AERONAUTICS
& SPACE ADMINISTRATION
SIMONEASTON
BAY
14-15-19
P.G. 15 (25)
LITTLE
SIMONEASTON
CREEK
14-15-14
BIG
SIMONEASTON
CREEK
14-15-30
P.G. 17 (25)
KENDALL NARROWS
14-15-16
WATTS BAY
14-15-10
P.G. 18 (25)
P.G. 19
(25)
P.G. 21
(25)
P.G. 20 (25)
WALKER MARSH
COMMONWEALTH OF VIRGINIA
MARINE RESOURCES COMMISSION
SIMONEASTON BAY
WATTS BAY
ACCOMACK CO. DIST. 28

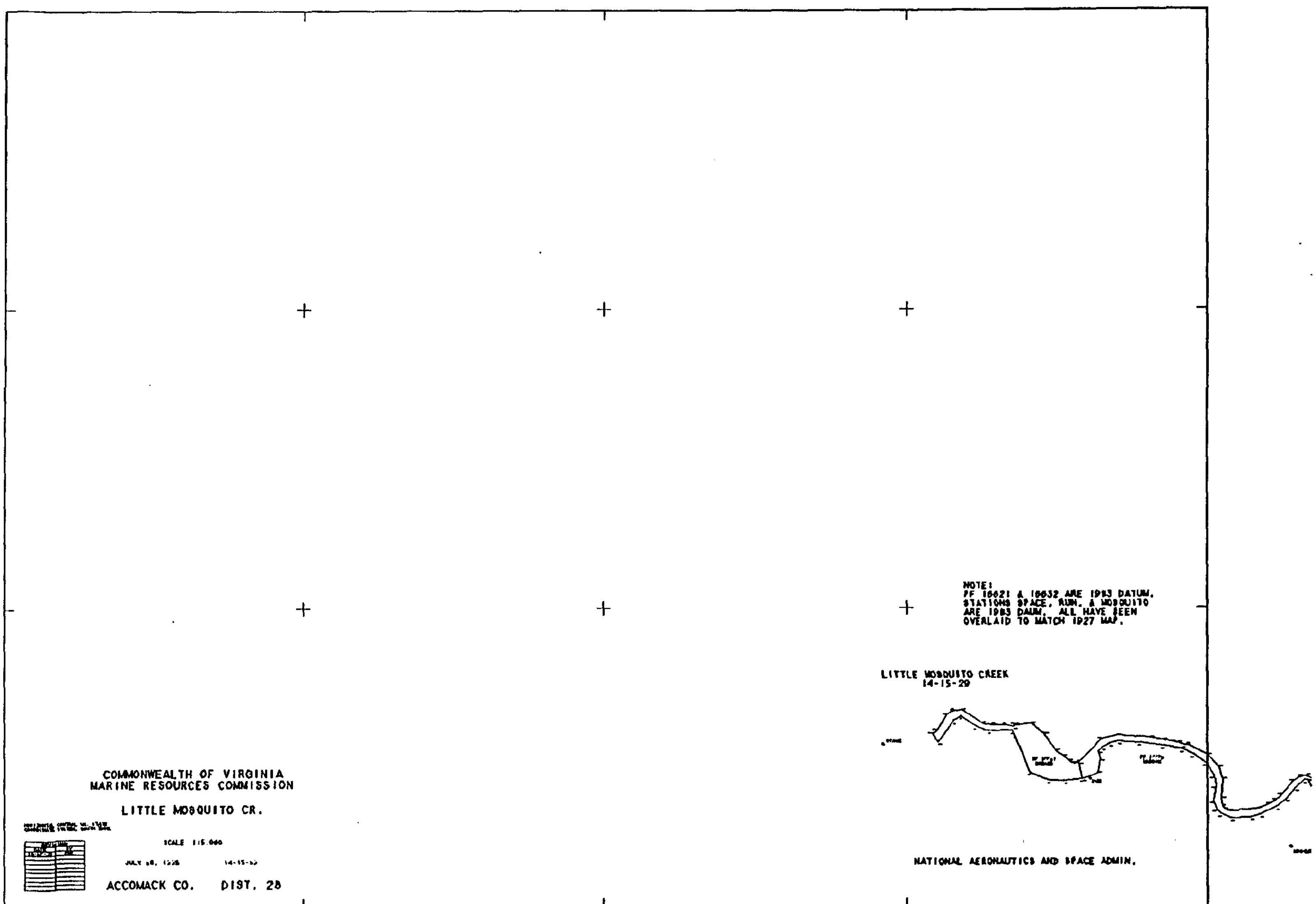
585-2880



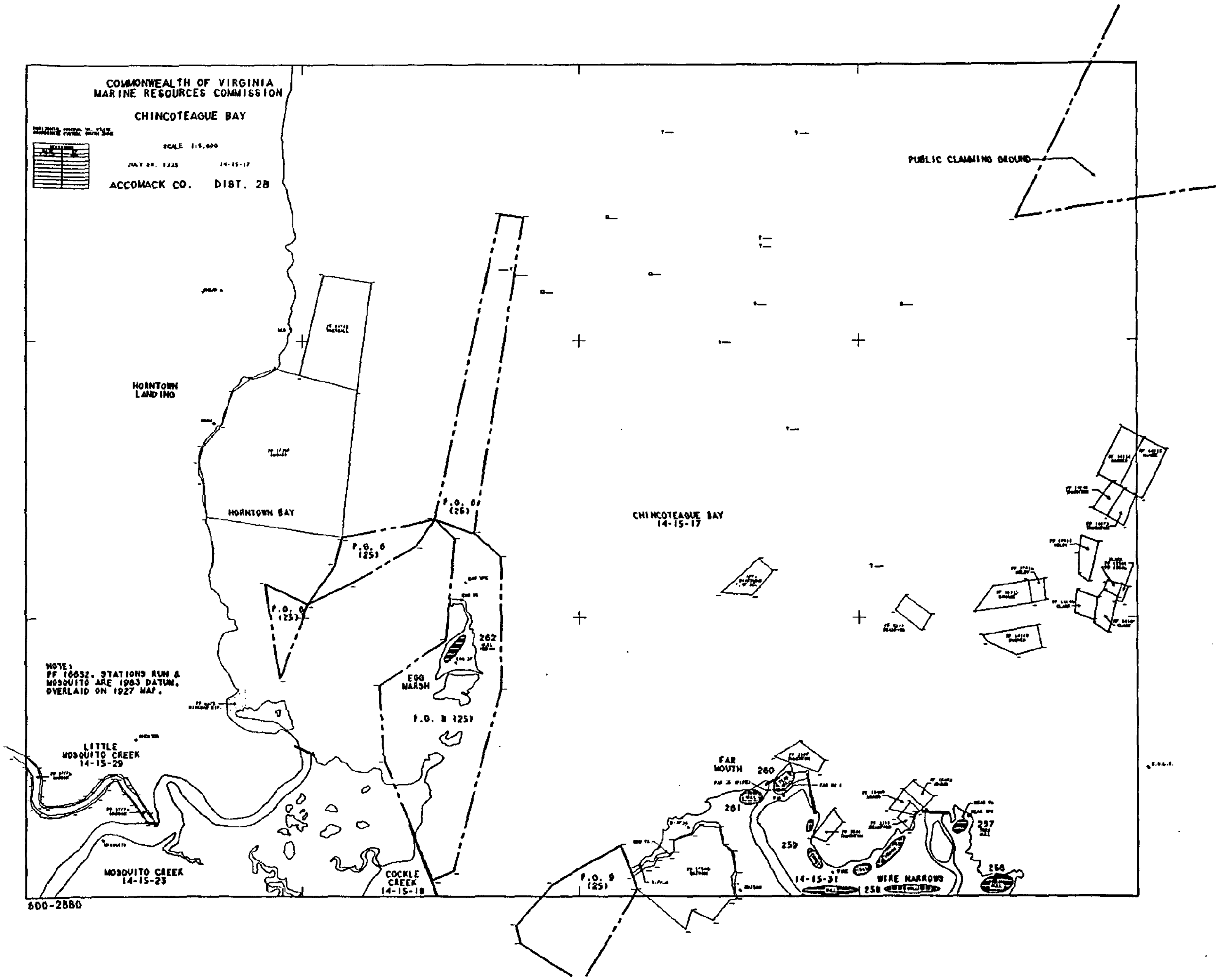
MOSQUITO CK.
14-15-23
P.C.G.
JENNY'S GUT
14-15-30
COCKLE CREEK
14-15-18
CHINCOTEAGUE
BAY
14-15-17
P.G. 9 (25)
P.G. 16
(25)
P.G. 13 (25)
P.G. 14
(25)
P.G. 10
(25)
P.G. 15
(25)
SINGNEASTON BAY
14-15-19
SHELLY BAY
MARSH
SHELLY
BAY
14-15-21
WILLIS MARSH
WILLIS CREEK
14-15-27
COCKLE CREEK
14-15-18
KENDALL
NARROWS
14-15-16
WALKER
MARSH
CHINCOTEAGUE
CHANNEL
14-15-26
QUEEN SOUND
14-15-20
SQUIRREL CREEK
14-15-24
SHOALING
POINT
PUBLIC CLAMMING GROUND
NEW MARSH ISLAND
CHINCOTEAGUE
POINT
THE
CANAL
WIRE NARROWS
MARSH
MUD
BAY
WIRE NARROWS
14-15-31
BLACK NARROWS
MARSH
BLACK
NARROWS
CHINCOTEAGUE
CHANNEL
14-15-26
LEASES NOT MAPPED
FOWLING
GUT
1983 DATUM
HORSE MARSH
14-16-04
CHINCOTEAGUE ISLAND
COMMONWEALTH OF VIRGINIA
MARINE RESOURCES COMMISSION
QUEEN SOUND
ACCOMACK CO. DIST. 28
BLACK PT. DRAIN
14-16-05
1983 DATUM
NOTE:
1983 DATUM OVERLAID TO
MATCH 1927 DATUM. 1983
DATUM IS FROM 11768774.
237
238
239
240
241
242
243
244
245
246
247
248
249
250
251
252
253
254
255

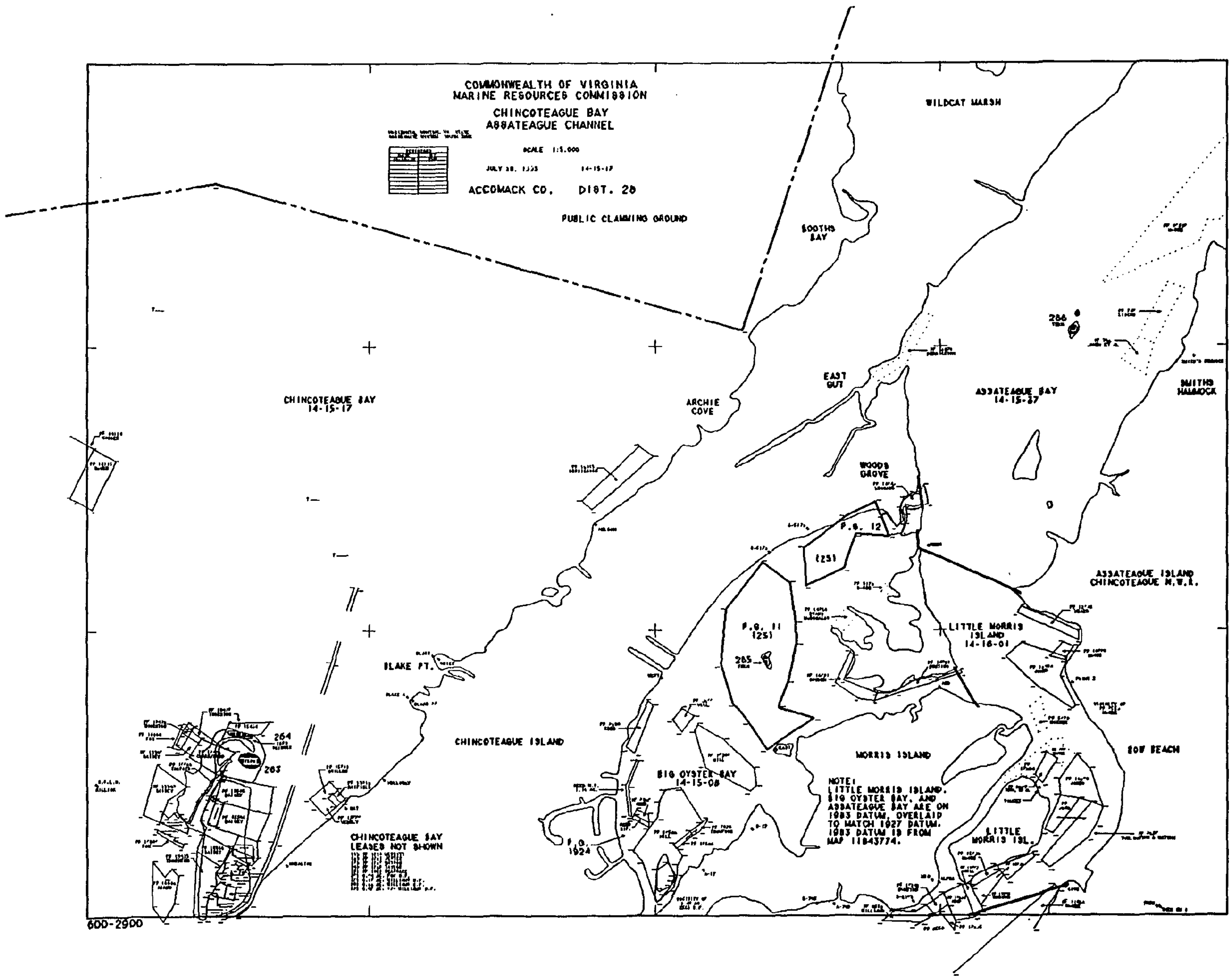
585-2880

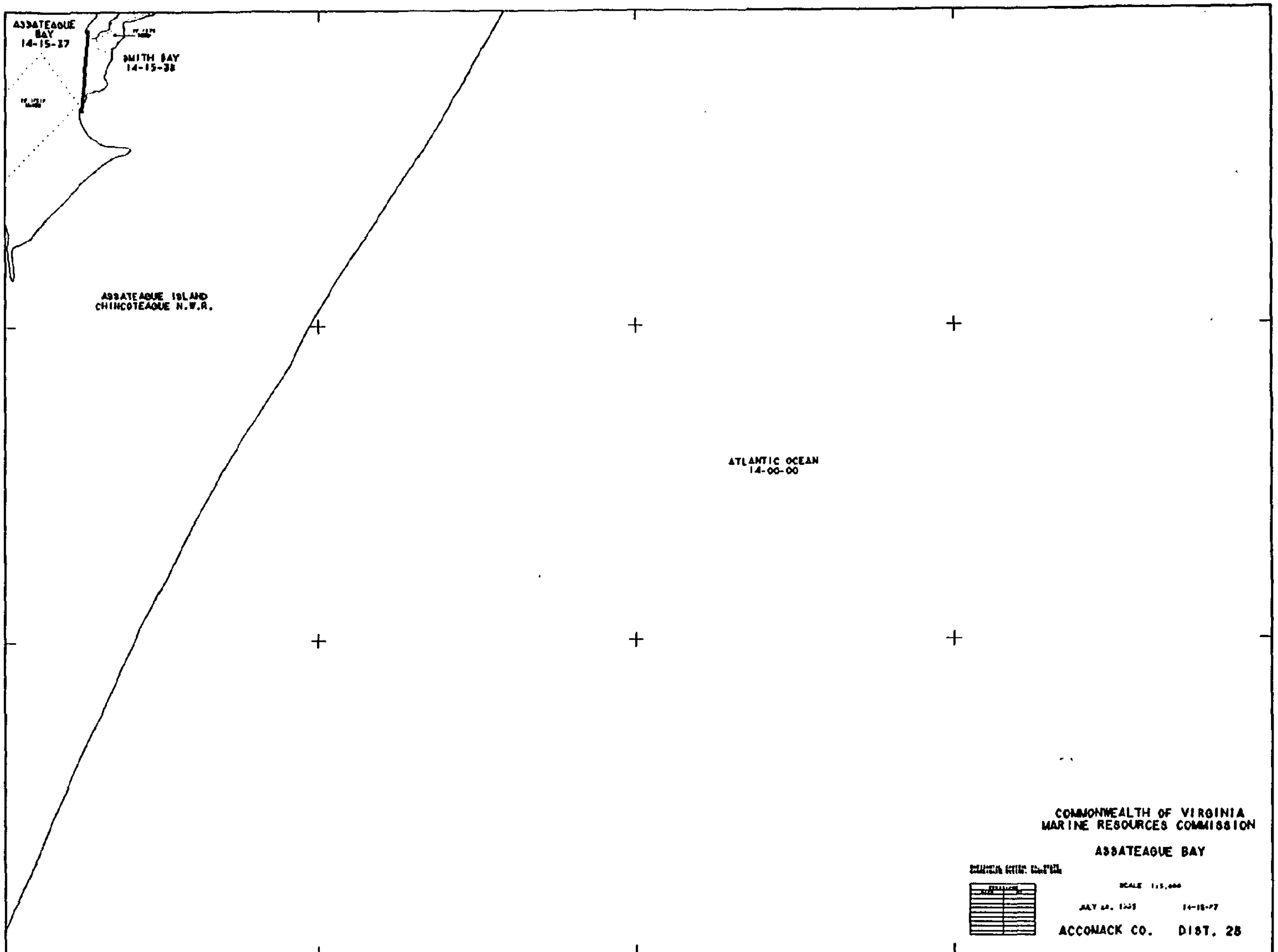

1927 DATUM
CHINCOTEAGUE BAY
14-15-17
DEEP HOLE
CREEK
P.C.O.
ROUND TUMP
BAY
1983 DATUM
LITTLE OYSTER BAY
14-15-06
1983 DATUM
JANEY'S CREEK MARSH
14-16-02
CARRS
MARSH
EEL
CREEK
CHINCOTEAGUE
ISLAND
PINEY ISLAND
ASSATEAGUE
CHANNEL
JANEY'S
CREEK
BIRCHTOWN
DUMFRIES
MARSH
ASSATEAGUE ISLAND
CHINCOTEAGUE N.W.R.
ATLANTIC OCEAN
14-00-00
SMALLY'S
DRAIN
1983 DATUM
LIVE SHOAL
14-16-03
1983 DATUM
HORSE MARSH
14-16-04
NOTE:
1983 DATUM OVERLAID TO MATCH
1927 DATUM. 1983 DATUM IS
FROM 11763774 AND 11803774.
1983 DATUM
BLACK PT. DRAIN
14-16-03
COMMONWEALTH OF VIRGINIA
MARINE RESOURCES COMMISSION
LIVE SHOAL
ASSATEAGUE CHANNEL
ACCOMACK CO. DIST. 28
585-2000

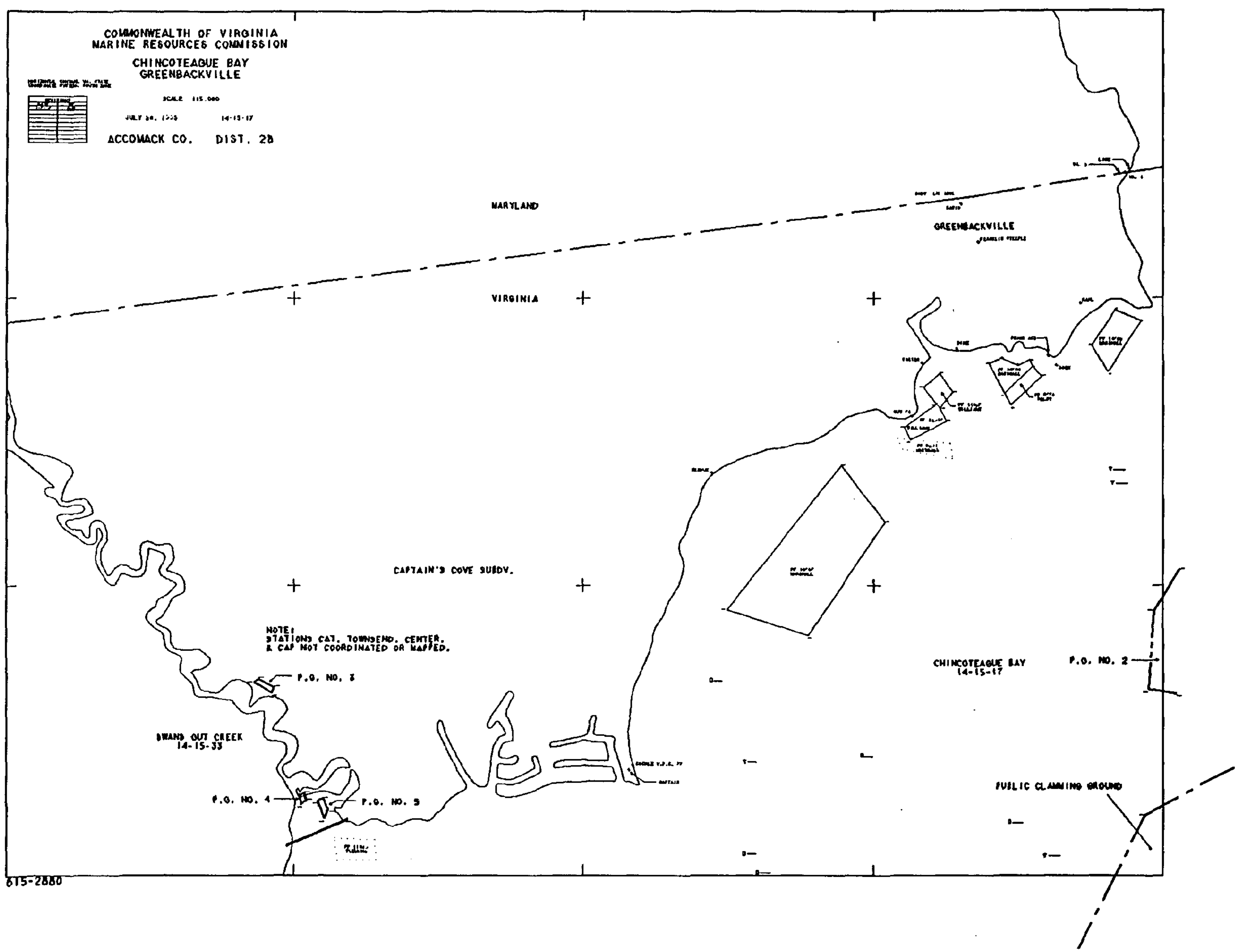

NOTE:
PF 16621 & 16632 ARE 1983 DATUM.
STATIONS SPACE, RUN, & MOSQUITO
ARE 1983 DAUM. ALL HAVE BEEN
OVERLAID TO MATCH 1927 MAP.
LITTLE MOSQUITO CREEK
14-15-29
NATIONAL AERONAUTICS AND SPACE ADMIN.
COMMONWEALTH OF VIRGINIA
MARINE RESOURCES COMMISSION
LITTLE MOSQUITO CR.
ACCOMACK CO. DIST. 28

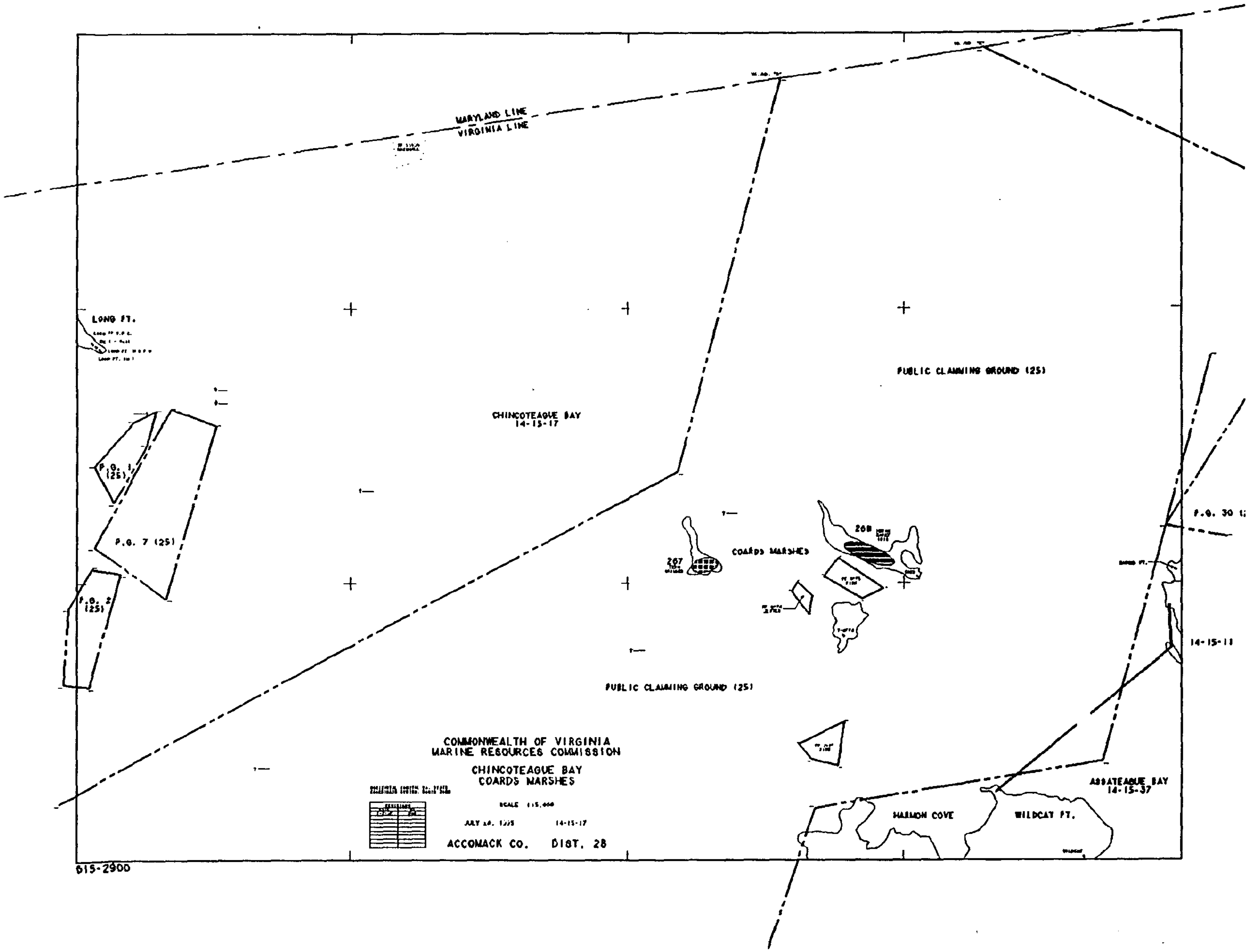
600-2860

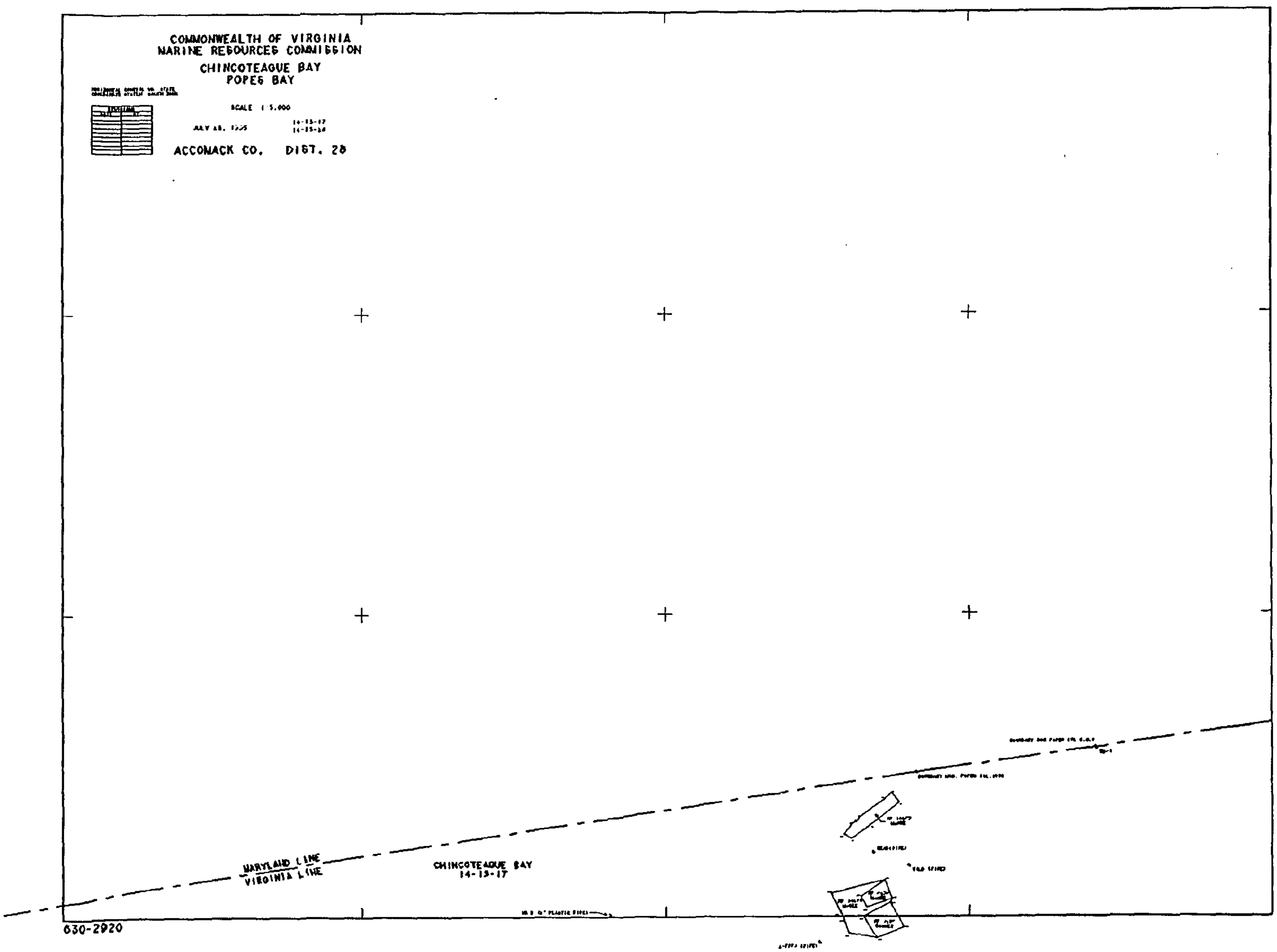

COMMONWEALTH OF VIRGINIA
MARINE RESOURCES COMMISSION
CHINCOTEAGUE BAY
SCALE 1:5,000
ACCOMACK CO. DIST. 28
PUBLIC CLAMMING GROUND
HORNTOWN LANDING
HORNTOWN BAY
CHINCOTEAGUE BAY 14-15-17
P.O. 6 (25)
P.O. 8 (25)
P.O. 9 (25)
EGG MARSH
262
NOTE:
PF 10632, STATIONS RUN &
MOSQUITO ARE 1963 DATUM,
OVERLAID ON 1927 MAP.
LITTLE MOSQUITO CREEK 14-15-29
MOSQUITO CREEK 14-15-23
COCKLE CREEK 14-15-18
FAR MOUTH
260
261
259
14-15-31
WIRE NARROWS
258
257
256
600-2880


COMMONWEALTH OF VIRGINIA
MARINE RESOURCES COMMISSION
CHINCOTEAGUE BAY
ASSATEAGUE CHANNEL
ACCOMACK CO. DIST. 2B
PUBLIC CLAMMING GROUND
WILDCAT MARSH
SOOTHS BAY
EAST GUT
ASSATEAGUE BAY
14-15-37
SMITHS HAMMOCK
ARCHIE COVE
CHINCOTEAGUE BAY
14-15-17
WOODS GROVE
P.G. 12
(25)
P.G. 11
(25)
265
266
ASSATEAGUE ISLAND
CHINCOTEAGUE N.W.R.
LITTLE MORRIS ISLAND
14-16-01
BLAKE PT.
CHINCOTEAGUE ISLAND
MORRIS ISLAND
TOW BEACH
BIG OYSTER BAY
14-15-08
NOTE: LITTLE MORRIS ISLAND, BIG OYSTER BAY, AND ASSATEAGUE BAY ARE ON 1983 DATUM, OVERLAID TO MATCH 1927 DATUM. 1983 DATUM IS FROM MAP 11843774.
LITTLE MORRIS ISL.
P.G. 1924
CHINCOTEAGUE BAY LEASES NOT SHOWN
264
263
600-2900


ASSATEAGUE BAY
14-15-27
SMITH BAY
14-15-38
ASSATEAGUE ISLAND
CHINCOTEAGUE N.W.R.
ATLANTIC OCEAN
14-00-00
COMMONWEALTH OF VIRGINIA
MARINE RESOURCES COMMISSION
ASSATEAGUE BAY
ACCOMACK CO. DIST. 28
600-2920

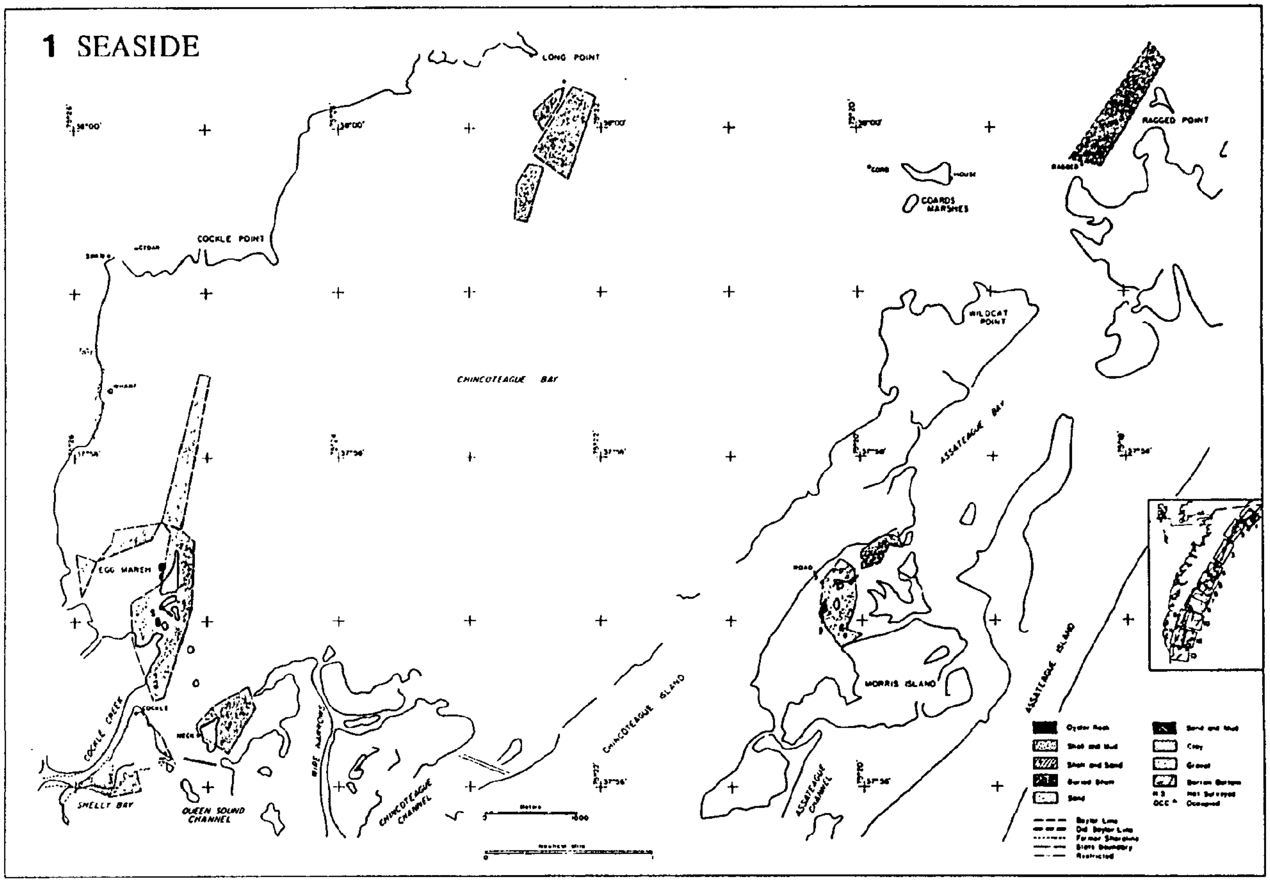

COMMONWEALTH OF VIRGINIA
MARINE RESOURCES COMMISSION
CHINCOTEAGUE BAY
GREENBACKVILLE
ACCOMACK CO. DIST. 2B
MARYLAND
VIRGINIA
GREENBACKVILLE
CAPTAIN'S COVE SUBDV.
NOTE:
STATIONS CAT, TOWNSEND, CENTER,
& CAP NOT COORDINATED OR MAPPED.
P.O. NO. 3
SWANS GUT CREEK
14-15-33
P.O. NO. 4
P.O. NO. 5
CHINCOTEAGUE BAY
14-15-17
P.O. NO. 2
PUBLIC CLAMMING GROUND
615-2880

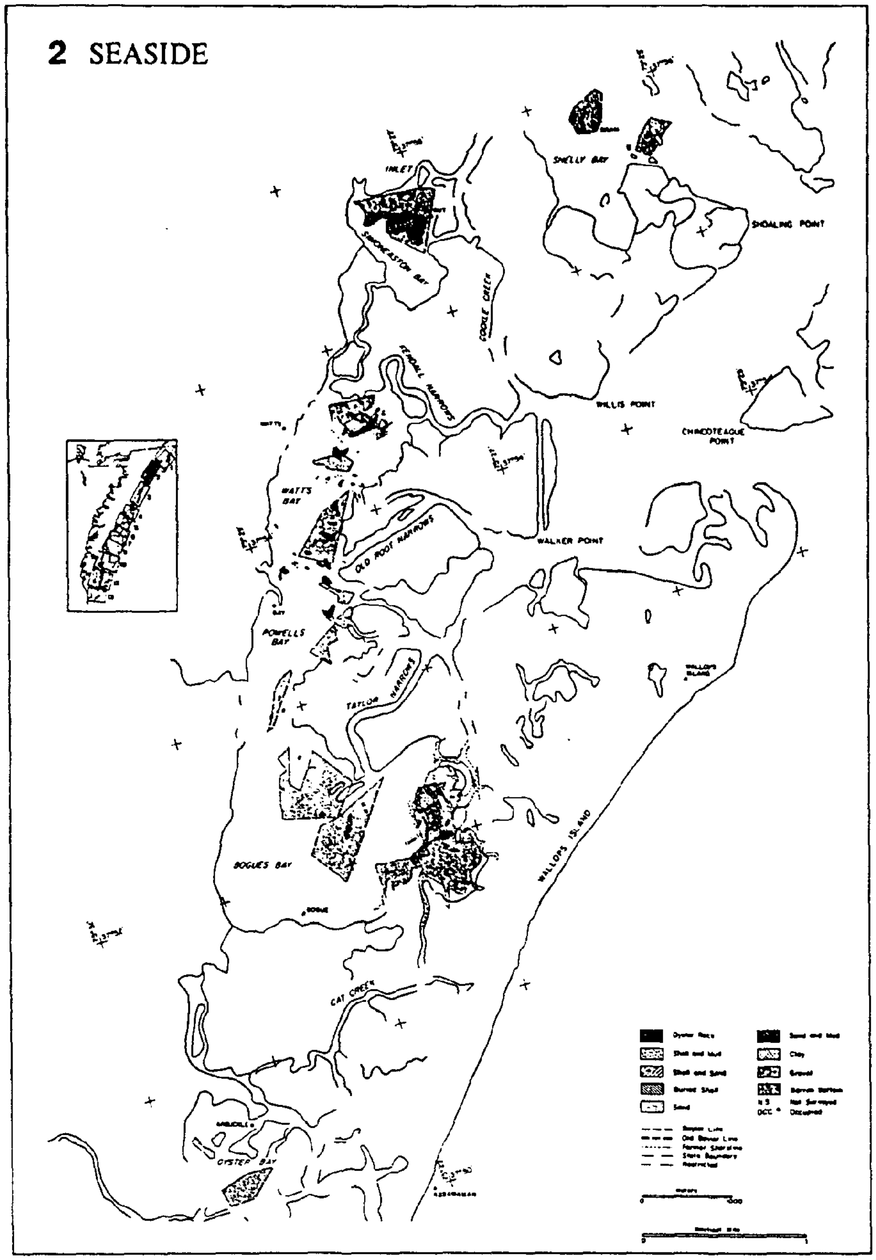

MARYLAND LINE
VIRGINIA LINE
LONG PT.
CHINCOTEAGUE BAY
14-15-17
PUBLIC CLAMMING GROUND (25)
P.G. 1 (25)
P.G. 7 (25)
P.G. 2 (25)
COARDS MARSHES
207
208
P.G. 30
14-15-11
PUBLIC CLAMMING GROUND (25)
ASSATEAGUE BAY
14-15-37
HARMON COVE
WILDCAT PT.
COMMONWEALTH OF VIRGINIA
MARINE RESOURCES COMMISSION
CHINCOTEAGUE BAY
COARDS MARSHES
ACCOMACK CO. DIST. 28
615-2900

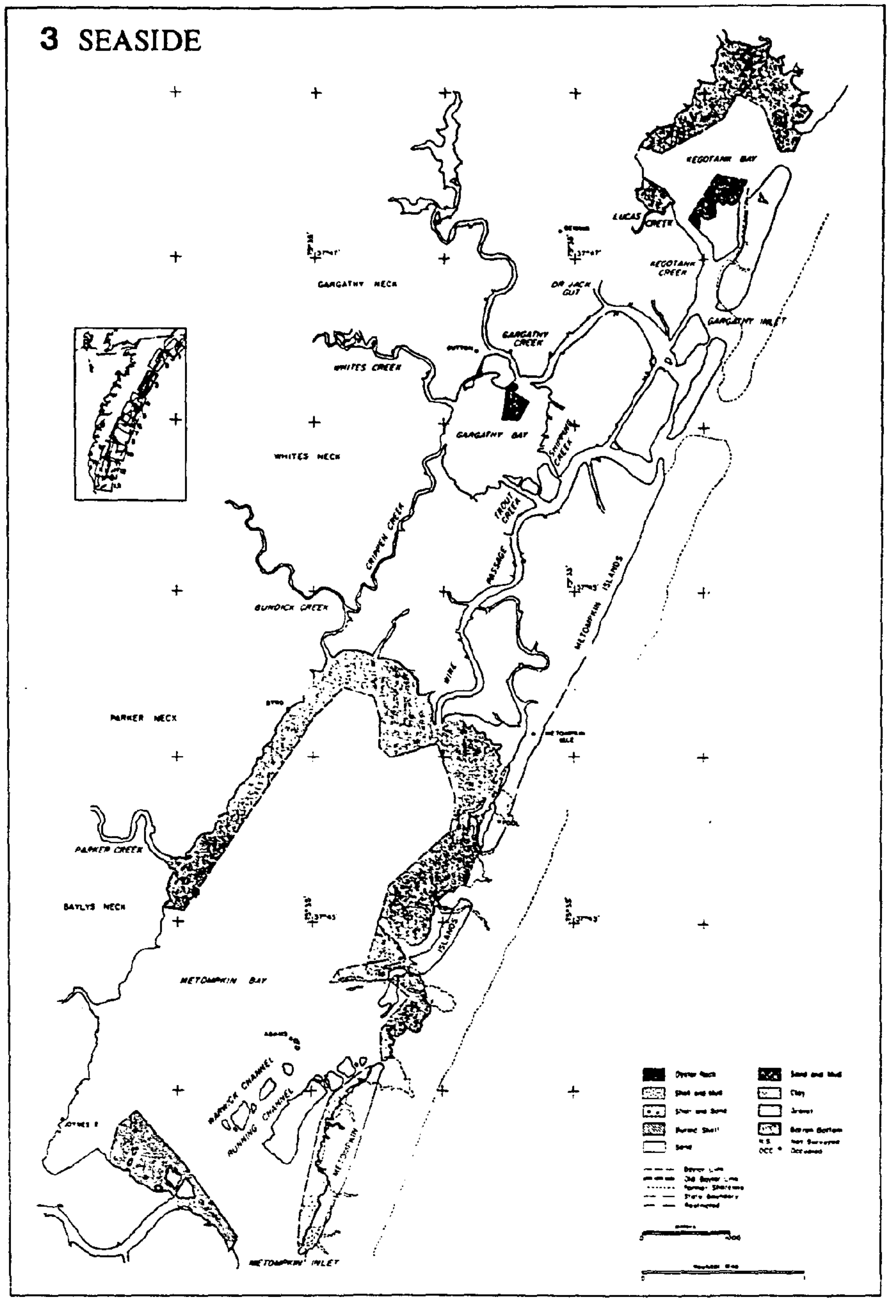

COMMONWEALTH OF VIRGINIA
MARINE RESOURCES COMMISSION
CHINCOTEAGUE BAY
POPES BAY
SCALE 1:5,000
14-15-17
ACCONACK CO. DIST. 28
MARYLAND LINE
VIRGINIA LINE
CHINCOTEAGUE BAY
14-15-17
630-2920

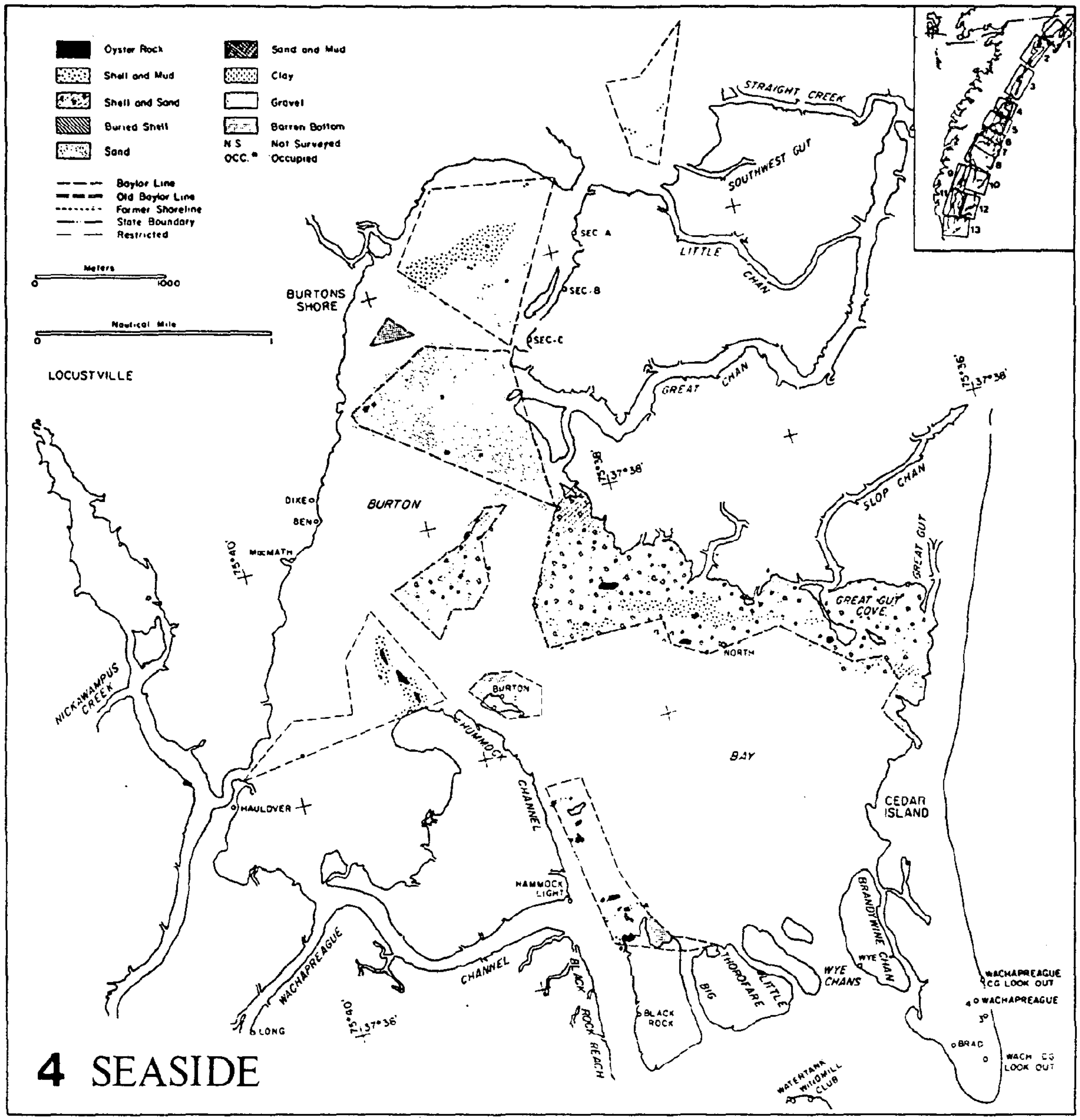
APPENDIX D

VIMS Baylor Ground Surveys

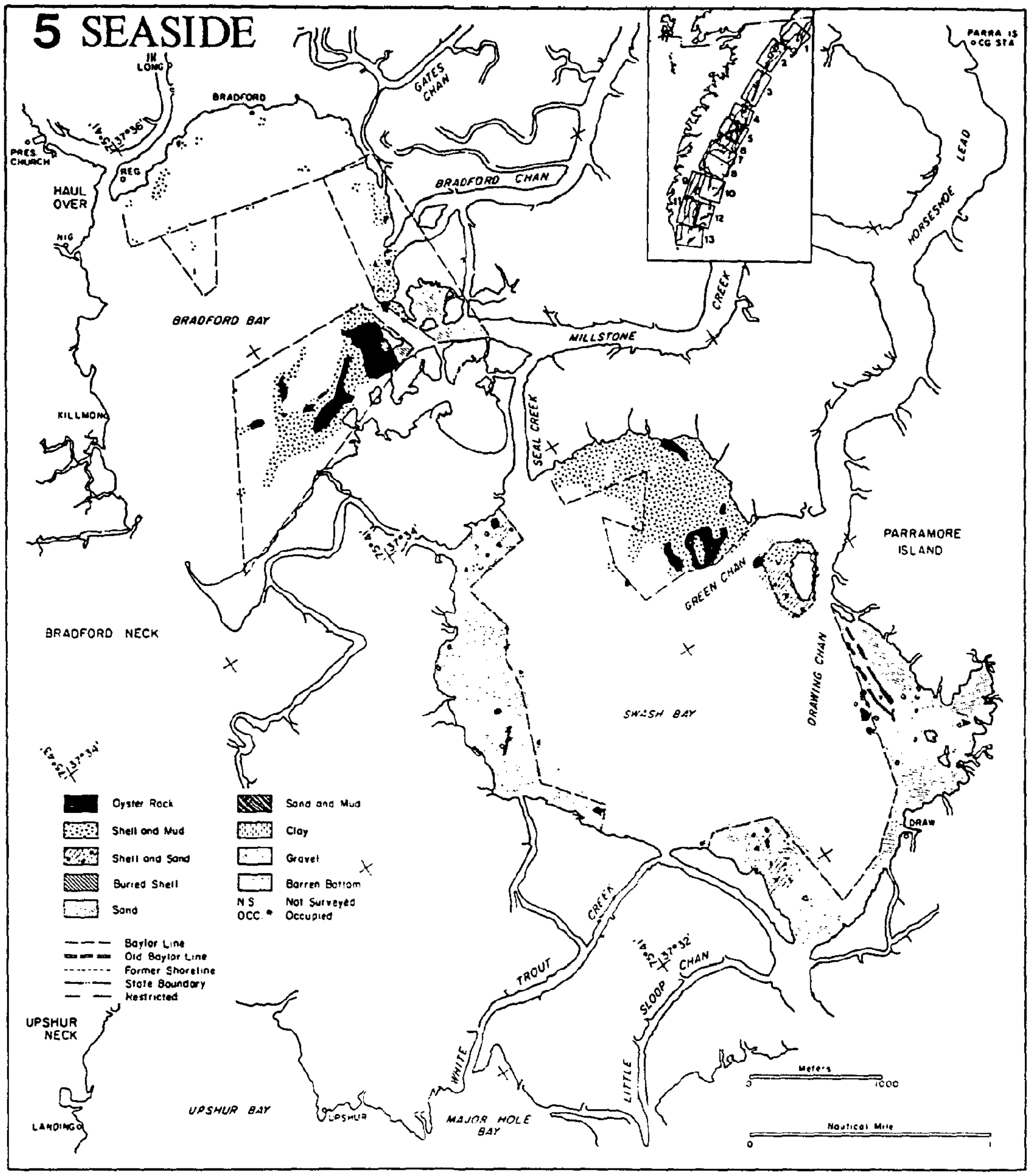

1 SEASIDE
LONG POINT
RAGGED POINT
COCKLE POINT
COARDS MARSHES
WILDCAT POINT
CHINCOTEAGUE BAY
ASSATEAGUE BAY
EGG MARSH
MORRIS ISLAND
CHINCOTEAGUE ISLAND
ASSATEAGUE ISLAND
COCKLE CREEK
SHELLY BAY
QUEEN SOUND CHANNEL
CHINCOTEAGUE CHANNEL
ASSATEAGUE CHANNEL
ROAD

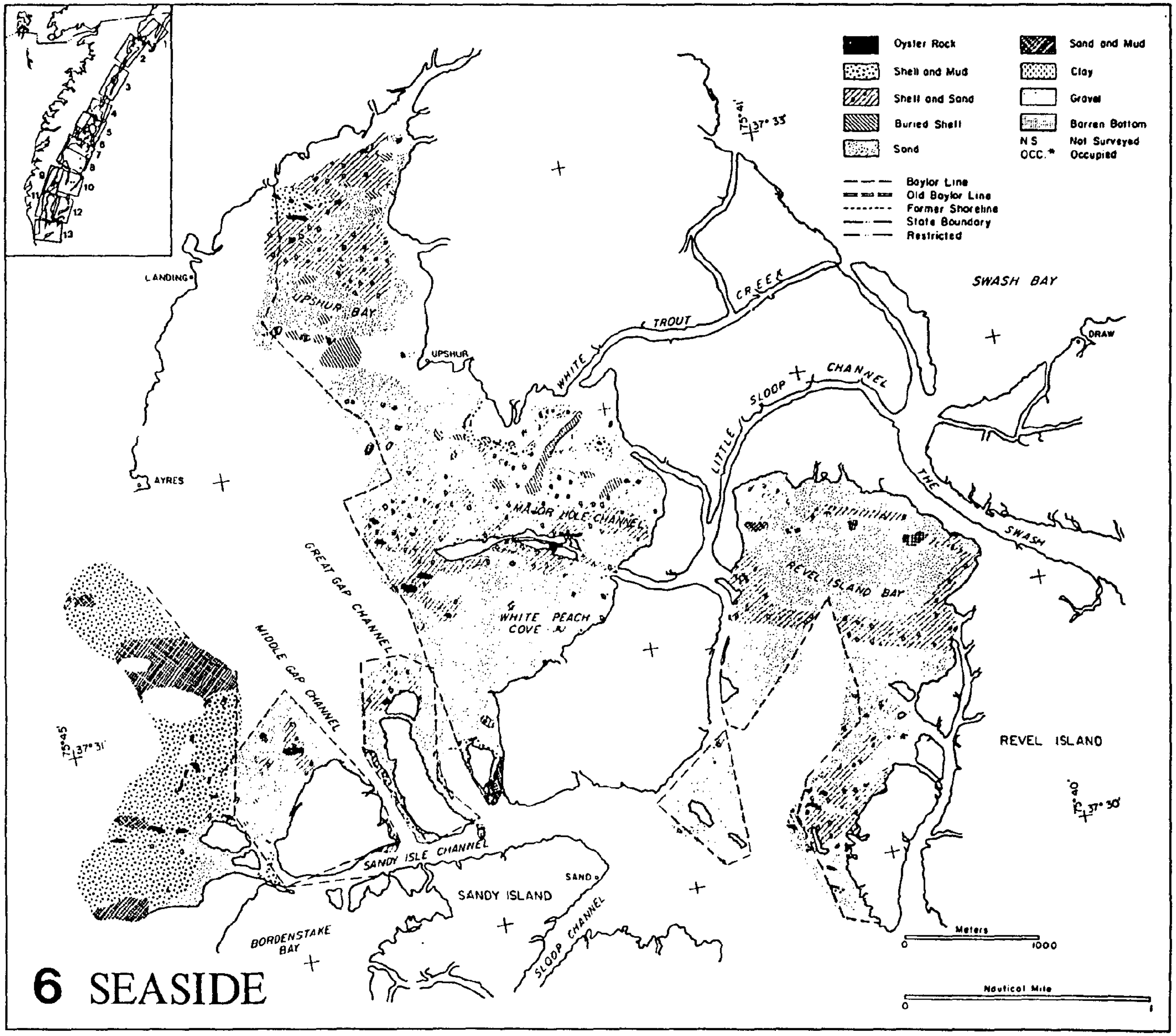

2 SEASIDE
INLET
SHELLY BAY
SHOALING POINT
WILLIS POINT
CHINCOTEAGUE POINT
WALKER POINT
WATTS BAY
OLD ROOT NARROWS
POWELLS BAY
TAYLOR NARROWS
BOGUES BAY
WALLOPS ISLAND
CAT CREEK
OYSTER BAY


3 SEASIDE
KEGOTANK BAY
LUCAS CREEK
KEGOTANK CREEK
GARGATHY NECK
DR JACK GUT
GARGATHY CREEK
GARGATHY INLET
WHITES CREEK
GARGATHY BAY
WHITES NECK
TROUT CREEK
CROPPER CREEK
PASSAGE
BUNDICK CREEK
METOMPKIN ISLANDS
WIRE
PARKER NECK
PARKER CREEK
BAYLYS NECK
METOMPKIN BAY
WARWICK CHANNEL
RUNNING CHANNEL
METOMPKIN INLET

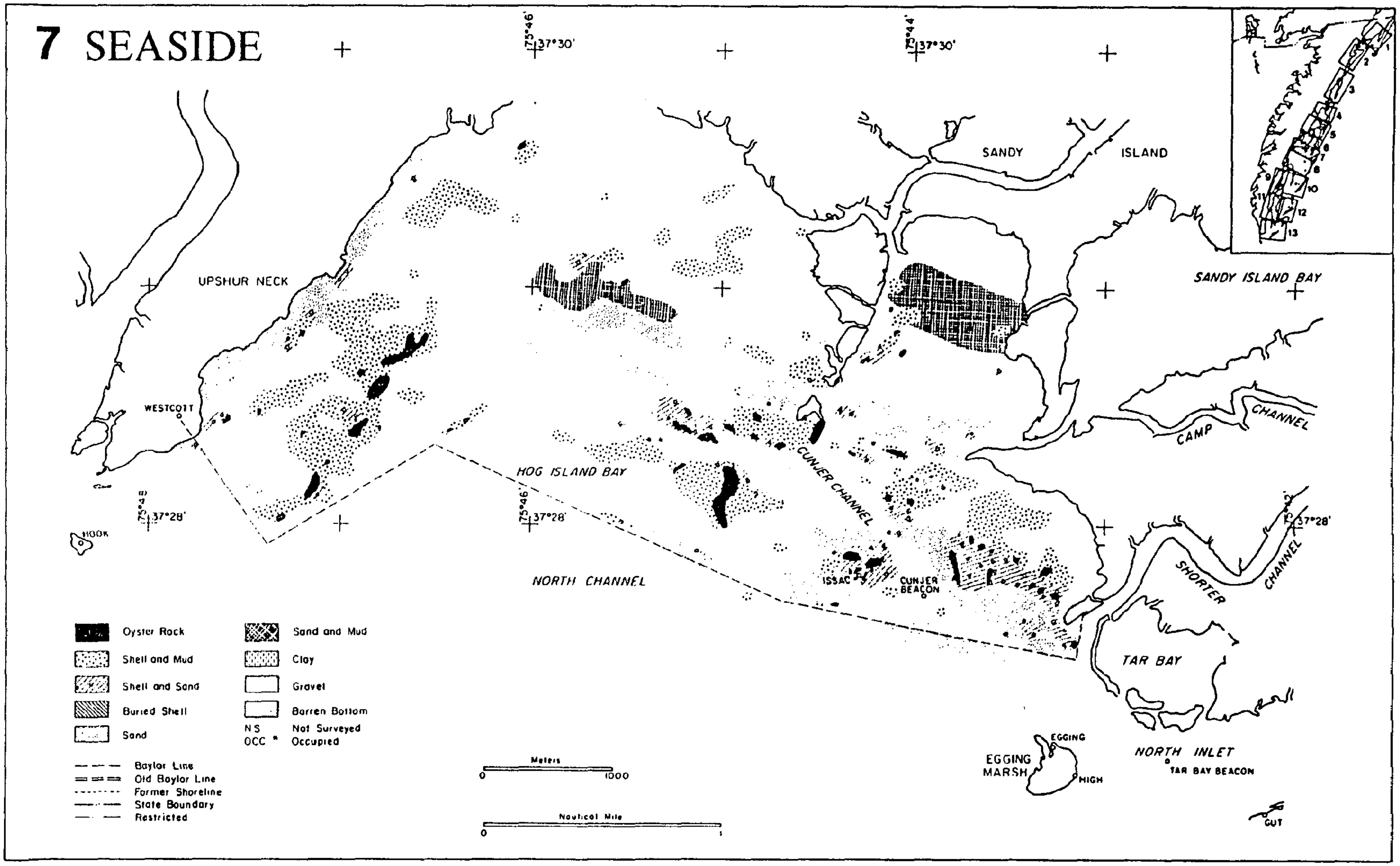

Oyster Rock
Shell and Mud
Shell and Sand
Buried Shell
Sand
Sand and Mud
Clay
Gravel
Barren Bottom
N S Not Surveyed
OCC.* Occupied
Baylor Line
Old Baylor Line
Former Shoreline
State Boundary
Restricted
Meters
0
1000
Nautical Mile
0
1
STRAIGHT CREEK
SOUTHWEST GUT
LITTLE CHAN
SEC. A
SEC. B
SEC. C
BURTONS SHORE
LOCUSTVILLE
GREAT CHAN
37°38'
75°36'
SLOP CHAN
GREAT GUT
BURTON
DIKE
BEN
McMATH
75°40'
GREAT GUT COVE
NORTH
BURTON
NICKAWAMPUS CREEK
HUMMOCK
BAY
CHANNEL
HAULOVER
CEDAR ISLAND
HAMMOCK LIGHT
BRANDYWINE CHAN
WYE
WYE CHANS
WACHAPREAGUE CG LOOK OUT
WACHAPREAGUE
WACHAPREAGUE
CHANNEL
BLACK ROCK REACH
BLACK ROCK
BIG
THOROFARE
LITTLE
LONG
37°36'
BRAD
WACH CG LOOK OUT
WATENTANK WINDMILL CLUB

4 SEASIDE

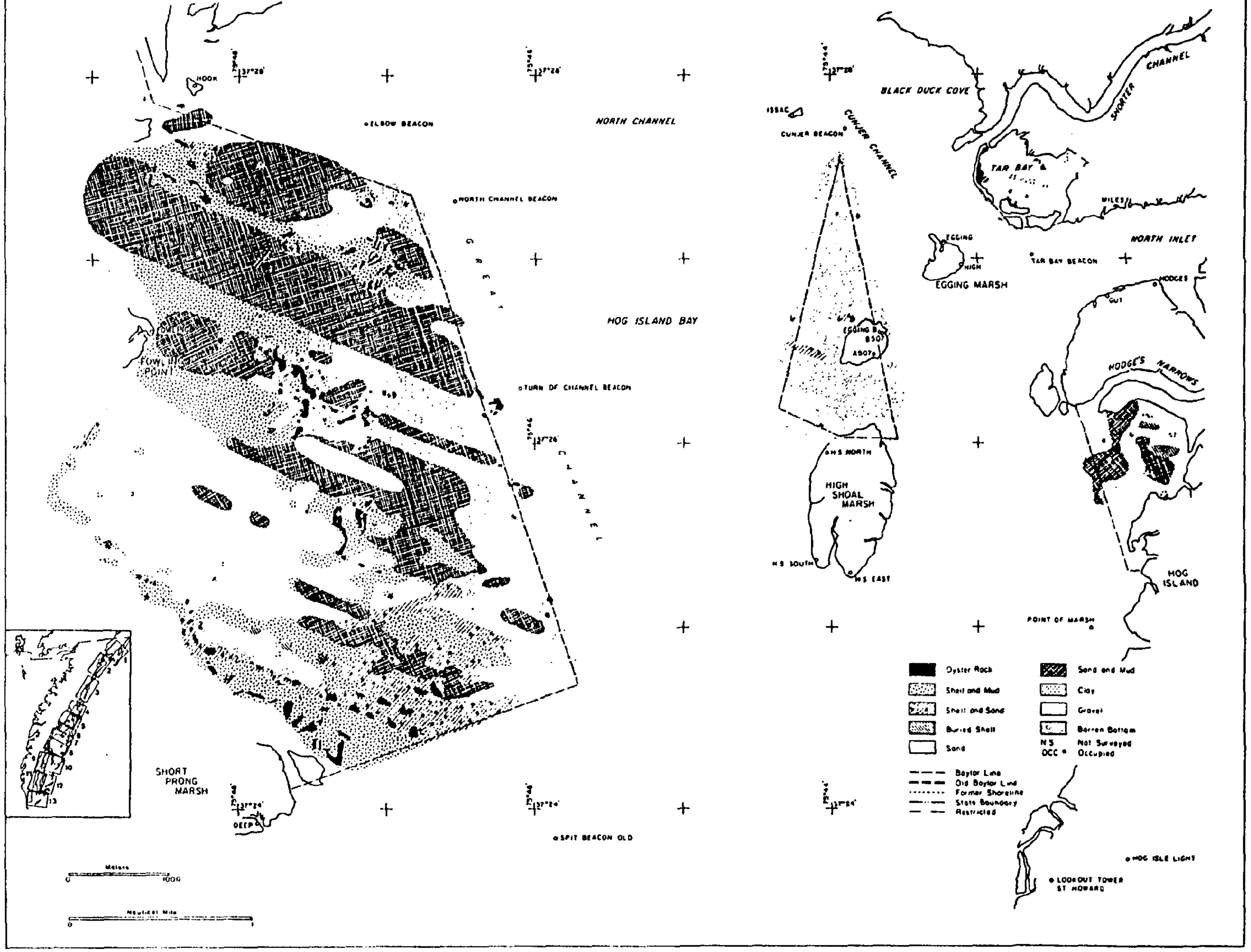

5 SEASIDE
BRADFORD
GATES CHAN
PARRA IS OCG STA
PRES CHURCH
HAUL OVER
BRADFORD CHAN
HORSESHOE LEAD
BRADFORD BAY
MILLSTONE
CREEK
KILLMON
SEAL CREEK
PARRAMORE ISLAND
GREEN CHAN
BRADFORD NECK
SWASH BAY
DRAWING CHAN
Oyster Rock
Shell and Mud
Shell and Sand
Buried Shell
Sand
Sand and Mud
Clay
Gravel
Barren Bottom
N S Not Surveyed
OCC. Occupied
Baylor Line
Old Baylor Line
Former Shoreline
State Boundary
Restricted
DRAW
TROUT CREEK
SLOOP CHAN
UPSHUR NECK
WHITE
LITTLE
Meters
Nautical Mile
UPSHUR BAY
MAJOR HOLE BAY
LANDING
UPSHUR


Oyster Rock
Shell and Mud
Shell and Sand
Buried Shell
Sand
Sand and Mud
Clay
Gravel
Barren Bottom
N S Not Surveyed
OCC.* Occupied
Baylor Line
Old Baylor Line
Former Shoreline
State Boundary
Restricted
SWASH BAY
DRAW
THE SWASH
LITTLE SLOOP CHANNEL
TROUT CREEK
WHITE
75°41'
37°33'
LANDING
UPSHUR BAY
UPSHUR
AYRES
MAJOR HOLE CHANNEL
WHITE PEACH COVE
REVEL ISLAND BAY
REVEL ISLAND
75°40'
37°30'
GREAT GAP CHANNEL
MIDDLE GAP CHANNEL
75°45'
37°31'
SANDY ISLE CHANNEL
SANDY ISLAND
SAND
SLOOP CHANNEL
BORDENSTAKE BAY
Meters
0
1000
Nautical Mile
0
1

6 SEASIDE

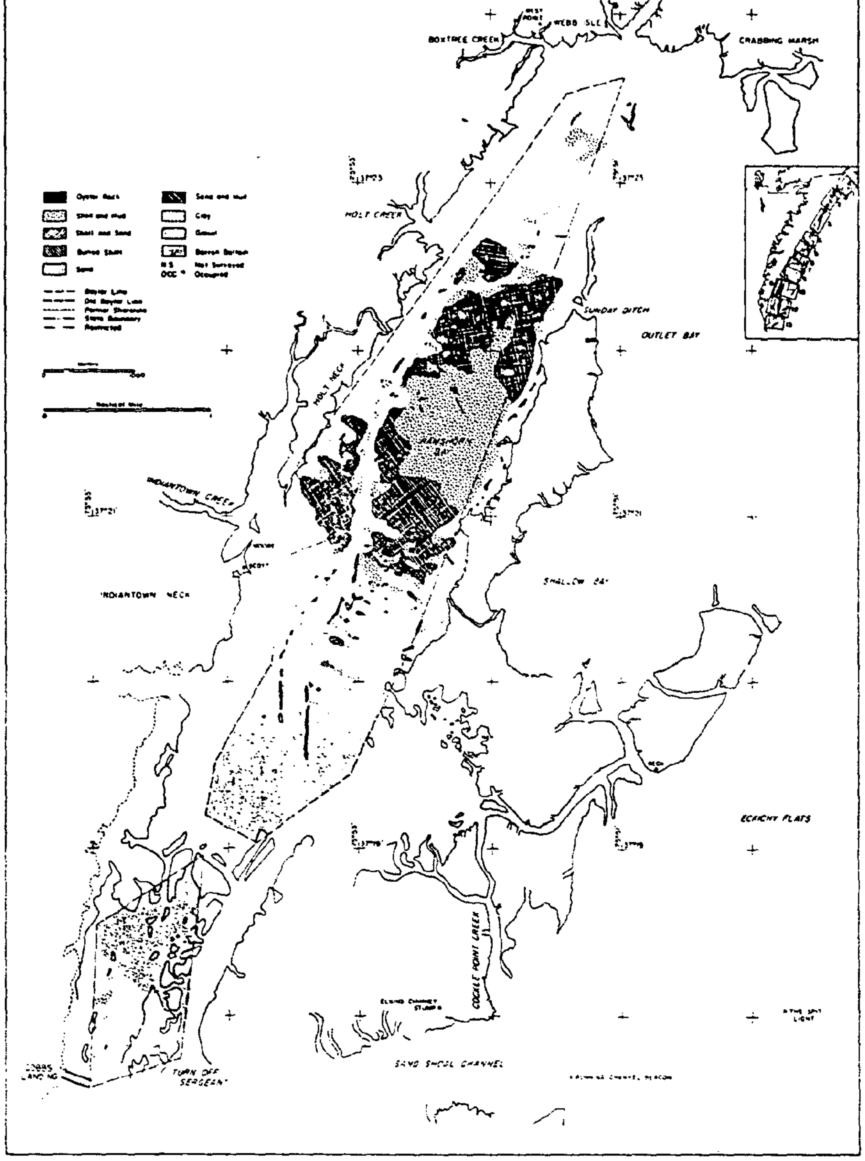

7 SEASIDE
75°46'
37°30'
75°44'
37°30'
SANDY
ISLAND
UPSHUR NECK
SANDY ISLAND BAY
WESTCOTT
CAMP
CHANNEL
HOG ISLAND BAY
CUNJER CHANNEL
75°48'
37°28'
HOOK
75°46'
37°28'
37°28'
NORTH CHANNEL
ISSAC
CUNJER BEACON
SHORTER
CHANNEL
TAR BAY
Oyster Rock
Shell and Mud
Shell and Sand
Buried Shell
Sand
Sand and Mud
Clay
Gravel
Barren Bottom
NS Not Surveyed
OCC * Occupied
Baylor Line
Old Baylor Line
Former Shoreline
State Boundary
Restricted
Meters
0
1000
Nautical Mile
0
1
EGGING
EGGING MARSH
HIGH
NORTH INLET
TAR BAY BEACON
GUT

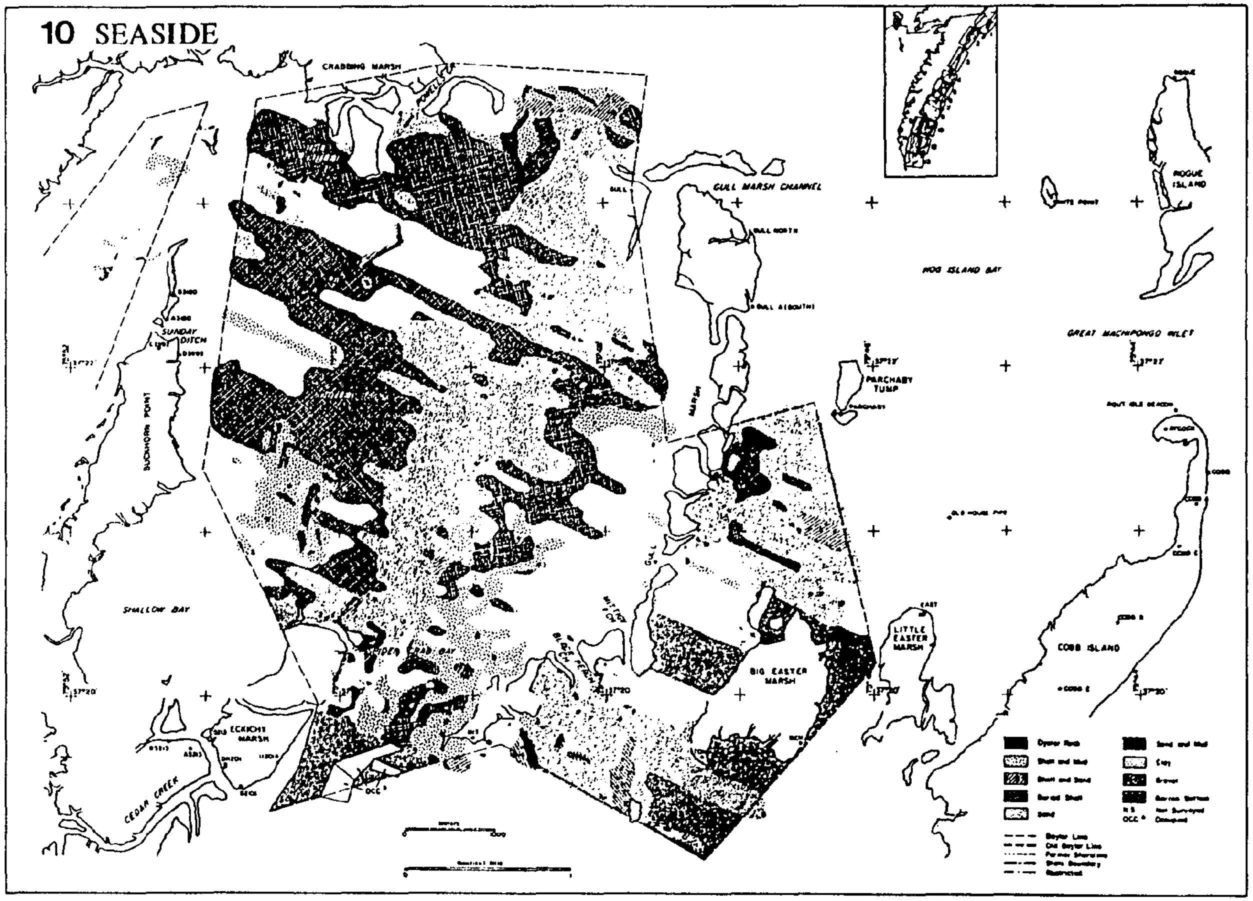
8 SEASIDE

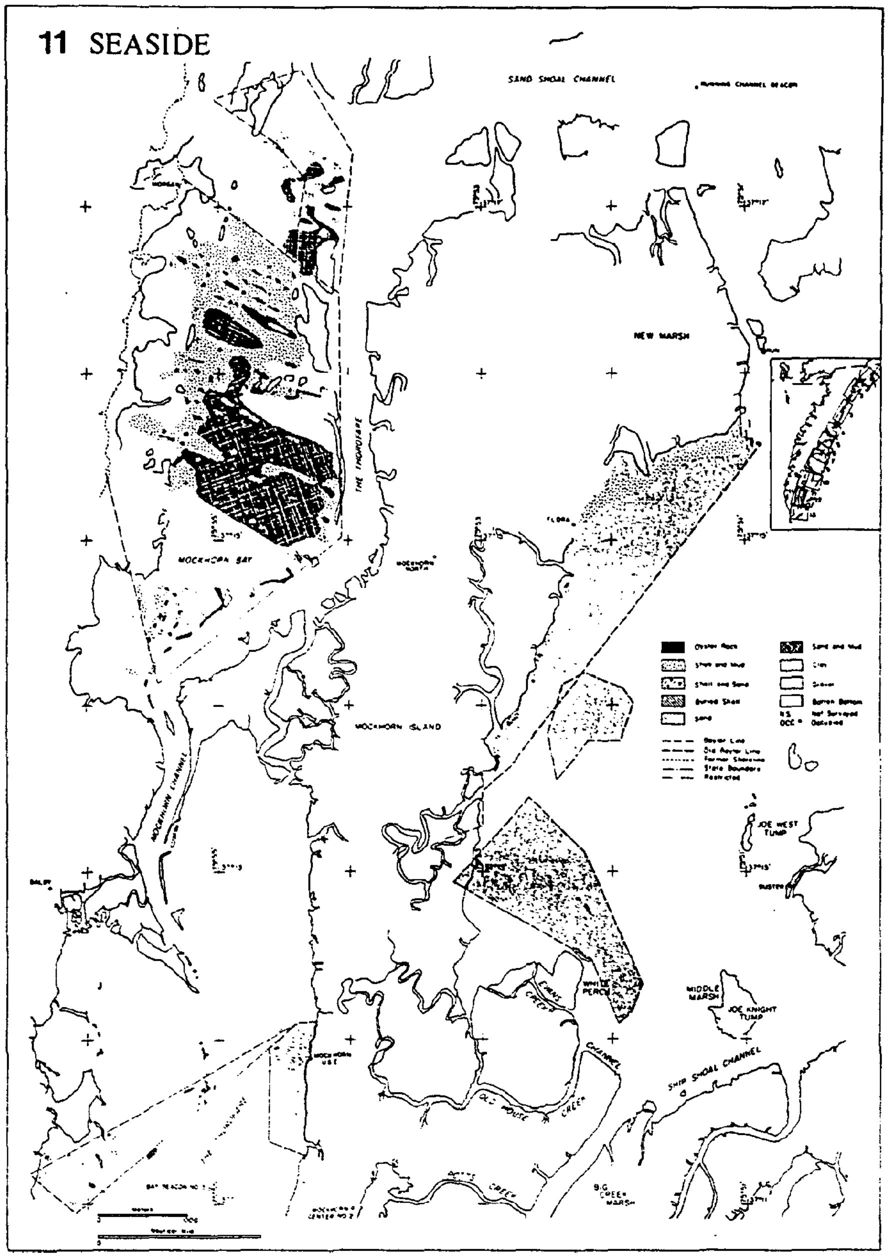


HOOK
ELBOW BEACON
NORTH CHANNEL
BLACK DUCK COVE
SHORTER CHANNEL
CUNJER CHANNEL
CUNJER BEACON
TAR BAY
NORTH INLET
EGGING MARSH
TAR BAY BEACON
NORTH CHANNEL BEACON
GREAT CHANNEL
HOG ISLAND BAY
TURN OF CHANNEL BEACON
HODGE'S NARROWS
HIGH SHOAL MARSH
HOG ISLAND
POINT OF MARSH
SHORT PRONG MARSH
SPIT BEACON OLD
HOG ISLE LIGHT
LOOKOUT TOWER ST HOWARD
Oyster Rock
Shell and Mud
Shell and Sand
Buried Shell
Sand
Sand and Mud
Clay
Gravel
Barren Bottom
N S Not Surveyed
OCC Occupied
Baylor Line
Old Baylor Line
Former Shoreline
State Boundary
Restricted
Meters
1000
Nautical Mile

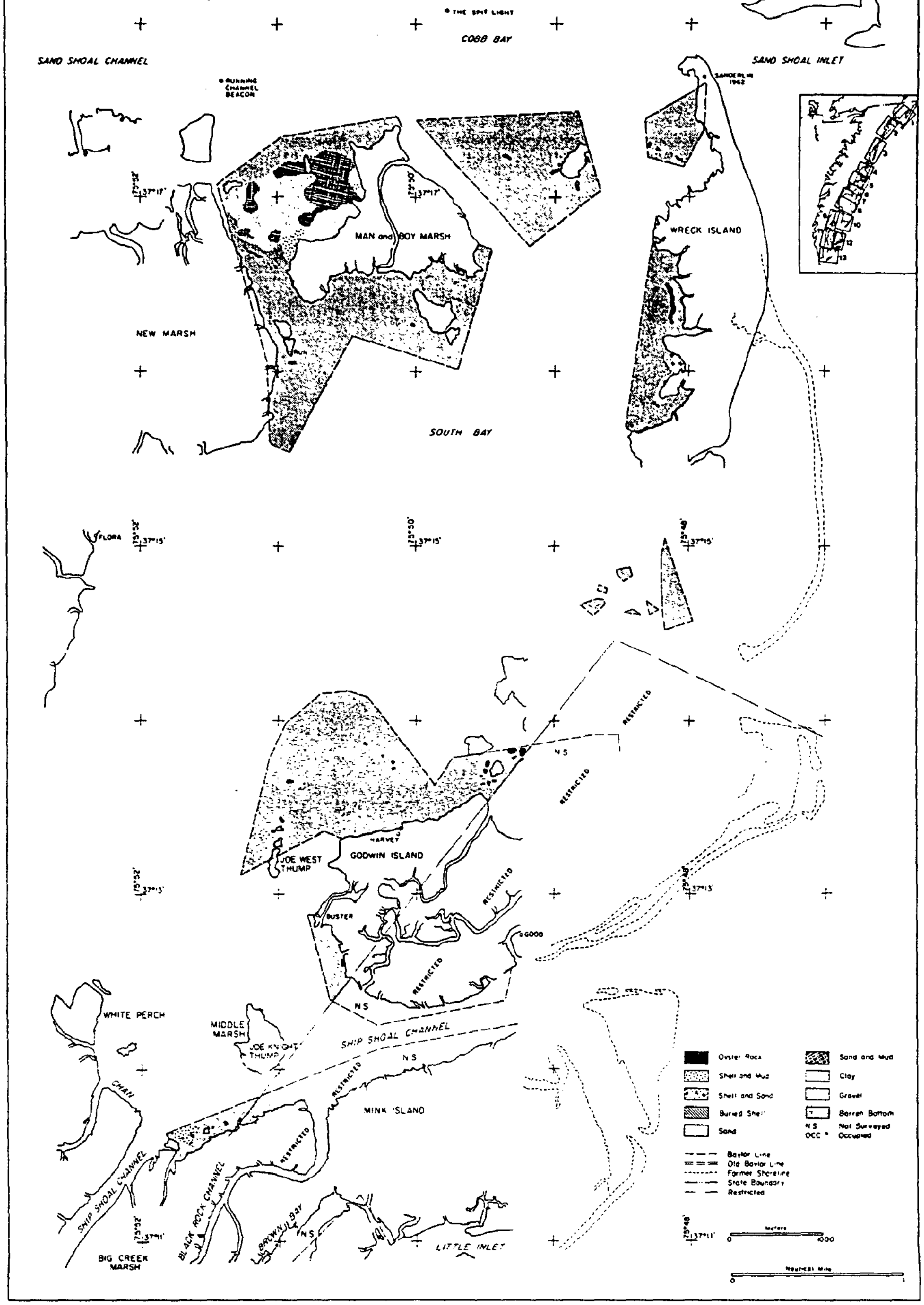
9 SEASIDE

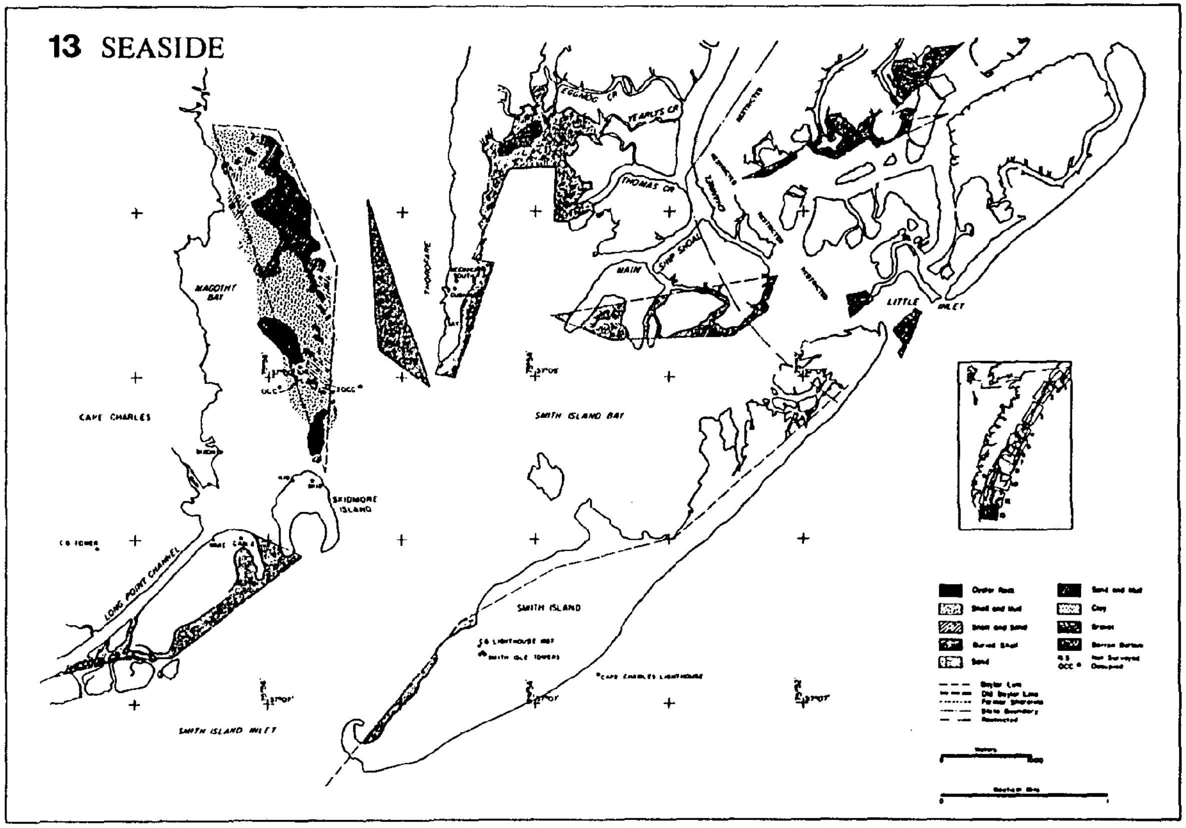

BOXTREE CREEK
WEBB SLE
CRABBING MARSH
Oyster Rock
Shell and Mud
Shell and Sand
Buried Shell
Sand
Sand and Mud
Clay
Gravel
Barren Bottom
N S Not Surveyed
OCC * Occupied
Baylor Line
Old Baylor Line
Former Shoreline
State Boundary
Restricted
HOLT CREEK
SUNDAY DITCH
OUTLET BAY
HOLT NECK
INDIANTOWN CREEK
INDIANTOWN NECK
SHALLOW BAY
ECKICHY FLATS
COCKLE POINT CREEK
SAND SHOAL CHANNEL
TURN OFF SERGEANT


10 SEASIDE
CRABBING MARSH
GULL MARSH CHANNEL
HOG ISLAND BAY
ROGUE ISLAND
GREAT MACHIPONGO INLET
PARCHABY TUMP
MARSH
LITTLE EASTER MARSH
BIG EASTER MARSH
COBB ISLAND
SUNDAY DITCH
BUCKHORN POINT
SHALLOW BAY
ECKICHY MARSH
CEDAR CREEK


11 SEASIDE
SAND SHOAL CHANNEL
NEW MARSH
THE THOROFARE
MOCKHORN BAY
MOCKHORN ISLAND
MOCKHORN CHANNEL
JOE WEST TUMP
MIDDLE MARSH
JOE KNIGHT TUMP
SHIP SHOAL CHANNEL
OLD HOUSE CREEK
B.G. CREEK MARSH

12 SEASIDE


COBB BAY
SAND SHOAL CHANNEL
SAND SHOAL INLET
MAN and BOY MARSH
WRECK ISLAND
NEW MARSH
SOUTH BAY
GODWIN ISLAND
JOE WEST THUMP
WHITE PERCH
MIDDLE MARSH
SHIP SHOAL CHANNEL
MINK ISLAND
BLACK ROCK CHANNEL
BIG CREEK MARSH
LITTLE INLET
RESTRICTED
Oyster Rock
Shell and Mud
Shell and Sand
Buried Shell
Sand
Sand and Mud
Clay
Gravel
Barren Bottom
N S Not Surveyed
OCC Occupied
Baylor Line
Old Baylor Line
Former Shoreline
State Boundary
Restricted
Meters
0
1000
Nautical Mile
0
1


13 SEASIDE
MAGOTHY BAY
CAPE CHARLES
SKIDMORE ISLAND
LONG POINT CHANNEL
SMITH ISLAND INLET
THOMAS CR
MAIN SHIP SHOAL
SMITH ISLAND BAY
SMITH ISLAND
CAPE CHARLES LIGHTHOUSE
LITTLE INLET
RESTRICTED
CHANNEL
Oyster Rock
Shell and Mud
Shell and Sand
Buried Shell
Sand
Sand and Mud
Clay
Gravel
Barren Bottom
Not Surveyed
Occupied
Baylor Line
Old Baylor Line
Former Shoreline
State Boundary
Restricted
Meters
Nautical Mile