Reconnaissance Study of Holland Island for Beneficial Use and Habitat Restoration

FINAL CONSOLIDATED REPORT

January 31, 2003

Under Contract To:

Maryland Environmental Service
2011 Commerce Park Drive
Annapolis, Maryland

For:
The Maryland Port Administration
2310 Broening Highway
Baltimore, Maryland

Submitted by:

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EXECUTIVE SUMMARY

Holland Island is located off the southern most part of Dorchester County, Maryland, in the eastern Chesapeake Bay. The size of Holland Island has been reduced from approximately 160 acres in 1915 to approximately 87 acres today as a result of erosion. The island now exists as three distinct landmasses, which are referred to as North Holland Island, Middle Holland Island, and South Holland Island. The Maryland Department of Natural Resources (MDNR) owns approximately a half-acre of land on the northeast edge of the southern remnant of Holland Island. The remaining acres are privately owned.

Holland Island was considered as a beneficial use project under the Maryland Port Administration's Dredged Material Management Program after being contacted by the primary landowner. Conceptual designs to increase the size of Holland Island were developed for two alignments with estimated sizes of 939 and 1,639 acres. The proposed alignments are to be located along the western shore of Holland Island. Each concept design would provide a 1:1 ratio between wetlands and uplands. The upland dike elevation scenarios are 10 and 20 feet; all wetland elevation scenarios are a maximum of 10 feet. Four separate studies were conducted to evaluate the use of dredged material to provide shoreline stabilization and environmental restoration.

The overall study was performed by Michael Baker Jr., Inc. (BAKER) under contract to Maryland Environmental Service (MES) and was sponsored by the Maryland Port Administration (MPA). The results of these studies determined that there is an adequate supply of material to construct the dike and the increase of wetland and upland habitat is anticipated to have an overall benefit to the biological resources in the Holland Island area. The four individual studies were:

- *Reconnaissance Study of Holland Island for Beneficial Use and Habitat Restoration, Geotechnical Report-* The geotechnical study focused on the subsurface conditions along the proposed alignments, design of a stable dike section, and the evaluation of quality and quantity of borrow sand for the construction of the dike. This study was completed by Engineering, Construction, Consulting, and Remediation in March 2002.

- *Reconnaissance Study of Holland Island for Beneficial Use and Habitat Restoration, Coastal Engineering Analysis-* A preliminary coastal engineering analysis for use in planning for the dredging engineering and dike design was conducted. This study was completed by Offshore & Coastal Technologies, Incorporated -East Coast in May 2002.

- *Reconnaissance Study of Holland Island for Beneficial Use and Habitat Restoration, Dredging Engineering Study-* This study provided a dredging engineering and cost analysis for both alternatives. Gahagan & Bryant Associates, Inc. completed the study in May 2002.

- *Reconnaissance Study of Holland Island for Beneficial Use and Habitat Restoration, Environmental Conditions Report-* The environmental conditions study assessed the environmental resources in the area and determined the potential impacts of the placement of the proposed dredged material. This study was completed by BAKER in August 2002.

The range of initial costs for construction is approximately $38.1 to $66.7 million with a construction schedule of two to four years. When all factors associated with moving maintenance material from the Baltimore Harbor channels (approach channels east of North Point/Rock Point line) to the Holland Island Habitat Restoration Site are considered, the estimated total unit cost ranges between $18.75/cubic yard (cy) to $19.99/cy dependent on alignment and dike height chosen.

The general site characteristics for Alignment No. 1 are:

- Water depth is approximately 0.5 – 9 feet (ft) Mean Lower Low Water (MLLW). Average water depth is 5 feet (ft) MLLW.
- Site area is 1,639 acres.
- The ratio of wetland to uplands acreage is 1:1.
- Site perimeter is 37,017 linear feet (LF).
- The site area to perimeter ratio is 0.044 acre (ac)/LF.
- Site capacity is 33.6 to 53.9 million cubic yards (mcy).
- Site life is 14 to 22 years.
- Site contains more than 12 mcy of sand suitable to build the dike.
- Highest total initial construction cost of alignments, but lowest unit cost.
- Highest total site use cost of alignments, but lowest unit cost.

The general site characteristics for Alignment No. 2 are:

- Water depth is approximately 0.5 - 5 ft. MLLW. Average water depth is 3.5 ft.
- Site area is 939 acres.
- The ratio of wetland to uplands acreage is 1:1.
- Site perimeter is 27,644 LF.
- The site area to perimeter ratio is 0.034 ac/LF.
- Site capacity is 16.9 to 28.5 mcy.
- Site life is 7 to 12 years.
- Site contains more than 7 mcy of sand suitable to build the dike.
- Lowest total initial construction cost of alignments, but highest unit cost.
- Lowest total site use cost of alignments, but highest unit cost.

The project will promote shoreline stabilization, saving Holland Island from further habitat loss due to erosion. It will protect existing resources on Holland Island such as heron, egret and waterbird species habitat, diamondback terrapin nesting habitat and wetland and upland habitat. Creation of a restoration island would also provide additional

wetland and upland habitat for birds and wildlife, including rare, threatened, and endangered (RTE) species. It will also decrease impacts to aquatic habitat from high turbidity and sedimentation caused by the eroding island. Existing submerged aquatic vegetation (SAV) beds on the eastern side of the island would also be protected as well as upland cemeteries.

Overall, potential impacts to environmental and historical resources as a result of the proposed construction and habitat restoration at Holland Island are expected to be minimal, and may include temporary increases in sedimentation rates, possible burial of abandoned gravesites, and potential burial of areas historically populated by SAV on the western side of the island. Management and design efforts may mitigate some of these potential impacts. This site would have minor negative impact on overall commercial Chesapeake Bay commercial fishing grounds. Several issues will require further consultation and coordination with appropriate governmental agencies.

1.0 INTRODUCTION

1.1 Project Description

Holland Island is located off the coast of the southern most part of Dorchester County, Maryland, in the eastern Chesapeake Bay. It is located at the mouth of Holland Strait, approximately two miles south of Bloodsworth Island as shown in Figure 1-1. The size of Holland Island has been reduced from approximately 160 acres in 1915 to approximately 87 acres today as a result of erosion. The island now exists as three distinct landmasses, which are referred to in this report as North Holland Island, Middle Holland Island, and South Holland Island. MDNR owns approximately a half-acre of land on the northeast edge of the southern remnant of Holland Island. The remaining acres are privately owned.

The water depths directly adjacent to Holland Island are very shallow, ranging from 0.5 to 2.5 ft depending on the tides. The western portion of the island has undergone the most significant impacts of the erosion. The current acreage of each section was estimated by overlaying a current aerial photo (June 2001) over the National Oceanic and Atmospheric Administration (NOAA) charts and scaling to calculate approximate current acreages. North Holland Island is approximately 2.09 acres, Middle Holland Island is approximately 5.51 acres, and South Holland Island is approximately 79.45 acres, for a total of approximately 87.05 acres.

Holland Island was considered as a beneficial use project under the MPA's Dredged Material Management Program after being contacted by the primary landowner. Conceptual designs to increase the size of Holland Island were developed for two alignments, with estimated sizes of 939 and 1,639 acres. The proposed site design would provide 50% wetlands and 50% uplands for both concept designs. The upland dike elevation scenarios are 10 and 20 feet, and all wetland elevation scenarios are a maximum of 10 feet. The proposed alignments are to be located along the western shore of Holland Island.

The footprints for these proposed islands are as shown in Figure 1-2. The project would be protected by a dike system on the west side of Holland Island. Alignment Number (No.) 1 will envelope an area of approximately 1,639 acres. Alignment No. 2 will enclose an area of approximately 939 acres. Both alignments would have a 1:1 ratio of wetlands to uplands. The dike system would be separated from the existing island by approximately 500 ft of water.

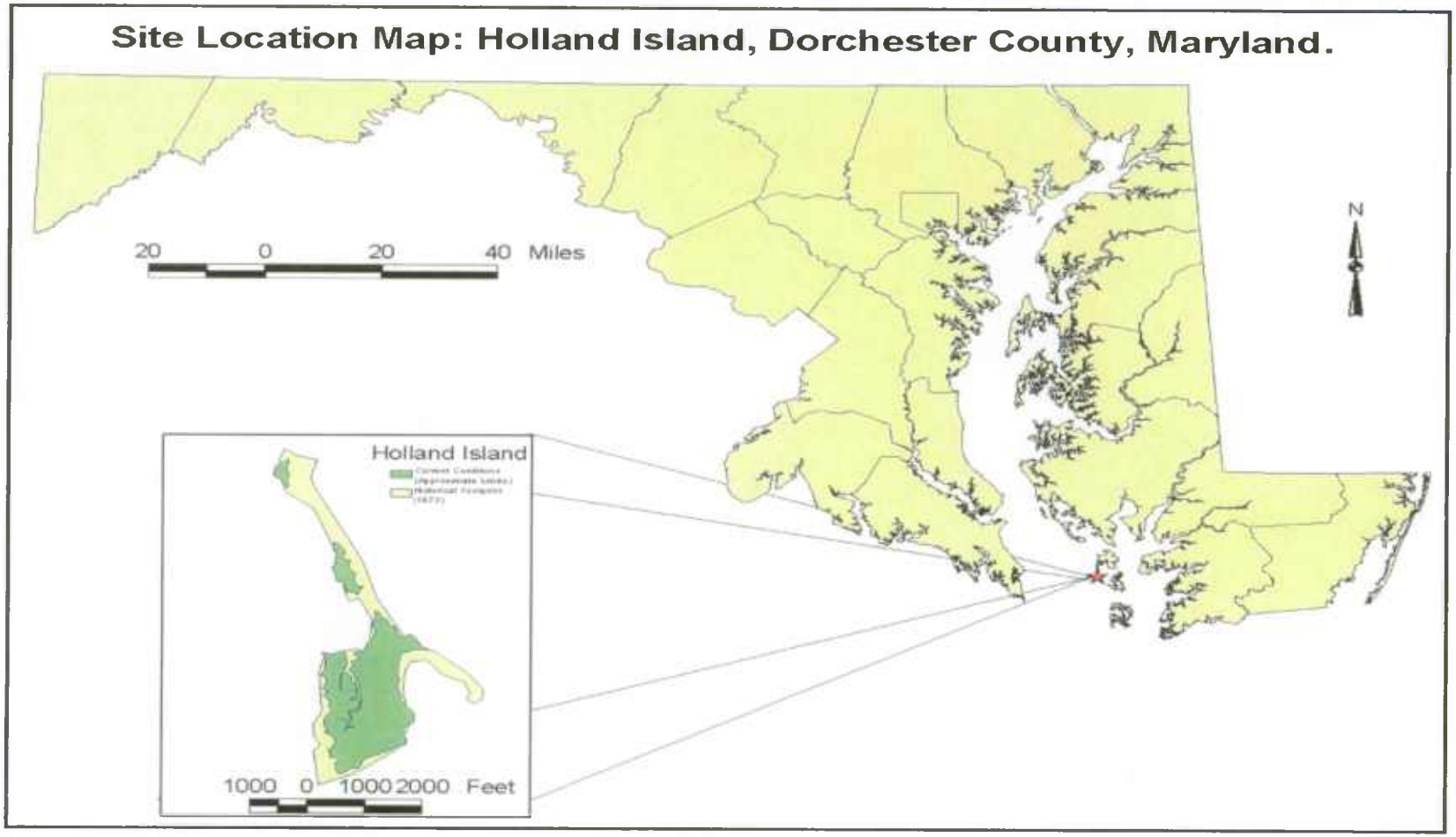
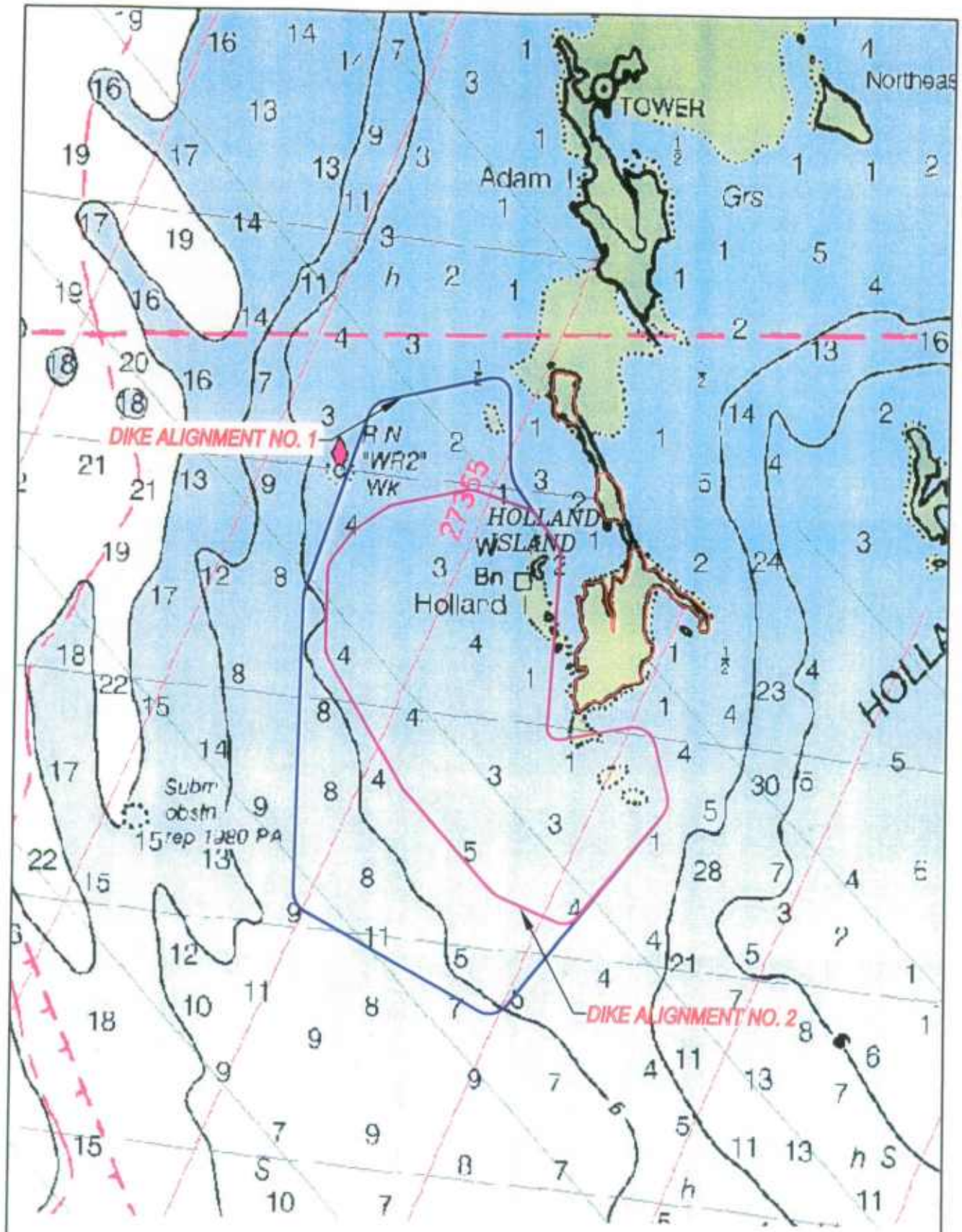


Figure 1-1 Holland Island Vicinity Map



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HOLLAND ISLAND	PROPOSED
FIGURE 1–2	ALIGNMENTS
DATE: OCT 2001	SCALE: 1" = 3000'	SHEET 01 OF 01

1.2 Project Objectives

The objectives of the Holland Island Reconnaissance Study were:

i) Evaluate the geotechnical conditions at the site, especially along the proposed alignments.
ii) Design a stable dike section at the site in order to establish a preliminary cost estimate for developing the site.
iii) Evaluate the availability of borrow material (sand) at the site for the construction of the dike.
iv) Determine the effects of bathymetry, topography, wind conditions, water levels, currents, and sediment data on the potential design and construction of dikes at the site.
v) Analyze sand borrow options, including excavation, transport and placement methods.
vi) Lay out two perimeter dike alignments, enclosing 1,639 and 939 acres. For each dike alignment, there will be two upland dike heights, 10 ft and 20 ft.
vii) Estimate neat quantities (quantity of material that fill the design template, not including material lost during construction) and construction quantities, including all rock products for the two alignments defined.
viii) Estimate costs for: excavation, transport, and placement for two different sand borrow options, perimeter dike alignments and upland dike heights; transport and placement costs of material dredged from Baltimore approach channels east of the North Point-Rock Point Line and proposed for placement at Holland Island; and site finishing cost including plan and design, habitat-monitoring, implementation of channels and seeding, and operations and maintenance.
ix) Research and evaluate existing environmental conditions and cultural resources at Holland Island, utilizing literature searches, site visits, and coordination with local, state, and federal agencies.
x) Identify potential impacts of the projects.
xi) Identify further study needs.

1.3 Consolidated Report Purpose and Format

The purpose of the consolidated report is to provide one report that summarizes the findings from four individual reports completed for the Reconnaissance Study of Holland Island for Beneficial Use and Habitat Restoration project. These reports are:

- *Reconnaissance Study of Holland Island for Beneficial Use and Habitat Restoration, Final Geotechnical Study*–prepared by Engineering, Construction, Consulting, and Remediation, Inc. (E2CR), March 27, 2002, for Michael Baker Jr., Inc (BAKER).

- *Reconnaissance Study of Holland Island for Beneficial Use and Habitat Restoration, Final Dredging Engineering Study*-prepared by Gahagan & Bryant Associates, Inc. (GBA), May 15, 2002, for BAKER.

- *Reconnaissance Study of Holland Island for Beneficial Use and Habitat Restoration, Final Coastal Engineering Analysis*- prepared by Offshore& Coastal Technologies, Inc., (OCTI) - East Coast, May 21, 2002, for BAKER.

- *Reconnaissance Study of Holland Island for Beneficial Use and Habitat Restoration, Final Environmental Conditions Study*-prepared by BAKER, August 21, 2002

References are provided throughout the report to specify the individual report referenced. The original four reports are included in the Appendices.

2.0 RECONNAISSANCE STUDIES

2.1. Geotechnical Analysis

The purpose of the geotechnical investigation was: 1) to evaluate the geotechnical conditions at the site, especially along the proposed alignments; 2) to design a stable dike section to establish a preliminary cost estimate for developing the site; and 3) to evaluate the availability of borrow material (sand) at the site for construction of the dike.

The study included reviewing existing data, such as Maryland Geological Survey and Soil Conservation Service data, drilling 12 borings, obtaining Shelby tube samples, conducting laboratory tests to determine the stress history, strength characteristics and index properties of various strata; evaluating the data; conducting slope stability analysis for the proposed dike system; evaluating the soils at the site for possible use for constructing the dike; and developing a dike section for use in preparing a cost estimate (Appendix A).

2.2. Coastal Engineering Analysis

The Coastal Engineering Analysis provided an assessment on bathymetry, topography, wind conditions, water levels, currents, and sediment data with respect to the potential design of the dike. The analysis was done utilizing available, relevant, and readily obtainable information. The analysis investigated storm surge, wind, annual deep water waves, longshore transport, and currents to determine a preliminary typical dike cross section.

Dike sections were developed based on wave analysis and the layout of two alternative dike alignments near Holland Island. The dike was designed for a 35-year return period storm. Armor stone sizes were estimated for a 1 vertical: 3 horizontal side slope for each of the alternatives. The section developed consisted of a three-layer section for the more extreme wave exposures, and a two-layer section for the less extreme exposures. The layers consist of the primary armor, an underlayer of intermediate stones, and a filter stone layer that will minimize the loss of fine sediment that may pass through the geotextile filter cloth. The proposed toe section consists of a bedding layer of filter stone along the bottom over a layer of geotextile filter cloth. The bedding stone is protected with a single layer of primary armor stones, with a toe width of three armor stones. The proposed dike crest elevations required to keep wave runup and overtopping to acceptable levels during the design storm event ranged from 8 feet MLLW for the southeast through northeast directions, to 11.25 feet MLLW for the southerly and southwesterly directions (Appendix B).

2.3. Dredging Engineering and Cost Estimate

The purpose of the dredging engineering assessment was to evaluate the suitability of the Holland Island site for construction of a dredge material dike system. The assessment

examined the two dike alignments with 10 and 20-foot dikes and a 1:1 ratio between wetland and upland habitats. The study included the following tasks: 1) analyze sand borrow options, including excavation, transport and placement methods; 2) lay out two perimeter dike alignments, enclosing 1,639 and 939 acres respectively. Each dike alignment had two possible upland dike heights, 10 and 20 feet; 3) estimate neat quantities and construction quantities for the two alignments, develop excavation, transport and placement costs for two different sand borrow options, two dike alignments, and two upland dike heights; 4) estimate neat quantities and construction quantities for all rock products and prepare cost estimate in bid format, and 5) estimate transport and placement costs of material dredged from Baltimore approach channels east of the North Point-Rock Point Line and estimate site finishing costs (Appendix C).

2.4. Environmental Conditions

The environmental conditions report investigated the current environmental conditions on and near Holland Island. The study identified the potential positive and negative environmental impacts associated with the two proposed dike configurations that would provide shoreline stabilization and create wetland and upland habitat. The study also identified further investigation needs. The assessment was based on literature searches, site visits, and coordination with local, state, and federal agencies (Appendix D).

3.0 RESULTS OF RECONNAISSANCE STUDIES

3.1 Summary of Geotechnical Study

This study focused on the geotechnical conditions along the proposed alignments, design of a stable dike section, and the evaluation of quality and quantity of borrow sand for the construction of the dike to an elevation of 20 feet above existing water level. Twelve borings were taken in November 2001 and analyzed to determine the soil characteristics at the locations of the proposed dikes. The results of the laboratory testing are provided in Appendix D of the Geotechnical Report (Appendix A).

3.1.1 Subsurface Conditions

The borings indicate that the subsurface stratigraphy along the perimeter of Alignment No. 1 and 2 generally consists of three major strata, as shown on Figures 7 and 8- Generalized Subsurface Profile in Appendix A of the Geotechnical Report (Appendix A).

Stratum I consists of very loose to medium dense gray and brown Silty Sand. Standard penetration resistance varies from about Weight of Hammer to 50 blows/ 2 inches. The fines content of the sand is generally less than 30%. The thickness of the stratum varies from 4 to 25 feet, and occurs at the surface (mud line) except in Borings H-4, H-5, and H-10, where Stratum II is at the mud line. In Boring H-8, this stratum was also encountered at elevation –18 feet. In Borings H-5 and H-10, Stratum I was encountered beneath Stratum II and the thickness of Stratum I varied from 5 to 10 feet. Stratum I was also encountered in Borings H-1 and H-10 at deeper depths, below Stratum II. The sand is semi-angular to angular, and is medium to fine. It should be noted that this stratum contains pockets of greenish gray Clayey Sand, identified as Stratum 1A. Stratum 1A was not encountered along Alignment No. 2.

Stratum II was encountered in Borings H-3, H-4, H-5, H-8, and H-10. This occurs at the mudline except in Boring H-3, where Stratum II was encountered within Stratum I from elevation –25 to –32 feet. Stratum II is about 6 to 20 feet thick at Borings H-4, H-5, H-8, and H-10, and consists of very soft to soft, greenish gray to brownish gray Silty Clay with a trace of some sand. Standard penetration resistance varies from Weight of Rod (WOR) to 8 blows/foot. It is believed that this stratum represents a channel that was eroded from Stratum I and was later redeposited in the eroded channel. It is normally consolidated.

Stratum III underlies most of the site and consists of soft to stiff green gray Silty Clay with pockets of Silty Sand. The top of the stratum varies from about Elevation –28 to –40 feet. Standard penetration resistance varies from WOR to 12 blows/foot. The WOR value is believed to be non-representative of the in-situ conditions. This stratum extends to the bottom of the borings, except in Borings H-1 and H-10 where it is only about 5 to 14 feet thick.

3.1.2 Borrow Area

Based on the borings, the sand is generally semi-angular to angular. The fines content varies from about 4% to 40% and is generally less than 30%. The sand is Clayey in some areas and also contains pockets of clay. The sand is considered suitable for building the dike.

For Alignment No. 1, the total volume of sand available is estimated to be about 15 million cubic yards. During construction, the bulking will be minimal since the sand is loose. In addition, about 15% of the fines will be lost. The net quantity of sand available for dike construction is estimated to be about 12 million cubic yards. Additional sand will also be available outside the dike area.

For Alignment No. 2, the total volume of sand available is estimated to be about 9 million cubic yards within the dike area, and the net volume available is about 7 million cubic yards. Additional sand will also be available outside the dike area.

3.1.3 Foundation/Slope Stability

Slope stability analyses were conducted using one typical case for the subsurface profile. The Purdue University PC STABL-V program was used to analyze the stability of the slopes. Failures can be analyzed using different approaches. For this study, the Modified Bishop Method was used. The shear strength of the foundation soils was based on the evaluation of the Standard Penetration Tests, since the soils are mostly Silty Sands in the foundation. The subsurface profiles did not warrant the use of a wedge type of failure since there are no thin soft layers. Therefore, only circular failures were analyzed.

For this study, it was assumed that the dike would be constructed by hydraulic dredging, and the slopes achievable would be 1 vertical: 3 horizontal below the water table. The acceptable factor of safety was assumed to be 1.3 at the end of the construction phase. The analysis presented in Appendix C of the Geotechnical Report (Appendix A) indicated the Factor of Safety for the assumed design section is in excess of 1.3 for deep seated and for shallow failures.

For Alignment No. 1, the foundation soils are anticipated to be mostly loose Silty Sands to very soft Silty Clay. The dike along Alignment No. 1 can be founded on the Silty Sand, using a slope of 1V:3H. However, the soft Clays will have to be undercut about 15 feet on the average. A total of approximately 15+million cubic yards of Silty Sand and a net (i.e. assuming 15% loss during hydraulic dredging and placement) of about 12+ million cubic yards of Silty Sand is estimated to be available within the diked area.

For Alignment No. 2, the soils in the foundation are anticipated to vary considerably, from very soft Silty Clay to loose Silty Sands. The sands are considered to be suitable for supporting the dike on a 1V:3H slope. The very soft

Clays will need to be undercut about 10 feet on the average. The total volume of Silty Sand available within the diked area is estimated to be about 9+million cubic yards and the net (assuming 15% loss during hydraulic dredging and placement) volume is estimated to be about 7+million cubic yards.

3.2 Summary of Coastal Engineering Analysis

3.2.1 Design Parameters

3.2.1.1 Bathymetry

According to navigation charts, the existing Holland Island is surrounded to a large extent by very shallow water that extends about 1 nautical mile on all sides of the island, except for a narrow channel of deep water to the east. The large area of shallow water, generally less than 6 feet deep Mean Low Water, is the Holland Island Bar. This shallow water provides the basis for the footprint of the dredge disposal island. Just west of this broad shallow area, the water depth increases rapidly into the main stem of the Bay deepening to over 20 feet in depth over approximately a 0.5-mile distance. The proposed new island limits are at the edge of the drop to the deeper water.

3.2.1.2 Water Levels and Storm Surge

Normal water level variations at Holland Island are generally dominated by astronomical tides although wind effects are also important in determining local water surface elevations. Astronomical tides at Holland Island are semi-diurnal tides with a period of approximately 12.4 hours, resulting in two high tides and two low tides each day. As a preliminary approximation for tidal elevations at Holland Island, the average of the tidal elevations at the McCready and Ewell, Maryland tide stations were used as shown in Figure 2-1 of Appendix B. The estimated astronomical tidal characteristics at Holland Island are: Mean Higher High Water elevation 2.2 feet; Mean High Water elevation 2.0 feet; Mean Tide Level elevation 1.1 feet; Mean Low Water elevation 0.1 feet; and MLLW elevation 0.0 feet. All elevations are referenced to MLLW as shown in Table 2-2 of Appendix B.

During storm conditions, water levels are dominated by storm surge and wave setup in combination with astronomical tide. Storm surge is a temporary rise in water level generated by large scale extratropical storms known as northeasters or by hurricanes. Wave setup is a term used to describe the rise in water level due to waves breaking near the shoreline.

Storm surges cause more extreme water levels than astronomical tides do, governing flooding, overtopping of structures and maximum expected depth limited wave heights in shallow areas. The nearest storm surge station to Holland Island is located at Chance, Maryland, approximately 8 miles to the east-northeast. Storm surge values measured at this station were assumed to be applicable to Holland

Island for the preliminary design. Storm surge elevations range from 5 feet above MLLW for the 5-year return interval storm to 6.8 feet MLLW for the 100-year return interval storm as shown in Table 2-3 of Appendix B. If this study moves forward, numerical modeling of the area surrounding Holland Island to refine the storm surge elevations should be considered as this analysis might reduce the design storm surge elevations.

3.2.1.3 Wind

There are no wind records specifically available for Holland Island. Therefore, the wind data for the Patuxent Naval Air Station (NAS) between 1945-1995 was used for Holland Island. This data was obtained from NOAA, Climatic Data Center for a US Army Corps of Engineers (USACE) project at Smith Island. Results show that winds are most often 5-10 miles per hour (mph) from the north-to-northwest octant and can approach 40 mph during a 5-year event and 55 mph during a 100-year event. The wind results are shown in Tables 2-4 thru 2-7 of Appendix B.

3.2.1.4 Wave Conditions

Wind statistics were used to estimate design wave conditions and typical annual wave conditions at Holland Island. The greatest wave heights are those originating from the Bay mainstem which also have the deepest waters and largest fetches, shown in Tables 2-8 to 2-11 in Appendix B. Waves from the easterly quadrant are much smaller due to the limited wave fetch. Wave heights can exceed 5 feet in a 5-year event and can approach 7 feet in a 100-year event arriving from the west to northwest octant.

3.2.1.5 Longshore Transport

Longshore sediment transport rates, driven by waves, are quite large on westward-facing shorelines. In these areas, transport is calculated to be approximately 40,000 cubic yards per year (cy/yr) to the south and 20,000 cy/yr to the north, generating a net transport rate of 20,000 cy toward the south. On north-facing beaches, the net sediment transport rate is calculated to be about 40,000 cy/yr toward the east. Both of these large transport rate situations are due to dominant waves from the northwest. Table 2-12 in Appendix B provides the results of the longshore transport analysis for each beach direction.

3.2.2 Dike Design

The preliminary design of the dike cross-section is based on previous studies for similar projects in the Chesapeake Bay. Information was used from the construction of Poplar Island and guidance documents from the USACE publications. The proposed dike section consists of a three-layer armor stone section for the more extreme wave exposures, and a two-layer armor stone section

for the less extreme exposure. The layers consist of the primary armor, an underlayer of intermediate stones, and a filter stone layer.

Dike sections were developed based on the wave analysis and layout of two alternative dike alignments near Holland Island (Figures 3-6 in Appendix C). The proposed toe section consists of a bedding layer of filter stone along the bottom over a layer of geotextile filter cloth, protected by a single layer of primary armor stone with a width of three stones. The armor side of the dike has a 1V:3H slope with two layers of armor stone The back slope is shown as 1V:5H (sand core) but may be as steep as 1V:1.5H (stone core) depending on the core building materials (Figure 3-1 in Appendix B). Water depths at the proposed dikes vary from 4 to about 11 feet below MLLW.

The proposed dike sections for Holland Island had some modifications to the toe structure design that are different from designs proposed for other dredge disposal dikes. These modifications include the inclusion of a filter layer of stone between the underlayer of stone and the dike core. This filter layer will extend approximately 5 feet seaward from the armor stones to provide protection against scour seaward of the structure.

3.2.2.1 Dike Design Values

The dike must be designed to withstand hydrodynamic forces due to waves and high water levels that are statistically probable in any given year. Previous dredge disposal dikes have used a 35-year return period for analysis. This return period was also used for Holland Island.

The wave heights used for design of the dike armor stones are nearshore wave heights modified by breaking in the relatively shallow water in front of the structures. The wave heights depend on the offshore wave height, wave period, wave angle, local water depth, and bottom slope. The local water depth is the sum of the normal water depth where the structures are to be constructed and the design storm surge level. For both of the proposed alignments, the nearshore wave design parameters were computed for each of the eight wave directions. These values as shown in Table 3-1 of Appendix B are used for calculating local wave heights at the toe of the dike.

3.2.2.2 Dike Crest Height

Potential wave runup and overtopping on the armor dike slopes is estimated for use in setting dike elevations so that the overtopping rates in the design storm are limited to values which will cause minimal and repairable damage to the dike roadway and back slopes.

Wave overtopping rates were calculated for the eight wave directions for both alignments and the required berm crest elevations are shown in Table 3-3 of Appendix B. For Alignment No.1, the maximum crest elevation is 11.25 feet MLLW for the South and Southwest directions. For Alignment No. 2, the maximum crest elevation is 10.25 feet MLLW for the South and Southwest directions. The analysis also shows that the crest elevation required to prevent overtopping for the North and Northwest cross sections for both alignments was 8.75 feet MLLW; the crest elevation for the West cross section for Alignment No. 2 was 9.75 feet MLLW. However, a minimum design elevation of 10 feet MLLW for the upland portion of the proposed island was established. Therefore, the dike elevations were raised to 10 feet for these sections.

3.2.2.3 Armor Section Design

There are two methods of calculating armor stone heights in current coastal engineering practice, the Hudson Equation and the method of van der Meer. For the Holland Island study, stone sizes were calculated with the van der Meer formula which resulted in stone sizes significantly smaller than those used for previous studies at Poplar and Parsons Islands. This is primarily due to lower design winds from the Patuxent wind records, which results in lower design values. In order to keep the present study conservative and more in line with the previous studies, the Hudson equation using a H_5 nearshore wave height was used for stone size calculations. A stone unit weight of 165 pounds per cubic feet and a stone stability coefficient of 2 were used in the calculations.

For Alignment No. 1, the armor stone weight ranges from 1,000 to 3,000 pounds for the north, northwest, west, southwest, and south sections. Along the southeast, east, and northeast sections, the armor stone weight is 300 pounds. For Alignment No. 2, the armor stone weight ranges from 1,000 to 2,400 pounds for the north, northwest, west, southwest, and south sections. Along the southeast, east, and northeast sections, the armor stone weight is 300 pounds. Armor layer specifications are provided in Table 3-4 of Appendix B.

3.3 Summary of Dredging Engineering and Cost Estimate

3.3.1 Borrow Material

The borrow material for the dike should ideally be sand with as little fines as possible and based on the geotechnical analysis, there is a sufficient source of borrow material on the Holland Island site (Appendix D). For Alignment No. 1, the estimated neat sand fill quantities for construction of a perimeter dike are between 2.3 million cubic yards for an upland dike height of 10 feet and 3.6 million cubic yards for an upland dike height of 20 feet (Appendix C). The estimated neat sand fill quantities for Alignment No. 2 are between 1.4 million cubic yards for an upland dike height of 10 feet and 2.4 million cubic yards for an upland dike height of 20 feet (Appendix C).

The two methods considered for providing sand borrow were: (1) hydraulically dredge directly from the on-site borrow area and (2) dredge and transport the off-site sand by hopper dredge to an underwater placement site and place the sand in the dikes with a hydraulic dredge.

Borrow methods 1 and 2 both use a hydraulic dredge to place the sand in the dikes. In borrow method 1, suitable on-site sand fill is pumped directly to dikes where it is shaped and armored. Borrow method 2 assumes that suitable fill material is not available within two or three miles and must be transported by hopper dredge from Craighill Channel, and then the material is bottom released in an on-site underwater stockpile and pumped into each section by hydraulic dredge. However, since suitable and sufficient borrow is available, method 2 will not be further investigated at this time.

3.3.2 Cost Estimate

The costs to construct the Holland Island site were estimated based on the configurations and typical dike sections shown in Figures 7 thru 17 of Appendix C. Quantities for each material type were estimated based on the typical dike sections, the alignment and average existing bottom elevation. Unit prices were estimated based on actual bid prices for similar construction projects at Poplar Island. A summary of initial construction costs for each alignment at elevations 10 and 20 feet using borrow method 1 are presented in Table 3 of Appendix C. The cost range of initial construction costs is $38.1 million to $66.7 million.

The Total Site Use Cost Analysis for each dike alignment and dike height is comprised of a Initial Construction Cost (preliminary construction, conceptual, pre-feasibility and feasibility study costs), Site Development Cost (dredge material management, site maintenance and site monitoring and reporting), Habitat Development Cost (plans and design, monitoring, implementation, and operation and maintenance), and Dredging, Transport, and Placement Cost (mobilization and demobilization, dredging, transport, and placement). These are presented in Tables 6 thru 9 in Appendix C.

The total site use costs for Alignment No.1 were estimated to be:

- $657.3 million for dike elevation of 10 feet with an Unit Cost of $19.56/cy
- $1,011.1 million for dike elevation of 20 feet with an Unit Cost of $18.75/cy
- Site capacity for dike elevation of 10 feet of 33.6 mcy
- Site capacity for dike elevation of 20 feet of 53.9 mcy

The total site use costs for Alignment No.2 were estimated to be:

- $337.6 million for dike elevation of 10 feet with an Unit Cost of $19.99/cy
- $539.2 million for dike elevation of 20 feet with an Unit Cost of $18.89/cy
- Site capacity for dike elevation of 10 feet of 16.9 mcy
- Site capacity for dike elevation of 20 feet of 28.5 mcy

3.4 Summary of Environmental Conditions

The environmental conditions study evaluated the existing environmental and cultural resources on and in the vicinity of Holland Island. The evaluation was based on literature searches, site visits, and communication with federal, state, and local agencies and the primary private property owner. North Holland Island, Middle Holland Island, and South Holland Island (the three sections of Holland Island) were investigated for environmental and cultural resources on each landmass.

3.4.1 Habitat Description

Holland Island is approximately 1.5 miles long and 0.5 mile wide. It is losing approximately 2 acres per year due to erosion. The majority of vegetation consists of tidal salt marsh grasses and scrub shrub, with occasional stands of larger trees on the higher, upland centers of the island. The largest section of the island is South Holland Island where significant rookeries exist.

North Holland Island is the smallest of the land areas and is made up almost entirely of tidal marsh. There is also a small exposed sandy beach on the eastern shore and a small upland stand of trees. Middle Holland Island consists mostly of eroding uplands with a fringe marsh. The majority of the vegetation consists of tidal marsh grasses and scrub shrub. A few upland trees were observed on the central part of the island. South Holland Island is the largest landmass of the three sections. The perimeter of the island consists of tidal saltmarsh while the central, upland area consists of several tree stands. A significant stream/canal system exists throughout the western and central areas of the island and large rookeries are known to exist on both sides of South Holland Island. Some small beach areas exist on the eastern shore of the island whereas no beach was observed on the western shore. Species observed on the islands are listed in Table 2-1 of Appendix D.

3.4.2 Water Quality

There are many factors influencing water quality in the Chesapeake Bay including land use and population changes. These factors can change due to amounts of fertilizer and urban sewage entering the Bay, and thus affect the quality of the water. The water quality of the Chesapeake Bay has degraded noticeably during the past century, with indicators being decreases in SAV, finfish, shellfish, and

dissolved oxygen, and increases in sediment. Neither of the proposed alignments is anticipated to have a long-term negative effect on water quality.

3.4.2.1 Surface Water

The Chesapeake Bay Water and Habitat Quality Monitoring Program maintains water quality status and trends for stations in the Chesapeake Bay. Status is a measure of current condition and stations are given a ranking of "good", "fair" or "poor". The two stations closest to Holland Island, shown in Figure 3-2 of Appendix D, are located two miles northeast of Holland Island and eight miles northwest of Holland Island. The data show that nutrients (total nitrogen and total phosphorus), algae abundance (measured by chlorophyll a presence), and total suspended solids ranked in the highest category of "good", with the exception of total nitrogen at one station and chlorophyll a at the other which were ranked "fair". These rankings were based on data collected from 1998 to 2000 (Table 3-3 Appendix D).

Some short-term impacts to water quality may be expected as a result of construction and placement of dredged materials for either of the proposed alignment sites. Localized elevated nutrient or turbidity levels may occur where ponded water is discharged during the dewatering of the dredged material as the soil consolidates. The discharge will be monitored regularly to meet all discharge permit restrictions.

3.4.2.2 Groundwater

The potential for contaminating the groundwater with the placement of dredged material is a concern at any site. However, the clay and silt sediments which are located beneath the project site are anticipated to provide protection to groundwater. In addition, groundwater contamination is not expected to be a potential concern at Holland Island, as the dredged material for the habitat restoration project is expected to be clean.

3.4.3 Sediment Quality

During the past 100 years, sedimentation rates within the Chesapeake Bay increased as a result of changes in land use and stresses imposed by populations within the watershed and also due to natural erosion forces from wind and wave action. Holland Island itself has been a subject of considerable erosion over the years. Aerial photographs and the preliminary coastal engineering analysis indicate that sediment is transported south due to wave and wind action.

Sediments in the area around Holland Island are a mixture of sand, silt and clay. Boring samples taken in November 2001 at specified sites on the western side of the island show that the predominant type of substrate is silty sand at the top of the borings with silty clay occurring at the bottom of the borings at approximately 45

feet below the water surface (Appendix A). These data suggest that the sediments on the western side of Holland Island would consist of silty sands overlaying a bottom layer of silty clay.

Sediments serve as a source for holding natural materials as well as contaminants that can adhere to fine particles. Disturbance through construction, dredging, or storm events could re-mobilize contaminants and particulates from the sediment into the water column. Nutrients, especially phosphorus, are adsorbed to sediment particles. When the sediments are disturbed, the phosphorus is released and becomes a food source for various forms of algae, thus resulting in potential algal blooms.

Toxic contamination would only be a factor if the site were directly adjacent to a contaminant source. It is not likely that contaminants from the nearby Bloodsworth Island Naval Reservation are currently affecting sediments adjacent to Holland Island.

The dredged material placed at the site is expected to be of good quality and suitable for habitat restoration and creation. During construction and placement of the dredged material, it is possible that some sedimentation may occur in the immediate area of the project as the result of some fines lost. Placement of the material will be closely monitored to minimize any loss of material. Alignment #2 would have less impact than Alignment #1 because it is smaller in size and the construction time frame would be shorter.

3.4.4 Biological Resources

The increase of habitat to wetland and upland habitat will have an overall benefit to the biological resources in the Holland Island area. The project will promote shoreline stabilization, saving Holland Island from further habitat loss due to erosion. It will also decrease impacts to aquatic habitat from high turbidity and sedimentation caused by the eroding island. As further information about the proposed construction at Holland Island becomes available, more details about how it may affect biological resources will be considered if the project moves forward.

3.4.4.1 Finfish and Essential Fish Habitat

Common fish species in the Holland Island vicinity are listed in Table 4-1 of Appendix D. In general, possible impacts to pelagic and bottom dwelling fish species from the proposed construction activities at Holland Island include: potentially elevated suspended sediment which may clog gills, and increase mortality of fish eggs and larvae due to smothering, dissolved oxygen reduction, change in functional utilization of habitat for feeding, nursery, cover, and overwintering, and potential blockage of migratory pathways of anadramous species due to their reluctance to pass through turbidity. It is expected that bottom dwelling fish such as flounder would be more impacted by construction activities

than pelagic species. It is also expected that the pelagic species can avoid the areas of construction, and that actual impacts will be minimal. Impacts to finfish during construction activities should be short-term, and the proposed restoration is expected to improve finfish habitat in the long-term by reducing turbidity through shoreline protection.

The screening tool provided on the NOAA Essential Fish Habitat (EFH) website determined that possibly nine fish species managed by the National Marine Fisheries Service (NMFS) are in the general vicinity of Holland Island. These species are: bluefish, summer flounder, Atlantic butterfish, windowpane flounder, black sea bass, king mackerel, Spanish mackerel, cobia, and red drum. Formal consultation with NMFS should be conducted before new habitat construction begins. The species most likely to frequent the area around Holland Island include bluefish and summer flounder. Possible impacts to the fish as a result of the proposed project are discussed below.

Construction activities at Holland Island may temporarily disturb juvenile habitat for bluefish, juvenile and adult habitat for windowpane flounder, and spawning of Atlantic butterfish. There is potential for impact to juvenile and adult habitat of cobia; however they should be able to avoid the area during construction. SAV is a habitat area of particular concern (HAPC) for juvenile summer flounder who utilize SAV beds as nursery habitat. The only SAV beds found near Holland Island lie on the east side where no construction will occur.

The presence of black sea bass, King mackerel, and Spanish mackerel in the Holland Island vicinity is not likely due to a lack of structured habitats in the area and their preference for coastal ocean waters. It is also unlikely that construction at Holland Island would have any impact on red drum, as they rarely occur in the area.

All EFH impacts should be confirmed in formal consultations with NMFS before new habitat construction begins. Coordination regarding construction project "time of year" restrictions should be conducted with all appropriate agencies to minimize any potential impacts.

3.4.4.2 Benthos

Benthic macroinvertebrates are organisms that live on or within the bottom sediments of aquatic environments. They are a vital food source for crabs and many types of fish that are essential to the economic value of the Chesapeake Bay. Dissolved oxygen depletion, elevated suspended sediments, nutrient loading, and toxic contamination can cause stress in the benthic community causing lower species diversity and lower overall numbers of organisms. A healthy benthic community would include a diverse range of species such as clams, oysters, small crustaceans, and worms varying in size, age, and quantity.

The Long-Term Benthic Monitoring and Assessment Comprehensive Report, prepared by Versar, Inc for MDNR, was reviewed for information relevant to Holland Island. The fixed benthic monitoring stations nearest to Holland Island are 10-30 miles away located near Calvert Cliffs and the Nanticoke River. The monitoring results from these stations probably do not accurately reflect the benthic conditions at Holland Island. Therefore, current information on the existing benthic conditions at Holland Island is not known.

It is not likely that contaminants from the nearby Bloodsworth Island Naval Reservation are currently affecting benthic organisms; however, baseline monitoring may be necessary to document existing conditions and determine the current status of the Holland Island benthic community.

The project will replace some benthic habitat with wetland and upland habitats. Alignment #1 will replace approximately 1,639 acres of potential benthos habitat with wetland and upland habitat. Alignment #2 will replace approximately 939 acres of potential benthos habitat with wetland and upland habitat.

Any benthos within the proposed construction area would be lost, and species such as the blue crab may be trapped in the diking efforts. However, it is unlikely that covering wintering blue crabs is a significant concern in the shallow waters of the concept areas as the blue crab typically overwinters in deeper waters. Also, most mobile invertebrates should be able to avoid the area until dike construction is completed, and any impacts that occur should be minimal.

3.4.4.3 Submerged Aquatic Vegetation

SAV are rooted aquatic plants which grow in the shallow shoreline areas throughout the Chesapeake Bay. They provide food and shelter for many animals of the estuary, as well as stabilize bottom sediments and reduce the erosive effects of waves. SAV is most abundant during warmer months, and generally die back in many areas during the winter. SAV is considered a HAPC for both juvenile and adult summer flounder. Based on survey data, there has been a decline in recent decades in the amount and variety of SAV in the Chesapeake Bay.

The Virginia Institute of Marine Science program for restoring and monitoring SAV finds that no SAV presence has been noted along the western shore of Holland Island since 1996. No SAV was observed at all around Holland Island during 1997 or 1998. In the past three years, SAV has only been observed on the eastern shore of Holland Island (Figure 4-1 in Appendix D). The University of Maryland, Center for Environmental Studies (UMCES) conducted a resource mapping study for MPA in 2002. Information from the UMCES study is included in Appendix E. The distribution of SAV on the eastern shore of Holland Island was confirmed by the UMCES study (Figure E-1 in Appendix E).

In general, SAV beds around Holland Island appear to have experienced a sharp decline since 1992. SAV was distributed around almost the entire perimeter of the island in 1992, with the densest distribution along the northeast half of Holland Island. The total acres of SAV in 1992 were approximately 1,379.

The proposed project would benefit SAV habitat on the eastern side of the island by reducing erosion and protecting existing habitat. The construction of new upland and wetland habitat would cause permanent loss of area for potential SAV beds; however, the channel between the new configuration and the existing island may provide acceptable habitat for SAV growth, and protection from strong wind and wave erosion.

3.4.4.4 Terrestrial Vegetation

The majority of the terrestrial vegetation at Holland Island consists of fringe marsh and high marsh species. The upland areas include some tree stands, especially on South Holland Island. North and Middle Holland Island consist mainly of scrub shrub with only a small area of larger trees, listed in Appendix D.

The diking and construction of new habitat are not planned to tie into the existing land at Holland Island; therefore there would be little to no impact on the existing vegetation along the western shore. The existing vegetation will be protected with the proposed habitat construction, and additional vegetation will be introduced on the habitat restoration island in order to create new habitat.

3.4.4.5 Wetlands

According to the Cowardin Classification System developed in 1979 for the United States Fish and Wildlife Service (USFWS), wetlands are divided into two main types. There are coastal wetlands known also as tidal or estuarine wetlands, and inland wetlands, which are often referred to as non-tidal, freshwater or palustrine wetlands.

The prominent wetland types of the lower Chesapeake Bay mainstem are estuarine, where the salinity and tidal influences combine in an environment that supports halophytic (salt tolerant) plant species (Table 2-1 in Appendix D). The three islands that comprise Holland Island are an example of tidal wetlands.

North Holland Island is almost completely comprised of a tidal wetland with a small sandy beach on its eastern side. Vegetation on Middle Holland Island observed during the September 19, 2001 site visit mainly consisted of tidal marsh grasses and scrub shrub. Plant species identified on this part of Holland Island suggest that it is almost entirely tidal marsh with one very small upland area where the remaining 100-year-old house stands.

On South Holland Island the majority of the island is comprised of a tidal wetland with the same species of vegetation as on the other two parts of Holland Island. South Holland Island more distinctively shows a fringe marsh and higher marsh area denoted by a water line mark created during the daily tidal influences.

To determine the historical extent of wetlands on Holland Island, National Wetland Inventory (NWI) maps were obtained for the site. It should be noted that in 1990, at the time of classification, Holland Island was much larger in size and was comprised of only one island. Calculations indicate that the size of the island in 1990 was approximately 117.11 acres compared to its current size of approximately 87.05 acres.

The Island historically is classified as an estuarine inter-tidal habitat that has one upland area of 0.6 acres located adjacent to the 100-year-old house. The NWI has four wetland classifications for the remainder of the Island (Figure 4-3 of Appendix D). These are: emergent persistent (81% of all three island remnants); forested scrub shrub with broad-leaved deciduous trees at higher elevations (12% of Middle and South Holland Island); forested scrub shrub with broad-leaved deciduous trees at lower elevations (1.5% of all three island remnants); and unconsolidated shore and sand areas (4% of all three island remnants).

The construction project is expected to have a positive impact on wetlands at Holland Island. New wetland habitat will be created and existing wetlands will be protected from erosion by the dike construction. Alignment No. 1 will create approximately 820 acres of wetland habitat. A smaller amount of wetland habitat, approximately 470 acres, will be created with Alignment No. 2.

3.4.4.6 Birds and Wildlife

Several heron breeding grounds, or rookeries, exist at Holland Island. In addition to herons, many other water birds nest at Holland Island, including egrets, swan, geese, ducks, and osprey. Bald eagles have reportedly been observed as well. A bald eagle nest was known to exist at Holland Island. However, MDNR officials report that the nest has not been present for the past several years. Gulls, terns, and pelicans feed along the shorelines and migrating songbirds use the island as a resting point in the spring and fall. No mammals were observed during the field visits; however white tailed deer and fox have been sited in the past and evidence of rabbits was found. Many species of wildlife, fish, reptiles, crabs, mammals, insects, and birds, were noted and recorded during a site visit (Appendix D).

A rookery of bird nests was observed in the shrubbery on the southern tip of the remnant. USFWS believes the nests were most likely built by green herons (*Butoroides striatus*) or little blue herons (*Egretta caerulea*). Two groups of unidentified swans (mute or tundra) were observed in the Holland Straits. A bald eagle (*Haliaeetus leucocephalus*) was sighted perched in a tree south of the dock during the September 27 site visit by an observer from MES. Brown pelicans

(*Pelicanus occidentalis*) were observed flying around the entire Holland Island area.

The 2002 study by UMCES included colonial nesting sites and waterfowl and shorebird usage for the area surrounding Holland Island. Colonial nesting marine birds and waterbirds include herons, egrets, ibises, gulls, terns, skimmers, and pelicans. These birds typically nest in colonies concentrated in small areas and are vulnerable to disturbance. The study identified possible colonial nesting sites on Holland Island and concluded that the Bay area surrounding Holland Island is suitable habitat for waterfowl and shorebird usage.

Herons, egrets and other waterbird species utilize the marshland and upland habitats, especially on South Holland Island, and may avoid neighboring areas while construction is taking place due to the increase in noise levels. Waterbird breeding season is generally from March through August, and could be disrupted by construction activities in the area at that time. However, as with the Poplar Island Environmental Restoration Project, coordination with appropriate agencies should result in agreements allowing year-round construction tempered by "time of year" restrictions to protect nesting in rookeries. Potential impacts to birds during construction may be of a shorter duration with Alignment No. 2 than with Alignment No. 1 because the smaller site should have a shorter construction and material placement period.

3.4.4.7 Rare, Threatened, and Endangered Species (RTE)

The Maryland Wildlife and Heritage Division of MDNR stated that they had no records of federal or state RTE species within the Holland Island site. However, the presence of significant waterbird colonies and waterfowl concentration areas should also be taken into consideration before beginning construction.

MDNR and USFWS both agree that a bald eagle nest was present on Holland Island. USFWS, Chesapeake Bay Field Office, confirmed that the eagle was present in Nest DO-94-16. MDNR has stated that the nest no longer exists. However, the island owner stated in correspondence that a pair of bald eagles is nesting on Holland Island. Further investigation into the presence of a bald eagle nest should be completed before construction begins at Holland Island.

The shortnose sturgeon (*Acipenser brevirostrum*), a federally listed endangered species, is also a concern within the Chesapeake Bay. As of March 2002, the closest catch of the shortnose sturgeon to Holland Island was in Hooper Straits, approximately 5 miles northeast of Holland Island. The UMCES study did not identified any shortnose sturgeon in the immediate vicinity of Holland Island (Figure E-2 in Appendix E).

The island's owner has reported that the diamondback terrapins use the sandy beach areas of Holland Island every year for nesting locations. According to the

Maryland Wildlife and Heritage Division of MDNR, the diamondback terrapin is under review for inclusion on the RTE Animals of Maryland List. Formal consultation with MDNR regarding the presence and status of diamondback terrapins at Holland Island should be completed if the habitat restoration project moves forward.

A definitive answer concerning the presence of bald eagles and diamondback terrapins at Holland Island will need to be determined prior to construction. Further consultations with NMFS and USFWS about the status of the shortnose sturgeon in the Holland Island vicinity is recommended throughout the construction project.

3.4.5 Commercial Fishery

The area in the general vicinity of Holland Island supports several fisheries, including blue crabs, clams, oysters, and finfish. Specific data is not kept for Holland Island itself; however, Tangier Sound to the east and Chesapeake Bay to the west both have available data on fisheries maintained by MDNR. Oyster harvests are managed by MDNR according to harvest area codes (Appendix D). Blue crab and finfish harvest information is categorized by NOAA codes, but managed by MDNR (Figure 5-2 Appendix D).

3.4.5.1 Oysters

An abundance of oyster shells were observed on the northeast portion of Middle Holland Island during the September 2001 site visit. There are several reasons that could explain the presence of oyster shells such as, building roads or watermen's past activities. It is unlikely that any oyster bars were ever directly adjacent to Holland Island because oysters typically grow in waters 8 to 12 feet deep. The 2002 UMCES study confirmed the low abundance of oysters in the vicinity of Holland Island as shown in Figure E-3 of Appendix E.

MDNR does not keep specific oyster bar harvest data; rather it is compiled by harvest area codes. Holland Island is located near the intersection of three different oyster harvest code areas that extend quite a distance from Holland Island. Oyster disease has limited the harvest numbers for many years and harvest is generally low, about 3591.5 bushels for all three areas combined.

The closest Natural Oyster Bar (NOB) on the western side of Holland Island is several miles away in the mid-Chesapeake Bay, as confirmed by the UMCES study (Figure E-4 in Appendix E). Historical oyster bars have no legal significance, although many are within the boundaries of the legal NOBs throughout the Chesapeake Bay, and are protected. Two historical oyster bars may exist west of Holland Island. These are known as "Jugs Hill" and "Parks Hill" shown in Figure 5-1 of Appendix D. "Parks Hill" appears to lie within the proposed alignment areas. It appears that these historic oyster bars are no longer fished or viable; however, further coordination with MDNR on the presence or absence of these

historic oyster bars, and any liability issues should be determined before construction.

Disruption to the oyster harvest is expected to be minimal because most harvesting occurs in water greater than 8 feet. NOBs east of Holland Island would most likely benefit from shoreline protection reducing erosion and turbidity on the eastern side of the island.

3.4.5.2 Blue Crabs

Commercial fishery information regarding the blue crab (*Callinectes sapidus*) in the Holland Island vicinity was provided by MDNR. MDNR maintains a database of information on certain areas of the Chesapeake Bay, categorized by NOAA codes. The locations of the NOAA harvest codes are shown on Figure 5-2 of Appendix D. Data for blue crabs has been maintained since 1990 and the information is summarized in Table 5-1 of Appendix D,including over-wintering density of blue crabs (adult and juvenile) sampled in NOAA Codes 29 and 92. In general, the size of the blue crab harvest from the Holland Island vicinity has been decreasing. The overall harvest numbers are less in Tangier Sound than the Chesapeake Bay, however the number of over-wintering crabs is greater in the Tangier Sound area. As shown in Table 5-1, the total crab catch for the Tangier Sound area ranged from 2,111,073 to 4,562,919 pounds between 1990 and 2000. The results from the UMCES study on crab catch for a similar geographical area and time period gave a range of crab catch from 1,600,000 to 4,160,000 pounds.

The UMCES study also provided a graphical representation of winter mean crab abundance for the years 1990-1998. The graphical representation (Figure E-5 of Appendix E) rated the abundance of crabs from high to low and showed a higher abundance of crabs to the east of Holland Island. The study was in agreement with the NOAA information that shows a higher abundance of overwintering crabs in the Tangier Sound area which is located to the east and south of Holland Island.

Crab pots were observed during the September 27, 2001 site visit along the northwest side of Middle and North Holland Island. Continuation of crabbing near Holland Island may not be able to take place during construction; however there is an abundance of crabbing grounds in the vicinity of Holland island, and the construction would only impact a very small portion of the crabbing industry.

3.4.5.3 Finfish

Commercial finfish information was also provided by MDNR, based on NOAA codes 29 and 92. In general, the most abundant species in terms of poundage were croaker, common eel, menhaden, gray sea trout, spot, white perch, bluefish, and striped bass. Table 5-2 in Appendix D provides poundage information from 1996-2000. Based on MDNR data collected for areas 29 and 92, total pounds of finfish caught between 1990 and 2000 were estimated to be approximately 8,000,000

pounds. Data for a similar area included in the UMCES study indicated total finfish catch to range between 495,200 and 782,800 pounds. Information on the specific species of finfish included in the UMCES study was not available to compare with the MDNR list. The difference in finfish catch between the two studies may result from a difference in the number of species included and a difference in geographical areas.

Several pound nets were observed south and west of Holland Island during the site visit on September 19, 2001. These pound nets did not appear to be in the location of the proposed alignments. The UMCES study included an analysis of commercial and recreational fishing grounds in the vicinity of Holland Island. This study indicated the presence of one pound net along the proposed dike Alignment No. 1 and one adjacent to the southwest shoreline of the existing Holland Island. The location of these nets would need to be verified if the Holland Island study moves forward (Figure E-6 of Appendix E).

Commercial fishing for finfish does not take place directly adjacent to Holland Island due to extremely shallow water. Available commercial fishing data did show significant fishing in Tangier Sound, east of Holland Island, and the mainstem of the Chesapeake Bay, west of the island. No disruption to commercial fishing is anticipated during construction activities.

3.4.5.4 Clams

Soft shell clams are another valuable commercial fishery in the Chesapeake Bay, however in the Holland Island vicinity, clamming activity has been very limited. Specific data is not kept for Holland Island although MDNR Fisheries statisticians keep data for Tangier Sound and Chesapeake Bay sections. The only data MDNR had for the area was for the year 2000, with clam landings in the upper half of Tangier Sound reported at 298 bushels. This indicates that there has been little to no clamming activity in the Holland Island vicinity in the past 6 years. There are no anticipated impacts to the clamming industry in the Holland Island vicinity.

3.4.6 Recreational Resources

Holland Island is predominantly privately owned; therefore, there are no public recreational resources of significance. Recreational and commercial fishing and boating immediately adjacent to the island is limited due to very shallow water depths. The deeper channel in Kedges and Holland Straits, east of Holland Island is recreationally fished for spot and sea trout.

Any fishing activity within the proposed alignments around the western shore would be permanently displaced by the diking and restoration activities. However, there is an abundance of alternative recreational fishing and boating areas in the Holland Island area that would be available.

3.4.7 Historical Resources

A literature search at the Maryland Historical Trust (MHT), Dorchester County Historical Society, and the Dorchester County Public Library provided historical and cultural resources information pertaining to Holland Island. MHT has no record of standing structures on Holland Island; however information on three archaeological sites was present; the William A Parks Site, the Jenkins Cannon Cemetery, and Holland Island Pier.

The UMCES study confirmed the presence of archaeological sites located throughout Holland Island (Figure E-7 in Appendix E). MHT also stated that navigational charts for the Chesapeake Bay indicated two wreck sites west of Holland Island. To date there has been no submerged archeological evaluation or survey to determine the eligibility of these sites for the Maryland Register of Historic Properties. The wreck sites do not appear to be located within the proposed alignments for Holland Island. Further coordination with MHT is recommended to avoid disturbance of these areas by project activities.

According to anecdotal information provided by the owner of Holland Island, two submerged cemeteries (one consisting of only two graves) were located along the western shore of Holland Island. The presence of these cemeteries was not verified during the September 2001 field visits. However, if these areas are submerged, they may be directly impacted by the concept alignments, and restoration activities planned for the western side of Holland Island. Coordination with MHT would be necessary regarding placing fill on these areas. The two cemeteries that were verified in 2001 exist further upland and east and would not be impacted by the dikes. The existing house sits directly on the edge of the western shore, and could potentially benefit from the dikes and restoration activities, if it does not give way to erosion before then.

3.4.8 Aesthetics/Noise

Holland Island is remote and uninhabited. The majority of sounds are from natural sources such as waves, birds, and wind. Occasional recreational boating and fishing equipment is heard. The view is of an undeveloped Chesapeake Bay shoreline consisting of tidal wetlands and few upland tree stands. The nearest mainland dwellings are in the small town of Wenona, approximately 8 miles to the east, in Somerset County, Maryland. Other nearby landmasses include Bloodsworth Island and South Marsh Island. Both are uninhabited, and used as a Navy test range and a state wildlife management area, respectively. Because of the proximity to the Navy test range, occasional aircraft and artillery noise may be heard. Some viewshed and noise disturbances may occur during the construction and placement phase of the habitat restoration. This would be temporary and would not affect any human receptors.

3.4.9 Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) Liability

Preliminary evaluations of Holland Island and the concept areas have indicated that no hazardous, toxic, or radioactive substances exist within the project area. However, Bloodsworth Island, which is located approximately two miles north of Holland Island is owned by the United States Navy, and has been used for target practice in the past. Bloodsworth Island is included on the EPA Superfund list of hazardous sites, and is in the site investigation process. According to a memo from the Patuxent River NAS, the presence of unexploded ordnance in the Holland Island vicinity is "highly unlikely". There is no anticipated CERCLA liability at Holland Island, although caution should be taken if any unexploded ordnance or suspicious objects are encountered, and officials at NAS Patuxent River should be notified.

3.4.10 Critical Areas

The Critical Area Act designated all waters and lands within 1,000 feet of tidal waters or adjacent tidal wetlands as the "Critical Area". The Critical Area Act also establishes a minimum buffer of 100 feet of natural vegetation from the edge of tidal waters or wetlands. This buffer may only be disturbed for activities such as access to the shoreline, and shore erosion control measures. The Maryland Critical Areas Commission also considers open waters to be a critical area; therefore, all of Holland Island is subject to the Maryland Critical Areas regulations. The stabilization and habitat construction project areas are considered consistent with the Critical Area regulations, however specific activities should be coordinated with the Dorchester County Critical Area Commission.

3.4.11 Navigation

Due to the very shallow water surrounding Holland Island, caution is necessary when approaching the shore. The proposed configurations do not lie within or adjacent to any federal navigation areas. The nearest prohibited area is located approximately two miles north, adjacent to Pone Island, and should be avoided during navigation to Holland Island.

Impact to navigation is expected to be minimal because very few boats maneuver the shallow water directly around Holland Island. The proposed alignments are not located in any restricted or prohibited areas as displayed on the NOAA nautical charts.

4.0 FUTURE STUDY NEEDS

Several issues have been raised in the previous sections that should be resolved, and further studies should be completed if the restoration and beneficial use of the dredged material project at Holland Island is to be further considered in the selection process. The issues recommended for further study to complete the evaluation of the site are summarized below:

- Further coordination with the MHT to document historic findings.
- Coordination with the NMFS on Essential Fish Habitat.
- Formal confirmation from MDNR and USFWS regarding the bald eagle nesting site presence at Holland Island.
- Formal confirmation with MDNR and USFWS regarding the presence of diamondback terrapins at Holland Island.
- Follow up with MDNR concerning the presence or absence of historical oyster bars "Jugs Hill" and "Parks Hill".
- Coordination with the Dorchester County Critical Area Commission.
- Continued SAV monitoring and comprehensive mapping.
- Site-specific sediment sampling.
- Site-specific benthic sampling.
- Further determination of the extent of commercial and recreational fishing in area.
- Coordination with NAS Patuxent River on future work near the Bloodsworth Island boundary.
- Groundwater and hydrodynamic studies.
- Further coordination with appropriate agencies (USFWS, MDNR) regarding rookeries in the vicinity of the project area.
- Numerical modeling of the area surrounding Holland Island to refine storm surge elevations.

5.0 CONCLUSIONS

Based upon the information presented in the four studies summarized in this report, either of the proposed dike alignments at Holland Island would provide a suitable location for an environmental restoration project using dredged material. Although the cost for placement of dredged material may be higher at Holland Island than at other proposed restoration sites due to the distance from the dredging activity, this option should still be considered as a potential site.

Reconnaissance level geotechnical studies indicated that the site has acceptable foundation conditions and sufficient borrow source material to create the habitat restoration dikes at Holland Island.

Some short-term impacts to water quality may be expected as a result of construction and placement of dredged materials at the restoration site. Localized elevated nutrient or turbidity levels may occur where ponded water is discharged during the dewatering of the dredged material as the soil consolidates. The discharge would be monitored regularly to meet all discharge permit restrictions. Overall, potential impacts to environmental and historical resources as a result of the proposed construction and habitat restoration at Holland Island are expected to be minimal, and may include possible burial of abandoned gravesites, and potential burial of areas historically populated by SAV on the western side of the island. Management and design efforts may mitigate some of these potential impacts.

This site would have minor negative impacts on overall Chesapeake Bay commercial fishing grounds. There is no anticipated disruption to commercial fishing or oyster harvesting during construction activities but recreational fishing would be permanently displaced on the west side by the diking and restoration activities. Continuation of crabbing near Holland Island may not be able to take place during construction; however there is an abundance of crabbing grounds in the vicinity of Holland island, and the construction would only impact a very small portion of the crabbing industry.

There will be noise associated with construction but it would be temporary and would not affect any human receptors. There is not anticipated CERCLA liability at Holland Island, although caution should be taken if any unexploded ordnances or suspicious objects are encountered, and officials at NAS Patuxent River should be notified. Impact to navigation is expected to be minimal because very few boats maneuver the shallow water directly around Holland Island.

The studies showed that this site would have positive environmental impacts including protection of shoreline from erosion, protection of existing resources on Holland Island including heron, egret and waterbird species habitat, diamondback terrapin nesting habitat and wetland habitat and upland habitat. Existing SAV beds on the eastern side of the island would also be protected as well as upland cemeteries and other potential MHT sites from erosion. Creation of a habitat restoration island would also provide additional habitat for birds and wildlife, including RTE species in the area through provision of

additional wetland and upland habitat. The project will promote shoreline stabilization, saving Holland Island from further habitat loss due to erosion. It will also decrease impacts to aquatic habitat from high turbidity and sedimentation caused by the eroding island.

It is recommended that the Holland Island restoration project proceed for further consideration. Some additional studies, as outlined in Section 4.0, are required to determine the appropriate dike alignment. A formal engineering design should be initiated upon completion of the additional studies and selection of an alignment.

6.0 REFERENCES

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Appendix A

APPENDIX A

Reconnaissance Study of Holland Island for Beneficial Use and Habitat Restoration

FINAL GEOTECHNICAL REPORT

March 27, 2002

Under Contract To:

Maryland Environmental Service
2011 Commerce Park Drive
Annapolis, Maryland

For:
The Maryland Port Administration
2310 Broening Highway
Baltimore, Maryland

Maryland Environmental Service

Submitted by:

Baker

Michael Baker Jr., Inc.
Glen Burnie, Maryland

E2CR inc.

ENGINEERING · CONSTRUCTION · CONSULTING · REMEDIATION ·

GEOTECHNICAL RECONNAISSANCE REPORT

FOR:

HOLLAND ISLAND

CHESAPEAKE BAY, MD

PREPARED FOR:

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MARCH 2002

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EXECUTIVE SUMMARY

This report presents the results of the geotechnical reconnaissance study conducted in association with the conceptual development of a proposed beneficial use of dredged material project at Holland Island, in Dorchester County, Maryland. The proposed project would restore and create island habitat. Two dike alignments are being evaluated in this project. Alignment Numbers 1 and 2 will envelope areas of 1,639 acres and 939 acres, respectively.

This study focused on the geotechnical conditions along the proposed alignments, design of a stable dike section, and the evaluation of quality and quantity of borrow sand for the construction of the dike to an elevation of 20 feet above the existing water level. A total of twelve borings were drilled in and around the proposed dike alignments. Disturbed and undisturbed samples were extracted and the necessary index properties and strength tests were conducted in the laboratory for the geotechnical evaluation.

Analysis of the borrow area borings indicated that the available sand is generally semi-angular to angular and its fine contents varies from about 4% to 40% and is generally less than 30%. It is estimated that the total volume of suitable silty sand within the areas of Alignments 1 and 2 is approximately 15 million cubic yards and 9 million cubic yards, respectively. The net quantity of sand available (assuming a 15% loss of fines during construction) will be approximately 12 million cubic yards and 7 million cubic yards, respectively. The silty sands are considered to be suitable to support the dike on a slope of 3H: 1V up to an elevation of 20 feet above the water surface. The slope stability analyses indicated a factor of safety in excess of 1.3 for deep seated and shallow failures.

The foundation borings also indicated that pockets of soft sands should be anticipated at the surface in some borings along Alignment Numbers 1 and 2. These may need to be undercut to support the dike. The soft soils near Borings H-4 and H-5 along Alignment Number 1 will have to be undercut approximately 15 feet on the average. Along Alignment Number 2, the depth of undercut near Borings H-5, H-8 and H-10 will be approximately 10 feet on the average.

I INTRODUCTION

This report presents the results of the geotechnical reconnaissance study conducted in association with the conceptual development of a proposed beneficial use of dredged material project at Holland Island, in Dorchester County, Maryland. The overall study is being performed by Michael Baker, Jr., Inc. under contract to the Maryland Environmental Service (MES) and is sponsored by the Maryland Port Administration through MES. The investigation was conducted for Michael Baker Jr., Inc., in general accordance with E2CR's proposal dated August 23, 2001, and was verbally authorized by Michael Baker, Jr., Inc.

II SITE LOCATION / DESCRIPTION

Holland Island is located on the east side of the Chesapeake Bay, in Dorchester County, Maryland, about 20 miles east northeast of the mouth of the Potomac River. The island is located at the mouth of the Holland Straits, 4.6 miles south of Bloodsworth Island, as shown on Figure 1 and Figure 2 in Appendix A. The depth of water in the area varies from about 5 feet (ft.) to 10 ft. The existing conditions at the site are shown on Figure 3 in Appendix A.

III PROJECT DESCRIPTION

It is proposed to construct a beneficial use of dredged material project to restore and create island habitat. The project would be protected by a dike system on the west side of Holland Island. Two dike alignments are being evaluated as shown on Figure 4 in Appendix A. Alignment Number (No.) 1 will envelope an area of approximately 1,639 acres. Alignment No. 2 will enclose an area of approximately 939 acres. The dike system will be separated from the existing island by about 500 ft. of water. The existing conditions at the site are shown on Figure 3 in Appendix A.

The dike will be constructed by hydraulically or mechanically dredging the sand from the borrow area, stockpiling the sand if necessary, and then hydraulically or mechanically depositing the

sand along the dike alignment. Hydraulic placement offers certain construction advantages and was used for analytical purposes in this report. It should be noted that if dike is constructed using only mechanical dredging, the properties of the sand in the dike would change. This could affect the stability of the dike, especially shallow failures. The outside face of the dike will be protected from wave action by armor stone.

The wetlands and uplands within the diked area will be created from sediments dredged from approach channels to Baltimore. The top of the dike enclosure, where needed, is expected to vary from Elevation (El.) 5 ft. to El. 20 ft. For design purposes, the most severe case was assumed. Hence, the top of the dike was assumed to be at El. +20 ft. for this reconnaissance study.

IV PURPOSE AND SCOPE

The purpose of this reconnaissance geotechnical investigation was to:

i) Evaluate the geotechnical conditions at the site, especially along the proposed alignments;
ii) Design a stable dike section at the site in order to establish a preliminary cost estimate for developing the site;
iii) Evaluate the availability of borrow material (sand) at the site for the construction of the dike.

It should be understood that this investigation was not a design study, or even a preliminary design study. Those phases would be conducted at a later date.

The scope of our study included reviewing the available data such as Maryland Geological Survey (MGS) and Soil Conservation Service (SCS) data, drilling 12 borings; obtaining Shelby tube samples; conducting laboratory tests to determine the stress history, strength characteristics

and index properties of various strata; evaluating the data; conducting slope stability analysis for the proposed dike system; evaluating the soils at the site for possible use for constructing the dike; and preparing a geotechnical report, including developing a dike section for use in preparing a cost estimate. Evaluating offsite borrow areas was outside of the scope of this study.

V FIELD INVESTIGATION

The field investigation was conducted in November 2001. A total of 12 borings (H-1 through H-12) were drilled at the approximate locations shown on Figure 4 in Appendix A. All borings were drilled using a trailer mounted drill rig placed on a barge. Standard penetration tests were conducted and split spoon samples were obtained in every boring at depth intervals of 2.5 ft. to 5 ft. A representative portion of each sample was placed in a glass jar and was appropriately marked. Three inch Shelby tube samples were obtained in Borings H-4, H-5 & H-12 in the cohesive soils. All samples were sent to our laboratory for further testing. The depth of the borings varied from about 40 ft. to 70 ft., as tabulated below:

	Depth (ft.)	
Boring	Water	Boring
H-1	6	48.7
H-2	10	60
H-3	13	45
H-4	13	55
H-5	7	40
H-6	6	40
H-7	8	45
H-8	7	50
H-9	8.5	40
H-10	9	70
H-11	8	45
H-12	7	45

All borings were inspected and the samples were logged and classified by a Geologist. The edited logs of the borings are included in Appendix E.

VI LABORATORY TESTING

All samples were visually classified in the laboratory by a Geotechnical Engineer to corroborate and/or modify the field classifications. Selected samples were tested for their natural water content, Atterberg limits, sieve analysis, percent fines, shear strength (unconfined compression tests, torvane and pocket penetrometer tests) and consolidation characteristics. A total of 63 water contents, 10 Atterberg limits, 5 sieve analysis, 31 percent fines, 3 consolidation tests and 4 unconfined compression tests were conducted. All tests were conducted in accordance with American Society for Testing Materials (ASTM) procedures. The results of the laboratory tests are included in Appendix D. A summary of laboratory test results is presented in Table 1 in Appendix B.

VII PUBLISHED DATA

The available data that was reviewed included:

- Maryland Geologic Survey (MGS) Reports and Maps (Figure 5 in Appendix A)
- Soil Conservation Service Publications for Dorchester County
- MGS's side scan sonar profiles (Figure 6 in Appendix A). The survey was conducted by MGS on June 2, 2001. The side scan sonar profiles were used to locate some borings.

A. Area Geology

The site lies in the Coastal Plain Physiographic Province. According to Maryland Geologic Survey, the formation at the site is the lowland deposits (Qdu) (Figure 5 in Appendix A).

This basically consists of undifferentiated gray to buff Sand and Gravel, gray to brown lignitic Silt and Clay, occasional boulders and rare shell beds. Surficial deposits occur as intercalated fluvial sands and marsh muds, well-sorted stabilized sand dunes, shell bearing estuarine clays and silts, and beach zone sand.

VIII SUBSURFACE CONDITIONS

The subsurface conditions along the perimeter of the dike and in the potential borrow area (within the diked area) are significantly different and are therefore, discussed separately.

A. Foundations

The borings indicate that the subsurface stratigraphy along the perimeter of Alignment No. 1 and 2 generally consist of three major strata, as shown on Figures 7 and 8 – Generalized Subsurface Profile in Appendix A.

Stratum I: This stratum, depicted in green consists of very loose to medium dense gray and brown Silty Sand (SM). Standard penetration resistance varies from about Weight of Hammer (WOH) to 50 blows/2 inch. Fines content (i.e. percent passing U.S. standard sieve No. 200) is generally 4% and 40%. The thickness of stratum varies from 4 ft. to 25 ft. It occurs at the surface (mud line), except in Borings H-4, H-5 and H-10, where Stratum II is at the mud line. In Boring H-8, this stratum was also encountered at El. –18 ft. In Borings H-5 and H-10, Stratum I was encountered beneath Stratum II and the thickness of Stratum I generally varied from about 5 ft. to 10 ft. Stratum I was also encountered in Borings H-1 and H-10 at deeper depths, below Stratum II, as shown on Figures 7 and 8 in Appendix A. The sand is semi-angular to angular, and is medium to fine.

It should be noted that this stratum contains pocket of greenish gray Clayey Sand. It is defined as Stratum IA and depicted, as dark green in Figure 7 included in Appendix A. Stratum IA was not encountered along Alignment No. 2.

Stratum II: This stratum is depicted in yellow on Figures 7 and 8. This was encountered in Borings H-3, H-4, H-5, H-8 and H-10. This occurs at the mud line except in Boring H-3, where Stratum II was encountered within Stratum I from El. –25 ft. to El. –32 ft. Stratum II is about 6 ft. to 20 ft. thick at Boring H-4, H-5, H-8 and H-10 locations, and consists of very soft to soft, greenish gray to brownish gray Silty Clay (CL-CH) with a trace of some sand. Standard penetration resistance varies from Weight of Rod (WOR) to 8 blows/ft. Laboratory test data indicates that its index properties are as follows:

Liquid limit (LL)	55 to 73
Plastic Limit (PL)	25 to 33
Plasticity Index (PI)	27 to 40
Water Content	59% to 73%
Preconsolidation Pressure (psf)	500 to 1000

The water content in the samples was generally less than the Liquid Limit.

It is believed that this stratum represents a channel that was eroded from Stratum I and was later redeposited in the eroded channel. It is normally consolidated.

Stratum III: This stratum, depicted in red, underlies most of the site, and consists of soft to stiff green gray Silty Clay with pockets of Silty Sand. The top of the stratum varies from about El. -28 to El. -40. Standard penetration resistance varies from WOR to 12 blows/ft. The WOR value is believed to be non-representative of the in-situ conditions. Laboratory tests indicate that the geotechnical properties of this stratum are as follows:

Liquid Limit	28 to 57
Plasticity Index	27 to 11
Water Content	30% to 52%

This stratum extends to the bottom of the borings, except in Borings H-1 and H-10 where it is only about 5 ft. to 14 ft. thick.

B. Borrow Area

The subsurface conditions in the borrow area, especially close to the shore, are highly variable, compared to those along or close to the proposed alignment of the dike. Near the shore, the soils consist of discontinuous layers of gray brown Silty Clay, Sandy Clay, Clayey Sand and Silty Sand. The thickness of the layers vary from 3 ft. to 20 ft., and there appears to be a lack of continuity of any significantly thick layers.

Along or close to the alignment, the Silty Sand appears to be up to about 25 ft. thick, with minimal clay cover.

Laboratory tests indicate that the percent fines content in the Silty Sands vary from 4% to 40%, but is generally less than 30%, as shown in Table 1 in Appendix B.

The borrow area soils data, including thickness of clay to be stripped and the thickness of the sand available, are summarized in Table 2 in Appendix B and also shown on Figure 10 (see Appendix A). The locations of potential borrow areas are shown on Figure 9 in Appendix A.

IX EVALUATION AND ANALYSIS

A. General

The two major issues concerning the geotechnical evaluation of a dredged material placement site are:

- Borrow: Availability of suitable borrow material within the enclosed area:

The borrow should ideally be a Sand, with as little fines (i.e. percent passing U.S. Standard sieve No. 200) as possible. If Sand is not available locally, it will either have to be imported (which increases the cost significantly), or the dike would have to be constructed from on-site Clay (usually not practical due to the low strength of the Clay placed in the dike), or another type of enclosed structure would need to be used.

- Foundation: Foundation conditions under the enclosed (perimeter) dike:

Soft Clays in the foundation soils would require flatter slopes for the dike, or steeper slopes and stabilizing berms. Stiff Clays and Sands are the preferred conditions. Flatter slopes or berms would increase the cost. Additionally, areas that have very soft Clays may require the total or partial removal (either by displacement or by undercutting) of the very soft Clay. The undercut soil has to be disposed of, either on-site or off-site, and the undercut area has to be backfilled with Sand.

In evaluating the stability of a slope, four variables have to be considered:

i) The analytical method used.
ii) Shear strength of the foundation soil and the embankment soil.
iii) The slope of the dike.
iv) The acceptable factor of safety.

B. Borrow: Quality and Quantity of Sand

In evaluating the borrow area, two variable have to be evaluated: i) quality of sand and ii) quantity (volume) of sand.

i) Quality of Sand:

The borings indicate that the sand, in general, is semi-angular to angular. The fines content varies from about 4% to 40%, and is generally less than 30%. The sand is Clayey in some areas, and also contains pockets/layers of clay. The sand is considered to be suitable for building the dike.

ii) Quantity of Sand

The locations of the potential borrow areas are shown on Figure 9 in Appendix A.

The quantity of sand available in all stratums was estimated based on the limited available data. It was assumed that no dredging will be done within 300 feet of the toe of the dike. The thickness of Clay that will need to be stripped and the thickness of Sand available at each boring are shown in Table 2 in Appendix B and are also presented on Figure 10 in Appendix A.

For Alignment No. 1, the volume of total sand available is estimated to be about 15 million cubic yards. During construction, the bulking will be minimal, since the sand is loose. In addition, about 15% of the fines will be lost. Therefore, the net quantity of sand available for dike construction is estimated to be about 12 million cubic yards. Additional sand will also be available outside the dike area.

For Alignment No. 2, the total volume of sand available within the dike area is about 9 million cubic yards, and the net volume available is about 7 million cubic yards. Additional sand will also be available outside the dike area.

It appears that adequate sand is available to build the dike to El. 20.

C. Foundation/Slope Stability

i) Analytical Method

Slope stability analyses were conducted using one typical case for the subsurface profile. Purdue University PC STABL-V program was used to analyze the stability of the slopes. This program incorporates many different analytical methods, such as circular failure and wedge failure. Also, the failures can be analyzed using different approaches, such as the Modified Bishop Method, the Modified Janbu Method and the Spencer Method. For this study, the Modified Bishop method was used. The Janbu Method results in Factor of Safety, which is generally considered to be too conservative, and is about 15% less than the Bishop's Method.

ii) Design Parameters (Shear strength of foundation and embankment)

For Alignment No. 1 and Alignment No. 2, the shear strength of the foundation soils was based on the evaluation of Standard Penetration Tests (SPT), since the soils in the foundation are mostly Silty Sands.

At Alignment No. 1, very soft Clay was encountered in Borings H-4 and H-5. At Alignment No. 2, soft Clay was encountered in Borings H-5, H-8 and H-10. These soft Clays will have to be undercut.

The following design parameters were used for the foundation soils.

Stratum	N	γ pcf	C psf	ϕ Degree
I	6-10	120	0	28
II *	WOR	115	100	0
III	4-12	120	500	0

* Will be undercut

N = Standard Penetration Resistance in blows/ft.

γ = Density of soil in pcf

C = Cohesion in psf

ϕ = Angle of internal friction

The dike will be constructed from the on-site sands. In past projects, the ϕ in the dike has been assumed to be 30° above the water and 28° below the water for hydraulically dredged sands for non-plastic Silty Sands. However, it is conceivable and likely that the fines in the dike at this site could be plastic, especially since the borrow area inside Alignment No. 2 consists of Clayey Silty Sands, Clayey Sands and Silty Clays near the shore. Therefore, two cases were analyzed: one for non-plastic fines in the dike fill and the other for plastic fines in the dike fill. The following design parameters were used for design:

Case A – Non-Plastic Fines	γ pcf	C psf	ϕ degrees
• Above Water	120	-	30
• Below Water	120	-	28

Case B – Plastic Fines	γ pcf	C psf	ϕ degrees
• Above Water	115	100	20
• Below Water	110	0	20

The subsurface profiles did not warrant the use of a wedge type of failure, since there are no thin soft layers. Therefore, only circular failures were analyzed. It should be noted that if mechanical dredging is used, the ϕ values used in the above analysis would decreased, thereby reducing the factor of safety specially for shallow failures.

iii) Slope of dike

During construction, the slope of the dike can vary considerably, depending upon the type of soil, placement methodology, and whether the soil is placed above or below the water. Past experience has indicated that dikes constructed from Silty Sands (non-plastic) can achieve slopes as steep as 2H:1V below the water. However, 3H:1V is a more realistically obtainable slope. Also, during dredging, pumping and placement, about 15% of the fines can wash out for hydraulically dredged and placed sand. Thus, if a borrow area has 30% non-plastic fines, the dike will tend to have about 10% to 15% fines. For mechanically dredged and placed sands, the loss of fines would be much smaller. For this reconnaissance phase, it was assumed that the dike would be constructed by hydraulic dredging, and the slopes achievable would be 3H:1V below the water table.

iv) Acceptable Factor of Safety

The acceptable factor of safety was assumed to be 1.3, at the end of the dike construction phase. This was also based on the experience at the Hart-Miller Island Dredged Material Containment Facility and the Poplar Island Environmental

Restoration Projects, and was considered to be acceptable to the U.S. Army Corps of Engineers (USACE). The USACE will be involved in the permit process, and will review and approve the final design for this project, if this project is implemented.

The design sections for slope stability analysis are shown on Figures 11 and 12 in Appendix A. The results of the analyses: Case A (non-plastic fill) and Case B (plastic Silty Sand) are presented in Appendix C.

The analysis indicates that the Factor of Safety for the assumed design section is in excess of 1.3 for deep seated and for shallow failures. It is recommended that the slopes of the dike be no steeper than 3H:IV, as shown on the design section.

D. Undercutting

The borings indicate that along Alignment No. 1, soft soils should be anticipated at the surface (mud line) near Borings H-4 and H-5. Similarly, soft soils are anticipated in Borings H-5, H-8 and H-10, along Alignment No.2. These soft soils will need to be undercut. The volume of undercut, in relation to total dike alignment length, is anticipated to be larger along Alignment No. 2 compared to Alignment No. 1. Other areas of soft soils that will need to be undercut should also be anticipated and would be identified in the next level of study, if undertaken.

X CONCLUSIONS

Based on the limited boring data, the following is concluded:

A. Alignment No.1

i) The foundation soils for Alignment No. 1 are anticipated to be mostly loose Silty Sands, except near Borings H-4 and H-5, where the soils are very soft Silty Clay.

ii) The dike along Alignment No. 1 can be founded on the Silty Sand, using a slope of 3H:IV. However, the soft Clays near Borings H-4 and H-5 will have to be undercut about 15 ft. on the average.

iii) A total of about 15+ million cubic yards of Silty Sand and a net (i.e. assuming 15% loss of during hydraulic dredging and placement) of about 12+ million cubic yards of Silty Sand is estimated to be available within the diked area.

B. Alignment No. 2

i) The soils in the foundation are anticipated to vary considerably, from very soft Silty Clay (near Borings H-5, H-8 and H-10) to loose Silty Sands (near Boring H-6).

ii) The sands are considered to be suitable for supporting the dike on a 3H:IV slope. However, the very soft Clays will need to be undercut. The depth of undercut near Borings H-5, H-8 and H-10 will have to be about 10 ft. on the average.

iii) The total volume of Silty Sand available within the diked area is estimated to be about 9+ million cubic yards and the net (i.e. assuming 15% loss of during hydraulic dredging and placement) volume is estimated to be about 7+ million cubic yards.

REFERENCES

Achilleos, E (1988), *User Guide For PC STABL 5M*, School Of Civil Engineering, Purdue University, West Lafayette, Indiana.

Terzaghi, K. and Peck, R.B. (1948), *Soil Mechanics in Engineering Practice*, 1st edn., Wiley, New York.

U.S. Navy, Naval Facilities Engineering Command, *Soil Mechanics – Design Manual 7.01*, Alexandria, Virginia, 1986.

U.S. Navy, Naval Facilities Engineering Command, *Foundations & Earth Structures – Design Manual 7.02*, Alexandria, Virginia, 1986.

APPENDICES

Appendix A
Figures

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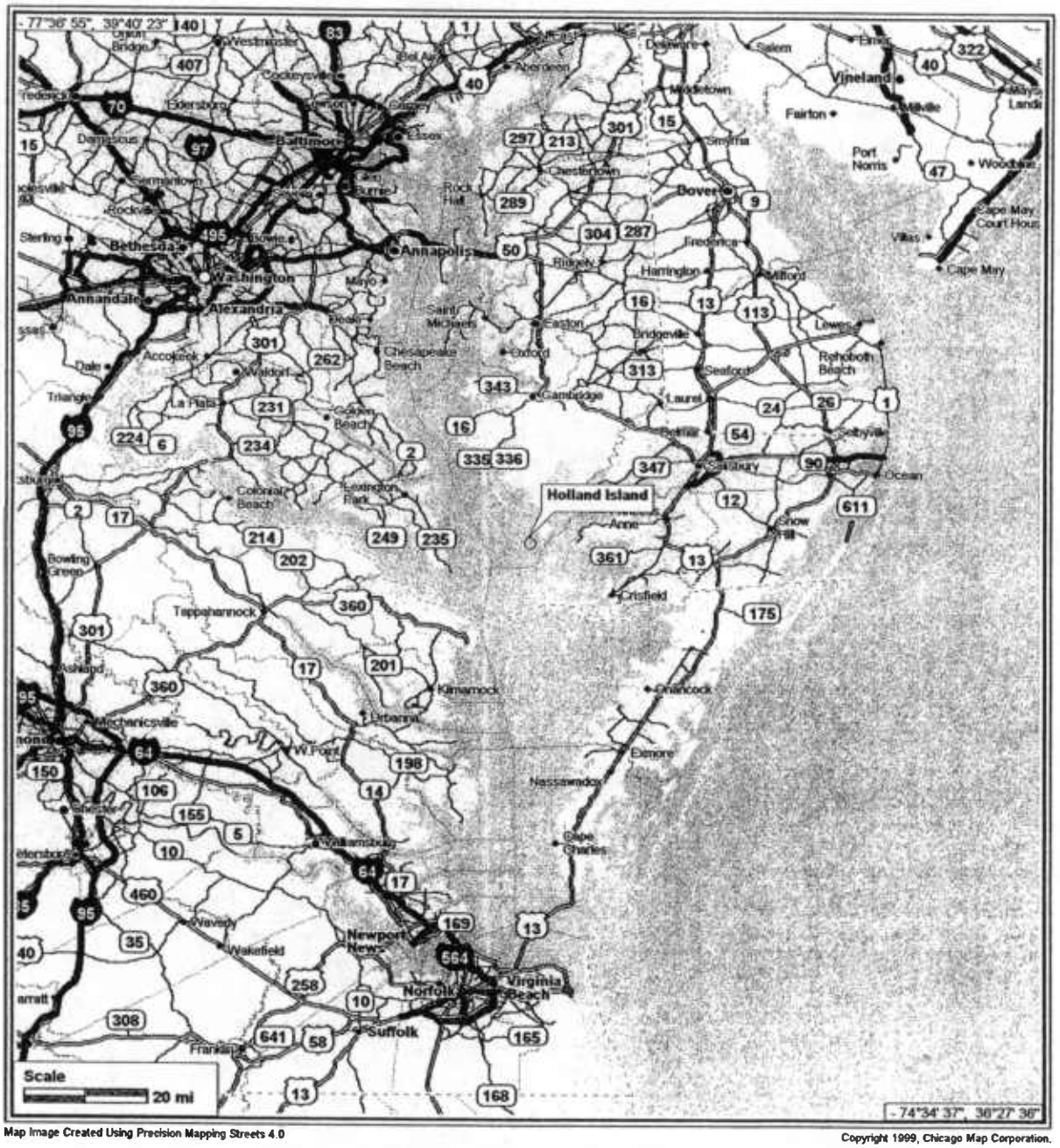
SITE VICINITY MAP
HOLLAND ISLAND
CHESAPEAKE BAY, MARYLAND

FIGURE: 1	DRAWN BY: NS	CHECKED BY:
DATE: NOV., 01	JOB NO: 01558-04	SCALE:

HOLLAND ISLAND



Map Image Created Using Precision Mapping Streets 4.0

Copyright 1999, Chicago Map Corporation.

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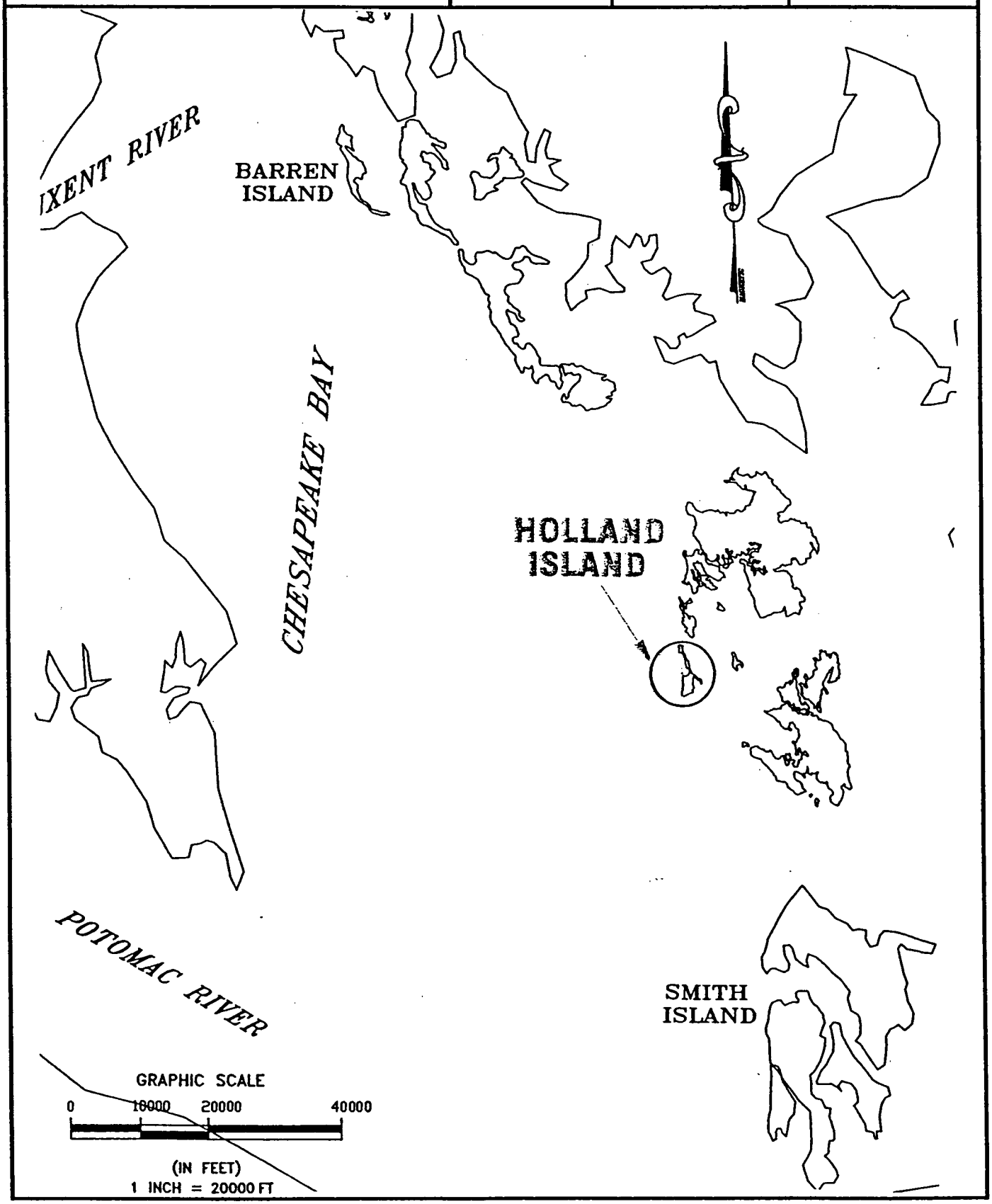
SITE LOCATION PLAN
HOLLAND ISLAND
CHESAPEAKE BAY, MARYLAND

FIGURE: 2	DRAWN BY: NS	CHECKED BY:
DATE: NOV., 01	JOB NO: 01558-04	SCALE:



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EXISTING CONDITIONS
HOLLAND ISLAND
CHESAPEAKE BAY, MARYLAND

FIGURE: 3	DRAWN BY: NS	CHECKED BY:
DATE: NOV.01	JOB NO.: 01558-04	SCALE:

Note: **Aerial photograph taken in July 2001**

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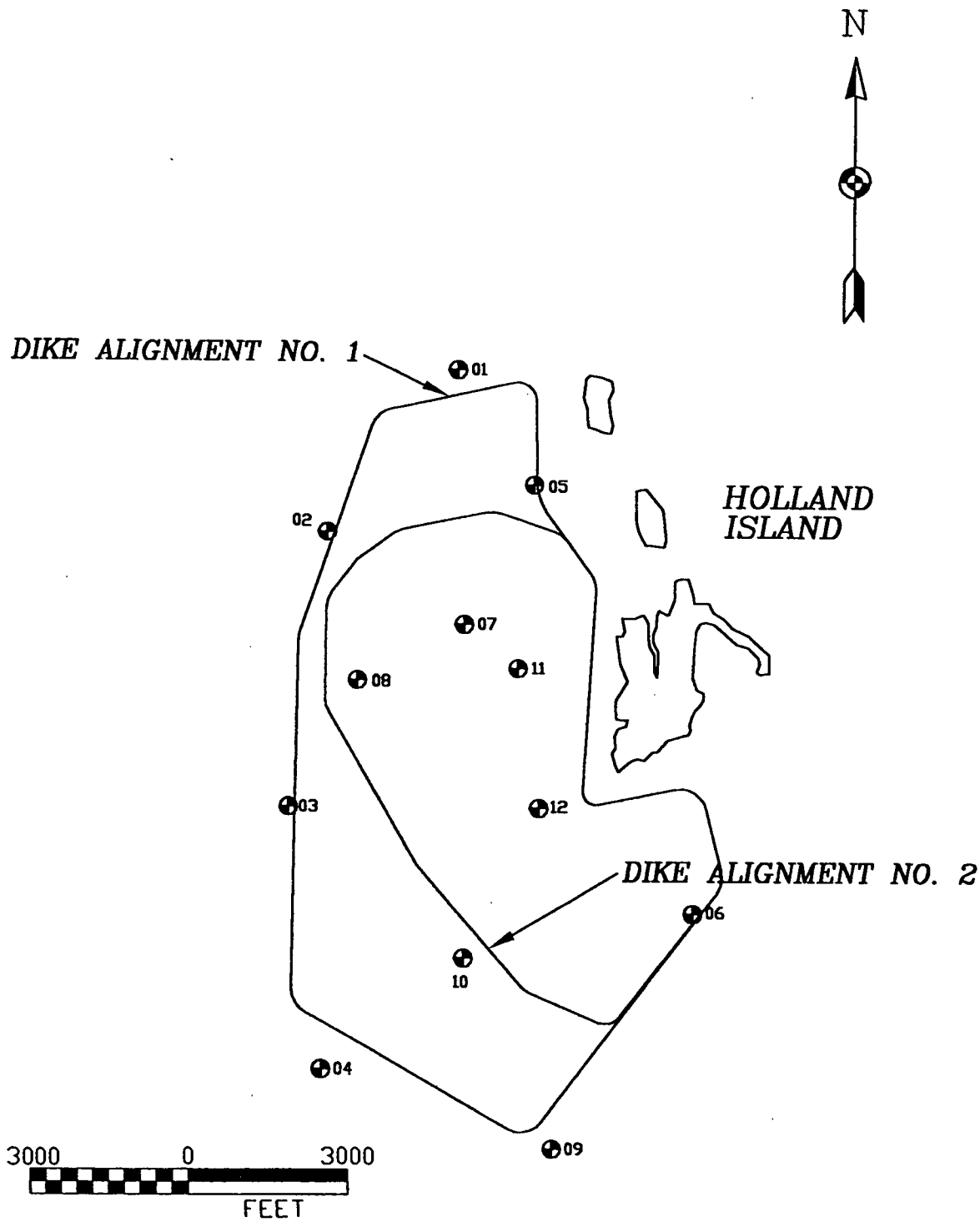
ALTERNATE ALIGNMENTS / TEST BORING LOCATION PLAN

HOLLAND ISLAND, CHESAPEAKE BAY, MARYLAND

FIGURE: 4	DRAWN BY: NS	CHECKED BY:
DATE: NOV., 01	JOB NO: 01558-04	SCALE: 1"=3000'



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E2CR inc.

CONSTRUCTION · REMEDIATION ·

GEOLOGICAL MAP
HOLLAND ISLAND
CHESAPEAKE BAY, MARYLAND

FIGURE: 5	DRAWN BY: NS	CHECKED BY:
DATE: NOV., 01	JOB NO: 01558-04	SCALE:

adapted from
Maryland Geological Survey's
Geologic Map of Maryland
(1968)

5 0 5
statute miles

0
5 kilometers 5

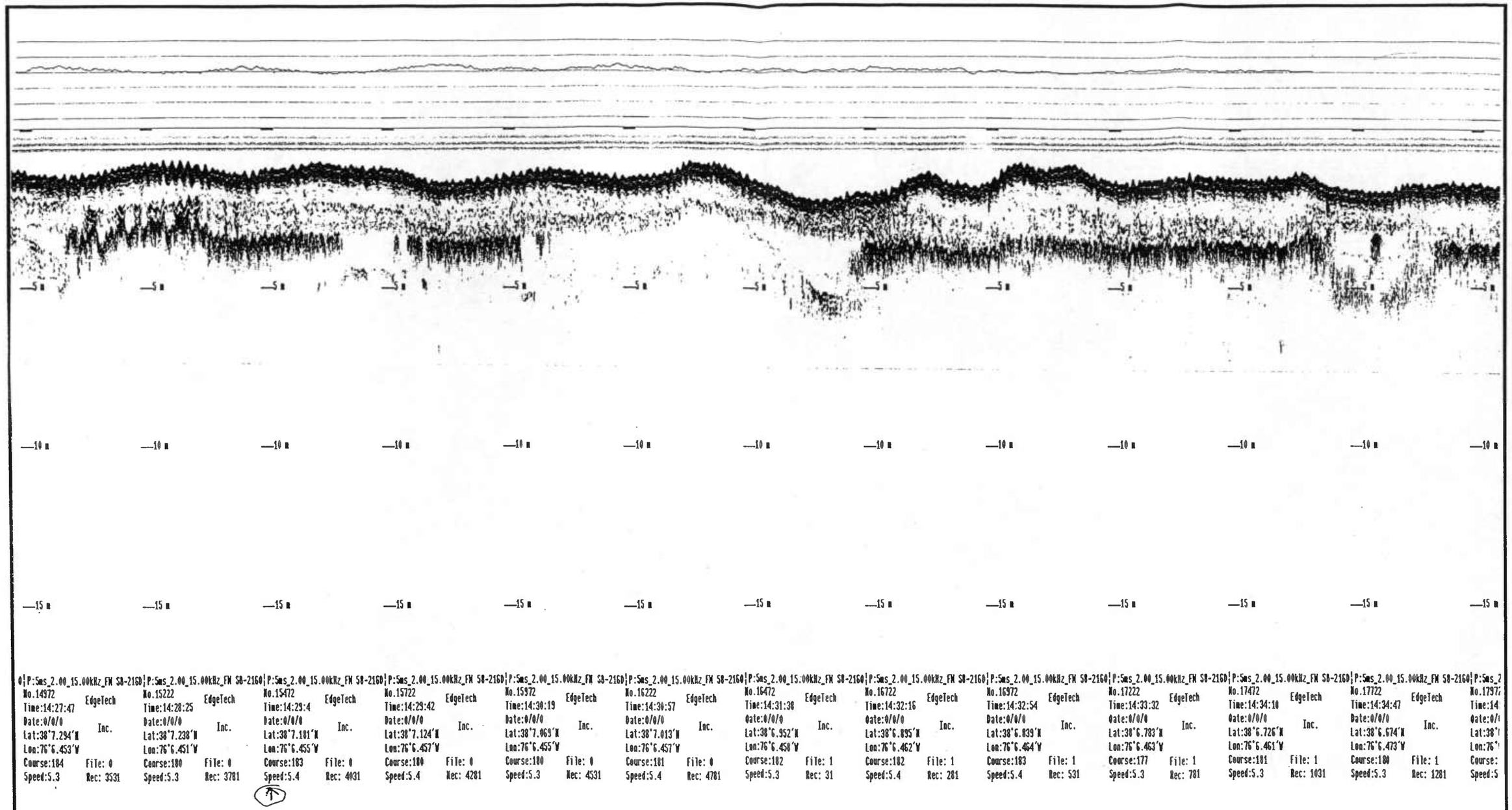
QUATERNARY
PLEISTOCENE TO RECENT

Qdu

Lowland Deposits
Undifferentiated gray to buff sand and gravel, gray to brown lignitic silt and clay, occasional boulders, and rare shell beds.
Surficial deposits occur as intercalated fluvial sands and marsh muds (e.g. in upstream floodplains of the Wicomico and Nanticoke Rivers), well sorted, stabilized sand dunes (e.g. eastern Wicomico County), shell-bearing estuarine clays and silts (e.g. lower Dorchester County and Pocomoke River basin of Worcester County), and beach zone sands (e.g. Fenwick and Assateague Islands). Wisconsin to Holocene in age.
Subsurface deposits of pre-Wisconsin age consist of buff to reddish-brown sand and gravel locally incised into Miocene sediments (e.g. Salisbury area), estuarine to marine white to gray sands, and gray to blue, shell-bearing clays (e.g. Worcester County).

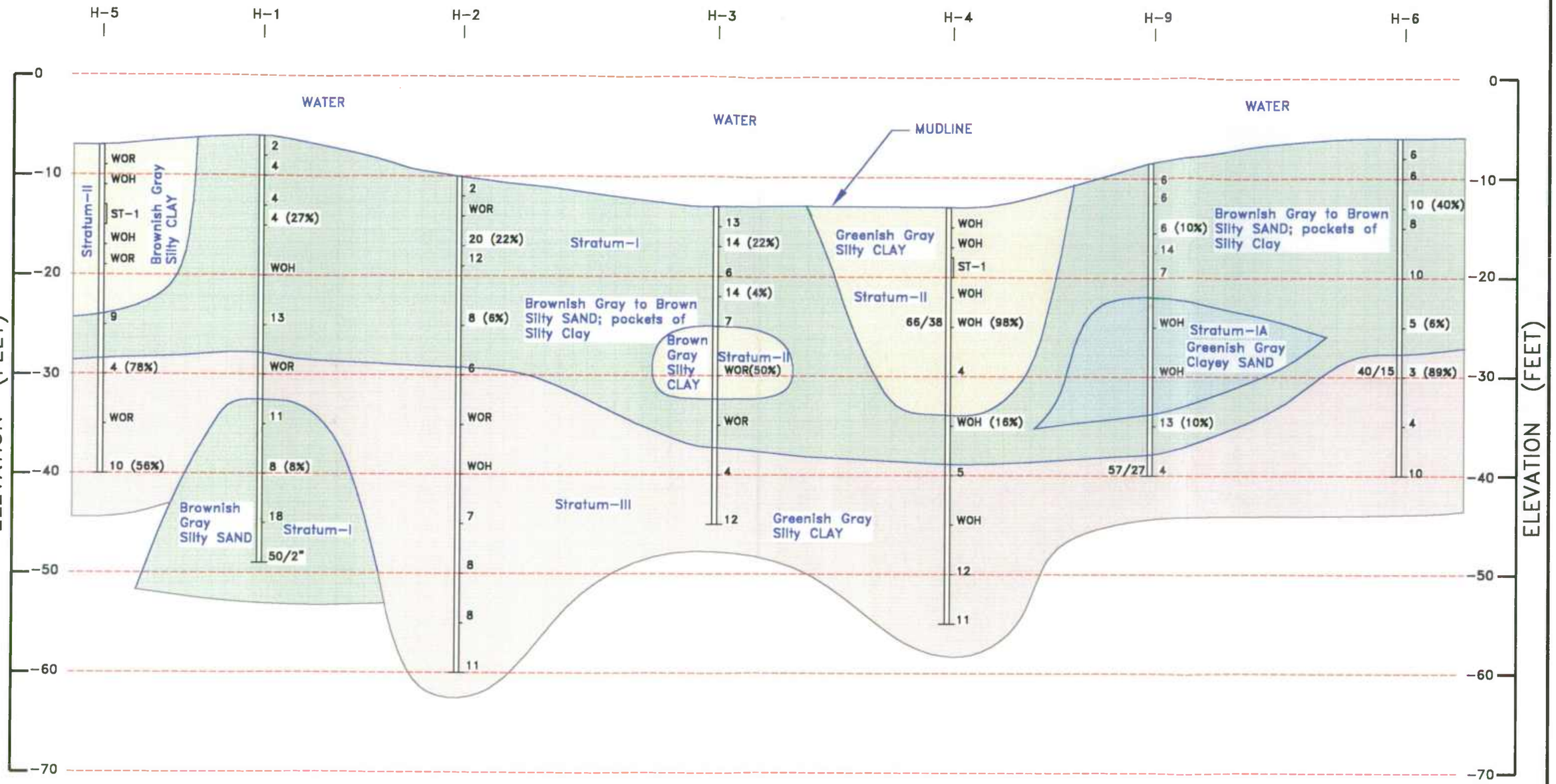
Ql

Lowland Deposits
Gravel, sand, silt and clay. Medium- to coarse-grained sand and gravel; cobbles and boulders near base; commonly contains reworked Eocene glauconite; varicolored silts and clays; brown to dark gray lignitic silty clay; contains estuarine to marine fauna in some areas (includes in part Pamlico, Talbot, Wicomico and Sunderland Formations of earlier reports); thickness 0 to 150 feet.



Note: The survey was conducted by MGS on June 2, 2001

E2CR, INC.	SIDE SCAN SONAR PROFILE HOLLAND ISLAND	FIGURE: 6	DRAWN BY: NS	CHECKED BY:
		DATE: NOV.,2001	JOB NO.: 01558	SCALE:



LEGEND

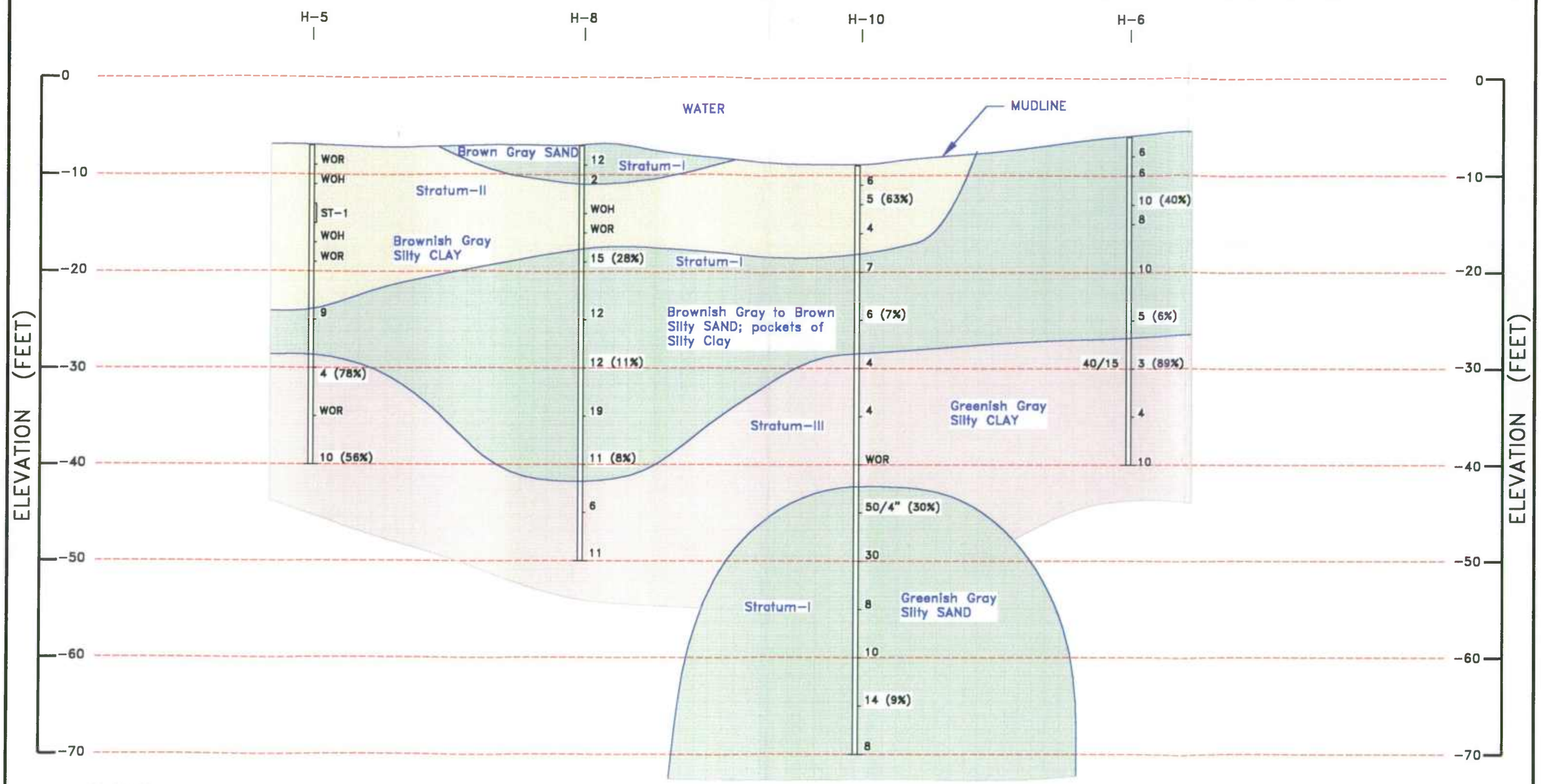
H-1 – Boring Number

WOR – Weight of Rod
WOH – Weight of Hammer
10 – Standard Penetration Resistance, Blows/foot
– Water surface elevation
(22%) – Percentage Fines
66/38 – Liquid Limit/Plasticity Index
ST – Shelby Tube

HOLLAND ISLAND
DIKE ALIGNMENT NO. 1

SCALE
H: 1" = 2000'
V: 1" = 10'

E2CR, INC.	GENERALIZED SUBSURFACE PROFILE	FIGURE: 7	DRAWN BY: NS	CHECKED BY: SB
		DATE: JAN., 2002	JOB NO.: 01558-04	SCALE:



LEGEND

H-1 – Boring Number

WOR – Weight of Rod
WOH – Weight of Hammer
10 – Standard Penetration Resistance, Blows/foot
– Water surface elevation
(22%) – Percentage Fines
66/38 – Liquid Limit/Plasticity Index
ST – Shelby Tube

HOLLAND ISLAND
DIKE ALIGNMENT NO. 2

SCALE
H: 1" = 2000'
V: 1" = 10'

E2CR, INC.

GENERALIZED SUBSURFACE PROFILE

FIGURE: 8	DRAWN BY: NS	CHECKED BY: SB
DATE: JAN., 2002	JOB NO.: 01558-04	SCALE:

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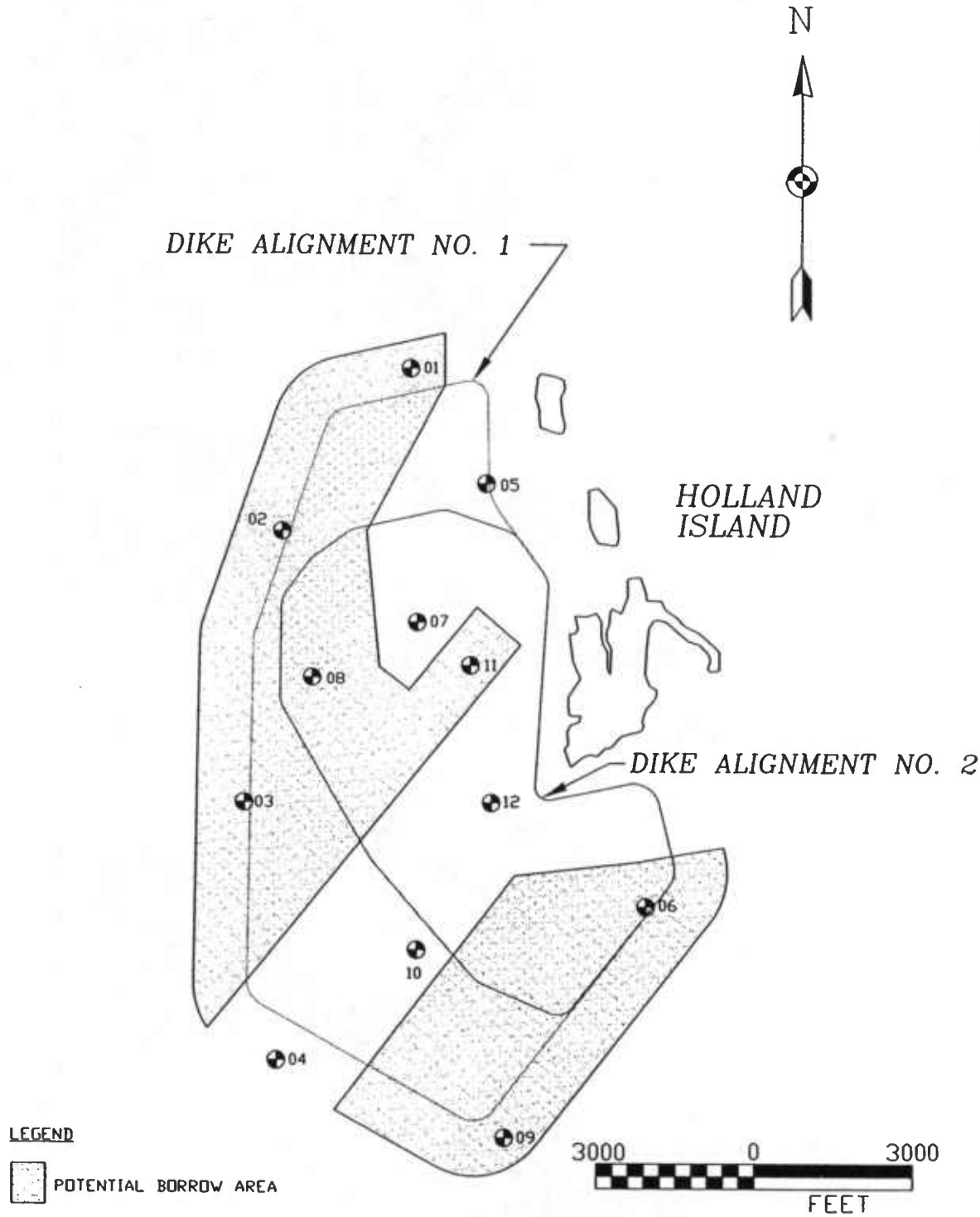
LOCATION OF POTENTIAL BORROW AREAS
HOLLAND ISLAND,
CHESAPEAKE BAY, MARYLAND

FIGURE: 9	DRAWN BY: NS	CHECKED BY:
DATE: NOV., 01	JOB NO: 01558-04	SCALE: 1"=3000'



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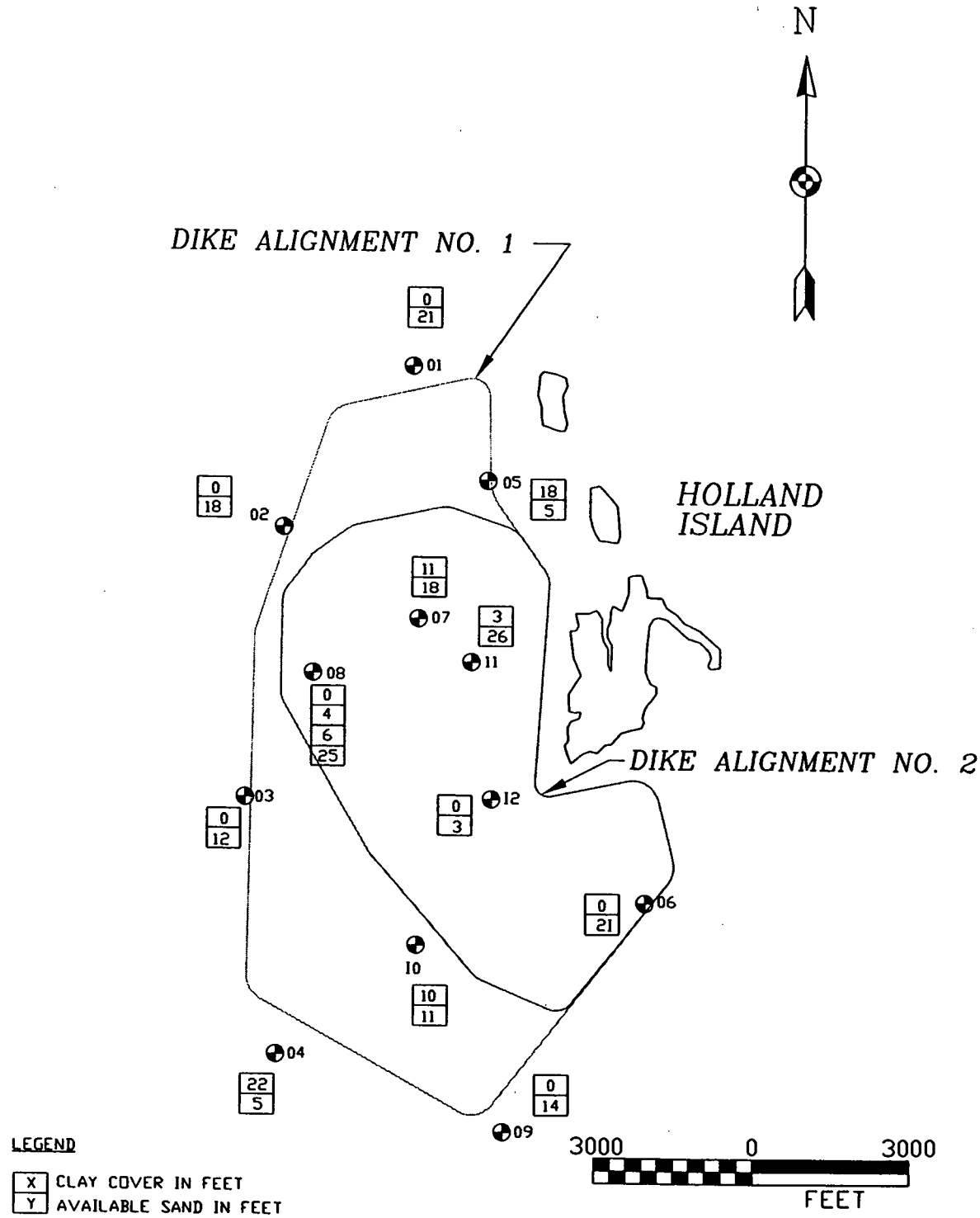
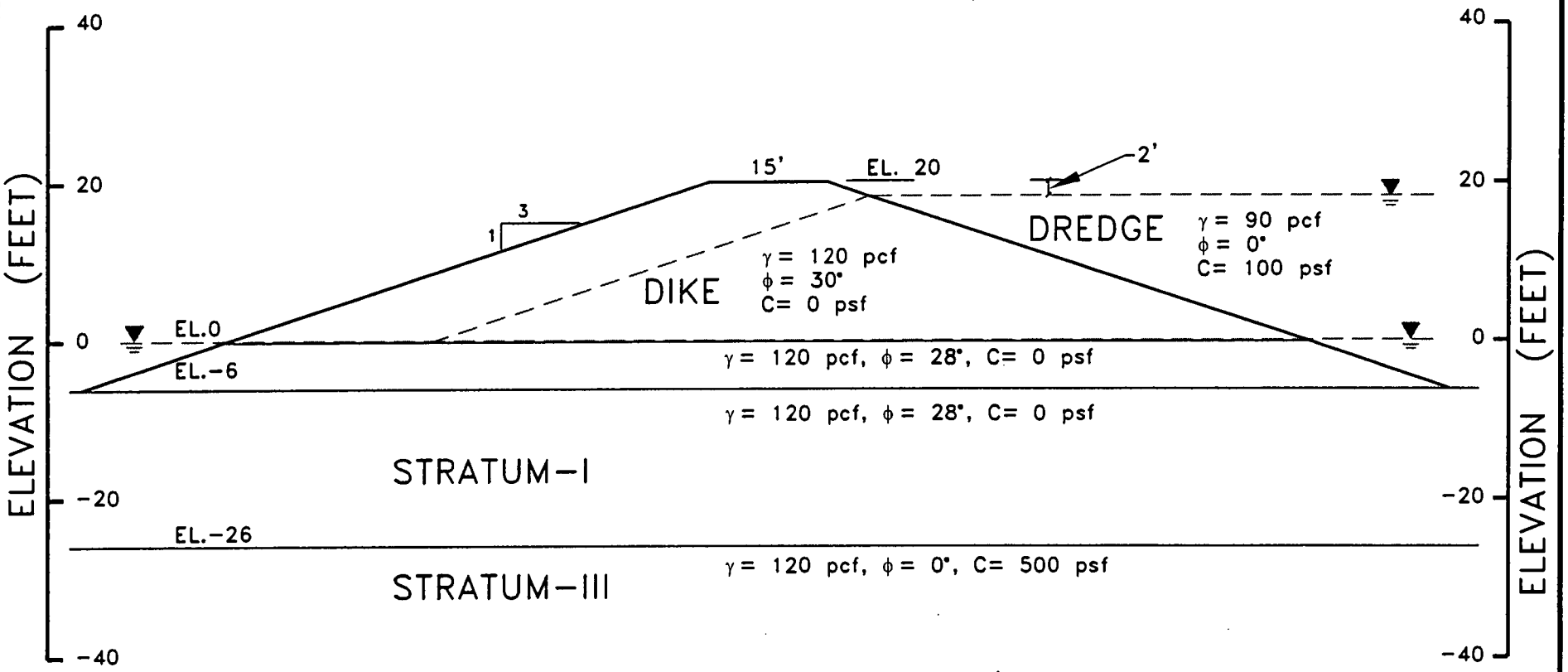
CONSTRUCTION · REMEDIATION ·

THICKNESS OF CLAY AND SAND - BORROW AREAS

HOLLAND ISLAND, CHESAPEAKE BAY, MARYLAND

FIGURE: 10	DRAWN BY: NS	CHECKED BY:
DATE: NOV., 01	JOB NO: 01558-04	SCALE: 1"=3000'



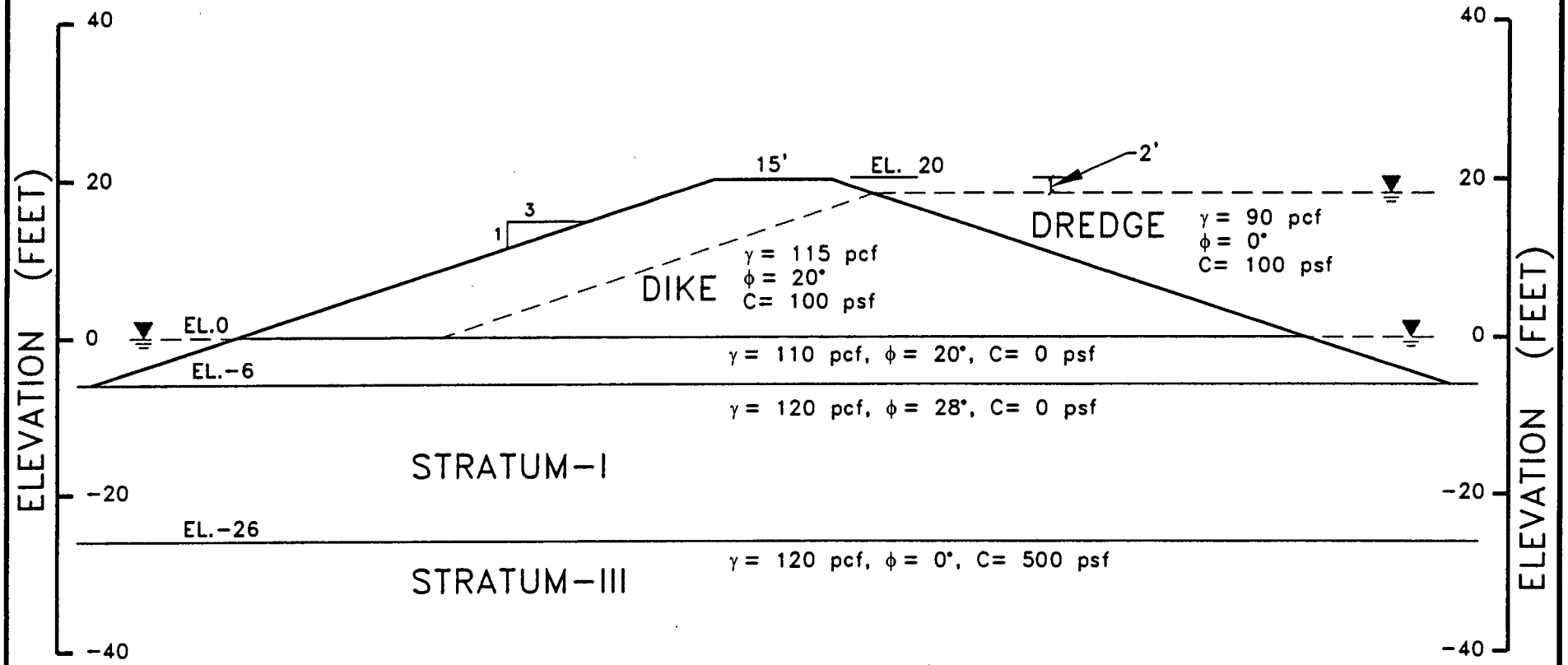


CASE-A (Non plastic fines in the embankment)

CASE-A1: Dike to EL. +10
CASE-A2: Dike to EL. +15
CASE-A3: Dike to EL. +20

SCALE
H: 1" = 20'
V: 1" = 20'

E2CR, INC.	HOLLAND ISLAND SLOPE STABILITY ANALYSIS	FIGURE: 11	DRAWN BY: NS	CHECKED BY: SB
		DATE: JAN.,2002	JOB NO.: 01558	SCALE:



CASE-B (Plastic fines in the embankment)

CASE-B1: Dike to EL. +10
CASE-B2: Dike to EL. +15
CASE-B3: Dike to EL. +20

SCALE
H: 1" = 20'
V: 1" = 20'

E2CR, INC.	HOLLAND ISLAND SLOPE STABILITY ANALYSIS	FIGURE: 12	DRAWN BY: NS	CHECKED BY: SB
		DATE: JAN.,2002	JOB NO.: 01558	SCALE:

Appendix B
Tables

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TABLE-1: SUMMARY OF LABORATORY TEST RESULTS

Holland Island

E2CR Project No. 01558-04

Note : * Depth from the existing water surface at El. 0.00

BORING NO	SAMPLE NO	DEPTH* (FEET)	NATURAL MOISTURE CONTENT (%)	LIQUID LIMIT (%)	PLASTICITY INDEX (%)	GRAIN SIZE DISTRIBUTION			USCS CLASSIFICATION	SHEAR STRENGTH		STRATUM
						GRAVEL (%)	SAND (%)	FINES (%)		PENETRO QP(PSF)	TORVANE TV(PSF)	
H-1	S-4	13.0-15.0					73	27	SM			I
	S-9	38.5-40.0	20.9					8	SP-SM			I
H-2	S-3	15.0-17.0						22	SM			I
	S-5	23.5-25.0						6	SP-SM			I
	S-10	48.5-50.0	46.5									III
H-3	S-2	15.0-17.0	20.5				78	22	SM			I
	S-4	20.0-22.0	26.0				96	4	SP			I
	S-6	28.5-30.0	16.6					50	CL			II
	S-8	38.5-40.0	42.7							1500	1120	III
	S-9	43.5-45.0	45.2							2000	1250	III
H-4	S-2	15.0-17.0	73.3									II
	ST-1	18.0-20.0	67.9	73	40				CH	500		II
	S-3	20.0-22.0	65.7									II
	S-4	23.5-25.0	59.3	66	38			98	CH			II
	S-5	28.5-30.0	69.6									II

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TABLE-1: SUMMARY OF LABORATORY TEST RESULTS

Holland Island

E2CR Project No. 01558-04

Note : * Depth from the existing water surface at El. 0.00

BORING NO	SAMPLE NO	DEPTH* (FEET)	NATURAL MOISTURE CONTENT (%)	LIQUID LIMIT (%)	PLASTICITY INDEX (%)	GRAIN SIZE DISTRIBUTION			USCS CLASSIFICATION	SHEAR STRENGTH		STRATUM
						GRAVEL (%)	SAND (%)	FINES (%)		PENETRO QP(PSF)	TORVANE TV(PSF)	
H-4	S-6	33.5-35.0	32.4				84	16	SM			I
	S-7	38.5-40.0	52.7							1000	500	III
	S-8	43.5-45.0	41.8									III
	S-9	48.5-50.0	29.2									III
	S-10	53.5-55.0	31.4							3000	1500	III
H-5	S-1	7.0-9.0	53.7									II
	S-2	9.0-11.0	59.4									II
	ST-1	13.5-15.0	47.4	55	27				CH	340		II
	S-3	15.0-17.0	59.1									II
	S-4	17.0-19.0	23.2									II
	S-5	23.5-25.0	22.7									II
	S-6	28.5-30.0	31.9				22	78	CL			III
	S-7	33.5-35.0	30.8									III
	S-8	38.5-40.0	29.0				44	56	CL			III

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TABLE-1: SUMMARY OF LABORATORY TEST RESULTS

Holland Island

E2CR Project No. 01558-04

Note : * Depth from the existing water surface at El. 0.00

BORING NO	SAMPLE NO	DEPTH* (FEET)	NATURAL MOISTURE CONTENT (%)	LIQUID LIMIT (%)	PLASTICITY INDEX (%)	GRAIN SIZE DISTRIBUTION			USCS CLASSIFICATION	SHEAR STRENGTH		STRATUM
						GRAVEL (%)	SAND (%)	FINES (%)		PENETRO QP(PSF)	TORVANE TV(PSF)	
H-6	S-3	11.0-13.0	29.2				60	40	SM			I
	S-6	23.5-25.0	20.2				94	6	SP-SM			I
H-6	S-7	28.5-30.0	46.9	40	15			89	CL-ML			III
	S-8	33.5-35.0	45.9									III
	S-9	38.5-40.0	24.3									III
H-7	S-3	13.0-15.0	53.1	46	24			97	CL			II
	S-5	18.5-20.0	27.6				76	24	SM			I
	S-7	28.5-30.0	28.2	26	7			27	SC			I
	S-8	33.5-35.0	18.1									I
	S-9	38.5-40.0	43.6							1000	400	III
	S-10	43.5-45.0	41.2							2000	750	III
H-8	S-2	9.0-11.0	66.3									I
	S-3	12.0-14.0	54.4									II
	S-4	14.0-16.0	53.3									II
	S-5	17.5-19.0	28.7				72	28	SM			I

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TABLE-1: SUMMARY OF LABORATORY TEST RESULTS

Holland Island

E2CR Project No. 01558-04

Note : * Depth from the existing water surface at El. 0.00

BORING NO	SAMPLE NO	DEPTH* (FEET)	NATURAL MOISTURE CONTENT (%)	LIQUID LIMIT (%)	PLASTICITY INDEX (%)	GRAIN SIZE DISTRIBUTION			USCS CLASSIFICATION	SHEAR STRENGTH		STRATUM
						GRAVEL (%)	SAND (%)	FINES (%)		PENETRO QP(PSF)	TORVANE TV(PSF)	
H-8	S-7	28.5-30.0	19.9				89	11	SP-SM			I
	S-9	38.5-40.0	19.5			20	72	8	SP-SM			I
	S-10	43.5-45.0	40.0							1400	875	III
	S-11	48.5-50.0	43.8							1500	1000	III
H-9	S-3	13.5-15.5						10	SP-SM			I
	S-8	33.5-35.0						10	SP-SM			I
	S-9	38.5-40.0	44.6	57	27				CH-MH			III
H-10	S-2	11.0-13.0						63	CL			II
	S-5	23.5-25.0						7	SP-SM			I
	S-9	43.5-45.0						30	SC			III
	S-13	63.5-65.0	26.5					9	SP-SM			III
H-11	S-4	15.0-17.0	26.7				91	9	SP-SM			I
	S-5	18.5-20.0	32.1									I
	S-6	23.5-25.0	27.8	28	11			42	SC	500	250	I
	S-7	28.5-30.0	30.7							1000	500	I

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TABLE-1: SUMMARY OF LABORATORY TEST RESULTS

Holland Island

E2CR Project No. 01558-04

Note : * Depth from the existing water surface at El. 0.00

BORING NO	SAMPLE NO	DEPTH* (FEET)	NATURAL MOISTURE CONTENT (%)	LIQUID LIMIT (%)	PLASTICITY INDEX (%)	GRAIN SIZE DISTRIBUTION			USCS CLASSIFICATION	SHEAR STRENGTH		STRATUM
						GRAVEL (%)	SAND (%)	FINES (%)		PENETRO QP(PSF)	TORVANE TV(PSF)	
H-11	S-8	33.5-35.0	24.2					32	SM			I
	S-9	38.5-40.0	41.5							1800	1000	III
	S-10	43.5-45.0	44.1							1800	1000	III
H-12	S-2	9.0-11.0	37.7									I
	S-3	12.0-14.0	59.1									II
	S-4	14.0-16.0	60.2									II
	ST-1	18.0-20.0	52.4	56	28				CH	700		II
	S5	20.0-21.5	97.5									II
	S6	23.5-25.0	74.4				34	66	CL			II
	S-8	33.5-35.0	17.0				93	7	SP-SM			I
	S-9	38.5-40.0	46.0	57	27				CH-MH	1240	750	III
	S-10	43.5-45.0	38.4							1060	875	III

TABLE-2

Summary of Borrow Area Soils Data

Holland Island
E2CR Project No. 01558-04

Boring No.	Depth of Water (ft.)	Strip* Thickness (ft.)	Thickness of Upper Sand (ft.)	Strip* Thickness (ft.)	Thickness of Lower Sand (ft.)	Remarks
H-1	6	0	21	5	16	Good
H-2	10	0	18	32	-	Good
H-3	13	0	12	7	5	Good
H-4	13	22	5	15	-	No Good**
H-5	7	18	5	10	-	No Good**
H-6	6	0	21	13	-	Good
H-7	8	11	18	8	-	No Good**
H-8	7	0	4	6	25	Good
H-9	8	0	14	12	4	Good
H-10	9	10	11	13	27	No Good**
H-11	8	3	26	8	-	Good
H-12	7	0	3	22	5	No Good**

Note:
* Includes clay, clayey sand and sand containing too much fines.
**Not economical to mine the sand when the strip thickness (es) exceeds 10 ft. or when the quantity of sand is less than 5 ft.

Appendix C
Slope Stability Analysis

Case A: Non Plastic Fill

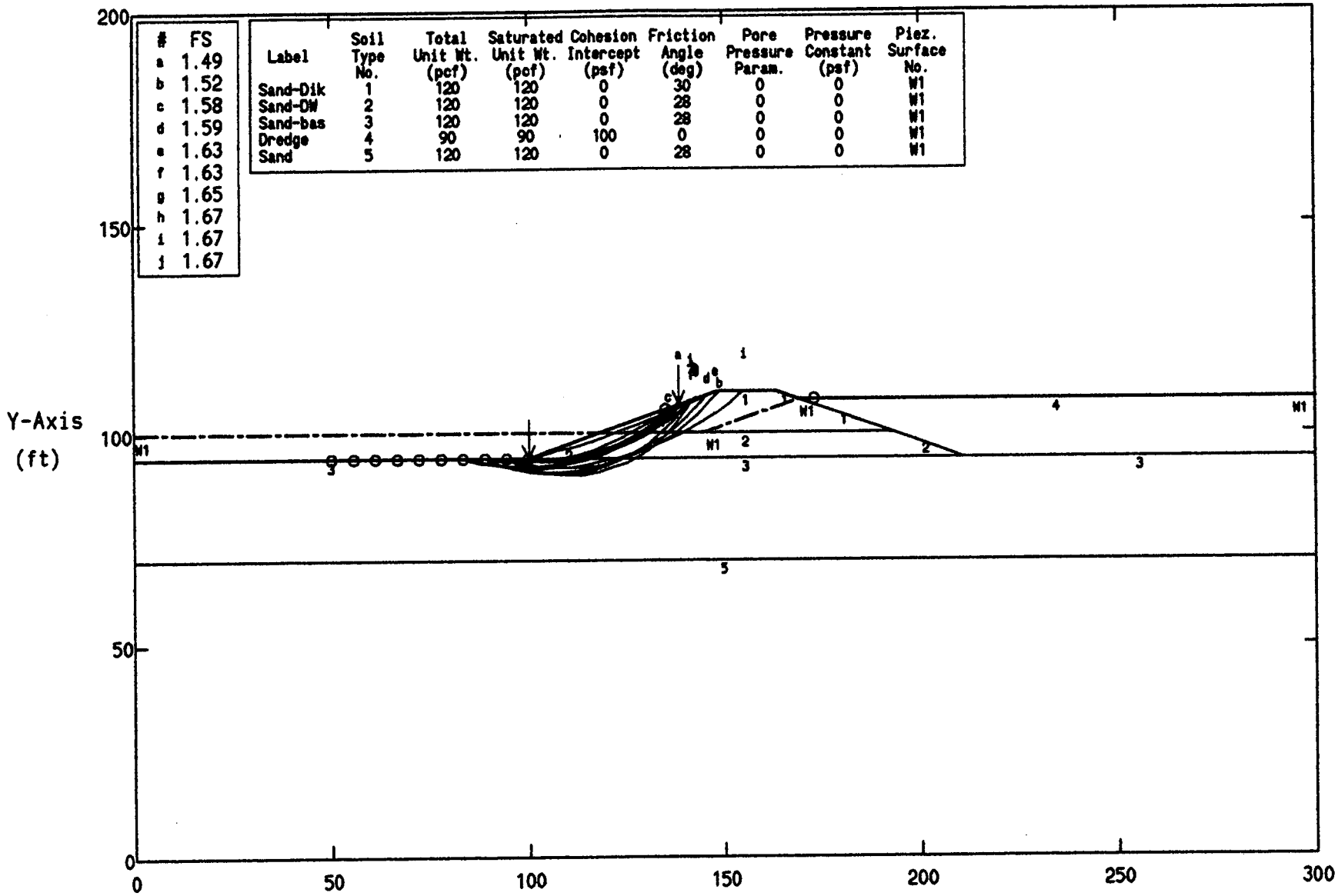
SUMMARY OF SLOPE STABILITY ANALYSIS CASE –A
(Non Plastic Fill)

Holland Island
E2CR Project No. 01558-04

Dike Height, H, Feet	Factor of Safety Through	
	Dike	Foundation
+10	1.49	2.04
+15	1.50	1.82
+20	1.50	1.70

Holland Island Dike to +10 : Case A1: Dike

Ten Most Critical. A:HIA1D.PLT By: GVK 11-24-01 10:22pm



#	FS
a	1.49
b	1.52
c	1.58
d	1.59
e	1.63
f	1.63
g	1.65
h	1.67
i	1.67
j	1.67

Label	Soil Type No.	Total Unit Wt. (pcf)	Saturated Unit Wt. (pcf)	Cohesion Intercept (psf)	Friction Angle (deg)	Pore Pressure Param.	Pressure Constant (psf)	Piez. Surface No.
Sand-Dik	1	120	120	0	30	0	0	W1
Sand-DW	2	120	120	0	28	0	0	W1
Sand-bas	3	120	120	0	28	0	0	W1
Dredge	4	90	90	100	0	0	0	W1
Sand	5	120	120	0	28	0	0	W1

PCSTABL5 FSmin=1.49 X-Axis (ft)

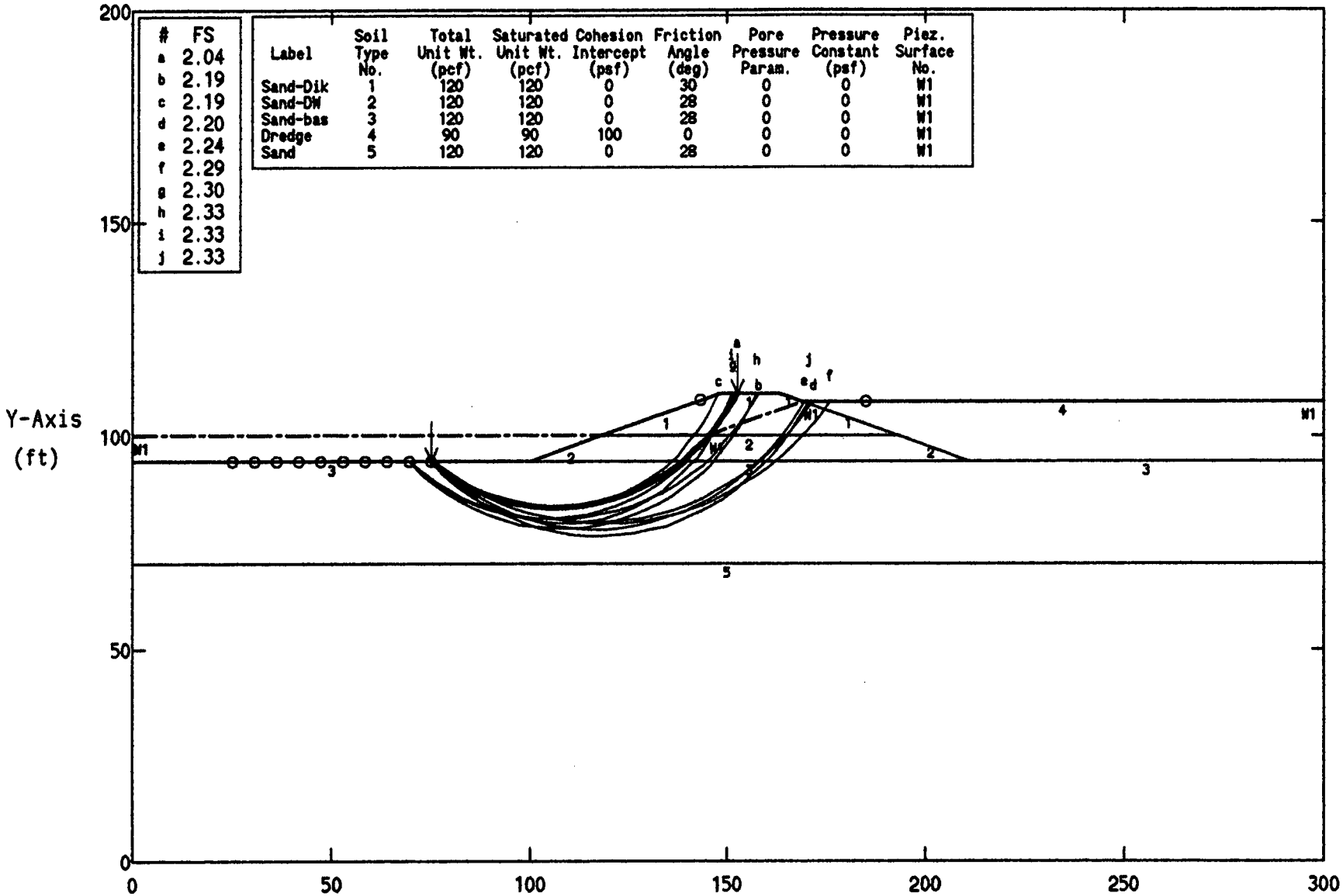
Factors Of Safety Calculated By The Modified Bishop Method

Holland Island Dike to +10 : Case A1: Foundation

Ten Most Critical. A:HIA1F.PLT By: GVK 11-24-01 10:25pm

#	FS
a	2.04
b	2.19
c	2.19
d	2.20
e	2.24
f	2.29
g	2.30
h	2.33
i	2.33
j	2.33

Label	Soil Type No.	Total Unit Wt. (pcf)	Saturated Unit Wt. (pcf)	Cohesion Intercept (psf)	Friction Angle (deg)	Pore Pressure Param.	Pressure Constant (psf)	Piez. Surface No.
Sand-Dik	1	120	120	0	30	0	0	W1
Sand-DW	2	120	120	0	28	0	0	W1
Sand-bas	3	120	120	0	28	0	0	W1
Dredge	4	90	90	100	0	0	0	W1
Sand	5	120	120	0	28	0	0	W1

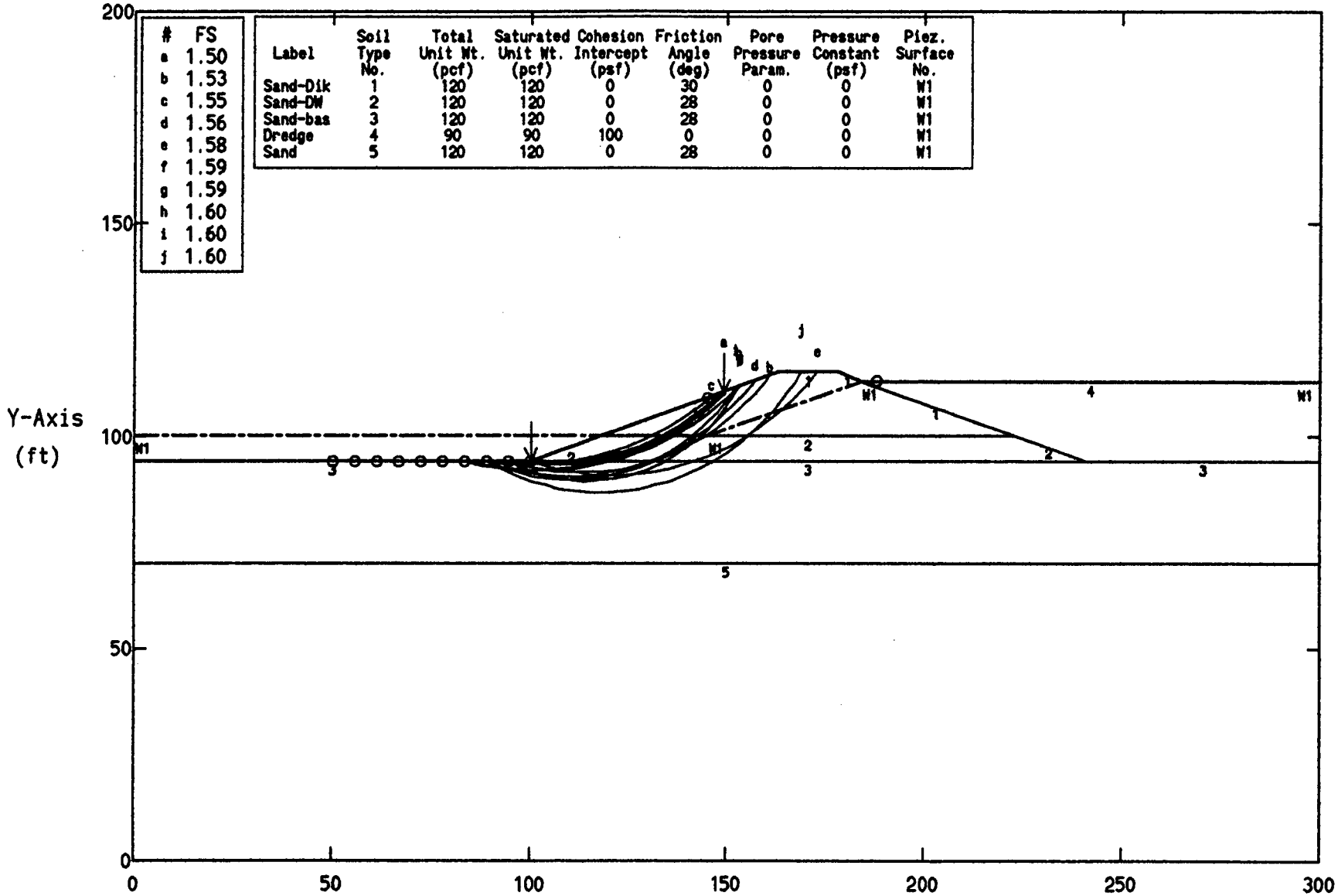


PCSTABL5 FSmin=2.04 X-Axis (ft)

Factors Of Safety Calculated By The Modified Bishop Method

Holland Island Dike to +15 : Case A2 : Dike

Ten Most Critical. A:HIA2D.PLT By: GVK 11-24-01 10:23pm



#	FS
a	1.50
b	1.53
c	1.55
d	1.56
e	1.58
f	1.59
g	1.59
h	1.60
i	1.60
j	1.60

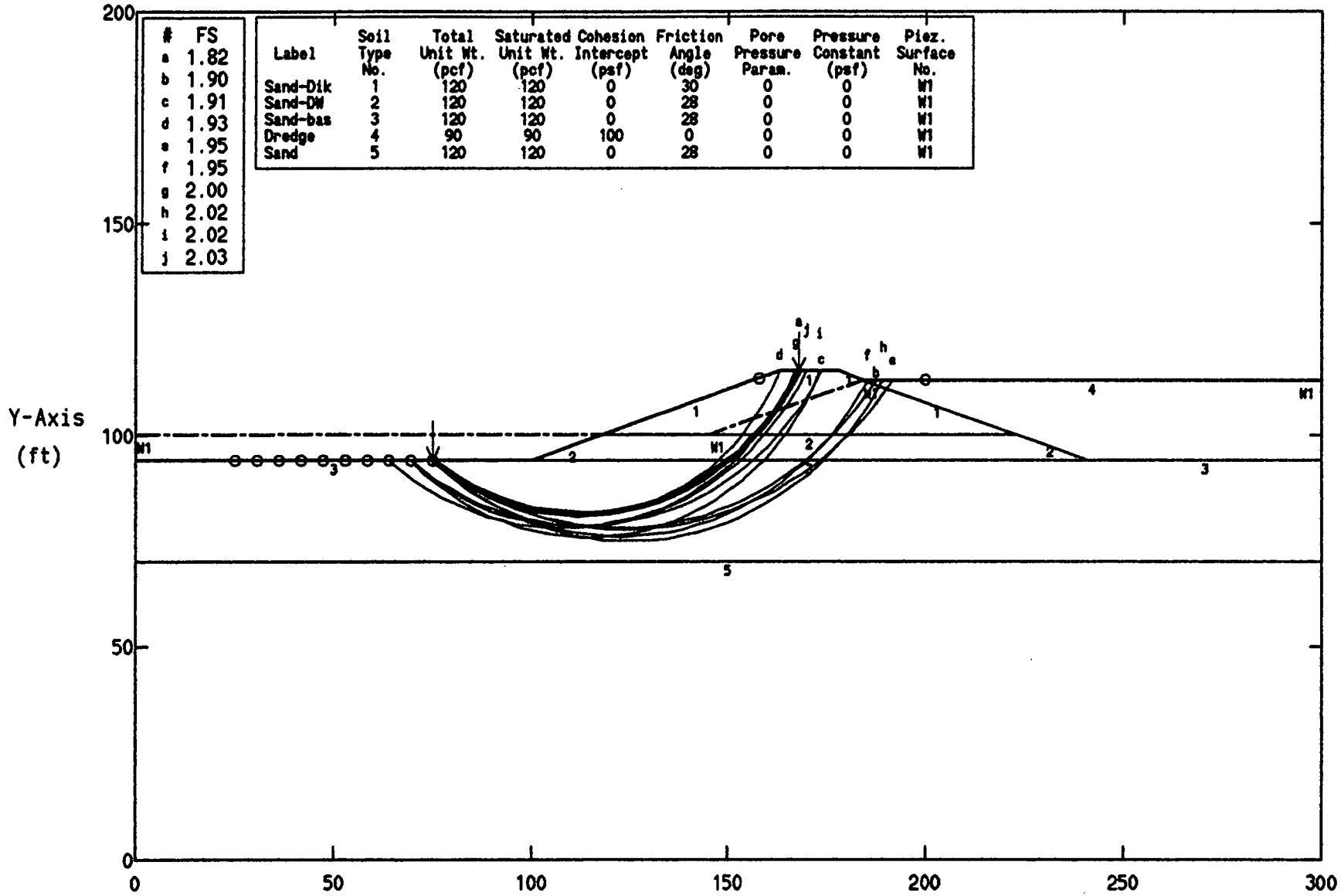
Label	Soil Type No.	Total Unit Wt. (pcf)	Saturated Unit Wt. (pcf)	Cohesion Intercept (psf)	Friction Angle (deg)	Pore Pressure Param.	Pressure Constant (psf)	Piez. Surface No.
Sand-Dik	1	120	120	0	30	0	0	W1
Sand-DW	2	120	120	0	28	0	0	W1
Sand-bas	3	120	120	0	28	0	0	W1
Dredge	4	90	90	100	0	0	0	W1
Sand	5	120	120	0	28	0	0	W1

PCSTABL5 FSmin=1.50 X-Axis (ft)

Factors Of Safety Calculated By The Modified Bishop Method

Holland Island Dike to +15 : Case A2 : Foundation

Ten Most Critical. A:HIA2F.PLT By: GVK 11-24-01 10:26pm



#	FS
a	1.82
b	1.90
c	1.91
d	1.93
e	1.95
f	1.95
g	2.00
h	2.02
i	2.02
j	2.03

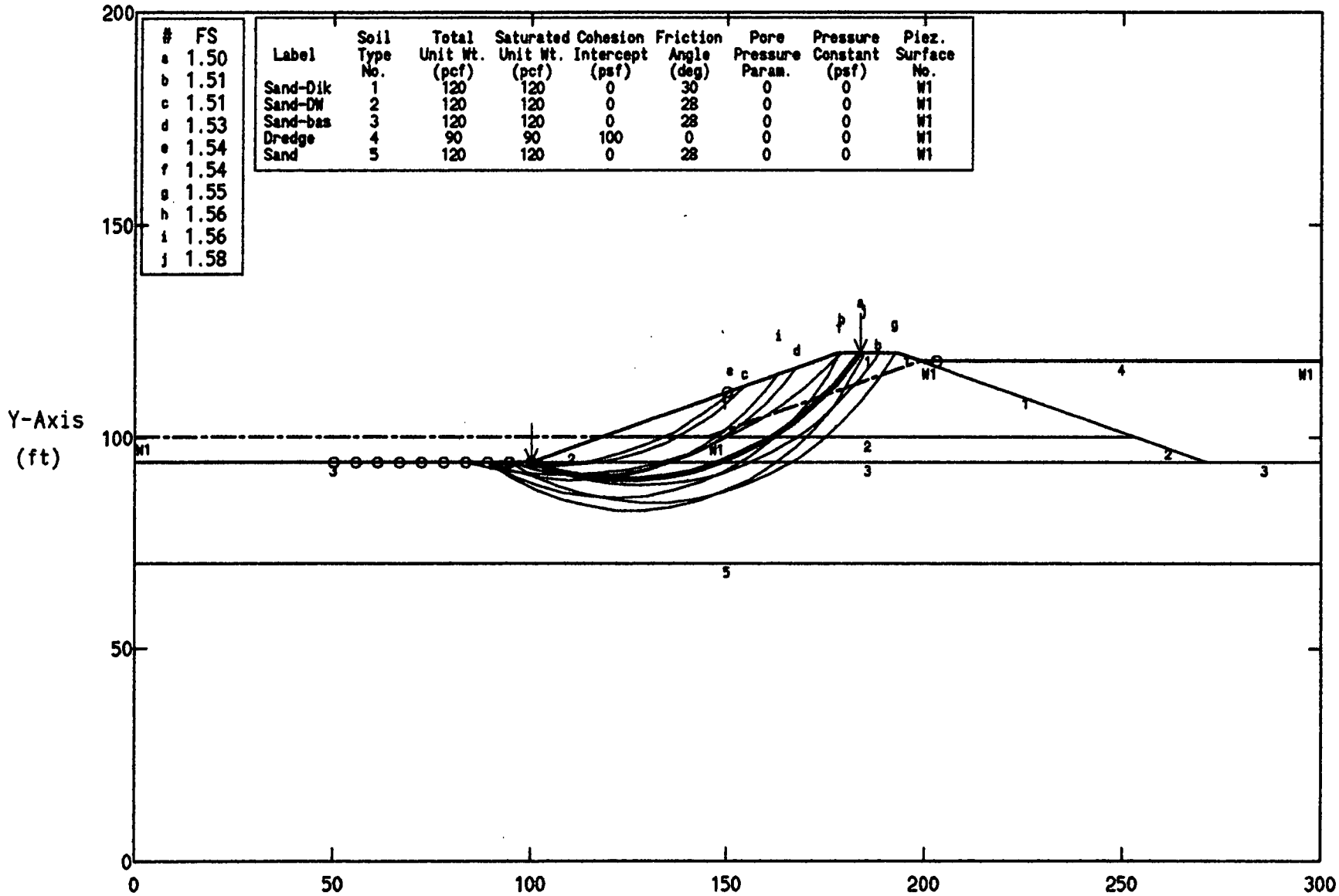
Label	Soil Type No.	Total Unit Wt. (pcf)	Saturated Unit Wt. (pcf)	Cohesion Intercept (psf)	Friction Angle (deg)	Pore Pressure Param.	Pressure Constant (psf)	Piez. Surface No.
Sand-Dik	1	120	120	0	30	0	0	W1
Sand-DW	2	120	120	0	28	0	0	W1
Sand-bas	3	120	120	0	28	0	0	W1
Dredge	4	90	90	100	0	0	0	W1
Sand	5	120	120	0	28	0	0	W1

PCSTABL5 FSmin=1.82 X-Axis (ft)

Factors Of Safety Calculated By The Modified Bishop Method

Holland Island Dike to +20: Case A3: Dike

Ten Most Critical. A:HIA3D.PLT By: GVK 11-24-01 10:24pm



#	FS
a	1.50
b	1.51
c	1.51
d	1.53
e	1.54
f	1.54
g	1.55
h	1.56
i	1.56
j	1.58

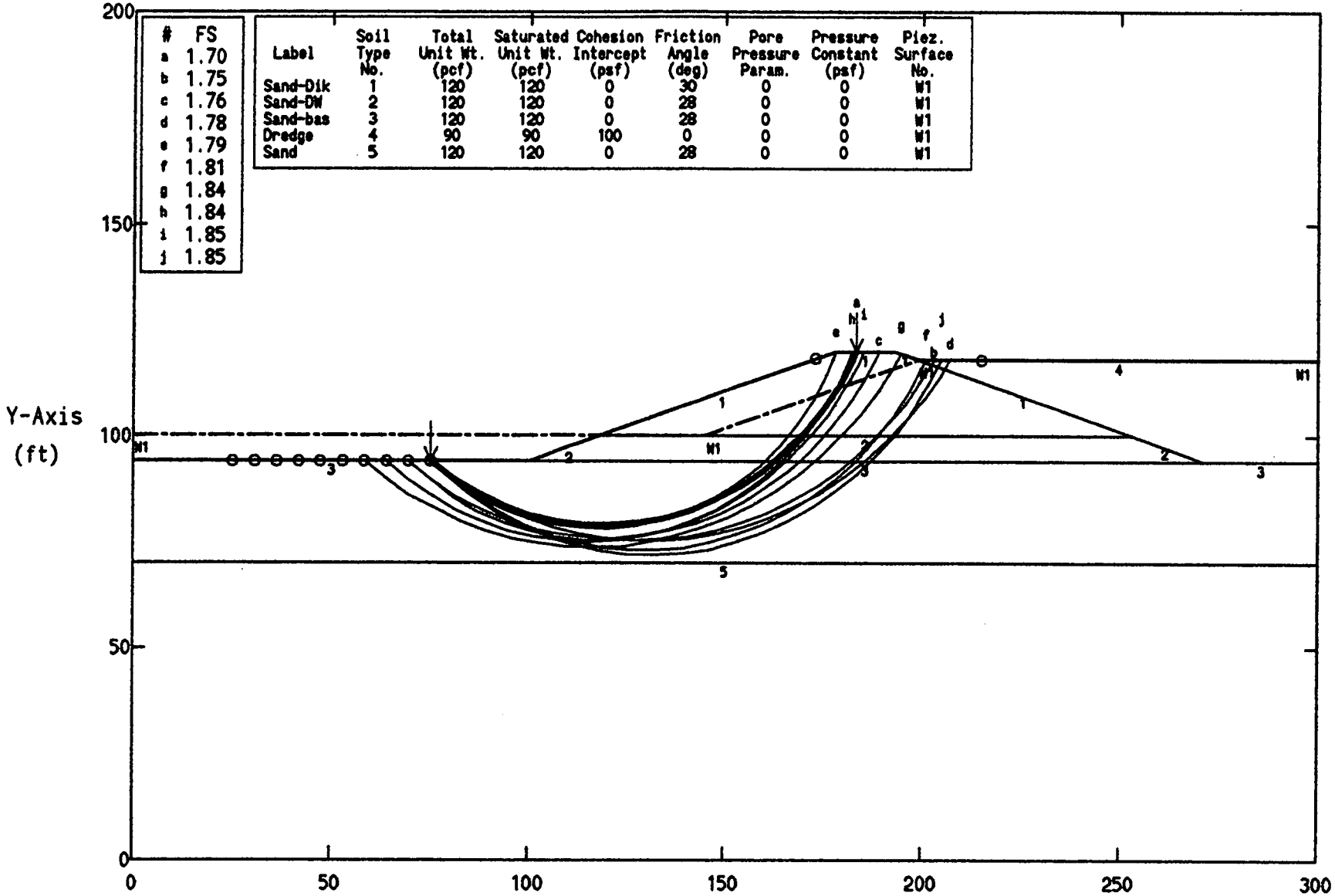
Label	Soil Type No.	Total Unit Wt. (pcf)	Saturated Unit Wt. (pcf)	Cohesion Intercept (psf)	Friction Angle (deg)	Pore Pressure Param.	Pressure Constant (psf)	Piez. Surface No.
Sand-Dik	1	120	120	0	30	0	0	W1
Sand-DW	2	120	120	0	28	0	0	W1
Sand-bas	3	120	120	0	28	0	0	W1
Dredge	4	90	90	100	0	0	0	W1
Sand	5	120	120	0	28	0	0	W1

PCSTABL5 FSmin=1.50 X-Axis (ft)

Factors Of Safety Calculated By The Modified Bishop Method

Holland Island Dike to +20: Case A3: Foundation

Ten Most Critical. A:HIA3F.PLT By: GVK 11-24-01 10:27pm



Label	Soil Type No.	Total Unit Wt. (pcf)	Saturated Unit Wt. (pcf)	Cohesion Intercept (psf)	Friction Angle (deg)	Pore Pressure Param.	Pressure Constant (psf)	Piez. Surface No.
Sand-Dik	1	120	120	0	30	0	0	W1
Sand-DW	2	120	120	0	28	0	0	W1
Sand-bas	3	120	120	0	28	0	0	W1
Dredge	4	90	90	100	0	0	0	W1
Sand	5	120	120	0	28	0	0	W1

PCSTABL5 FSmin=1.70 X-Axis (ft)

Factors Of Safety Calculated By The Modified Bishop Method

Case B: Plastic Silty Sand

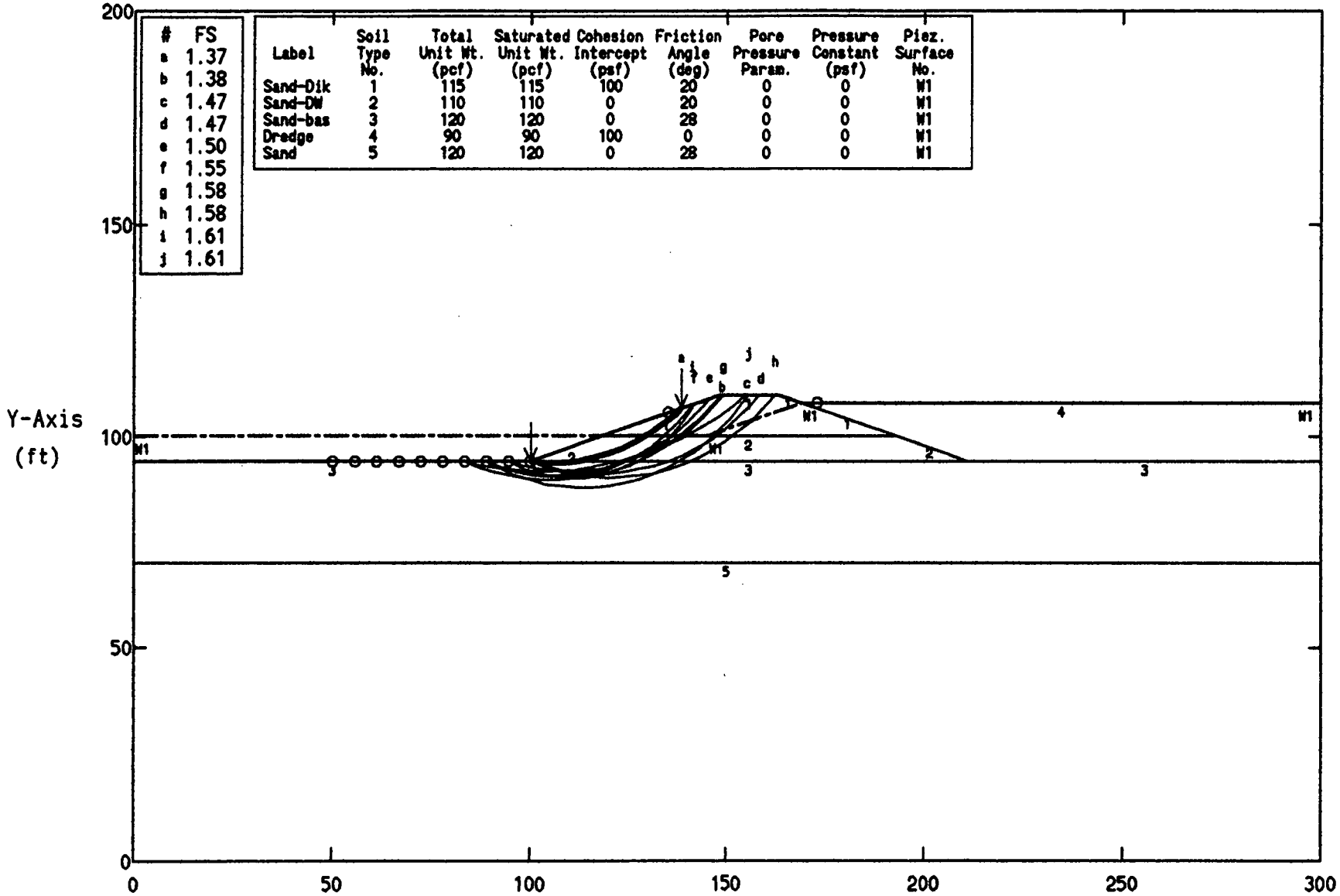
SUMMARY OF SLOPE STABILITY ANALYSIS CASE –B
(Plastic Silty Sand)

Holland Island
E2CR Project No. 01558-04

Dike Height, H, Feet	Factor of Safety Through	
	Dike	Foundation
+10	1.37	2.03
+15	1.33	1.78
+20	1.31	1.66

Holland Island Dike to +10 : Case B1: Dike

Ten Most Critical. A:HIB1D.PLT By: GVK 11-24-01 10:38pm



#	FS
a	1.37
b	1.38
c	1.47
d	1.47
e	1.50
f	1.55
g	1.58
h	1.58
i	1.61
j	1.61

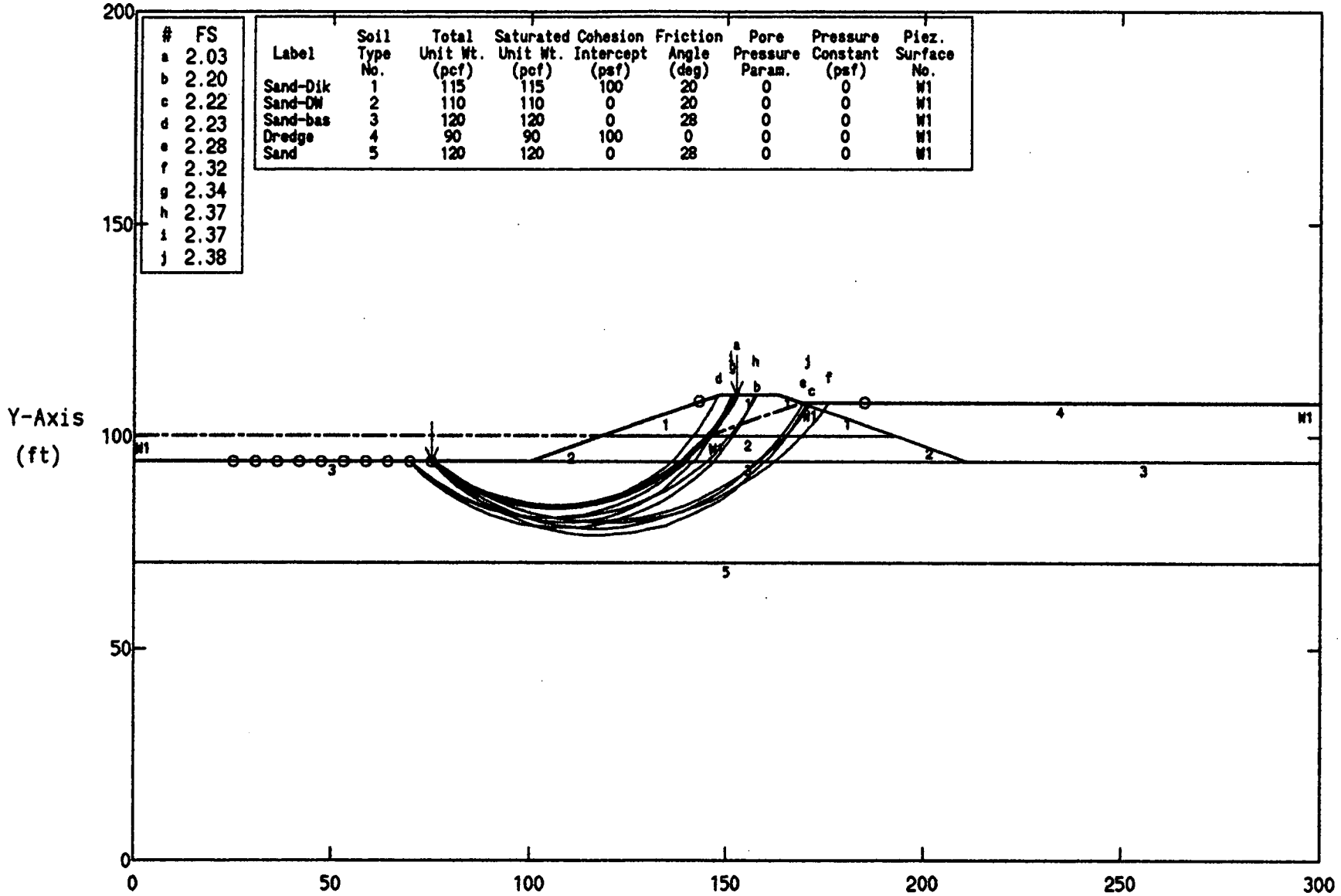
Label	Soil Type No.	Total Unit Wt. (pcf)	Saturated Unit Wt. (pcf)	Cohesion Intercept (psf)	Friction Angle (deg)	Pore Pressure Param.	Pressure Constant (psf)	Piez. Surface No.
Sand-Dik	1	115	115	100	20	0	0	W1
Sand-DW	2	110	110	0	20	0	0	W1
Sand-bas	3	120	120	0	28	0	0	W1
Dredge	4	90	90	100	0	0	0	W1
Sand	5	120	120	0	28	0	0	W1

PCSTABL5 FSmin=1.37 X-Axis (ft)

Factors Of Safety Calculated By The Modified Bishop Method

Holland Island Dike to +10 : Case B1: Foundation

Ten Most Critical. A:HIB1F.PLT By: GVK 11-24-01 10:37pm



#	FS
a	2.03
b	2.20
c	2.22
d	2.23
e	2.28
f	2.32
g	2.34
h	2.37
i	2.37
j	2.38

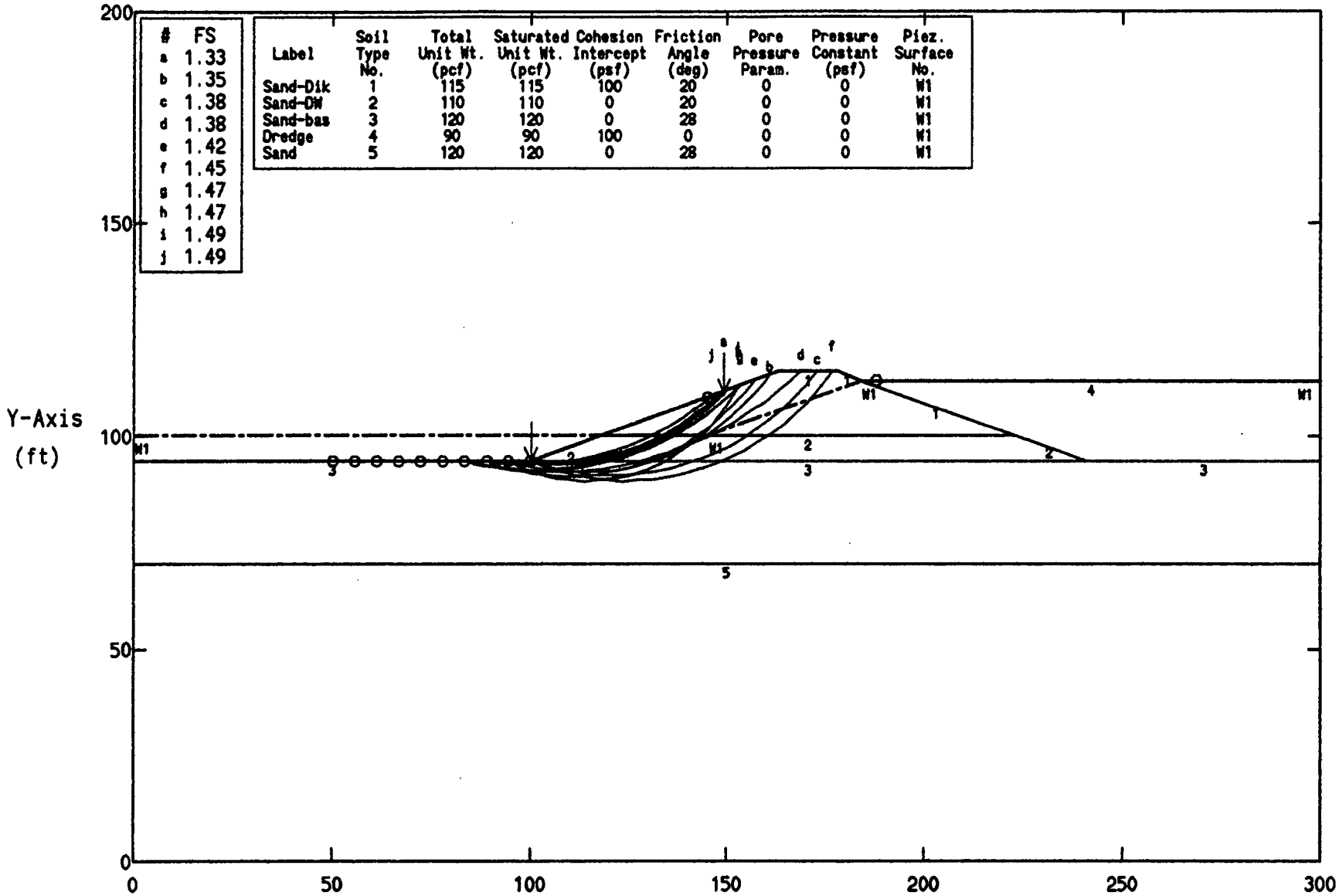
Label	Soil Type No.	Total Unit Wt. (pcf)	Saturated Unit Wt. (pcf)	Cohesion Intercept (psf)	Friction Angle (deg)	Pore Pressure Param.	Pressure Constant (psf)	Piez. Surface No.
Sand-Dik	1	115	115	100	20	0	0	W1
Sand-DW	2	110	110	0	20	0	0	W1
Sand-bas	3	120	120	0	28	0	0	W1
Dredge	4	90	90	100	0	0	0	W1
Sand	5	120	120	0	28	0	0	W1

PCSTABL5 FSmin=2.03 X-Axis (ft)

Factors Of Safety Calculated By The Modified Bishop Method

Holland Island Dike to +15 : Case B2: Dike

Ten Most Critical. A:HIB2D.PLT By: GVK 11-24-01 10:38pm



#	FS
a	1.33
b	1.35
c	1.38
d	1.38
e	1.42
f	1.45
g	1.47
h	1.47
i	1.49
j	1.49

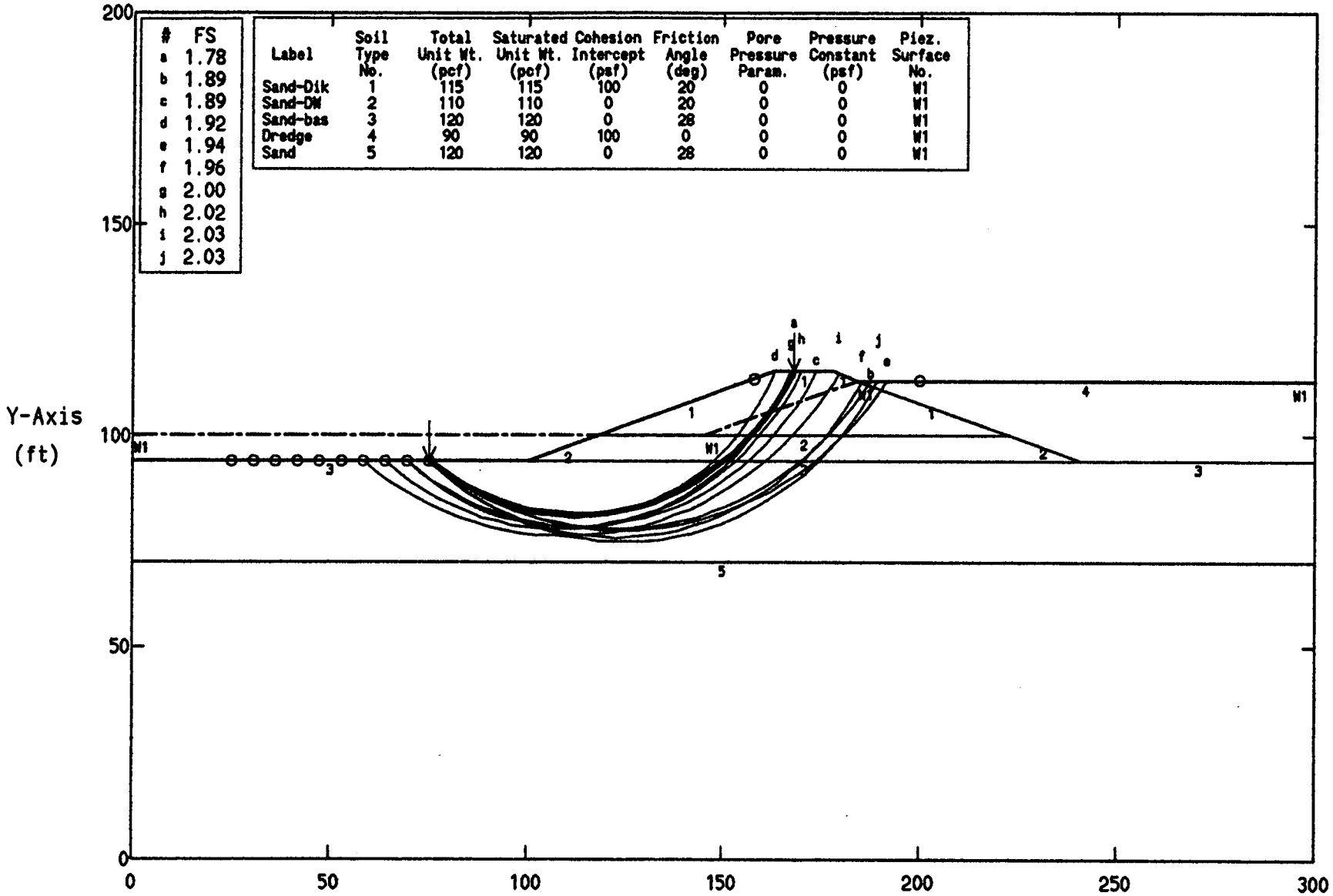
Label	Soil Type No.	Total Unit Wt. (pcf)	Saturated Unit Wt. (pcf)	Cohesion Intercept (psf)	Friction Angle (deg)	Pore Pressure Param.	Pressure Constant (psf)	Piez. Surface No.
Sand-Dik	1	115	115	100	20	0	0	W1
Sand-DW	2	110	110	0	20	0	0	W1
Sand-bas	3	120	120	0	28	0	0	W1
Dredge	4	90	90	100	0	0	0	W1
Sand	5	120	120	0	28	0	0	W1

PCSTABL5 FSmin=1.33 X-Axis (ft)

Factors Of Safety Calculated By The Modified Bishop Method

Holland Island Dike to +15 : Case B2: Foundation

Ten Most Critical. A:HIB2F.PLT By: GVK 11-24-01 10:36pm



#	FS
a	1.78
b	1.89
c	1.89
d	1.92
e	1.94
f	1.96
g	2.00
h	2.02
i	2.03
j	2.03

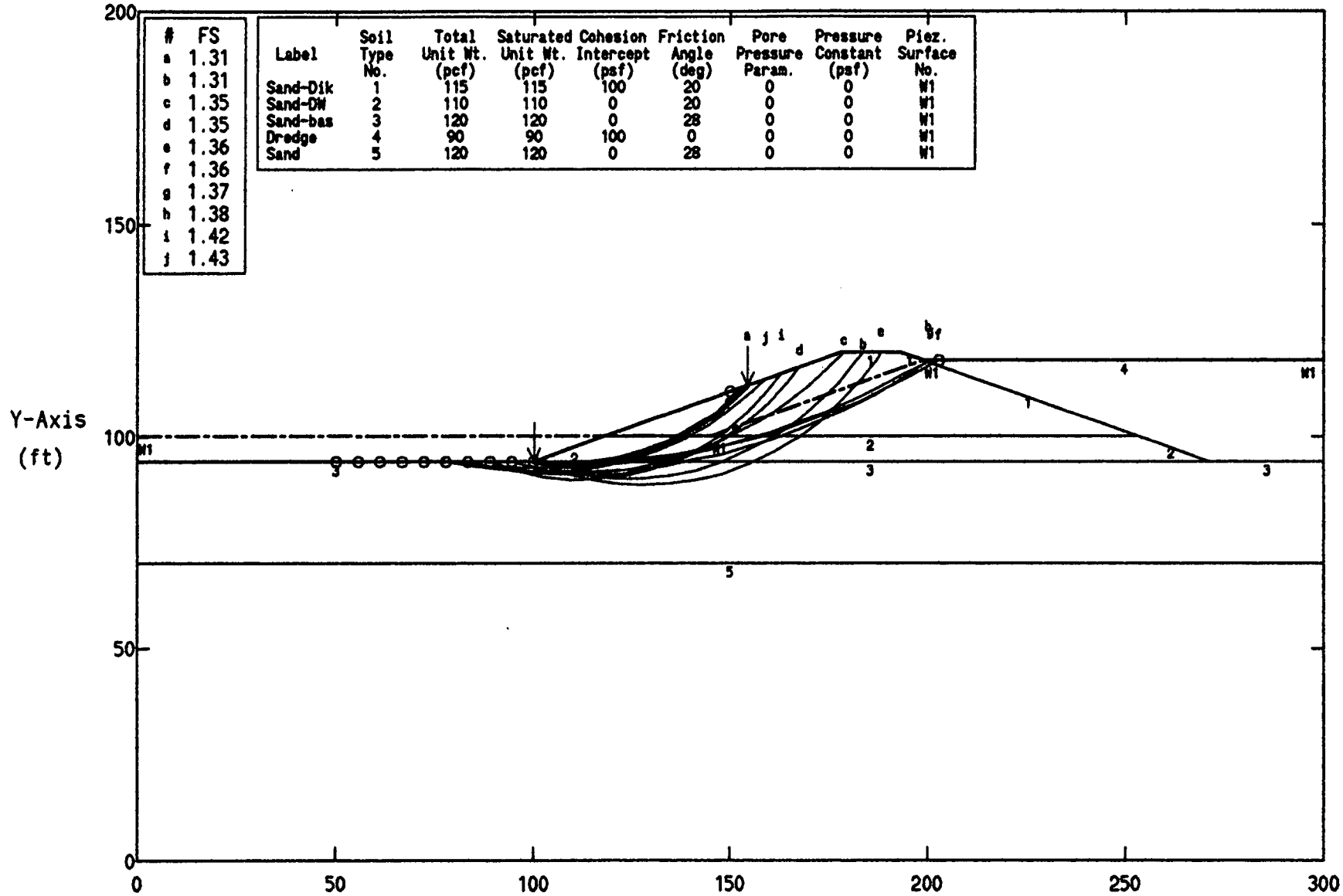
Label	Soil Type No.	Total Unit Wt. (pcf)	Saturated Unit Wt. (pcf)	Cohesion Intercept (psf)	Friction Angle (deg)	Pore Pressure Param.	Pressure Constant (psf)	Piez. Surface No.
Sand-Dik	1	115	115	100	20	0	0	W1
Sand-DW	2	110	110	0	20	0	0	W1
Sand-bas	3	120	120	0	28	0	0	W1
Dredge	4	90	90	100	0	0	0	W1
Sand	5	120	120	0	28	0	0	W1

PCSTABL5 FSmin=1.78 X-Axis (ft)

Factors Of Safety Calculated By The Modified Bishop Method

Holland Island Dike to +20 : Case B3:Dike

Ten Most Critical. A:HIB3D.PLT By: GVK 11-24-01 10:37pm

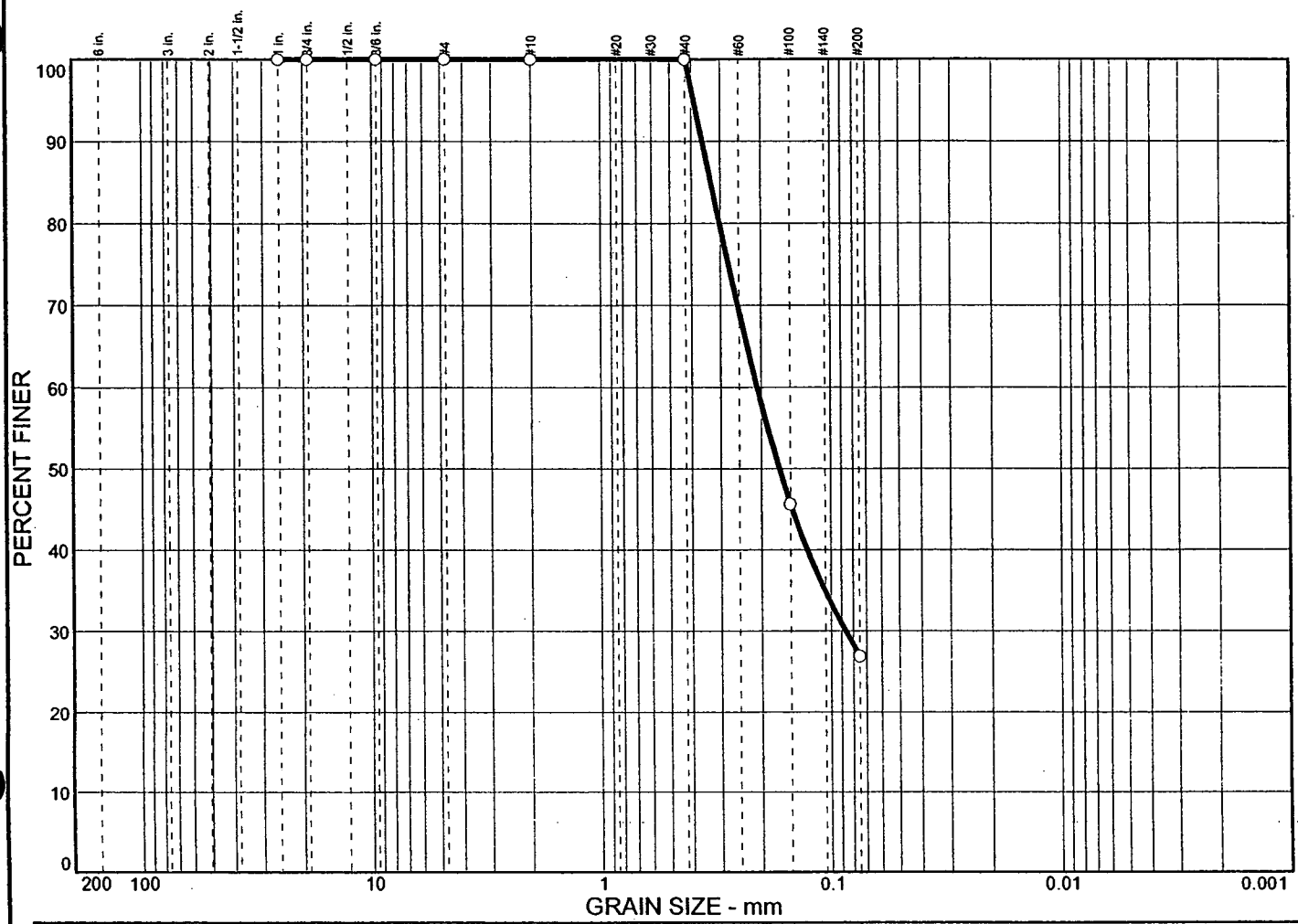


Label	Soil Type No.	Total Unit Wt. (pcf)	Saturated Unit Wt. (pcf)	Cohesion Intercept (psf)	Friction Angle (deg)	Pore Pressure Param.	Pressure Constant (psf)	Piez. Surface No.
Sand-Dik	1	115	115	100	20	0	0	W1
Sand-DW	2	110	110	0	20	0	0	W1
Sand-bas	3	120	120	0	28	0	0	W1
Dredge	4	90	90	100	0	0	0	W1
Sand	5	120	120	0	28	0	0	W1

PCSTABL5 FSmin=1.31 X-Axis (ft)

Factors Of Safety Calculated By The Modified Bishop Method

Particle Size Distribution Report



	% COBBLES	% GRAVEL		% SAND			% FINES	
		CRS.	FINE	CRS.	MEDIUM	FINE	SILT	CLAY
○	0.0	0.0	0.0	0.0	0.0	73.1	26.9	

X	LL	PL	D_{85}	D_{60}	D_{50}	D_{30}	D_{15}	D_{10}	C_c	C_u
○			0.330	0.209	0.168	0.0863				

MATERIAL DESCRIPTION	USCS	AASHTO
○ L.Brown,Silty Fine SAND	SM	

Project No. 01558-04 **Client:** Michael Baker, Jr.

Project: Holland Island

○ **Source:** H 01 **Sample No.:** S-4 **Elev./Depth:** 13.0'-15.0'

Remarks:

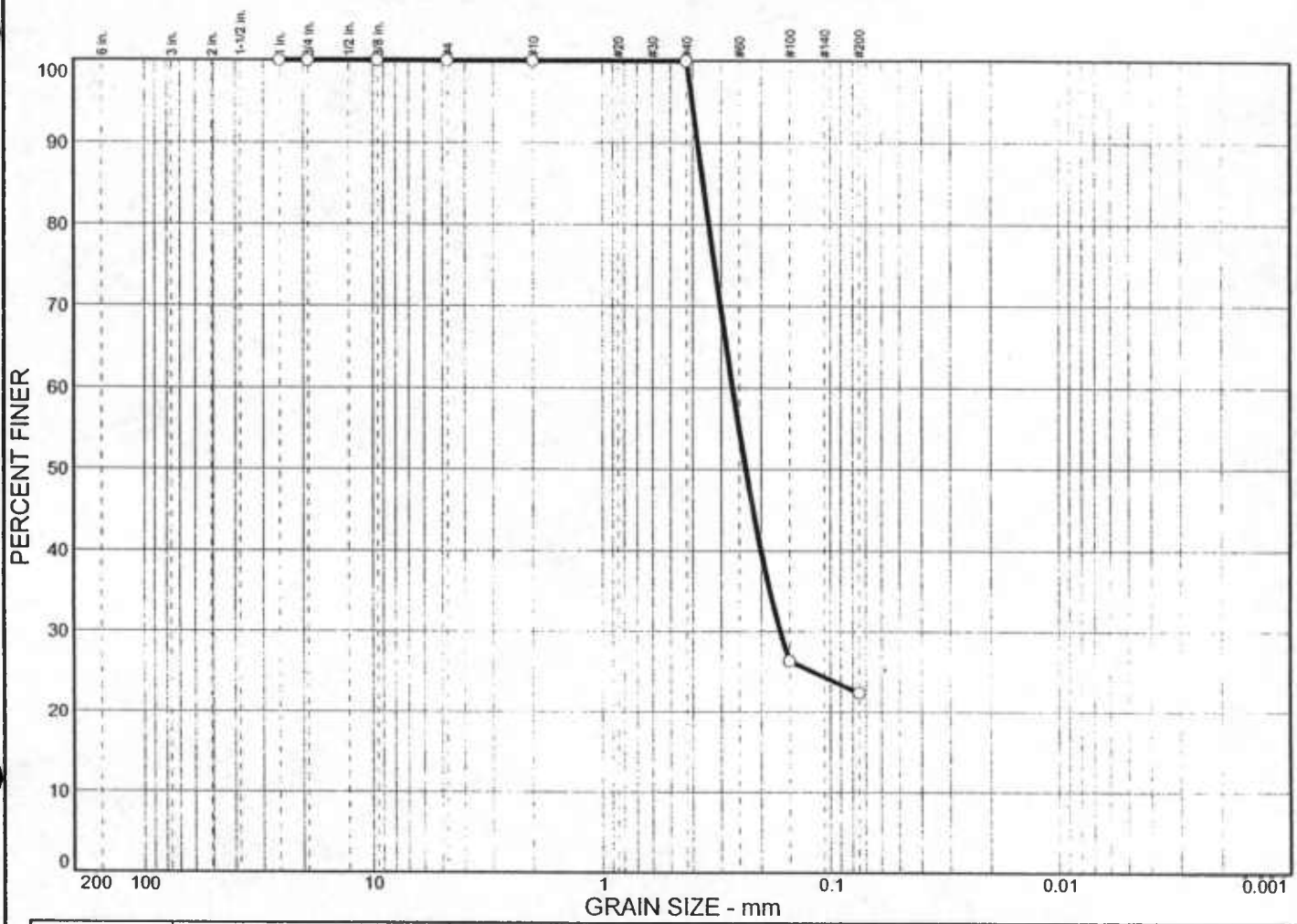
○

Particle Size Distribution Report

E2CR, Inc.

Plate

Particle Size Distribution Report



	% COBBLES	% GRAVEL		% SAND			% FINES	
		CRS.	FINE	CRS.	MEDIUM	FINE	SILT	CLAY
○	0.0	0.0	0.0	0.0	0.0	77.6	22.4	

	LL	PL	D_{85}	D_{60}	D_{50}	D_{30}	D_{15}	D_{10}	C_c	C_u
○			0.360	0.267	0.234	0.165				

MATERIAL DESCRIPTION	USCS	AASHTO
○ Grayish Brown,Silty Fine SAND	SM	

Project No. 01558-04 **Client:** Michael Baker, Jr.

Project: Holland Island

○ **Source:** H 03 **Sample No.:** S-2 **Elev./Depth:** 15.0'-17.0'

Remarks:

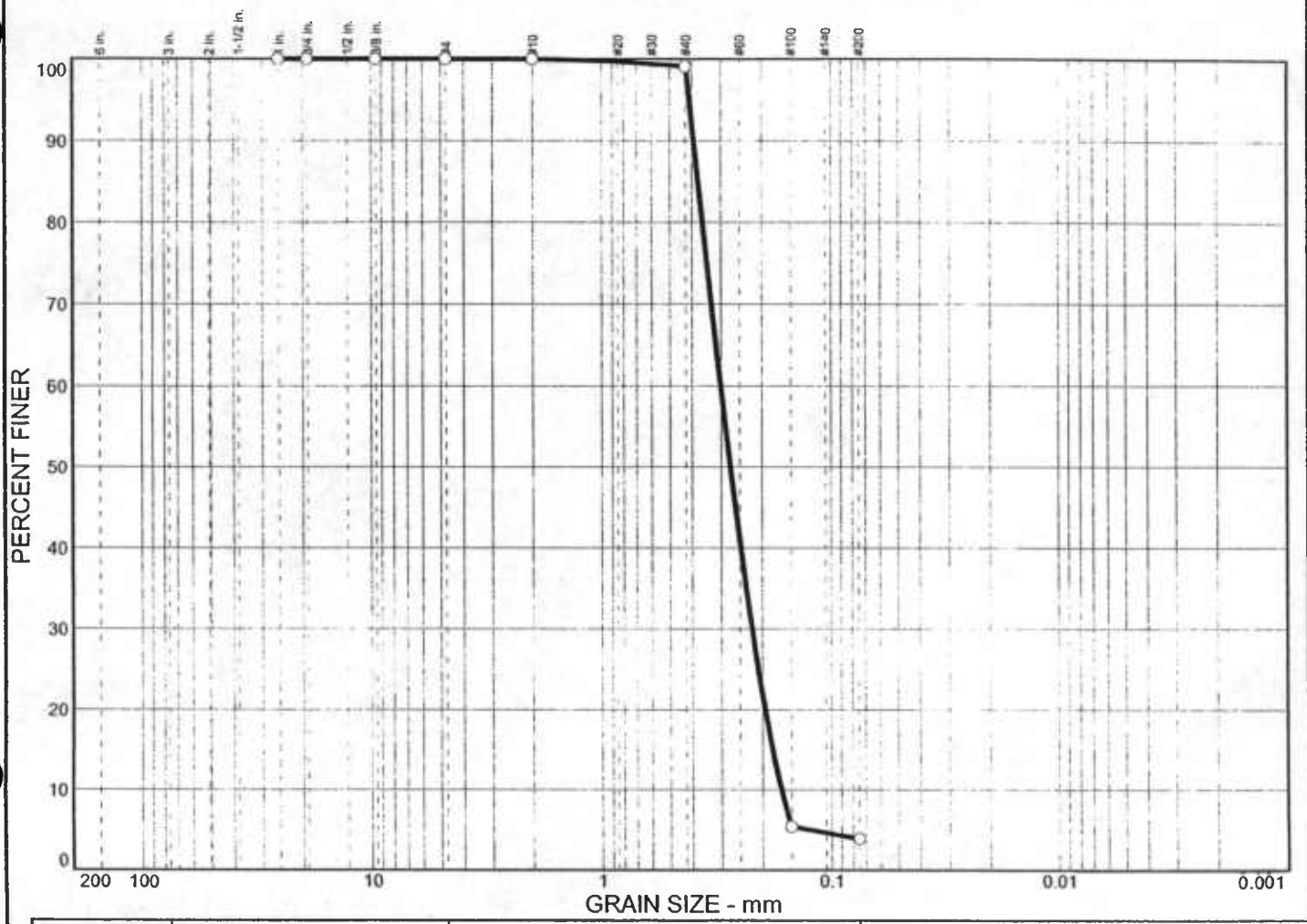
○ Natural Moisture = 20.5%

Particle Size Distribution Report

E2CR, Inc.

Plate

Particle Size Distribution Report



	% COBBLES	% GRAVEL		% SAND			% FINES	
		CRS.	FINE	CRS.	MEDIUM	FINE	SILT	CLAY
○	0.0	0.0	0.0	0.0	0.9	95.2	3.9	

	LL	PL	D_{85}	D_{60}	D_{50}	D_{30}	D_{15}	D_{10}	C_c	C_u
○			0.376	0.301	0.274	0.221	0.181	0.166	0.98	1.81

MATERIAL DESCRIPTION	USCS	AASHTO
○ Grayish Brown,Poorly Graded SAND	SP	

Project No. 01558-04 **Client:** Michael Baker, Jr.

Project: Holland Island

○ **Source:** H 03 **Sample No.:** S-4 **Elev./Depth:** 20.0'-22.0'

Remarks:

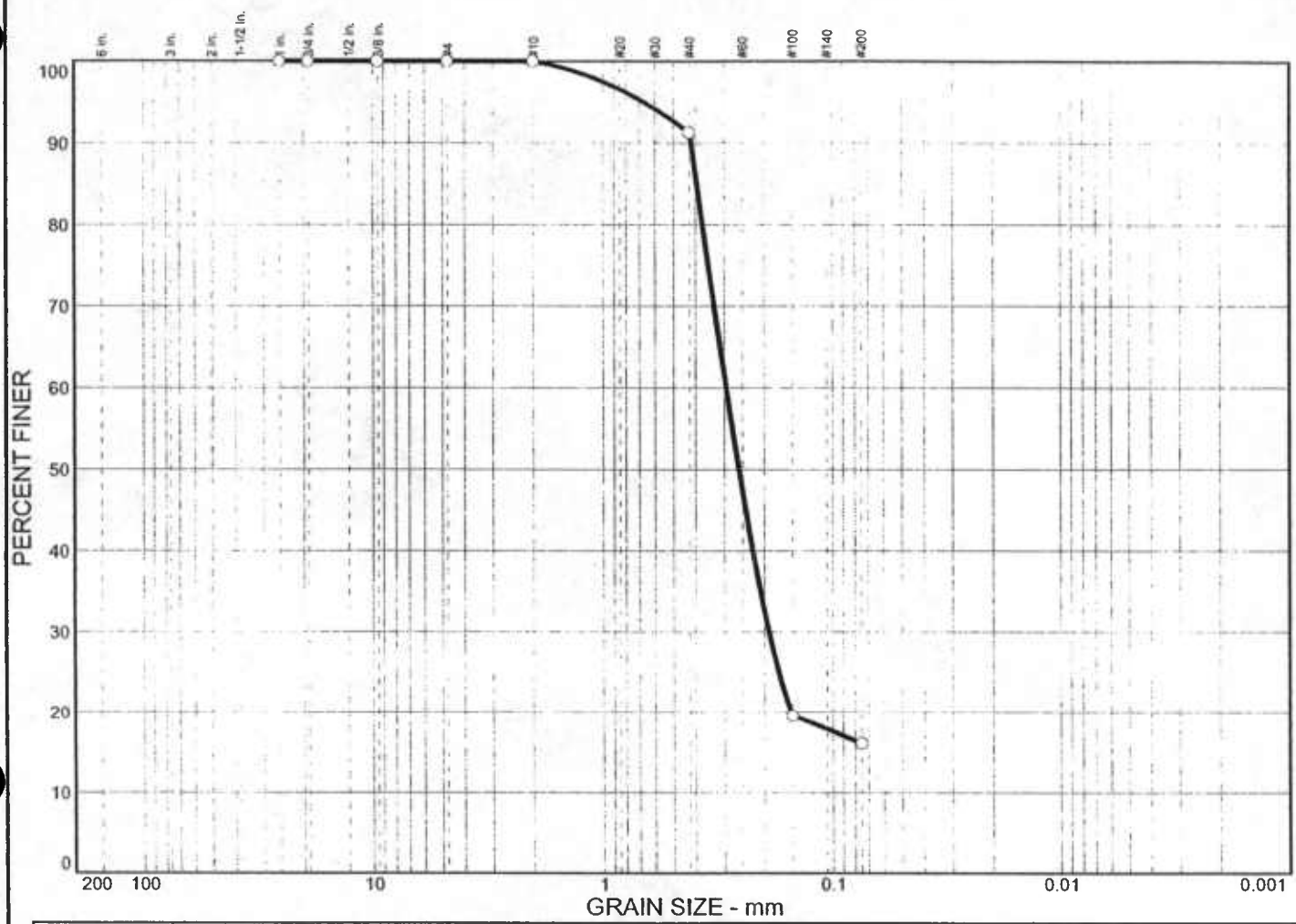
○ Natural Moisture = 26.0%

Particle Size Distribution Report

E2CR, Inc.

Plate

Particle Size Distribution Report



	% COBBLES	% GRAVEL		% SAND			% FINES	
		CRS.	FINE	CRS.	MEDIUM	FINE	SILT	CLAY
○	0.0	0.0	0.0	0.0	8.7	75.1	16.2	

	LL	PL	D_{85}	D_{60}	D_{50}	D_{30}	D_{15}	D_{10}	C_c	C_u
○			0.395	0.294	0.259	0.191				

MATERIAL DESCRIPTION	USCS	AASHTO
○ Brownish Gray,Silty F-M SAND	SM	

Project No. 01558-04 **Client:** Michael Baker, Jr.

Project: Holland Island

○ **Source:** H 04 **Sample No.:** S-6 **Elev./Depth:** 33.5'-35.0'

Remarks:

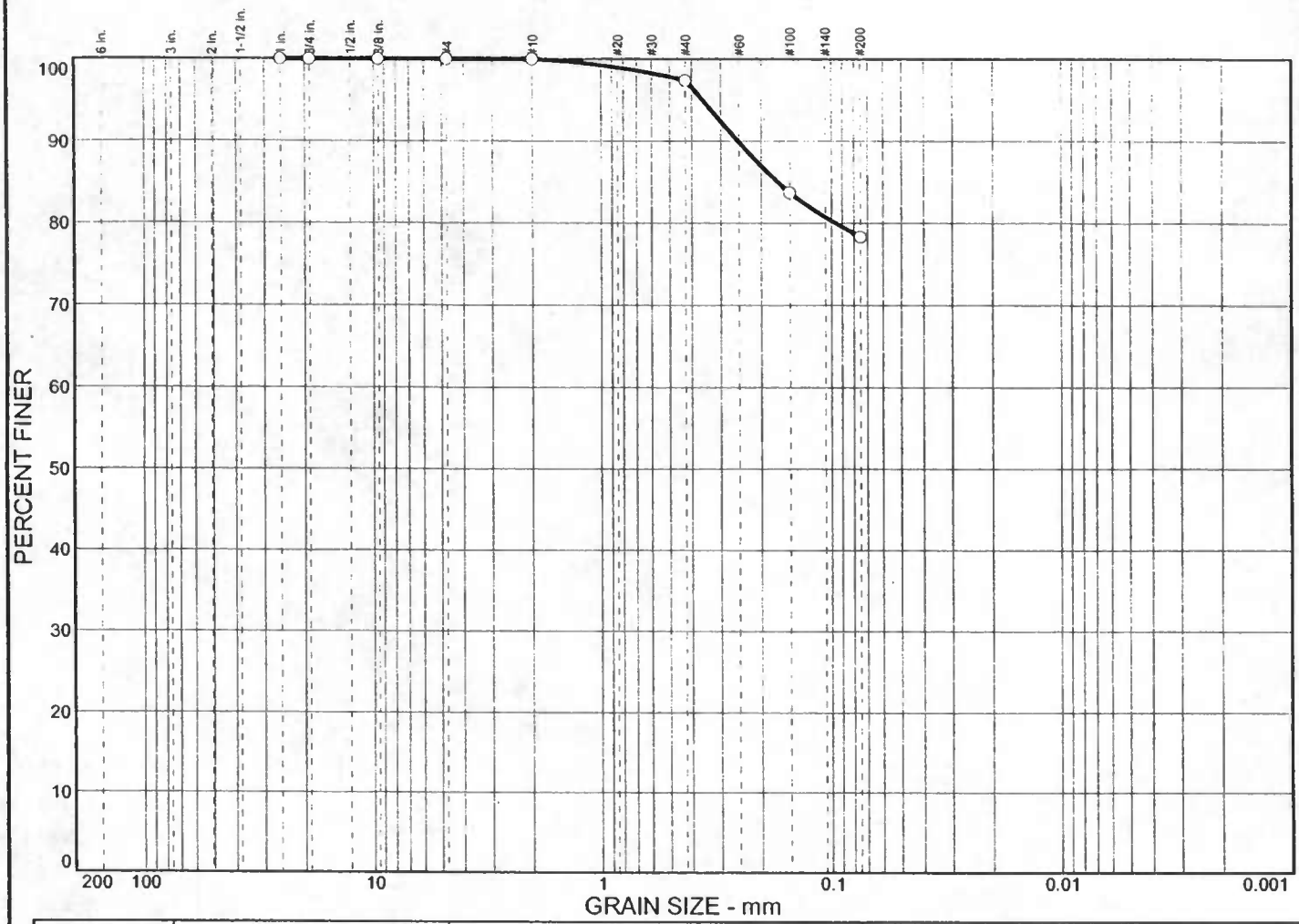
○ Natural Moisture = 32.4%

Particle Size Distribution Report

E2CR, Inc.

Plate

Particle Size Distribution Report



	% COBBLES	% GRAVEL		% SAND			% FINES	
		CRS.	FINE	CRS.	MEDIUM	FINE	SILT	CLAY
○	0.0	0.0	0.0	0.0	2.6	19.1	78.3	

	LL	PL	D_{85}	D_{60}	D_{50}	D_{30}	D_{15}	D_{10}	C_c	C_u
○			0.170							

MATERIAL DESCRIPTION	USCS	AASHTO
○ Greenish Gray,Silty CLAY,Little fine Sand	CL	

Project No. 01558-04 **Client:** Michael Baker, Jr.

Project: Holland Island

○ **Source:** H 05 **Sample No.:** S-6 **Elev./Depth:** 28.5'-30.0'

Remarks:

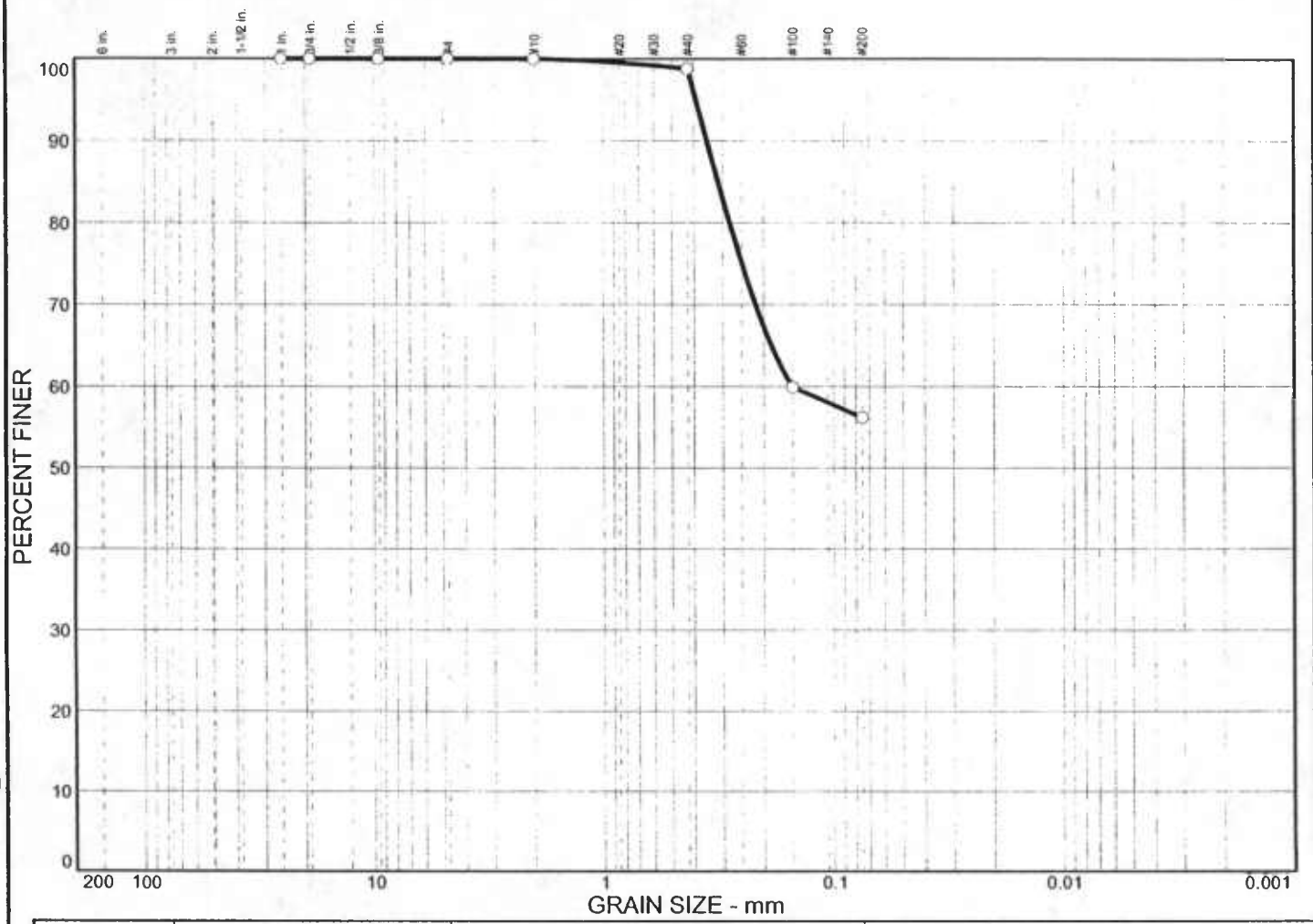
○ Natural Moisture = 31.9%

Particle Size Distribution Report

E2CR, Inc.

Plate

Particle Size Distribution Report



	% COBBLES	% GRAVEL		% SAND			% FINES	
		CRS.	FINE	CRS.	MEDIUM	FINE	SILT	CLAY
○	0.0	0.0	0.0	0.0	1.2	42.6	56.2	

	LL	PL	D_{85}	D_{60}	D_{50}	D_{30}	D_{15}	D_{10}	C_c	C_u
○			0.315	0.151						

MATERIAL DESCRIPTION	USCS	AASHTO
○ Greenish Gray,Sandy CLAY	CL	

Project No. 01558-04 **Client:** Michael Baker, Jr.

Project: Holland Island

○ **Source:** H 05 **Sample No.:** S-8 **Elev./Depth:** 38.5'-40.0'

Remarks:

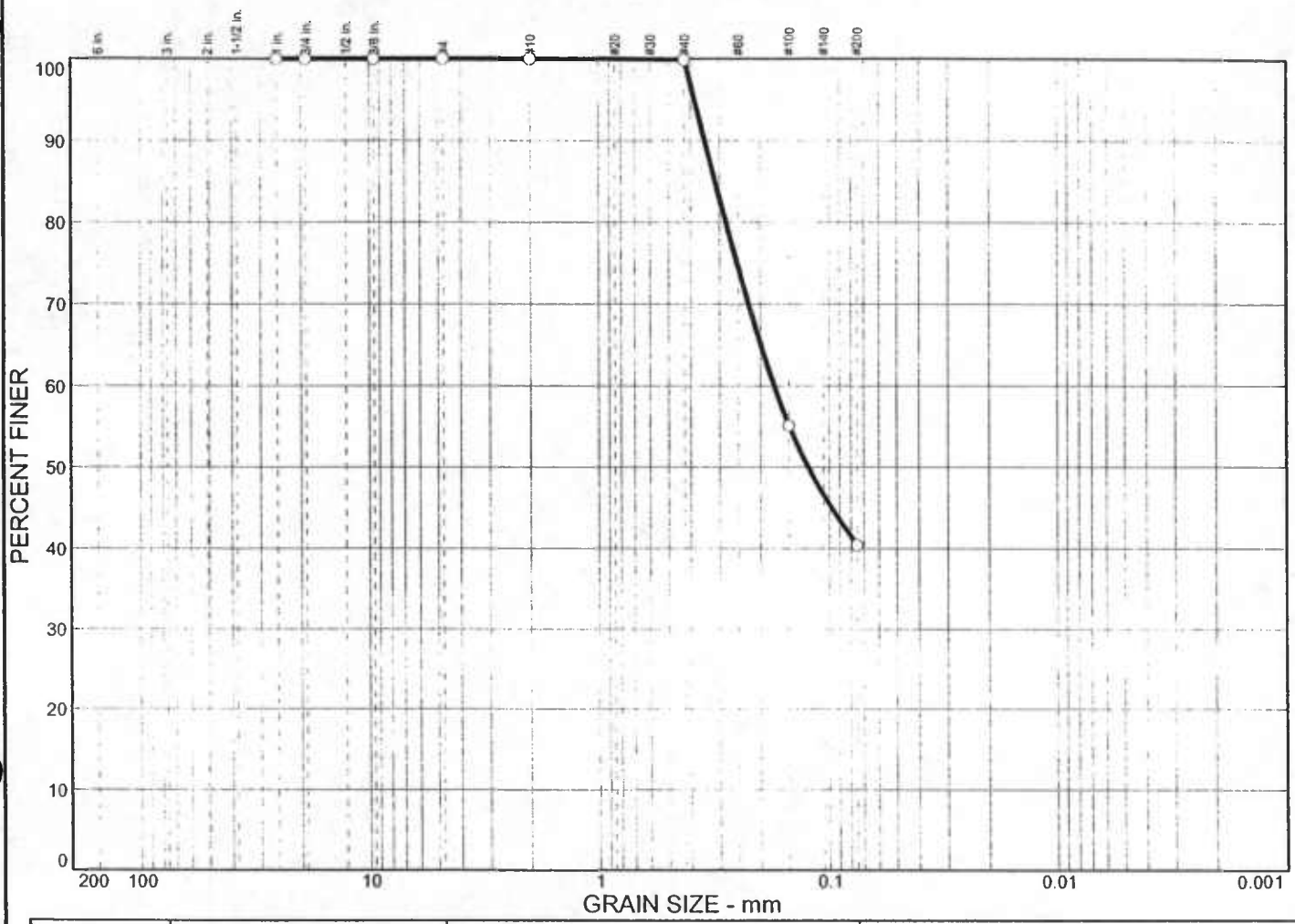
○ Natural Moisture = 29.0%

Particle Size Distribution Report

E2CR, Inc.

Plate

Particle Size Distribution Report



	% COBBLES	% GRAVEL		% SAND			% FINES	
		CRS.	FINE	CRS.	MEDIUM	FINE	SILT	CLAY
○	0.0	0.0	0.0	0.0	0.1	59.5	40.4	

	LL	PL	D_{85}	D_{60}	D_{50}	D_{30}	D_{15}	D_{10}	C_c	C_u
○			0.314	0.174	0.124					

MATERIAL DESCRIPTION	USCS	AASHTO
○ Brownish Gray,Silty Fine SAND,trace Clay	SM	

Project No. 01558-04 **Client:** Michael Baker, Jr.

Project: Holland Island

○ **Source:** H 06 **Sample No.:** S-3 **Elev./Depth:** 11.0'-13.0'

Remarks:

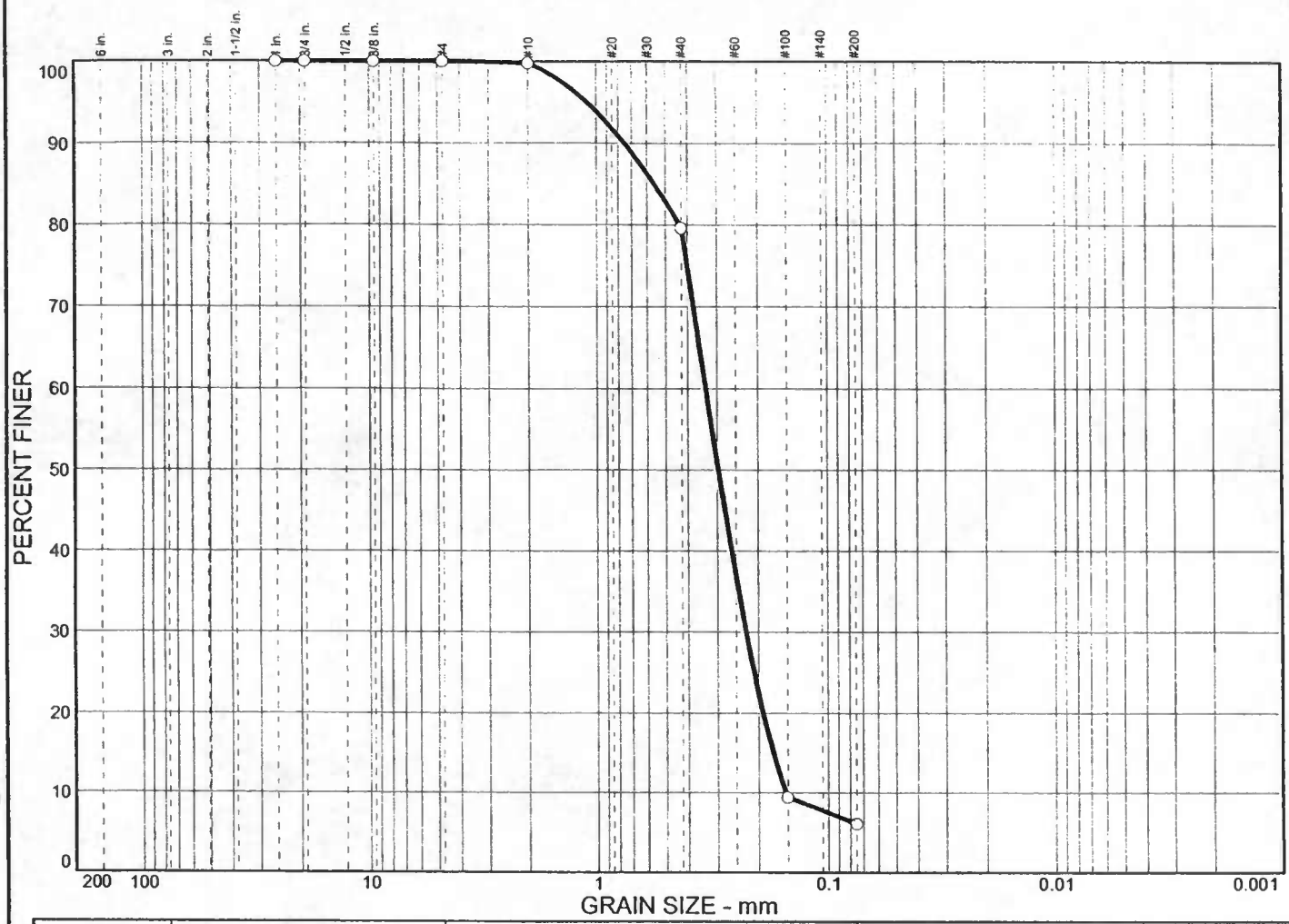
○ Natural Moisture = 29.2%

Particle Size Distribution Report

E2CR, Inc.

Plate

Particle Size Distribution Report



	% COBBLES	% GRAVEL		% SAND			% FINES	
		CRS.	FINE	CRS.	MEDIUM	FINE	SILT	CLAY
○	0.0	0.0	0.0	0.2	20.2	73.5	6.1	

	LL	PL	D_{85}	D_{60}	D_{50}	D_{30}	D_{15}	D_{10}	C_c	C_u
○			0.558	0.336	0.297	0.226	0.174	0.153	1.00	2.20

MATERIAL DESCRIPTION	USCS	AASHTO
○ Grayish Brown,Poorly Graded SAND,trace Silt	SP-SM	

Project No. 01558-04 **Client:** Michael Baker, Jr.

Project: Holland Island

○ **Source:** H 06 **Sample No.:** S-6 **Elev./Depth:** 23.5'-25.0'

Remarks:

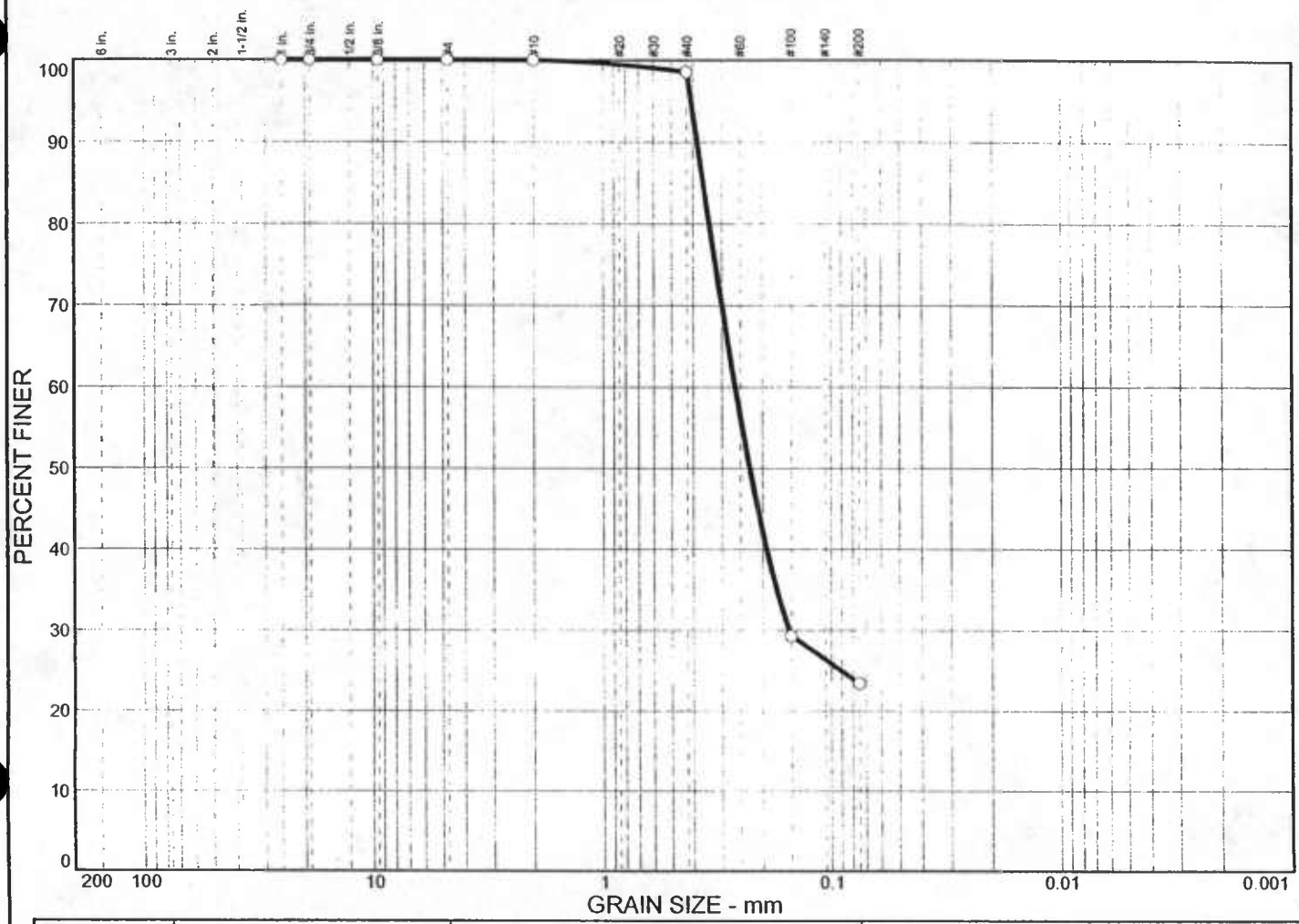
○ Natural Moisture = 20.2%

Particle Size Distribution Report

E2CR, Inc.

Plate

Particle Size Distribution Report



	% COBBLES	% GRAVEL		% SAND			% FINES	
		CRS.	FINE	CRS.	MEDIUM	FINE	SILT	CLAY
○	0.0	0.0	0.0	0.0	1.4	75.1	23.5	

	LL	PL	D_{85}	D_{60}	D_{50}	D_{30}	D_{15}	D_{10}	C_c	C_u
○			0.361	0.263	0.227	0.153				

MATERIAL DESCRIPTION	USCS	AASHTO
○ Brownish Gray,Silty Fine SAND	SM	

Project No. 01558-04 **Client:** Michael Baker, Jr.

Project: Holland Island

○ **Source:** H 07 **Sample No.:** S-5 **Elev./Depth:** 18.5'-20.0'

Remarks:

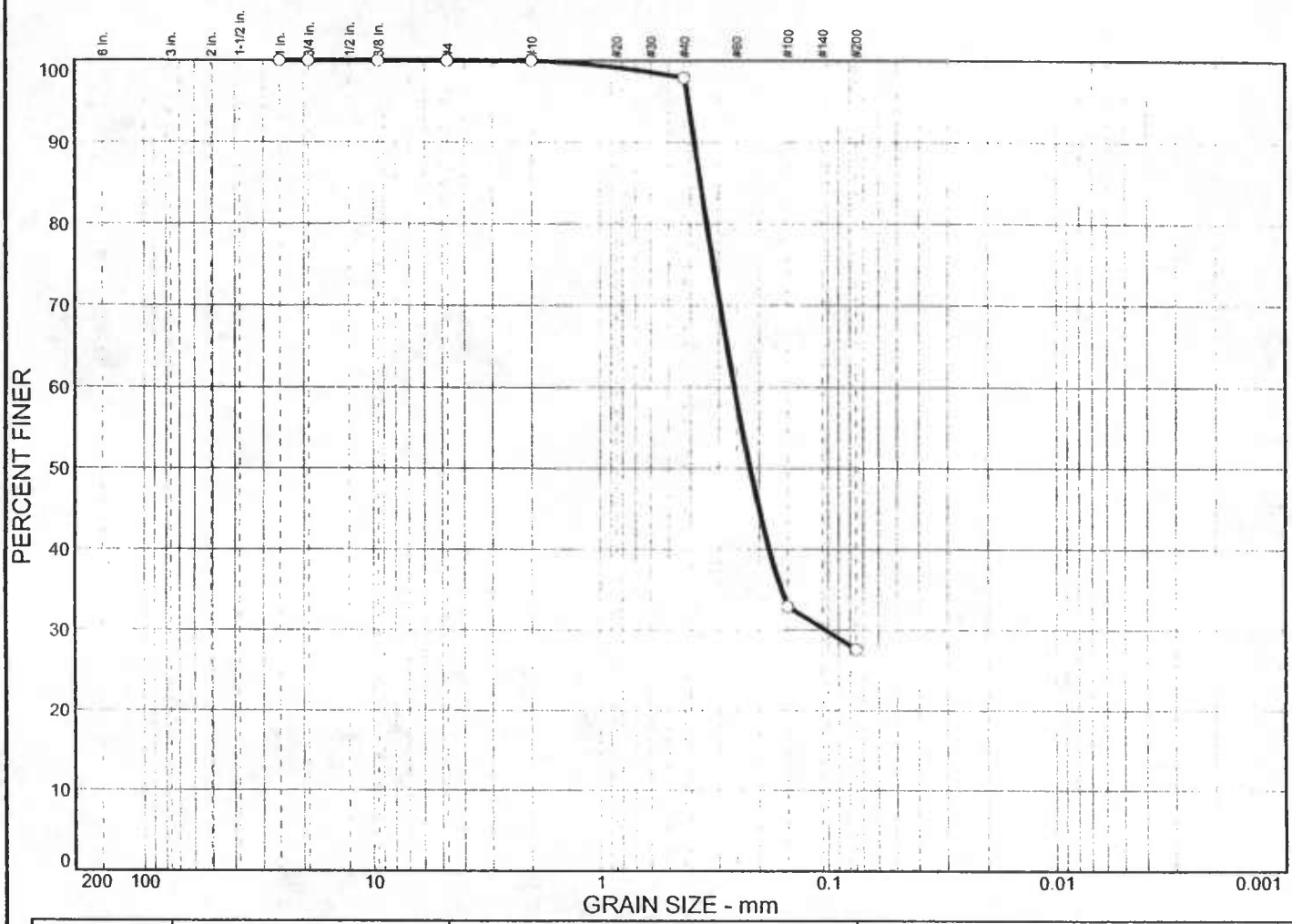
○ Natural Moisture = 27.6%

Particle Size Distribution Report

E2CR, Inc.

Plate

Particle Size Distribution Report



	% COBBLES	% GRAVEL		% SAND			% FINES	
		CRS.	FINE	CRS.	MEDIUM	FINE	SILT	CLAY
○	0.0	0.0	0.0	0.0	2.1	70.3	27.6	

	LL	PL	D_{85}	D_{60}	D_{50}	D_{30}	D_{15}	D_{10}	C_c	C_u
○			0.360	0.256	0.219	0.103				

MATERIAL DESCRIPTION	USCS	AASHTO
○ Brownish Gray,Silty Fine SAND	SM	

Project No. 01558-04 **Client:** Michael Baker, Jr.

Project: Holland Island

○ **Source:** H 08 **Sample No.:** S-5 **Elev./Depth:** 17.5'-19.0'

Remarks:

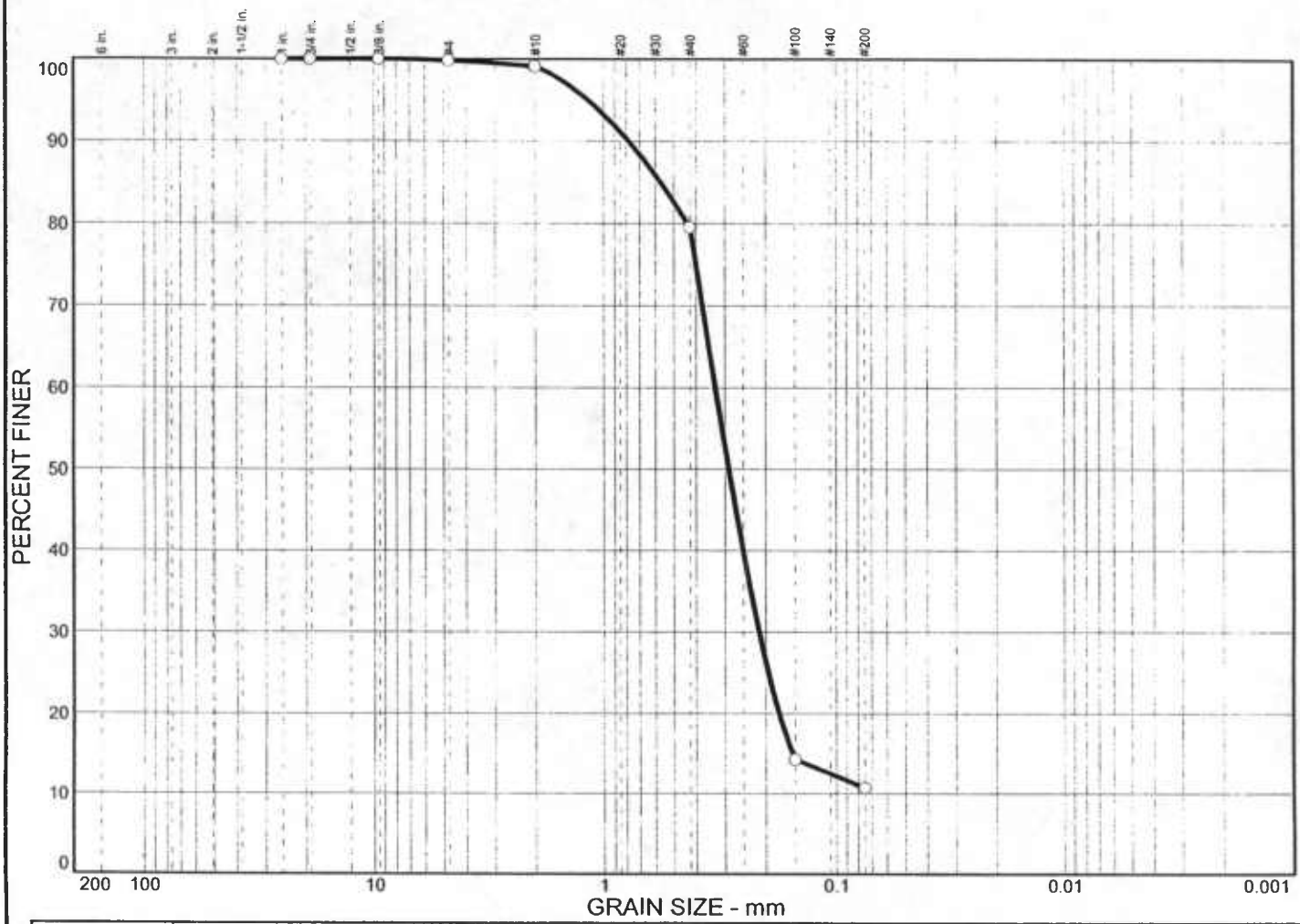
○ Natural Moisture = 28.7%

Particle Size Distribution Report

E2CR, Inc.

Plate

Particle Size Distribution Report



	% COBBLES	% GRAVEL		% SAND			% FINES	
		CRS.	FINE	CRS.	MEDIUM	FINE	SILT	CLAY
○	0.0	0.0	0.2	0.7	19.6	68.8	10.7	

	LL	PL	D_{85}	D_{60}	D_{50}	D_{30}	D_{15}	D_{10}	C_c	C_u
○			0.569	0.330	0.289	0.214	0.154			

MATERIAL DESCRIPTION	USCS	AASHTO
○ Grayish Brown,Poorly Graded SAND,trace Silt	SP-SM	

Project No. 01558-04 **Client:** Michael Baker, Jr.

Project: Holland Island

○ **Source:** H 08 **Sample No.:** S-7 **Elev./Depth:** 28.5'-30.0'

Remarks:

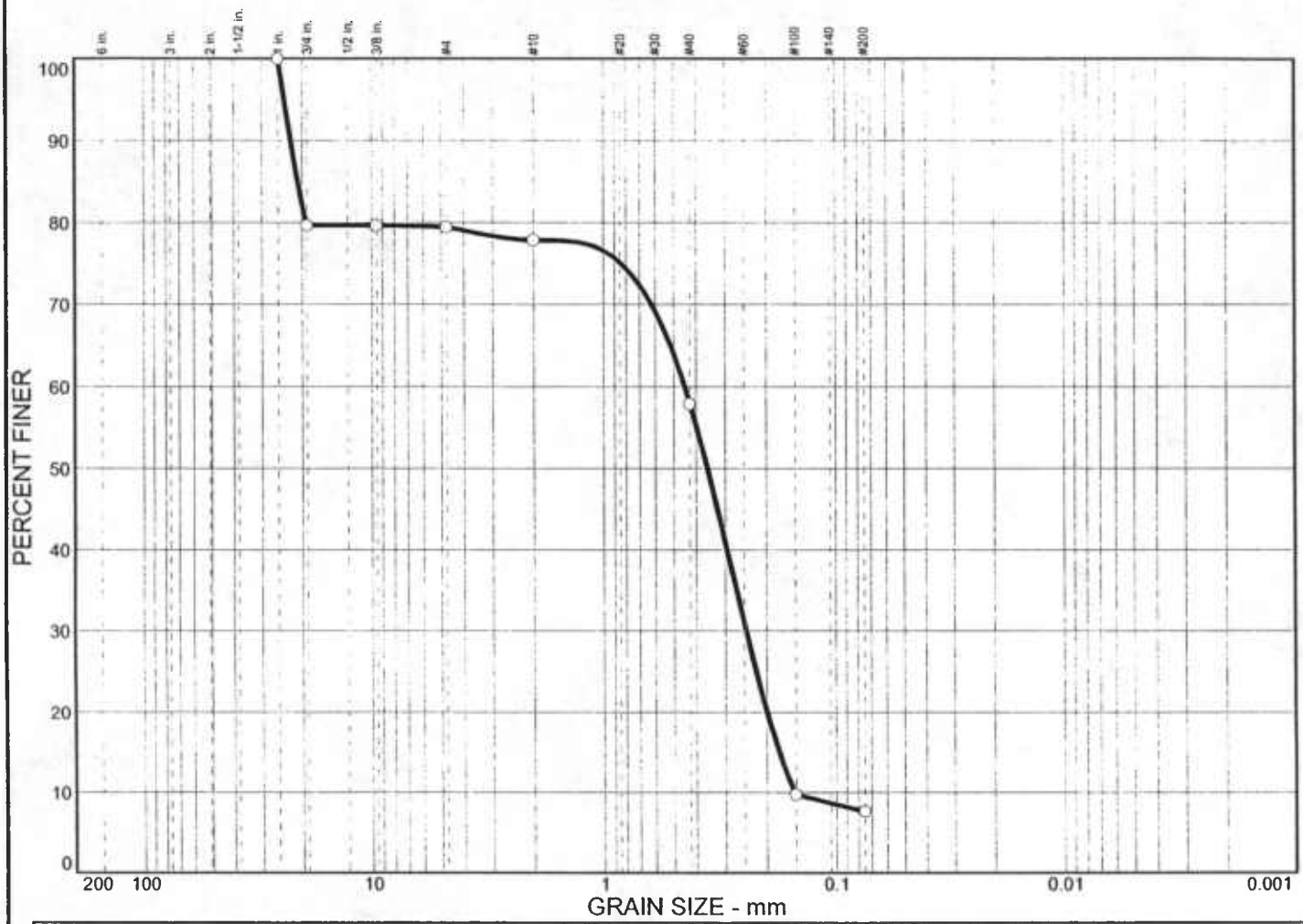
○ Natural Moisture = 19.9%

Particle Size Distribution Report

E2CR, Inc.

Plate

Particle Size Distribution Report



	% COBBLES	% GRAVEL		% SAND			% FINES	
		CRS.	FINE	CRS.	MEDIUM	FINE	SILT	CLAY
○	0.0	20.4	0.2	1.6	19.9	50.3	7.6	

	LL	PL	D_{85}	D_{60}	D_{50}	D_{30}	D_{15}	D_{10}	C_c	C_u
○			20.9	0.448	0.358	0.245	0.177	0.152	0.89	2.95

MATERIAL DESCRIPTION	USCS	AASHTO
○ Brownish Gray,Poorly Graded SAND with Silt and Gravel	SP-SM	

Project No. 01558-04 **Client:** Michael Baker, Jr.

Project: Holland Island

○ **Source:** H 08 **Sample No.:** S-9 **Elev./Depth:** 38.5'-40.0'

Remarks:

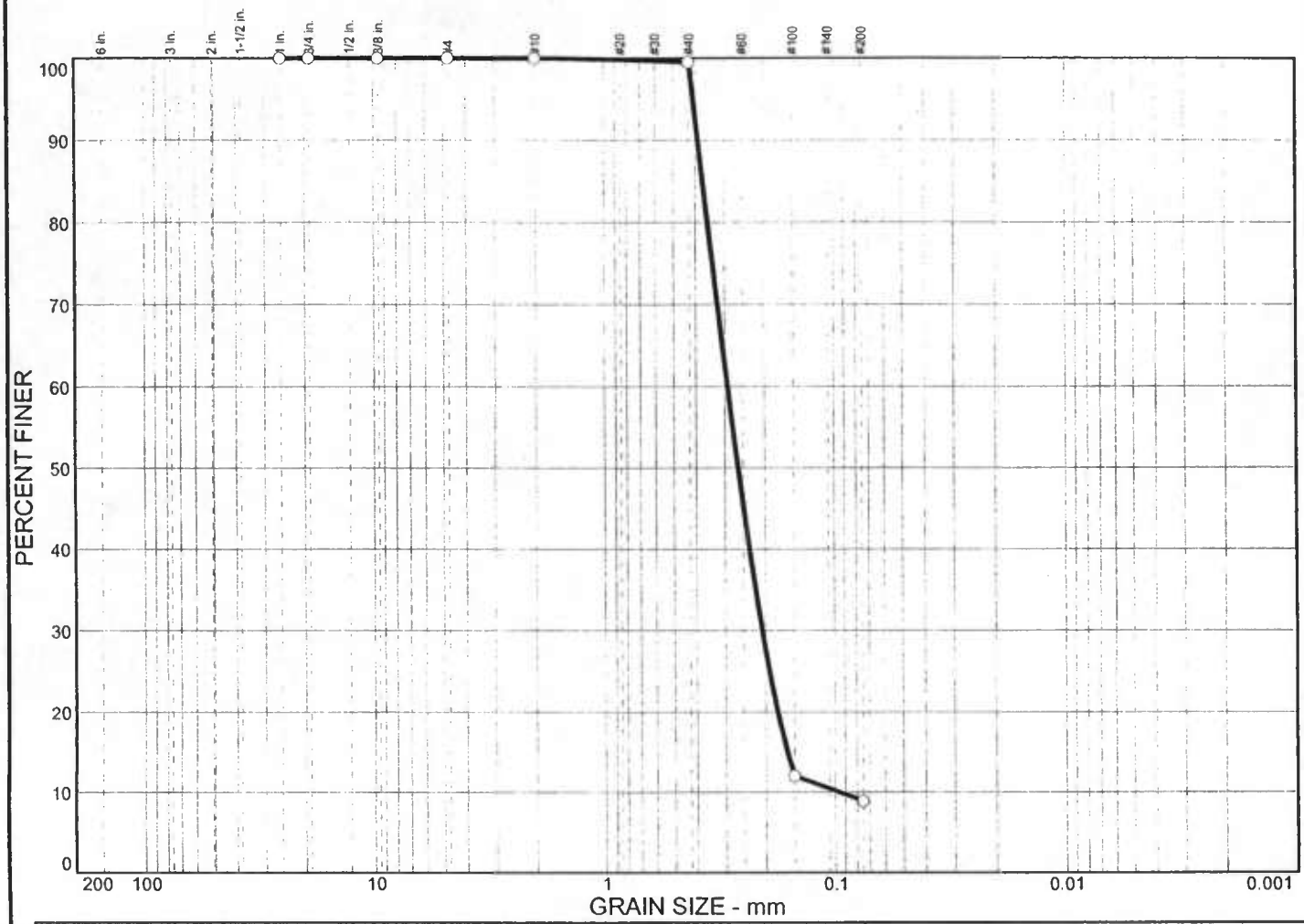
○ Natural Moisture = 19.5%

Particle Size Distribution Report

E2CR, Inc.

Plate

Particle Size Distribution Report



	% COBBLES	% GRAVEL		% SAND			% FINES	
		CRS.	FINE	CRS.	MEDIUM	FINE	SILT	CLAY
○	0.0	0.0	0.0	0.0	0.5	90.6	8.9	

	LL	PL	D_{85}	D_{60}	D_{50}	D_{30}	D_{15}	D_{10}	C_c	C_u
○			0.371	0.291	0.263	0.207	0.161	0.0959	1.53	3.04

MATERIAL DESCRIPTION	USCS	AASHTO
○ L.Gray,Poorly Graded SAND,trace Silt	SP-SM	

Project No. 01558-04 **Client:** Michael Baker, Jr.

Project: Holland Island

○ **Source:** H 11 **Sample No.:** S-4 **Elev./Depth:** 15.0'-17.0'

Remarks:

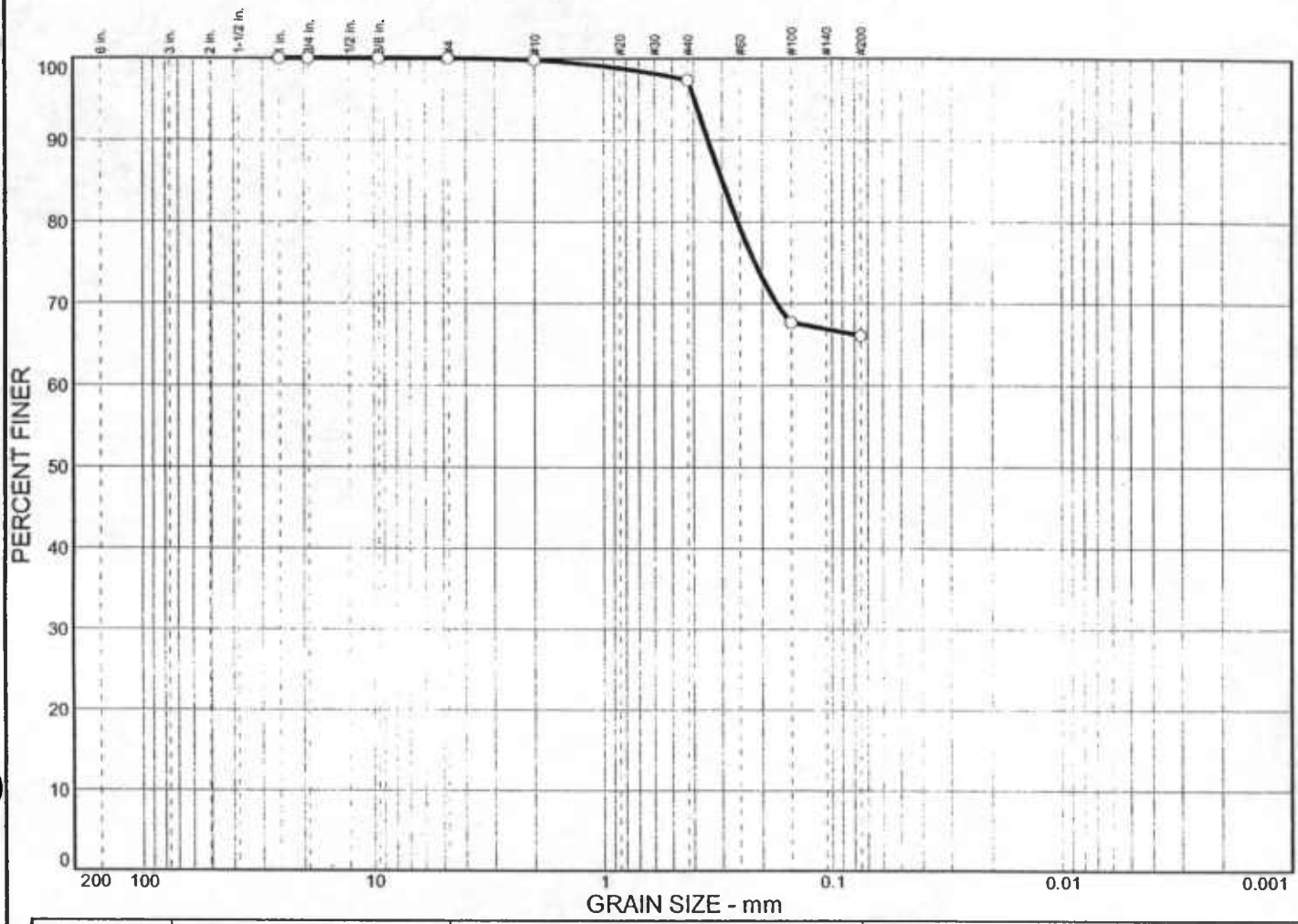
○ Natural Moisture = 26.7%

Particle Size Distribution Report

E2CR, Inc.

Plate

Particle Size Distribution Report



	% COBBLES	% GRAVEL		% SAND			% FINES	
		CRS.	FINE	CRS.	MEDIUM	FINE	SILT	CLAY
○	0.0	0.0	0.0	0.2	2.4	31.3	66.1	

	LL	PL	D_{85}	D_{60}	D_{50}	D_{30}	D_{15}	D_{10}	C_c	C_u
○			0.299							

MATERIAL DESCRIPTION	USCS	AASHTO
○ Grayish Black,Silty CLAY,some Fine Sand	CL	

Project No. 01558-04 **Client:** Michael Baker, Jr.

Project: Holland Island

○ **Source:** H 12 **Sample No.:** S-6 **Elev./Depth:** 23.5'-25.0'

Remarks:

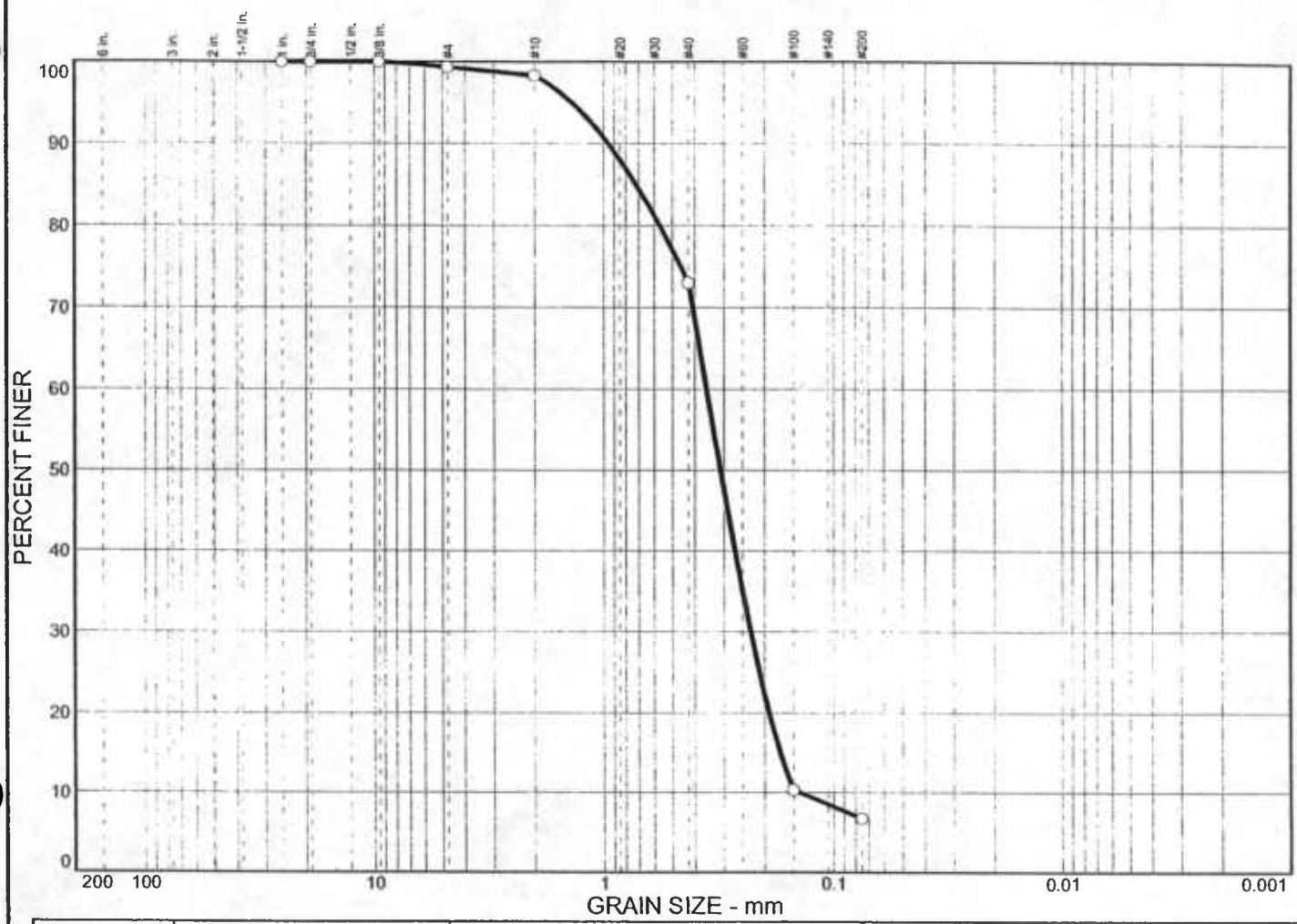
○ Natural Moisture = 74.4%

Particle Size Distribution Report

E2CR, Inc.

Plate

Particle Size Distribution Report



	% COBBLES	% GRAVEL		% SAND			% FINES	
		CRS.	FINE	CRS.	MEDIUM	FINE	SILT	CLAY
○	0.0	0.0	0.7	1.0	25.3	66.3	6.7	

	LL	PL	D_{85}	D_{60}	D_{50}	D_{30}	D_{15}	D_{10}	C_c	C_u
○			0.720	0.356	0.310	0.230	0.172	0.142	1.05	2.52

MATERIAL DESCRIPTION	USCS	AASHTO
○ Gray,Poorly Graded SAND,trace Silt	SP	

Project No. 01558-04 **Client:** Michael Baker, Jr.

Project: Holland Island

○ **Source:** H 12 **Sample No.:** S-8 **Elev./Depth:** 33.5'-35.0'

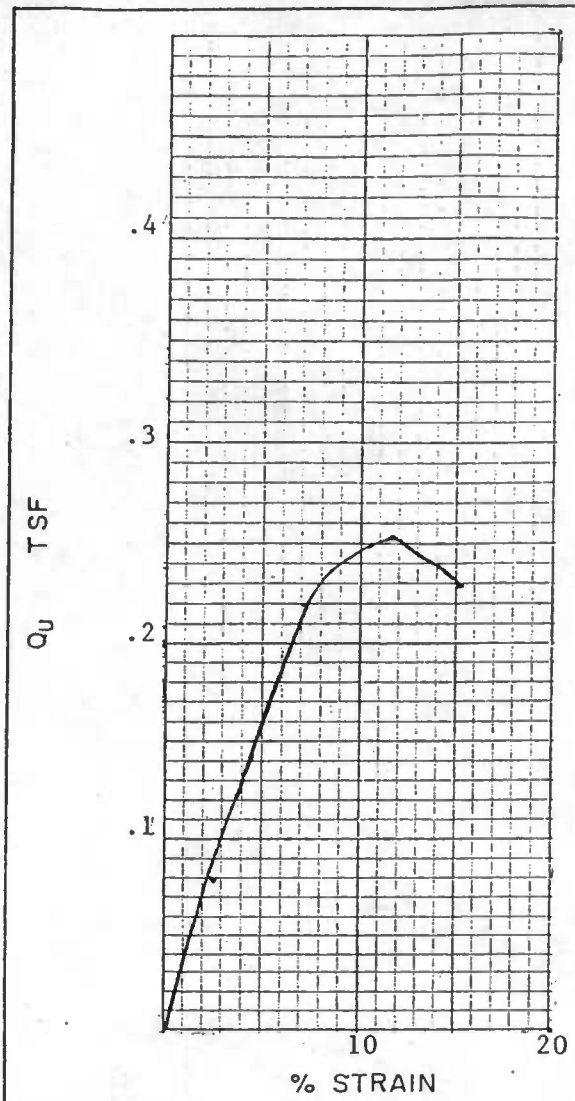
Remarks:

○ Natural Moisture = 17.0%

Particle Size Distribution Report

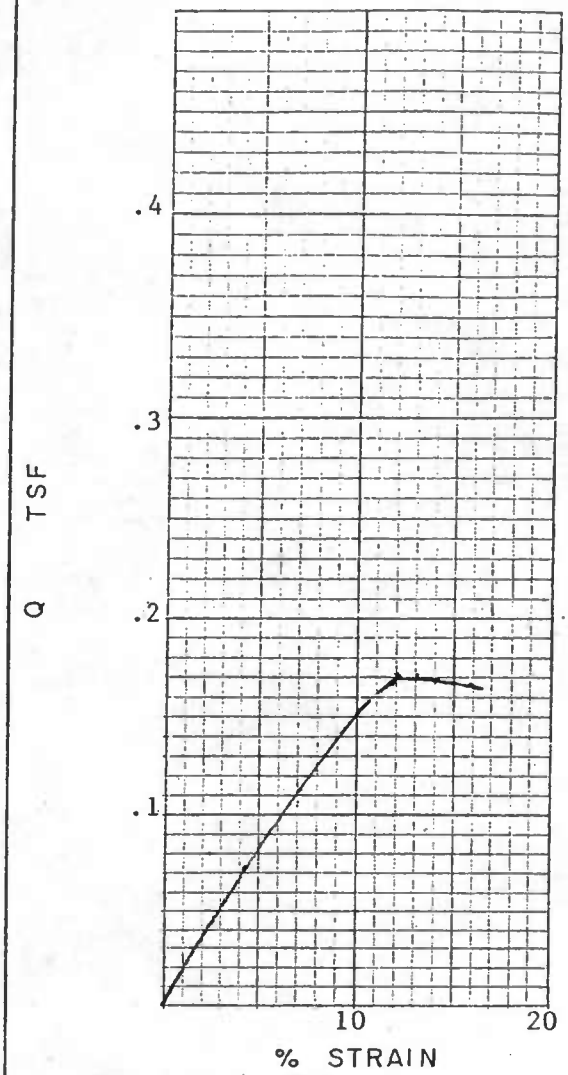
E2CR, Inc.

Plate



Boring H-4
Depth 19.5-20'
Q_u 0.25 TSF
W.C. % 60.4
Dry Wt. 63.8 PCF
Void Ratio
Q_{ur} TSF
Sensitivity
LL PI
Description Gray Clay

Sketch at Failure



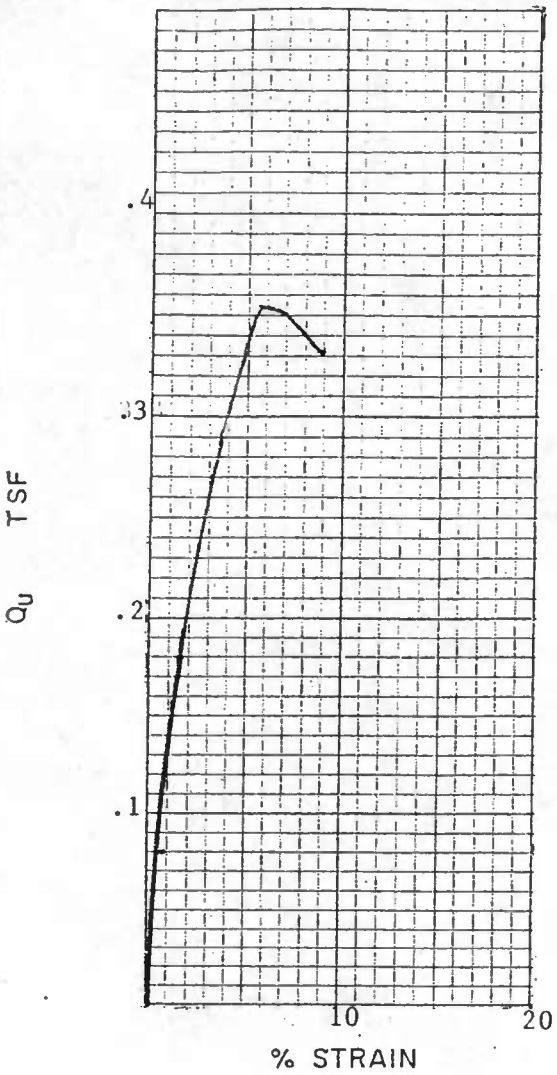
Boring H-5
Depth 14.5-15'
Q_u 0.17 TSF
W.C. % 47.4
Dry Wt 69.4 PCF
Void Ratio
Q_{ur} TSF
Sensitivity
LL PI
Description Gray Clay

Sketch at Failure

Project: **Holland Island**

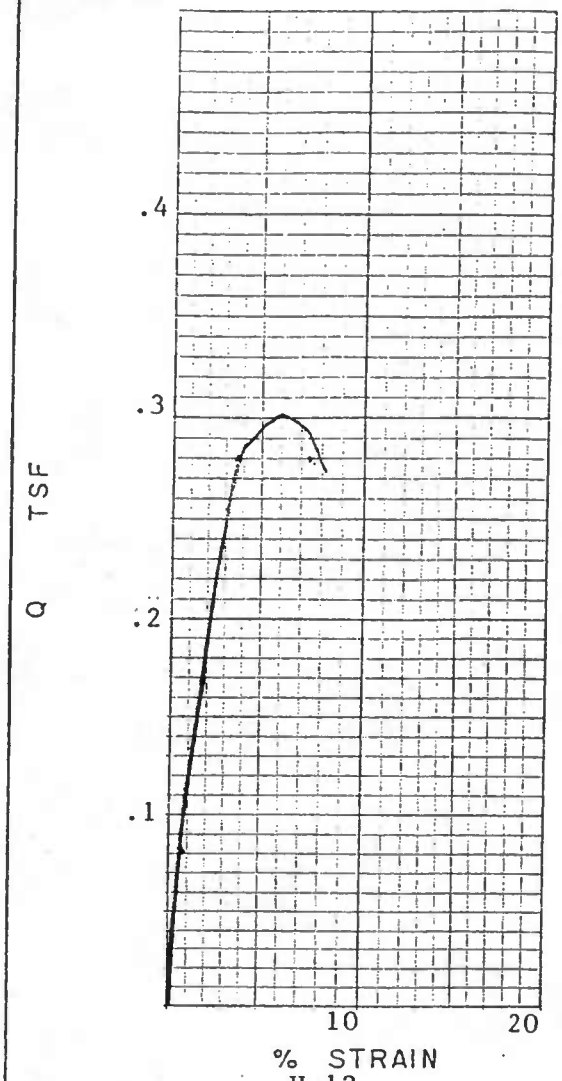
Client: **Michael Baker, Jr.** Date: 11/12/01

UNCONFINED COMPRESSION



Boring H-12
Depth 18.5 - 19'
Q_u 0.35 TSF
W.C. % 54.3
Dry Wt. 69.7 PCF
Void Ratio
Q_{ur} TSF
Sensitivity
LL PI
Description Gray Clay

Sketch at Failure



Boring H-12
Depth 19 - 19.5
Q_u 0.30 TSF
W.C. % 54.4
Dry Wt 67.3 PCF
Void Ratio
Q_{ur} TSF
Sensitivity
LL PI
Description Gray Clay

Sketch at Failure

Project: **Holland Island**

Client: **Michael Baker, Jr.** Date: 11-12-01

UNCONFINED COMPRESSION

E2CR

CONSOLIDATION TEST

PROJECT NAME: Holland Island

PROJECT NO: 01558-04

SAMPLE NUMBER: H5 : ST-1

DEPTH (FT): 13.5-15.0

MOISTURE CONTENT: 47.4 %

LAB NO:

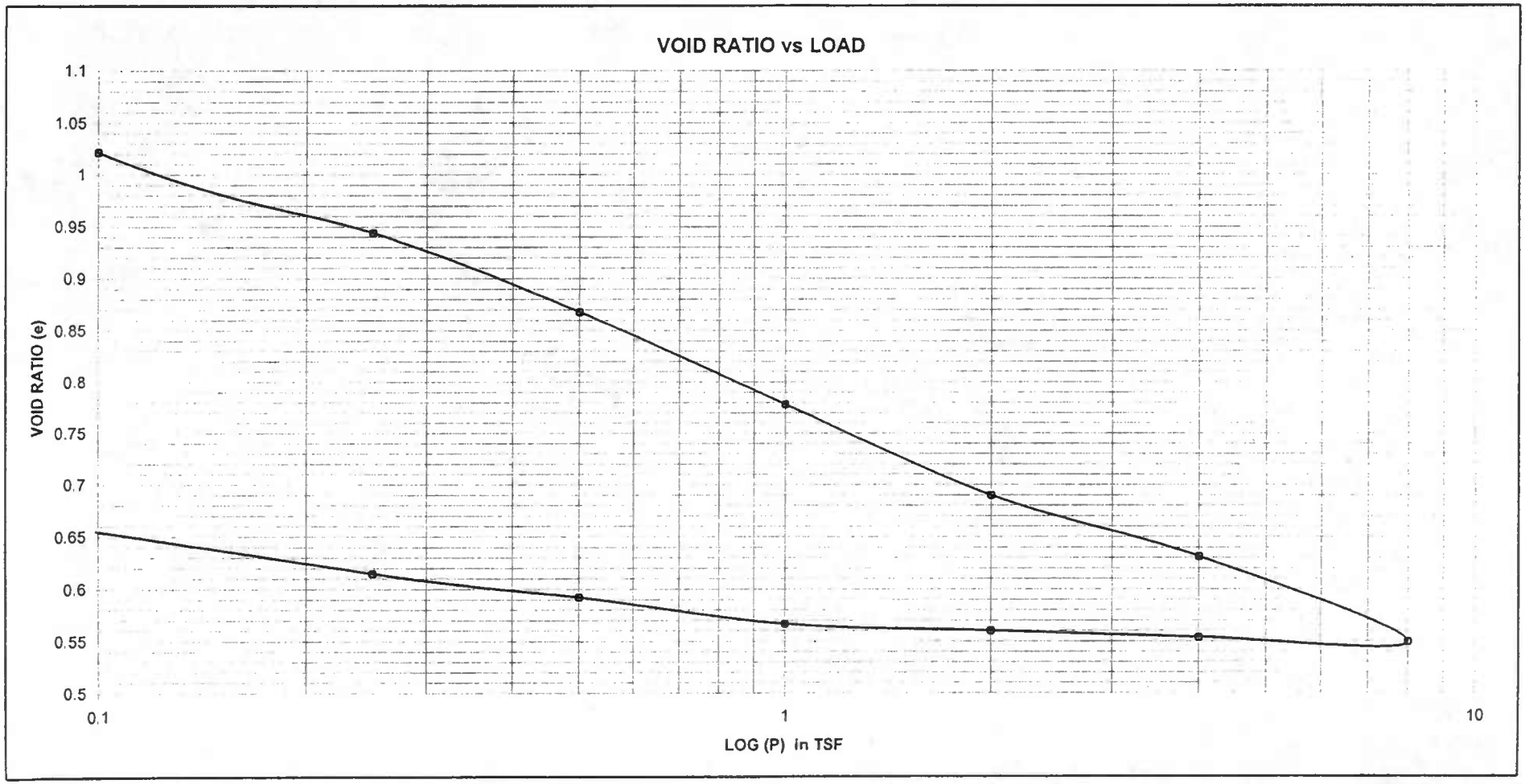
WET DENSITY (pcf): 105.3

DRY DENSITY (pcf): 71.4

SPECIFIC GRAVITY: 2.67

INITIAL VOID RATIO: 1.33

SOIL DESCRIPTION: Gray fine Sandy CLAY



E2CR

CONSOLIDATION TEST

PROJECT NAME: Holland Island

PROJECT NO: 01558-04

SAMPLE NUMBER: H12 : ST-1

DEPTH (FT): 18-20

MOISTURE CONTENT: 52.4 %

LAB NO:

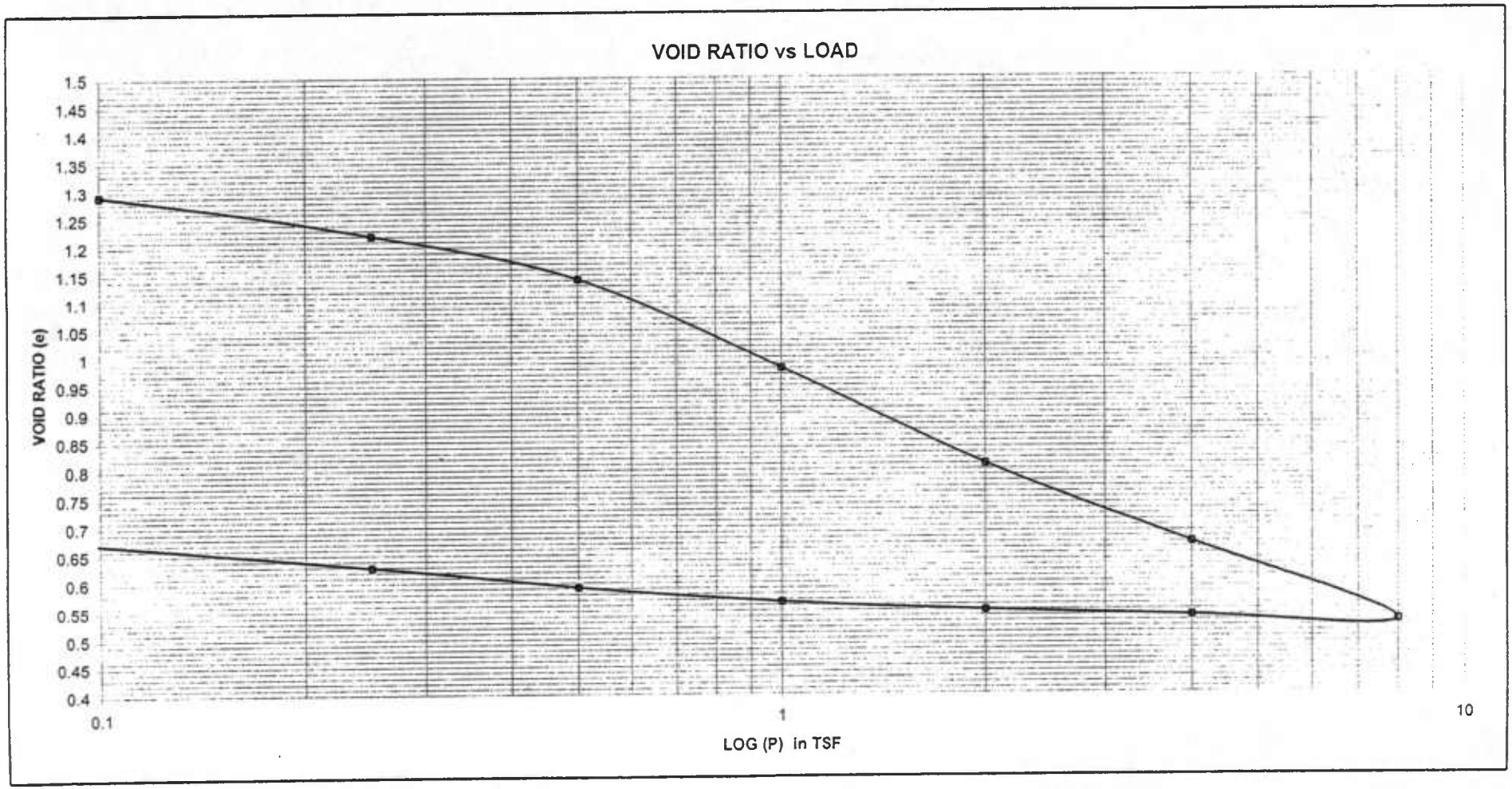
WET DENSITY (pcf): 104.4

DRY DENSITY (pcf): 68.5

SPECIFIC GRAVITY: 2.67

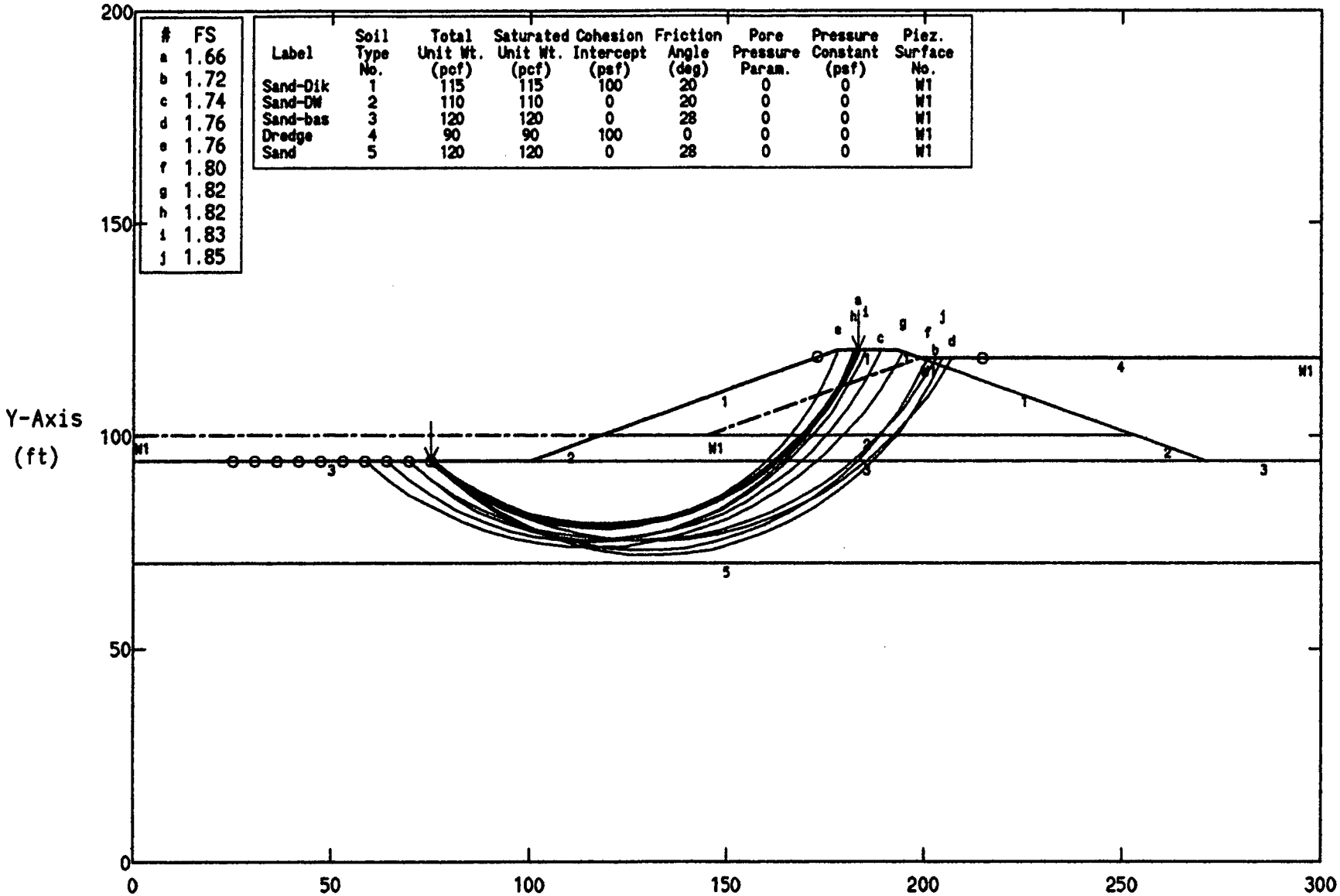
INITIAL VOID RATIO: 1.43

SOIL DESCRIPTION: Gray Silty CLAY



Holland Island Dike to +20 : Case B3:Foundation

Ten Most Critical. A:HIB3F.PLT By: GVK 11-24-01 10:36pm



#	FS
a	1.66
b	1.72
c	1.74
d	1.76
e	1.76
f	1.80
g	1.82
h	1.82
i	1.83
j	1.85

Label	Soil Type No.	Total Unit Wt. (pcf)	Saturated Unit Wt. (pcf)	Cohesion Intercept (psf)	Friction Angle (deg)	Pore Pressure Param.	Pressure Constant (psf)	Piez. Surface No.
Sand-Dik	1	115	115	100	20	0	0	W1
Sand-DW	2	110	110	0	20	0	0	W1
Sand-bas	3	120	120	0	28	0	0	W1
Dredge	4	90	90	100	0	0	0	W1
Sand	5	120	120	0	28	0	0	W1

PCSTABL5 FSmin=1.66 X-Axis (ft)

Factors Of Safety Calculated By The Modified Bishop Method

Appendix D
Laboratory Testing Data

Appendix E
Boring logs

E2CR, INC.

BORING LOG

PROJECT: Holland Island			PROJECT NO.: 01558-04	BORING NO.: H - 1
SITE: Eastern Shore, Maryland	BEGUN: 10/24/01	COMPLETED: 10/24/01	HOLE SIZE:	GROUND ELEVATION: 0.00 @ Water level
COORDINATES: 38° 08.121' / 76° 06.049'	DEPTH WATER ENC.	AT END DRILL	AT 24 Hrs	CAVED DEPTH
DRILLER: J. Sies	WEIGHT OF HAMMER: 140 lbs.	HEIGHT OF FALL	TYPE OF CORE	DEPTH OF BORING: 48.7
TYPE OF DRILL RIG & METHOD: Dietrich D-50	DEPTH TO ROCK	LOGGED BY: C. Jacobs		PAGE NO.: 1

DEPTH	STRATA ELE./ DEPTH	GRAPHIC LOG	DESCRIPTION	SAMPLE NO.	SAMPLE LENGTH	N-VALUE/ RQD (%)	SAMPLE TYPE AND DIAMETER	SAMPLE RECOVERY	REMARKS:
0	0		Water						Depth of Water 6.0' @ 12:00 noon
5	-5								
			Dark gray and brown, wet, Silty fine SAND (with Silty Clay layers) (SM)	S-1	24"	1- 1- 1- 3	DS	10"	
10	-10			S-2	24"	1- 2- 2- 3	DS	24"	
				S-3	24"	1- 2- 2- 3	DS	12"	
			Light brown, wet, Silty fine SAND (with layers of fine SAND and SILT (SM)	S-4	24"	2- 2- 2- 2	DS	17"	
15	-15								
				S-5	18"	WOH/18"	DS	8"	
20	-20		Medium gray, wet, Silty fine SAND (SM)						
			Orange, wet, fine to medium SAND, trace Silt and fine Gravel (SP-SM)	S-6	18"	4- 4- 9	DS	18"	
25	-25								
			Greenish gray, moist, Silty CLAY (with lenses of Silty Sand) (CL)	S-7	18"	WOR / 18"	DS	18"	
30	-30								
			Brownish gray, wet, Silty fine to medium SAND (with lenses of Silty Clay) (SM)	S-8	18"	2- 5- 6	DS	16"	
35	-35								

E2CR, Inc.	BORING LOG	BORING NO. H - 1	
PROJECT Holland Island		PROJECT NO. 01558-04	PAGE 2

DEPTH	STRATA ELE./ DEPTH	GRAPHIC LOG	DESCRIPTION	SAMPLE NO.	SAMPLE LENGTH	N-VALUE/ RQD (%)	SAMPLE TYPE AND DIAMETER	SAMPLE RECOVERY	REMARKS:
			Brownish gray, wet, Silty fine to medium SAND (with lenses of Silty Clay) (SP-SM)						
40	-40			S-9	18"	4- 4- 4	DS	18"	
45	-45			S-10	18"	4- 8- 10	DS	10"	
			Gray SAND, Stone Boulders	S-11	6"	50/2"	DS	3"	
50	-50		Bottom of Boring @ 48.7 feet						
55	-55								
60	-60								
65	-65								
70	-70								
75	-75								

E2CR, INC.

BORING LOG

PROJECT: Holland Island			PROJECT NO.: 01558-04	BORING NO.: H - 2
SITE: Eastern Shore, Maryland	BEGUN: 10/22/01	COMPLETED: 10/22/01	HOLE SIZE:	GROUND ELEVATION: 0.00 @ Water level
COORDINATES: 38° 07.624' / 76° 06.563'	DEPTH WATER ENC.	AT END DRILL	AT 24 Hrs	CAVED DEPTH
DRILLER: J. Sies	WEIGHT OF HAMMER: 140 lbs.	HEIGHT OF FALL	TYPE OF CORE	DEPTH OF BORING: 60
TYPE OF DRILL RIG & METHOD: Dietrich D-50	DEPTH TO ROCK	LOGGED BY: C. Jacobs		PAGE NO.: 1

DEPTH	STRATA ELE./ DEPTH	GRAPHIC LOG	DESCRIPTION	SAMPLE NO.	SAMPLE LENGTH	N-VALUE/ RQD (%)	SAMPLE TYPE AND DIAMETER	SAMPLE RECOVERY	REMARKS:
0	0		Water						Water Depth 10. 0' @ 10:30 am
5	-5								
10	-10		Dark gray and brown, wet, Silty fine SAND (SM)	S-1	24"	1- 1- 1- 2	DS	4"	
			Brownish gray, wet, Silty to Clayey fine SAND (SM-SC)	S-2	24"	WOR/24"	DS	10"	
15	-15		Medium gray, wet, Silty fine SAND (SM)	S-3	24"	8-10-10-12	DS	14"	
				S-4	24"	5- 6- 6- 4	DS	18"	
20	-20								
			Light gray and brown, wet, medium to fine SAND, trace Silt (SP-SM)	S-5	18"	3- 4- 4	DS	8"	
25	-25								
30	-30		Medium gray and brown, moist, Silty CLAY, some to trace fine Sand (CL)	S-6	18"	2- 3- 3	DS	10"	
35	-35			S-7	18"	WOR/18"	DS	18"	

E2CR, Inc.	BORING LOG	BORING NO. H - 2	
PROJECT Holland Island		PROJECT NO. 01558-04	PAGE 2

DEPTH	STRATA ELE/ DEPTH	GRAPHIC LOG	DESCRIPTION	SAMPLE DATA: SAMPLE NO.	SAMPLE LENGTH	N-VALUE/ RQD (%)	SAMPLE TYPE AND DIAMETER	SAMPLE RECOVERY	REMARKS:
			Medium gray and brown, moist, Silty CLAY, some to trace fine Sand (CL)						
40	-40			S-8	18"	WOH/18"	DS	18"	
45	-45			S-9	18"	1- 2- 5	DS	18"	
50	-50			S-10	18"	3- 3- 5	DS	18"	
55	-55			S-11	18"	3- 3- 5	DS	18"	
60	-60			S-12	18"	4- 5- 6	DS	18"	
			Bottom of Boring @ 60.0 feet						
65	-65								
70	-70								
75	-75								

E2CR, INC.

BORING LOG

PROJECT: Holland Island			PROJECT NO.: 01558-04	BORING NO.: H - 3
SITE: Eastern Shore, Maryland	BEGUN: 10/11/01	COMPLETED: 10/11/01	HOLE SIZE:	GROUND ELEVATION: 0.00 @ Water level
COORDINATES: 38° 06.786' / 76° 06.736'	DEPTH WATER ENC.	AT END DRILL	AT 24 Hrs	CAVED DEPTH
DRILLER: J. Sies	WEIGHT OF HAMMER: 140 lbs.	HEIGHT OF FALL	TYPE OF CORE	DEPTH OF BORING: 45
TYPE OF DRILL RIG & METHOD: Dietrich D-50	DEPTH TO ROCK	LOGGED BY: C. Jacobs		PAGE NO.: 1

DEPTH	STRATA ELE./ DEPTH	GRAPHIC LOG	DESCRIPTION	SAMPLE NO.	SAMPLE LENGTH	N-VALUE/ RQD (%)	SAMPLE TYPE AND DIAMETER	SAMPLE RECOVERY	REMARKS:
0	0		Water						Water Depth 13.3' @ 11:00 am
5	-5								
10	-10								
15	-15		Yellowish brown, wet, Silty fine SAND (with a lens of Silty Clay near the tip) (SP-SM)	S-1	24"	5- 6- 7- 8	DS	14"	
				S-2	24"	5- 6- 8-12	DS	23"	
				S-3	24"	2- 3- 3- 5	DS	8"	
20	-20		Yellowish brown, wet, fine SAND, trace Silt (with layers of Silty fine Sand) (SP-SM)	S-4	24"	5- 7- 7- 9	DS	20"	
25	-25			S-5	18":	3- 3- 4	DS	5"	
			Orange and medium brown gray, Sandy CLAY (CL)						
30	-30			S-6	18"	WOR/18"	DS	18"	
			Reddish brown, wet, Silty fine SAND (SM)						
35	-35			S-7	18"	WOR/18"	DS	18"	

E2CR, Inc.	BORING LOG	BORING NO. H - 3	
PROJECT Holland Island		PROJECT NO. 01558-04	PAGE 2

DEPTH	STRATA ELE./ DEPTH	GRAPHIC LOG	DESCRIPTION	SAMPLE NO.	SAMPLE LENGTH	N-VALUE/ RQD (%)	SAMPLE TYPE AND DIAMETER	SAMPLE RECOVERY	REMARKS:
			Reddish brown, wet, Silty fine SAND (SM)						
			Greenish gray, moist, Silty CLAY, trace fine Sand (CL)						
40	-40			S-8	18"	2- 2- 2	DS	18"	
45	-45			S-9	18"	3- 5- 7	DS	18"	
			Bottom of Boring @ 45.0 feet						
50	-50								
55	-55								
60	-60								
65	-65								
70	-70								
75	-75								

E2CR, INC.

BORING LOG

PROJECT: Holland Island			PROJECT NO.: 01558-04	BORING NO.: H - 4
SITE: Eastern Shore, Maryland	BEGUN: 10/12/01	COMPLETED: 10/12/01	HOLE SIZE:	GROUND ELEVATION: 0.00 @ Water level
COORDINATES: 38° 05.988' / 76° 06.622'	DEPTH WATER ENC.	AT END DRILL	AT 24 Hrs	CAVED DEPTH
DRILLER: J. Sies	WEIGHT OF HAMMER: 140 lbs.	HEIGHT OF FALL	TYPE OF CORE	DEPTH OF BORING: 55
TYPE OF DRILL RIG & METHOD: Dietrich D-50	DEPTH TO ROCK	LOGGED BY: C. Jacobs		PAGE NO.: 1

DEPTH	STRATA ELE./ DEPTH	GRAPHIC LOG	DESCRIPTION	SAMPLE NO.	SAMPLE LENGTH	N-VALUE/ RQD (%)	SAMPLE TYPE AND DIAMETER	SAMPLE RECOVERY	REMARKS:
0	0		Water						Water Depth 13. 0' @ 8:30 am
5	-5								
10	-10								
			Grayish brown, wet, Silty fine SAND (SM)	S-1	24"	WOH/24"	DS	NR	
15	-15		Greenish gray, wet to moist, Silty CLAY, trace fine Sand and organics (CH)	S-2	24"	WOH/24"	DS	19"	
				ST-1	24"	Pushed Tube	ST	20"	
20	-20			S-3	24"	WOH/18"	DS	16"	
				S-4	18"	WOH/18"	DS	18"	
25	-25								
			Greenish gray, moist, Silty CLAY (with lenses of peat)	S-5	18"	2- 2- 2	DS	18"	
30	-30								
35	-35			S-6	18"	WOH/18"	DS	10"	

E2CR, Inc.	BORING LOG	BORING NO. H - 4
PROJECT: Holland Island		PROJECT NO. 01558-04 / PAGE 2

DEPTH	STRATA ELE./ DEPTH	GRAPHIC LOG	DESCRIPTION	SAMPLE NO.	SAMPLE LENGTH	N-VALUE/ RQD (%)	SAMPLE TYPE AND DIAMETER	SAMPLE RECOVERY	REMARKS:
			Gray and brown, wet, Silty fine to medium SAND (with layers of Sand and Gravel)						
			Gray and brown, wet, Silty fine to medium SAND (with layers of Sand and Gravel)	S-7	18"	8- 2- 3	DS	18"	
40	-40		Blue gray, moist, Silty CLAY (with a layer of Silty fine to medium Sand) (CL)						
				S-8	18"	WOH/18"	DS	18"	
45	-45								
				S-9	18"	3- 5- 7	DS	18"	
50	-50								
				S-10	18"	3- 5- 6	DS	15"	
55	-55		Bottom of Boring @ 55.0 feet						
60	-60								
65	-65								
70	-70								
75	-75								

E2CR, INC.

BORING LOG

PROJECT: Holland Island			PROJECT NO.: 01558-04	BORING NO.: H - 5
SITE: Eastern Shore, Maryland	BEGUN: 10/23/01	COMPLETED: 10/23/01	HOLE SIZE:	GROUND ELEVATION: 0.00 @ Water level
COORDINATES: 38° 07.760' / 76° 05.775'	DEPTH WATER ENC.	AT END DRILL	AT 24 Hrs	CAVED DEPTH
DRILLER: J. Sies	WEIGHT OF HAMMER: 140 lbs.	HEIGHT OF FALL	TYPE OF CORE	DEPTH OF BORING: 40
TYPE OF DRILL RIG & METHOD: Dietrich D-50	DEPTH TO ROCK	LOGGED BY: C. Jacobs		PAGE NO.: 1

DEPTH	STRATA ELE./ DEPTH	GRAPHIC LOG	DESCRIPTION	SAMPLE NO.	SAMPLE LENGTH	N-VALUE/ RQD (%)	SAMPLE TYPE AND DIAMETER	SAMPLE RECOVERY	REMARKS:
0	0		Water						
5	-5								
			Brownish gray, fine Sandy CLAY (with occasional layers of Silty Sand) (CL)	S-1	24"	WOR/24"	DS	20"	
10	-10			S-2	24"	WOH/24"	DS	12"	
				ST-1	24"	Pushed Tube	ST	18"	
15	-15			S-3	24"	WOH/24"	DS	24"	
				S-4	24"	WOR/24"	DS	24"	
20	-20								
				S-5	18"	2- 4- 5	DS	8"	
25	-25		Brownish gray, Silty fine to medium SAND, trace fine Gravel (SM)						
				S-6	18"	2- 2- 2	DS	10"	
30	-30		Greenish gray, Sandy CLAY (CL)						
				S-7	18"	WOR/18"	DS	18"	
35	-35								

E2CR, Inc.	BORING LOG	BORING NO. H - 5
PROJECT Holland Island		PROJECT NO. 01558-04 / PAGE 2

DEPTH	STRATA ELE./ DEPTH	GRAPHIC LOG	DESCRIPTION	SAMPLE DATA: SAMPLE NO.	SAMPLE LENGTH	N-VALUE/ RQD (%)	SAMPLE TYPE AND DIAMETER	SAMPLE RECOVERY	REMARKS:
			Greenish gray, Sandy CLAY (CL)						
				S-8	18"	3- 5- 5	DS	18"	
40	-40		Bottom of Boring @ 40.0 feet						
45	-45								
50	-50								
55	-55								
60	-60								
65	-65								
70	-70								
75	-75								

E2CR, INC.

BORING LOG

PROJECT: Holland Island			PROJECT NO.: 01558-04	BORING NO.: H - 6
SITE: Eastern Shore, Maryland	BEGUN: 10/10/01	COMPLETED: 10/10/01	HOLE SIZE:	GROUND ELEVATION: 0.00 @ Water level
COORDINATES: 38° 06.453' / 76° 05.157'	DEPTH WATER ENC.	AT END DRILL	AT 24 Hrs	CAVED DEPTH
DRILLER: J. Sies	WEIGHT OF HAMMER: 140 lbs.	HEIGHT OF FALL	TYPE OF CORE	DEPTH OF BORING: 40
TYPE OF DRILL RIG & METHOD: Dietrich D-50	DEPTH TO ROCK	LOGGED BY: C. Jacobs		PAGE NO.: 1

DEPTH	STRATA ELE./ DEPTH	GRAPHIC LOG	DESCRIPTION	SAMPLE NO.	SAMPLE LENGTH	N-VALUE/ RQD (%)	SAMPLE TYPE AND DIAMETER	SAMPLE RECOVERY	REMARKS:
0	0		Water						Water depth 6.0' @ 11:30 am
5	-5								
			Brownish gray, wet, Silty fine SAND (SM)	S-1	24"	1- 2- 4- 4	DS	8"	
10	-10		Medium gray, wet, fine SAND and SILT, trace clay (with layer of Silty Clay and lenses of fine to medium Sand) (SM)	S-2	24"	3- 3- 3- 3	DS	4"	
				S-3	24"	3- 4- 6- 6	DS	8"	
15	-15			S-4	24"	4- 4- 4- 4	DS	12"	
20	-20		Yellowish to grayish brown, wet, fine to medium SAND, trace Silt (with layers of Silty fine Sand (SP-SM)	S-5	18"	4- 4- 6	DS	12"	
25	-25			S-6	18"	2- 2- 3	DS	18"	
30	-30		Yellowish to grayish brown, Silty CLAY (CL-ML)	S-7	18"	1- 1- 2	DS	18"	
35	-35		Greenish gray, moist to wet, fine to medium Sandy CLAY (CL)	S-8	18"	2- 2- 2	DS	18"	

E2CR, Inc.	BORING LOG	BORING NO. H - 6	
PROJECT Holland Island		PROJECT NO. 01558-04	PAGE 2

DEPTH	STRATA ELE./ DEPTH	GRAPHIC LOG	DESCRIPTION	SAMPLE DATA: SAMPLE NO.	SAMPLE LENGTH	N-VALUE/ RQD (%)	SAMPLE TYPE AND DIAMETER	SAMPLE RECOVERY	REMARKS:
			Greenish gray, moist to wet, fine to medium Sandy CLAY (CL)						
				S-9	8"	3- 4- 6	DS	18"	
40	-40		Bottom of Boring @ 40.0 feet						
45	-45								
50	-50								
55	-55								
60	-60								
65	-65								
70	-70								
75	-75								

E2CR, INC.

BORING LOG

PROJECT: Holland Island			PROJECT NO.: 01558-04	BORING NO.: H - 7
SITE: Eastern Shore, Maryland	BEGUN: 10/11/01	COMPLETED: 10/11/01	HOLE SIZE:	GROUND ELEVATION: 0.00 @ Water level
COORDINATES: 38° 07.340' / 76° 06.046'	DEPTH WATER ENC.	AT END DRILL	AT 24 Hrs	CAVED DEPTH
DRILLER: J. Sies	WEIGHT OF HAMMER: 140 lbs.	HEIGHT OF FALL	TYPE OF CORE	DEPTH OF BORING: 45
TYPE OF DRILL RIG & METHOD: Dietrich D-50	DEPTH TO ROCK	LOGGED BY: C. Jacobs		PAGE NO.: 1

DEPTH	STRATA ELE./ DEPTH	GRAPHIC LOG	DESCRIPTION	SAMPLE NO.	SAMPLE LENGTH	N-VALUE/ RQD (%)	SAMPLE TYPE AND DIAMETER	SAMPLE RECOVERY	REMARKS:
0	0		Water						Water depth 8.2' @ 8:30 am
5	-5								
10	-10		Brownish gray, wet, Silty CLAY, little organics, trace fine Sand (CL)	S-1	24"	WOH/24"	DS	24"	
				S-2	24"	WOH/24"	DS	2"	
15	-15			S-3	24"	WOH/24"	DS	24"	
				S-4	24"	WOH/24"	DS	20"	
20	-20		Grayish brown, wet, Silty fine to medium SAND (SM)	S-5	18"	3- 5- 8	DS	17"	
25	-25			S-6	18"	5- 5- 1	DS	14"	
			Greenish gray, wet, Clayey fine to medium SAND (SC)						
30	-30			S-7	18"	WOR/18"	DS	17"	
35	-35			S-8	18"	3- 5- 5	DS	16"	

E2CR, Inc.	BORING LOG	BORING NO. H - 7	
PROJECT Holland Island		PROJECT NO. 01558-04	PAGE 2

DEPTH	STRATA ELE./ DEPTH	GRAPHIC LOG	DESCRIPTION	SAMPLE DATA: SAMPLE NO.	SAMPLE LENGTH	N-VALUE/ RQD (%)	SAMPLE TYPE AND DIAMETER	SAMPLE RECOVERY	REMARKS:
			Greenish gray, wet, Clayey fine to medium SAND (SC)						
			Brownish gray, moist, Silty CLAY, trace fine Sand (CL)						
40	-40			S-9	18"	3- 4- 5	DS	18"	
45	-45			S-10	18"	3- 4- 7	DS	18"	
			Bottom of Boring @ 45.0 feet						
50	-50								
55	-55								
60	-60								
65	-65								
70	-70								
75	-75								

E2CR, INC.

BORING LOG

PROJECT: Holland Island			PROJECT NO.: 01558-04	BORING NO.: H - 8
SITE: Eastern Shore, Maryland	BEGUN: 10/12/01	COMPLETED: 10/12/01	HOLE SIZE:	GROUND ELEVATION: 0.00 @ Water level
COORDINATES: 38° 07.172' / 76° 06.464'	DEPTH WATER ENC.	AT END DRILL	AT 24 Hrs	CAVED DEPTH
DRILLER: J. Sies	WEIGHT OF HAMMER: 140 lbs.	HEIGHT OF FALL	TYPE OF CORE	DEPTH OF BORING: 50
TYPE OF DRILL RIG & METHOD: Dietrich D-50	DEPTH TO ROCK	LOGGED BY: C. Jacobs		PAGE NO.: 1

DEPTH	STRATA ELE./ DEPTH	GRAPHIC LOG	DESCRIPTION	SAMPLE NO.	SAMPLE LENGTH	N-VALUE/ RQD (%)	SAMPLE TYPE AND DIAMETER	SAMPLE RECOVERY	REMARKS:
0	0		Water						Water depth 7.0' @ 12:30 pm
5	-5								
			Brownish gray, wet, fine to medium SAND, trace Silt (SP-SM)	S-1	24"	4- 6- 6- 2	DS	9"	
10	-10			S-2	24"	1- 1- 1- 1	DS	16"	
			Brownish gray, wet to very moist, Silty CLAY (with layers of Silty fine to medium Sand and organics) (CL- OH)	S-3	24"	WOH/24"	DS	10"	
15	-15			S-4	24"	WOR/24"	DS	13"	
			Brownish gray, wet, Silty fine to medium SAND (SM)	S-5	18"	5- 7- 8	DS	13"	
20	-20								
			Medium gray to light brown,wet, fine to medium SAND, trace Silt (SP-SM)	S-6	18"	4- 5- 7	DS	18"	
25	-25								
				S-7	18"	3- 5- 7	DS	14"	
30	-30								
35	-35		Brownish gray, wet, Silty fine	S-8	18"	7- 9- 10	DS	18"	

E2CR, Inc.	BORING LOG	BORING NO. H - 8	
PROJECT Holland Island		PROJECT NO. 01558-04	PAGE 2

DEPTH	STRATA ELE/ DEPTH	GRAPHIC LOG	DESCRIPTION	SAMPLE NO.	SAMPLE LENGTH	N-VALUE/ RQD (%)	SAMPLE TYPE AND DIAMETER	SAMPLE RECOVERY	REMARKS:
			SAND, trace medium to coarse Sand and fine to medium Gravel (SM)						
			Brownish gray, wet, Silty fine SAND, trace medium to coarse Sand and fine to medium Gravel (SP-SM)	S-9	18"	4- 4- 7	SD	3"	
40	-40								
			Brownish gray, moist, Silty CLAY, trace fine Sand (CL)						
45	-45			S-10	18"	3- 3- 3	DS	18"	
				S-11	18"	4- 5- 6	DS	18"	
50	-50		Bottom of Boring @ 50.0 feet						
55	-55								
60	-60								
65	-65								
70	-70								
75	-75								

E2CR, INC.

BORING LOG

PROJECT: Holland Island			PROJECT NO.: 01558-04	BORING NO.: H - 9
SITE: Eastern Shore, Maryland	BEGUN: 10/24/01	COMPLETED: 10/24/01	HOLE SIZE:	GROUND ELEVATION: 0.00 @ Water level
COORDINATES: 38° 05.745' / 76° 05.699'	DEPTH WATER ENC.	AT END DRILL	AT 24 Hrs	CAVED DEPTH
DRILLER: J. Sies	WEIGHT OF HAMMER: 140 lbs.	HEIGHT OF FALL	TYPE OF CORE	DEPTH OF BORING: 40
TYPE OF DRILL RIG & METHOD: Dietrich D-50	DEPTH TO ROCK	LOGGED BY: C. Jacobs		PAGE NO.: 1

DEPTH	STRATA ELE/ DEPTH	GRAPHIC LOG	DESCRIPTION	SAMPLE NO.	SAMPLE LENGTH	N-VALUE/ RQD (%)	SAMPLE TYPE AND DIAMETER	SAMPLE RECOVERY	REMARKS:
0	0		Water						Water depth 8.5' @ 1:30 pm
5	-5								
10	-10		Brownish gray, wet, Silty fine SAND (SM)	S-1	24"	3- 3- 3- 3	DS	8"	
			Light brown, wet to moist, Clayey SILT and fine SAND (ML)	S-2	24"	3- 3- 3- 3	DS	10"	
15	-15		Orange brown, wet, Silty fine SAND (SP-SM)	S-3	24"	3- 3- 3- 3	DS	9"	
				S-4	24"	4- 6- 8- 9	DS	9"	
20	-20			S-5	18"	2- 3- 4	DS	9"	
			Greenish gray, wet to moist, Clayey fine SAND and SILT (SC)						
25	-25			S-6	18"	WOH/18"	DS	13"	
30	-30			S-7	18"	WOH/18"	DS	14"	
35	-35		Brownish gray, wet, Silty fine	S-8	18"	3- 5- 8	DS	18"	

E2CR, Inc.	BORING LOG	BORING NO. H - 9
PROJECT: Holland Island		PROJECT NO. 01558-04 / PAGE 2

DEPTH	STRATA ELE./ DEPTH	GRAPHIC LOG	DESCRIPTION	SAMPLE NO.	SAMPLE LENGTH	N-VALUE/ RQD (%)	SAMPLE TYPE AND DIAMETER	SAMPLE RECOVERY	REMARKS:
			SAND (with occasional Sand and Gravel layers) (SP-SM)						
40	-40		Greenish gray, moist, Silty CLAY, trace fine Sand and plant fragments (CH-MH)	S-9	18"	2- 2- 2	DS	18"	
			Bottom of Boring @ 40.0 feet						
45	-45								
50	-50								
55	-55								
60	-60								
65	-65								
70	-70								
75	-75								

E2CR, INC.

BORING LOG

PROJECT: Holland Island			PROJECT NO.: 01558-04	BORING NO.: H - 10
SITE: Eastern Shore, Maryland	BEGUN: 10/24/01	COMPLETED: 10/24/01	HOLE SIZE:	GROUND ELEVATION: 0.00 @ Water level
COORDINATES: 38° 06.343' / 76° 06.029'	DEPTH WATER ENC.	AT END DRILL	AT 24 Hrs	CAVED DEPTH
DRILLER: J. Sies	WEIGHT OF HAMMER: 140 lbs.	HEIGHT OF FALL	TYPE OF CORE	DEPTH OF BORING: 70
TYPE OF DRILL RIG & METHOD: Dietrich D-50	DEPTH TO ROCK	LOGGED BY: C. Jacobs		PAGE NO.: 1

DEPTH	STRATA ELE/ DEPTH	GRAPHIC LOG	DESCRIPTION	SAMPLE NO.	SAMPLE LENGTH	N-VALUE/ RQD (%)	SAMPLE TYPE AND DIAMETER	SAMPLE RECOVERY	REMARKS:
0	0		Water						Water depth 8.8' @ 7:30 am
5	-5								
10	-10		Medium gray, very moist, Silty CLAY, little fine Sand (CL)	S-1	24"	3- 3- 3- 3	DS	10"	
			Brownish gray, wet, Silty CLAY (CL)	S-2	24"	3- 3- 2- 1	DS	20"	
15	-15			S-3	18"	3- 2- 2- 3	DS	6"	
20	-20		Light brown, wet, fine SAND, trace Silt (SP-SM)	S-4	24"	2- 2- 5- 5	DS	18"	
25	-25			S-5	18"	2- 2- 4	DS	18"	
30	-30		Brownish to greenish gray, moist, fine Sandy CLAY (CL)	S-6	18"	3- 2- 2	DS	18"	
35	-35			S-7	18"	2- 2- 2	DS	18"	

E2CR, Inc.	BORING LOG	BORING NO. H - 10
PROJECT: Holland Island		PROJECT NO. 01558-04 / PAGE 2

DEPTH	STRATA ELE./ DEPTH	GRAPHIC LOG	DESCRIPTION	SAMPLE NO.	SAMPLE LENGTH	N-VALUE/ RQD (%)	SAMPLE TYPE AND DIAMETER	SAMPLE RECOVERY	REMARKS:
			Brownish to greenish gray, moist, fine Sandy CLAY (CL)						
			Greenish gray, moist, Silty CLAY, trace fine Sand and plant fragments (CL)	S-8	18"	WOR/18"	DS	18"	
40	-40								
			Greenish gray, wet, Clayey fine to medium SAND and GRAVEL (SC)	S-9	18"	50/4"	DS	4"	
45	-45								
			Greenish gray and light brown, wet, fine SAND, trace Silt (mildly glauconitic) (SP-SM)	S-10	18"	5- 12- 18	DS	18"	
50	-50								
				S-11	18"	2- 4- 4	DS	9"	
55	-55								
				S-12	12"	4- 5- 5	DS	12"	
60	-60								
				S-13	18"	3- 7- 7	DS	10"	
65	-65								
				S-14	18"	2- 3- 5	DS	18"	
70	-70		Bottom of Boring @ 70.0 feet						
75	-75								

E2CR, INC.

BORING LOG

PROJECT	PROJECT NO.	BORING NO.
Holland Island	01558-04	H - 11

SITE	BEGUN	COMPLETED	HOLE SIZE	GROUND ELEVATION
Eastern Shore, Maryland	10/24/01	10/24/01		0.00 @ Water level
COORDINATES	**DEPTH WATER ENC.**	**AT END DRILL**	**AT 24 Hrs**	**CAVED DEPTH**
38° 07.204" / 76° 05.838"				
DRILLER	**WEIGHT OF HAMMER**	**HEIGHT OF FALL**	**TYPE OF CORE**	**DEPTH OF BORING**
J. Sies	140 lbs.			45
TYPE OF DRILL RIG & METHOD	**DEPTH TO ROCK**	**LOGGED BY:**		**PAGE NO.**
Dietrich D-50		C. Jacobs		1

DEPTH	STRATA ELE./ DEPTH	GRAPHIC LOG	DESCRIPTION	SAMPLE NO.	SAMPLE LENGTH	N-VALUE/ RQD (%)	SAMPLE TYPE AND DIAMETER	SAMPLE RECOVERY	REMARKS:
0	0		Water						Water depth 8.0' @ 9:00 am
5	-5								
10	-10		Brownish gray, wet, Silty CLAy, trace to little fine Sand (CL)	S-1	24"	WOH/24"	DS	22"	
				S-2	24"	6- 8- 8- 9	DS	18"	
			Brownish gray, wet, Silty fine SAND (SM)						
15	-15		Brownish gray, wet, fine SAND, trace Silt (SP-SM)	S-3	24"	4- 5- 5- 5	DS	17"	
				S-4	24"	4- 5- 5- 8	DS	14"	
20	-20		Brownish gray, moist, fine Clayey SAND (with mica layers of Silty Sand) (SC)	S-5	18"	1- 2- 2	DS	18"	
25	-25			S-6	18"	WOR/18"	DS	18"	
30	-30			S-7	18"	1- 2- 9	DS	18"	
			Brownish gray, wet, fine SAND and SILT, trace Clay and shell fragments (SM)						
35	-35			S-8	18"	WOR/18"	DS	18"	

E2CR, Inc.	BORING LOG	BORING NO. H - 11	
PROJECT Holland Island		PROJECT NO. 01558-04	PAGE 2

DEPTH	STRATA ELE./ DEPTH	GRAPHIC LOG	DESCRIPTION	SAMPLE NO.	SAMPLE LENGTH	N-VALUE/ RQD (%)	SAMPLE TYPE AND DIAMETER	SAMPLE RECOVERY	REMARKS:
			Brownish gray, wet, fin SAND and SILT, trace Clay and shell fragments (SM)						
			Greenish gray, moist, Silty CLAY, trace to little fine Sand (CL)	S-9	18"	WOR/18"	DS	18"	
40	-40								
				S-10	18"	4- 5- 6	DS	18"	
45	-45		Bottom of Boring @ 45.0 feet						
50	-50								
55	-55								
60	-60								
65	-65								
70	-70								
75	-75								

E2CR, INC.

BORING LOG

PROJECT: Holland Island			PROJECT NO.: 01558-04	BORING NO.: H - 12
SITE: Eastern Shore, Maryland	BEGUN: 10/10/01	COMPLETED: 10/10/01	HOLE SIZE:	GROUND ELEVATION: 0.00 @ Water level
COORDINATES: 38° 06.777 / 76° 05.761	DEPTH WATER ENC.	AT END DRILL	AT 24 Hrs	CAVED DEPTH
DRILLER: J. Sies	WEIGHT OF HAMMER: 140 lbs.	HEIGHT OF FALL	TYPE OF CORE	DEPTH OF BORING: 45
TYPE OF DRILL RIG & METHOD: Dietrich D-50	DEPTH TO ROCK	LOGGED BY: C. Jacobs		PAGE NO.: 1

DEPTH	STRATA ELE./ DEPTH	GRAPHIC LOG	DESCRIPTION	SAMPLE NO.	SAMPLE LENGTH	N-VALUE/ RQD (%)	SAMPLE TYPE AND DIAMETER	SAMPLE RECOVERY	REMARKS:
0	0		Water						Water depth 7.2' @ 8:00 am
5	-5								
			Brownish gray, wet, Silty fine SAND, (SM)	S-1	24"	2- 1- 2- 2	DS	6"	
				S-2	24"	1-1-WOH/ 12"	DS	9"	
10	-10		Brownish gray, wet, Silty CLAY (CL)						
				S-3	24"	WOH/24"	DS	12"	
15	-15			S-4	24"	WOH/24"	DS	24"	
				ST-1	24"	Pushed Tube	DS	24"	
20	-20		Grayish brown, wet, Silty CLAY, some organics (CL-OH)	S-5	18"	1- 1- 1	DS	18"	
				S-6	18"	3- 5- 8	DS	12"	
25	-25		Light grayish brown, moist to wet, Sandy CLAY (CL)						
			Brownish green, moist, fine Sandy CLAY (CL)	S-7	18"	3- 3- 6	DS	18"	
30	-30								
			Grayish brown, wet, fine to medium SAND, trace Silt (SP-SM)	S-8	18"	3- 3- 3	DS	12"	
35	-35								

E2CR, Inc.	BORING LOG	BORING NO. H - 12	
PROJECT Holland Island		PROJECT NO. 01558-04	PAGE 2

DEPTH	STRATA ELE/ DEPTH	GRAPHIC LOG	DESCRIPTION	SAMPLE NO.	SAMPLE LENGTH	N-VALUE/ RQD (%)	SAMPLE TYPE AND DIAMETER	SAMPLE RECOVERY	REMARKS:
			Grayish brown, wet, fine to medium SAND, trace Silt (SP-SM)						
			Greenish gray to brown, moist, Silty CLAY, trace fine Sand (CH-MH)	S-9	12"	3- 3- 3	DS	12"	
40	-40								
				S-10	18"	3- 4- 6	DS	18"	
45	-45		Bottom of Boring @ 45.0 feet						
50	-50								
55	-55								
60	-60								
65	-65								
70	-70								
75	-75								

Appendix B

APPENDIX B

Reconnaissance Study of Holland Island for Beneficial Use and Habitat Restoration

FINAL
Coastal Engineering Analysis

May 21, 2002

Under Contract To:

Maryland Environmental Service
2011 Commerce Park Drive
Annapolis, Maryland

For:
The Maryland Port Administration
2310 Broening Highway
Baltimore, Maryland

Submitted by:

Baker

Michael Baker Jr., Inc.
Glen Burnie, Maryland

FINAL
COASTAL ENGINEERING ANALYSIS
HOLLAND ISLAND, MARYLAND

May 21, 2002

Under Contract To:

Maryland Environmental Service
2011 Commerce Park Drive
Annapolis, MD 21401

For:

Maryland Port Administration
2310 Broening Highway
Baltimore, Maryland 21224

By

Michael Baker Jr., Incorporated
801 Cromwell Park Drive, Suite 110
Glen Burnie, MD 21061

And

Offshore & Coastal Technologies, Incorporated –East Coast
P.O. Box 1368
Chadds Ford, Pennsylvania 19317-1368

FINAL
COASTAL ENGINEERING ANALYSIS
HOLLAND ISLAND, MARYLAND

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COASTAL ENGINEERING ANALYSIS
HOLLAND ISLAND, MARYLAND

Executive Summary

This document presents a preliminary coastal engineering analysis for use in planning for dredging engineering and dike design for potential beneficial use and habitat restoration at Holland Island, Maryland.

According to navigation charts, the existing Holland Island is surrounded to a large extent by very shallow water that extends about 1 nautical mile on all sides of the island, except for a narrow channel of deep water to the east which is less than 6 feet deep Mean Low Water. This shallow water provides the basis for the footprint for the dredge disposal island. Just west of this broad shallow area, the water depth increases rapidly into the main bay, deepening to over 20 feet in depth over approximately a 0.5-mile distance. The proposed new island limits are at the edge of the drop to deeper water.

Existing data sources indicate that Holland Island exhibits a mean tide range of approximately 1.9 feet and an extreme 100-year water level of 6.8 feet above Mean Lower Low Water (MLLW). Winds most often are 5-10 miles per hour from the north-to-northwest octant, and can approach 40 mph during a 5-year event and 55 mph during a 100-year event. Wave heights can exceed 5 feet in a 5-year event and can approach 7 feet in a 100-year event, arriving from the west-to-northwest octant.

Longshore sediment transport rates, driven by waves, are thus quite large on westward-facing shorelines. In these areas, transport is calculated to be approximately 40,000 cubic yards per year (cy/yr) to the south and 20,000 cy/yr to the north, generating a net transport rate of 20,000 cubic yards toward the south. On north-facing beaches, the net sediment transport rate is calculated to be about 40,000 cy/yr toward the east. Both of these large transport rate situations are due to dominant waves from the northwest.

Dike sections were developed based on the wave analysis and layout of two alternative dike alignments near Holland Island. The dike sections have a 1 vertical to 3 horizontal slope. Armor stone sizes have been estimated for the 1:3 slopes for each alignments. Water depths at the proposed dikes vary from 4 feet to about 11 feet below MLLW.

The section developed consists of a three-layer section for the more extreme wave exposures, and a two-layer section for the less extreme exposures. The layers consist of the primary armor, an underlayer of intermediate stones, and a filter stone layer that will minimize the loss of fine sediment that may pass through the geotextile filter cloth. The proposed toe section consists of a bedding layer of filter stone along the bottom over a layer of geotextile filter cloth, protected with a single layer of primary armor stones, with a width of three stones. This toe section, which provides a significant reserve against scour, should be simple to build as it has been constructed at other sites successfully with available technology.

COASTAL ENGINEERING ANALYSIS
HOLLAND ISLAND, MARYLAND

May 2002

1. INTRODUCTION

1.1 Purpose and Need

This document presents a preliminary coastal engineering analysis prepared in association with the conceptual development of a proposed beneficial use of dredged material project. The coastal engineering analysis was prepared by Offshore & Coastal Technologies, Incorporated – East Coast (OCTI) for Holland Island, Maryland, as requested by Michael Baker Jr., Inc. The overall study of Holland Island is being prepared by Michael Baker Jr., Inc., under contract to Maryland Environmental Service (MES) for the Maryland Port Administration.

This analysis includes assessments utilizing available, relevant and readily obtainable data on bathymetry, topography, wind conditions, water levels, currents, and sediment data with regard to the potential design of and effects on dike construction at the site. The Poplar Island habitat restoration project has been used as a model for these analyses. No new modeling has been performed as part of this phase of the study.

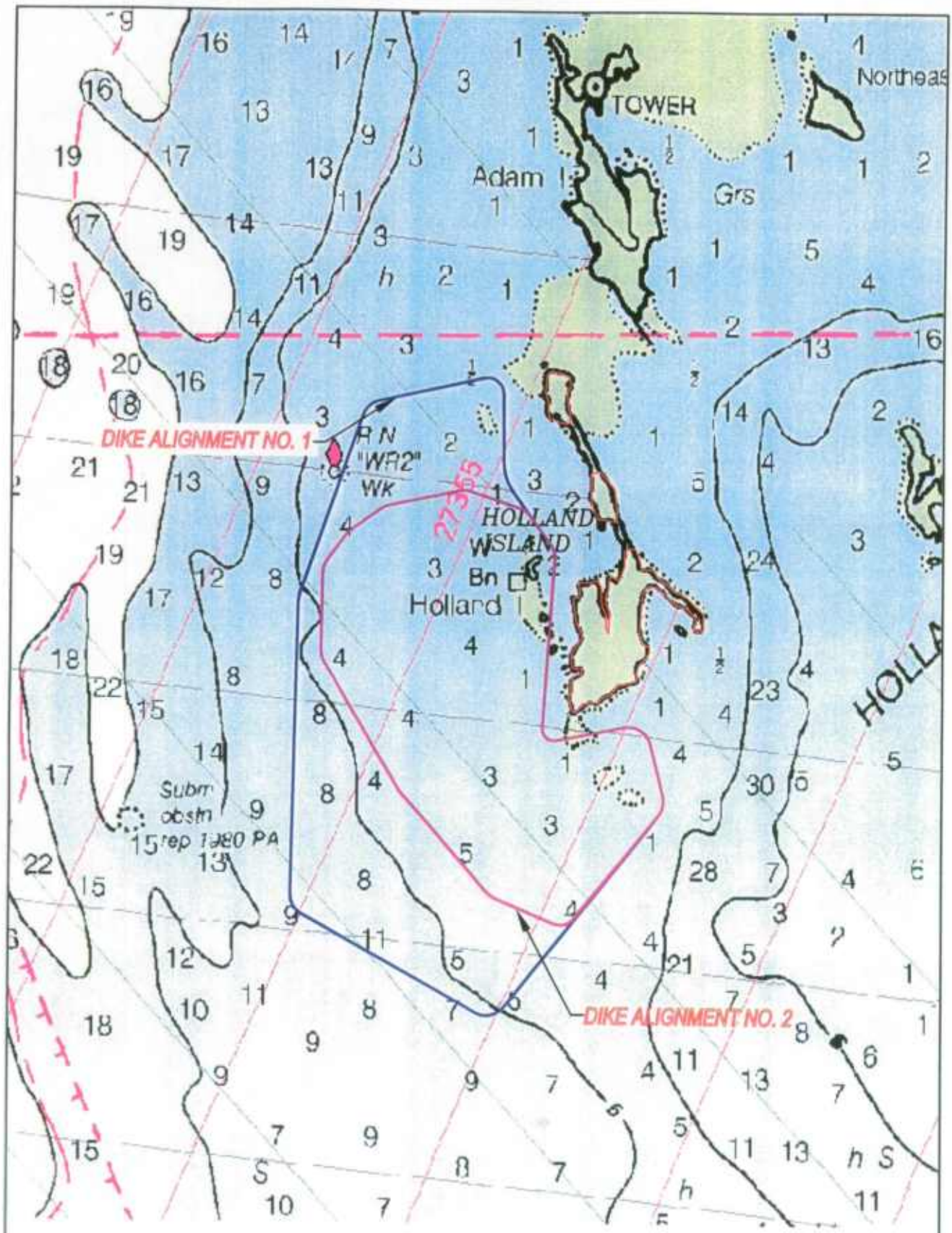
The assessment of wave exposure and water depths is based on two potential dike alignments provided by Michael Baker Jr., Inc., shown in Figure 1-1.

1.2 Project Objective

The objective of the coastal engineering analysis is to determine the effects of bathymetry, topography, wind conditions, water levels, currents, and sediment data on the potential design and construction of dikes at the site. The coastal engineering analysis will be used as a planning factor for dredging engineering and dike design. This analysis is sufficient to support preliminary dredging engineering and related efforts.

1.3 Site Location/Description

Holland Island is located off the coast of the southernmost portion of Dorchester County, Maryland in the eastern Chesapeake Bay. It is located at the mouth of the Holland Straits, approximately 2 miles from the southern tip of Bloodsworth Island.



Baker

MICHAEL BAKER JR. INC.
CONSULTING ENGINEERS
801 Cromwell Park Drive
Suite # 110
Glen Burnie, Maryland 21061

HOLLAND ISLAND	PROPOSED
FIGURE 1–1	ALIGNMENTS
DATE: OCT 2001	SCALE: 1" = 3000'	SHEET 01 OF 01

This proposed beneficial use of dredged material project would restore and create island habitat at Holland Island. The project would be protected by a dike system located on the western side of Holland Island. The two dike alignments shown in Figure 1-1 will be evaluated. Alignment 1 will envelope approximately 1,639 acres; Alignment 2 will envelope approximately 939 acres. The dike system will be separated from the existing island by approximately 500 feet of water.

2. PRELIMINARY COASTAL ENGINEERING DESIGN CRITERIA

2.1 Bathymetry and Topography

According to navigation charts (Maryland Department of Natural Resources, 1987), the existing Holland Island is surrounded to a large extent by very shallow water that extends about 1 nautical mile on all sides of the island, except for a narrow channel of deep water to the east. The large area of shallow water, generally less than 6 feet deep Mean Low Water (MLW), is the Holland Island Bar. This shallow water provides the basis for the footprint for the dredge disposal island. Just west of this broad shallow area, the water depth increases rapidly into the main bay, deepening to over 20 feet in depth over approximately a 0.5-mile distance. The proposed new island limits are at the edge of the drop to deeper water.

The topography of the existing island is generally low, allowing extensive flooding and erosion during storms.

2.2 Soils

A reconnaissance level geotechnical investigation at the project site was performed by Engineering Consultation Construction Remediation, Inc. (E2CR, 2002). This study indicated that foundation soils along Alignment No.1 are predominantly loose Silty Sand, except near Borings H-4 and H-5 where soils are very soft Silty Clay. A dike at a slope of 1 vertical to 3 horizontal could be constructed on the Silty Sands; however, the soft clays will need to be excavated.

Along Alignment No. 2, soils were found to vary considerably from very soft Silty Clays (near Borings H-5, H-8, and H-10) to loose Silty Sands (Boring H-6). The sands are considered to be suitable for supporting a dike at 1V:3H; however, the soft clays will need to be excavated.

Analysis of the borrow area indicates that the sand is considered to be suitable for construction of building a dike.

2.3 Water Levels

Normal water level variations at Holland Island are generally dominated by astronomical tides, although wind effects are also important in determining local water surface

elevations. Astronomical tides at Holland Island are semi-diurnal tides, with a period of approximately 12.4 hours, resulting in two high tides and two low tides each day. The National Oceanic and Atmospheric Administration (NOAA) publishes tide ranges for various stations on the Chesapeake Bay in the vicinity of Holland Island.

Tidal datum characteristics for four NOAA tidal measurement stations surrounding Holland Island are presented in Table 2-1. The table presents Mean Higher High Water (MHHW), Mean High Water (MHW), Mean Sea Level (MSL), MLW, and MLLW relative to MLLW. It can be seen that the tide range is significantly greater at the McCready and Ewell, Maryland stations, which are on the eastern side of Chesapeake Bay, as compared to the Solomons, Maryland and Lewiston, Virginia stations, which are on the western side of the bay. See Figure 2-1 for locations of the tidal stations.

TABLE 2-1
NOAA Tide Statistics, feet MLLW

Tide Elevation	Solomons, MD	Lewisetta, VA	McCready, MD	Ewell, MD
	38° 19.0'N	37° 59.8'N	38° 18.0'N	37° 59.7'N
	76° 27.2'W	76° 27.8'W	76° 00.4'W	76° 01.9'W
MHHW	1.5	1.5	2.7	1.8
MHW	1.3	1.4	2.4	1.7
MSL	0.8	0.8	1.3	0.9
MLW	0.2	0.1	0.2	0.1
MLLW	0.0	0.0	0.0	0.0

As a preliminary approximation for tidal elevations at Holland Island, it is recommended that the average of the McCready, Maryland and Ewell, Maryland stations be used, as shown in Table 2-2. McCready Creek is about 15 miles north and Ewell is about 15 miles south of Holland Island. The Holland Island tidal elevation statistics have an uncertainty of about plus or minus 0.3 feet due to the variation of tide statistics in the area. Because this approach is an interpolation, site-specific tide measurements at the site or numerical modeling of the bay surrounding Holland Island would be required to refine the astronomical tidal characteristics should the site move forward for further study.

TABLE 2-2
Estimated Astronomical Tidal Characteristics, Holland Island, MD

DATUM	ELEVATION (feet MLLW)
Mean Higher High Water (MHHW)	2.2
Mean High Water (MHW)	2.0
Mean Tide Level (MTL)	1.1
Mean Low Water (MLW)	0.1
Mean Lower Low Water (MLLW)	0.0

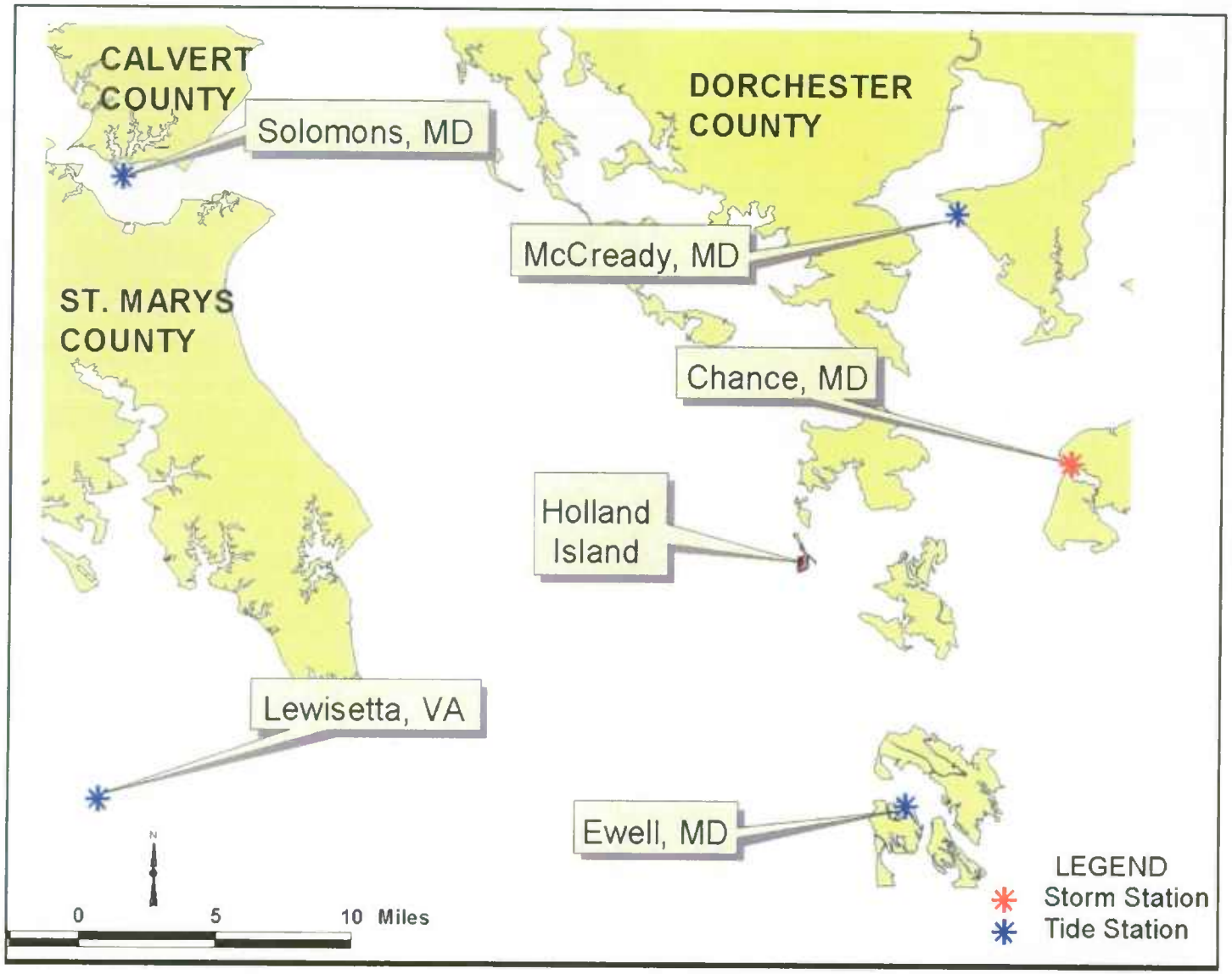


Figure 2-1 Tide Station and Storm Surge Station Locations

During storm conditions, water levels are dominated by storm surge and wave setup in combination with the astronomical tide. Storm surge is a temporary rise in water level generated either by large-scale extratropical storms know as northeasters, or by hurricanes. The rise in water level results from wind stresses, the low pressure of the storm disturbance and the Coriolis force. Wave setup is a term used to describe the rise in water level due to wave breaking near the shoreline. A comprehensive evaluation of storm-induced water levels for several Chesapeake Bay locations has been conducted by the Boon, et al. (1978) as part of the Federal Flood Insurance Program.

Storm surges cause more extreme water levels than astronomical tides do, governing flooding, overtopping of structures and maximum expected depth limited wave heights in shallow areas. The closest storm surge station location to Holland Island is Chance, Maryland (38° 10.2'N, 75° 56.8'W), approximately 8 miles to the east-northeast of Holland Island (see Figure 2-1). The results for Chance are summarized in Table 2-3. It is assumed that these water levels will apply to Holland Island. Numerical modeling of the area surrounding Holland Island to refine the storm surge elevations might reduce the design storm surge elevations at Holland Island, since storm surges are the greatest along the eastern edge of the bay, and Holland Island is to the west of the storm surge station.

The storm surge elevations range from 5 feet above MLLW for the 5-year return interval to 6.8 feet MLLW for the 100-year interval. These values do not include the effects of wave setup, which will increase the mean water level during storm events.

TABLE 2-3
Storm Surge Elevations[1]

RETURN INTERVAL	ELEVATION (feet MLLW)
5 year	5.0
10 year	5.2
25 year	5.8
50 year	6.4
100 year	6.8

[1] For Chance, Maryland, (38° 10.2'N, 75° 56.8'W) from Boon et al., 1978.

2.4 Winds

There are no wind records available specifically for Holland Island. Wind data for the Patuxent Naval Air Station for the period from 1945 to 1995 have been analyzed for a project at Smith Island, Maryland by the US Army Corps of Engineers. The wind data were obtained from the National Oceanic and Atmospheric Administration, National Climatic Data Center. Hourly 1-minute average wind speed and direction data were

provided. The elevation of the wind instruments varied over the period of record and therefore had to be adjusted to 33 feet. A FORTRAN program was written which made the appropriate adjustments for elevation and extracted the highest observed wind speed for each year of record and direction from the data set. These maximum annual wind speeds are presented in Table 2-4.

Using these data, various return interval wind speeds for each of the principal compass directions were calculated. The approach used to estimate the return intervals was to divide the wind observations into 16 principal compass directions, i.e. north, north northeast, northeast, etc. A Gumbel statistical distribution was fit to the maximum wind speeds for a particular direction. Using the Gumbel distribution, the return interval wind speeds were calculated for the 5-year, 10-year, 25-year, 50-year, and 100-year storm events for each of the principal 16 directions. Table 2-5 shows the various return interval wind speeds by direction.

The percent frequency of occurrence for various wind speed bands for all months of the year (annual distribution) was also of interest. A FORTRAN program was written to extract the number of wind occurrences within specified wind speed and direction bands from the dataset. The number of wind occurrences within 5 mile per hour wind speed bands for each principal compass direction is provided in Table 2-6. These data indicate that the winds from the WNW through the N directions (clockwise) are both more frequent and of a greater magnitude.

The percent frequency of occurrence for various wind speed bands by month was also examined. A FORTRAN program was written to extract the number of wind occurrences within specified wind speed bands versus each month of the year for the entire period of record. The number of wind occurrences within 5 mile per hour wind speed bands for each month is provided in Table 2-7. This table demonstrates that winter storms, generally known as "northeasters", dominate storm generated coastal processes in the Chesapeake Bay region. Hurricane season typically extends from June through November, but in the local region, their greatest frequency is in the August-September time period.

Furthermore, Maryland's Chesapeake Bay is situated geographically so that it escapes the extreme impacts associated with the full brunt of historical hurricanes. Consequently, most tropical storms recorded in Maryland actually have been gales or fringe effects from hurricanes. Gale winds range from 39 to 74 miles per hour. As can be seen from Table 2-7, there have been 58 recorded occurrences of winds greater than or equal to 40 miles per hour at the Patuxent Naval Air Station. Of those, 42 occurred between the months of December through May, which is typically the time frame associated with the winter storm season, although northeasters have occurred as early as October (e.g. Halloween Storm of October, 1991).

Of the 18 recorded occurrences of wind speeds greater than or equal to 40 miles per hour during the hurricane months, nine appear to have been generated by tropical storms. During Hurricane Hazel (October, 1954), winds in excess of 40 miles per hour were

recorded for six consecutive hours with a maximum occurrence of 62 miles per hour from the southeast. Two other hurricanes, namely Connie (August, 1955) and Flossy (September, 1956) produced the three other occurrences of recorded winds between 40 and 50 miles per hour. Examination of historic records indicate an absence of tropical storm activity being associated with the remaining nine occurrences of winds greater than or equal to 40 miles per hour during the warm weather months. These recordings are believed to be associated with local weather disturbances such as thunderstorms, frontal squall lines, or extratropical storm activity.

These data bear out the fact that historically the Chesapeake Bay region is generally subjected to maximum winds speeds between gale and hurricane force. There was not one recorded occurrence of a wind speed greater than 74 miles per hour in the dataset examined. The wind speed frequency distributions derived from these data indicate wind speeds range between 35 and 50 miles per hour for the 25 to 50 year return intervals, respectively.

TABLE 2-4
Patuxent Naval Air Station
One Minute Average
Maximum Wind Speed (Mph At 33 Feet)
Per Year And Principal Compass Direction

YEAR	N	NNE	NE	ENE	E	ESE	SE	SSE	S	SSW	SW	WSW	W	WNW	NW	NNW
1945	34	27	27	30	26	29	32	26	25	29	26	31	24	43	41	33
1946	25	27	28	25	21	25	27	28	35	29	30	27	32	30	48	46
1947	34	39	28	22	23	18	26	26	22	27	25	31	30	36	40	35
1979	33	30	30	27	18	22	25	26	25	29	21	23	30	39	37	47
1949	25	30	28	29	20	26	26	26	28	25	28	27	30	30	40	35
1960	35	23	22	30	20	35	30	30	20	39	26	27	35	39	30	31
1987	40	27	25	27	28	26	30	30	28	26	28	26	24	45	33	36
1952	32	25	22	29	27	37	30	32	26	29	25	29	34	30	32	36
1960	35	30	28	30	20	18	25	26	26	27	23	39	26	30	35	35
1987	31	32	30	26	26	49	62	23	30	26	26	50	24	34	30	32
1955	30	25	30	34	30	48	30	44	28	29	28	29	28	39	35	34
1955	30	29	33	30	28	30	28	28	28	26	28	29	25	30	35	39
1987	31	23	28	23	47	28	26	28	28	29	37	27	26	36	47	36
1960	34	26	27	21	29	18	22	27	26	26	26	29	27	34	30	42
1960	25	27	25	29	19	18	28	23	26	27	28	27	27	34	30	35
1960	29	29	28	39	26	28	26	30	26	27	37	39	29	36	48	39
1961	26	29	28	36	37	30	30	30	26	27	34	31	29	30	36	36
1962	30	26	39	18	29	30	26	22	21	26	26	26	26	34	33	28
1983	26	21	26	27	16	26	26	22	28	27	25	27	29	27	30	26
1960	34	30	33	27	39	28	30	26	22	27	30	33	33	39	37	39
1965	26	26	26	26	29	31	29	26	28	31	39	26	31	42	39	34
1960	26	27	28	27	24	25	26	28	26	29	28	33	45	39	28	25
1987	25	26	22	21	18	22	26	26	28	34	26	37	29	34	30	29
1960	34	39	28	30	26	22	28	28	28	39	28	29	33	34	44	34
1987	26	21	26	21	26	26	26	26	26	26	26	26	26	34	31	28
1979	25	21	18	27	18	28	25	26	30	27	30	39	36	27	32	36
1979	31	21	26	30	21	20	22	26	28	26	26	33	30	29	28	28
1979	25	22	22	30	37	30	28	28	28	26	28	29	34	26	25	28
1975	29	19	26	19	21	26	28	25	28	34	30	34	43	32	43	39
1979	26	26	18	19	16	18	26	28	28	29	28	27	24	27	28	31
1979	22	29	18	26	35	22	22	26	28	26	26	26	29	34	30	29
1979	26	26	30	29	23	18	23	32	26	39	30	39	32	34	33	36
1979	22	19	26	26	23	26	30	26	26	26	30	26	26	34	26	36
1980	31	26	18	19	19	28	22	28	26	27	32	27	28	39	33	28
1981	26	23	18	19	21	18	28	30	28	26	23	29	72	37	28	28
1952	23	27	28	22	23	22	19	28	26	27	26	27	32	39	30	26
1983	26	26	26	22	23	22	26	26	22	26	30	26	31	34	30	36
1983	19	19	30	27	18	22	26	28	22	27	45	26	25	39	32	26
1955	21	27	17	19	45	28	28	23	23	26	26	29	28	30	35	36
1979	26	29	22	29	26	35	28	25	26	29	30	29	26	39	30	31
1987	26	26	23	21	22	23	26	22	23	26	26	34	39	34	30	36
1988	34	29	21	18	21	28	21	26	26	29	28	39	28	39	30	27
1987	23	26	23	21	26	23	28	21	26	29	30	27	36	30	30	36
1990	26	29	28	30	18	18	28	28	30	26	26	26	28	39	30	39
1992	26	34	26	19	19	17	18	30	22	26	32	26	32	26	30	36
1992	30	34	22	39	24	26	30	23	30	32	28	34	34	32	30	36
1983	31	39	28	34	26	22	22	28	30	34	26	26	23	32	30	39
1994	31	27	26	22	31	17	21	26	28	31	33	28	28	31	31	39
1995	28	19	21	19	71	23	22	37	27	23	23	26	27	24	39	33

TABLE 2-5
Patuxent Naval Air Station
One Minute Average Wind Speed (Mph)
Adjusted To 33 Feet Elevation

DIRECTION	RETURN PERIODS (years)				
	5	10	25	50	100
N	30.91	34.18	38.31	41.38	44.42
NNE	29.03	32.39	36.63	39.78	42.90
NE	26.75	29.58	33.16	35.81	38.44
ENE	27.66	31.71	36.82	40.61	44.38
E	31.93	37.66	44.89	50.25	55.58
ESE	29.74	34.32	40.12	44.42	48.69
SE	30.02	34.15	39.38	43.25	47.10
SSE	28.43	31.17	34.64	37.20	39.75
S	26.68	28.89	31.68	33.76	35.81
SSW	28.28	30.93	34.27	36.76	39.22
SW	31.54	34.77	38.85	41.87	44.87
WSW	30.64	33.88	37.97	41.00	44.02
W	34.51	38.71	44.02	47.95	51.86
WNW	36.96	40.14	44.15	47.12	50.07
NW	38.18	41.59	45.90	49.10	52.27
NNW	36.02	39.40	43.66	46.83	49.97

TABLE 2-6
Patuxent Naval Air Station
Wind Occurrences Vs. Direction
No. Of Observations 1945 To 1995

Direction/ Occurrences	ONE MINUTE AVERAGE WIND SPEED (MPH at 33 feet)										
	0-5	5-10	10-15	15-20	20-25	25-30	30-35	35-40	40-45	>45	TOTAL
N	4733	12457	7158	2788	721	156	40	6	6	6	28060
NNE	2934	10292	5518	2060	540	93	12	1	1	2	21419
NE	3184	10292	4392	1444	331	52	1	2	0	1	19706
ENE	2491	7016	2670	761	110	93	12	12	2	2	13360
E	3236	8082	2934	187	420	12	12	1	0	3	15154
ESE	2281	6729	2678	761	154	60	12	2	2	3	12639
SE	3119	11793	7144	2454	453	57	20	2	4	2	25044
SSE	3360	11329	2060	2454	455	57	12	1	1	2	25229
S	5971	15842	6847	2670	420	12	1	1	2	2	31312
SSW	3362	11405	7000	2872	453	60	12	2	4	4	25173
SW	3524	12410	8585	4282	1002	154	22	2	2	1	29986
WSW	2795	8407	5650	2550	523	107	31	4	4	2	20078
W	4674	10648	5536	2429	622	171	37	2	4	2	24129
WNW	4031	9266	5028	3590	1468	622	187	40	12	2	24256
NW	5354	12003	7972	6122	3479	1235	331	79	13	3	36641
NNW	4371	11439	7999	4821	1658	466	107	31	4	2	30900
TOTAL	59420	169366	94424	42731	12510	3431	922	224	40	12	383086

NO DATA = 4682, CALM = 37387

TABLE 2-7
Patuxent Naval Air Station
Wind Occurrences Vs. Month
Number Of Observations 1945 To 1995

Month/ Occurrences	ONE MINUTE AVERAGE WIND SPEED (MPH at 33 feet)										
	0-5	5-10	10-15	15-20	20-25	25-30	30-35	35-40	40-45	>45	TOTAL
JAN	4959	12287	7529	4433	1779	577	151	28	0	0	31749
FEB	4231	11293	7242	4211	1559	561	186	41	0	0	29358
MAR	3856	12466	8931	5339	2004	653	170	34	10	0	33467
APR	3511	12512	9117	5388	1559	365	79	35	0	2	32574
MAY	4755	14977	9129	3530	734	103	19	4	1	0	33256
JUN	5250	15550	8183	2622	417	56	11	4	0	2	32089
JUL	6159	17152	7218	1921	260	40	21	2	0	1	32774
AUG	6659	17405	6517	1623	268	56	21	2	1	1	32553
SEP	5626	15096	7290	2294	461	91	37	11	1	0	30907
OCT	4995	14690	7841	3095	725	126	32	8	3	6	31521
NOV	4452	13012	7884	3898	1265	335	80	22	1	0	30949
DEC	4967	12926	7543	4377	1449	474	115	29	7	2	31889
TOTAL	59420	169366	94424	42731	12510	3431	922	224	40	18	383086

NO DATA = 4682
CALM = 37387

2.5 Design Deep Water Waves

The wind statistics presented in the previous section have been used to estimate design wave conditions and typical annual wave conditions at Holland Island. "Deep water waves" are the waves generated over the longer fetches extending over the main bay but do not include very local bathymetry-controlled refraction or shoaling. Fetch lengths and typical average water depths were estimated from navigation charts of the area for each direction in the wind statistic tables, and equations 3-39 and 3-40 of the Shore Protection Manual (1984) were used to calculate significant wave heights and wave periods for each condition.

Table 2-8 shows the significant wave height (technically defined as the average of the highest 33% of waves) associated with various return periods for each of the wind directions. It can be seen that the greatest wave heights are those from the northwest. Waves from the westerly, southwesterly, and southerly directions are also relatively large, while waves from the easterly quadrant are much smaller, due to the limited wave fetch in these directions. Table 2-5 contains the wind speeds associated with each of the directions and return periods.

TABLE 2-8
Holland Island, Maryland
Significant Wave Height, feet

			RETURN PERIODS (years)				
DIRECTION	**Fetch, ft**	**Depth, ft**	**5**	**10**	**25**	**50**	**100**
N	39520	15.0	2.6	2.9	3.2	3.5	3.7
NNE	25840	12.5	2.0	2.3	2.6	2.8	3.0
NE	12160	10.0	1.4	1.5	1.7	1.8	2.0
ENE	12160	10.0	1.4	1.6	1.8	2.1	2.3
E	12160	10.0	1.7	2.0	2.1	2.6	2.9
ESE	12160	10.0	1.5	1.8	2.1	2.1	2.5
SE	12160	10.0	1.5	1.8	2.1	2.3	2.5
SSE	97280	20.0	3.4	4.7	4.1	4.8	4.6
S	182400	30.0	4.4	4.7	5.1	5.3	5.7
SSW	136800	30.0	4.3	4.7	5.2	5.5	5.8
SW	91200	30.0	4.2	4.7	5.2	5.5	6.0
WSW	79040	30.0	3.9	4.8	4.8	5.3	5.6
W	66880	30.0	4.2	4.7	5.1	5.3	6.3
WNW	79040	30.0	4.7	5.3	5.7	6.0	6.0
NW	91200	30.0	5.1	5.6	6.1	6.5	6.9
NNW	65360	22.5	4.0	4.4	4.8	5.2	5.5

The wave periods associated with the design wave heights are shown in Table 2-9. It should be noted that there can be variations in wave periods for different storms with similar wave heights, and a range of wave periods around those listed in Table 2-9 should be examined when using the table for wave force or runup calculations to determine the most severe condition.

TABLE 2-9
Holland Island, Maryland
Wave Period, Seconds

DIRECTION	Fetch, ft	Depth, ft	RETURN PERIODS (years)				
			5	10	25	50	100
N	39520	15.0	3.2	3.3	3.5	3.6	3.7
NNE	25840	12.5	2.9	2.9	3.0	3.1	3.2
NE	12160	10.0	2.2	2.3	2.7	2.6	2.5
ENE	12160	10.0	2.2	2.3	2.5	2.6	2.9
E	12160	10.0	2.3	2.5	2.7	2.6	2.9
ESE	12160	10.0	2.3	2.4	2.5	2.7	2.9
SE	12160	10.0	2.3	2.3	2.5	2.6	2.7
SSE	97280	20.0	3.9	4.1	4.2	4.4	4.5
S	182400	30.0	4.5	4.7	4.8	5.0	5.2
SSW	136800	30.0	4.4	4.6	4.8	4.9	5.0
SW	91200	30.0	4.2	4.4	4.8	4.7	4.9
WSW	79040	30.0	4.0	4.2	4.3	4.5	4.9
W	66880	30.0	4.1	4.4	4.8	4.6	4.9
WNW	79040	30.0	4.3	4.5	4.8	4.6	4.9
NW	91200	30.0	4.6	4.7	4.9	5.0	5.2
NNW	65360	22.5	4.0	4.1	4.3	4.4	4.6

2.6 Annual Deep Water Waves

The wave heights and periods associated with the wind velocity and wind directions from Table 2-6 were calculated in the same manner as the design wave heights and periods, shown below in Tables 2-10 and 2-11. This allows the calculation of the frequency of typical wave governed events, such as longshore transport, or frequency of given wave heights and directions, by using the number of occurrences in the wind record, as provided in Table 2-6. "Deep water waves" are the waves generated over the longer fetches extending over the main bay but do not include very local bathymetry-controlled refraction or shoaling. "Annual" deep water waves are those that typically occur during any given year as indicated by Table 2-6. In Table 2-10 the wave fetch and water depths were used with the average velocity of each wind speed range for each wind direction to calculate the wave height.

TABLE 2-10 Holland Island, Maryland Significant Wave Height, feet												
			Wind Speed Range, mph									
Direction	Fetch (feet)	Depth (feet)	0-5	5-10	10-15	15-20	20-25	25-30	30-35	35-40	40-45	>45
N	39520	15.0	0.0	0.3	0.9	1.3	1.7	2.1	2.5	2.9	3.3	3.6
NNE	25840	12.5	0.0	0.4	0.7	1.0	1.0	1.5	2.1	2.4	2.7	3.0
NE	12160	10.0	0.0	0.3	0.5	0.8	1.0	1.3	1.0	1.0	2.0	2.3
ENE	12160	10.0	0.0	0.3	0.5	0.8	1.0	1.3	1.5	1.0	2.4	2.3
E	12160	10.0	0.0	0.3	0.5	0.8	1.0	1.3	1.0	1.0	2.0	2.3
ESE	12160	10.0	0.0	0.3	0.5	0.8	1.0	1.3	1.5	1.0	2.0	2.3
SE	12160	10.0	0.0	0.3	0.5	0.8	1.0	1.3	1.5	1.0	2.0	2.3
SSE	97280	20.0	0.0	0.8	1.3	1.9	2.0	3.0	3.5	4.4	1.0	5.0
S	182400	30.0	0.0	0.7	1.6	2.0	3.3	4.1	1.0	5.5	6.1	6.7
SSW	136800	30.0	0.0	0.8	1.5	2.3	3.0	3.0	1.0	5.1	5.0	6.4
SW	91200	30.0	0.0	0.8	1.3	2.0	2.0	3.3	3.7	1.0	5.2	5.8
WSW	79040	30.0	0.0	0.8	1.2	1.9	2.5	4.1	3.7	4.4	5.0	5.5
W	66880	30.0	0.0	0.5	1.1	1.7	2.3	2.9	3.5	4.1	4.7	5.3
WNW	79040	30.0	0.0	0.6	1.2	1.9	2.5	3.1	3.7	4.4	5.0	5.5
NW	91200	30.0	0.0	0.6	1.3	2.0	2.6	3.3	3.9	4.6	5.2	5.8
NNW	65360	22.5	0.0	0.5	1.1	1.7	2.2	2.8	3.3	3.8	4.3	4.8

The wave period associated with the waves in Table 2-10 are calculated in Table 2-11.

TABLE 2-11 Holland Island, Maryland Wave Period, Seconds												
			Wind Speed Range, mph									
Direction	Fetch (feet)	Depth (feet)	0-5	5-10	40-45	15-20	20-25	25-30	30-35	35-40	40-45	>45
N	39520	15.0	0.5	1.5	2.1	2.4	2.7	2.9	3.1	1.8	1.8	3.7
NNE	25840	12.5	0.5	1.4	1.8	2.1	2.4	2.6	2.8	1.8	1.8	3.2
NE	12160	10.0	0.5	1.2	1.5	1.7	1.8	2.1	2.3	2.4	2.5	2.6
ENE	12160	10.0	0.5	4.2	1.5	1.7	1.8	2.1	2.4	2.4	2.5	2.6
E	12160	10.0	0.5	4.2	4.0	1.7	1.8	2.1	2.3	2.4	2.5	2.6
ESE	12160	10.0	0.5	4.2	1.5	1.7	1.8	2.1	2.1	2.4	2.5	2.6
SE	12160	10.0	0.5	4.2	4.0	1.7	1.8	2.1	2.1	2.4	2.5	2.6
SSE	97280	20.0	0.6	1.8	2.5	3.0	1.8	3.7	4.0	4.2	1.8	4.6
S	182400	30.0	0.6	1.8	2.9	3.5	1.8	1.8	4.0	5.0	5.3	5.6
SSW	136800	30.0	0.6	1.8	2.8	3.3	1.8	4.2	4.0	1.8	5.0	5.2
SW	91200	30.0	0.6	1.8	2.1	3.1	1.8	1.8	1.8	1.8	4.0	4.6
WSW	79040	30.0	0.6	1.7	2.5	3.0	1.8	3.7	1.8	4.2	1.8	4.6
W	66880	30.0	0.6	1.7	2.4	2.9	3.2	3.5	3.8	4.0	4.2	4.4
WNW	79040	30.0	0.6	1.7	2.5	3.0	3.4	3.7	4.0	4.2	4.4	4.6
NW	91200	30.0	0.6	1.8	2.6	3.1	3.5	3.8	4.1	4.4	4.6	4.8
NNW	65360	22.5	0.6	1.7	2.3	2.8	3.1	3.4	3.7	3.9	4.1	4.3

2.7 Longshore Transport

Longshore sediment transport is the movement of sand along the shoreline due to waves approaching the shoreline at an angle. Longshore transport is a primary cause of sandy beach erosion. The rate of longshore transport depends on the wave climate, the orientation of the beach, and on the available supply of granular material on the beach. The potential longshore transport, which is the transport that would take place if an adequate supply of sand is available on the beach, can be estimated from formulas in the Shore Protection Manual (SPM, 1984).

A computer program that uses wave heights, wave directions, wave durations, and shoreline orientations to calculate the potential longshore transport was used to estimate the transport at the Holland Island site. The wave characteristics in Table 2-10 were used with the frequency of wind conditions in Table 2-6 to calculate total average annual longshore transport for beaches of various orientations. The results are shown in Table 2-12.

The beach direction is defined as the clockwise angle from north of the shoreline to the left of an observer who is standing on the beach looking out to sea. Thus, a beach facing the east would have a beach direction of 0.0 degrees, a beach facing south would have a beach direction of 90 degrees, and a beach facing west would have a direction of 180 degrees.

The potential longshore transport varies significantly for different beach directions because of the variation in wave conditions from different directions.

The longshore transport is defined as positive if it is traveling to the right as seen by an observer standing on the beach looking out to sea, and as negative if the transport is to the left. The net transport is the sum of the positive and negative transports.

The largest rates of transport occur on westward facing beaches, where the transport is 41,500 cubic yards per year (cy/yr) to the south and 22,500 cy/yr to the north, and north facing beaches, where the transport is 41,300 cy/yr to the east and 1700 cy/yr to the west. Both of these large transports are due to dominant waves from the northwest.

TABLE 2-12
Holland Island, Maryland
Potential Longshore Transport, cy/year

Beach Direction (°)	Direction Beach Faces	Net Transport	Leftward Transport	Rightward Transport
0.0	E	-3732	-5318	1587
22.5	ESE	-14376	-15161	785
45.0	SE	-23492	-24173	681
67.5	SSE	-25858	-26855	997
90.0	S	-16877	-23132	6255
112.5	SSW	-1224	-17937	16712
135.0	SW	7235	-17432	24666
157.5	WSW	-5449	-32191	26742
180.0	W	-19017	-41512	22495
292.5	WNW	-12712	-29876	17164
225.0	NW	10597	-7644	18241
247.5	NNW	30832	-4188	35020
270.0	N	39519	-1749	41267
292.5	NNE	27893	-808	28701
315.0	NE	9909	-680	10590
337.5	ENE	2874	-940	3814
360.0	E	-3732	-5318	1587

The variation of potential longshore transport with beach direction has also been plotted in Figure 2-2.

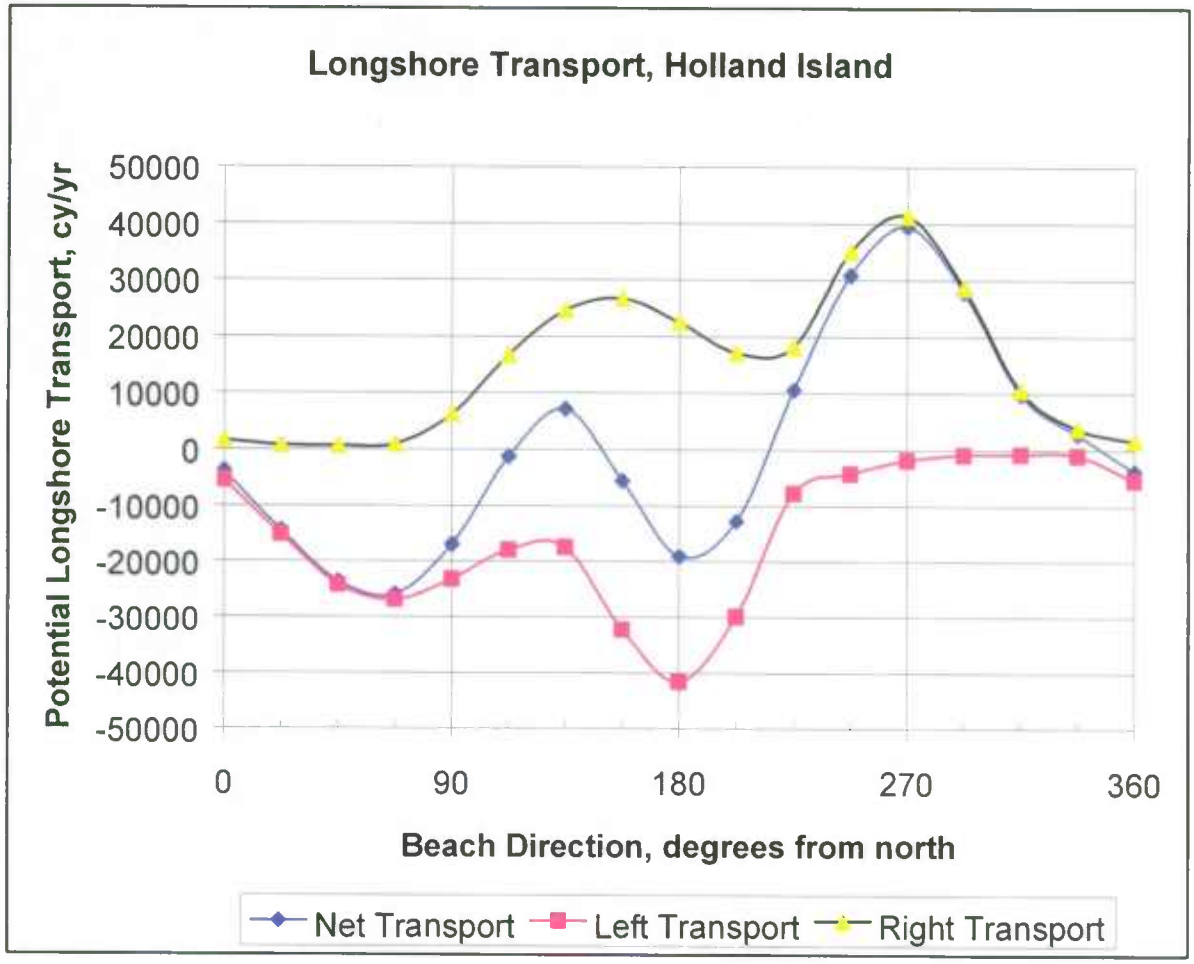


Figure 2-2 Longshore Transport Rates

2.8 Currents

No site-specific information on currents in the vicinity of Holland Island exists. Due to the shallow water in the area of interest and the influence of the islands and channels, current data from further offshore in Chesapeake Bay is not applicable to this site.

A review of the NOS tidal current tables indicate that currents in this part of the bay peak at about 1.3 knots in both flood and ebb. This is a rough approximation given that the tidal current predictions from NOS are very coarse in resolution and that currents generally are governed by the details of the local bathymetry. In the shallow waters near Holland Island, the currents could be significantly higher.

Currents in the area could be greatly modified during and after the construction of a sediment retaining dike structure. Numerical modeling will be required to quantify existing currents near Holland Island, and modifications to the currents due to the construction of structures in the area.

3. PRELIMINARY DIKE DESIGN

3.1 Introduction

The preliminary design of the dike cross-section is based on previous studies for similar projects in the Chesapeake Bay, information on the construction of the Poplar Island project, and guidance from Corps of Engineers publications such as the Shore Protection Manual (1984) and Engineering Manual 1110-2-16121, "Design of Coastal Revetments, Seawalls, and Bulkheads," (1995).

Previous dredge disposal dikes in the Chesapeake Bay have been constructed and planned with armor side slopes of 1 vertical to 3 horizontal. This armor slope will be maintained for the present project.

Modifications to the designs proposed for other dredge disposal dikes include modifications to the toe structure to obtain a more easily constructed structure, and the inclusion of a filter layer of stone between the underlayer of stone and the dike core. The recommended toe structure consists of an extension of the filter layer along the existing bottom, overlain with a single layer of primary armor stones one layer thick and three stones wide. The filter layer will distribute armor stone loading on the bottom and prevent settlement into the bottom, and will protect the bottom from scour and erosion. The filter layer will extend approximately 5 feet seaward of the armor stones to provide protection against scour seaward of the structure.

The filter layer between the underlayer stone and the dike will provide additional protection against washout of fine-grained material between the relatively large underlayer stones. The underlayer stones are typically between 1 and 1.5-foot in diameter. Voids in this material will be substantial, and must be bridged by the geotextile filter to prevent the loss of the fine-grained core. The geotextile may fail due to a combination of contact with sharp underlayer stones, stresses across bridged voids, and wave pressure stresses. Construction errors can also lead to improper overlap of geotextile material or tears in the filter cloth. The inclusion of a filter layer of smaller stone will greatly reduce the potential for failure of the geotextile filter, and is recommended for the dike structure.

Details of the typical dike cross-section are shown in Figure 3-1. The design armor stone weights and layer thicknesses are defined later in this section for various dike locations. W1 and t1 are the median stone weight and layer thickness for the armor layer; W2 and t2 are the stone weight and layer thickness for the armor underlayer; and W3 and t3 are the stone weight and layer thickness for the filter layer.

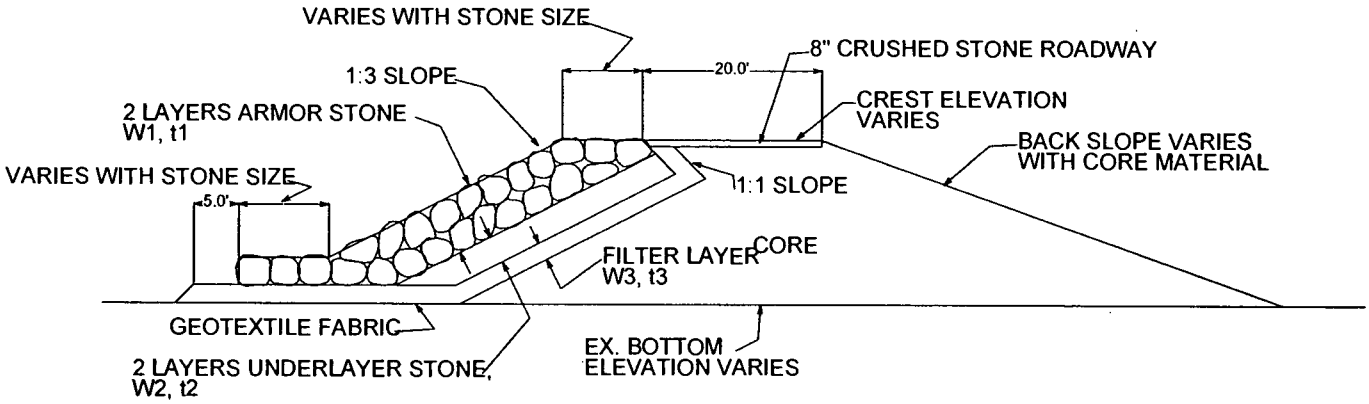


Figure 3-1 Typical Dike Cross-Section

The core material will be determined by the availability of suitable local materials. Materials that may be used for the core include locally available stiff clay, or sand. If neither of these materials is available locally then a granular fill such as sand or quarry-run stone will have to be imported. The dike back slope will be determined by the core material properties. For sand cores, a back slope of 1:5 has been used previously. For clay dikes, the back slope will be determined by geotechnical stability analysis. Stone core back slopes may be as steep as 1:1.5.

3.2 Dike Design Values

The hydrodynamic forces due to waves and high water levels that the dike must be designed to withstand have a statistical probability of occurring in any given year. Design values must be assigned to these variables so that the probability that the design values will be exceeded within the desired life of the project is acceptably low. Typically, a design life, such as 50 years, is assigned to the project, and a return period for the design level storm, such as 25 or 50 years, is chosen. The return period is the average interval between storms of a given intensity.

Previous dredge disposal dike studies have used a life cycle cost optimization to choose the appropriate storm return period for use in design. For Poplar Island and Parsons Island, it was found that the 35-year storm is optimal for design of the dikes. This same return period will be used for the present project.

3.3 Nearshore Design Values

The wave heights used for design of the dike armor stones are nearshore wave heights modified by breaking in the relatively shallow water in front of the structures. The wave heights depend on the offshore wave height, wave period, wave angle, local water depth, and bottom slope. The local water depth is the sum of the normal water depth where the structures are to be built and the design storm surge level. Because the local wave height depends directly on the water level, the local wave height return period depends on the joint return period statistics of the offshore wave height and water level. In general, storms in the Chesapeake Bay with strong winds from southerly directions are associated with increased water levels, while storms with strong northerly winds are associated with lesser water levels. Joint wave and water level return periods are not available for the Chesapeake Bay, and their development is beyond the scope of the present project.

The Holland Island site is exposed to the largest waves from the northwest and southerly directions. Because southerly waves are associated with increased water levels it is conservative to assume that the 35-year wave condition will occur with a water level near the 35-year return period elevation, which is approximately +6 feet MLLW. Because northerly waves are associated with decreased water levels it is overly conservative to assume that the 35-year wave conditions occurs simultaneously with the 35-year water level return period elevation. A design water level of +5 feet MLLW, which is approximately a 5-year storm surge event, is chosen for use with storm waves from the northerly directions. The development of joint wave and water level statistics could potentially result in the reduction of both local wave height values and run-up and overtopping values, and is recommended for final design.

Table 3-1 shows the water depths, storm surge, and offshore wave parameters for various wave directions for each of the dike alignments shown in Figures 3-2 and 3-3. The values shown in Table 3-1 are used for calculating local wave heights at the toe of the dike.

TABLE 3-1 Nearshore Wave Design Parameters								
Wave Direction	Water Depth	Storm Surge	Depth at Toe	Wave Period	Offshore Height, Hs	Nearshore Hs	Nearshore H10	Nearshore H2
	(ft MLLW)	(ft)	(ft)	(sec)	(ft)	(ft)	(ft)	(ft)
Dike Alignment 1								
N	3.0	5	5.0	5.0	3.4	3.1	3.0	4.9
NW	3.0	5	5.0	5.0	6.3	5.0	5.0	6.6
W	10.0	5	15.0	5.0	5.0	5.2	6.5	7.9
SW	11.0	6	17.0	4.7	5.0	4.9	6.5	7.0
S	11.0	6	17.0	5.0	5.3	5.0	6.2	7.6
SE	5.0	6	11.0	2.4	2.2	2.4	2.4	3.2
E	4.0	6	10.0	2.6	2.5	2.3	3.0	3.8
NE	3.0	5	5.0	2.4	3.0	1.9	2.4	3.0
Dike Alignment 2								
N	5.0	5	5.0	5.0	5.0	3.1	5.0	4.9
NW	4.9	5	9.0	5.0	6.3	5.0	5.0	6.6
W	7.0	5	12.0	5.0	5.0	3.0	4.0	7.6
SW	5.0	6	11.0	4.7	5.3	4.0	4.0	6.9
S	5.0	6	11.0	5.0	5.3	4.0	5.0	7.0
SE	4.0	6	10.0	2.4	2.2	2.1	2.6	3.8
E	4.0	6	10.0	2.8	2.5	2.3	3.0	3.8
NE	3.0	5	8.0	2.4	1.8	1.9	2.4	3.0

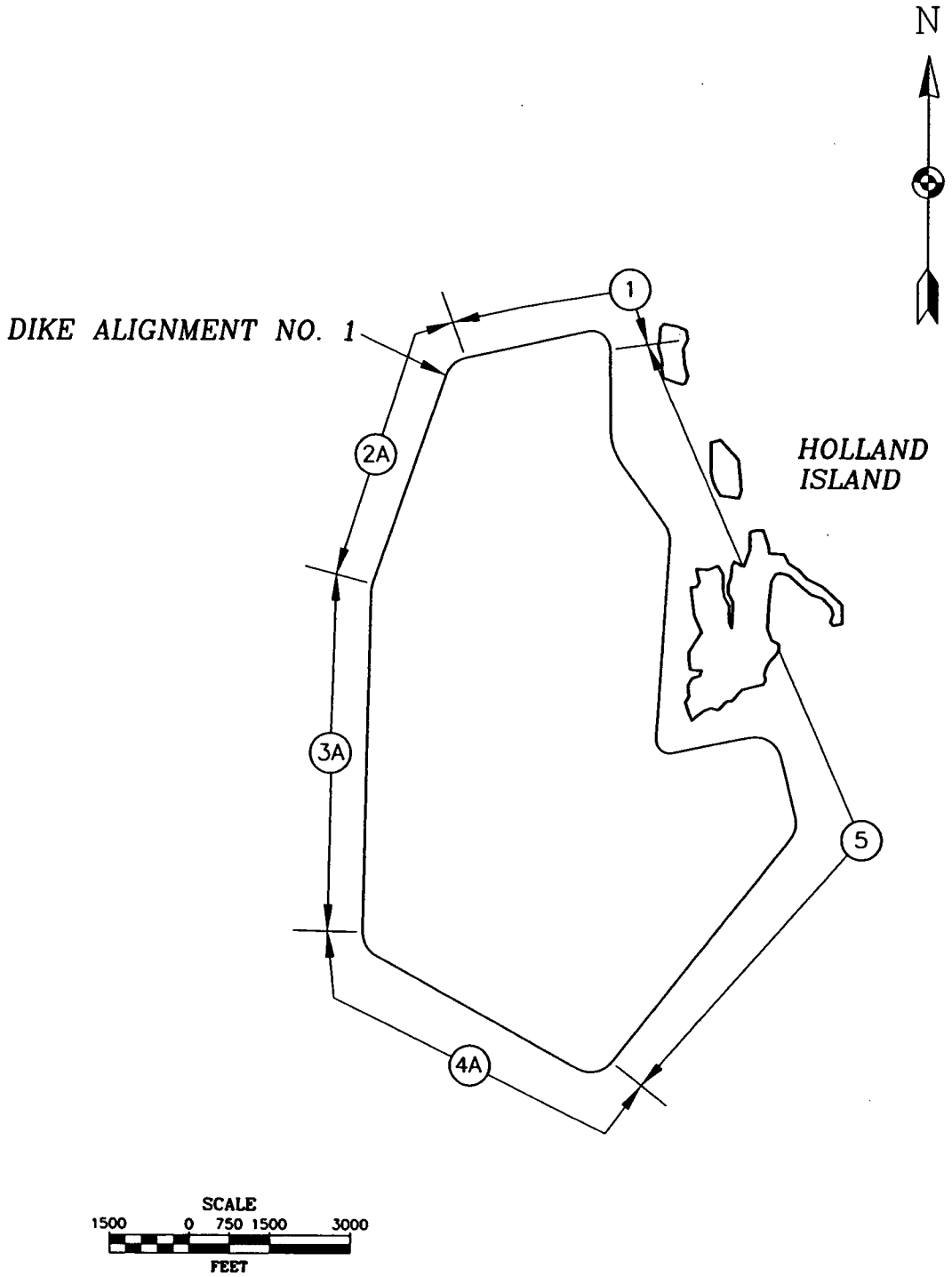


FIGURE 3-2. PRELIMINARY DIKE ALIGNMENT NO. 1

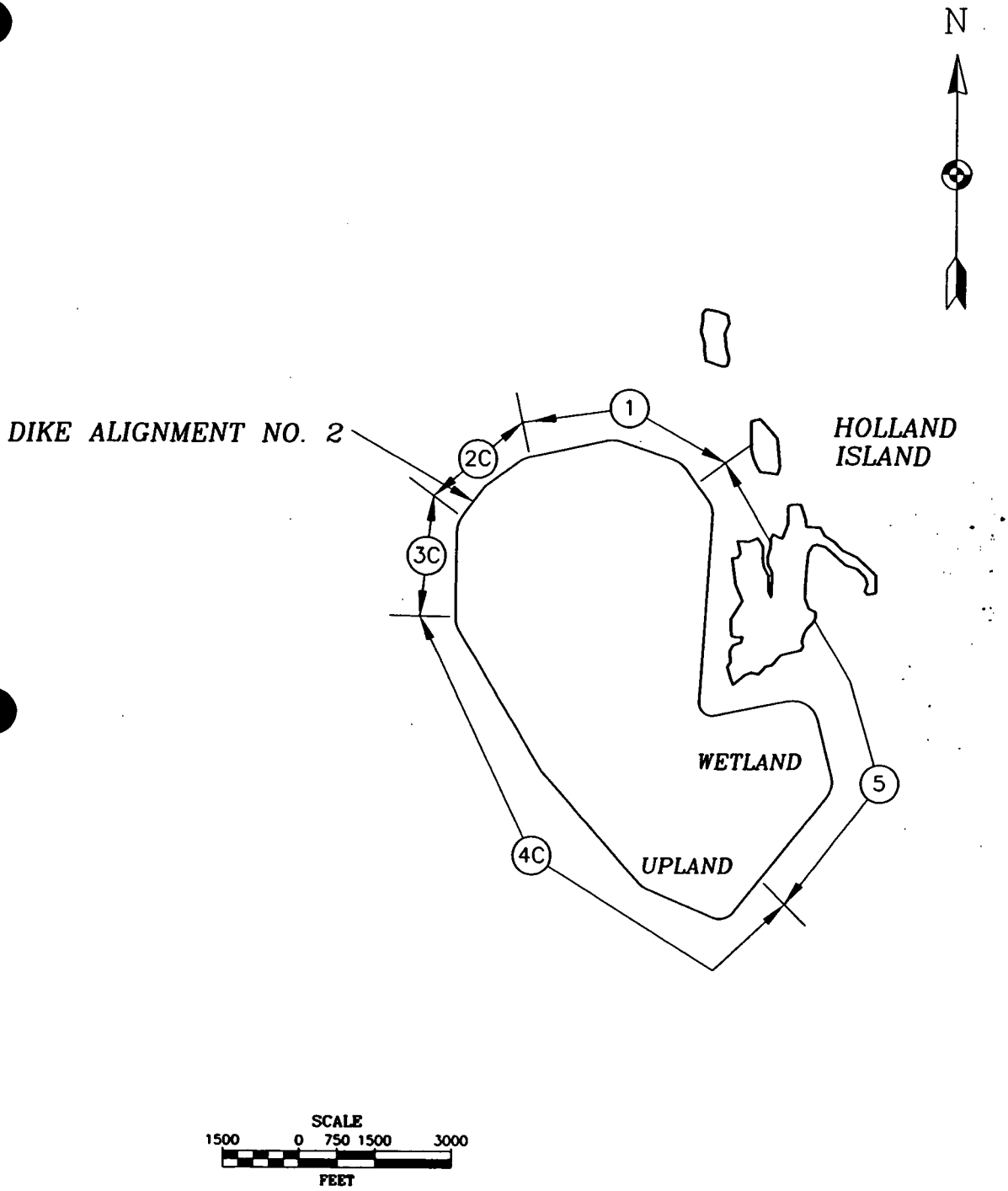


FIGURE 3-3. PRELIMINARY DIKE ALIGNMENT NO. 2

The value in the first six columns of Table 3-1 are used as input to the Goda Wave Transformation routine of the Automated Coastal Engineering System (ACES) software package (Leenknecht et. al. 1989) to obtain nearshore significant wave height (Hs), 10-percent wave height (H10), and 2-percent wave height (H2) for use in design.

The directions in the table are the directions a segment of the dike is facing. In general, the design condition for a particular dike direction is due to an offshore wave from the direction the dike is directly facing. For the westerly facing direction however, the most extreme case is for a northwest offshore wave approaching the dike at a 45-degree angle.

3.4 Geotechnical Factors

Geotechnical factors critical to the planning, design and construction of the confinement dikes include foundation strength, settlement estimates, and dike core material availability.

The geotechnical reconnaissance study indicates that a dike constructed with a slope of 1:3 (vertical to horizontal) is feasible (E2CR, 2002). Wave runup and overtopping, and armor stone are evaluated for a 1:3 side slope dike for both alignments. Allowance for settlement and additional toe protection should be made in the cost analysis based upon the recommendations of the geotechnical investigators.

3.5 Dike Height – Wave Runup and Overtopping

Potential runup and overtopping on the armor dike slopes must be estimated for use in setting dike elevations, so that the overtopping rates in the design storm are limited to values which will cause minimal and repairable damage to the dike roadway and back slopes.

Dike runup has been calculated according to two methods. The first is the method recommended by the Corps of Engineers EM 1110-2-1614, "Design of Coastal Revetments, Seawalls, and Bulkheads," (1995), which is by Ahrens and Heimbaugh (1988). The second method is by van der Meer and Stam (1992). The results are shown in Table 3-2 below.

The Ahrens method is the extreme runup value, based on a line fit to envelope all of the experimental data used to determine runup values. The van der Meer method is the 2 percent runup value, or runup exceeded by just 2 percent of all waves. It can be seen that the two methods give very similar results for the 1:3 slopes. For the present project, wave runup elevations are calculated using the Ahrens runup value and the design water level.

TABLE 3-2 Wave Runup					
Dike Direction	Design Water Level (ft MLLW)	Hs (ft)	Runup van der Meer (ft)	Runup Aherns (ft)	Runup Elev. Ahrens (ft MLLW)
Dike Alignment 1, 1:3 Armor slopes					
N (x-section 1)*	6	3.1	5.0	5.4	10.4
NW (x- section 2A)*	5	5.0	7.0	7.0	12.0
W (x- section 3A)*	6	5.2	7.5	7.5	12.0
SW (x- section 4A)*	6	4.8	6.9	6.9	12.0
S (x- section 4A)*	6	5.0	7.3	7.3	13.4
SE(x- section 5)*	6	2.1	2.8	2.7	8.7
E(x- section 5)*	6	2.3	3.1	2.9	8.9
NE(x-section 5)*	5	1.9	2.8	2.8	7.5
Dike Alignment 2, 1:3 Armor slopes					
N(x- section 1)*	5	3.1	5.4	5.4	10.4
NW(x- section 2C)*	5	5.0	7.0	7.0	12.0
W(x-section 3C)*	5	4.8	6.9	7.0	12.0
SW(x-section 4C)*	6	4.8	6.9	6.9	12.0
S(x-section 4C)*	6	4.8	7.0	7.0	13.1
SE(x- section 5)*	6	2.1	2.5	2.7	8.7
E(x- section 5)*	6	2.3	3.1	2.9	8.9
NE(x-section 5)*	8.0	1.9	2.5	2.5	7.5

*Refer to Figures 3-2 and 3-3 for location of cross sections.

Wave overtopping for various elevations of dike crest was calculated using the method recommended in EM 1110-2-1614 (by Ward, 1992). A certain amount of wave overtopping is generally allowable if the quantity of overtopped water in the design storm is not sufficient to cause unacceptable damage to the crest and back slope. Previous studies of dredge disposal confinement dikes have used the overtopping criteria by Goda (1985), limiting overtopping to approximately 20 liters/meter/second.

Wave overtopping rates were calculated for the eight wave directions. Table 3-3 shows the required crest elevations to keep the overtopping rate in the recommended range for the 35-year design event.

TABLE 3-3 Required Berm Crest Elevations

Required Berm Crest Elevations, 1:3 Slope		
Direction	Crest Elevation Alignment 1 (ft MLLW)	Crest Elevation Alignment 2 (ft MLLW)
N	8.75	8.75
NW	8.75	8.75
W	10.25	9.75
SW	11.25	10.25
S	11.25	10.25
SE	8	8
E	8	8
NE	8	8

As shown in Table 3-3, the crest elevations to prevent overtopping for the N and NW cross sections for both alignments and the crest elevation for the W cross section for Alignment 2 are 8.75 and 9.75 feet, respectively. However, a minimum design elevation of 10 feet MLLW for the upland portion of the proposed island was established by MES. Therefore, the dike elevations were raised to 10 feet for these sections. From an overtopping perspective, this adds conservatism to the coastal design of the dike.

3.6 Armor Section Design

The primary armor stones are designed to be stable in the design level storm, using the nearshore wave heights calculated previously. There are two methods of calculating armor stone heights in current coastal engineering practice. The most widely used method is the Hudson Equation, (SPM, 1984). More recently, the method of van der Meer has been recommended for revetment design by EM 1110-2-1614. Generally, the method of van der Meer gives smaller stone sizes, and has been used in previous dike design studies in Chesapeake Bay, for example, Parsons Island.

For the present study, stone sizes calculated with the van der Meer formula result in stone sizes significantly smaller than used for previous similar studies for Poplar and Parsons Islands. This is primarily due to lower design winds from the Patuxent wind records, which results in lower design waves. In order to keep the results of the present study conservative, and more in line with the previous study, the Hudson equation using a H_5 nearshore wave height, will be used for stone size calculations. A stone unit weight of 165 pcf and a stone stability coefficient of 2 are used in the calculations. The results are shown in Table 3-4.

Also shown in the table are the recommended preliminary underlayer and filter layer stone weights and layer thicknesses. For the smaller armor sections the filter layer is not recommended because the underlayer is sufficiently small to make it unnecessary.

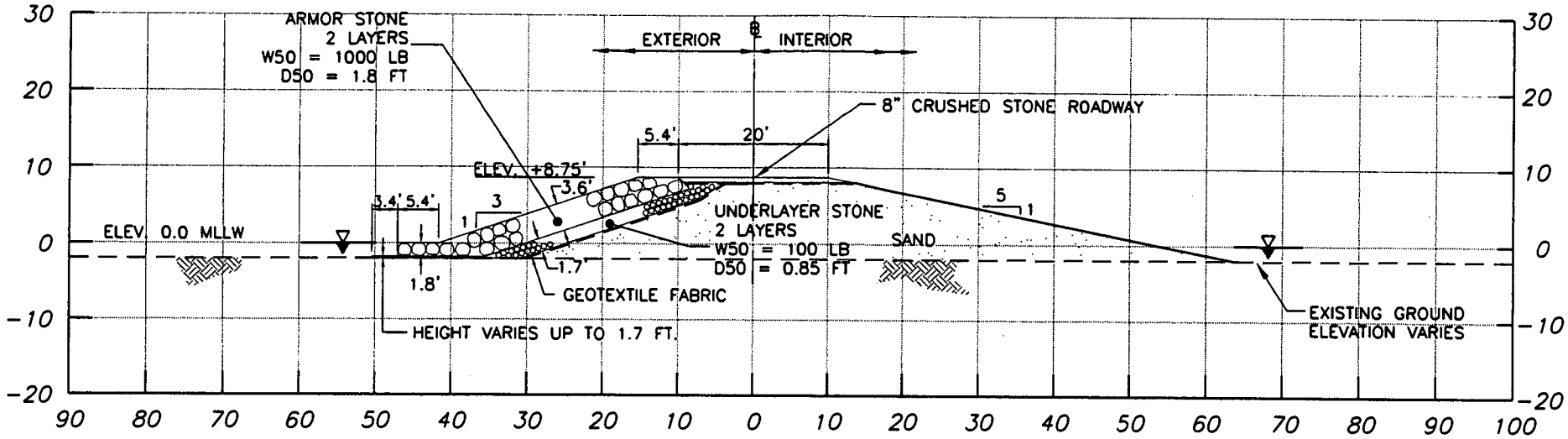
Representative dike cross sections with appropriate dimensions are provided for each direction, alignment, and slope in Figures 3-4 through 3-10.

TABLE 3-4 Armor Layer Specifications

	Armor Stone			Underlayer Stone			Filter Layer		
Alignment 1 Slope 1:3	W1 (W_{50} lbs)	Thickness, t_1 (feet) (t_1=2D_{50})	D_{50} (feet)	W2 (W_{50} Lbs)	Thickness, t_2 (feet) (t_2=2D_{50})	D_{50} (feet)	W3 (W_{50} Lbs)	Thickness t_3 (feet) (t_3=2D_{50})	D_{50} (feet)
N (x-section 1)*	1000	3.6	1.80	100	1.7	0.55	N/A	N/A	N/A
NW (x- section 2A)*	2000	4.6	2.3	200	2.4	1.05	N/A	N/A	N/A
W (x- section 3A)*	3000	5.3	2.65	300	2.4	1.2	30	1.1	0.55
SW (x- section 4A)*	3000	5.3	2.65	300	2.4	1.2	30	1.1	0.55
S (x- section 4A)*	3000	5.3	2.65	300	2.4	1.2	30	1.1	0.55
SE(x- section 5)*	300	2.4	1.2	30	1.1	0.55	N/A	N/A	N/A
E(x- section 5)*	300	2.4	1.2	30	1.1	0.55	N/A	N/A	N/A
NE(x-section 5)*	300	2.4	1.2	30	1.1	0.55	N/A	N/A	N/A
Alignment 2 Slope 1:3									
N(x- section 1)*	1000	3.6	1.8	100	1.7	0.55	N/A	N/A	N/A
NW(x- section 2C)*	2400	4.9	2.3	200	2.1	1.05	N/A	N/A	N/A
W(x-section 3C)*	2400	4.9	2.65	200	2.4	1.15	24	1.1	0.55
SW(x-section 4C)*	2400	4.9	2.65	200	2.3	1.15	24	1.1	0.55
S(x-section 4C)*	2400	4.9	2.45	240	2.3	1.15	24	1.1	0.55
SE(x- section 5)*	300	2.4	1.2	30	1.1	0.55	N/A	N/A	N/A
E(x- section 5)*	300	2.4	1.2	30	1.1	0.55	N/A	N/A	N/A
NE(x-section 5)*	300	2.4	1.2	30	1.1	0.55	N/A	N/A	N/A

* Refer to Figures 3-2 and 3-3 for location of cross sections.

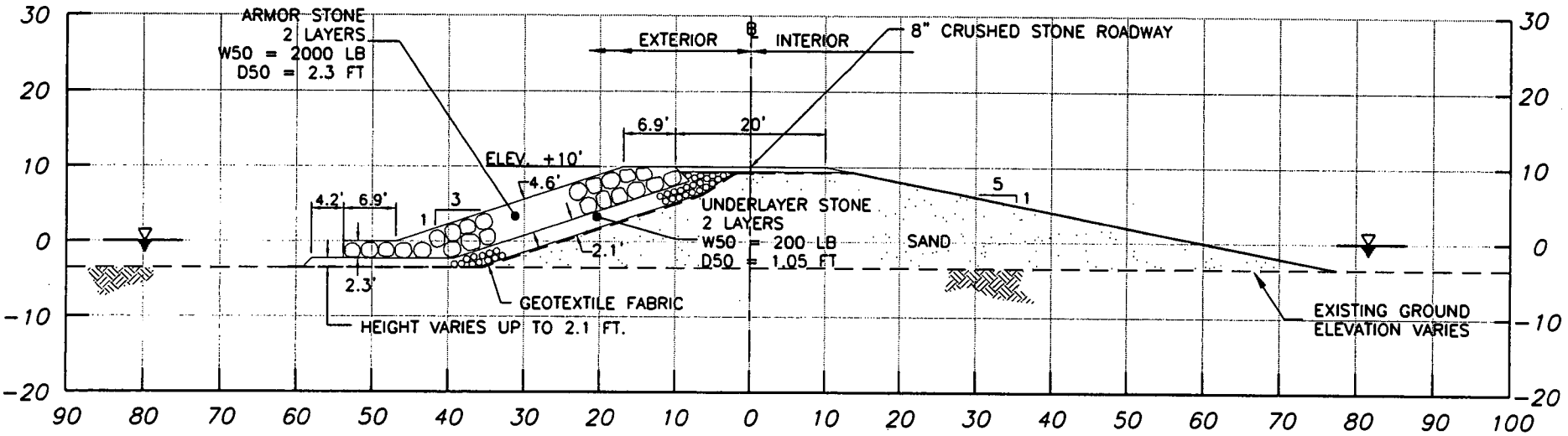
FIGURE No. 3-4 – HOLLAND ISLAND TYPICAL DIKE SECTION



TYPICAL DIKE SECTION 1
SCALE: 1" = 20'

N

ALIGNMENTS 1 & 2



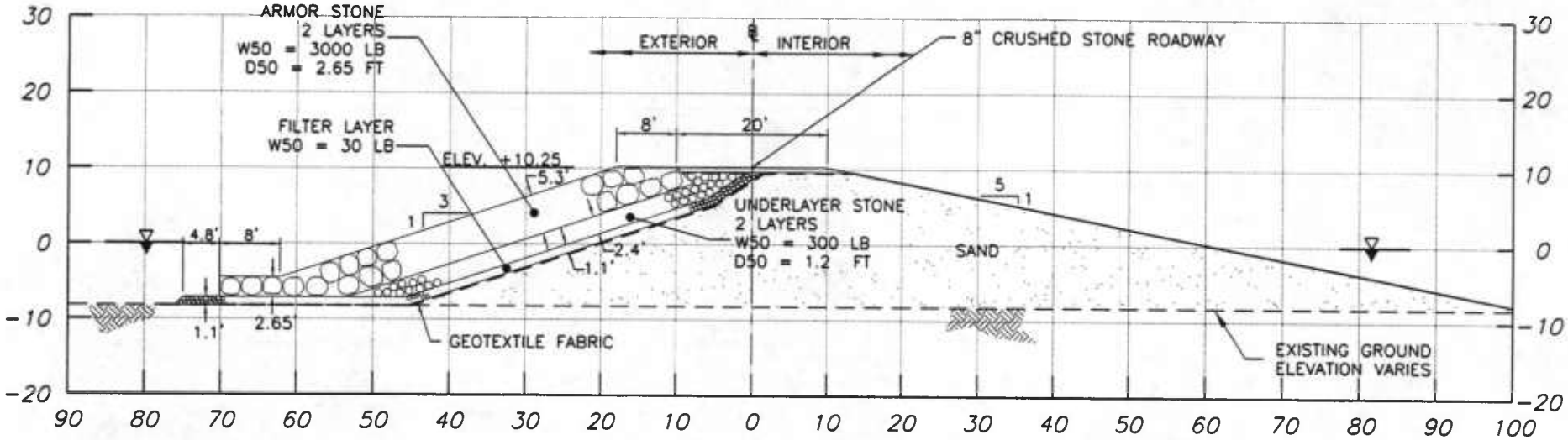
TYPICAL DIKE SECTION 2A & 2C
SCALE: 1" = 20'

NW

ALIGNMENTS 1 & 2

FIGURE No. 3-5 – HOLLAND ISLAND TYPICAL DIKE SECTION

FIGURE No. 3-6 – HOLLAND ISLAND TYPICAL DIKE SECTION

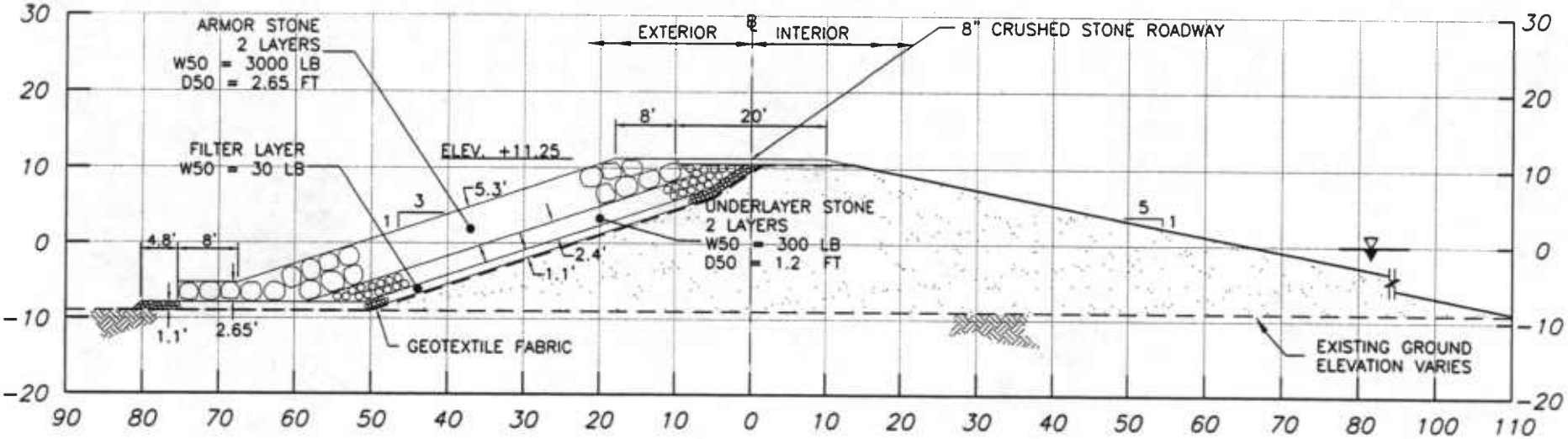


TYPICAL DIKE SECTION 3A

SCALE: 1" = 20'

W

ALIGNMENT 1



TYPICAL DIKE SECTION 4A

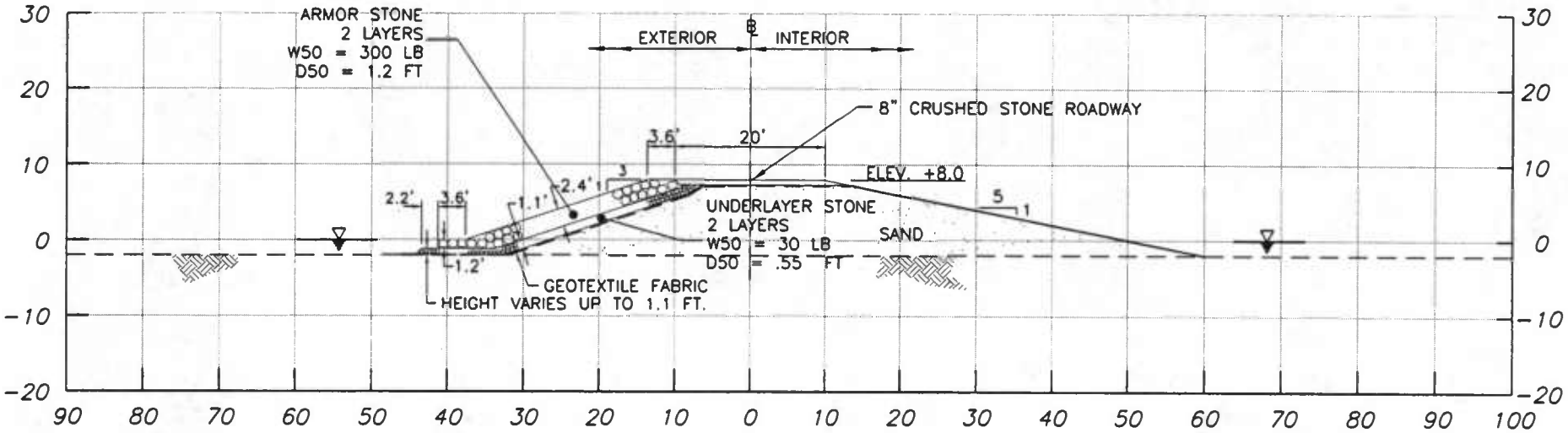
SCALE: 1" = 20'

SW, S

ALIGNMENT 1

FIGURE No. 3-7 – HOLLAND ISLAND TYPICAL DIKE SECTION

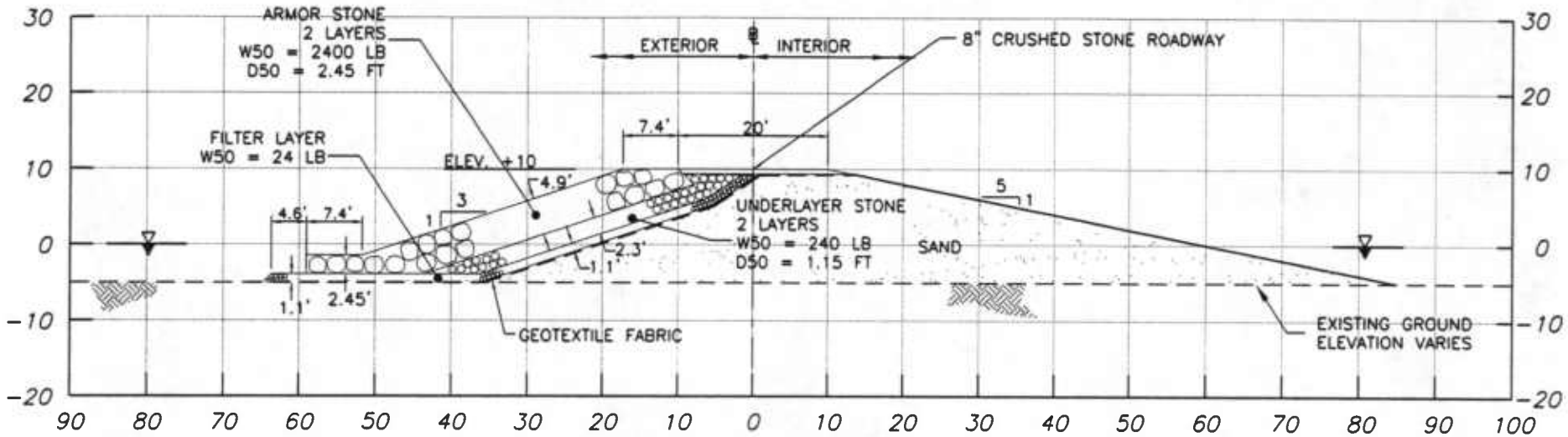
FIGURE No. 3-8 – HOLLAND ISLAND TYPICAL DIKE SECTION



TYPICAL DIKE SECTION 5
SCALE: 1" = 20'

SE, E, NE
ALIGNMENTS 1 & 2

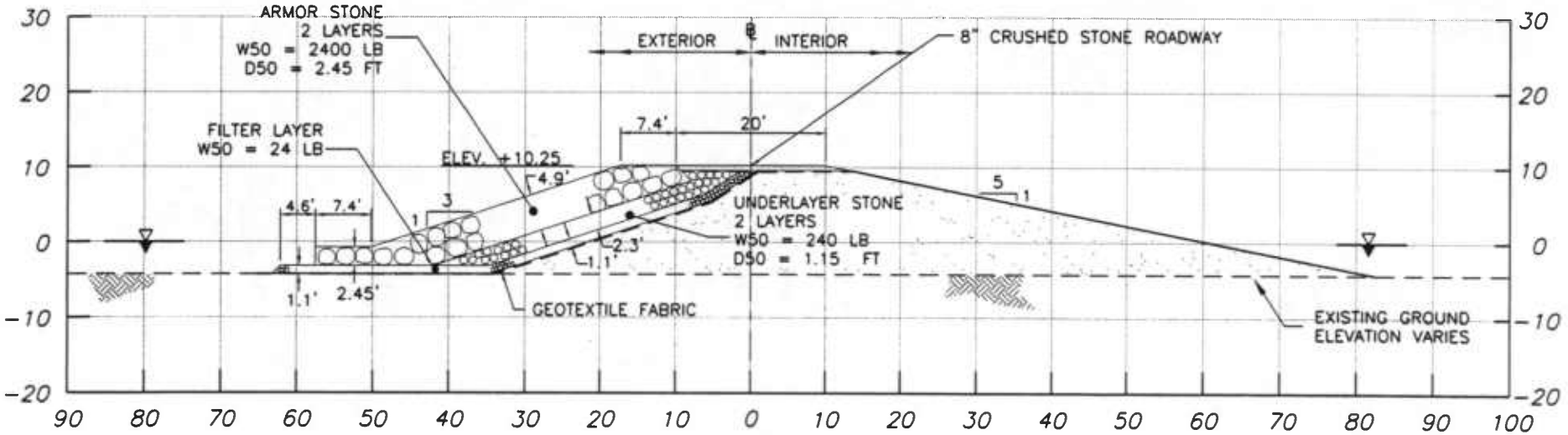
FIGURE No. 3-9 – HOLLAND ISLAND TYPICAL DIKE SECTION



TYPICAL DIKE SECTION 3C
SCALE: 1" = 20'

W

ALIGNMENT 2



TYPICAL DIKE SECTION 4C
SCALE: 1" = 20'

SW, S

ALIGNMENT 2

FIGURE No. 3-10 – HOLLAND ISLAND TYPICAL DIKE SECTION

4. SUMMARY AND CONCLUSIONS

This document presents a preliminary coastal engineering analysis for use in planning for dredging engineering and dike design for potential beneficial use and habitat restoration at Holland Island, Maryland.

Existing data sources indicate that Holland Island exhibits a mean tide range of approximately 1.9 feet and an extreme 100-year water level of 6.8 feet above MLLW. Winds most often are 5-10 miles per hour from the north-to-northwest octant, and can approach 40 mph during a 5-year event and 55 mph during a 100-year event. Wave heights can exceed 5 feet in a 5-year event and can approach 7 feet in a 100-year event, arriving from the west-to-northwest octant.

Longshore sediment transport rates, driven by waves, are thus quite large on westward-facing shorelines. In these areas, transport is calculated to be approximately 40,000 cy/yr to the south and 20,000 cy/yr to the north, generating a net transport rate of 20,000 cubic yards toward the south. On north-facing beaches, the net sediment transport rate is calculated to be about 40,000 cy/yr toward the east. Both of these large transport rate situations are due to dominant waves from the northwest.

Dike sections have been developed based on the wave analysis and layout of two alternative dike alignments near Holland Island. Armor stone sizes have been estimated for 1:3 slopes for each of the alignments.

The section developed herein consists of a three-layer section for the more extreme wave exposures, and a two-layer section for the less extreme exposures. The layers consist of the primary armor, an underlayer of intermediate stones, and a filter stone layer that will minimize the loss of fine sediment that may pass through the geotextile filter cloth.

The proposed dike crest elevations required to keep wave runup and overtopping to acceptable levels during the design storm event ranges from 8 feet MLLW for the southeast through northeast directions, to 11.25 feet MLLW for the southerly and southwesterly directions.

The proposed toe section consists of a bedding layer of filter stone along the bottom over a layer of geotextile filter cloth. The bedding stone is protected with a single layer of primary armor stones, with a toe width of three armor stones. This toe section, which provides a significant reserve against scour, should be simple to build as it has been constructed at other sites successfully with available technology.

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Appendix C

APPENDIX C

Reconnaissance Study of Holland Island for Beneficial Use and Habitat Restoration

FINAL
Dredging Engineering Study

May 15, 2002

Under Contract To:

Maryland Environmental Service
2011 Commerce Park Drive
Annapolis, Maryland

For:
The Maryland Port Administration
2310 Broening Highway
Baltimore, Maryland

Submitted by:

Baker

Michael Baker Jr., Inc.
Glen Burnie, Maryland

RECONNAISSANCE STUDY

FOR

DREDGED MATERIAL PLACEMENT SITE CONSTRUCTION

AT

HOLLAND ISLAND

Prepared for:

Michael Baker, Jr., Inc.
801 Cromwell Park Drive
Suite 110
Glen Burnie, MD 21061

Prepared by:

GBA
ENGINEERS ★ SURVEYORS

Gahagan & Bryant Associates, Inc.

Baltimore, MD

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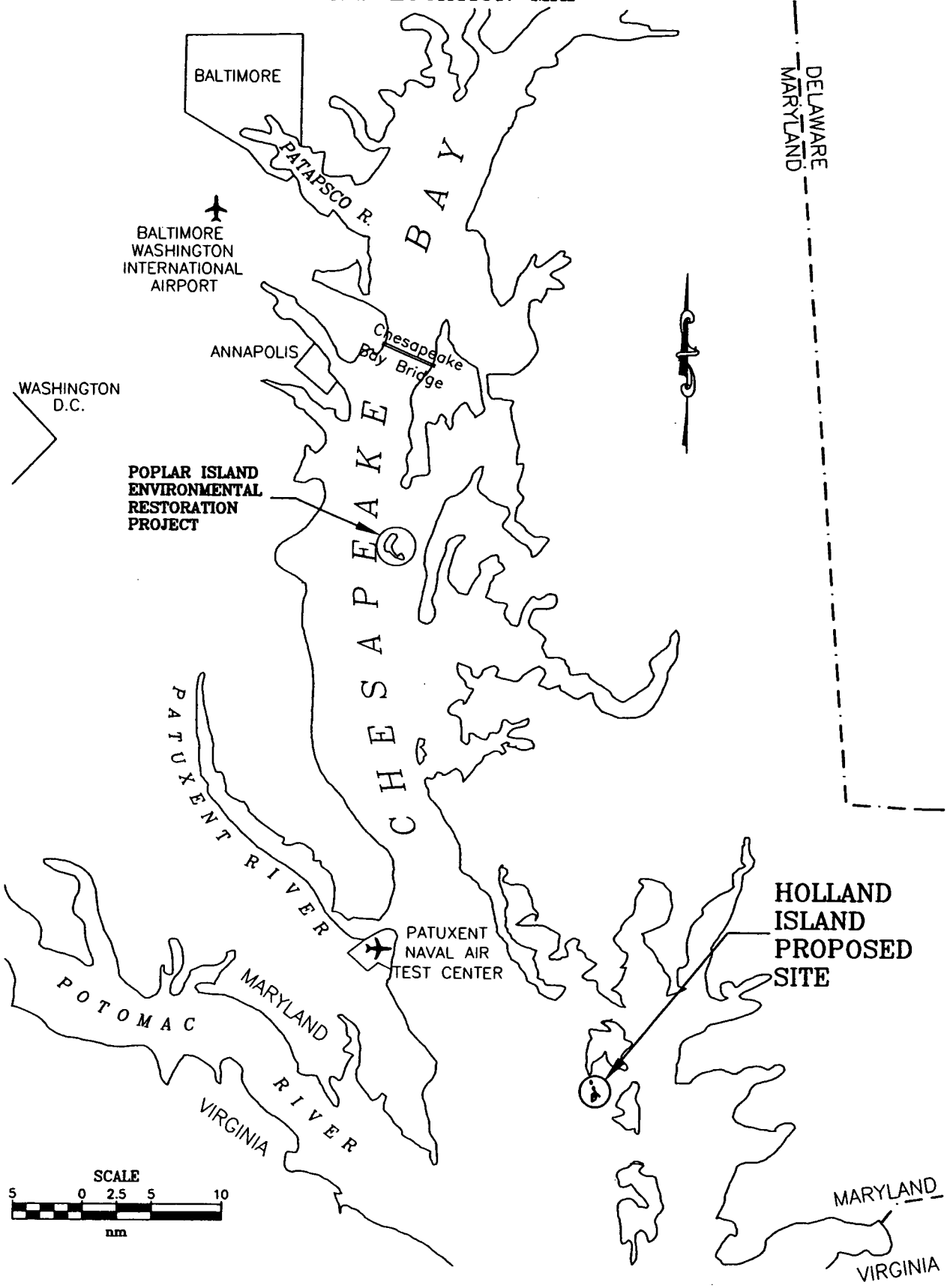
1.0 PROJECT BACKGROUND

The Maryland Environmental Service (MES), under sponsorship by the Maryland Port Administration (MPA), is examining the feasibility and suitability of various sites for the placement of dredged material.

Holland Island (See Figure 1) is one site being studied for possible placement of dredged material for beneficial use. It is located southwest of Bloodsworth Island approximately 45 nautical miles south of the Poplar Island Restoration Project on the eastern side of the Chesapeake Bay. Michael Baker Jr., Inc. (Baker) retained Gahagan & Bryant Associates, Inc. (GBA), to provide an initial dredging engineering assessment of site feasibility and construction costs.

GBA's scope is to evaluate the suitability of this site for construction to enclose two island habitat restoration site configurations. Each dike alignment will be characterized by a 10 and 20-foot upland dike height and the ratio between upland and wetland areas will be 1:1. This report outlines the findings of our assessment.

FIGURE 1 – HOLLAND ISLAND LOCATION MAP



2.0 PROJECT OBJECTIVES

GBA's task is to provide a dredging engineering assessment for the feasibility of constructing a habitat restoration site at Holland Island. Specifically, GBA's tasks are comprised of the following:

Task 1 – Analyze sand borrow options, including excavation, transport and placement methods. From the Engineering, Construction, Consulting, Remediation (E2CR) Geotechnical Feasibility Study for Holland Island, there is sufficient sand on site to construct all proposed dikes (E2CR, 2002). The sand would be hydraulically dredged directly from the on-site borrow area.

Task 2 - Layout two perimeter dike alignments, enclosing 1,639 and 939 acres. For each dike alignment, there will be two upland dike heights, 10 feet (ft) and 20 ft. Prepare plan drawings with overlays of shoreline data and other significant features.

Task 3 - Estimate neat quantities (quantity of material that fill the design template, not including material lost during construction) and construction quantities for the two alignments defined. Develop excavation, transport and placement costs for two different sand borrow options, two perimeter dike alignments and two upland dike heights. Quantities and costs for unsuitable excavation and backfill will also be estimated from E2CR, 2002.

Task 4 - Estimate neat quantities and construction quantities for all rock products based on dike cross-sections developed by Offshore & Coastal Technologies, Inc – East Coast (OCTI) Preliminary Coastal Engineering Analysis for Holland Island (OCTI, 2002). Obtain unit costs from OCTI, 2002 and estimates based on Poplar Island Phase I & Phase II for the following products:

1. Armor stone, underlayer stone, filter layer stone, road stone, and geotextile.
2. Spillways, nursery planting

Summarize all line items in bid format and include item, quantity, unit cost and total costs (including mobilization and demobilization cost).

Task 5 - Estimate transport and placement costs of material dredged from Baltimore approach channels east of the North Point-Rock Point Line and proposed for placement at Holland Island. Estimate site finishing cost including: plan and design, habitat-monitoring, implementation of channels and seeding, and operations and maintenance.

3.0 SITE CHARACTERISTICS

3.1 Site Characteristics

Holland Island is owned by three private parties and the Maryland Department of Natural Resources. The island is located in Dorchester County, MD on the eastern side of the Chesapeake Bay, south of Bloodsworth Island. Many existing natural oyster bars are located in the vicinity of Holland Island. NOB 28-13 is to the northeast and NOB 23-5 is to the southeast of Holland Island (see Figure 2). Also to the west, there is deep water that reaches a depth of 22 ft.

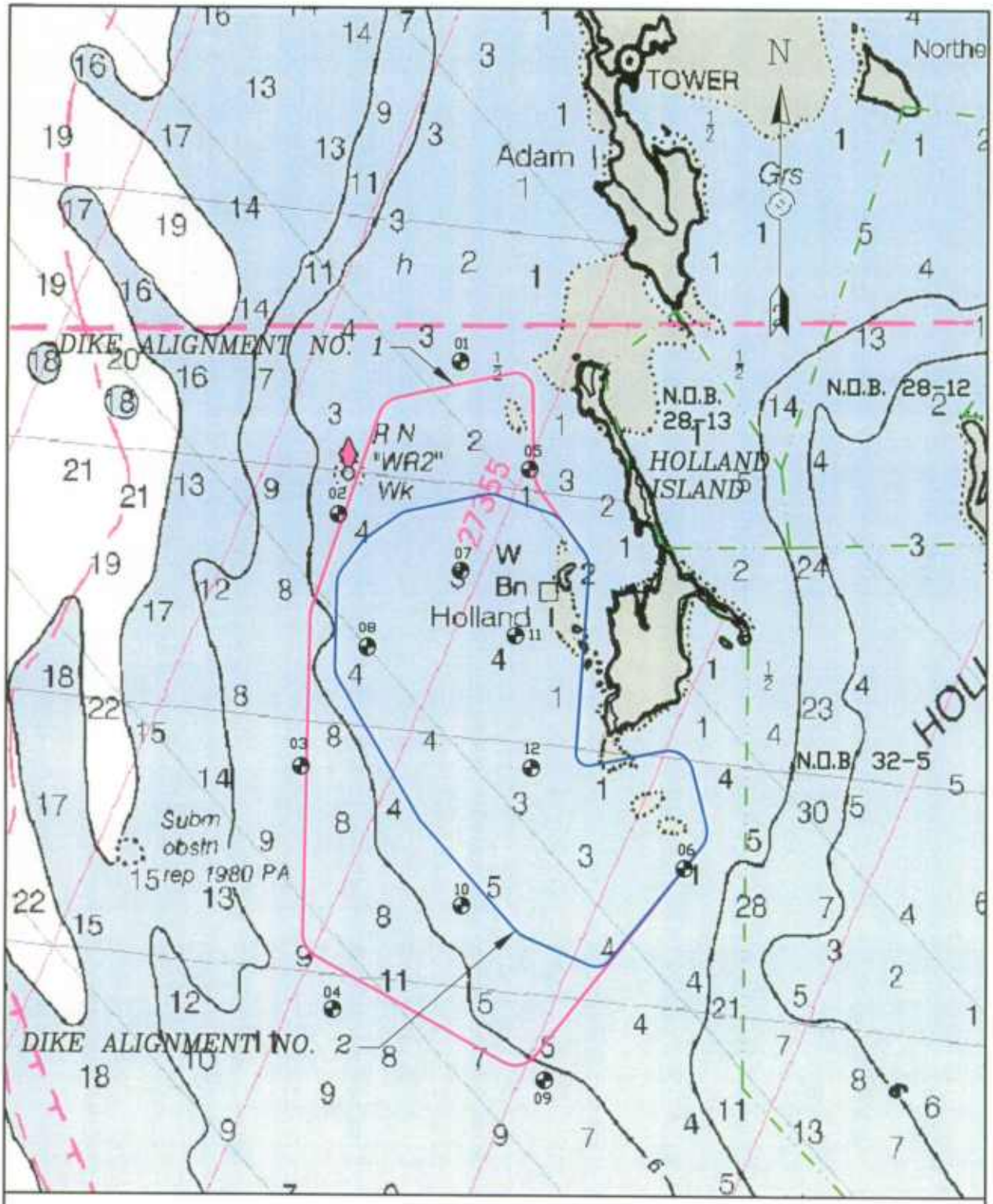
MPA, MES, Baker and GBA prepared two conceptual dike alignment options each with a 1:1 ratio between upland and wetland areas and each with two dike height options. Quantity takeoffs and cost estimating for each dike alignment were calculated. Each of the following figures contains dike alignment and typical dike section layouts. Alignment No. 1 is an option utilizing local site characteristics with a 10 and 20 ft upland dike height (see Figures 3 & 4). The dike centerline area for Alignment No. 1 is 1,639 acres and the outside edge of toe armor area is 1,703 acres. Alignment No. 2 is a reduced area option with a 10 and 20 ft upland dike height (see Figures 5 & 6). The dike centerline area for Alignment No. 2 is 939 acres and the outside edge of toe armor area is 987 acres. Tables 1 and 2 provide site characteristics for both dike alignments and dike heights, including quantities for rock and hydraulic fill material.

3.2 Design Characteristics

The primary exposure of the Holland Island shoreline to heavy wave action is from the northwest (OCTI, 2002). For preliminary quantity estimates, the dike sections used are similar to the Poplar Island Restoration Project, except for a variation of the toe dike. At Poplar Island, the toe dike consists of a breakwater built to the water surface with toe armor stone and quarry run whereas at Holland Island the slope armor stone extends out to the toe over the filter layer below the water.

The typical dike sections vary along Alignments 1 and 2 based on the direction of wave action and/or the proposed upland dike heights. These differences are shown in Figures 7 thru 17. For Alignment 1, an "A" designates an upland dike height of 10 feet and a "B" designates an upland dike height of 20 feet. For Alignment 2, an "A" or "C" designates an upland dike height of 10 feet and a "B" or "D" designates an upland dike height of 20 feet. Dike sections 1 and 5 are the same for both alignments and run parallel to the existing Holland Island. These sections are not affected by the upland dike height. These planning factors were selected based on the assumption that environmental conditions would be generally similar to those experienced at the Poplar Island Restoration Project. Site-specific analysis would be needed for feasibility and design studies.

Bathymetric information for the Holland Island area was limited during the preparation of this report. The dike alignments and geotechnical-boring plan used by Engineering, Consultation,



LEGEND

- E2CR BORING LOCATION
- NATURAL OYSTER BAR

GAHAGAN & BRYANT ASSOCIATES

HOLLAND ISLAND FIGURE 2	NATURAL OYSTER BAR & BORING PLAN	
DATE: MAR 2002	SCALE: 1" = 3000'	SHEET 01 OF 01

Construction, Remediation, Inc. (E2CR, 2002) were correlated for this study (see Figure 2). NOAA nautical charts show a deep shelf with greater than 20 ft. Mean Low Lower Water (MLLW) of water to the west of the proposed dike alignment for Holland Island.

Additional bathymetric, geotechnical and environmental data will be required for the feasibility, planning and design phases of this project, if undertaken.

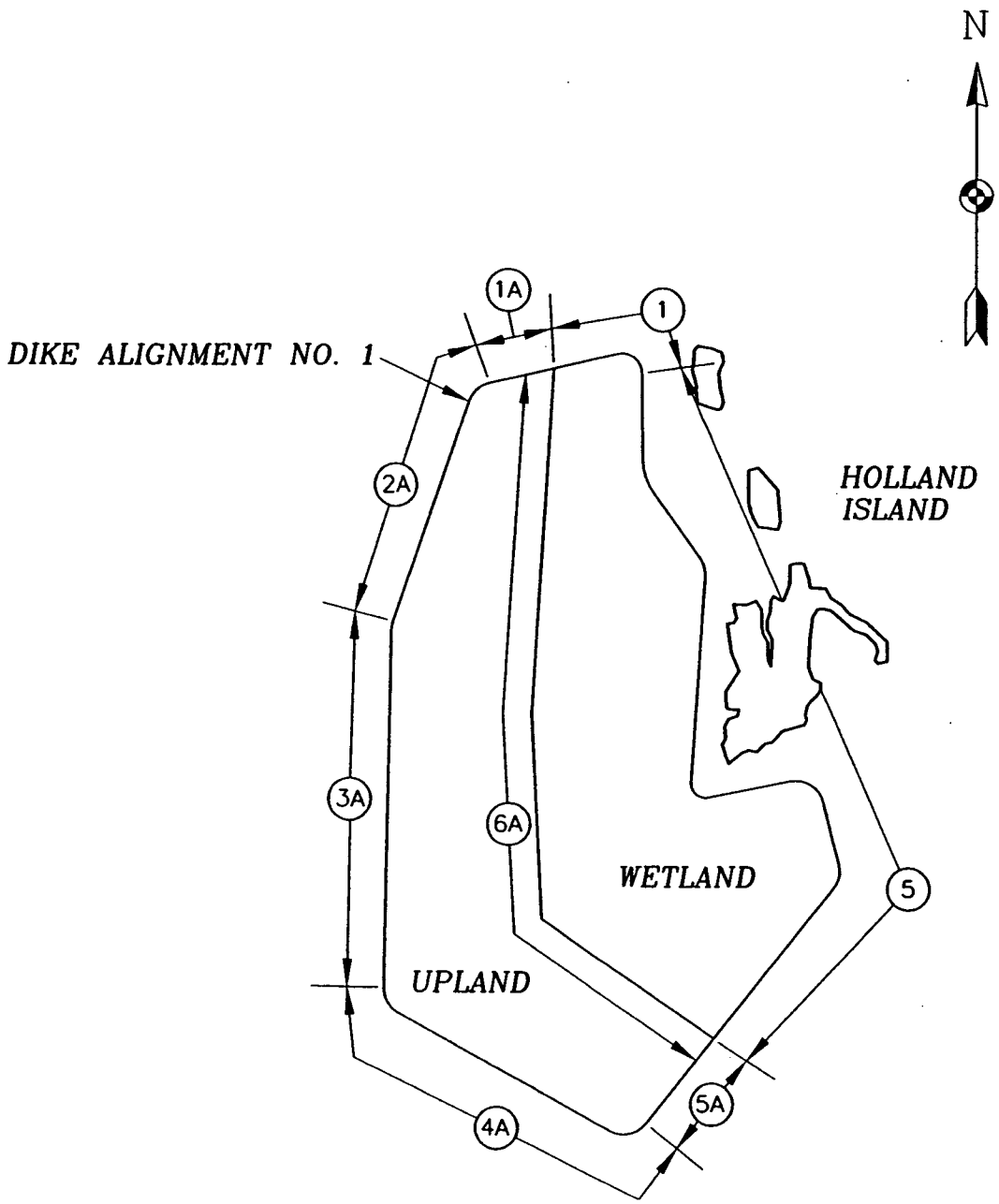


FIGURE 3. PRELIMINARY DIKE ALIGNMENT NO. 1 (10 FT)

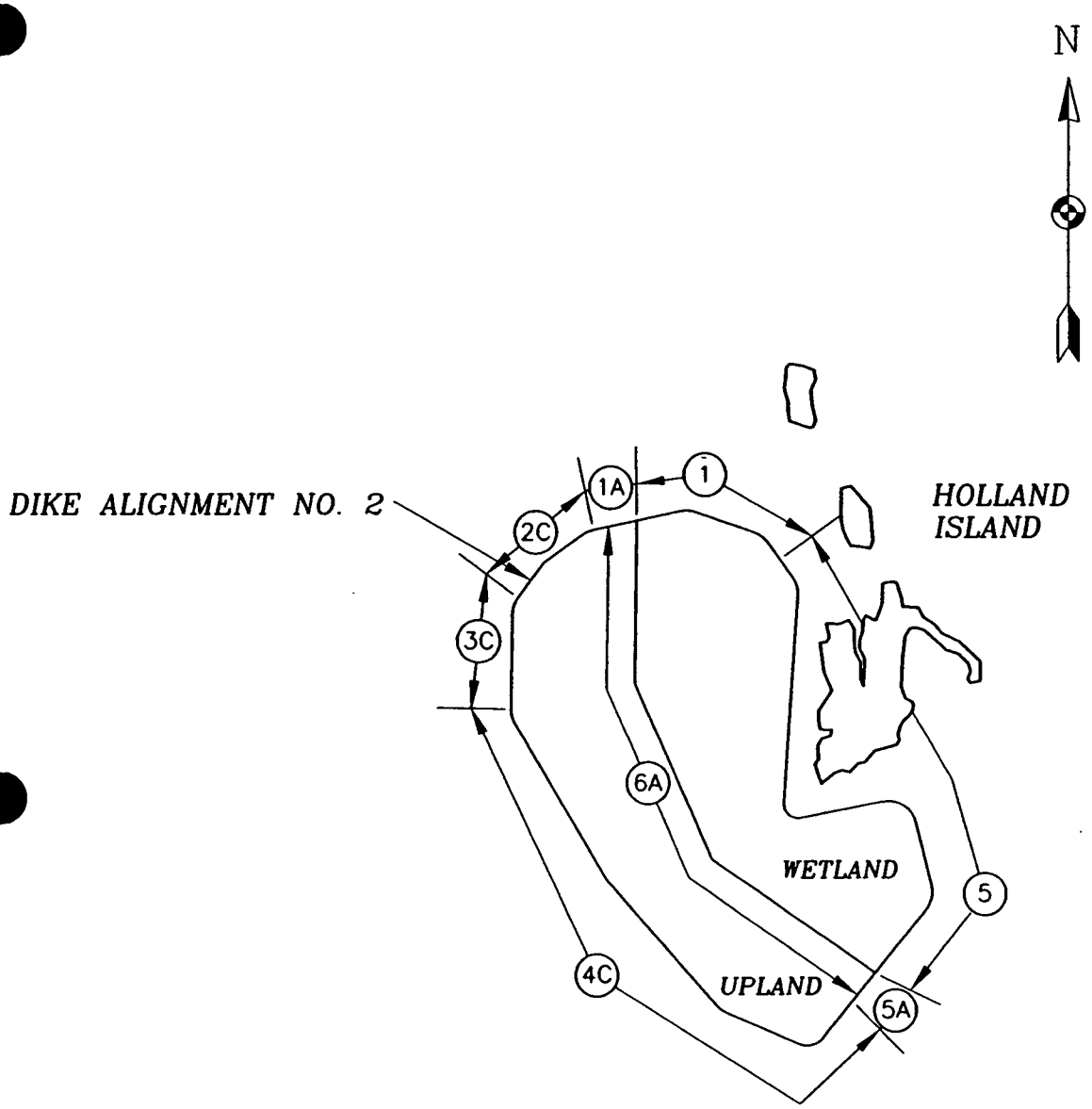


FIGURE 5. PRELIMINARY DIKE ALIGNMENT NO. 2 (10 FT)

Holland Island Habitat Development

Table 1 - Preliminary Site Characteristics and Quantities for Dike Alignment No.1

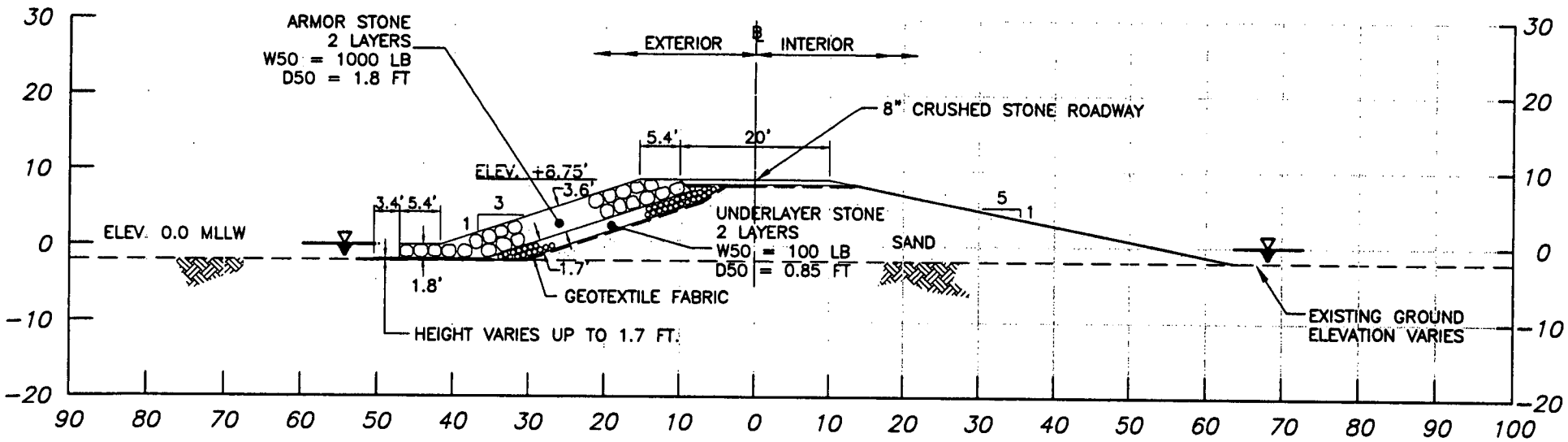
SITE CHARACTERISTICS	Dike Alignment No. 1 (10 ft)			Dike Alignment No. 1 (20 ft)		
Upland Baseline Area -	819	Acres		819	Acres	
Upland Baseline Perimeter -	33,428	LF		33,428	LF	
Upland Site Volume below sea level -	7.27	MCY		7.27	MCY	
Upland Site Volume above sea level -	10.58	MCY		23.80	MCY	
Upland Volume -	17.85	MCY		31.07	MCY	
Upland Site Capacity -	25.97	MCY		46.31	MCY	
Wetland Baseline Area -	819	Acres		819	Acres	
Wetland Baseline Perimeter -	30,701	LF		30,701	LF	
Wetland Site Volume below sea level -	3.44	MCY		3.44	MCY	
Wetland Site Volume above sea level -	1.98	MCY		1.98	MCY	
Wetland Volume -	5.42	MCY		5.42	MCY	
Wetland Site Capacity -	7.63	MCY		7.63	MCY	
Total Baseline Area -	1,639	Acres		1,639	Acres	
Total Baseline Perimeter -	37,017	LF		37,017	LF	
Total Volume -	23.27	MCY		36.49	MCY	
Total Site Capacity -	33.60	MCY		53.94	MCY	
Volume of available sand within diked area -	12.00	MCY		12.00	MCY	
QUANTITIES	**Dike Alignment No. 1 (10 ft)**			**Dike Alignment No. 1 (20 ft)**		
Hydraulic Fill Material	LF	CY/LF	CY	LF	CY/LF	CY
Unsuitable Backfill -			400,000			400,000
Perimeter Dike Section 1 to +8.75 -	1,792	20.4	36,592	1,792	20.4	36,592
Perimeter Dike Section 1A to +10 -	1,170	25.0	29,283			
Perimeter Dike Section 1B to +20 -				1,170	69.0	80,727
Perimeter Dike Section 2A to +10 -	4,634	29.9	138,471			
Perimeter Dike Section 2B to +20 -				4,634	76.7	355,186
Perimeter Dike Section 3A to +10.25 -	6,564	51.2	336,164			
Perimeter Dike Section 3B to +20 -				6,564	105.3	691,475
Perimeter Dike Section 4A to +11.25 -	5,566	61.3	341,114			
Perimeter Dike Section 4B to +20 -				5,566	109.8	611,321
Perimeter Dike Section 5 to +8 -	15,353	19.1	384,216	15,353	19.1	293,477
Perimeter Dike Section 5A to +10 -	1,939	26.6	51,496			
Perimeter Dike Section 5B to +20 -				1,939	70.5	136,732
Interior Dike Section 6A to +10 -	13,556	38.1	516,544			
Interior Dike Section 6B to +20 -				13,556	70.1	950,358
Total -	**50,574**		**2,233,880**	**50,574**		**3,555,870**
Perimeter Dike Section 1 Stone Work	LF	Tons/LF	Tons	LF	Tons/LF	Tons
Underlayer Stone -	1,792	3.1	5,476	1,792	3.1	5,476
Slope Dike Armor Stone -	1,792	6.7	11,997	1,792	6.7	11,997
Perimeter Dike Section 1A & 1B Stone Work	LF	Tons/LF	Tons	LF	Tons/LF	Tons
Underlayer Stone -	1,170	3.4	4,010	1,170	3.4	4,010
Slope Dike Armor Stone -	1,170	7.5	8,757	1,170	7.5	8,757
Perimeter Dike Section 2A & 2B Stone Work	LF	Tons/LF	Tons	LF	Tons/LF	Tons
Underlayer Stone -	4,634	5.7	26,528	4,634	5.7	26,528
Slope Dike Armor Stone -	4,634	10.0	46,219	4,634	10.0	46,219
Perimeter Dike Section 3A & 3B Stone Work	LF	Tons/LF	Tons	LF	Tons/LF	Tons
Filter layer Stone -	6,564	4.9	32,034	6,564	4.9	32,034
Underlayer Stone -	6,564	6.8	44,810	6,564	6.8	44,810
Slope Dike Armor Stone -	6,564	16.2	106,649	6,564	16.2	106,649
Perimeter Dike Section 4A & 4B Stone Work	LF	Tons/LF	Tons	LF	Tons/LF	Tons
Filter layer Stone -	5,566	5.2	29,045	5,566	5.2	29,045
Underlayer Stone -	5,566	7.6	42,103	5,566	7.6	42,103
Slope Dike Armor Stone -	5,566	17.9	99,501	5,566	17.9	99,501
Perimeter Dike Section 5 Stone Work	LF	Tons/LF	Tons	LF	Tons/LF	Tons
Underlayer Stone -	15,353	2.2	33,107	15,353	2.2	33,107
Slope Dike Armor Stone -	15,353	3.9	59,700	15,353	3.9	59,700
Perimeter Dike Section 5A & 5B Stone Work	LF	Tons/LF	Tons	LF	Tons/LF	Tons
Underlayer Stone -	1,939	2.5	4,930	1,939	2.5	4,930
Slope Dike Armor Stone -	1,939	4.7	9,174	1,939	4.7	9,174
Perimeter Dike Totals	LF	Tons/LF	Tons	LF	Tons/LF	Tons
Filter layer Stone -	12,130	N/A	61,078	12,130	N/A	61,078
Underlayer Stone -	37,017	N/A	160,965	37,017	N/A	160,965
Slope Dike Armor Stone -	37,017	N/A	341,998	37,017	N/A	341,998
Miscellaneous	LF	SY/LF	SY	LF	SY/LF	SY
Road Stone -	50,574	1.5	74,679	50,574	1.5	74,679
Geotextile -	37,017	14.5	536,753	37,017	14.5	536,753

Holland Island Habitat Development

Table 2 - Preliminary Site Characteristics and Quantities for Dike Alignment No. 2

SITE CHARACTERISTICS	Dike Alignment No. 2 (10 ft)			Dike Alignment No. 2 (20 ft)		
Upland Baseline Area -	470	Acres		470	Acres	
Upland Baseline Perimeter -	24,437	LF		24,437	LF	
Upland Site Volume below sea level -	2.65	MCY		2.65	MCY	
Upland Site Volume above sea level -	6.06	MCY		13.64	MCY	
Upland Volume -	8.71	MCY		16.29	MCY	
Upland Site Capacity -	12.86	MCY		24.52	MCY	
Wetland Baseline Area -	470	Acres		470	Acres	
Wetland Baseline Perimeter -	22,843	LF		22,843	LF	
Wetland Site Volume below sea level -	1.71	MCY		1.71	MCY	
Wetland Site Volume above sea level -	1.14	MCY		1.14	MCY	
Wetland Volume -	2.84	MCY		2.84	MCY	
Wetland Site Capacity -	4.02	MCY		4.02	MCY	
Total Baseline Area -	939	Acres		939	Acres	
Total Baseline Perimeter -	27,644	LF		27,644	LF	
Total Volume -	11.56	MCY		19.13	MCY	
Total Site Capacity -	16.88	MCY		28.54	MCY	
Volume of available sand within diked area -	8.00	MCY		8.00	MCY	
QUANTITIES	**Dike Alignment No. 2 (10 ft)**			**Dike Alignment No. 2 (20 ft)**		
Hydraulic Fill Material	LF	CY/LF	CY	LF	CY/LF	CY
Unsuitable Backfill -			250,000			250,000
Perimeter Dike Section 1 to +8.75 -	2,832	20.4	57,814	2,832	20.4	57,814
Perimeter Dike Section 1A to +10 -	788	25.0	19,714			
Perimeter Dike Section 1B to +20 -				788	69.0	54,348
Perimeter Dike Section 2C to +10 -	1,819	32.0	58,233			
Perimeter Dike Section 2D to +20 -				1,819	80.4	146,170
Perimeter Dike Section 3C to +10 -	1,984	34.3	68,069			
Perimeter Dike Section 3D to +20 -				1,984	84.4	167,495
Perimeter Dike Section 4C to +10.25 -	9,377	32.1	301,062			
Perimeter Dike Section 4D to +20 -				9,377	79.9	748,978
Perimeter Dike Section 5 to +8 -	10,193	19.1	255,093	10,193	19.1	194,848
Perimeter Dike Section 5A to +10 -	651	26.6	17,300			
Perimeter Dike Section 58 to +20 -				651	70.5	45,935
Interior Dike Section 6A to +10 -	9,818	38.1	374,095			
Interior Dike Section 6B to +20 -				9,818	70.1	688,275
Total -	**37,462**		**1,401,380**	**37,462**		**2,353,863**
Perimeter Dike Section 1 Stone Work	LF	Tons/LF	Tons	LF	Tons/LF	Tons
Underlayer Stone -	2,832	3.1	8,651	2,832	3.1	8,651
Slope Dike Armor Stone -	2,832	6.7	18,955	2,832	6.7	18,955
Perimeter Dike Section 1A & 1B Stone Work	LF	Tons/LF	Tons	LF	Tons/LF	Tons
Underlayer Stone -	788	3.4	2,699	788	3.4	2,699
Slope Dike Armor Stone -	788	7.5	5,896	788	7.5	5,896
Perimeter Dike Section 2C & 2D Stone Work	LF	Tons/LF	Tons	LF	Tons/LF	Tons
Underlayer Stone -	1,819	6.3	11,551	1,819	6.3	11,551
Slope Dike Armor Stone -	1,819	10.0	18,145	1,819	10.0	18,145
Perimeter Dike Section 3C & 3D Stone Work	LF	Tons/LF	Tons	LF	Tons/LF	Tons
Filter layer Stone -	1,984	4.1	8,159	1,984	4.1	8,159
Underlayer Stone -	1,984	5.1	10,182	1,984	5.1	10,182
Slope Dike Armor Stone -	1,984	12.0	23,817	1,984	12.0	23,817
Perimeter Dike Section 4C & 4D Stone Work	LF	Tons/LF	Tons	LF	Tons/LF	Tons
Filter layer Stone -	9,377	4.0	37,661	9,377	4.0	37,661
Underlayer Stone -	9,377	4.9	46,234	9,377	4.9	46,234
Slope Dike Armor Stone -	9,377	11.6	108,541	9,377	11.6	108,541
Perimeter Dike Section 5 Stone Work	LF	Tons/LF	Tons	LF	Tons/LF	Tons
Underlayer Stone -	10,193	2.2	21,981	10,193	2.2	21,981
Slope Dike Armor Stone -	10,193	3.9	39,637	10,193	3.9	39,637
Perimeter Dike Section 5A & 5B Stone Work	LF	Tons/LF	Tons	LF	Tons/LF	Tons
Underlayer Stone -	651	2.5	1,656	651	2.5	1,656
Slope Dike Armor Stone -	651	4.7	3,082	651	4.7	3,082
Perimeter Dike Totals	LF	Tons/LF	Tons	LF	Tons/LF	Tons
Filter layer Stone -	11,361	N/A	45,820	11,361	N/A	45,820
Underlayer Stone -	27,644	N/A	102,956	27,644	N/A	102,956
Slope Dike Armor Stone -	27,644	N/A	218,073	27,644	N/A	218,073
Miscellaneous	LF	SY/LF	SY	LF	SY/LF	SY
Road Stone -	37,462	1.5	55,318	37,462	1.5	55,318
Geotextile -	27,644	14.5	400,844	27,644	14.5	400,844

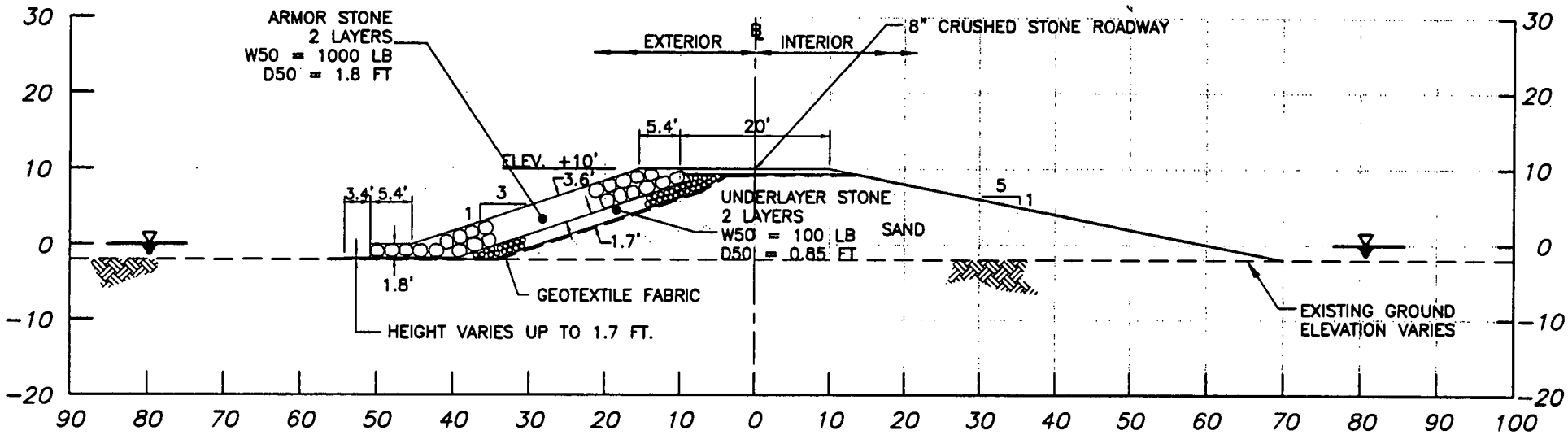
FIGURE No. 7 – HOLLAND ISLAND TYPICAL DIKE SECTIONS



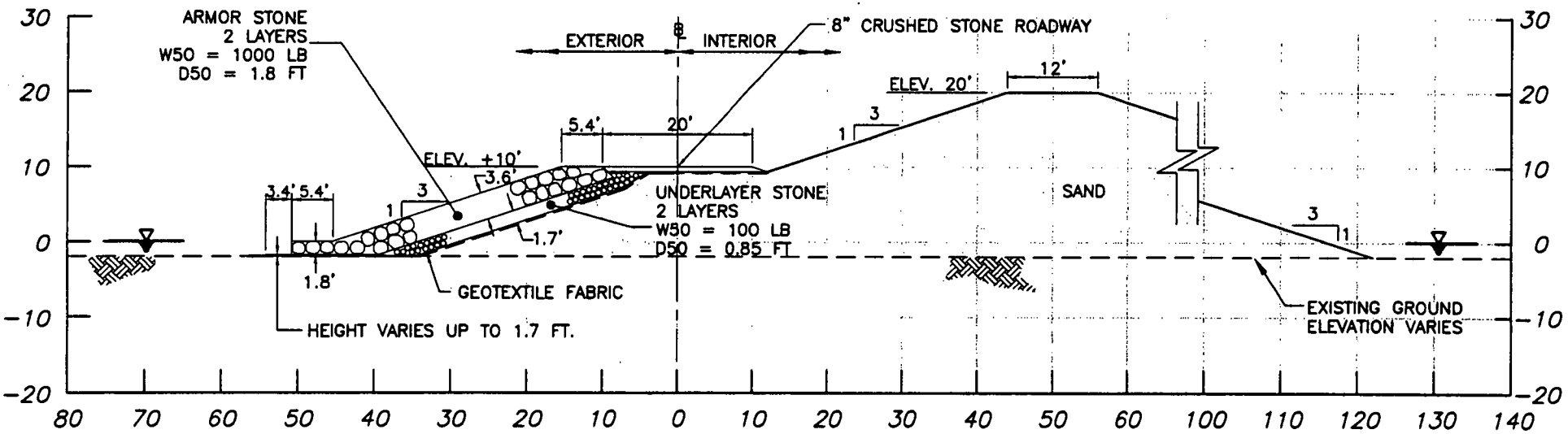
TYPICAL DIKE SECTION 1

SCALE: 1" = 20'

FIGURE No. 8 – HOLLAND ISLAND TYPICAL DIKE SECTIONS

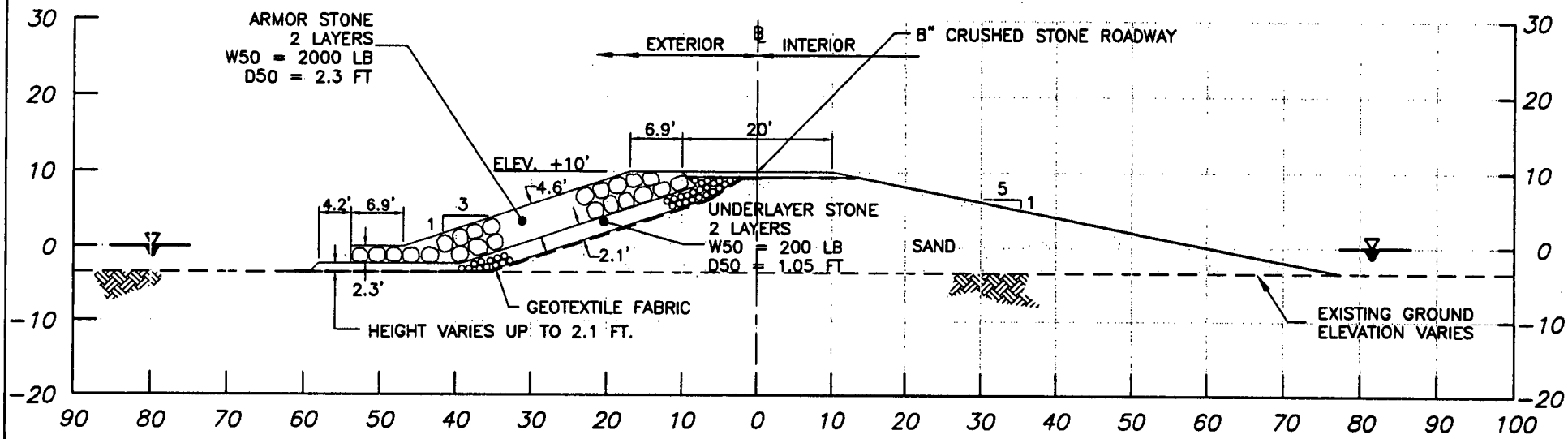


TYPICAL DIKE SECTION 1A
SCALE: 1" = 20'

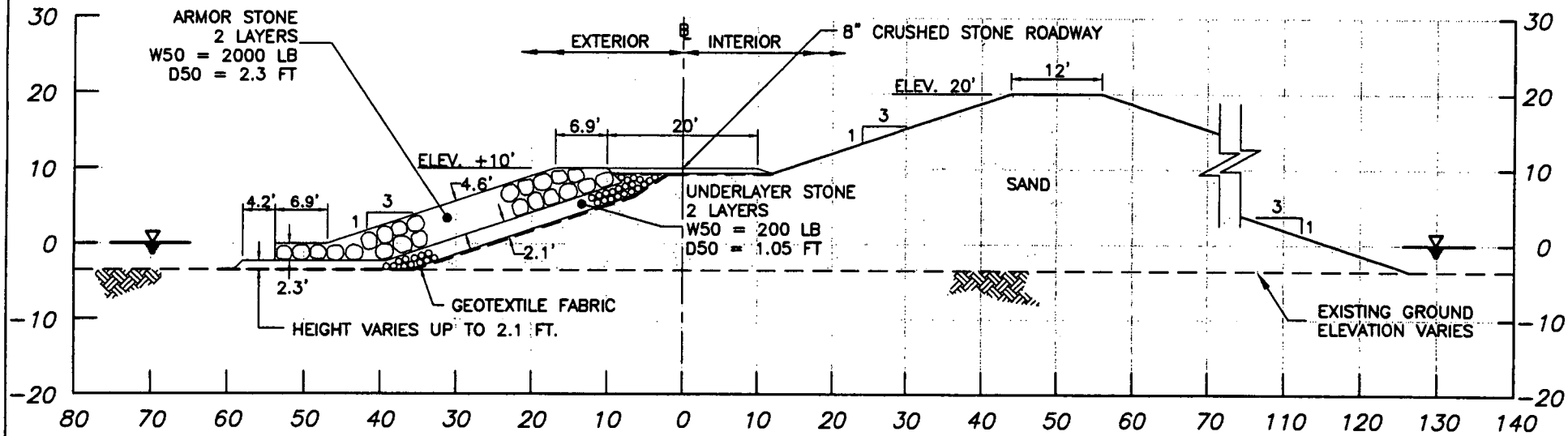


TYPICAL DIKE SECTION 1B
SCALE: 1" = 20'

FIGURE No. 9 – HOLLAND ISLAND TYPICAL DIKE SECTIONS

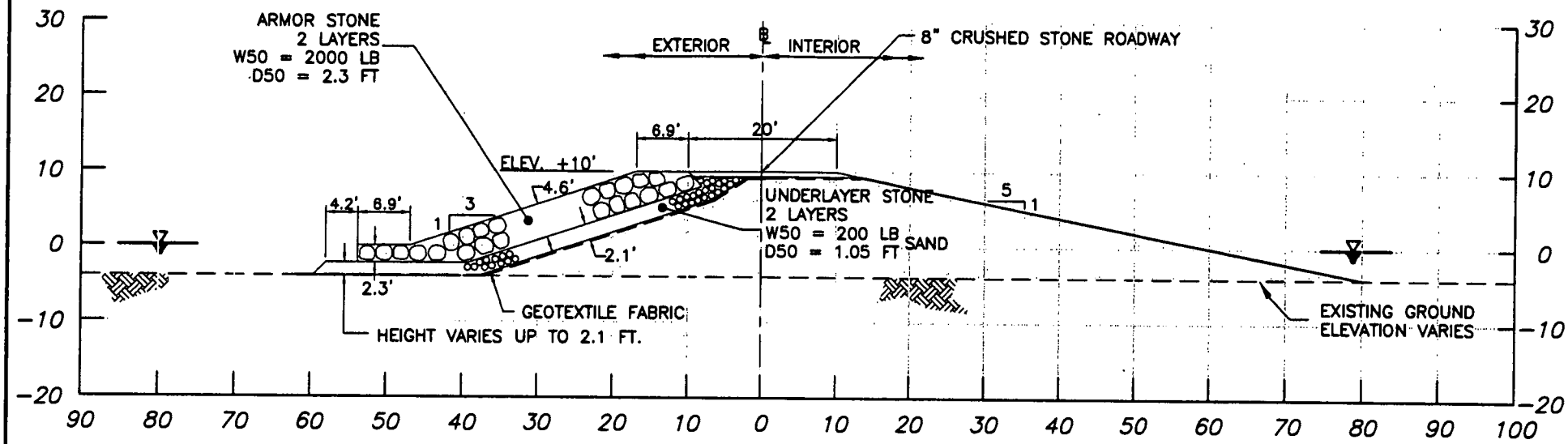


TYPICAL DIKE SECTION 2A
SCALE: 1" = 20'

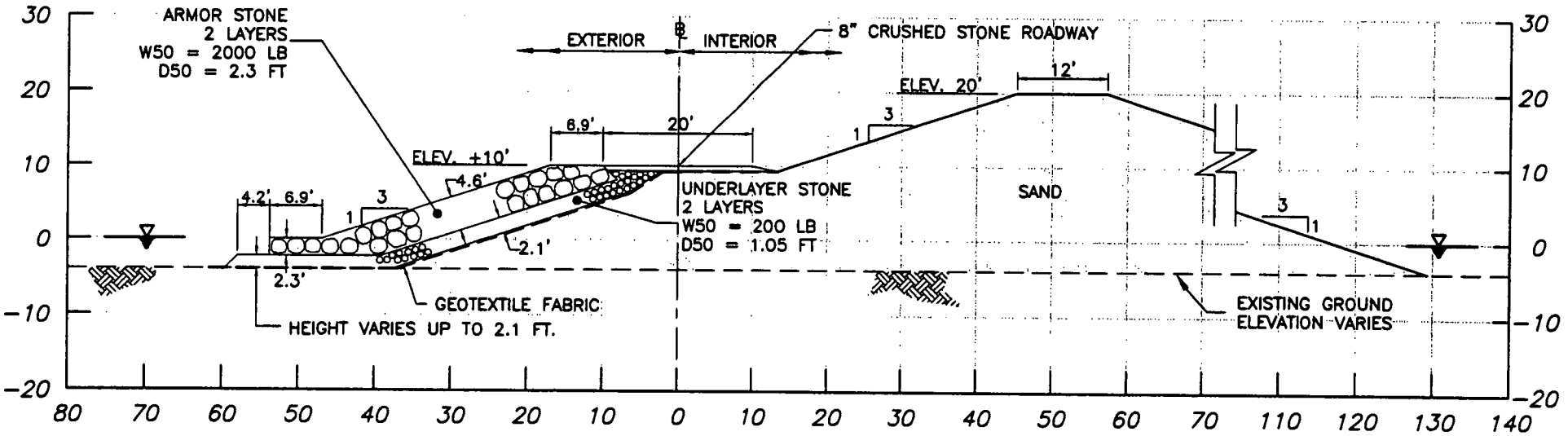


TYPICAL DIKE SECTION 2B
SCALE: 1" = 20'

FIGURE No. 10 – HOLLAND ISLAND TYPICAL DIKE SECTIONS

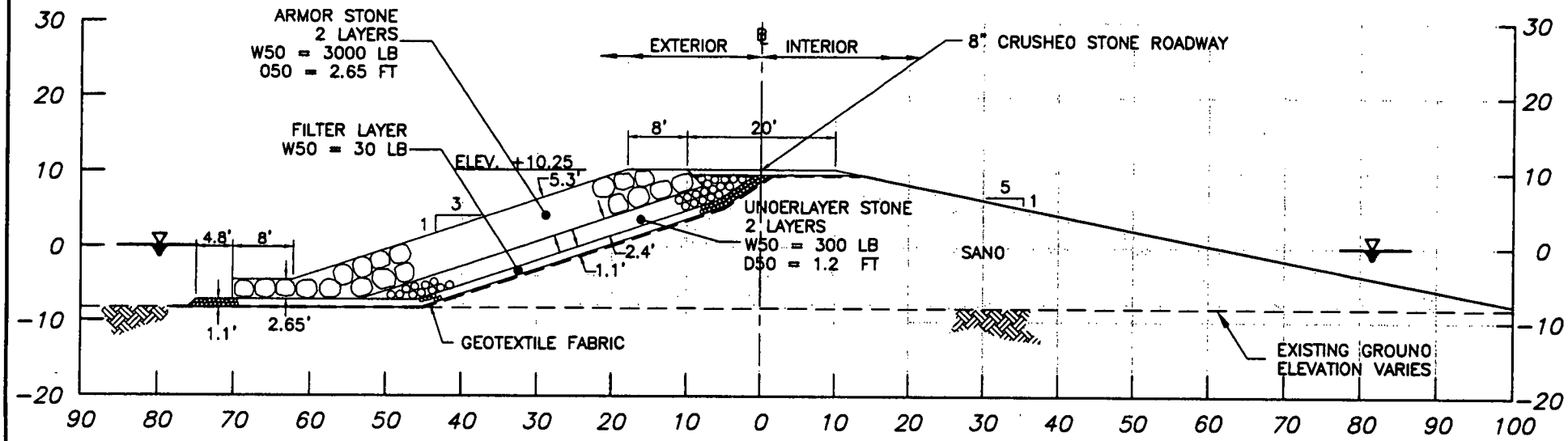


TYPICAL DIKE SECTION 2C
SCALE: 1" = 20'

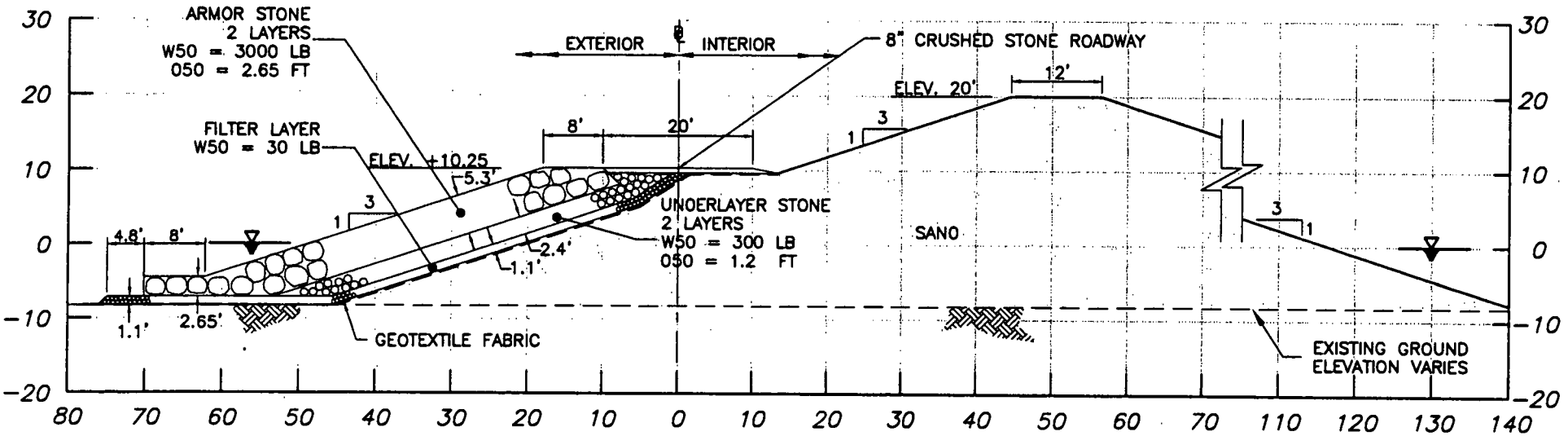


TYPICAL DIKE SECTION 2D
SCALE: 1" = 20'

FIGURE No. 11 – HOLLAND ISLAND TYPICAL DIKE SECTIONS

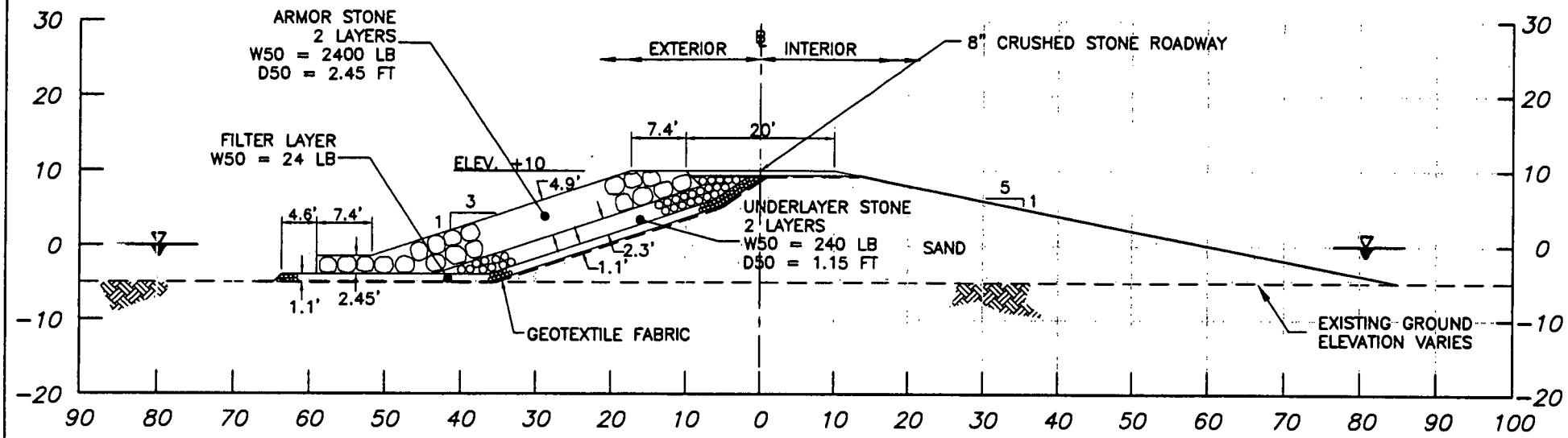


TYPICAL DIKE SECTION 3A
SCALE: 1" = 20'



TYPICAL DIKE SECTION 3B
SCALE: 1" = 20'

FIGURE No. 12 – HOLLAND ISLAND TYPICAL DIKE SECTIONS



TYPICAL DIKE SECTION 3C
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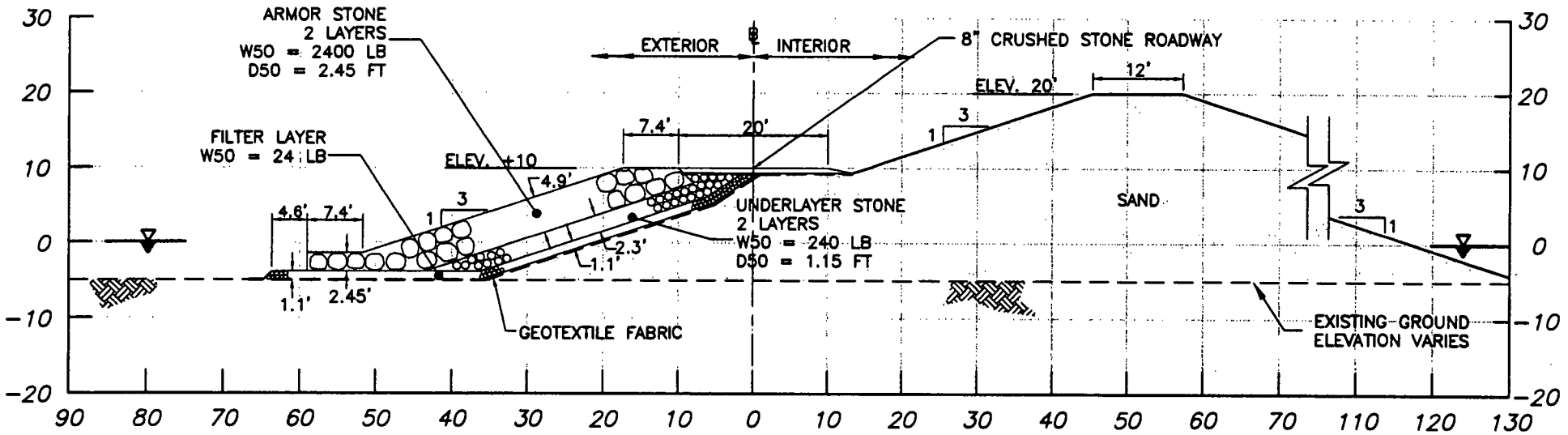
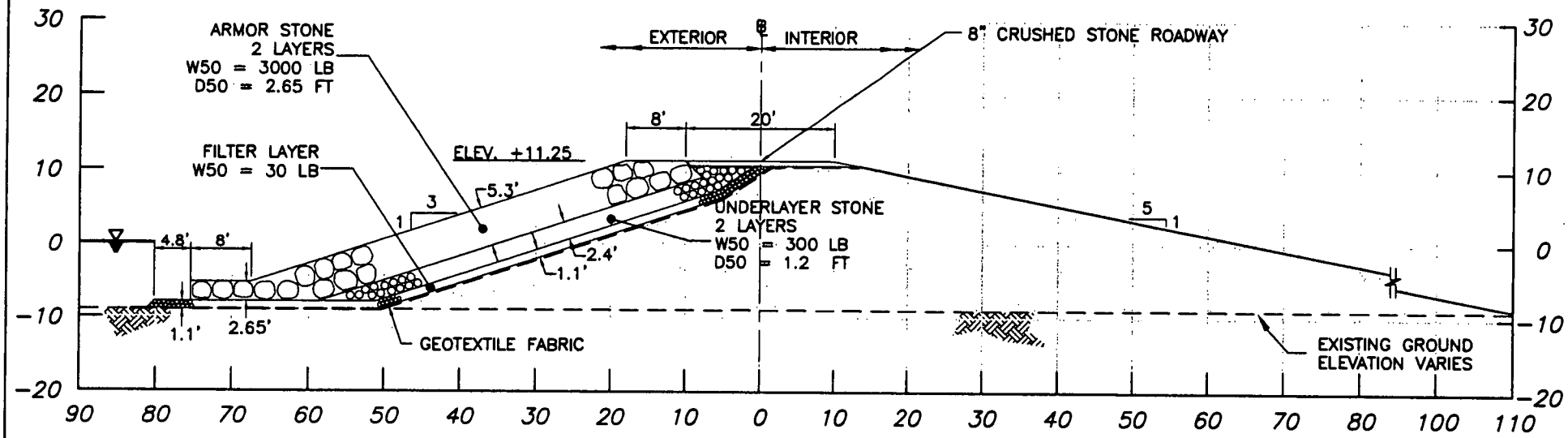
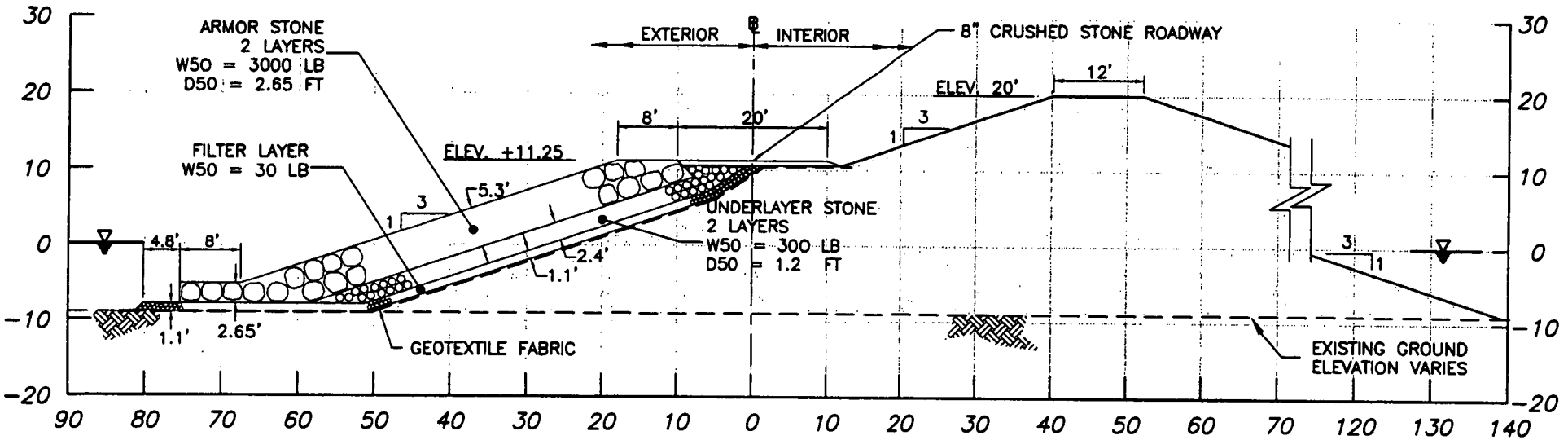


TYPICAL DIKE SECTION 3D
SCALE: 1" = 20'

FIGURE No. 13 – HOLLAND ISLAND TYPICAL DIKE SECTIONS

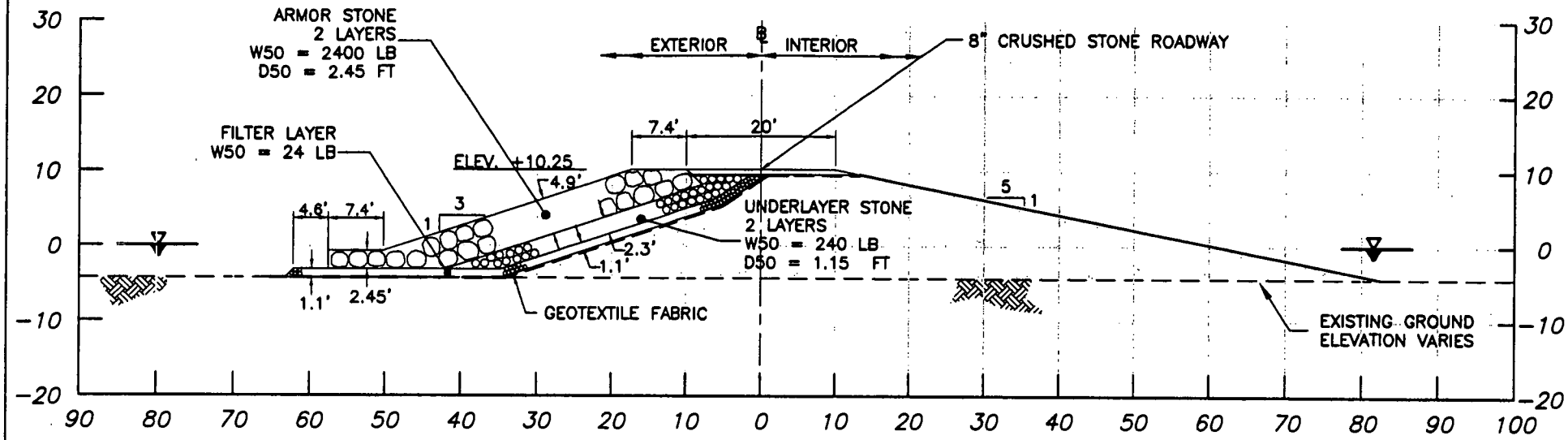


TYPICAL DIKE SECTION 4A
SCALE: 1" = 20'

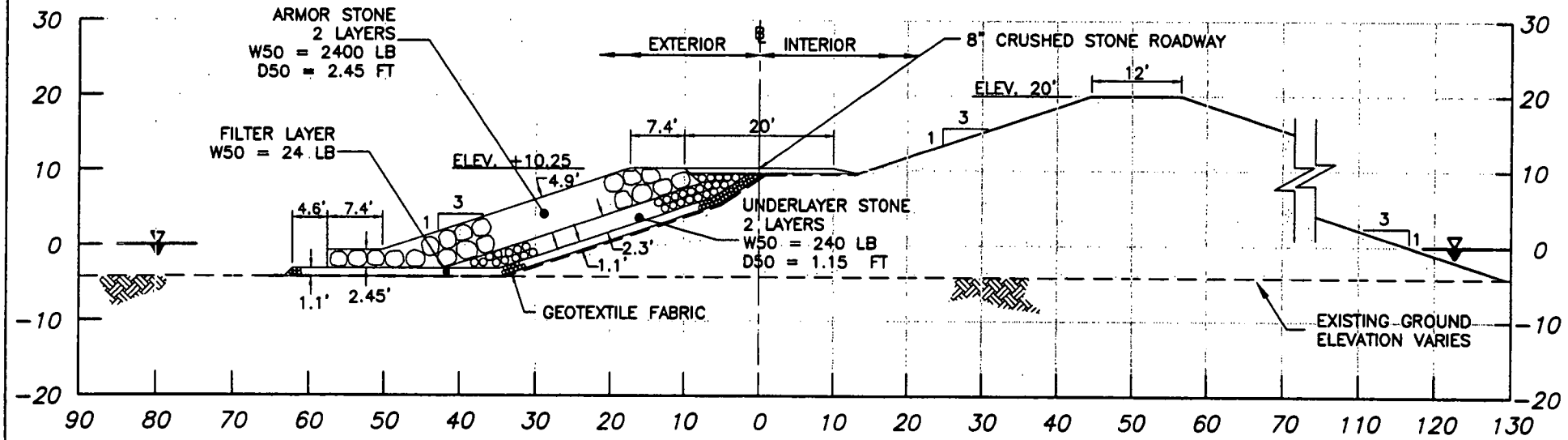


TYPICAL DIKE SECTION 4B
SCALE: 1" = 20'

FIGURE No. 14 – HOLLAND ISLAND TYPICAL DIKE SECTIONS

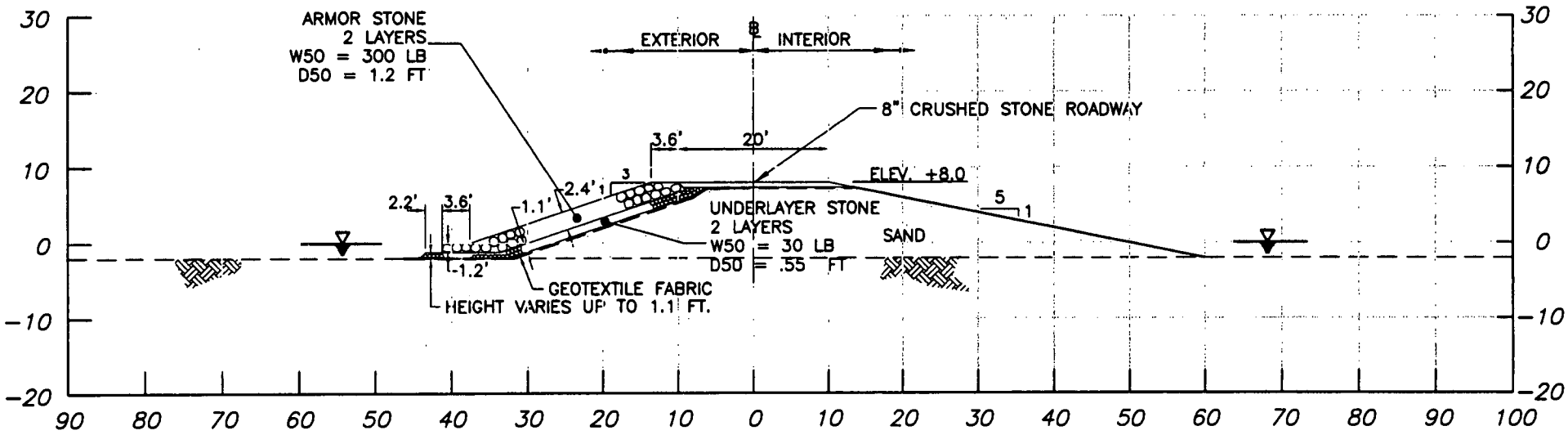


TYPICAL DIKE SECTION 4C
SCALE: 1" = 20'



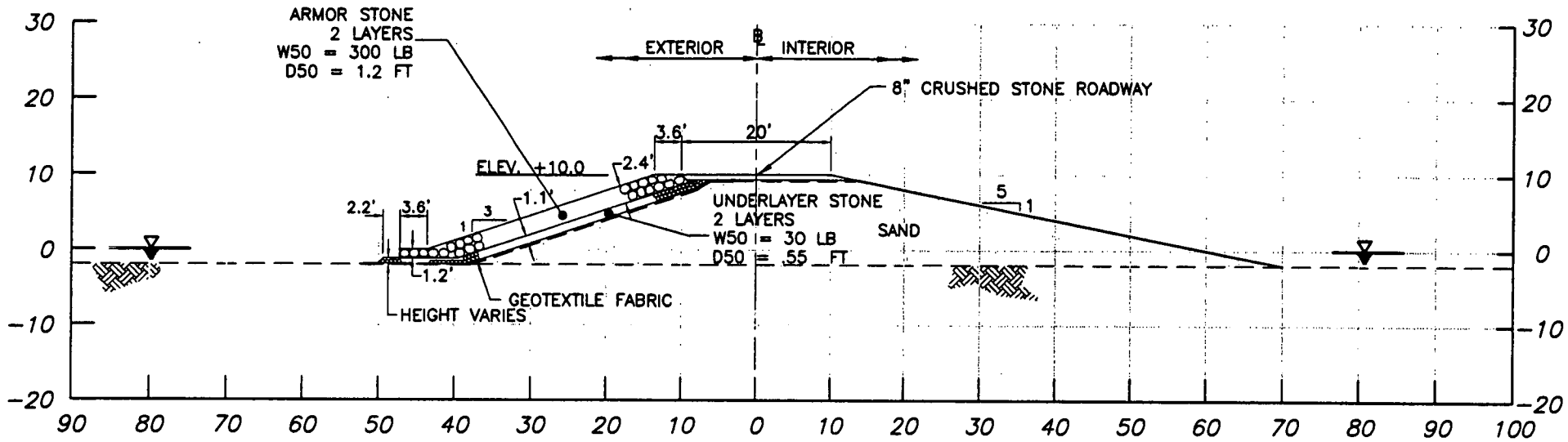
TYPICAL DIKE SECTION 4D
SCALE: 1" = 20'

FIGURE No. 15 – HOLLAND ISLAND TYPICAL DIKE SECTIONS

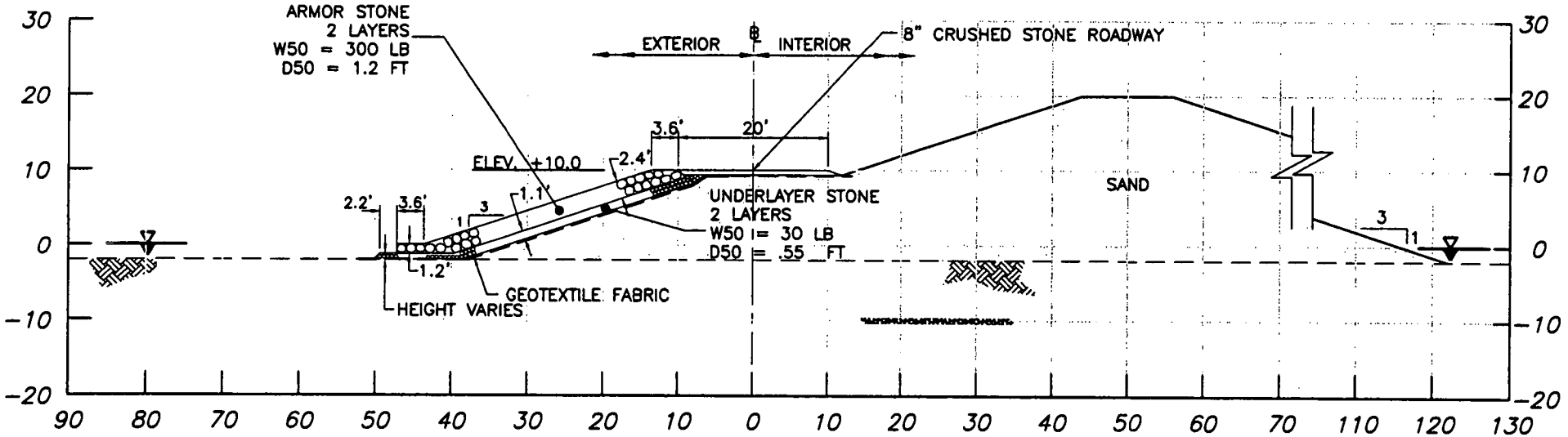


TYPICAL DIKE SECTION 5
SCALE: 1" = 20'

FIGURE No. 16 – HOLLAND ISLAND TYPICAL DIKE SECTIONS

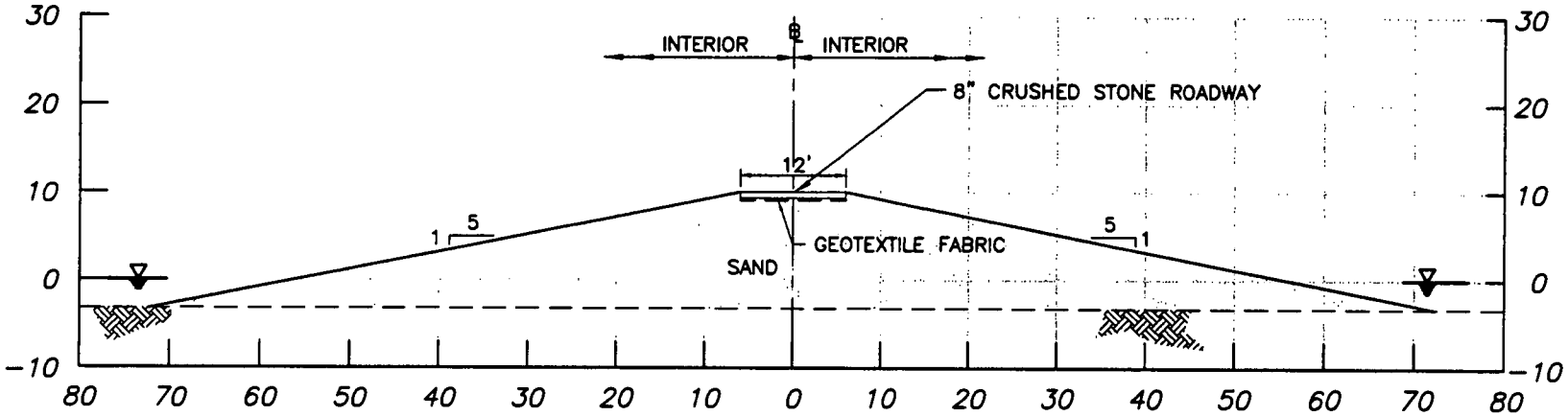


TYPICAL DIKE SECTION 5A
SCALE: 1" = 20'

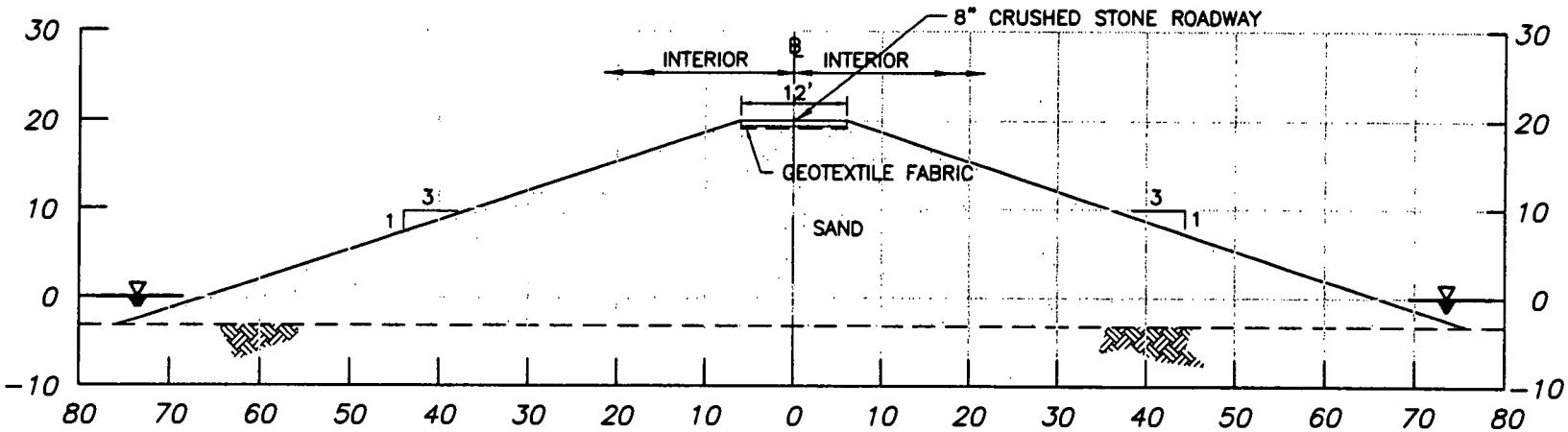


TYPICAL DIKE SECTION 5B
SCALE: 1" = 20'

FIGURE No. 17 – HOLLAND ISLAND TYPICAL DIKE SECTIONS



TYPICAL LONGITUDINAL DIKE SECTION NO. 6A
SCALE: 1" = 20'



TYPICAL LONGITUDINAL DIKE SECTION NO. 6B
SCALE: 1" = 20'

4.0 ALTERNATE BORROW METHODS

The estimated neat sand fill quantities for construction of perimeter dike Alignment No. 1 at Holland Island are between 2.3 million cubic yards for an upland dike height of 10 ft and 3.6 million cubic yards for an upland dike height of 20 ft. The estimated neat sand fill quantities for perimeter dike Alignment No. 2 are between 1.4 million cubic yards for an upland dike height of 10 ft and 2.4 million cubic yards for an upland dike height of 20 ft.

Two different methods for providing sand borrow were considered to meet the estimated quantities: (1) hydraulically dredge directly from the on-site borrow area (2) dredge and transport the off-site sand by hopper dredge to an underwater placement site and place the sand in the dikes with a hydraulic dredge.

Borrow methods 1 and 2 both use a hydraulic dredge to place the sand in the dikes. In borrow method 1, suitable on-site sand fill is pumped directly to dikes where it is shaped and armored. Borrow method 2 assumes that suitable fill material is not available within two or three miles and must be transported by hopper dredge from about 71 nautical miles away from Craighill Channel. After transport, the material is bottom released in an on-site underwater stockpile and pumped into section by hydraulic dredge.

Borings were taken by E2CR (Figure 2) and from a preliminary analysis, there appears to be a sufficient source of borrow material on the Holland Island site. For Alignment No. 1 there is 12+ million cubic yards and for Alignment No. 2 there is 8+ million cubic yards of silty sand available for borrow source material (E2CR, 2002).

5.0 COST ANALYSIS

The preliminary construction costs for Holland Island were determined by using the configurations described in the previous sections. Unit prices were estimated based on actual bid prices for similar construction projects at Poplar Island. The preliminary construction costs for the two dike alignments are presented in Table 3. The preliminary construction costs are broken down by line item, dike alignment and dike height (4 alternatives). Line items include: mobilization and demobilization, roadway stone, geotextile filter fabric, one personnel pier, excavation and backfill for weak unsuitable foundation material, various layers of slope stones, spillway structures to convey decant and rain water within cells and directly to the bay, nursery planting and suitable dike core fill material. These costs are presented in Tables 6 thru 9 - (see Table 5) - Item A. In addition to preliminary construction costs, study costs (engineering planning and design costs) were estimated to develop an "initial construction cost".

The initial construction costs include preliminary construction plus conceptual, pre-feasibility and feasibility study costs, and are summarized below. Table 3 outlines the four Alternative Initial Construction Costs (from Tables 6 thru 9 – Item A). This matrix of costs range from $38.1 million at $1.65 per cy of capacity (Alignment 1, +10, borrow #1) to $66.7 million at $1.24 per cy of capacity (Alignment 1, +20, borrow #1). The lowest unit cost option has an initial construction cost of $66.7 million at $1.24 per cy of capacity (Alignment 1, +20, borrow #1).

Table 3 - Summary Of Initial Construction Costs

	+10–Borrow # 1		+20–Borrow # 1	
Alignment No.	Initial Construction Cost $Million	Unit Cost $/Cy	Initial Construction Cost $Million	Unit Cost $/Cy
1	$55.5	$1.65	$66.7	$1.24
2	$38.1	$2.25	$46.2	$1.62

Note: Initial Construction Costs include preliminary construction plus study costs (see Tables 6 Thru 9 Item A).
Unit Cost is expressed in dollars per cubic yard of capacity.

The Total Site Use costs were also developed for each dike alignment, borrow source and dike height. The estimated total site use costs for each alternative are presented in Tables 6 thru 9 – Items A thru D. Total site use costs include: initial construction cost (described above); site development cost (dredge material management, site maintenance and site monitoring and reporting); habitat development cost (plans and design, monitoring, implementation, and operation & maintenance); and dredging, transport and placement cost. Table 4 outlines the four Alternative Total Site Use Costs. This matrix of costs range from $337.6 million at $19.99 per cy of capacity (Alignment 2, +10, borrow #1) to $1.011 billion at $18.75 per cy of capacity (Alignment 1, +20, borrow #1). The lowest unit cost option has a total site use cost of $1.011 billion at $18.75 per cy of capacity (Alignment 1, +20, borrow #1).

Table 4 - Summary Of Total Site Use Costs

	+10–Borrow# 1		+20–Borrow# 1	
Alignment No.	Total Site Use Cost $Million	Unit Cost $/Cy	Total Site Use Cost $Million	Unit Cost $/Cy
1	$657.3	$19.56	$1,011.1	$18.75
2	$337.6	$19.99	$539.2	$18.89

Note Total Site Use Costs include: Initial Construction, Site Development, Habitat Development and Dredging/Placement (see Table 6 Thru 9 Items A thru D).
Unit Cost is expressed in dollars per cubic yard of capacity.

Certain factors may change the costs estimated in this report. A 15% contingency cost is included to offset unforeseen developments. For example, construction industry conditions and fuel prices drive the cost of construction, dredging, transport and placement. Also, the limited available geotechnical information at this time may be a likely source of adjustments in estimated costs. The cost estimates in this study were conducted at a conceptual level and therefore, the results should be considered preliminary. Pre-feasibility, feasibility and engineering design studies would be required to assess detailed project costs.

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Table 5 - Preliminary Construction Costs

	Unit	Unit Rate	Alignment No. 1 (10 ft) Qty	Alignment No. 1 (10 ft) Cost $	Alignment No. 1 (20 ft) Qty	Alignment No. 1 (20 ft) Cost $	Alignment No. 2 (10 ft) Qty	Alignment No. 2 (10 ft) Cost $	Alignment No. 2 (20 ft) Qty	Alignment No. 2 (20 ft) Cost $
Mobilization/Demobilization	L.S.	N/A	Job	$3,250,000	Job	$3,250,000	Job	$3,000,000	Job	$3,000,000
Road Stone	S.Y.	$11.00	74,679	$821,465	74,679	$821,465	55,318	$608,496	55,318	$608,496
Geotextile	S.Y.	$3.50	536,753	$1,878,636	536,753	$1,878,636	400,844	$1,402,953	400,844	$1,402,953
Personnel Pier	L.S.	$500,000	Job	$500,000	Job	$500,000	Job	$500,000	Job	$500,000
Unsuitable Foundation Excavation	C.Y.	$8.75	400,000	$3,500,000	400,000	$3,500,000	250,000	$2,187,500	250,000	$2,187,500
Stone Work										
Filter Layer	Ton	$33.00	61,078	$2,015,588	61,078	$2,015,588	45,820	$1,512,065	45,820	$1,512,065
Underlayer	Ton	$39.00	160,965	$6,277,617	160,965	$6,277,617	102,956	$4,015,268	102,956	$4,015,268
Slope Dike Armor Stone	Ton	$39.00	341,998	$13,337,927	341,998	$13,337,927	218,073	$8,504,830	218,073	$8,504,830
Spillways	Each	$200,000	8	$1,600,000	8	$1,600,000	6	$1,200,000	6	$1,200,000
Nursery Planting	L.S.	N/A	Job	$270,000	Job	$270,000	Job	$200,000	Job	$200,000
SUBTOTAL				$33,451,234		$33,451,234		$23,131,112		$23,131,112

			Alignment No. 1 (10 ft)		Alignment No. 1 (20 ft)		Alignment No. 2 (10 ft)		Alignment No. 2 (20 ft)	
Borrow Alternative 1										
Dike Fill Hydraulic Excavation - Mechanical Placement from Onsite	C.Y.	$8.50	2,233,880	$18,987,984	3,555,870	$30,224,894	1,401,380	$11,911,732	2,353,863	$20,007,839
A1 TOTAL CONSTRUCTION COST				**$52,439,217**		**$63,676,128**		**$35,042,845**		**$43,138,951**
per CY of Site Capacity				$1.56		$1.18		$2.08		$1.51
Borrow Alternative 2										
Clam Shell Dredge from Craighill Channel	C.Y.	$2.25	2,233,880	$5,026,231	3,555,870	$8,000,707	1,401,380	$3,153,106	2,353,863	$5,296,193
71 miles one way barge transport	C.Y.	$7.10	2,233,880	$15,860,551	3,555,870	$25,246,676	1,401,380	$9,949,800	2,353,863	$16,712,430
Dike Fill Hydraulically from barge	C.Y.	$7.50	2,233,880	$16,754,103	3,555,870	$26,669,024	1,401,380	$10,510,352	2,353,863	$17,653,976
A2 TOTAL CONSTRUCTION COST				**$71,092,119**		**$93,367,641**		**$46,744,370**		**$62,793,711**
per CY of Site Capacity				$2.12		$1.73		$2.77		$2.20

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Table 6 - Total site use cost analysis for Dike Alignment No. 1 (10 ft)*

BASIS FOR ESTIMATE:

Site Capacity (Mcy)	33.6	Site Surface Area (Ac)	1,639
Site Operating Life (Years)	14	Site Perimeter Dike (Ft)	37,017
Annual Channel (Cut) Volume (Mcy)	2.50	Site Interior Dikes (Ft)	13,556
Average One-Way Haul Distance (NM)	76	Final Dike Elev. (Ft)	10.0

Item	*Quantity*	*Unit*	*Unit Cost*	*Item Cost*	*Comments*
A. Initial Construction Costs			**$1.65**	**$55,439,217**	
Total Construction Costs				$52,439,217	Refer to Table 5, Borrow Source Onsite**
Study Costs				$3,000,000	Conceptual, pre-feasibility and feasibility costs.
B. Site Development Costs				**$64,036,593**	
Dredged Material Management	14.0	Year	$1,747,787	$24,469,018	Placement, dewatering and crust
					management costs for the operating life.
					$150,000+ ($975 per Acre)
Site Maintenance	16.0	Year	$1,755,786	$28,092,575	Site Maintenance for operating life plus
					2 years following site placement.
					$90,000+ ($45 per Perimeter Ft.)
Site Monitoring and Reporting	17.0	Year	$675,000	$11,475,000	Environmental monitoring for operating life
					plus 3 years following site placement.
Subtotal Total Annual Cost:			$4,178,573		
C. Site Finishing Cost (Habitat Development)				**$25,930,526**	
Plan and Design	3.0	Year	$1,000,000	$3,000,000	
Monitoring	14.0	Year	$250,000	$3,500,000	
Implementation				$12,430,526	
Channels	870	Acre	$6,000	$5,220,000	$8/cy x 3 cy/LF x 250 LF/acre
Planting/Seeding	1639	Acre	$4,400	$7,210,526	$4,400 per acre
Operation & Maintenance	14.0	Year	$500,000	$7,000,000	
D. Dredging, Transportation & Placement Costs				**$426,160,000**	
Mob and Demob	14.0	Year	$2,000,000	$28,000,000	Mob & Demob for operating life of site
Dredging	33.6	Mcy	$2.00	$67,200,000	Clamshell Dredging
Transport	33.6	Mcy	$7.60	$255,360,000	$0.10 Per One-Way Haul in NM (76 NM)
Placement	33.6	Mcy	$2.25	$75,600,000	Hydraulic Unloader
SUBTOTAL COST A+B+C+D				**$571,566,337**	
Contingency	15.00%			$85,734,951	
TOTAL COST A+B+C+D				**$657,301,287**	
TOTAL UNIT COST				**$19.56**	**per cubic yard**

* Costs are estimated in 2002 dollars.

** Engineering Consultation Construction Remediation, Inc. (E2CR 2002).

HOLLAND ISLAND HABITAT DEVELOPMENT

Table 7 - Total site use cost analysis for Dike Alignment No. 1 (20 ft)*

BASIS FOR ESTIMATE:

Site Capacity (Mcy)	53.9	Site Surface Area (Ac)	1,639
Site Operating Life (Years)	22	Site Perimeter Dike (Ft)	37,017
Annual Channel (Cut) Volume (Mcy)	2.50	Site Interior Dikes (Ft)	13,556
Average One-Way Haul Distance (NM)	76	Final Dike Elev. (Ft)	20.0

Item	*Quantity*	*Unit*	*Unit Cost*	*Item Cost*	*Comments*
A. Initial Construction Costs			$1.24	**$66,676,128**	
Total Construction Costs				$63,676,128	Refer to Table 5, Borrow Source Onsite**
Study Costs				$3,000,000	Conceptual, pre-feasibility and feasibility costs.
B. Site Development Costs				**$97,465,177**	
Dredged Material Management	22.0	Year	$1,747,787	$38,451,315	Placement, dewatering and crust
					management costs for the operating life.
					$150,000+ ($975 per Acre)
Site Maintenance	24.0	Year	$1,755,786	$42,138,862	Site Maintenance for operating life plus
					2 years following site placement.
					$90,000+ ($45 per Perimeter Ft.)
Site Monitoring and Reporting	25.0	Year	$675,000	$16,875,000	Environmental monitoring for operating life
					plus 3 years following site placement.
Subtotal Total Annual Cost:			**$4,178,573**		
C. Site Finishing Cost (Habitat Development)				**$31,930,526**	
Plan and Design	3.0	Year	$1,000,000	$3,000,000	
Monitoring	22.0	Year	$250,000	$5,500,000	
Implementation				$12,430,526	
Channels	870	Acre	$6,000	$5,220,000	$8/cy x 3 cy/LF x 250 LF/acre
Planting/Seeding	1639	Acre	$4,400	$7,210,526	$4,400 per acre
Operation & Maintenance	22.0	Year	$500,000	$11,000,000	
D. Dredging, Transportation & Placement Costs				**$683,164,290**	
Mob and Demob	22.0	Year	$2,000,000	$44,000,000	Mob & Demob for operating life of site
Dredging	53.9	Mcy	$2.00	$107,875,830	Clamshell Dredging
Transport	53.9	Mcy	$7.60	$409,928,152	$0.10 Per One-Way Haul in NM (76 NM)
Placement	53.9	Mcy	$2.25	$121,360,308	Hydraulic Unloader
SUBTOTAL COST A+B+C+D				**$879,236,121**	
Contingency	15.00%			$131,885,418	
TOTAL COST A+B+C+D				**$1,011,121,539**	
TOTAL UNIT COST				**$18.75**	**per cubic yard**

* Costs are estimated in 2002 dollars.

** Engineering Consultation Construction Remediation, Inc. (E2CR 2002).

HOLLAND ISLAND HABITAT DEVELOPMENT

Table 8 - Total site use cost analysis for Dike Alignment No. 2 (10 ft)*

BASIS FOR ESTIMATE:

Site Capacity (Mcy)	16.9	Site Surface Area (Ac)	939
Site Operating Life (Years)	7	Site Perimeter Dike (Ft)	27,644
Annual Channel (Cut) Volume (Mcy)	2.50	Site Interior Dikes (Ft)	9,818
Average One-Way Haul Distance (NM)	76	Final Dike Elev. (Ft)	10.0

Item	*Quantity*	*Unit*	*Unit Cost*	*Item Cost*	*Comments*
A. Initial Construction Costs			$2.25	**$38,042,845**	
Total Construction Costs				$35,042,845	Refer to Table 5, Borrow Source Onsite**
Study Costs				$3,000,000	Conceptual, pre-feasibility and feasibility costs.
B. Site Development Costs				**$26,217,399**	
Dredged Material Management	7.0	Year	$1,065,917	$7,461,421	Placement, dewatering and crust
					management costs for the operating life.
					$150,000+ ($975 per Acre)
Site Maintenance	9.0	Year	$1,333,998	$12,005,979	Site Maintenance for operating life plus
					2 years following site placement.
					$90,000+ ($45 per Perimeter Ft.)
Site Monitoring and Reporting	10.0	Year	$675,000	$6,750,000	Environmental monitoring for operating life
					plus 3 years following site placement.
Subtotal Total Annual Cost:			$3,074,915		
C. Site Finishing Cost (Habitat Development)				**$15,203,370**	
Plan and Design	3.0	Year	$1,000,000	$3,000,000	
Monitoring	7.0	Year	$250,000	$1,750,000	
Implementation				$6,953,370	
Channels	470	Acre	$6,000	$2,820,000	$8/cy x 3 cy/LF x 250 LF/acre
Planting/Seeding	939	Acre	$4,400	$4,133,370	$4,400 per acre
Operation & Maintenance	7.0	Year	$500,000	$3,500,000	
D. Dredging, Transportation & Placement Costs				**$214,065,987**	
Mob and Demob	7.0	Year	$2,000,000	$14,000,000	Mob & Demob for operating life of site
Dredging	16.9	Mcy	$2.00	$33,766,411	Clamshell Dredging
Transport	16.9	Mcy	$7.60	$128,312,363	$0.10 Per One-Way Haul in NM (76 NM)
Placement	16.9	Mcy	$2.25	$37,987,213	Hydraulic Unloader
SUBTOTAL COST A+B+C+D				**$293,529,601**	
Contingency	15.00%			$44,029,440	
TOTAL COST A+B+C+D				**$337,559,041**	
TOTAL UNIT COST				**$19.99**	**per cubic yard**

* Costs are estimated in 2002 dollars.

** Engineering Consultation Construction Remediation, Inc. (E2CR 2002).

HOLLAND ISLAND HABITAT DEVELOPMENT

Table 9 - Total site use cost analysis for Dike Alignment No. 2 (20 ft)*

BASIS FOR ESTIMATE:

Site Capacity (Mcy)	28.5	Site Surface Area (Ac)	939
Site Operating Life (Years)	12	Site Perimeter Dike (Ft)	27,644
Annual Channel (Cut) Volume (Mcy)	2.50	Site Interior Dikes (Ft)	9,818
Average One-Way Haul Distance (NM)	76	Final Dike Elev. (Ft)	20.0

Item	*Quantity*	*Unit*	*Unit Cost*	*Item Cost*	*Comments*
A. Initial Construction Costs			**$1.62**	**$46,138,951**	
Total Construction Costs				$43,138,951	Refer to Table 5, Borrow Source Onsite**
Study Costs				$3,000,000	Conceptual, pre-feasibility and feasibility costs.
B. Site Development Costs				**$41,591,974**	
Dredged Material Management	12.0	Year	$1,065,917	$12,791,007	Placement, dewatering and crust
					management costs for the operating life.
					$150,000+ ($975 per Acre)
Site Maintenance	14.0	Year	$1,333,998	$18,675,967	Site Maintenance for operating life plus
					2 years following site placement.
					$90,000+ ($45 per Perimeter Ft.)
Site Monitoring and Reporting	15.0	Year	$675,000	$10,125,000	Environmental monitoring for operating life
					plus 3 years following site placement.
Subtotal Total Annual Cost:			$3,074,915		
C. Site Finishing Cost (Habitat Development)				**$18,953,370**	
Plan and Design	3.0	Year	$1,000,000	$3,000,000	
Monitoring	12.0	Year	$250,000	$3,000,000	
Implementation				$6,953,370	
Channels	470	Acre	$6,000	$2,820,000	$8/cy x 3 cy/LF x 250 LF/acre
Planting/Seeding	939	Acre	$4,400	$4,133,370	$4,400 per acre
Operation & Maintenance	12.0	Year	$500,000	$6,000,000	
D. Dredging, Transportation & Placement Costs				**$362,199,000**	
Mob and Demob	12.0	Year	$2,000,000	$24,000,000	Mob & Demob for operating life of site
Dredging	28.5	Mcy	$2.00	$57,080,000	Clamshell Dredging
Transport	28.5	Mcy	$7.60	$216,904,000	$0.10 Per One-Way Haul in NM (76 NM)
Placement	28.5	Mcy	$2.25	$64,215,000	Hydraulic Unloader
SUBTOTAL COST A+B+C+D				**$468,883,295**	
Contingency	15.00%			$70,332,494	
TOTAL COST A+B+C+D				**$539,215,789**	
TOTAL UNIT COST				**$18.89**	**per cubic yard**

* Costs are estimated in 2002 dollars.

** Engineering Consultation Construction Remediation, Inc. (E2CR 2002).

6.0 SUMMARY & CONCLUSIONS

The range of initial costs for construction is about $38.1 to $66.7 million. The schedule for construction is about two to four years. The range of total use costs is between $338 million to $1.01 billion. When all factors associated with moving maintenance material from the Baltimore Harbor channels to the Holland Island Habitat Restoration Site are considered, the estimated total unit cost ranges between $18.75/cy to $19.99/cy dependent on alignment and dike height chosen.

6.1 Alignment No. 1 General Site Characteristics

- Water depth is approximately 0.5 - 9 ft. MLLW. Average water depth is 5 ft. MLLW.
- Site area is 1,639 acres.
- The ratio of wetland to uplands acreage is 1:1
- Site perimeter is 37,017 L.Ft.
- The site area to perimeter ratio is 0.044 ac/L.Ft.
- Site capacity is 33.6 to 53.9 Mcy.
- Site life is 14 to 22 years.
- Highest total initial construction cost, but lowest unit cost.
- Highest total site use cost, but lowest unit cost.

6.2 Alignment No. 2 General Site Characteristics

- Water depth is approximately 0.5 - 5 ft. MLLW. Average water depth is 3.5 ft.
- Site area is 939 acres.
- The ratio of wetland to uplands acreage is 1:1
- Site perimeter is 27,644 L.Ft.
- The site area to perimeter ratio is 0.034 ac/L.Ft.
- Site capacity is 16.9 to 28.5 Mcy.
- Site life is 7 to 12 years.
- Lowest total initial construction cost, but highest unit cost.
- Lowest total site use cost, but highest unit cost.

Note that the analysis in this study was conducted at a reconnaissance level and therefore, the results should be considered preliminary. A feasibility study and engineering design would be needed to implement the proposed project.

7.0 REFERENCES

E2CR (2002). Geotechnical Feasibility Study for Holland Island Chesapeake, MD. Engineering Construction Consulting Remediation, Baltimore, MD.

OCTI (2002). Preliminary Coastal Engineering Analysis Holland Island, Maryland. Offshore & Coastal Technologies, Inc – East Coast, Chadds Ford, PA

GBA (2001). Conceptual/Pre-feasibility Study for Dredged Material Placement Site Construction at Parsons Island. Gahagan & Bryant Associates, Inc., Baltimore, MD

Appendix D

APPENDIX D

Reconnaissance Study of Holland Island for Beneficial Use and Habitat Restoration

FINAL
Environmental Conditions Report

August 21, 2002

Under Contract To:

Maryland Environmental Service
2011 Commerce Park Drive
Annapolis, Maryland

For:
The Maryland Port Administration
2310 Broening Highway
Baltimore, Maryland

Submitted by:

Baker

Michael Baker Jr., Inc.
Glen Burnie, Maryland

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EXECUTIVE SUMMARY

Holland Island is located off the southern most part of Dorchester County, Maryland, in the eastern Chesapeake Bay. The size of Holland Island has been reduced from approximately 160 acres in 1915 to approximately 87 acres today as a result of erosion. Holland Island now exists as three distinct landmasses, which are referred to in this report as North Holland Island, Middle Holland Island, and South Holland Island. A private owner purchased the majority of acreage in 1995. The Maryland Department of Natural Resources (MDNR) owns approximately a half-acre of land on the northeast edge of the southern remnant of Holland Island. Two other private parties own a total of approximately 1.25 acres of land at Holland Island.

Holland Island was considered as a beneficial use project under the Maryland Port Administration's Dredged Material Management Program (DMPP) after being contacted by the primary landowner. Conceptual designs to increase the size of Holland Island were developed for two alignments, with estimated sizes of 939 and 1,639 acres. The proposed site design would provide 50% wetlands and 50% uplands for both concept designs. The upland dike elevation scenarios are 10 and 20 feet, and all wetland elevation scenarios are a maximum of 10 feet. The proposed alignments are to be located along the western shore of Holland Island.

This report evaluates the existing environmental conditions at Holland Island as a result of literature searches, site visits, and coordination with local, state, and federal agencies. Potential impacts of the conceptual designs are assessed, and further investigation needs are included as part of this report.

Holland Island consists mainly of tidal marsh with some upland tree stands. The vegetation is characterized by tidal salt marsh grasses and scrub shrub. South Holland Island is the largest of the landmasses, and contains the most upland area where larger trees exist as part of a rookery.

Water quality in the Holland Island vicinity is generally good, with salinity samples indicating a high mesohaline environment. Sediment in the Holland Island vicinity is a mixture of sand, silt and clay, with the October 2001 borings indicating that the predominant substrate on the western side of the island generally consists of silty sand overlaying silty clay (Engineering, Construction, Consulting, and Remediation, Inc, 2002).

Holland Island is located within an area that is designated as Essential Fish Habitat (EFH) for nine species that are managed by the National Marine Fisheries Service (NMFS). The Virginia Institute of Marine Science (VIMS) surveys Submerged Aquatic Vegetation (SAV) around Holland Island on an annual basis. The most recent information from year 2000 and preliminary information from 2001 shows patches of widgeon grass only adjacent to the eastern shore of Holland Island. 1996 was the last year in which very sparse distribution of SAV was observed along the west coast of Holland Island. There was no occurrence of SAV at Holland Island in 1997 and 1998 according to the annual

VIMS survey. In general, SAV beds around Holland Island appear to have experienced a sharp decline since 1992. Widgeon grass is considered a habitat area of particular concern (HAPC) for adult and juvenile summer flounder.

Waterbird rookeries with large numbers of herons, egrets, and other colonial waterbirds are known to exist at Holland Island. Two osprey nests were observed during a Maryland Environmental Service (MES) site visit on September 27, 2001. No mammals were observed during the site visit on September 19, 2001 by Michael Baker Jr., Inc. (BAKER); however a hole resembling a groundhog or muskrat shelter was observed, and several bird carcasses were also seen which might indicate mammalian or raptor presence. White tailed deer have been observed at Holland Island in the past. A bald eagle nest was known to exist at Holland Island, although MDNR officials report that the nest has not been present for the past several years. No other federally proposed or listed endangered or threatened species are known to exist within the area. Shortnose sturgeon is an endangered species that is being monitored throughout the Chesapeake Bay. There have been no reports of shortnose sturgeon caught in the Holland Island vicinity. The closest reported catch was in the Hooper Straits, located north of Bloodsworth Island, in June 2000.

The area in the general vicinity of Holland Island supports several fisheries, including blue crabs, oysters, clams, and finfish. Recreational and commercial fishing directly adjacent to the island is very limited due to the shallow water depths. Specific data is not kept for Holland Island itself; however, Tangier Sound and Chesapeake Bay mainstem both have available data that is managed by MDNR. The oyster harvest around Holland Island is historically very low. There is no clamming activity in the general vicinity of Holland Island. In general, the size of the blue crab harvest in the vicinity of Holland Island has been decreasing since 1993 according to information provided from MDNR. The overall numbers of blue crabs are less in Tangier Sound than in the Chesapeake Bay section adjacent to Holland Island. The most abundant species of fish caught in the Holland Island area are croaker, common eel, menhaden, gray sea trout, spot, white perch, bluefish, and striped bass.

The Maryland Historical Trust (MHT) identified three sites of historical significance at Holland Island. Based on MHT records, the sites include an old house site where artifacts (brick and ceramic) were found, a family cemetery, and an old pier site. Based on site visits to the island, other historical and cultural resource sites may exist at Holland Island that have not been documented by MHT. A second, larger cemetery exists which contains approximately 50 tombstones; this cemetery has not been documented with MHT. An existing house is located on the western shore of Middle Holland Island. The house is over 100 years old, and its eligibility for inclusion into the National Register of Historic Places has not been determined. Further documentation and coordination with the property owner and MHT would be necessary.

Holland Island is remote and not regularly inhabited with the majority of sounds being from natural sources. Occasional recreational boating and fishing equipment may be heard, and aircraft and artillery may also be occasionally heard due to the proximity of the Bloodsworth Island Naval Reservation. The proposed conceptual designs do not lie

within or adjacent to any federal navigation areas; the closest "prohibited area" being approximately two miles north, near Bloodsworth Island. No Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) liability is anticipated being associated with Holland Island. However, Bloodsworth Island is on the Environmental Protection Agency's Superfund list of hazardous sites, and is currently being investigated. Officials at Naval Air Station (NAS) Patuxent River were contacted prior to completing any drilling work near the Bloodsworth Island boundary. The NAS officials stated that the presence of any unexploded ordnance in the vicinity of Holland Island was highly unlikely.

All of Holland Island is subject to the Maryland Critical Area regulations; however the restoration activities are considered an extension of the existing natural conditions, and are consistent with the intent of the Critical Area Act.

Some short-term effects to water quality may be expected as a result of construction and placement of dredged material. Discharge during dredged material placement and dewatering may temporarily increase turbidity in the surrounding water, however, these effects will be strictly monitored to insure levels are within permitted limits. As the dredged material used in the habitat restoration will be from the channels of the Chesapeake Bay main stem, sediment quality is expected to be good.

There would be little to no impact on the existing vegetation along the western shore of Holland Island because construction will not tie into the current landmass at Holland Island. Herons, egrets and other migratory bird species utilize the marshland and upland habitats, especially on South Holland Island, and may avoid neighboring areas while construction is taking place. The Poplar Island Environmental Restoration Project (PIERP) construction coexisted with heron and eagle habitat through the use of the United States Fish and Wildlife Service (USFWS) and MDNR monitored environmental construction windows and "time of year" restrictions, which inhibit construction during critical time periods for individual species. It is expected that the appropriate agencies will be consulted and agreements will be reached regarding the construction of the Holland Island restoration project, if undertaken.

Although SAV has not been observed on the western shore of Holland Island since 1996, any construction in the shallow depths would displace some shallow water habitat where SAV may potentially grow. Fish and mobile invertebrates are expected to be able to avoid the area during construction, but some may be trapped in the dikes, especially bottom dweller species, and could be lost. Again, it is expected that further consultation with appropriate agencies will be conducted. The project is expected to have an overall benefit on biological resources, as it will increase valuable nursery habitat for many species and protect SAV habitat on the eastern side of the island, as well as stabilizing and protecting the island and its existing wetlands.

Very little recreational and commercial fishing for finfish takes place directly adjacent to Holland Island, so there would be little impact on the fishery. However, MES personnel observed several crab pots along the western shore of Holland Island during the September 27, 2001 site visit. Close coordination with MDNR is recommended

regarding any crabbing activity in the vicinity of Holland Island. No legal oyster bar boundaries exist on the western side of Holland Island, although two traditional named oyster bars may exist. Local watermen have no recent record of oyster bars in this location; however the presence or absence of these historical bars would be determined if the project moves forward.

According to anecdotal information provided by the property owner, two submerged cemeteries (one consisting of only two graves) were located along the western shore of Holland Island. The presence of these cemeteries was not verified during the September 19, 2001 field visit (BAKER, 2001). Consultation with MHT is recommended regarding potential impacts to these cemeteries if the project moves forward. The two cemeteries that were verified during the September 19, 2001 visit exist further upland and east and would not be impacted by the dikes. The existing house located on Middle Holland Island sits directly on the edge of the western shore, and could potentially benefit from the dikes and restoration activities, if it does not give way to erosion before then.

Some viewshed and noise disturbances may occur during construction activities; however this would be temporary and would not affect any human receptors. Impact to navigation is expected to be minimal because very few boats navigate the shallow water adjacent to Holland Island. Groundwater contamination is not expected to be a potential concern, as the dredged material is expected to be clean and not pose a threat to aquifers.

In conclusion, this Environmental Conditions Report documents the findings of various environmental parameters of concern at Holland Island. The increase of habitat to wetland and upland habitat will have an overall benefit to the biological resources in the Holland Island area. The project will promote shoreline stabilization, saving Holland Island from further habitat loss due to erosion. It will also decrease impacts to aquatic habitat from high turbidity and sedimentation caused by the eroding island. Overall, potential impacts to environmental and historical resources as a result of the proposed construction and habitat restoration at Holland Island are expected to be minimal, and may include temporary increases in sedimentation rates, possible burial of abandoned gravesites, and burial of areas historically populated by SAV. Management and design efforts may mitigate some of these potential impacts. Several issues will require further consultation and coordination with appropriate governmental agencies.

CONCEPTUAL STUDY OF HOLLAND ISLAND ENVIRONMENTAL CONDITIONS

1.0 INTRODUCTION AND SITE DESCRIPTION

Holland Island is located off the coast of the southern most part of Dorchester County, Maryland, in the eastern Chesapeake Bay. It is located at the mouth of Holland Strait, approximately two miles south of Bloodsworth Island. Figure 1-1 illustrates the geographical location of Holland Island. Holland Island has been breached over the years in several locations. For the purposes of this study, Holland Island is discussed according to its three distinct landmasses created from the resultant breaching: North Holland Island, Middle Holland Island, and South Holland Island. A private owner purchased the majority of acreage at Holland Island in 1995. The Maryland Department of Natural Resources (MDNR) owns approximately a half-acre of land on the northeast edge of the southern remnant of Holland Island. Two other private parties own a total of approximately 1.25 acres of land at Holland Island (Property ownership documentation, Maryland Environmental Service).

Holland Island was settled in the last decades of the 1600's and reached its peak population between 1890 and 1910. By the 1920's, erosion from the wind and tide forced most residents of Holland Island to relocate to the mainland on the Eastern Shore of Maryland. The island's size has been reduced from approximately 160 acres in 1915 to approximately 87 acres today (www.intercom.net/local/holland). Figure 1-2 depicts the footprint of Holland Island as of July 2001. Figure 1-3 illustrates Holland Island and neighboring islands as they appeared in the *1877 Atlas for District 10 of Dorchester County.*

The water depths directly adjacent to Holland Island are very shallow, ranging from 0.5 to 2.5 feet depending on the tides. The western portion of the island has undergone the most significant impacts of the erosion. The current acreage of each section was estimated by overlaying a current aerial photo (June 2001) over the National Oceanic and Atmospheric Administration (NOAA) charts and scaling to calculate approximate current acreages. North Holland Island is approximately 2.09 acres, Middle Holland Island is approximately 5.51 acres, and South Holland Island is approximately 79.45 acres, for a total of approximately 87.05 acres.

Holland Island was considered as a beneficial use project option under the Maryland Port Administration's (MPA) Dredged Material Management Program (DMMP) after being contacted by the primary landowner. The owner of Holland Island has shown much interest in actively pursuing the beneficial use of dredged materials project. Conceptual designs were developed for two alignments with estimated sizes of 939 and 1,639 acres. The proposed site design would provide 50% wetlands and 50% uplands for both concept designs. The upland dike elevations will be 10 and 20 feet, and all wetland dike elevations will be a maximum of 10 feet. The proposed alignments are to be located along the western shore of Holland Island. Figure 1-4 illustrates the two configurations developed for Holland Island.

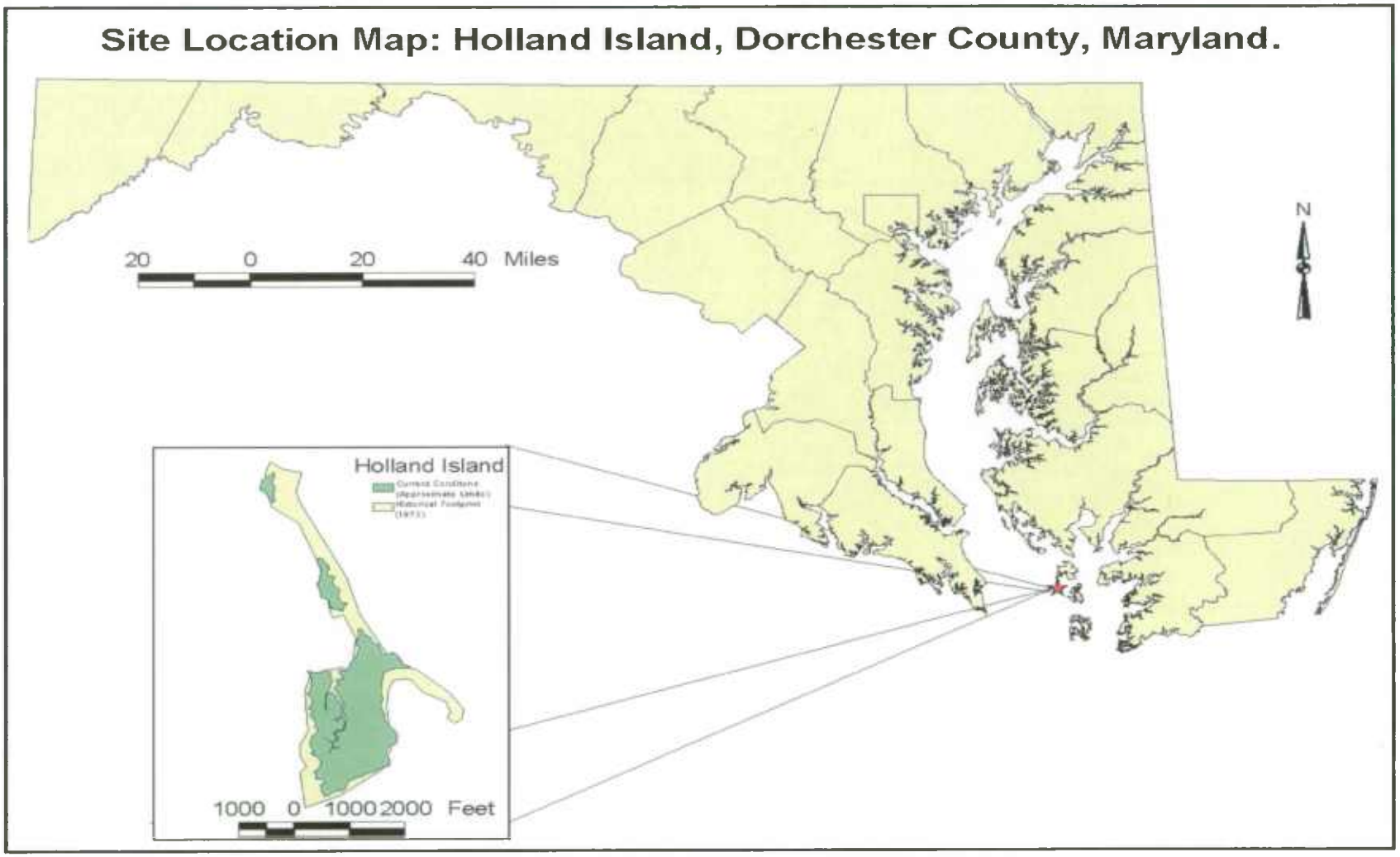

Figure 1-1 Holland Island Vicinity Map

Figure 1-2 Holland Island Footprint, July 2001

Figure 1-3 Holland Island, 1877 Atlas of Dorchester County

In October 2000, the MPA/Maryland Department of Transportation (MDOT) completed a report to the Maryland General Assembly Senate Budget and Taxation Committee and House Appropriations Committee regarding the Governor's Strategic Plan for Dredged Material Management (MPA 2000). The report identified Holland Island as a possible long-term option for dredged material and also provided a preliminary estimate of the costs and capacities associated with a habitat restoration site at Holland Island using dredged material.

This Environmental Conditions report discusses the existing environmental conditions at Holland Island as a result of literature search, site visits, and coordination with local, state, and federal agencies. Potential impacts of the project are assessed, and further investigation needs are included.

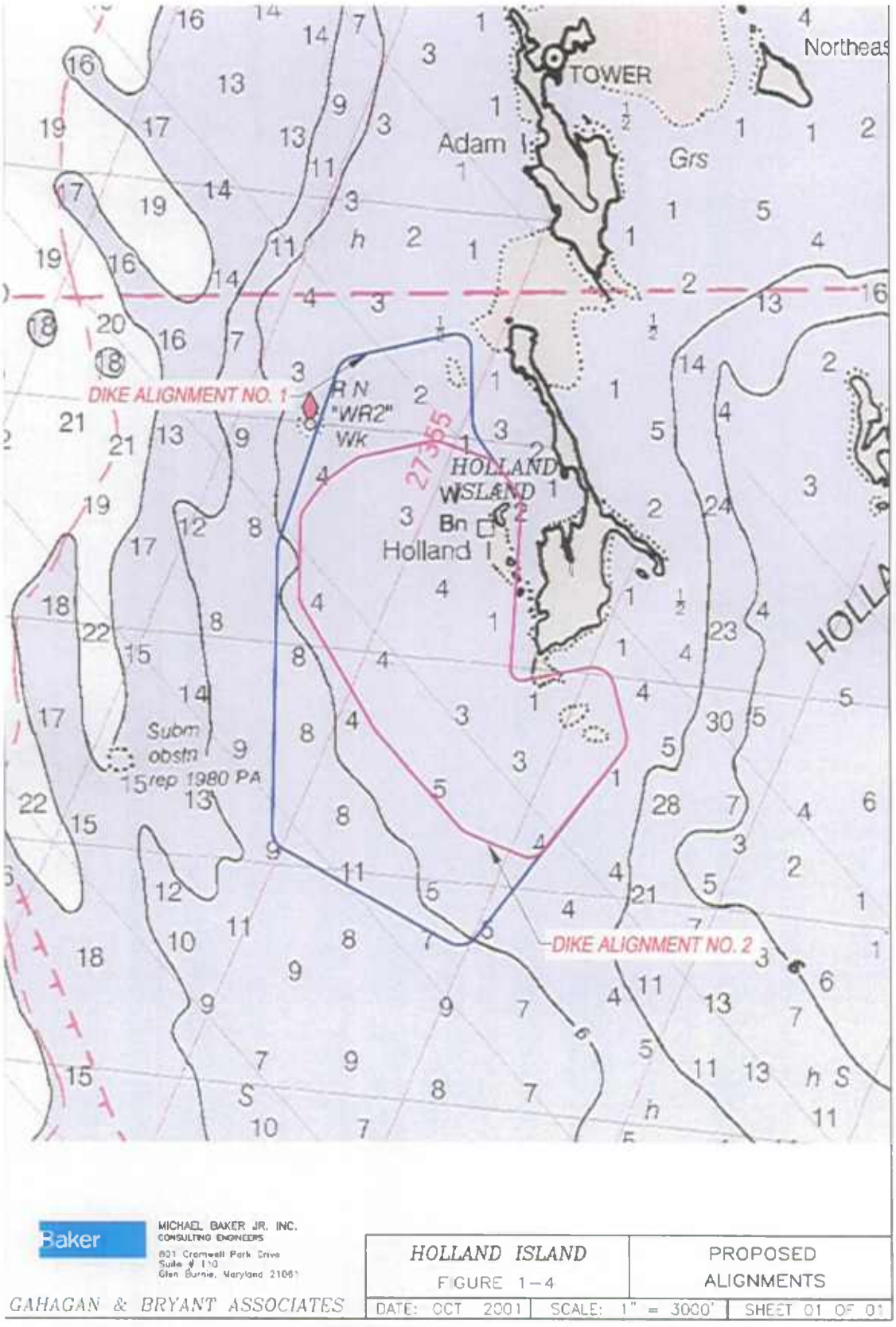

Figure 1-4 Holland Island Proposed Alignments

2.0 HABITAT DESCRIPTION

Holland Island is approximately one and one-half miles long and one-half mile wide. It is losing approximately two acres a year due to erosion (Personal communication, Stephen White). Attempts have been made by the owner of the island to install stone bulkheads, sandbags, etc., to prevent further erosion near the house at the northern end of Middle Holland Island. The majority of vegetation consists of tidal salt marsh grasses and scrub shrub, with occasional stands of larger trees on the higher, upland centers of the island. The largest section of the island is South Holland Island where significant rookeries exist.

North Holland Island is the smallest of the land areas which is made up almost entirely of tidal marsh. There is also a small exposed sandy beach on the eastern shore and a small upland stand of trees. In earlier years, the tree stand was larger, and supported a nesting habitat for heron and osprey. The majority of the island consists of both the tall and short forms of saltmarsh cordgrass (*Spartina alterniflora)*. The two forms of saltmarsh cordgrass can be found in different environments. The tall form, which is greater than 1.5 feet, is typical of a regularly flooded low marsh. The short form, which is less than 1.5 feet, is characteristic of irregularly flooded high marsh (Tiner, 1987). Seaside goldenrod (*Solidago sempervirens*) and common reed (*Phragmites australis*) are prevalent as well. Marsh elders (*Iva frutescens*) surround the southern tip of the island, and several dead trees and stumps are noted in the water at the south and west shores.

Middle Holland Island consists mostly of eroding uplands with a fringe marsh. The majority of the vegetation consists of tidal marsh grasses and scrub shrub. The most prevalent vegetation along the island shore was saltmarsh cordgrass, both the tall and short forms. On slightly higher ground, the dominant scrub shrub vegetation are the marsh elder and the groundsel tree (*Baccharis halimifolia)*. Additionally, wax myrtle (*Myrica cerifera*) and pokeberry (*Phytolacca Americana*) were found. Seaside goldenrod was observed adjacent to the upland areas. In addition, extensive stands of common reed, and black needlerush (*Juncus roemerianus*) were observed along the western/central length of the island. On the west side of the island the habitat from the waters edge included layers of peat and detritus followed by smooth cordgrass, saltmeadow cordgrass, and big cordgrass (*Spartina cynosuroides*) growing in sandy substrate. Salt grass (*Distichlis spicata*) grew among the saltmeadow cordgrass. Patches of phragmites, black needlerush, sweet flag (*Acorus calamus*) and switch grass (*Panicum virgatum*) also occurred in this area. A few red maple trees (*Acer rubrum*) were observed in the upland central part of the island. There was no beach on the western shore of the island; therefore the waves from the Chesapeake Bay pound directly against the marsh grasses. A succulent species identified as sea rocket (*Cakile edentula*) was observed on the southeastern beach area. Sea lettuce (*Ulva lactuca*) was visible beside the existing pier. Widgeon grass (*Ruppia maritima*) was observed sparsely distributed along the eastern shore. Several trees have been planted by the landowner and are protected with wire or plastic buckets around the trunks. The majority of the planted tree species appear to be willow oaks (*Quercus phellos*).

South Holland Island is the largest landmass of the three major sections. The perimeter of the island consists of tidal saltmarsh, while the central, upland area consists of several stands of larger trees. A significant stream/canal system exists throughout the western and central area of the island, and large rookeries are known to exist on both sides of South Holland Island. A dredging machine was located on the northwestern area of the island, and a small floating dock was observed at the entrance to the channel, in the southwestern portion of the island. Some small beach areas exist on the eastern shore of the island, whereas no beach was observed on the western shore. The fringe marsh around the perimeter of the island is made up of *Spartina alterniflora*, short and tall forms. The higher marsh area towards the center of the island is made up of black needlerush, marsh elder, and the groundsel tree. Saltmarsh aster (*Aster tenuifolius*) was found mixed throughout the marsh grass. Other vegetation observed included: Silky dogwood (*Cornus amomum*), salt grass, salt meadow cordgrass (*Spartina patens*), common glasswort (*Salicornia europaea*), American elm (*Ulmus americanus*), and persimmon (*Diospyros virginiana*).

The vegetation, terrestrial wildlife and bird species observed or known to occur at Holland Island were cataloged and summarized in Table 2-1. Site visit reports and photographs are included as Appendices I and II.

Table 2-1 Ecological Inventory of Holland Island

Common Name	Species Name	Vegetation Vegetative Layer	Wetland Indicator Status [1]
Saltmarsh cordgrass	*Spartina alterniflora*	Herbaceous	OBL
Marsh elder	*Iva frutescens*	Scrub shrub	FACW+
Groundsel tree	*Baccharis halimifolia*	Scrub shrub	FACW
Seaside goldenrod	*Solidago sempervirens*	Herbaceous	FACW
Common reed	*Phragmites australis*	Herbaceous	FACW
Black needlerush	*Juncus roemerianus*	Herbaceous	OBL
Red maple	*Acer rubrum*	Tree	FAC
Sea rocket	*Cakile edentula*	Herbaceous	FACU
Widgeon grass	*Ruppia maritima*	Submerged Aquatic Vegetation	N/A
Saltmarsh aster	*Aster tenuifolius*	Herbaceous	OBL
Willow oak	*Quercus phellos*	Tree	FAC+
Silky dogwood	*Cornus amomum*	Scrub shrub	FACW
Salt grass	*Distichlis spicata*	Herbaceous	FACW+
Saltmeadow cordgrass	*Spartina patens*	Herbaceous	FACW+
Persimmon	*Diospyros virginiana*	Tree	FAC-
Common glasswort	*Salicornia europaea*	Herbaceous	OBL
American elm	*Ulmus americanus*	Tree	FACW-
American hackberry	*Celtis occidentalis*	Tree	FACU
Wax myrtle	*Myrica cerifera*	Tree	FAC
Pokeberry	*Phytolacca americana*	Herbaceous	FACU+
Big cordgrass	*Spartina cynosuroides*	Herbaceous	OBL
Sweet flag	*Acorus calamus*	Herbaceous	OBL
Switch grass	*Panicum virgatum*	Herbaceous	FAC
Sea lettuce	*Ulva lactuca*	Algae	N/A
Weeping willow	*Salix babylonica*	Tree	FACW-

Table 2-1 Ecological Inventory of Holland Island (continued)

Birds

Common Name	Species Name
Tundra swan	*Cygnus columbianus*
Warbler	*Protonotaria citrea*
Herring gull	*Larus argentautus*
Great blue heron	*Ardea herodias*
Snowy egret	*Egretta thula*
Greater yellowlegs	*Tringa melanoleuca*
Dunlin	*Calidris alpina*
Brown pelican	*Pelicanus occidentalis*
Osprey	*Pandion haliaetus*
Great egret	*Casmerodius albus*
Tricolored heron	*Egretta tricolor*
Little Blue heron	*Egretta caerulea*
Black-crowned night-heron	*Nycticorax nycticorax*
Yellow-crowned night-heron	*Nycticorax violaceus*
Glossy ibis	*Plegadis falcinellus*
Bald eagle	*Haliaeetus leucocephalus*
Mute Swan	*Cygnus olor*
Cattle egret	*Bubulcus ibis*
Great black gull	*Larus marinus*
Cormorant	*Phalacrocorax auritus*
Northern flicker	*Colaptes auratus*
Green heron	*Butoroides striatus*
Boat tailed gackle	*Quiscalus major*
Black duck	*Anas rubripes*

Reptiles and Amphibians

Common Name	Species Name
Northern diamondback terrapin	*Malaclemys terrapin terrapin*

Other

Common Name	Species Name
Saltmarsh mosquito	*Aedes solicitans*
Fiddler crab	*Uca spp.*
Saltmarsh snail	*Melampus bidentatus*
Monarch butterfly	*Danaus plexippus*
Dragonfly	*Odonata order*

(1) **Indicator Status Categories*:**
OBL-Obligate Wetland-Occur almost always under natural conditions in wetlands
FACW-Facultative Wetland-Usually occur in wetlands
FAC-Facultative-Equally likely to occur in wetlands or non-wetlands
FACU-Facultative Upland-Usually occur in nonwetlands
+ and - indicates frequency toward higher or lower end of category

* Reed, P.B. 1988. National List of Plant Species That Occur in Wetlands: 1988 Virginia. NERC.
N/A = Not Applicable

3.0 WATER AND SEDIMENT QUALITY

3.1 Water Quality

There are many factors influencing water quality in the Chesapeake Bay including land use and population changes. These factors can change due to amounts of fertilizer and urban sewage entering the Bay, and thus affect the quality of the water. The water quality of the Chesapeake Bay has degraded noticeably during the past century, with indicators being decreases in Submerged Aquatic Vegetation (SAV), finfish, shellfish and dissolved oxygen, and increases in sediments.

Maryland's Chesapeake Bay Water Quality Monitoring Program has monitored water quality throughout the Bay since 1984, and a Chesapeake Bay Segmentation Scheme was developed to characterize areas with similar long-term salinity and circulation patterns. The Chesapeake Bay Segmentation Scheme was developed by the Chesapeake Bay Program's Data Analysis Work Group, and was most recently revised in 1998. Figure 3-1 represents the segmentation scheme with the different colors denoting the segments of similar salinity and circulation patterns. Holland Island falls into the Tangier Sound segment; however, data from both Tangier Sound and the Chesapeake Bay monitoring stations provide a good representation of conditions likely to be present at Holland Island.

The locations of the Chesapeake Bay Program water quality monitoring stations are shown in Figure 3-2. The first station, CB5.2, is located approximately eight miles northwest of Holland Island, and lies in the central portion of the Lower Chesapeake Bay mainstem. It is influenced by flow from the Potomac and Patuxent Rivers, which have slightly higher nutrient content in the water as compared to the second station (EE3.1). Salinity ranges from 10 to 17 parts per thousand (ppt) indicating a high mesohaline environment. The second station, EE3.1, is located in the Tangier/Pocomoke Sounds, and is approximately two miles northeast of Holland Island. Salinity patterns are similar to the adjacent waters of the lower Chesapeake Bay mainstem. The water depth here is shallower than the mainstem, thus light is able to penetrate the water. Table 3-1 lists the average pH, conductivity and salinity from the two Chesapeake Bay Program Monitoring Stations during the years 1995 through 2000. These samples were taken at a depth of 0.5 meters, which is comparable to the depth of the water samples taken at Holland Island.

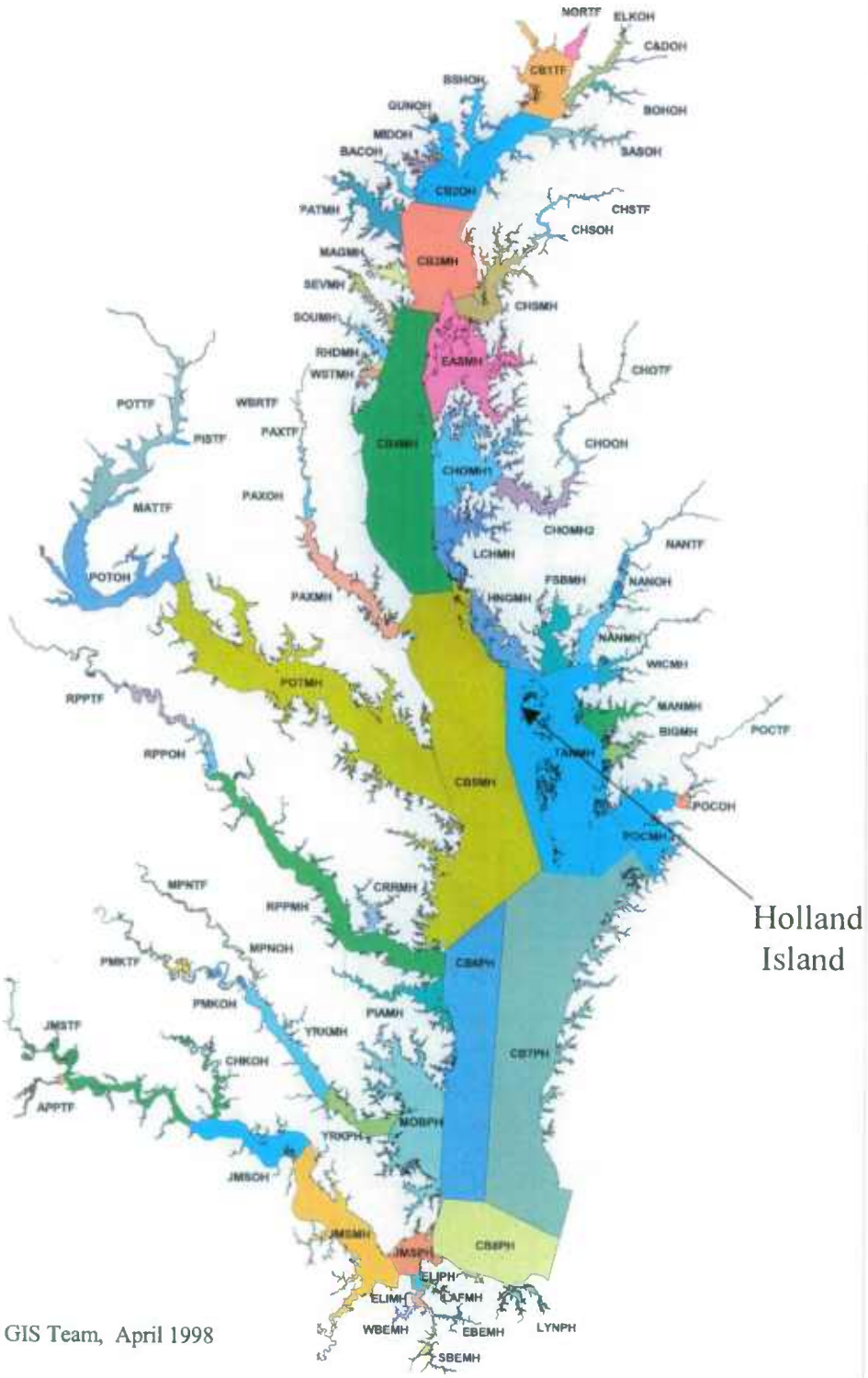

Figure 3-1 Chesapeake Bay Segmentation Scheme

Map from Chesapeake Bay Program Website: www.chesapeakebay.net

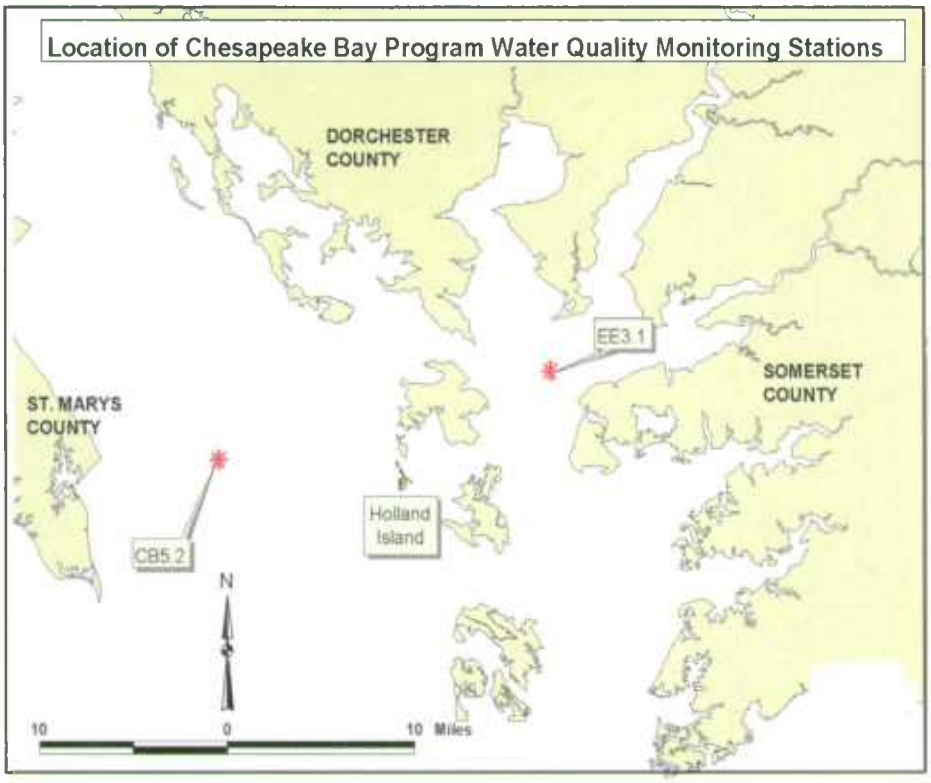

Figure 3-2 Location of Chesapeake Bay Program Water Quality Monitoring Stations

Table 3-1 Chesapeake Bay Program, Water Quality Data for CB5.2 & EE3.1 At Depth of 0.5 Meters

Station	Year	Average pH	Average Conductivity (mS/cm)	Average Salinity (ppt)	Average Temp (Deg C)
CB5.2	1995	8.13	26.87	16.35	17.22
CB5.2	1996	8.19	18.16	10.55	17.47
CB5.2	1997	8.24	22.65	13.52	14.49
CB5.2	1998	8.37	19.76	11.65	19.01
CB5.2	1999	8.24	26.72	16.25	17.95
CB5.2	2000	8.20	24.05	14.46	17.44
EE3.1	1995	7.90	27.36	16.68	17.88
EE3.1	1996	7.90	19.76	11.58	17.66
EE3.1	1997	7.90	21.96	12.96	16.76
EE3.1	1998	7.90	20.06	12.33	18.29
EE3.1	1999	7.80	26.60	16.16	14.13
EE3.1	2000	7.90	24.72	14.89	15.69

During the site visit to Holland Island on September 19, 2001, four water samples were collected. Figure 3-3 illustrates the water sample locations. Table 3-2 describes where the samples were collected, the key parameters tested, and the results of this testing.

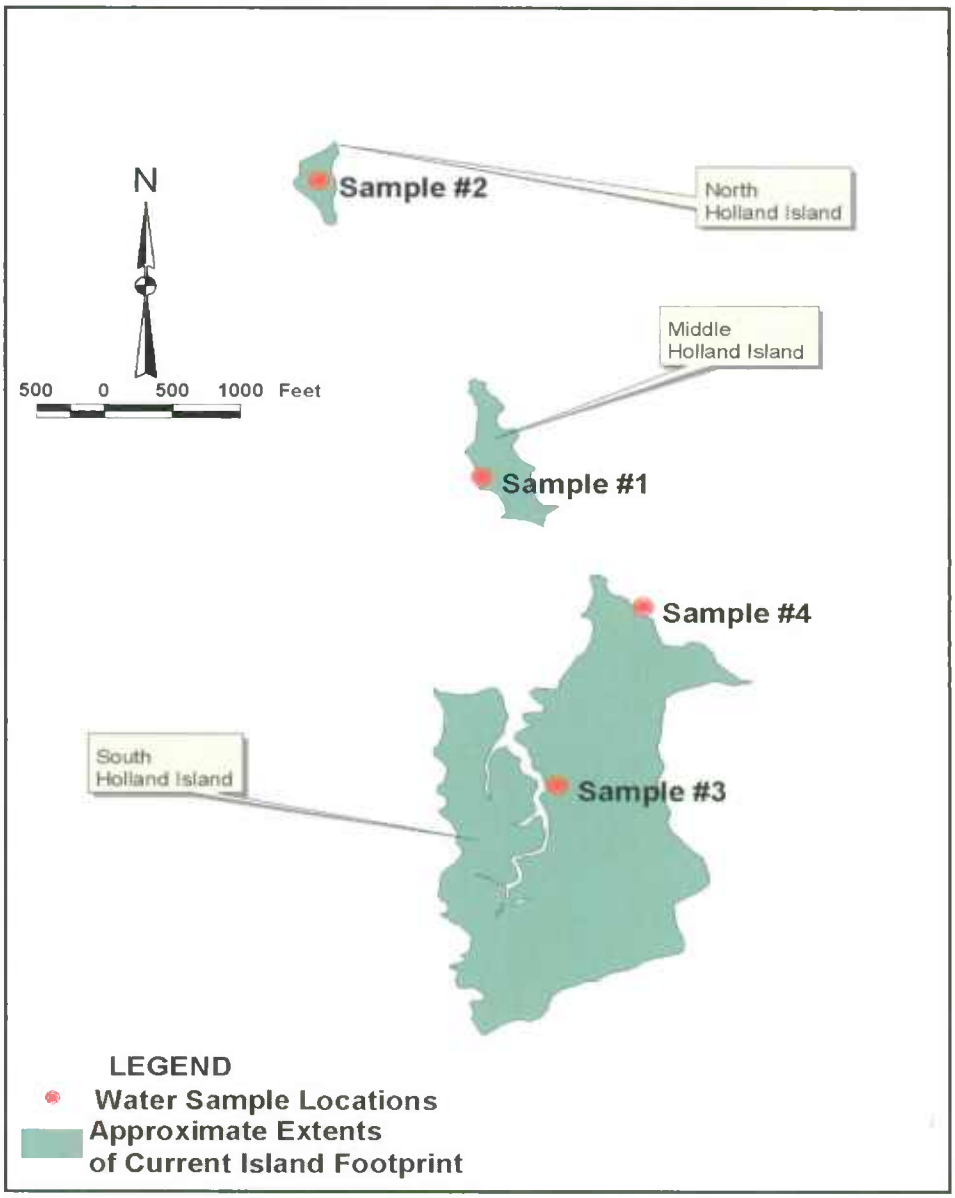

Figure 3-3 Location of Water Samples taken September 19, 2001

Table 3-2 Water Samples Collected at Holland Island, September 19, 2001

Sample Number	Location	pH	Conductivity (mS/cm)	Salinity (ppt)
1	Western Side of Middle Holland Island	7.34	27.49	16.80
2	Standing Water in Middle of North Holland Island	7.50	28.36	17.40
3	South Holland Island, Center where Channel Bisects Island	7.60	27.77	17.00
4	Northern tip of South Holland Island	8.12	27.72	17.00

Samples collected at Holland Island show salinity levels of approximately 17 ppt, which is indicative of a high mesohaline environment. It should also be noted that salinity varies seasonally with levels being lower in the spring and higher in the summer and fall. Many plant and animal species live within a restricted salinity range and therefore the salinity levels will determine the type of species occurring in any given area. Both monitoring stations CB5.2 and EE3.1 and the samples collected at Holland Island reflect the high mesohaline environment expected at this location.

Dissolved Oxygen (DO) is essential for survival of biological organisms and a DO value of greater than 5.0 mg/L is required for fish and shellfish viability. Although no DO levels were recorded at Holland Island, the Chesapeake Bay Program monitoring stations reflect DO levels of 9.5 mg/L in the mainstem (CB5.2) and 8.5 mg/L at the tributary station (EE3.1). These results suggest that the environment surrounding Holland Island would support the development of fish and shellfish habitats as well as increased SAV growth.

Water temperature can affect many characteristics of the Bay including how much oxygen can be dissolved into the water, the metabolic rates for species living in the Bay, and the rate of photosynthesis for plants. On average, the temperatures at both Chesapeake Bay Program monitoring stations has been 17.0° C during the five-year sampling period investigated, indicating that temperatures for Holland Island would be similar.

Conductivity is a measure of the ability of water to pass an electrical current. It is generally a measure of total dissolved solids in the water, usually consisting of sulphates, bicarbonates, and chlorides of calcium, magnesium and sodium. Conductivity measurements at Holland Island averaged 27.8 milliSiemens per centimeter (mS/cm), compared to the 6 year average at CB5.2 of 27.5 mS/cm and EE3.1 of 24.4 mS/cm. These measurements are consistent with the range of conductivity in a coastal bay region. The pH levels can determine the type of organism inhabiting a particular area. Most organisms have adapted themselves to specific pH levels and are sensitive to changes within their environment. Samples taken at Holland Island during the site visit show a average pH level of 7.6 which is just slightly above neutral. For both of the Chesapeake

Bay Program monitoring stations, the five-year trend shows pH levels remaining consistent with average readings of 8.2 for CB5.2 and 7.9 for EE3.1. These data indicate that no adverse effects on living resources would have occurred as a result of major changes in pH levels.

The Chesapeake Bay Water and Habitat Quality Monitoring Program also maintains water quality status and trends for stations in the Chesapeake Bay. Status is a measure of current condition and stations are given a ranking of "good", "fair" or "poor". The data show that nutrients (total nitrogen and total phosphorus), algae abundance (measured by chlorophyll a presence), and total suspended solids at stations EE3.1 and CB5.2 ranked in the highest category of "good", with the exception of total nitrogen at station EE3.1 and chlorophyll a at CB5.2 which were ranked "fair". These rankings were based on data collected from 1998 to 2000 (http://www.chesapeakebay.net/status/map-tidal1.cfm http://www.dnr.state.md.us/bay/tribstrat/low_east/les_status_trends.html).

Nutrient levels in tidal waters, especially nitrogen and phosphorous, play an important role in water quality, due to their role in the stimulation of algal growth. Excess amounts of phosphorus and nitrogen cause rapid growth of algae, creating dense populations or blooms. When algae die they fall to the bottom sediment where decomposition occurs and results in oxygen depletion or hypoxia. Algal abundance is estimated by measuring active chlorophyll a. Data on nutrients and productivity (chlorophyll a) from station CB5.2 and EE3.1 are presented in Table 3.3, for 1999. Chlorophyll a increased during the months of March through May and again in September for CB5.2 and in March, August and November at station EE3.1. None of the remaining nutrients studied exhibited any type of seasonal patterns.

Table 3-3 Summary of Nutrient Conditions at Stations CB5.2 and EE3.1 at Depth 0.5

Sample Month	Station	Chlorophyll a (ug/L)	Particulate Carbon (mg/L)	Particulate Nitrogen (mg/L)	Particulate Phosphorous (mg/L)	Total Dissolved Nitrogen (mg/L)	Total Dissolved Phosphorous (mg/L)
January	CB5.2	4.261	0.763	0.131	0.011	0.390	0.014
February	CB5.2	4.112	0.587	0.096	0.008	0.390	0.010
March	CB5.2	10.280	1.040	0.164	0.016	0.475	0.009
April	CB5.2	13.083	1.740	0.206	0.010	0.580	0.007
May	CB5.2	10.018	1.370	0.198	0.010	0.455	0.009
June	CB5.2	9.420	1.700	0.227	0.011	0.455	0.013
July	CB5.2	5.046	1.265	0.210	0.017	0.505	0.013
August	CB5.2	8.037	1.070	0.189	0.014	0.335	0.017
September	CB5.2	11.513	1.100	0.202	0.011	0.340	0.014
October	CB5.2	5.888	0.757	0.145	0.010	0.345	0.011
November	CB5.2	4.187	1.000	0.158	0.007	0.355	0.014
December	CB5.2	6.579	0.908	0.166	0.009	0.390	0.014
January	EE3.1	5.830	0.675	0.116	0.011	0.350	0.011
February	EE3.1	4.340	1.040	0.151	0.011	0.420	0.009
March	EE3.1	11.364	1.920	0.300	0.024	0.830	0.010
April	EE3.1	6.728	1.310	0.249	0.016	0.740	0.010
May	EE3.1	4.735	0.754	0.148	0.010	0.490	0.013
June	EE3.1	7.177	1.440	0.232	0.016	0.380	0.012
August	EE3.1	15.251	1.510	0.301	0.023	0.390	0.015
September	EE3.1	6.878	0.944	0.171	0.020	0.570	0.016
October	EE3.1	6.479	0.803	0.160	0.020	0.430	0.014
November	EE3.1	10.253	1.120	0.174	0.025	0.420	0.013
December	EE3.1	6.579	1.240	0.214	0.022	0.430	0.012

3.2 Sediment Quality

Holland Island lies within the Atlantic Coastal Plain Physiographic Province of Maryland. In the immediate vicinity of Holland Island, the Coastal Plain sediments are approximately 4,000 feet thick (Rasmussen & Slaughter, 1957). Soils in Dorchester County are sandy loams, silty loams and clay loams. In the vicinity of Holland Island, soils are brackish and waterlogged. Since the natural drainage of these soils is not sufficient to carry off excess precipitation, water is retained and results in high water tables with saturated soil zones.

During the past 100 years, sedimentation rates increased as a result of changes in land use and stresses imposed by populations within the watershed. This has had a disruptive effect on the Bay's health where sedimentation can cloud the water enough to disrupt living resources habitats and the growth of SAV.

Sediments in the area around Holland Island are a mixture of sand, silt and clay. Boring samples taken in October 2001 at specified sites on the western side of the island show that the predominant type of substrate is silty sand at the top of the borings with silty clay occurring at the bottom of the borings at approximately forty-five feet below the water surface (E2CR, 2002). These data suggest that the sediments on the west side of Holland Island would consist of silty sands overlaying a bottom layer of silty clay.

Holland Island itself has been subject to considerable erosion. From aerial photographs, provided by the MPA and taken in July of 2001, it appears that there is sediment movement from north to south and to the east (see Appendix I, Photograph 19). A sediment plume is apparent on the southeastern portion of the South Holland Island. According to the preliminary coastal analysis, the predominant longshore transport rate for westward facing beaches occur to the south. For north facing beaches, the predominant longshore transport rate is to the east. Both of these transports are due to dominant waves from the northwest (Offshore & Coastal Technologies, Inc.-East Coast, 2002).

Sediments serve as a source for holding natural materials as well as contaminants that can adhere to fine particles. Disturbance through construction, dredging, or storm events could re-mobilize contaminants that may be currently present, and particulates from the sediment into the water column. Nutrients, especially phosphorous, are adsorbed to sediment particles. When the sediments are disturbed, the phosphorous is released and becomes a food source for various forms of algae, thus resulting in algal blooms.

Toxic contamination would only be a factor if the site were directly adjacent to a contaminant source. The Bloodsworth Island Naval Reservation that has been used as a bombing range in past years is located approximately two miles north of Holland Island. It is not likely that contaminants from the Naval Reservation are currently affecting sediments adjacent to Holland Island. However, baseline monitoring and sampling should be completed to document existing conditions should the study move forward.

An overall review of Chesapeake Bay sediment quality was performed between 1984 and 1981. This study, performed by the Chesapeake Bay Program, found that Baltimore Harbor, Anacostia River, and South Elizabeth River had the highest and most variable trace metal concentrations. The studied water segments around Holland Island (Lower Eastern shore, and mid-Chesapeake Bay) showed the lowest sediment trace metal concentrations. (Eskin, et al. 1996). Holland Island is not near an urbanized area, and it is not expected to contain high concentrations of contaminants.

4.0 Biological Resources

4.1 Fish

Many finfish and shellfish species provide valuable commercial and recreational fisheries resources in the Chesapeake Bay region. A list of species that occur in the mid-Chesapeake Bay, mesohaline region (which includes Holland Island) is included in Table 4-1.

Common fish species in the Holland Island vicinity include the Atlantic menhaden (*Brevoortia tyrannus*), white perch (*Morone americana*), striped bass (*Morone saxatilis*), spot (*Leiostomus xanthurus*), and weakfish or gray seatrout (*Cynoscion regalis*).

The Atlantic menhaden is found in coastal and estuarine waters from Nova Scotia to northern Florida. It is an important feeder fish for striped bass, bluefish, seatrouts, and other large fish. Menhaden are common in all salinities of the Chesapeake Bay during spring, summer and fall. During the winter most menhaden migrate south. Menhaden spawn in the ocean and larvae appear in the Chesapeake Bay in large numbers during May and June. The larvae use brackish and fresh waters as nursery areas, and once they are juveniles they inhabit widespread areas of the estuary.

White perch frequent areas with level bottoms of compact silt, mud, sand or clay, and prefer waters of less than 18 percent salinity. They are year-round residents of the Chesapeake Bay, spending winters in the deeper channels. White perch spawn in the spring in waters of low salinity, and the juveniles use the shore margins of the spawning area as nursery habitat.

Striped bass spend most of their adult lives in the ocean, but migrate up rivers and streams to spawn. Eggs and larvae spend up to three years maturing in the Chesapeake Bay estuary. Juveniles move downstream to areas of higher salinity. Mature striped bass can be found in and around a variety of inshore habitats, including areas off sandy beaches and along rocky shorelines, in shallow water or deep trenches, and in the open Bay.

Spot swim in coastal and estuarine waters along the east coast. The area of greatest abundance occurs from the Chesapeake Bay to South Carolina. Spot have one of the most extensive distributions of any marine-estuarine fish species in the Bay. Adult spot migrate into estuarine areas in the spring, and move offshore in the fall to spawn. Larvae grow rapidly in warm, offshore waters and move into estuarine areas from late fall to early spring. Low salinity areas of bays and tidal creeks comprise the primary nursery habitat for juvenile spot, as well as eelgrass communities.

Weakfish or gray seatrout are often found near the periphery of eelgrass beds. Adult weakfish frequent shallow sandy bottom areas with salinities above 10 percent. The Chesapeake Bay provides feeding areas and spawning grounds for adult weakfish and is an important nursery area for juveniles. Weakfish spawn near the mouth of the

Chesapeake Bay from April to June. Larvae are found throughout the lower Bay in late summer and juveniles grow in the tributaries. Mature fish move into more saline waters.

The 1996 amendments to the Magnuson-Stevens Fishery Conservation and Management Act set forth the Essential Fish Habitat (EFH) provisions to identify and protect important habitats of federally managed fish species. Congress defined EFH as "those waters and substrate necessary to fish for spawning, breeding, feeding or growth to maturity." Federal agencies that fund, permit, or undertake activities that may adversely affect EFH are required to consult with the National Marine Fisheries Service (NMFS).

In utilizing the tool provided on the NFMS/EFH website, (www.nero.nmfs.gov/ro/doc/md1.html), it was determined that Holland Island exists within a general area that included EFH for nine species. These species are: windowpane flounder (*Scothalmus aquosus*), bluefish (*Pomatomus saltatrix*), Atlantic butterfish (*Peprilus triacanthus*), summer flounder (*Paralicthys dentatus*), black sea (*Centropristus striata*), king mackerel (*Scomberomorus maculates*), Spanish mackerel (*Scomberomorus maculates*), cobia (*Rachycentron canadum*), and red drum (*Sciaenops occelatus*). Table 4-2 lists these EFH species and their seasonal frequency and life stage present in the Holland Island vicinity.

Windowpane flounder inhabit estuaries and near-shore waters. They are mainly caught as a bycatch in bottom trawl fisheries due to their preference for sand and silty sand substrates. The silty sand substrate in the Holland Island vicinity is likely habitat for windowpane flounder. Spawning occurs throughout most of the year, peaking in the summer months. Windowpane generally migrate to deeper offshore waters to overwinter. Both juveniles and adults are common in the mainstem of the Chesapeake Bay and Tangier Sound, mesohaline areas of salinity less than 25 ppt (EFH Source Document, September 1999).

The bluefish range is the western North Atlantic Ocean, from Nova Scotia to the Gulf of Mexico. They are found both offshore and nearshore traveling in schools. Bluefish migrate seasonally, moving farther south in the fall. Spawning generally occurs in the spring and summer months in the ocean. Adults are not typically bottom feeders and are strong swimmers that can easily avoid turbid conditions; juveniles prefer shallow waters (EFH Source Document, September 1999). The shallow waters in the Holland Island vicinity are likely habitat for juvenile bluefish.

Atlantic butterfish range from Newfoundland to Florida, but are most abundant from the Gulf of Maine to Cape Hatteras. They winter near the edge of the continental shelf in the Middle Atlantic Bight. During the summer, butterfish occur over the entire mid-Atlantic shelf including sheltered bays and estuaries. Early stage butterfish eggs have been collected from the lower portions of the Chesapeake Bay. Butterfish begin spawning in the Chesapeake Bay as early as late May, with peak activity in June and July (EFH Source Document, September 1999). It is possible that butterfish spawning takes place within the Holland Island vicinity.

The geographical range of summer flounder includes the shallow estuarine waters and outer continental shelf from Nova Scotia to the Gulf of Mexico, with the abundance ranging from Massachusetts to North Carolina. Summer flounder exhibit strong migratory behavior, with adult and juveniles normally inhabiting shallow coastal waters during warmer months, and remaining in the ocean during fall and winter. Summer flounder are more common in the deep channels of the lower Bay than in the upper Bay. SAV, including widgeon grass is considered a habitat area of particular concern (HAPC) for adult and juvenile summer flounder. The NMFS defines HAPC for summer flounder as "all native species of macroalgae, seagrasses, and freshwater and tidal macrophytes in any size bed, as well as loose aggregations, within adult and juvenile summer flounder EFH" (EFH Source Document, September 1999 and www.nero.nmfs.gov). Documented widgeon grass beds at Holland Island are most likely considered HAPC for summer flounder.

The black sea bass is a warm temperature species that is usually associated with structured habitats such as reefs, oyster beds and shipwrecks on the continental shelf. It occurs from southern Nova Scotia to southern Florida. Eggs and larvae are believed to settle in coastal waters and move into estuarine or sheltered coastal nursery areas as juveniles. Adults are found slightly deeper than juveniles and summer in coastal areas usually near structured habitats. The black sea bass begins to migrate south and offshore in the fall to wintering areas in deeper waters (EFH Source Document, September 1999). The presence of this species in the Holland Island vicinity is not likely due to a lack of structured habitats in the area.

King mackerel adults occur in warm open ocean waters while juveniles occur further near shore in bays and estuaries. They range from the Gulf of Maine to the Gulf of Mexico but are most commonly found from the Chesapeake Bay southward. Visits to the Chesapeake by adults are generally confined to the middle and lower bay. They are often found near shore, among reefs, wrecks, and other underwater structures. King mackerel are migratory, preferring water temperatures over 68° F. Spawning occurs from May through October. The presence of this species in the Holland Island vicinity is unlikely (Chesapeake Bay Program website: http://www.chesapeakebay.net/baybio.htm).

Spanish mackerel live in the coastal waters of the western Atlantic Ocean with the same range as the King mackerel. They prefer shallow coastal ocean waters, but they freely enter tidal estuaries. They are rarely in waters below 64° F. Spanish mackerel is a common visitor to the Chesapeake Bay from spring to autumn, sometimes swimming as far north as the mouth of the Patuxent River. Spawning occurs off the coast of Virginia, between late spring and late summer. The presence of this species in the Holland Island vicinity is unlikely (http://www.chesapeakebay.net/baybio.htm).

Cobia live in the open ocean, and are sometimes found near shore around barrier islands and coral reefs. Their range is from the Mid-Atlantic States to Argentina, and they are rarely found as far north as Massachusetts. Cobia migrate to overwintering grounds near the Florida Keys, and to more northerly spawning/feeding grounds in the summer months. Adult and juvenile cobia have been caught as far north up the Chesapeake Bay as

the Tangier Sound, and may be found in the Holland Island vicinity. Eggs and larvae are frequently observed in Chesapeake Bay waters in the summer (Virginia Institute of Marine Science website www.vims.edu/adv/cobia/history).

Red drum are found from the Gulf of Maine to northern Mexico, but are most commonly found south of the Chesapeake Bay. Adult red drum occur in the Chesapeake from May through November and are abundant in the spring and fall near the Bay mouth. A red drum population has been noted as far north as the Patuxent River. During mild winters red drum may overwinter in the Bay, but adults and juveniles normally migrate offshore and southward in the winter and inshore in the spring. Spawning occurs in near shore coastal waters, along beaches and near inlets from late summer to mid fall. Eggs spawned in the ocean are carried by currents into estuaries where they hatch. The presence of this species in the Holland Island vicinity is unlikely (Chesapeake Bay Program Red Drum Management Plan).

Official consultation with the NMFS regarding EFH is recommended before any restoration or stabilization activities begin.

Table 4-1 Finfish Species Distribution in Mesohaline Area of Chesapeake Bay

Common Name	Scientific Name	Common Name	Scientific Name
Bull shark	*Carcharhinus leucas*	Dusky pipefish	*Syngnathus floridae*
Sandbar shark	*Carcharhinus plumbeus*	Northern pipefish	*Syngnathus fuscus*
Smooth dogfish	*Mustelus canis*	White perch	*Morone americana*
Spiny dogfish	*Squalus acanthias*	Striped bass	*Morone saxatilis*
Clearnose skate	*Raja eglanteria*	Black sea bass	*Centropristis striata*
Southern stingray	*Dasyatis americana*	Pumpkinseed	*Lepomis gibbosus*
Bluntnose stingray	*Dasyatis say*	Bluegill	*Lepomis macrochirus*
Cownose ray	*Rhinoptera bonasus*	Yellow perch	*Perca flavescens*
Shortnose sturgeon	*Acipenser brevirostrum*	Bluefish	*Pomatomus saltatrix*
Atlantic sturgeon	*Acipenser oxyrhynchus*	Cobia	*Rachycentron canadum*
American eel	*Anguilla rostrata*	Silver perch	*Bairdiella chrysoura*
Blueback herring	*Alosa aestivalis*	Spotted seatrout	*Cynoscion nebulosus*
Hickory shad	*Alosa mediocris*	Weakfish	*Cynoscion regalis*
Alewife	*Alosa pseudoharengus*	Spot	*Leiostomus xanthurus*
Atlantic menhaden	*Brevoortia tyrannus*	Atlantic croaker	*Micropogonias undulatus*
Gizzard shad	*Dorosoma cepedianum*	Black drum	*Pogonias cromis*
Bay anchovy	*Anchoa mitchilli*	Red drum	*Sciaenops ocellatus*
Inshore lizardfish	*Synodus foetens*	Striped mullet	*Mugil cephalus*
Oyster toadfish	*Opsanus tau*	White mullet	*Mugil curema*
Skilletfish	*Gobiesox strumosus*	Northern stargazer	*Astrocopus guttatus*
Red hake	*Urophycis chuss*	Striped blenny	*Chasmodes bosquianus*
Spotted hake	*Urophycis regia*	Feather blenny	*Hypsoblennius hentz*
Halfbeak	*Hyporhamphus unifasciatus*	Naked goby	*Gobiosoma bosc*
Atlantic needlefish	*Strongylura marina*	Seaboard goby	*Gobiosoma ginsburgi*
Sheepshead minnow	*Cyprinodon variegatus*	Green goby	*Microgobius thalassinus*
Banded killifish	*Fundulus diaphanus*	Harvestfish	*Peprilus alepidotus*
Mummichog	*Fundus heteroclitus*	Butterfish	*Peprilus triacanthus*
Striped killifish	*Fundulus majalis*	Northern searobin	*Prinonotus carolinus*
Rainwater killifish	*Lucania parva*	Summer flounder	*Paralichthys dentatus*
Mosquitofish	*Gambusia holbrooki*	Windowpane	*Scophthalmus aquosus*
Rough silverside	*Membras martinica*	Winter flounder	*Pleuronectes americanus*
Inland silverside	*Menidia beryllina*	Hogchoker	*Trinectes maculatus*
Atlantic silverside	*Menidia menidia*	Orange filefish	*Aluterus schoepfi*
Fourspine stickleback	*Apeltes quadracus*	Northern puffer	*Sphoeroides maculatus*
Threespine stickleback	*Gasterosteus aculeatus*	Striped burrfish	*Chilomycterus schoepfi*
Lined seahorse	*Hippocampus erectus*		

Source: Lippson and Lippson, Life in the Chesapeake Bay, 1997.

Table 4-2 Essential Fish Habitat Species, Seasonal Frequency and Life Stages in Holland Island Vicinity

EFH Species	Life Stage Present in Holland Island Vicinity*	Seasonal Distribution in Holland Island Vicinity
Windowpane flounder	J, A	Spring, Summer
Bluefish	J,A	Spring, Summer, Fall
Atlantic butterfish	E, L, J, A	Summer
Summer flounder	J, A	Spring, Summer, Fall
Black sea bass	J, A	Summer
King mackerel	J, A	Summer (Occasional)
Spanish mackerel	J, A	Spring, Summer, Fall (Occasional)
Cobia	J, A	Summer
Red drum	J, A	Fall

* E = eggs, L = larvae, J = juveniles, A = adults
Source: Essential Fish Habitat Source Documents: September 1999.

4.2 Benthos

Benthic macroinvertebrates are organisms that live on or within the bottom sediments of aquatic environments. They are a vital food source for crabs and many types of fish that are essential to the economic value of the Chesapeake Bay. Benthic macroinvertebrates are used as biological indicators because they are reliable and sensitive indicators of habitat quality in aquatic environments and are ecologically important components of the Chesapeake Bay's food web. Degradation in the benthic community is caused by stresses such as DO depletion, nutrient loading, erosion, and toxic contamination. When one or more of these stresses is present in a benthic community, only pollutant tolerant species remain, reducing the quantity and diversity of that community. A typical healthy benthic community in the Chesapeake Bay would include a diverse range of species such as clams, oysters, small crustaceans, and worms varying in size, age, and quantity.

The Chesapeake Bay Long-Term Benthic Monitoring Program measures water quality, sediment quality, and the abundance and richness of benthic invertebrates. The program is supported by a partnership among MDNR, the Virginia Department of Environmental Quality, and the U.S. EPA Chesapeake Bay Program. Long-term benthic monitoring has been part of Maryland's ecological monitoring program for the Chesapeake Bay since 1984.

The long-term benthic sampling program has two components. Probability samples are collected during the summer at 150 randomly selected sites in six major regions of the Chesapeake Bay mainstem and tributaries in Maryland. Results from the probability sampling component are used to characterize the number of acres in the Maryland portion of the Bay that meet the Chesapeake Bay Benthic Restoration Goals, which define a healthy benthic macroinvertebrate community. The second component of the program

samples 27 fixed sites to evaluate long-term trends in benthic communities to evaluate responses to improved water quality conditions.

The Long-Term Benthic Monitoring and Assessment Comprehensive Report, prepared by Versar, Inc for MDNR, was reviewed for information relevant to Holland Island. The fixed benthic monitoring stations nearest to Holland Island are located in the Maryland Chesapeake Bay mainstem near Calvert Cliffs, and in the Nanticoke River. The two stations located near Calvert Cliffs are considered "good" status, with the trend direction improving from 1987 to 1999. The station in the Nanticoke River indicated degrading benthic conditions. All of these fixed monitoring sites are located approximately 10-30 miles from Holland Island and probably do not accurately reflect the benthic conditions there. There has not been a fixed benthic monitoring site located at Holland Island since before 1984. A review of the random benthic monitoring sites from 1999 indicates that the closest station to Holland Island (Hooper Straits, north of Bloodsworth Island) met the Chesapeake Bay Benthic Community Restoration Goals (Versar, 2000).

4.3 Submerged Aquatic Vegetation

SAV are rooted aquatic plants which grow in the shallow shoreline areas throughout the Chesapeake Bay. They provide food and shelter for many animals of the estuary, as well as stabilize bottom sediments and dampen the effects of waves. SAV is most abundant during warmer months, and generally die back in many areas during the winter. SAV is considered a HAPC for both juvenile and adult summer flounder. Based on survey data, there has been a decline in recent decades in the amount and variety of SAV in the Chesapeake Bay. The Virginia Institute of Marine Science (VIMS) has established a program for restoring and monitoring SAV. An annual SAV survey using aerial photographs and United States Geological Survey (USGS) 7.5 minute quadrangles is conducted by VIMS. For Holland Island, the two quadrangles, Bloodsworth Island (#83) and Kedges Straits (#91) are used.

Figure 4-1 illustrates the abundance and type of SAV noted around Holland Island from the years 1984 to 2000. There was no occurrence of SAV at Holland Island during 1997 and 1998 and no information available for 1988. Therefore no maps are provided for these years. The most detailed current information for SAV at Holland Island is from the 2000 VIMS survey. The 2001 data is preliminary, however the initial field reports show a similar distribution as 2000. According to VIMS data, the most common type of SAV found around Holland Island is widgeon grass (*Ruppia maritima*). Recent survey data (1999-2001) has shown that it is growing along the eastern shore of the island only.

During the September 19, 2001 site visit, SAV was observed on the eastern edges of North and Middle Holland Island. Small patches of widgeon grass were observed off the eastern shore of North Holland Island, while more extensive beds of widgeon grass were observed along the eastern shore of Middle Holland Island, especially around the existing pier.

SAV distribution data for the years 1971-2000 is summarized on the VIMS website (www.vims.edu/bio/sav/quadtots.html). In general, SAV beds around Holland Island appear to have experienced a sharp decline since 1992. SAV was distributed around almost the entire perimeter of Holland Island in 1992, with the densest distribution along the northeast half of Holland Island. The total acres of SAV in 1992 were approximately 1,379. Figure 4-2 illustrates the SAV distribution trends over 1984-2000 adjacent to Holland Island.

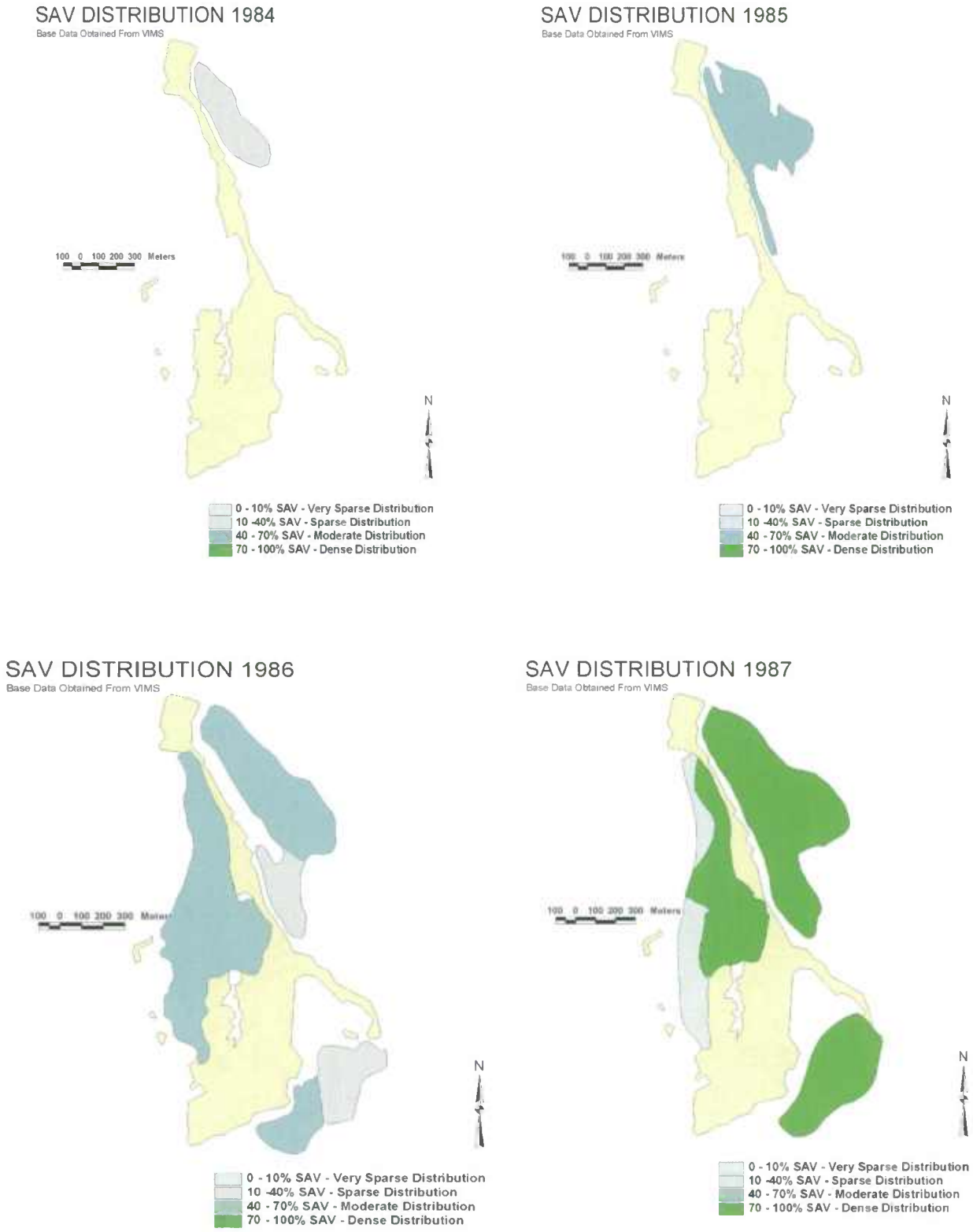

Figure 4-1 Submerged Aquatic Vegetation Adjacent to Holland Island (1984-2000)

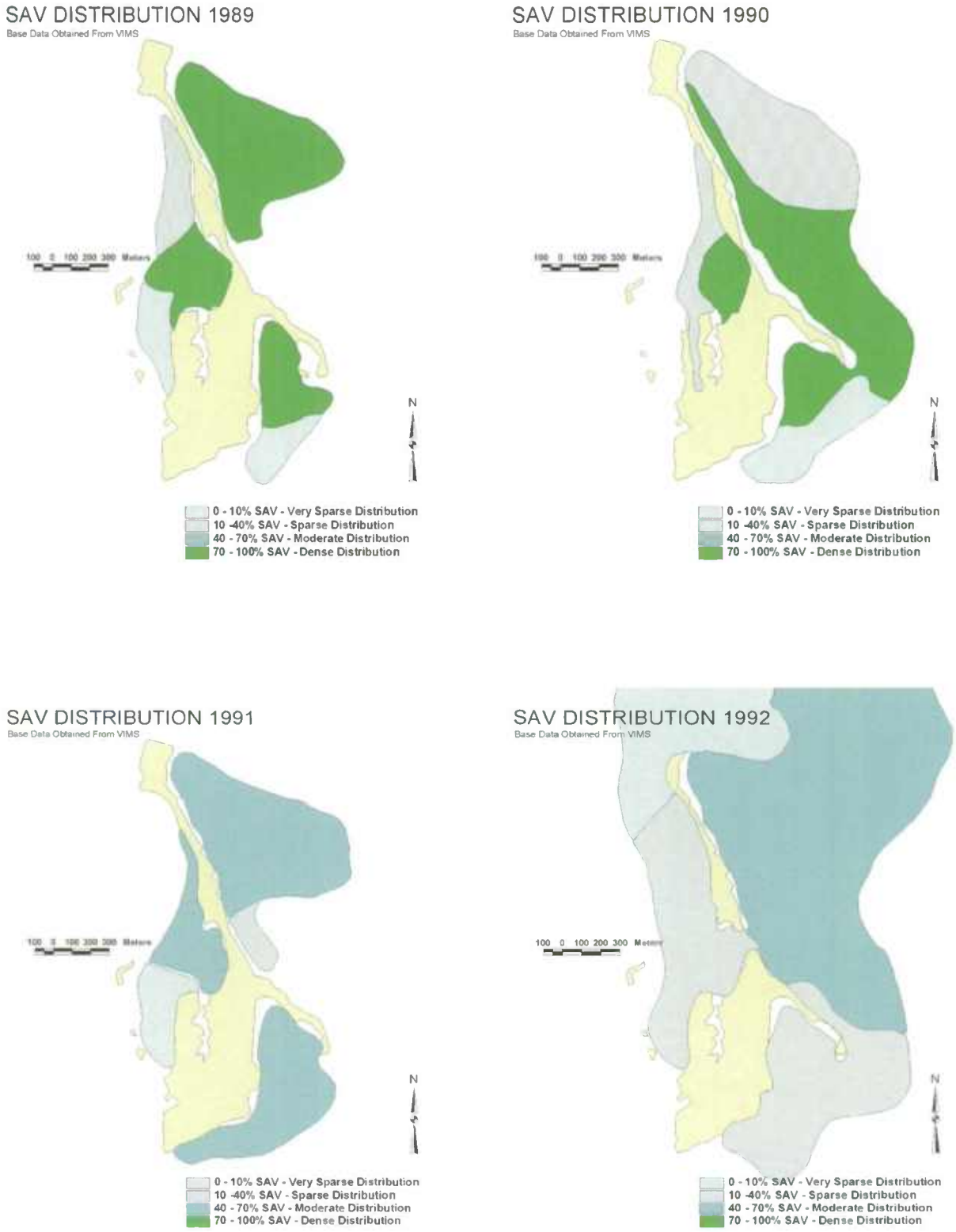

Figure 4-1 (cont.) Submerged Aquatic Vegetation Adjacent to Holland Island (1984-2000)

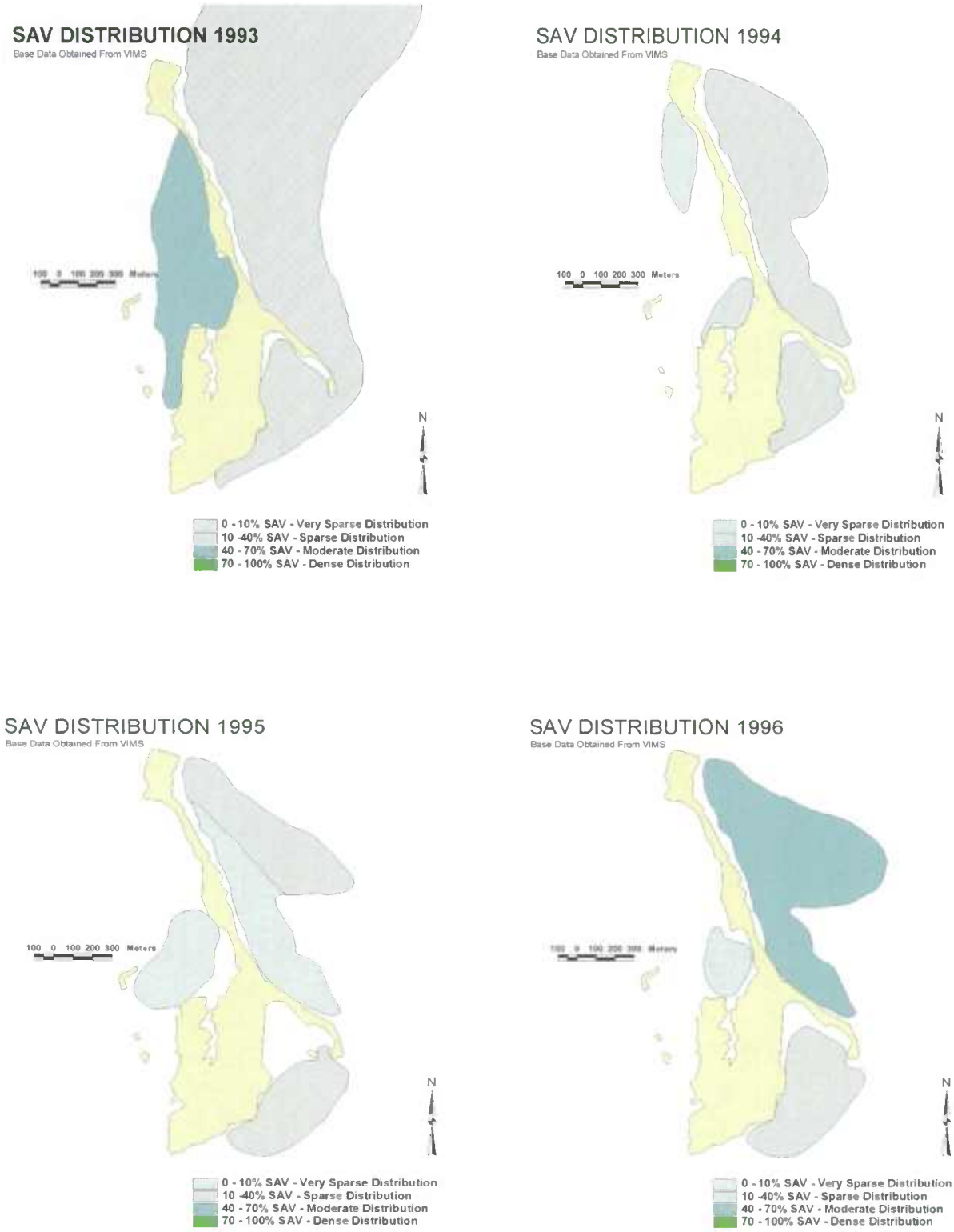

Figure 4-1 (cont.) Submerged Aquatic Vegetation Adjacent to Holland Island (1984-2000)

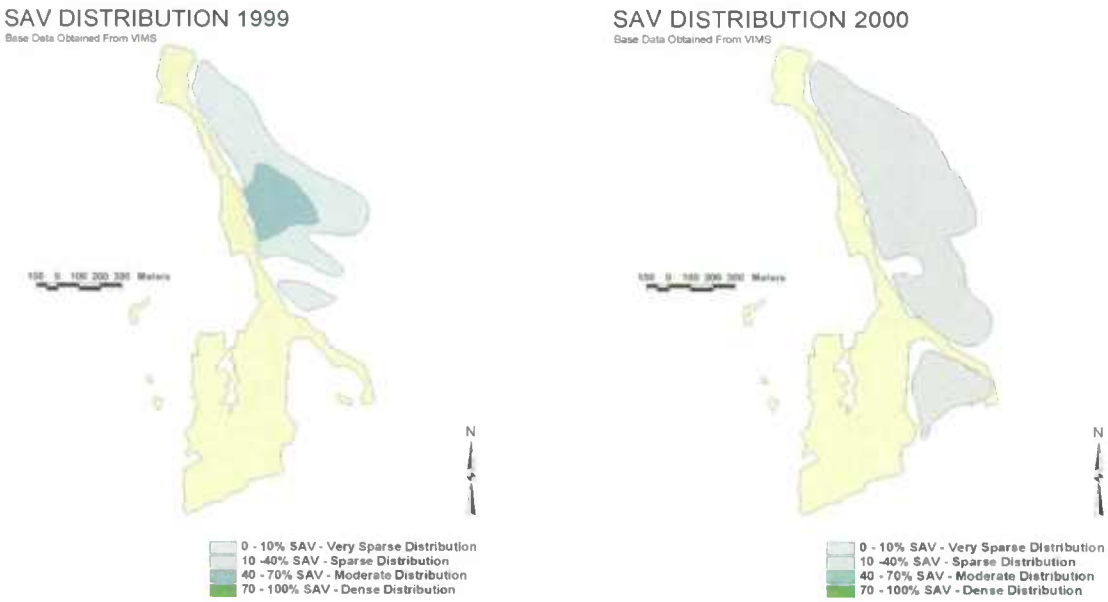

Figure 4-1 (cont.) Submerged Aquatic Vegetation Adjacent to Holland Island (1984-2000)

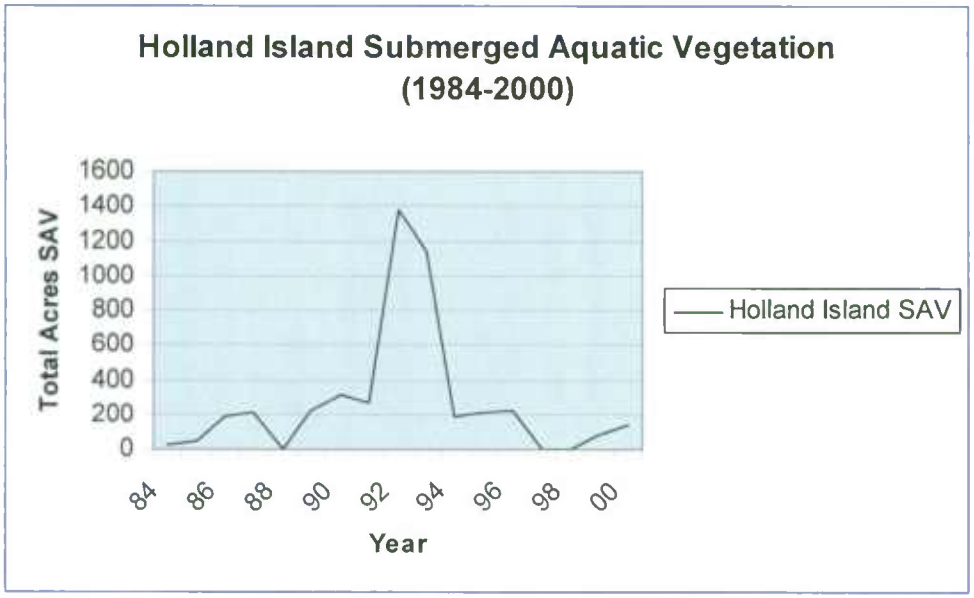

Figure 4-2 Trends in SAV Acreage Adjacent to Holland Island (1984-2000)

Note: There was no occurrence of SAV in 1997 or 1998, and no information available for 1988. A value of "0" was entered as the total SAV acreage for those years.

4.4 Terrestrial Vegetation

The majority of the terrestrial vegetation at Holland Island consists of fringe marsh and high marsh species. The upland areas include some tree stands, especially on South Holland Island. North and Middle Holland Island consist mainly of scrub shrub with very little larger tree presence. A few dead trees are present around the shoreline of Middle and North Holland Island. The smaller trees and shrubs consisted mainly of marsh elder and groundsel tree. Other tree species that exist at Holland Island include red maple (*Acer rubrum*), hackberry, cottonwood, persimmon (*Diospyros virginiana*), and locust. Toadstools were also found in this area.

Efforts have been made by the landowner to plant trees and maintain a small yard south of the house on Middle Holland Island. The majority of the trees planted appear to be willow oak. A few weeping willow (*Salix babylonica*), native elm, and pine species have been planted as well, to determine which species survive in various areas around the island.

4.5 Wetlands

According to the Cowardin Classification System developed in 1979 for the United States Fish and Wildlife Service (USFWS), wetlands are divided into two main types. There are coastal wetlands known also as tidal or estuarine wetlands, and inland wetlands, which are often referred to as non-tidal, freshwater or palustrine wetlands (Cowardin et al. 1979).

The prominent wetland types of the lower Chesapeake Bay mainstem are estuarine, where the salinity and tidal influences combine in an environment that supports halophytic (salt tolerant) plant species. Included species types are saltmarsh cordgrasses in the lower inter-tidal zones and black needlerush in the upper inter-tidal zones.

The three islands that comprise Holland Island are an example of tidal wetlands, which are "regularly flooded and exposed to the tide at least once a day" (Mitsch & Gosselink, 1993). During the field visit to the islands (BAKER, 2001), both low and high tide was observed. During low tide, more of the vegetation that is normally inundated during high tide was exposed. This high tide mark was clearly visible during the site visit.

North Holland Island is almost completely comprised of a tidal wetland with a small sandy beach on its eastern side. Saltmarsh cordgrass and seaside goldenrod are prevalent throughout the island. A few marsh elder are present at the southern tip of the island.

Vegetation observed on Middle Holland Island during the September 19, 2001, site visit mainly consisted of tidal marsh grasses and scrub shrub. At slightly higher elevations, scrub shrub species of marsh elder and groundsel tree were dominant. Other vegetation identified were common reed, seaside goldenrod and black needlerush, which were restricted to the central and western portion of the island. Plant species identified on this

part of Holland Island suggest that it is almost entirely tidal marsh with one very small upland area where the remaining 100-year-old house stands.
South Holland Island is the largest of the group and has a few more upland areas present.

However, once again, the majority of the island is comprised of a tidal wetland with the same species of vegetation present as in the other two parts of Holland Island. The island shows more distinctively a fringe marsh and higher marsh area denoted by a water line mark created during the daily tidal influences. The fringe marsh along the perimeter of the island is again dominated by both long and short forms of *Spartina alterniflora*, whereas the higher marsh area which is located in the center of the island contain species of black needlerush, marsh elder, saltmarsh aster and groundsel tree. Again, other vegetation observed supports the tidal wetland classification given throughout the study area; namely silky dogwood, salt grass, saltmeadow cordgrass and persimmon. Table 2-1, Ecological Inventory of Holland Island, also includes the wetland indicator status of the vegetation at Holland Island.

To determine the historical extent of wetlands on Holland Island, National Wetland Inventory (NWI) maps were obtained for the site. These maps, published in 1990, were derived from a review of the 1972 USGS 7.5 minute topographic maps of the Bloodsworth Island and Kedges Straits quadrangles and the original aerial photography used to create these maps.

It should be noted that in 1990, at the time of classification, Holland Island was much larger in size and was comprised of only one island. Calculations indicate that the size of the island in 1990 was approximately 117.11 acres compared to its current size of approximately 87.05 acres.

The Island historically is classified as an estuarine inter-tidal habitat that has one upland area of 0.6 acres located adjacent to the 100-year-old house. The NWI has four wetland classifications for the remainder of the Island. These are:

- E2EM1U - emergent persistent (81% of all three island remnants);
- E2FO/SS1P - forested scrub-shrub with broad-leaved deciduous trees at higher elevations (12% of Middle and South Holland Island);
- E2SS1P - forested scrub-shrub with broad-leaved deciduous trees at lower elevations (1.5% of all three island remnants)
- E2US2P - unconsolidated shore and sand areas (4% of all three island remnants).

Figure 4-3 shows the distribution of wetlands as classified by the NWI.

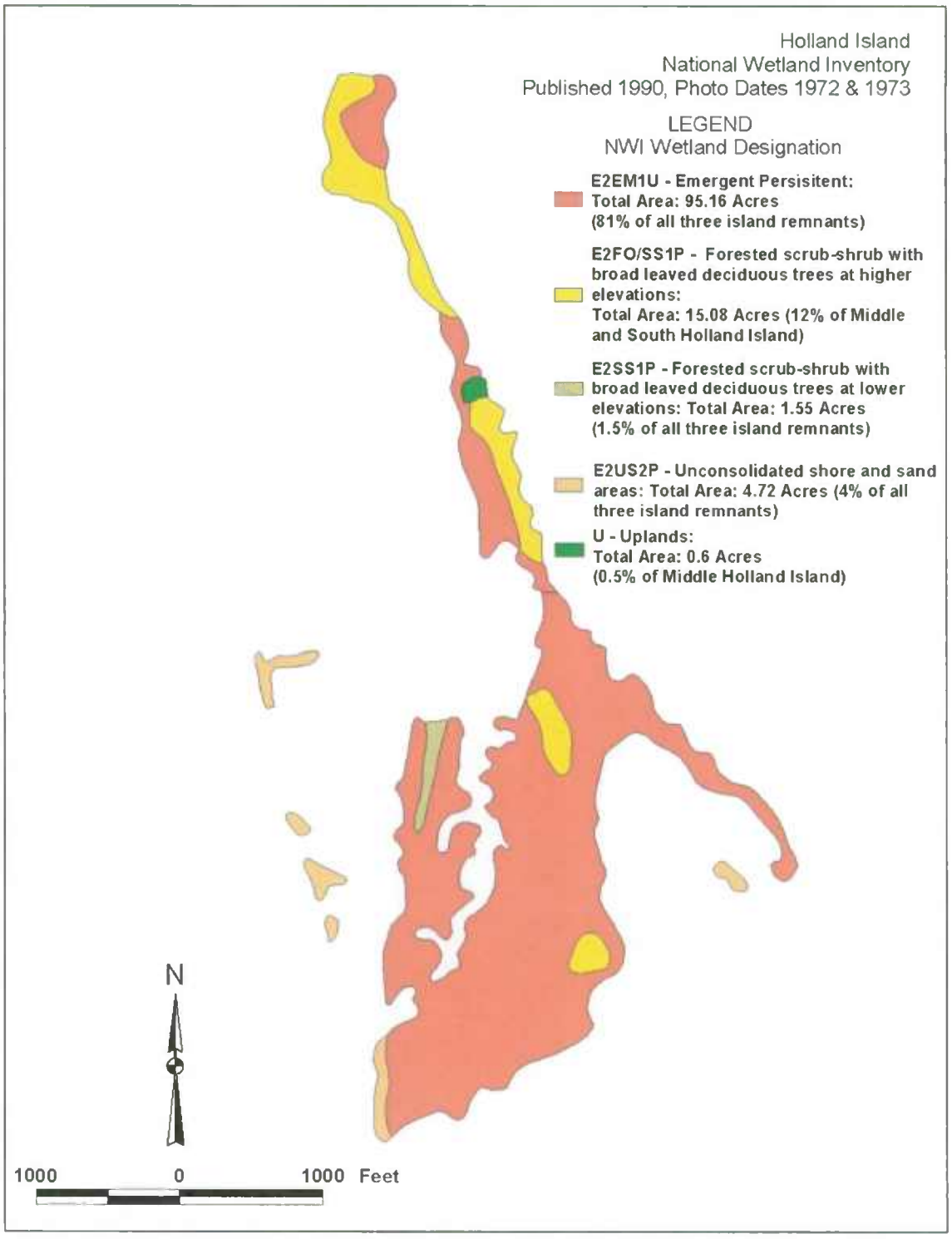

Figure 4-3 National Wetland Inventory-Historical Wetlands at Holland Island

4.6 Birds/Wildlife

Several heron breeding grounds, or rookeries, exist at Holland Island. In addition to herons, many other waterbirds nest at Holland Island, including egrets, swan, geese, ducks, and osprey. Bald eagles have reportedly been observed as well. A bald eagle nest was known to exist at Holland Island. However, MDNR officials report that the nest has not been present for the past several years. Gulls, terns, and pelicans feed along the shorelines. Migrating songbirds use the island as a resting point in the spring and fall. Specific bird and wildlife observations made during the site visit are included below.

A great blue heron (*Ardea herodias*) and snowy egret (*Egretta thula*) were observed flying off of North Holland Island. Cattle egrets (*Bubulcus ibis*) were perched in the low trees. Also observed were greater yellow legs *(Tringa melanoleuca),* a great black back gull *(Larus marinus),* cormorants *(Phalacrocorax auritus)* and dunlin (*Calidris alpina*). Fiddler crabs (*Uca spp.)* were abundant on the muddy areas where tides had receded in the western and southern portions of the island. A sea turtle, possibly a Northern diamondback terrapin (*Malaclemys terrapin terrapin)*, was observed while the observers patrolled the perimeter of the island in a small 12-foot skiff. On the beach of one of the coves, mammal tracks were found; possibly river otter (*Lutra canadensis*). Small fish (possibly killifish), sparse SAV, monarch butterflies (*Danaus plexippus)*, dragon flies (*Odonata order*), blue crab exoskeletons, and mussel shells, were also observed in the area. A small bird of prey (possible a sharpshined hawk or a merlin), unidentified species of swallows, and what is believed to be a northern flicker (*Colaptes auratus*) were also observed on the central remnant. A rookery of bird nests was observed in the shrubbery on the southern tip of the remnant. The USFWS believes the nests were most likely built by green herons (*Butoroides striatus*) or little blue herons (*Egretta caerulea*). The nests were approximately 1-2 ft off the ground, approximately 10-12 inches in diameter, created with medium size twigs, and lined with small shell fragments.

Two groups of swans, consisting of approximately 30 birds per group, were observed in the Holland Straits on the eastern side of Middle Holland Island. From the viewing point of the observers, the species of swans (mute or tundra) could not be determined. A bald eagle (*Haliaeetus leucocephalus*) was sighted perched in a tree south of the dock during the September 27 site visit by MES. Saltmarsh mosquitoes (*Aedes solicitans*) were prevalent, especially farther upland. An osprey nest stand was observed on the eastern beach, however no nest was currently present. Other possible osprey nests were present in the trees at the southern tip of the island section. Other bird species noted were an unidentified warbler (*Protonotaria citrea*), herring gulls (*Larus argentautus*), and several small, black unidentified birds. It was not possible during the site visit to identify the specific type of warbler. Some warbler species are classified as rare, threatened or endangered species (RTEs); however, there is no information from either USFWS or MDNR that any RTE species of warbler exist on Holland Island. Rabbit scat and tracks, most likely marsh rabbit (*Sylviagus palustris*) were prevalent on the beaches and property around the existing house.

Brown pelicans (*Pelicanus occidentalis*) were observed flying around the entire Holland Island in general, however several were noted while departing South Holland Island. Many saltmarsh snails (*Melampus bidentatus*) were observed on the stems of the saltmarsh cordgrass. Approximately 20 swans were congregating along the eastern shore of South Holland Island. A hole resembling a groundhog, nutria or muskrat shelter was observed in the north central portion of the island. Also, the remains of birds found along the island indicate either mammalian or raptor presence. At the southeast end of the island, many nests were noted in the highest trees, as part of the rookery. Along the central and western marsh area, many herons, egrets, gulls and terns were observed. An osprey (*Pandion haliaetus*) was also observed on the western shore.

Other avian species that have been reported at Holland Island include: great egrets (*Casmerodius albus*), tricolored herons (*Egretta tricolor*), little blue herons (*Egretta caerulea*), black-crowned night-herons (*Nycticorax nycticorax*), yellow-crowned night-herons (*Nycticorax violaceus*), glossy ibises (*Plegadis falcinellus*), seagulls, boat tailed grackles (*Quiscalus major*), and black ducks (*Anas rubripes*). No mammals were observed during the field visits, however white tailed deer and fox have been sited in the past.

A site-specific bird study was identified in the literature. Scientists from the USFWS and USGS conducted a study to determine if specific contaminants are affecting the reproduction of black-crowned night-herons nesting in the Baltimore Harbor. Samples from Holland Island were used as a background reference. The study showed that contaminants such as organochlorines and heavy metals were greater in the birds from the Baltimore Harbor area than Holland Island. However, an unusual occurrence of skin lesions on both the Baltimore and Holland Island heron colonies was also observed. Further research is being conducted to determine the cause of the lesions (www.fws.gov/r5cbfo/niteheron.htm).

4.7 Rare, Threatened, and Endangered Species

According to a September 1995 letter from the MDNR to Stephen White, a bald eagle nest was present on Holland Island. MDNR expected that the eagle territory would continue to be used in the future. A letter received on October 3, 2001 from the USFWS, Chesapeake Bay Field Office, reiterated that the federally threatened bald eagle is present at Holland Island in Nest DO-94-16. No other federally proposed or listed endangered or threatened species were known to exist within the area. A follow up phone call to Mr. Glenn Therres, MDNR Wildlife and Heritage Division, revealed that the bald eagle nest once present at Holland Island no longer exists, and has been absent for at least two years. However, the island owner stated in correspondence dated October 12, 2001, that a pair of bald eagles continues to nest at Holland Island. Further investigation into this matter should be completed before construction begins at Holland Island.

A letter from Lori Byrne of the Maryland Wildlife and Heritage Division of MDNR stated that they had no records of federal or state rare, threatened or endangered species

within the Holland Island site. However, the presence of significant waterbird colonies and waterfowl concentration areas should be taken into consideration when completing construction.

The shortnose sturgeon (*Acipenser brevirostrum*), a federally listed endangered species, is also a concern within the Chesapeake Bay. As of March 2002, the closest catch of the shortnose sturgeon to Holland Island was in the Hooper Straits, approximately 5 miles northeast of Holland Island (Personal Communication, Michael Mangold).

The island owner has reported that the diamondback terrapin uses the sandy beach areas of Holland Island every year for nesting locations. According to the Maryland Wildlife and Heritage Division of MDNR, the diamondback terrapin is under review for inclusion on the RTE Animals of Maryland List. Formal confirmation with MDNR regarding the presence and status of diamondback terrapins at Holland Island should be completed if the habitat restoration project moves forward.

5.0 Commercial Fishery

The area in the general vicinity of Holland Island supports several fisheries, including blue crabs, clams, oysters, and finfish. Specific data is not kept for Holland Island itself; however, Tangier Sound to the east and Chesapeake Bay to the west both have available data on fisheries maintained by MDNR. These areas are distinguished by certain codes, as described below.

Oysters are managed by MDNR according to harvest area codes. The codes for areas in the Holland Island vicinity include:

- Area 192: Tangier Sound, south of Wenona,
- Area 292: Tangier Sound, north of Wenona,
- Area 129: Chesapeake Bay, South of Cove Point, East of Ship Channel

Blue crab and finfish harvest information is categorized by NOAA codes. The NOAA codes for areas in the Holland Island vicinity include:

- NOAA code 29: Chesapeake Bay mainstem, South of Cove Point, to the Maryland/Virginia line
- NOAA Code 92: Tangier Sound, located east of Holland Island between Bloodsworth, South Marsh, and Smith Islands and the eastern shore of Maryland.

5.1 Oysters

An abundance of oyster shells and other shellfish shells were observed on the Northeast portion of Middle Holland Island during the September 2001 site visit. The presence of these shells may indicate that oysters were abundant in the vicinity of Holland Island at one point. They may also have been remnants of roads and other structures at Holland Island, or from watermen's past activities. Oysters usually grow in waters 8 to 12 feet deep, so it is unlikely that oyster bars were ever directly adjacent to Holland Island and its shallow waters.

MDNR does not keep specific oyster bar harvest data; rather it is compiled by harvest area codes. Holland Island is located near the intersection of three different oyster harvest code areas. These areas extend quite a distance from Holland Island. The harvest for the area in general is very low. Oyster disease has limited the harvest numbers for many years. The 2000 harvest data for the three oyster bar harvest areas are:

- Area 192: 1,472.5 bushels
- Area 292: 82 bushels
- Area 129: 2,037 bushels

(Provided by N. Butowski, MDNR)

MES provided Figure 5-1 which illustrates both the legal oyster bar boundaries (NOBs) and traditional named oyster bars around the vicinity of Holland Island. NOBs indicate the legal delineations and boundaries of oyster bars where clammers cannot work. In general, destruction of NOBs is prohibited. Historical oyster bars have no legal significance, although many are within the boundaries of the legal NOBs throughout the Chesapeake Bay, and are protected. There are no official NOB designations on the western side of Holland Island, the closest being several miles away in the mid-Chesapeake Bay.

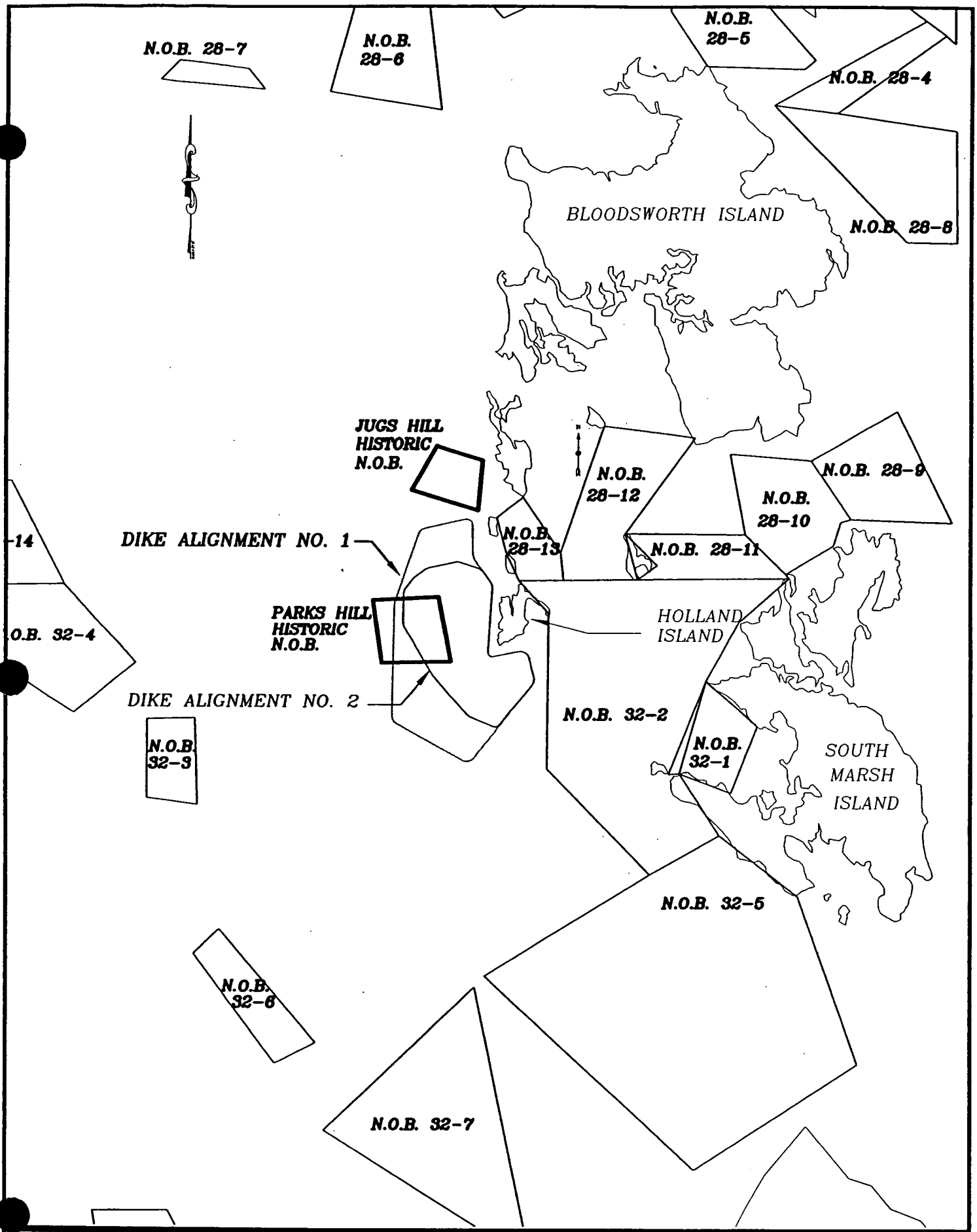

FIGURE: 5-1

SOURCE: MARYLAND ENVIRONMENTAL SERVICE

HOLLAND ISLAND & 2 CONCEPTS
HISTORIC & LEGAL OYSTER BAR
LOCATIONS-OCTOBER 2001

The condition of the historical named oyster bars "Parks Hill" and "Jugs Hill" is unknown. According to the MDNR Fisheries Oxford Cooperative Laboratory, these bars are not part of the annual baywide oyster survey. The most recent information about the area is from the Maryland Bay Bottom Survey that was conducted from 1974 to 1983. This survey showed sand and mud bottoms in the Parks Hill area, and had no data for the Jugs Hill area.

The Maryland Geological Survey performed acoustic surveys on June 2, 2001 in the Holland Island area. The acoustic surveys indicated that almost the entire bottom area in the Holland Island Vicinity was relatively smooth and flat. One small patch (less than 20 meters across) may have been interpreted as oyster shell, but could also be an erosional remnant projecting above the sand layer. The surface waves on the date of the survey hindered precise interpretation of the results (Personal Communication, Jeff Halka).

Contact was made with watermen from both Dorchester and Somerset counties, who have no recent record of oyster harvests from these bars. Oyster harvests on the western shore of Holland Island have been almost non-existent, according to representatives of the Dorchester County watermen's association. In order to clarify the presence or absence of these named oyster bars, a follow up bottom survey and mapping project may need to be coordinated with MDNR.

5.2 Blue Crabs

Commercial fishery information regarding the blue crab (*Callinectes sapidus*) in the Holland Island vicinity was provided by a MDNR database. The database maintains information on certain areas of the Chesapeake Bay, categorized by NOAA codes. The locations of the NOAA harvest codes are shown on Figure 5-2. Data for blue crabs has been maintained since 1990. The blue crab fishery information is summarized in Table 5-1, including over-wintering density of blue crabs (adult and juvenile) sampled in NOAA Codes 29 and 92. In general, the size of the blue crab harvest from the Holland Island vicinity has been decreasing. The overall harvest numbers are less in Tangier Sound than the Chesapeake Bay, however the number of over-wintering crabs is greater in the Tangier Sound area.

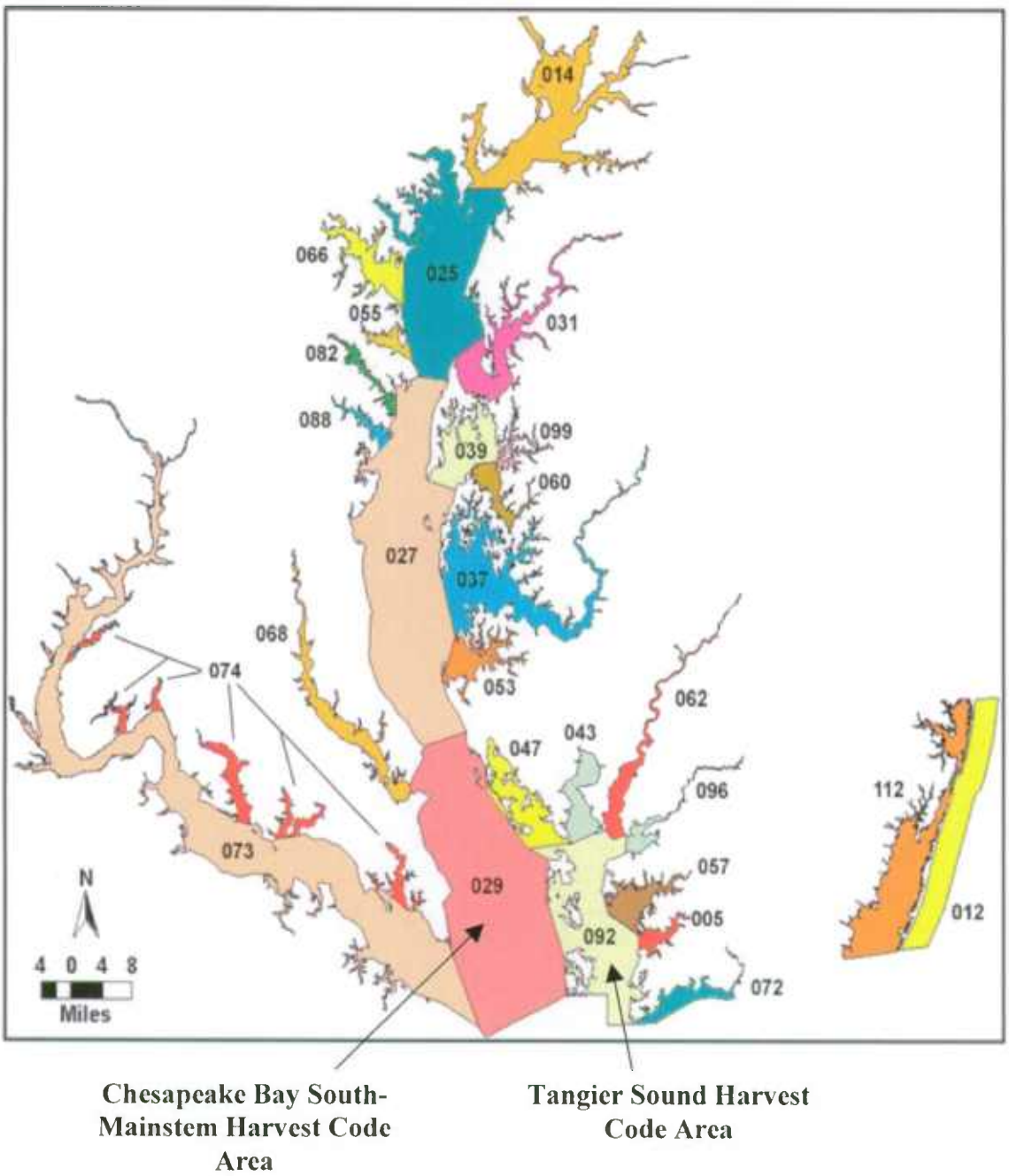

Figure 5-2 NOAA Harvest Codes in the Chesapeake Bay
Map obtained from MDNR website http://mddnr.chesapeakebay.net/mdcomfish/crab/crabnoaatotal.html

Table 5-1: Blue Crab Commercial Fishery Data 1990-2000

Location	Year	Pounds	Dollars	Over-wintering Density (No.Crabs/1,000 square meters)
Chesapeake Bay, NOAA Code 29	1990	6,125,668	2,731,778	24.8
Chesapeake Bay, NOAA Code 29	1991	6,068,857	2,714,544	55.2
Chesapeake Bay, NOAA Code 29	1992	3,754,637	2,247,130	25.3
Chesapeake Bay, NOAA Code 29	1993	8,557,139	4,765,890	25.2
Chesapeake Bay, NOAA Code 29	1994	5,512,917	4,517,169	17.9
Chesapeake Bay, NOAA Code 29	1995	6,705,390	4,886,913	4.6
Chesapeake Bay, NOAA Code 29	1996	6,334,239	4,521,782	28.1
Chesapeake Bay, NOAA Code 29	1997	7,638,035	5,606,132	68.9
Chesapeake Bay, NOAA Code 29	1998	4,550,741	4,714,452	11.7
Chesapeake Bay, NOAA Code 29	1999	5,744,426	4,795,239	12.3
Chesapeake Bay, NOAA Code 29	2000	3,801,205	4,772,426	6.5
	Total	64,793,253	46,273,455	281
	Average	5,890,296	4,206,678	26
Tangier Sound, NOAA Code 92	1990	3,220,881	3,120,639	181.8
Tangier Sound, NOAA Code 92	1991	4,001,162	3,409,663	184.4
Tangier Sound, NOAA Code 92	1992	2,828,062	2,789,766	70
Tangier Sound, NOAA Code 92	1993	4,562,919	4,013,520	56.2
Tangier Sound, NOAA Code 92	1994	3,538,941	4,886,913	54.2
Tangier Sound, NOAA Code 92	1995	3,588,328	4,333,567	92.5
Tangier Sound, NOAA Code 92	1996	2,736,054	4,962,110	108.5
Tangier Sound, NOAA Code 92	1997	3,084,398	4,670,546	80
Tangier Sound, NOAA Code 92	1998	1,966,997	3,658,111	39.5
Tangier Sound, NOAA Code 92	1999	2,424,004	4,655,511	29.2
Tangier Sound, NOAA Code 92	2000	2,111,073	4,352,846	40.1
	Total	34,062,819	44,853,192	936
	Average	3,096,620	4,077,563	85

5.3 Finfish

Commercial finfish information was also provided by MDNR, based on NOAA codes 29 and 92. This data is summarized on Table 5-2. In general, the most abundant species in terms of poundage were croaker, common eel, menhaden, gray sea trout, spot, white perch, bluefish, and striped bass. Data is also included for the summer flounder.

Several pound nets were observed south and west of Holland Island during the site visit on September 19, 2001. These nets were traditionally used to catch menhaden but are now used for catching striped bass and other species (Personal Communication, Hank Conley, Chesapeake Sportfishing). These pound nets did not appear to be in the location of the proposed alignments.

Table 5-2 Finfish Commercial Fishery Data, 1996-2000

Location	Species	1996		1997		1998		1999		2000	
		Pounds	Dollars	Pounds	Dollars	Pounds	Dollars	Pounds	Dollars	Pounds	Dollars
Chesapeake Bay, NOAA Code 29	Bluefish	4,198	1,163	7,446	2,474	26,114	7,803	44,153	10,411	12,736	2,421
Chesapeake Bay, NOAA Code 29	Croaker	20,043	7,244	54,586	18,078	104,921	39,461	140,302	44,066	103,045	32,586
Chesapeake Bay, NOAA Code 29	Menhaden	116,245	11,888	211,597	21,411	491,536	53,332	1,074,385	86,888	1,094,826	126,402
Chesapeake Bay, NOAA Code 29	Striped Bass	40,064	70,390	173,893	234,456	307,604	414,716	360,710	560,946	346,941	55,150
Chesapeake Bay, NOAA Code 29	Summer Flounder	3,627	6,789	1,932	4,198	8,833	18,473	5,455	12,130	11,891	19,401
Tangier Sound, NOAA Code 92	Croaker	70,064	25,809	60,187	19,332	185,017	67,156	56,745	19,565	48,500	15,401
Tangier Sound, NOAA Code 92	Common Eel	23,675	8,882	13,575	7,116	32,091	41,495	10,855	13,579	18,075	20,907
Tangier Sound, NOAA Code 92	Menhaden	2,500	232	N/A	N/A	9,220	996	19,943	1,594	33,950	3,793
Tangier Sound, NOAA Code 92	Gray Seatrout	6,293	9,259	6,272	5,164	18,633	10,241	11,997	8,453	7,875	3,842
Tangier Sound, NOAA Code 92	Spot	23,375	13,151	36,495	21,492	77,654	31,783	38,778	17,416	27,727	13,146
Tangier Sound, NOAA Code 92	White Perch	16,958	11,516	20,975	10,862	1,106	794	19,636	14,246	50,775	32,998
Tangier Sound, NOAA Code 92	Summer Flounder	467	883	146	311	538	1,081	702	1,488	1,396	2,457

5.4 Clams

Soft shell clams are another valuable commercial fishery in the Chesapeake Bay; however in the Holland Island vicinity, clamming activity has been very limited. Specific data is not kept for Holland Island although MDNR Fisheries statisticians keep data for Tangier Sound and Chesapeake Bay sections. The only data MDNR had for the area was for the year 2000, with clam landings in the upper half of Tangier Sound reported at 298 bushels. This indicates that there has been little to no clamming activity in the Holland Island vicinity in the past 6 years. (Information provided by C. Lewis, MDNR Shellfish Division). A representative from the Natural Resource Police stated that they also had no specific record or information concerning clamming activity directly adjacent to Holland Island.

6.0 RECREATIONAL RESOURCES

Because Holland Island is predominantly privately owned, there are no public recreational resources of significance. However, kayakers use the island as part of a water trail, and occasionally as a camping stop. One kayaking group uses the island for student field trips (Personal Communication, Stephen White, owner of Holland Island). A boat pier is located on the northeastern side of Middle Holland Island. At one time the house was used as a hunting lodge, but it is rarely used now except by the property owner. Wildlife observation (herons, egrets, other bird species) is a possible recreational activity that may take place on Holland Island at the extensive rookery areas.

Recreational and commercial fishing and boating immediately adjacent to the island is limited due to very shallow depths. However, a small boat was observed to be fishing or crabbing off the northwest edge of Middle Holland Island during the September 19, 2001 field visit. The deeper channel in Kedges and Holland Straits, east of Holland Island is recreationally fished for spot and sea trout.

7.0 HISTORICAL RESOURCES

A literature search at the Maryland Historical Trust (MHT), Dorchester County Historical Society, and the Dorchester County Public Library provided historical and cultural resources information pertaining to Holland Island. MHT has no record of standing structures on Holland Island; however information on three archaeological sites was present; the William A Parks Site, the Jenkins Cannon Cemetery, and Holland Island Pier. These archaeological sites are illustrated on Figure 7-1, and described in greater detail below.

- **William A Parks Site (MHT # DO-116):**
  This is a 19th century house site that has been destroyed by erosion. Dr. Thomas Davidson of Salisbury State College completed the data sheet for this site in 1982. At that time, the site was visible as a scatter of oyster shells, brick and ceramics extending along approximately 50 meters of the northwest shoreline. The *1877 Atlas of the Eastern Shore* indicates that this was the house of William A. Parks, a 19th century oysterman. The types of artifacts found at the site include stoneware, glass bottles, and pearlware, dating from 1800-1900. The site appears to be submerged, as the area that was denoted on the USGS 7.5' Quad map is now under water according to recent aerial photographs.

- **Jenkins Cannon Cemetery (MHT # DO-186):**
  The Jenkins Cannon Cemetery is located on South Holland Island. Stephen L White completed a data sheet for the MHT in October 1991. At that time, sixteen tombstones were present. The dates on the tombstones ranged from 1814 to 1912. According to Mr. White, the Holland Island Methodist Church cemetery was located approximately 100 meters southeast of this private graveyard. No official documentation of this second cemetery was present at the MHT.

- **Holland Island Pier (MHT Quad file note):**
  A third site listed by the MHT was a former pier that was located at the southern tip of South Holland Island. The approximate location of this pier was discovered during a Phase I Underwater Archaeological Project. The Phase I Underwater Archaeological Project was not on file at MHT. The pier site is referred to only as a "file note". The formal response from MHT did not indicate any information regarding the pier site.

MHT also stated that navigational charts for the Chesapeake Bay indicated two wreck sites west of Holland Island. To date there has been no submerged archeological evaluation or survey to determine the eligibility of these sites for the Maryland Register of Historic Properties. The wreck sites do not appear to be located within the proposed alignments for Holland Island. Further coordination with MHT is recommended to avoid disturbance of these areas by project activities.

7.1 Other Historical Information

Holland Island once supported over 50 families, with an estimated total population of over 300 people. There were several retail establishments: a school, post office, farms, orchards and a baseball park. It was a productive community that lived off the bounty of the Chesapeake Bay. Due to the rising tide and erosion, residents were forced to move in the early 1920's. Residents moved their homes piece by piece by barge to Cambridge or Crisfield, Maryland, on the Eastern Shore (Dunkle, 1985).

On the September 19, 2001 field visit, any findings related to historical or cultural resources were documented and photographed. An existing original house, which is over 100 years old, sits on the northern edge of the eroding shoreline of Middle Holland Island. The house was photographed from all angles. It is in fair to poor condition, with the western edge sitting directly over top of the shoreline. The brick foundation is buffered by sandbags and other erosion control measures. This house has not been determined for eligibility under the National Register of Historic Places. On the northeast point of Middle Holland Island, several ceramic plate pieces, glass, and bottles were observed among the oyster shells and other debris.

On South Holland Island, two cemeteries were observed. The first was a small, family cemetery recorded as the Jenkins Cannon cemetery by MHT. According to the MHT data sheet completed for this cemetery, 16 tombstones were present. However, during the 2001 field visit, it was determined that the smaller stones accompanying each headstone were probably footstones; therefore eight actual tombstones marking graves are present. The second observed cemetery was a larger cemetery, with approximately 50 tombstones present in an approximately 25 feet by 45 feet rectangular area. The second cemetery is located in the northeast quadrant of South Holland Island. It is possible that this cemetery was associated with the Methodist Church at Holland Island referenced by Mr. White. A separate MHT data sheet was not completed for this cemetery.

Two submerged cemeteries were observed during a June 1999 site visit by MES and MPA. These cemeteries were located on the western shores of North and South Holland Island. The presence of these cemeteries could not be confirmed during the September 19, 2001 field visit.

For the purposes of the Environmental Conditions Report, no other action besides photographing and listing these historical and cultural resources has been taken. In the event that a feasibility study or further restoration is required at Holland Island, consultation may be necessary with agencies on the county, state, and possibly federal level regarding the historical and cultural resources. Specific forms to complete include the MHT, Maryland Inventory of Historic Properties Form, and the MHT National Register Eligibility Review Form. In addition, black and white photographs must be provided of any structures.

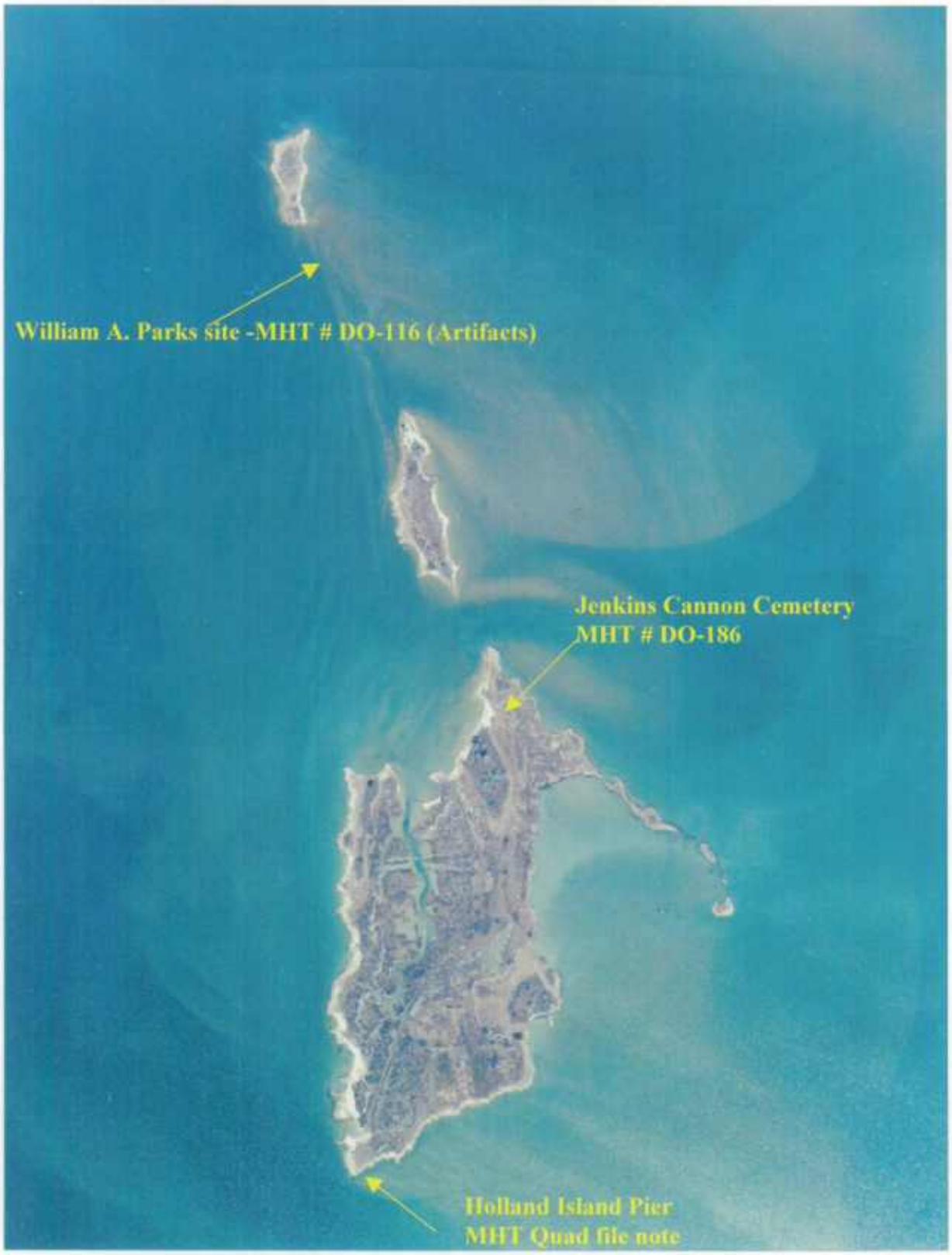

Figure 7-1 Historic Locations at Holland Island on File at Maryland Historic Trust
Photo taken July 2001

8.0 OTHER

8.1 Groundwater

Holland Island, located within Dorchester County, lies within the Coastal Plain province of Maryland. The sediments of the Maryland Coastal Plain form a wedge of generally unconsolidated sand, silt, and clay that thickens from a few feet at the Fall Line (the contact of the Piedmont and Coastal Plain provinces) to more than 7,500 feet at the Maryland Coast. In Dorchester County, the Coastal Plain sediments are unconsolidated Cretaceous, Tertiary, and recent clastics that were deposited in fluvio-deltaic or marine environments. These unconsolidated sediments overlie generally crystalline "basement" rocks of Paleozoic and Precambrian age. In the immediate vicinity of Holland Island, the Coastal Plain sediments are approximately 4,000 feet thick (Rasmussen and Slaughter, 1957).

These various geologic formations serve as aquifers and aquicludes, depending upon their sediment composition. An aquifer is defined by Fetter (1980) as the rock or sediment in a geologic formation that is saturated and sufficiently permeable to transmit economic quantities of water to wells or springs. In contrast, an aquiclude is a geologic formation that is capable of absorbing water slowly, but does not transmit it rapidly enough to supply a well or spring. In general, the formations that are primarily comprised of sand function as aquifers, while those primarily composed of clay function as aquicludes.

According to Rasmussen and Slaughter (1957), the aquifers contained in the Pleistocene, Pliocene and Miocene formations of southern Dorchester County have been encroached by bay waters, resulting in salinity concentrations that render the water unpotable. Therefore, the most shallow aquifer with potable supplies on Holland Island would be the Piney Point Formation of Eocene age. Historical data collected from several wells within a 4-mile radius of the island indicate that the Piney Point formation is typically found between 350 – 550 feet below ground surface, and provides water of generally good quality (Rasmussen and Slaughter, 1957).

> "The general quality of water is good and is comparatively uniform. The iron content of the aquifer is consistently moderate (average 0.52 ppm). Bicarbonate is moderately high (average 409 ppm) and is the highest of all the major aquifers in the three counties. The average content of chloride is 17.5 ppm. An exceptionally high value of 2,077 ppm of chloride from a well on Hoopers Island, Dorchester County, was excluded from the average. ... The average dissolved solids content of the water from the Piney Point formation is moderately high (440 ppm). The aquifer yields water that is just out of the soft class (average hardness of 61 ppm). The average of the pH values is 8.0."

The presence of highly permeable sands in the Holland Island vicinity was supported by the results of the geotechnical boring adjacent to the island. These sands are separated from the underlying Piney Point aquifer by several hundreds of feet of sediment, including two primary aquicludes, namely the St. Mary's and Calvert formations.

8.2 Aesthetics and Noise

Holland Island is remote and uninhabited. The majority of sounds are from natural sources such as waves, birds, and wind. Occasional recreational boating and fishing equipment is heard. The view is of an undeveloped Chesapeake Bay shoreline consisting of tidal wetlands and few upland tree stands. The nearest mainland dwellings are in the small town of Wenona, approximately 8 miles to the east, in Somerset County, Maryland. Other nearby landmasses include Bloodsworth Island and South Marsh Island. Both are uninhabited, and used as a Navy test range and a state wildlife management area, respectively. Because of the proximity to the Navy test range, occasional aircraft and artillery noise may be heard.

8.3 Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) Liability

Preliminary evaluations of Holland Island and the concept areas have indicated that no hazardous, toxic, or radioactive substances exist within the project area. However, Bloodsworth Island, which is located approximately two miles north of Holland Island is owned by the United States Navy, and has been used for target practice in the past. Bloodsworth Island is included on the EPA Superfund list of hazardous sites, and is in the site investigation process. According to a memo from the Patuxent River Naval Air Station (NAS), the presence of unexploded ordnance in the Holland Island vicinity is "highly unlikely". All available historic data on Bloodsworth Island suggests that there has never been any ordnance released outside of the range boundary. Figure 8-1 illustrates the Bloodsworth Island Range Boundary relative to Holland Island, as well as navigation areas near Bloodsworth Island. Officials at the NAS Patuxent River were notified before geotechnical drilling operations began.

8.4 Critical Areas

The Critical Area Act designated all waters and lands within 1,000 feet of tidal waters or adjacent tidal wetlands as the "Critical Area". The Critical Area Act also establishes a minimum buffer of 100 feet of natural vegetation from the edge of tidal waters or wetlands. This buffer may only be disturbed for activities such as access to the shoreline, and shore erosion control measures. The Maryland Critical Areas Commission also considers open waters to be a critical area; therefore, all of Holland Island is subject to the Maryland Critical Area regulations. The restoration measures proposed for Holland Island would be considered consistent with the intent of the Critical Area Act. Specific erosion control and stabilization activities should be coordinated with the Dorchester County Planning and Zoning's Critical Area Program.

8.5 Navigation

Due to the very shallow water surrounding Holland Island, caution is necessary when approaching the shore. The proposed configurations do not lie within or adjacent to any federal navigation areas. The nearest prohibited area is located approximately two miles north, adjacent to Pone Island, and should be avoided during navigation to Holland Island. Pone Island is included in the restricted area surrounding Bloodsworth Island. The prohibited area, as defined in Chapter 2 of U.S Coast Guard Pilot 3, *Navigation Regulations*, includes all waters within a circle 0.5 mile in radius with its center at latitude 38°10'10", longitude 76°06'00". The Bloodsworth Island range boundary is described as the danger zone or danger area. The Coast Guard Regulations state that:

> "persons, vessels or other craft shall not enter or remain in the prohibited area at any time unless authorized to do so by the enforcing agency, and that no person, vessel or other craft shall enter or remain in the danger zone when notified by the enforcing authority to keep clear or when firing is or will soon be in progress".

Warnings of firing in the danger zone will be indicated by a red flag or white light displayed at the control tower on Adams Island (located between Holland Island and Bloodsworth Island), or by aircraft patrolling the area, as well as broadcasting firing intentions on citizens band radio using channels 11 and 12. The danger and restricted areas are also depicted on Figure 8-1.

Figure 8-1 US Naval Reservation Bloodsworth Island Boundary and Navigation Areas

9.0 Potential Impacts

9.1 Water Quality and Sediment Quality

Some short-term impacts to water quality may be expected as a result of construction and placement of dredged materials. Localized elevated nutrient or turbidity levels may occur where ponded water is discharged during the dewatering of the dredged material as the soil consolidates. The discharge will be monitored regularly to meet all discharge permit restrictions. If nutrients, such as phosphorus, are adsorbed to the native sediments in the project area, concentrations may temporarily increase in the vicinity of Holland Island if they are disturbed through construction, dredging, or storm events. Phosphorus or other nutrients released from disturbed sediments into the water column may become a source of food for various types of algae, resulting in algae blooms.

Dredged material placed at the site is expected to be of good quality and suitable for habitat restoration and creation. The long-term effects of shoreline stabilization and habitat restoration will protect Holland Island and are expected to have on overall positive impact on water quality in the Holland Island area by reducing erosion and turbidity.

9.2 Biological Resources

The increase of habitat to wetland and upland habitat will have an overall benefit to the biological resources in the Holland Island area. The project will promote shoreline stabilization, saving Holland Island from further habitat loss due to erosion. It will also decrease impacts to aquatic habitat from high turbidity and sedimentation caused by the eroding island. As further information about the proposed construction at Holland Island becomes available, more details about how it may affect biological resources will be considered if the project moves forward.

Fish

Common fish species in the Holland Island vicinity include the Atlantic menhaden (*Brevoortia tyrannus*), white perch (*Morone americana*), striped bass (*Morone saxatilis*), spot (*Leiostomus xanthurus*), and weakfish or gray seatrout (*Cynoscion regalis*). Section 4.1 describes the life cycle and habitat of these species. In general, possible impacts to pelagic and bottom dwelling fish species from the proposed construction activities at Holland Island include: potential elevated suspended sediment which may clog gills, mortality of fish eggs and larvae due to smothering, dissolved oxygen reduction, change in functional utilization of habitat for feeding, nursery, cover, and overwintering, and potential blockage of migratory pathways of anadramous species due to their reluctance to pass through turbidity. It is expected that bottom dwelling fish such as flounder would be more impacted by construction activities than pelagic species. It is also expected that the pelagic species can avoid the areas of construction, and that actual impacts will be minimal. Impacts to finfish during construction activities should be short-term, and the

proposed restoration is expected to improve finfish habitat in the long-term by reducing turbidity through shoreline protection.

Essential Fish Habitat

The screening tool provided on the NOAA EFH website determined that possibly nine fish species managed by the NMFS are in the general vicinity of Holland Island. These species are: bluefish, summer flounder, Atlantic butterfish, windowpane flounder, black sea bass, king mackerel, Spanish mackerel, cobia, and red drum. Formal consultation with the NMFS should be conducted before new habitat construction begins. The species most likely to frequent the area around Holland Island include blue fish and summer flounder. Section 4.1 describes the life cycle and habitat of these species. Possible impacts to the fish as a result of the proposed project are discussed below.

Both juvenile and adult windowpane flounder are common in the mainstem of the Chesapeake Bay and Tangier Sound mesohaline areas of salinity less than 25 ppt. Construction activities at Holland Island may temporarily disturb juvenile and adult habitats.

No impacts to spawning, eggs, or larval habitat of the bluefish are projected because spawning does not occur in the Chesapeake Bay and eggs and larvae do not occur near Holland Island. It is possible that juvenile habitat may be disturbed during construction activities.

Construction activities could impact all life stages of the Atlantic butterfish in the Chesapeake Bay Mainstem. Spawning occurs in the warmer months, and it is possible that spawning could be temporarily disrupted during construction.

Summer flounder spawning occurs offshore, and eggs and larvae are found in the ocean, and would not be impacted by the proposed construction at Holland Island. SAV is a HAPC for juvenile summer flounder who utilize SAV beds as nursery habitat. The only SAV beds found around Holland Island the past two years are on the east side of the island where construction will not occur.

The presence of black sea bass, King mackerel, and Spanish mackerel in the Holland Island vicinity is not likely due to a lack of structured habitats in the area and their preference for coastal ocean waters. It is also unlikely that construction at Holland Island would have any impact on red drum, as they rarely occur in the area.

Adult and juvenile cobia have been caught as far up the Chesapeake Bay as Tangier Sound. Spawning occurs in warmer months near the mouth of the Chesapeake Bay. Spawning should not be impacted by the construction activities at Holland Island. Larvae are predominantly found in the coastal Atlantic Ocean. There is minimal potential for impact to juvenile and adult habitat; however they should be able to avoid the area during construction.

All EFH impacts should be confirmed in formal consultations with the NMFS before new habitat construction begins. Coordination regarding construction project "time of year" restrictions should be conducted with all appropriate agencies to minimize any potential impacts.

Benthos

The dredged material to be used in this project is expected to be of good quality, and toxic contamination is not expected unless the site was directly adjacent to a contaminant source. The Bloodsworth Island Naval Reservation that has been used as a bombing range in past years is located approximately two miles north of Holland Island. It is not likely that contaminants from the Naval Reservation are currently affecting benthic organisms, however, baseline monitoring may be necessary to document existing conditions and determine the current status of the Holland Island benthic community.

Any benthos within the proposed construction area would be lost, and species such as the blue crab may be trapped in the diking efforts. However, it is unlikely that covering wintering blue crabs in a significant concern in the shallow waters of the concept areas as the blue crab typically overwinters in deeper waters. Also, most mobile invertebrates should be able to avoid impacts until dike construction is completed, and any impacts that occur should be minimal. The project is expected to have an overall positive effect on biological resources, as it is increasing valuable nesting, breeding, and nursery habitat for a variety of species. It will also stabilize the erosion currently destroying Holland Island's western shore, thereby protecting valuable wetlands and rookeries.

SAV

According to VIMS data, no SAV presence has been noted along the western shore of Holland Island since 1996. No SAV was observed at all around Holland Island during 1997 and 1998, and in the past three years, SAV has only been observed on the eastern shore of Holland Island. The proposed project would benefit SAV habitat on the eastern side of the island by reducing erosion and protecting existing habitat. The construction of new upland and wetland habitat would cause permanent loss of area for potential SAV beds; however, the channel between the new configuration and the existing island may provide acceptable habitat for SAV growth, and protection from strong wind and wave erosion.

Terrestrial Vegetation

The diking and construction of new habitat are not planned to tie into the existing land at Holland Island; therefore there would be little to no impact on the existing vegetation along the western shore. The existing vegetation will be protected with the proposed habitat construction, and additional vegetation will be introduced, in order to create new habitat.

Wetlands

The construction project is expected to have a positive impact on wetlands at Holland Island. New wetland habitat will be created and existing wetlands will be protected from erosion by the dike construction.

Birds and Wildlife

Herons, egrets and other waterbird species utilize the marshland and upland habitats, especially on South Holland Island, and may avoid neighboring areas while construction is taking place due to the increase in noise levels. Waterbird breeding season is generally from March through August, and could be disrupted by construction activities in the area at that time. However, as with the Poplar Environmental Restoration Project, coordination with appropriate agencies should result in agreements allowing year-round construction tempered by "time of year" restrictions to protect nesting in rookeries.

Rare, Threatened, and Endangered Species

A definitive answer concerning the presence of bald eagles and diamondback terrapins at Holland Island will need to be determined prior to construction. Further consultations with the NMFS and USFWS about the status of the shortnose sturgeon in the Holland Island vicinity is recommended throughout the construction project. No shortnose sturgeon have been recovered in the vicinity to date.

9.3 Commercial Fisheries

Commercial fishing for finfish does not take place directly adjacent to Holland Island due to extremely shallow water. Pound nets were observed during the September 2001 site visits although they did not seem to be within the proposed alignment areas. Available commercial fishing data did show significant fishing in Tangier Sound, east of Holland Island, and the mainstem of the Chesapeake Bay, west of the island. No commercial fishing would be disrupted during construction activities.

There are no anticipated impacts to the clamming industry in the Holland Island vicinity, as clamming has historically been very limited in the area. There are no state recognized NOBs within or adjacent to the concept area. The nearest NOBs are adjacent to the eastern side of Holland Island, or several miles west, in the mid-Chesapeake Bay.

No state recognized NOBs lie within the proposed project area. Two historical oyster bars may exist west of Holland Island. These are known as "Jugs Hill" and "Parks Hill" (See Figure 5-1). The south area, known as "Parks Hill" appears to lie within the proposed alignment areas. It appears that these historic oyster bars are no longer fished or viable; however, further coordination with DNR on the presence or absence of these historic oyster bars, and any liability issues should be determined before construction. Disruption to the oyster harvest is expected to be minimal because most harvesting occurs in water greater than 8 feet. NOBs east of Holland Island would most likely

benefit from shoreline protection reducing erosion and turbidity on the eastern side of the island.

Crab pots were observed during the September 27, 2001 site visit along the northwest side of Middle and North Holland Island. Continuation of crabbing there may not be able to take place; however there is an abundance of crabbing grounds in the vicinity of Holland island, and the construction would only impact a very small portion of the crabbing industry.

9.4 Recreational Resources

Very little recreational fishing and boating occurs around the immediate vicinity of Holland Island due to shallow waters. Any activity within the alignment around the western shore would be permanently displaced by the diking and restoration activities. However, there is an abundance of suitable recreational fishing and boating areas in the Holland Island area, around islands that are not surrounded by such shallow water.

9.5 Historical Resources

According to anecdotal information provided by the owner of Holland Island, two submerged cemeteries (one consisting of only two graves) were located along the western shore of Holland Island. The presence of these cemeteries was not verified during the September 2001 field visits (MES and Baker trip reports, 2001). However, if these areas are submerged, they may be impacted by the concept alignments, and restoration activities planned for the western side of Holland Island. Coordination with MHT would be necessary regarding placing fill on these areas. The two cemeteries that were verified in 2001 exist further upland and east and would not be impacted by the dikes. The existing house sits directly on the edge of the western shore, and could potentially benefit from the dikes and restoration activities, if it does not give way to erosion before then.

9.6 Other

Some viewshed and noise disturbances may occur during the construction and filling phase of the habitat restoration at Holland Island. This would be temporary and would not affect any human receptors. There is no anticipated CERCLA liability at Holland Island, although caution should be taken if any unexploded ordnance or suspicious objects are encountered, and officials at NAS Patuxent River should be notified.

Impact to navigation is expected to be minimal because very few boats maneuver the shallow water directly around Holland Island. The proposed alignments are not located in any restricted or prohibited areas as displayed on the NOAA nautical charts. The stabilization and habitat construction projects area considered consistent with the Critical Area regulations, however specific activities should be coordinated with the Dorchester County Critical Area Commission.

Potential for contaminating the groundwater with dredged material is a concern at any site. Groundwater contamination is not expected to be a potential concern at Holland Island, as the dredged material for the habitat restoration project is expected to be clean and not pose a threat to aquifers.

10.0 FUTURE STUDY NEEDS

Several issues should be finalized, and further study should be completed if the restoration and beneficial use of dredged material project at Holland Island is approved. The following data gaps and areas of further study are recommended:

- Further coordination with the MHT to document historic findings.
- Coordination with the NMFS on Essential Fish Habitat.
- Formal confirmation from MDNR and USFWS regarding the bald eagle nesting site presence at Holland Island.
- Formal confirmation with MDNR and USFWS regarding the presence of diamondback terrapins at Holland Island.
- Follow up with MDNR concerning the presence or absence of historical oyster bars "Jugs Hill" and "Parks Hill".
- Coordination with the Dorchester County Critical Area Commission.
- Continued SAV monitoring and comprehensive mapping.
- Site-specific sediment sampling.
- Site-specific benthic sampling.
- Further determination of the extent of commercial and recreational fishing in area.
- Coordination with NAS Patuxent River on future work near the Bloodsworth Island boundary.
- Groundwater and hydrodynamic studies.
- Further coordination with appropriate agencies (USFWS, MDNR) regarding rookeries in the vicinity of the project area.

11.0 CONCLUSIONS

In conclusion, this Environmental Conditions Report documents the findings of various environmental parameters of concern at Holland Island. Included in these parameters are: water quality, sediment quality, benthic community, recreational and commercial fisheries, RTE species, SAV, wetlands, historic resources, CERCLA liability, critical areas, and navigation. Sections 1.0 through 8.0 in this report provide detail regarding the current condition of these environmental parameters at Holland Island.

Overall, potential impacts to environmental and historical resources as a result of the proposed construction and habitat restoration at Holland Island are expected to be minimal, and may include temporary increases in sedimentation rates, possible burial of abandoned gravesites, and burial of areas previously populated by SAV. Management and design efforts may mitigate some of these potential impacts. Several issues will require further consultation and coordination with appropriate governmental agencies. Section 9.0 and 10.0 of this report describe the potential impacts and future study needs in more detail.

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APPENDIX I

Holland Island Site Reconnaissance
Environmental and Cultural Resources Report

On Friday September 14, representatives from Michael Baker Jr., Inc. (BAKER), Chesapeake Environmental Management (CEM), Engineering, Consultation, Construction, Remediation (E2CR), Offshore Coastal Technologies, Inc. (OCTI), and Gahagan and Bryant Dredging Engineering attempted to visit Holland Island. A 46-foot charter boat (*Carrie Sue*) was taken out of Calvert Marina in Solomons, Maryland at approximately 0900 hours. The original plan was to bring a smaller boat as well, which could access the shallow waters around the island. Due to fairly strong winds (10-12 knots) and choppy Chesapeake Bay conditions, it was not possible to bring the smaller boat, or set foot on Holland Island. The island was observed from a distance, at the southern and eastern shores. Several brown pelicans were observed, and large groups of tundra swan (approximately 30-50 birds per group) were noted just off the island's eastern shore. Extensive crab pot lines were set out around the southern and eastern shores. The extent of breaching and erosion was observed and neighboring islands were also distinguished. An attempt was made to collect soil samples from the side of the charter boat, but the water depths were too great for the soil auger to reach bottom.

On Wednesday September 19, representatives from BAKER and CEM were able to set foot on Holland Island, and complete an environmental site reconnaissance. The 46-foot charter boat was used to cross the Chesapeake Bay, and a smaller 19-foot boat and 12-foot skiff were brought as well, to assist in accessing the shore of the island through very shallow waters. The Island was reached at approximately 1000 hours, which was just after the morning low tide at 0929 hours. The following sections detail the vegetation, wildlife, aquatic habitat, and historical/cultural resources observed at Holland Island. Photographs were taken of all significant findings.

Mr. Stephen White, the owner of Holland Island, was notified by telephone and email prior to both visits to the island.

General:
Because the island has been significantly breached and exists in three distinct landmasses, it will be referred to in this report as: North Holland Island, Middle Holland Island, and South Holland Island. The majority of vegetation consists of tidal salt marsh grasses and scrub shrub, with occasional stands of larger trees on the upland interior of the island. The largest section of the island is South Holland Island, where large rookeries are known to exist, and two cemeteries were observed in the upland areas. An original house (over 100 years old) still stands on Middle Holland Island, although the western side is directly over the edge of the shoreline due to increased erosion over time. Attempts have been made by the owner of the island to install stone bulkheads, sandbags, etc., to prevent further erosion. North Holland Island is the smallest of the landmasses, and is characterized entirely by tidal marsh.

Water samples were taken at four locations on Holland Island: the western side of Middle Holland Island, from standing water on Northern Holland Island, from the channel which bisects South Holland Island, and the northern tip of South Holland Island. The average salinity reading was 17.05 parts per thousand (ppt), which is indicative of moderately brackish waters in the upper mesohaline of middle Chesapeake Bay. The upper mesohaline is classified as salinity of 5-18 ppt. (White, 1989).

The majority of Holland Island can be classified as a tidal wetland, due to the vegetation and hydrology observed. The vegetation, terrestrial wildlife and bird species observed or known to occur at Holland Island were cataloged and summarized in Table 2-1.

NORTH HOLLAND ISLAND:

North Holland Island is the smallest of the three landmasses. It consists almost entirely of a tidal wetland with some exposed sandy beach on the eastern shore. A duck blind that is falling down and decaying was observed towards the southern, upland area of the island. Specific observations are noted below.

Vegetation:

The majority of the island vegetation consists of saltmarsh cordgrass (*Spartina alterniflora)*, including both the tall and short forms. Seaside goldenrod (*Solidago sempervirens*) is also prevalent. Marsh elders (*Iva frutescens*) surround the southern tip of the island, and several larger trees and stumps are noted in the water at the south and west shores.

Wildlife:

A great blue heron (*Ardea herodias*) and snowy egret (*Egretta thula*) were observed flying off of this island section. Also observed were greater yellow legs (Tringa melanoleuca) and dunlin (*Calidris alpina*). Fiddler crabs (*Uca spp.)* were abundant on the muddy areas where tides had receded in the western and southern portions of the island. A sea turtle was observed while patrolling the perimeter of the island in the small 12-foot skiff. One large bird nest was observed in a fallen tree on the western side of the island.

Aquatic Habitat:

According to the 2000 Virginia Institute of Military Science (VIMS) mapping and reporting, the most common type of Submerged Aquatic Vegetation (SAV) found around Holland Island is widgeon grass (*Ruppia maritima*) (http://www.vims.edu/bio/sav/). Water around Holland Island is very shallow with depths ranging from ½ to 5 feet, at high tide. SAV presence has been historically patchy. Small patches of widgeon grass were observed during the site visit off the eastern shore of North Holland Island.

Historical/Cultural Resources:

Previous records from a site visit by MES with landowner indicated that two submerged graves existed at the southwestern shore of North Holland Island. These graves were not located during the September 19, 2001 field visit.

MIDDLE HOLLAND ISLAND:

A pier exists at the eastern side of Middle Holland Island, opposite the existing house. Attempts were made to approach the pier in the 19-foot boat; however the low tide exposed a submerged stone breakwater/jetty surrounding the pier, making it impossible to dock there. The 19-foot boat was able to approach the shore on the northern tip of Middle Holland Island, at a small beach. Extensive attempts have been made by the island owner to control erosion, including sandbagging, installation of a stone bulkhead, and purchasing of heavy equipment to assist in building a dike.

Vegetation:

The majority of the mid-island vegetation is characterized by tidal marsh grasses and scrub shrub. The most prevalent vegetation along the island shore was *Spartina alterniflora,* both the tall and short forms. On slightly higher ground, the dominant scrub shrub vegetation is the marsh elder, and the groundsel tree, *Baccharis halimifolia.* Seaside goldenrod was observed adjacent to the upland areas. In addition, extensive stands of common reed (*Phragmites australis*), and black needlerush (*Juncus roemerianus*) were observed along the western/central length of the island. A few red maple trees (*Acer rubrum*) were observed in the upland central part of the island. There was no beach on the western shore of the island; the waves from the Chesapeake Bay pound directly against the marsh grasses. A succulent species identified as sea rocket (*Cakile edentula*) was observed on the southeastern beach area. Several trees have been planted by the island owner and are protected with wire or plastic buckets around the trunks. The majority of the planted tree species appear to be willow oaks (*Quercus phellos*).

Wildlife:

Two groups of tundra swans (*Cygnus columbianus*), or mute swans (*Cygnus olor*) consisting of approximately 30 birds per group, were observed in the Holland Straits on the eastern side of Middle Holland Island. From the observers' viewing point, the type of swans could not be determined. Saltmarsh mosquitoes (*Aedes solicitans*) were extremely prevalent, especially in the upland. An osprey nest platform was observed on the eastern beach, however no nest was currently present. Other nests were present in the trees at the southern tip of the island section. Other bird species noted were a warbler (*Protonotaria citrea*), and herring gull (*Larus argentautus*), and several small, black unidentified birds.

No terrestrial species, reptiles or amphibians were observed on Middle Holland Island. Several birdhouses had been set up near the existing house.

Aquatic Habitat:

Widgeon grass was observed around the eastern shore of Middle Holland Island, especially the northeastern area around the pier.

There were several fallen trees and stumps, especially around the east and south portions of Middle Holland Island, that could provide some cover for aquatic life. Small minnows were observed in shallow pools on the eastern beach side.

Historical/Cultural Resources:

On the northern end of Middle Holland Island, many pieces of ceramic plates and bowls, bottles, colored glass and brick were observed lying among oyster shells and other types of shells and debris on the beach and rocks surrounding the house. The house itself is an original structure, built during the most productive period of Holland Island's history (late 1800s). The house is in fair to poor condition, with much evidence of weathering. The western side of the house is sitting directly on the edge of the shoreline, approximately 3 feet above sea level. There is a small yard on the south side of the house, and a new structure that appears to be a shed.

SOUTH HOLLAND ISLAND:

South Holland Island is by far the largest landmass of the three major sections. The perimeter of the island consists of tidal saltmarsh, while the central, upland area consists of several stands of larger trees. A significant stream/canal system exists throughout the western/central area of the island, and large rookeries are known to exist on both sides of South Holland Island. A piece of heavy equipment was located on the northwestern area of the island, and a small floating dock was observed at the entrance to the channel, in the southwestern portion of the island.

Vegetation:

The fringe marsh around the perimeter of the island is made up of *Spartina alterniflora*, short and tall form. The higher marsh area towards the center of the island is made up of black needlerush, marsh elder, and groundsel tree. Saltmarsh aster (*Aster tenuifolius*) was found mixed throughout the marsh grass. Other vegetation observed included: silky dogwood (*Cornus amomum*), salt grass (*Distichlis spicata*), salt meadow cordgrass (*Spartina patens*), common glasswort (*Salicornia europaea*), American elm (*Ulmus americanus*), and persimmon (*Diospyros virginiana*).

Wildlife:

In general, brown pelicans were observed flying around the entire Holland Island, however several were noted while departing South Holland Island. Extensive crab lines were set up off of the southern tip of South Holland Island as well. Many saltmarsh snails (*Melampus bidentatus*) were observed on the stems of the saltmarsh cordgrass. Approximately 20 swans were congregating along the eastern shore of the island. A hole resembling a groundhog, nutria or muskrat shelter was observed in the north central portion of the island. Also, the remains of birds found throughout the island may indicate a mammalian or raptor presence. At the southeast end of the island, many nests were noted in the highest trees, as part of the rookery. Along the central and western marsh area, many herons, egrets, gulls and terns were observed. An osprey (*Pandion haliaetus*) was also observed on the western shore.

Other avian species that have been reported to use Holland Island include: great Egrets (*Casmerodius albus*), tricolored Herons (*Egretta tricolor*), little blue herons (*Egretta*

caerulea), black-crowned night-herons (*Nycticorax nycticorax*), yellow-crowned night-herons (*Nycticorax violaceus*), glossy ibises (*Plegadis falcinellus*), and bald eagles (*Haliaeetus leucocephalus*) (MES Trip Report, July 1999).

Aquatic Habitat:

Some small beach areas existed on the eastern shore of the island, whereas no beach was observed on the western shore. The wave action was rough along the southern tip of the island. No SAV was observed along the eastern shore or elsewhere around South Holland Island. This is consistent with the most recent SAV data in the VIMS report.

Historical/Cultural Resources:

Two cemeteries were observed in the north and central areas of South Holland Island. The first, smaller cemetery was located in a thick area of larger trees, in an upland area. Eight tombstones were observed, each consisting of a headstone and associated footstone. This was likely a small, family cemetery, with dates of death ranging from 1885 to 1912. A small pile of red bricks was located approximately 30 feet south west of the cemetery, which may be from an old chimney. The owner of the island reported that the Jenkins-Cannon house reportedly stood near this cemetery.

A second, larger cemetery was observed farther south on the island, in an upland area with smaller scrub shrub and trees. Approximately 50-75 tombstones were observed in this cemetery, which was estimated to be 25 feet by 45 feet in size. The general dates of death observed on the headstones were 1845-1919. According to recent aerial photographs, the vegetation around this cemetery leads to the belief that roads were present in this area, and that the church and main area of the town were probably in this general location. Various small piles of red bricks were observed south of the cemetery, which are likely remnants of old houses and structures.

According to the records present at the Maryland Historical Trust (MHT), only the small family cemetery is documented on the maps, and has a corresponding data sheet. The data sheet was completed by the MHT in 1991, and states that "according to Mr. Stephen White, a church related cemetery is located ca. 100m SE of the private graveyard".

Previous records indicated that a submerged cemetery was located off the southwestern shore of South Holland Island (MES Trip Report, July 1999). This was not located during the tour around the island on September 19, 2001. If the submerged cemetery were still present, it would be directly impacted by the dredging operations and conceptual configurations that are planned for the western portion of South Holland Island.

Holland Island Aerial Photo, July 2001
Approximate locations of Photographs

Photograph 1: Fiddler crabs (*Uca spp.*) in the tidal pools of North Holland Island.

Photograph 2: Pier at eastern edge of Middle Holland Island.

Photograph 3: Typical marsh vegetation, South Holland Island.

Photograph 4: Vegetation in higher marsh (Black needlerush-*Juncus roemerianus*).

Photograph 5: Wetland area, Middle Holland Island.

Photograph 6: Nest and shoreline, Middle Holland Island.

Photograph 7: Fallen tree, southeastern point of Middle Holland Island.

Photograph 8: Western Shoreline, North Holland Island.

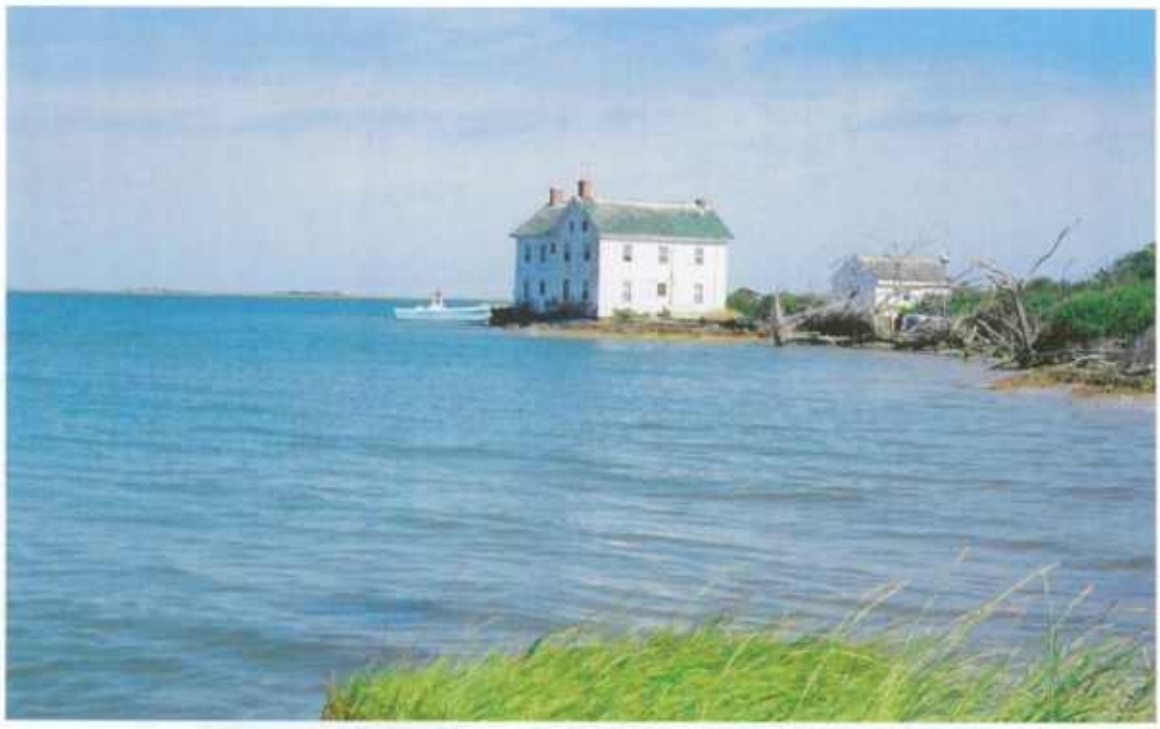
Photograph 9: Erosion control measures, Middle Holland Island.

Photograph 10: Erosion control measures, Middle Holland Island.

Photograph 11: Stone jetty, western shore, Middle Holland Island.

Photograph 12: Shell debris and pottery shards, eastern shore of Middle Holland Island.

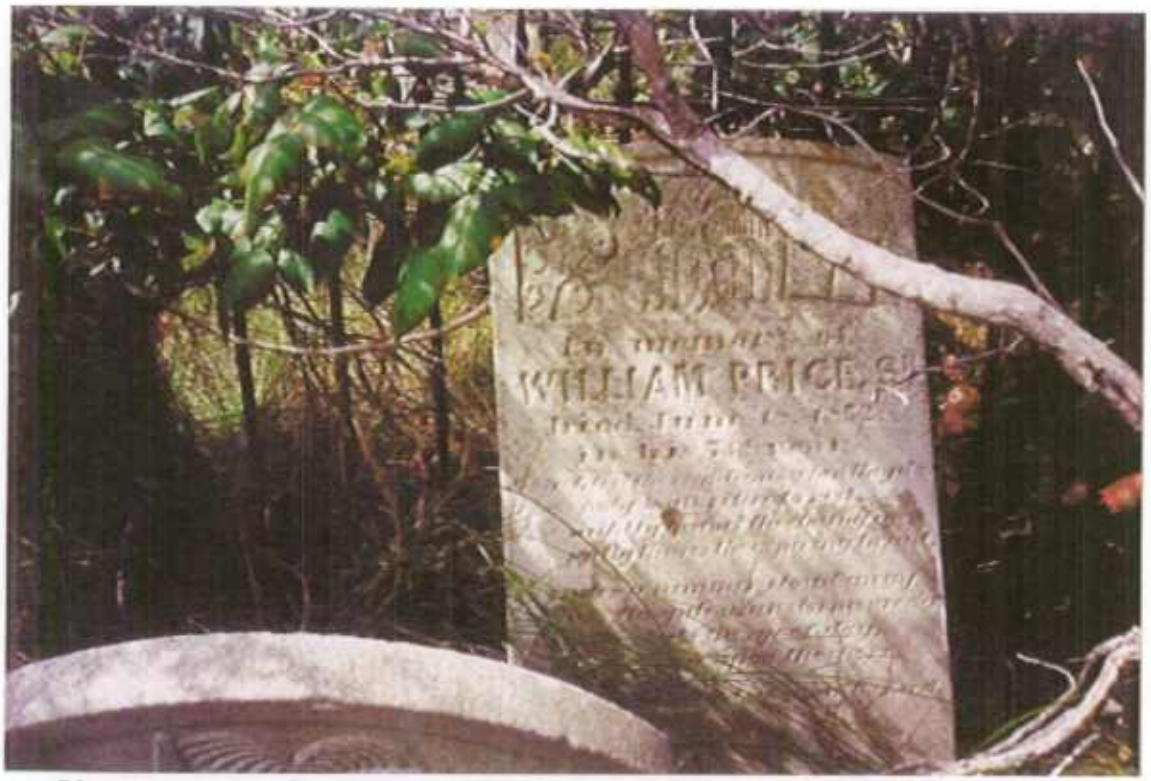
Photograph 13: Close-up view of pottery shards and bottles, Middle Holland Island.



Photograph 14: View of existing house from the south

Photograph 15: View of existing house—western edge directly over the shoreline.

Photograph 16: Small family cemetery, South Holland Island.



Photograph 17: Tombstone at main church cemetery, South Holland Island.

Photograph 18: View of channel, Southwest area, South Holland Island.

Photograph 19: Aerial photo taken July 2001.

APPENDIX II

Holland Island
MES Site Visit
September 27, 2001

On Thursday, September 27, 2001 at approximately 9:35 AM, Maryland Environmental Service (MES) personnel arrived in the waters surrounding Holland Island. The weather was clear and sunny (60° Farenheit) with southwest winds of approximately 10-15 knots. Holland Island is located southwest of Bloodsworth Island and west of Tangier Sound in Dorchester County, Maryland (Figure 1). Holland Island is composed of three main island remnants; labeled as the northern, central and southern remnants for purposes of this discussion. MES personnel initially approached the island by boat from the north/northeast and headed south along the eastern side of the island remnants. The MES vessel circled the island remnants in a counter-clockwise direction. The vessel was able to dock at the central remnant only, which allowed MES staff to explore this remnant. MES personnel took photos of Holland Island. Digital photos and an aerial photograph labeling the locations of major observations from the site visit are attached.

Northern Remnant

On the northern remnant, vegetation consists of low shrubs, marsh-wetland area, two sandy beaches, and shoreline grasses (Photos 1-3). This island is narrow, approximately 200 feet wide, and these habitats exist on both the eastern and western shorelines. Several tree snags were observed on the eastern shoreline. A great blue heron (*Ardea herodias*) was observed on the eastern shoreline, and a great black back gull (*Larus marinus*) was perched on a signpost. A fairly large patch of Phragmites (*Phragmites australis*) is on the southern end of the remnant. Cormorants (*Phalacrocorax auritus*) were perched on the snags along the southern end (Photo 4). Crab pots are located along the northwest side between the northern and central remnants. Brown pelicans (*Pelecanus occidentalis*) were observed in flight around this area as well.

Central Remnant

At the northern tip of the central remnant (Photos 5-6) a house, some outbuildings, and a dock exist. A flock of herring gulls (*Larus argentautus*) were perched on and around the dock area (Photo 7). A bald eagle (*Haliaeetus leucocephalus*) was perched in a tree south of the dock, and flew off as the boat approached the dock. Just south of the dock on the east side are two possible osprey (*Pandion haliaetus*) nests in large defoliated trees (Photos 8-9). Brown pelicans were seen flying near the island. Around the dock area and along the western shoreline of the house were tree snags (Photo 10). Saltmeadow cordgrass (*Spartina patens)* and smooth cordgrass (*Spartina alterniflora*) (Photo 11) were identified in the marsh areas north and south of the dock. Oyster (C*rassostrea virginica*) and soft-shelled clam (*Mya arenaria*) shells were predominating on the beach. Rabbit scat and tracks, most likely marsh rabbit (*Sylviagus palustris*) were prevalent on the beaches and property around the house (Photo 12). The property around the 110-year-old house also contains construction equipment, a shed, debris piles, and empty plastic barrels (Photo 13-15). The north and west sides of the house foundation are being severely undercut by waves and erosion. North of the dock is a small low rock breakwater. Sea lettuce (*Ulva lactuca*)(Photo 16) was visible beside the dock. Plant species identified on this remnant included: poison ivy

(*Toxicodendron radicans*), and recently planted willow oak (*Quercus phellos*), maple trees (*Acer rubrum*), and marsh elder (*Iva frutescens*) (Photo 17). Additionally, blue mussels (*Mytilus edulis)*, blue crab (*Callinectes sapidus*), and periwinkle (*Littorina*) shells (Photo 18) were found on the sandy beach near the dock; bird tracks (likely heron or egret) were also found in this area (Photo 19). Mute swans (*Cygnus olor*) were observed in the waters around the central remnant (Photo 20).

Several sandy beach coves exist on the east side of the central remnant. Marsh fiddler crabs (*Uca pugnax*) were found in the marsh areas with spartina, which flanked the north and south ends of the 3 sandy coves (Photo 20). On the beach of one of these coves, mammal tracks were found (Photo 21) possibly river otter (*Lutra canadensis*). Small fish (possibly killifish) (photo 22), sparse SAV, monarch butterflies (photo 23), dragon flies (*Odonata order*), blue crab exoskeletons, mussel shells, and mosquitoes (*Aedes solicitans*) were also observed in the area. Additionally, wax myrtle (*Myrica cerifera*), groundsel tree (*Baccharis halimifolia*), seaside goldenrod (*Solidago sempervirens*), and pokeberry (*Phytolacca americana*) were also found. Brick debris, iron pieces--possibly from stoves, rounded stones thought to be ballast stones, and some pottery were observed on the beaches. A nesting platform was placed in the shrubs near one of the coves; this appeared to be a highly utilized bird habitat. Two osprey nests were observed in trees along the western shoreline. Snowy egrets (*Egretta thula*) and cattle egrets (*Bubulcus ibis*) were perched in the low trees and shrubs on the eastern side of the remnant island. At the southern tip of the island there were tree snags (Photo 24). A small bird of prey (possible a sharpshined hawk or a merlin), unidentified species of swallows, and what is believed to be a northern flicker (*Colaptes auratus*) were also observed on the central remnant. A rookery of bird nests was observed in the shrubbery on the southern tip of the remnant. The US Fish and Wildlife Service believes the nests were most likely built by green herons (*Butoroides striatus*) or little blue herons (*Egretta caerulea*), were approximately 1-2 ft off the ground, approximately 10-12 inches in diameter, created with medium size twigs, and lined with small shell fragments (Photo 25). Toadstools (Photo 26) were also found in this area.

On the west side of the island the habitat from the waters edge included layers of peat and detritus followed by smooth cordgrass, saltmeadow cordgrass, and big cordgrass (*Spartina cynosuroides*) growing in sandy substrate. Spike grass (*Distichlis spicata*) grew among the saltmeadow cordgrass. Patches of phragmites, black needlerush (*Juncus roemerianus*), sweet flag (*Acorus calamus*) and switch grass (*Panicum virgatum*) also occurred in this area (Photo 27-28). A small intertidal pond was discovered in a higher marsh area (Photo 29). Fish otoliths from the skeletal remains of a black or red drum juvenile were identified. There was slight topographical elevation of approximately 1-2' towards the north end of the remnant; tree snags were also evident (Photo 30).

Southern Remnant

An extensive marsh area occupied the northeastern side of this remnant, from the eastern arm to the northern tip (Photo 31). A pair of swans, possibly mute swans, was observed in the waters off of the shoreline. Scattered tree stands to the north and south of the island were visible. A nesting platform was visible. A dense flock of mute or tundra (*Cygnus columbianus*) swans (60+) (Photo 32) and brown pelicans were observed in this area (Photo 33). Seagulls, boat tailed grackles (*Quiscalus major*), two little blue herons (*Egretta caerulea*), and a bald eagle in a tree near a nest were observed from the boat in this vicinity.

A diamondback terrapin (*Malaclemys terrapin*), and black ducks (*Anas rubripes*) were also observed in this area. Vegetation visible from the boat included: smooth cordgrass, saltmeadow cordgrass, black needlerush, phragmites (~500-square foot stand), and marsh elder. The southern tip of the remnant and parts of the western shoreline (Photo 34) had sandy areas visible, with many gulls perched along the shoreline. Crab pots were scattered along the western side of island and continued up to the northern remnant. On the west side, marshes similar to those on the central remnant were evident (Photo 35), and extended around to the northwest side and mixed with higher elevation vegetation (Photos 36-37). An abandoned truck was observed on the northern end of the southern remnant.

HOLLAND ISLAND

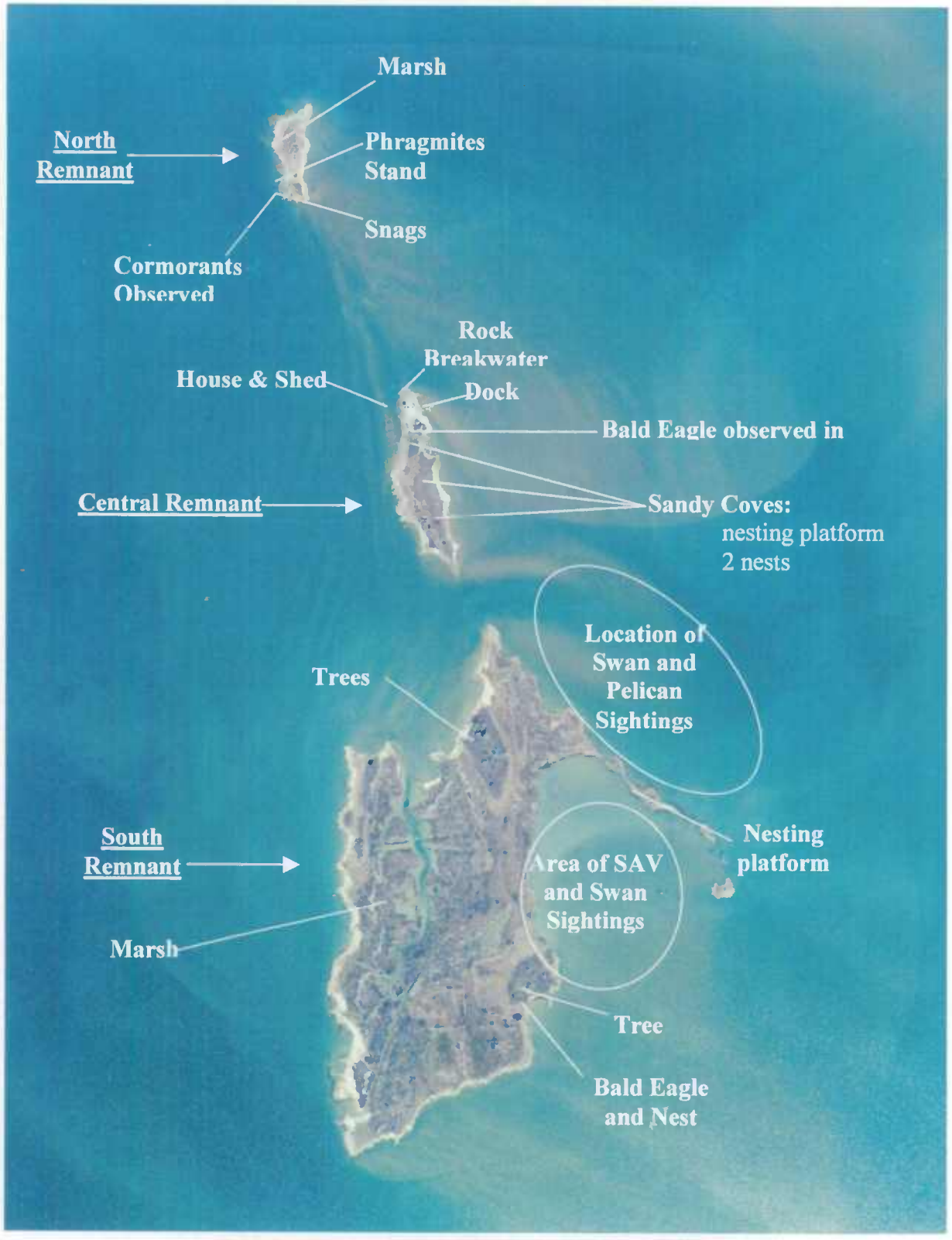


Photo procured by Maryland Port Authority, July 2001

Holland Island Site Visit

Northern Remnant

Holland Island - Eastern shore of Northern Remnant.

Holland Island - Western shore of Northern Remnant.

Holland Island - Southwestern shore of Northern Remnant. Circled are Cormorants perched on snags.

Holland Island Site Visit

Central Remnant

Holland Island - Northern shore of Central Remnant with Mr. White's House.

Holland Island - Western shore of Central Remnant with Mr. White's House.

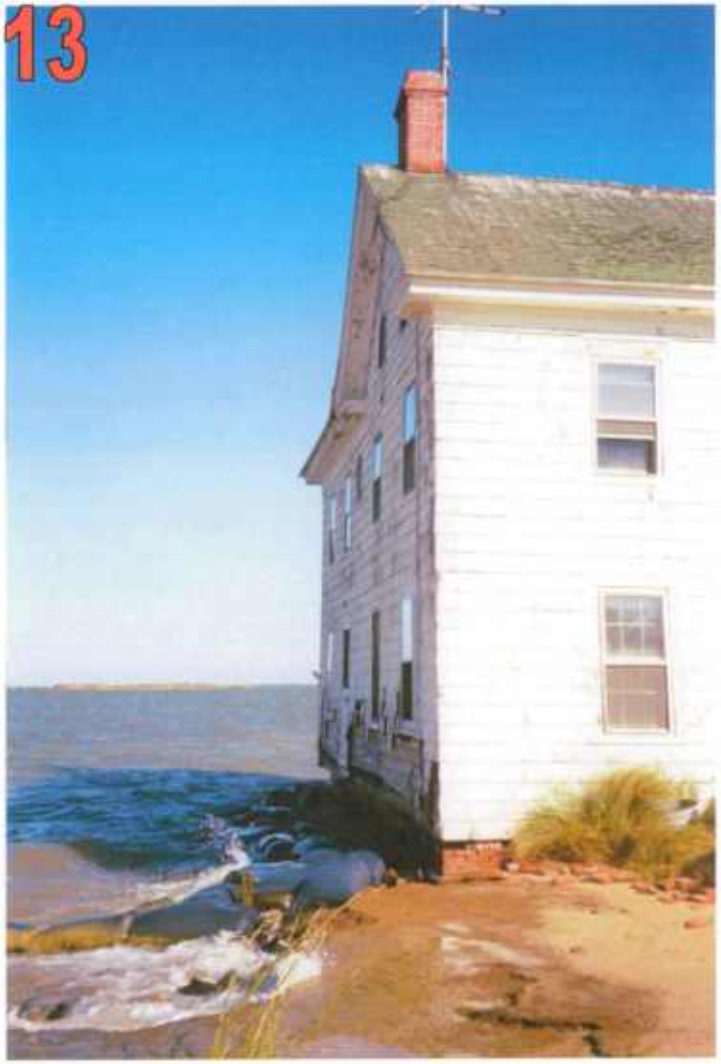
Holland Island - The east side of Mr. White's house located on the northern tip of the Central Remnant. Note gulls on dock.

Holland Island - Nests spotted in the trees lining the eastern shore of the Central Remnant.

Holland Island - Western shore of Central Remnant.

Holland Island - Smooth Cordgrass (*Spartina alterniflora)* on the banks of the Central Remnant.

Holland Island - Rabbit tracks in the Central Remnant's sand.



Holland Island - Erosion of shore surrounding Mr. White's house located on the northern tip of the Central Remnant.

Holland Island - The northern end of Mr. White's house located on the northern shore of the Central remnant.

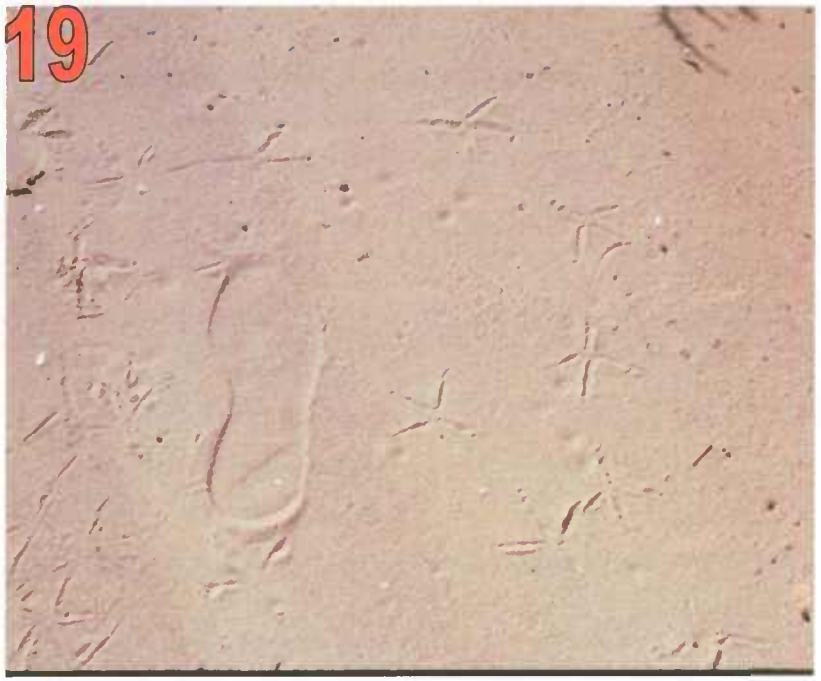
Holland Island - Barrels and debris piled behind the house located on the northern tip of the Central Remnant.

Holland Island – Sea lettuce (*Ulva lactuca*) in the water along the Central Remnant.

Holland Island - Marsh Elder (*Iva frutescens*) in the sand on the eastern side of the Central Remnant.

Holland Island - A periwinkle(*Littorina)* found in the sand of the Central Remnant.

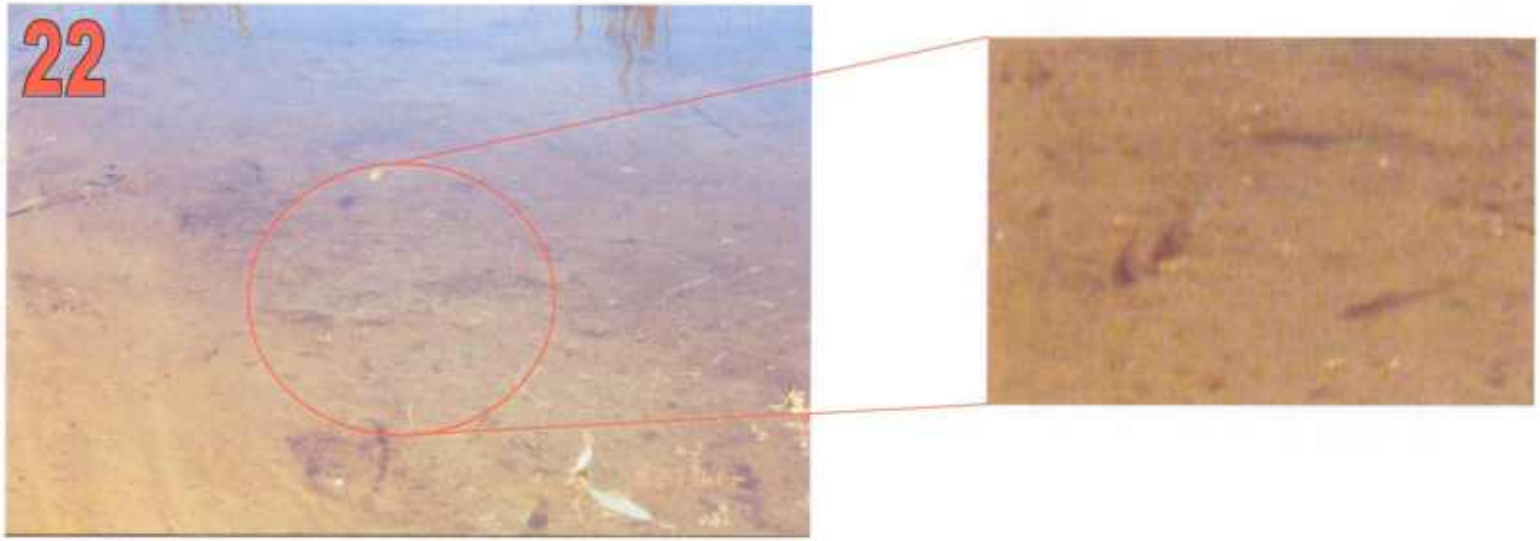
Holland Island - The shell of a Bluecrab (*Callinectes sapidus)* in the sand of the Central Remnant.



Holland Island - Bird tracks.

Holland Island - Dead trees in a cove on the eastern side of the Central Remnant.

Holland Island - Eastern side of Central Remnant. In the sand are mammal tracks, possibly river otter *(Lutra canadensis)*.



Holland Island - Fish, most likely killifish, swimming in a cove on the eastern side of the Central Remnant.

Holland Island - A Monarch butterfly (*Danaus plexippus*) rests in a bush on the Central Remnant.

Holland Island - Southern shore of Central Remnant looking towards Southern Remnant (northern tip).

Holland Island - A bird's nest found on the southern end of the Central Remnant.

Holland Island - Toadstools found on the southern end of the Central Remnant.

Holland Island - Cordgrass on the banks of the Central Remnant.

Holland Island - Southwestern shoreline of the Central Remnant.

Holland Island - Intertidal pond located on the western side of the Central Remnant.

Holland Island - Southern end of Mr. White's house located on the northern shore of the Central Remnant. Note tree snags and slight increase in elevation of the northern shore.

Holland Island Site Visit

Southern Remnant

Holland Island - Northern shore of Southern Remnant with swans (most likely mute swan) on the right

Holland Island - Eastern shore of the Southern Remnant with 60+ swans, possibly tundra or mute. A break-away portion of the remnant island is visible in the right foreground of this photograph.

Holland Island - Brown Pelicans (*Pelecanus occidentalis)* flying along the eastern shore of the Southern Remnant.

Holland Island - sandy Southern shore of Southern Remnant.

Holland Island - marshes on Western shore of Southern Remnant.

Holland Island - North-western shore of Southern Remnant.

APPENDIX III

From: Sarah Weller
To: Monde, Michele
Date: 7/10/02 8:51AM
Subject: Fwd: FW: NOB question

For your files

>>> <KGREENHAWK@dnr.state.md.us> 06/28/02 09:53AM >>>
Sarah,

Hope this helps. Louis is very knowledgable about the NOBs.

-----Original Message-----
From: Wright, Louis
To: Greenhawk, Kelly
Sent: 6/27/2002 11:13 PM
Subject: RE: NOB question

he legal definition is found in the Annotated Code in three places, 4-1000m, 4-1100h, and 4-11A-01g. Basically it says that anything shown on the current charts as a NOB is a NOB, or if can be shown by the public that they have made a living on a location over the past 5 years (this is meant for lease protests and protests of reclassifications and is based on the Goldsborough definition from the 1880's), or if the area has been planted with shell or seed. The historic bars really have no legal significance, since they have been "reclassified" by the Bay Bottom Survey bars and the more recent additions and reclassifications last year when the charts were brought into NAD83 (see 4-1102b). Many of the historic bars are within the boundaries of the newer bars and therefore are protected in that manner. It used to be Fisheries policy that no plantings were to be made outside of the charted bars, as that took away bottom from clammers and leaseholders. I don't think that that policy is currently practiced, judging from the location of a number of recent sanctuaries and reserve areas.

The protection afforded by NOB status depends mostly on the various Fisheries laws and how various agencies view the bars. DNR looks at them with great importance; I think that the Department of Planning at one time clasified them as "areas of critical State concern." Any real protection depends on how the local judges come down on the watermen for clamming and other violations. In general, destruction of NOB's is prohibited under 4-1118.1, but this section also gives the State the authority to dig up NOB's for the shell deposits.

Louis

-----Original Message-----
From: Greenhawk, Kelly
Sent: Thursday, June 27, 2002 11:46 AM
To: Wright, Louis
Subject: FW: NOB question

Louis,

Can you word a definition ????

-----Original Message-----
From: Sarah Weller [mailto:sweller@mbakercorp.com]
Sent: Wednesday, June 26, 2002 4:42 PM
To: KGREENHAWK@dnr.state.md.us
Subject: NOB question

Hello,

I'm working with the Maryland Environmental Service on the Holland Island Environmental Conditions report--you helped me several months ago with some oyster bar information.

I have a general question for you-What is the difference in protection between the legal NOBs, and the historic oyster bars? Basically, what is the definition of NOB and how are these areas protected?

Again I really appreciate your help..

Regards,

Sarah Weller
Baker Environmental, Inc.
770 Lynnhaven Parkway, Suite 240
Virginia Beach, VA 23452
P: 757-631-5407
F: 757-463-0503

From: Sarah Weller
To: Monde, Michele
Date: 7/10/02 8:51AM
Subject: Fwd: RE: clamming data

For your files

>>> <CLEWIS@dnr.state.md.us> 07/01/02 03:34PM >>>
I looked back as far as 1990, and soft clams were reported in Tangier Sound or the lower Chesapeake Bay during the years 1990, 1992, 1993, and 2000. There was nothing reported from those areas during any other year.

Connie Lewis

-----Original Message-----
From: Sarah Weller [mailto:sweller@mbakercorp.com]
Sent: Wednesday, June 26, 2002 4:47 PM
To: CLEWIS@dnr.state.md.us
Subject: clamming data

Hello,

You had provided me with clamming data in the Holland Island vicinity for an Environmental Conditions Report I am working on with Maryland Environmental Service. You only had information for the year 2000, with clam landings in the upper half of the Tangier Sound at 298 bushels.

I just want to confirm that the absence of clam data indicates no clamming activity in the area as well, and how many years you have on record with no clam data/activity?

I appreciate your help-please contact me if you have questions.

Regards,

Sarah Weller
Baker Environmental, Inc.
770 Lynnhaven Parkway, Suite 240
Virginia Beach, VA 23452
P: 757-631-5407
F: 757-463-0503

Maryland Department of Housing and Community Development

Division of Historical and Cultural Programs

100 Community Place
Crownsville, Maryland 21032

410-514-7600
1-800-756-0119
Fax: 410-987-4071
Maryland Relay for the Deaf:
711 or 1-800-735-2258

http://www.dhcd.state.md.us

Parris N. Glendening
Governor

Raymond A. Skinner
Secretary

Marge Wolf
Deputy Secretary

October 23, 2001

Ms. Sarah Weller
Michael Baker Jr., Inc.
801 Cromwell Park Drive, Suite 110
Glen Burnie, MD 21061

Re: Holland Island, Dorchester County

Dear Ms. Weller:

In response to your request of September 24, 2001, the Maryland Historical Trust (MHT) has reviewed the above-referenced project with respect to information on historical resources.

MHT files record two inventoried archeological sites on Holland Island. These include the William A. Parks Site (18DO116; 19th century domestic) and the Jenkins Cannon Cemetery (18DO185; 19th-20th graveyard near house ruins)(see Attachments A and B). There has been no evaluation of the eligibility of these sites for the Maryland Register of Historic Properties. Additional historical archeological resources are probably present on Holland Island, while some may have experienced erosional damage. This assessment is based partly on a review of Lake, Griffing, and Stevenson's 1877 atlas (Attachment C), which depicts a number of houses, as well as a school and M.E. church. During a 1991 field reconnaissance of the island, Dr. Gary Shaffer of MHT's staff learned from Mr. Stephen L. White that a second cemetery is associated with a church property, perhaps the M.E. church.

Navigational charts for the Chesapeake Bay inventory two wreck sites west of Holland Island. To date, there has been no submerged archeological evaluation or survey to determine the eligibility of these sites for the Maryland Register of Historic Properties. The wrecks would most likely require a submerged archeological Phase I survey prior to permit issuance or insurance that potential damage by project activities (anchorage's, dredge or another underwater disturbance activity) can be avoided. The state's underwater archeologist would also request a monitor presence be assigned with permit issuance, to allow this office to opportunity to observe any and all project activities.

MHT has no record of any standing structures on Holland Island. A search of the Maryland Inventory of Historic Properties found no listings. One book entitled *Holland's Island's Disappearing,* and published by its author Ms. Gail M. Walczyk, was located in MHT's library.

Any state-sponsored project on Holland Island would require further consultation with MHT and possible historic preservation studies pursuant to Maryland law (Art. 83B, 5-617 & 5-618, Ann. Code of MD). We request that you treat the enclosed site locational information as confidentially as possible, in order to prevent site damage. If you have any questions or require further information, please contact Dr. Gary Shaffer (terrestrial archeology, 410-514-7638), Mr. Stephen Bilicki (underwater archeology, 410-514-7668), or Ms. Tania Tully (structures, 410-514-7636).

Sincerely,

Elizabeth J. Cole
Administrator
Project Review and Compliance

EJC/GDS/SRB/TGT
200103478
Cc: Ms. Tammy Banta (MD Environmental Service)
Mr. Christopher Kehoe

17 October, 2001

Dear Ms. Weller :

I am sorry to report that neither the general catalogue of our collections nor the indices to the Maryland Historical Magazine back to 1905 contain any mention of Holland's Island in Dorchester County, Maryland.

Sincerely yours

Francis P. O'Neill
Reference Librarian

201 West Monument Street, Baltimore, Maryland 21201-4674

From: <NBUTOWSKI@dnr.state.md.us>
To: <sweller@mbakercorp.com>
Date: 10/15/01 1:47PM
Subject: FW: data request

Dear Ms. Weller,

Regarding your data requests:

3. Are there records for blue crab harvests from the area? Mid-bay?

4. Is there record of specific finfish catches in the Holland Island area?

I requested info on your questions from our commercial data person and she put together the following spreadsheets (see attachment). Our data base is not specific to Holland Island but in the vicinity. NOAA code 29 is the Chesapeake Bay mainstem south of Cove Pt. to the MD/VA line. NOAA code 92 is Tangier Sound. There are separate spreadsheets for finfish and crabs. The column labels should be self explanatory. Please email me if you have any questions. Hope you will find the data useful.

> <<Query56.xls>>
>
##

This message has been scanned for viruses.

NOAACODE	SPECNAME	11 YEAR TOTAL	AVG ANNUAL LBS
029	AMBER JACKS	184	17
029	BLUEFISH UNC	147025	13366
029	BONITO	250	23
029	BUTTERFISH UNC	2195	200
029	CARP	1423	129
029	CATFISH	10517	956
029	CATFISH - WHITE	58	5
029	CATFISH - CHANNEL	15728	1430
029	COBIA	590	54
029	COD - AT, UNCLASSIFIED	75	7
029	CRAPPIE	267	24
029	CROAKER	444694	40427
029	DRUM BLACK	19926	1811
029	DRUM RED	529	48
029	EEL COMMON	41986	3817
029	FLOUNDER SUMMER	38284	3480
029	FLOUNDER WINTER	1640	149
029	FLOUNDER YELLOWTAIL	25	2
029	GIZZARD SHAD	44652	4059
029	HERRING SEA	231	21
029	HICKORY SHAD	115	10
029	JACK CRAVALLE	25	2
029	LINGCOD	23	2
029	LM BASS	5	0
029	KINGFISH	1500	136
029	MACKEREL AT	291	26
029	MENHADEN	3190769	290070
029	MULLET - BLACK OR SILV	163	15
029	POMPANO	52	5
029	PORGY UNC	30	3
029	RIVER HERRING	116155	10560
029	SB - RELEASED	373649	33968
029	SB - UNCLASSIFIED striped bass	1528635	138967
029	SEA BASS BLACK	633	58
029	SEA TROUT GRAY	56817	5165
029	SEA TROUT SPOTTED	19724	1793
029	SHARK - DUSKY	30	3
029	SHARK - MAKO	50	5
029	SHARK UNC	389	35
029	SHEEPSHEAD	15	1
029	SM BASS	50	5
029	SPADEFISH	6228	566
029	SPANISH MACKEREL	40960	3724
029	SPOT	71817	6529
029	STURGEON	222	20
029	TARPON	50	5
029	TAUTOG	217	20
029	UNKNOWN	0	0

NOAACODE	YEAR	Pounds	
029	90	6,125,668	
029	91	6,068,857	
029	92	3,754,637	
029	93	8,557,139	
029	94	5,512,917	
029	95	6,705,390	
029	96	6,334,239	
029	97	7,638,035	
029	98	4,550,741	
029	99	5,744,426	
029	00	3,801,205	
		64,793,253	5,890,296 AVERAGE
092	90	3,220,881	
092	91	4,001,162	
092	92	2,828,062	
092	93	4,562,919	
092	94	3,538,941	
092	95	3,588,328	
092	96	2,736,054	
092	97	3,084,398	
092	98	1,966,997	
092	99	2,424,004	
092	00	2,111,073	
		34,062,819	3,096,620 AVERAGE

029	WHITE PERCH	42566	3870
029	WHITING UNC	5	0
029	YELLOW PERCH	4887	444
092	BLUEFISH UNC	26350	2395
092	BULLHEAD	10825	984
092	BUTTERFISH UNC	360	33
092	CARP	698	63
092	CATFISH	7088	644
092	CATFISH - WHITE	3000	273
092	CATFISH - CHANNEL	500	45
092	CRAPPIE	3297	300
092	CROAKER	669037	60822
092	DOLPHINFISH	58	5
092	DRUM BLACK	873	79
092	DRUM RED	403	37
092	EEL COMMON	184636	16785
092	FLOUNDER SUMMER	7692	699
092	FLOUNDER WINTER	13	1
092	GIZZARD SHAD	1610	146
092	HALIBUT - AT	80	7
092	HERRING SEA	150	14
092	HORSESHOE CRAB	580	53
092	LINGCOD	16	1
092	MENHADEN	113783	10344
092	MULLET - BLACK OR SILV	53	5
092	PORGY UNC	2057	187
092	RIVER HERRING	185	17
092	SB - RELEASED	11112	1010
092	SB - UNCLASSIFIED	61745	5613
092	SEA BASS BLACK	6106	555
092	SEA TROUT GRAY	119783	10889
092	SEA TROUT SPOTTED	1745	159
092	SHARK UNC	125	11
092	SPANISH MACKEREL	317	29
092	SPOT	447942	40722
092	SWELLFISH	148	13
092	TAUTOG	709	64
092	TUNA - YELLOWFIN	429	39
092	WHITE PERCH	175512	15956
092	WHITING UNC	429	39
092	YELLOW PERCH	4525	411

Parris N. Glendening
Governor

Kathleen Kennedy-Townsend
Lt. Governor

Maryland Department of Natural Resources

Tawes State Office Building
Annapolis, Maryland 21401

J. Charles Fox
Secretary

Karen M. White
Deputy Secretary

October 17, 2001

Ms. Sarah Weller
Michael Baker, Jr., Inc.
801 Cromwell Park Drive, Suite 110
Glen Burnie, MD 21061

RE: **Environmental Review for Holland Island, Dorchester County, Maryland.**

Dear Ms. Weller:

The Wildlife and Heritage Service has no records for Federal or State rare, threatened or endangered plants or animals within this project site. This statement should not be interpreted as meaning that no rare, threatened or endangered species are present. Such species could be present but have not been documented because an adequate survey has not been conducted or because survey results have not been reported to us.

However, there is a significant waterbird colony located on Holland Island. Waterbird colonies are a rare resource that should be protected. Conservation of waterbird colonies that are located in the Chesapeake Bay Critical Area is required by state law (§ 8-1801/1806). Significant mortality of chicks or eggs resulting from disturbance of the colony during the breeding season is a violation of the U.S. Migratory Bird Treaty Act. Disturbance includes actions such as cutting nest trees, cutting nearby trees or nearby construction that causes abandonment of chicks by the adults. No construction or timber harvesting activities should occur in the area during the breeding season. The breeding season varies for each different waterbird species, but is generally from 15 March through 15 August. For further technical assistance regarding conservation of waterbird colonies, please contact Scott Smith of the Wildlife and Heritage Service at (410) 827-8612.

Also, the open waters that are adjacent to or part of the site are known historic waterfowl concentration areas. If there is to be any construction of water-dependent facilities please contact Mr. Larry Hindman of the Wildlife and Heritage Service, at (410) 827-8612, for technical assistance regarding waterfowl.

Sincerely,

Lori A. Byrne

Lori A. Byrne,
Environmental Review Specialist,
Wildlife & Heritage Service

ER# 2001.1841.do
cc: S.A. Smith
L. Hindman

MICHAEL BAKER JR., INC.
PHONE CALL REPORT

PROJECT/LOCATION: Holland Island Conceptual Study	S.O. NO.: 25147-000-0000--04000 DATE: October 10, 2001 CONTRACT NO.:
To: Maryland Department of Natural Resources, Wildlife and Heritage Division Repres.: Glenn Therres Phone No. : 410-260-8572	From: Sarah Weller Repres.: Michael Baker Corporation Phone No.: 410-424-2322

SUBJECT: Bald Eagle Nest and other RTE at Holland Island

Sarah Weller of Michael Baker Corporation contacted the Mr. Therres as a follow up to a RTE letter received from US Fish and Wildlife Service. Fish and Wildlife stated that the federally threatened bald eagle is present at Holland Island (as of 1994) and to contact Mr. Therres for more information. Mr. Therres stated that a bald eagle nest is no longer present at Holland Island, and had not been for a few years. He stated that we should concentrate on the colonial waterbirds (herons, egrets, etc.) at Holland Island, and that the person to contact was Lori Byrne. I stated that I had mailed her a letter, and that we should be getting her reply very soon.

Baker

Michael Baker Jr., Inc.
A Unit of Michael Baker Corporation

801 Cromwell Park Drive, Suite 110
Glen Burnie, MD 21061

(410) 424-2210
FAX (410) 424-2300

October 9, 2001

Phyllis Carter
NAS Patuxent River Range Operations
Patuxent River, MD 20670

RE: Drilling Operations at Holland Island

Dear Ms. Carter:

Michael Baker Jr., Inc., has been contracted by the Maryland Environmental Service (MES) to prepare a Conceptual Study of Holland Island for potential beneficial use and habitat restoration. As part of this study, geotechnical drilling work will be performed in the vicinity of Holland Island. The NAS Patuxent River Office of Environmental Planning (OEP) has been contacted regarding possible UXO and clearance issues for completing the drilling operations. OEP advised us to notify the NAS Patuxent River Range Operations two days prior to sampling at a particular location fairly close to the Bloodsworth Island U.S Naval Reservation boundary.

The drilling operations will mobilize on Monday, October 8, and continue until Friday October 19, weather permitting. Sampling at the location nearest to Bloodsworth Island will not begin any earlier than Thursday, October 11. This letter serves to notify the NAS Patuxent River Range Operations of these drilling activities. If you have any questions or concerns, please contact Siva Balu, Drilling Manager, at 410-574-4393 or Michele Monde, Project Manager, at 410-424-2317.

Sincerely,

MICHAEL BAKER JR., INC.

Sarah E Weller

Sarah Weller
Environmental Scientist

Enclosure

cc: Tammy Banta, MES
Steve Storms, MPA
Siva Balu, E2CR
Russell Piovesan, NAS Patuxent River, OEP

MICHAEL BAKER JR., INC.
PHONE CALL REPORT

PROJECT/LOCATION: Holland Island Conceptual Study	S.O. NO.: 25147-000-0000–04000 DATE: October 9, 2001 CONTRACT NO.:
To: NAS Patuxent River Range Operations Building Repres.: Phyllis Carter Phone No. : 301-342-4607	From: Sarah Weller Repres.: Michael Baker Corporation Phone No.: 410-424-2322

SUBJECT: Notification of Drilling Activities at Holland Island

Sarah Weller of Michael Baker Corporation contacted the NAS Patuxent River Range Operations Building at the request of the NAS Patuxent River Environmental Planning Office. A memo received by Baker on September 6, 2001 from the Environmental Office suggested notifying the Range Ops before completing the drilling and geotechnical work at Holland Island. A representative at the Range Ops was informed and stated that since we are not in an airplane, there was no need to inform them of our plans. She told the air traffic controller that a boat and drilling operations would be taking place at Holland Island over the next 2 weeks (until October 19) so that they are aware. She said that she did not want a fax or letter from us, and that she could not think of anyone else at Range Ops that we should inform.

From: Sarah Weller
To: Monde, Michele
Date: 10/9/01 11:41AM
Subject: Range Operations

I spoke to a representative at the Pax Range Ops. She said that as long as we aren't in a plane around Bloodsworth, they don't need to know of our activities. She did tell the air traffic controller of the drilling plans at Holland for the next 2 weeks, but couldn't think of anyone else to notify at their office. She didn't want a letter or fax... I did a phone call report. Do you think that is sufficient?

Baker

Michael Baker Jr., Inc.
A Unit of Michael Baker Corporation

801 Cromwell Park Drive, Suite 110
Glen Burnie, MD 21061

(410) 424-2210
FAX (410) 424-2300

October 5, 2001

Maryland Historical Society
Library Services
201 West Monument Street
Baltimore, MD 21201

RE: Request for Historical Information, Holland Island, Maryland

Dear Whom it May Concern:

Michael Baker Jr., Inc., has been contracted by the Maryland Environmental Service (MES) to prepare a Conceptual Study of Holland Island for potential beneficial use and habitat restoration. As part of this study, an environmental conditions investigation is being conducted to determine a variety of factors. Included in these factors is historical and cultural resource information.

The purpose of this letter is to formally request historical information at Holland Island, and to document the Maryland Historical Society's response for the project's files. A brief list of any available information at the Maryland Historical Society concerning Holland Island would be sufficient.

Please see the enclosed map of Holland Island and neighboring landmasses. It is located on two USGS topographic maps; Bloodsworth Island quadrangle, and Kedges Straits quadrangle. Thank you for your prompt reply to this request. If you have any questions, please call me at (410)424-2322 or Michele Monde, Project Manager, at (410)424-2317.

Sincerely,

MICHAEL BAKER JR., INC.

Sarah Weller

Sarah Weller
Environmental Scientist

Enclosure

United States Department of the Ir

FISH AND WILDLIFE SERVICE
Chesapeake Bay Field Office
177 Admiral Cochrane Drive
Annapolis, MD 21401

October 3, 2001

Ms. Sarah Weller
Environmental Scientist
Michael Baker, Jr., Inc.
801 Cromwell Park Drive, Suite 110
Glen Burnie, Maryland 21061

RE: Holland Island
Dorchester County, MD

Dear Ms. Weller:

This responds to your August 27, 2001, request for information on the presence of species which are federally listed or proposed for listing as endangered or threatened within the above referenced project area. We have reviewed the information you enclosed and are providing comments in accordance with Section 7 of the Endangered Species Act (87 Stat. 884, as amended; 16 U.S.C. 1531 *et seq.*).

The federally threatened bald eagle *(Haliaeetus leucocephalus)* is present within the project area. Nest DO-94-16 is located on the north tip of Holland Island. For further information regarding activity at this nest, Glenn Therres of the Maryland Wildlife and Heritage Division should be contacted at (410) 260-8572.

Except for occasional transient individuals, no other federally proposed or listed endangered or threatened species are known to exist within the area. Should additional information on the distribution of listed or proposed species becomes available, this determination may be reconsidered.

This response relates only to federally protected threatened or endangered species under our jurisdiction. For information on the presence of other rare species, you should contact Lori Byrne of the Maryland Wildlife and Heritage Division at (410) 260-8573.

An additional concern of the Service is wetlands protection. Federal and state partners of the Chesapeake Bay Program have adopted an interim goal of no overall net loss of the basin's remaining wetlands, and the long term of increasing the quality and quantity of the basin's wetlands resource base. Because of this policy and the functions and values wetlands perform,

the Service recommends avoiding wetland impacts. All wetlands within the project area should be identified, and if construction in wetlands proposed, the U.S. Army Corps of Engineers, Baltimore District should be contacted for permit requirements. They can be reached at (410) 962-3670.

We appreciate the opportunity to provide information relative to fish and wildlife issues, and thank you for your interest in these resources. If you have any questions or need further assistance, please contact Andy Moser at (410) 573-4537.

Sincerely,

Mary Ratnaswamy

Mary J. Ratnaswamy, Ph.D.
Program Leader, Endangered Species
Chesapeake Bay Field Office

cc:
Maryland Wildlife and Heritage Division, Annapolis, MD
(ATTN: Glenn Therres)

From: <NBUTOWSKI@dnr.state.md.us>
To: <SWELLER@mbakercorp.com>
Date: 10/2/01 9:24AM
Subject: RE: Commercial fisheries info-Holland Island

Hello,

I will be giving you pieces of information as I obtain them since I have to go to different sources. To begin with,
Question 1) We don't keep bar specific harvest data, Holland Island is near the intersection of three different harvest code areas, which extend a good distance from the island. Harvest for the area in general is very low.
2000-2001 harvest

Area 192 - Tangier Sound, south of Wenona - 1472.5 Bu
Area 292 - Tangier Sound, north of Wenona - 82 Bu
Area 129 - Chesapeake Bay, South of Cove Point and east of Ship channell - 2037Bu

I'll get back to you with more later.

-----Original Message-----
From: Sarah Weller [mailto:SWELLER@mbakercorp.com]
Sent: Monday, October 01, 2001 3:38 PM
To: nbutowski@dnr.state.md.us
Subject: Commercial fisheries info-Holland Island

Good afternoon,

I am working on an Environmental Assessment for Holland Island, (in mid Chesapeake Bay, off of Dorchester County, just south of Bloodsworth Island.) I'd like to include some commercial fishery information for the area around Holland Island (oyster, crabs, finfish, softshell clam, etc.) I'm not sure where to start and was hoping you could help. Any info you could provide would be helpful (specific to the Holland Island area....) Some specific questions are:

1. Are there productive oyster bars in the vicinity of Holland island, and if so, do you have any harvest data?

2. What is the nearest clam fishery to Holland Island?

3. Are there records for blue crab harvests from the area? Mid-bay?

4. Is there record of specific finfish catches in the Holland Island area?

Thank you very much for your time. I can be reached at the following:
Have a good day,

Sarah Weller
Baker Environmental, Inc.
801 Cromwell Park Drive, Suite 110
Glen Burnie, MD 21061
410-424-2322
F: 410-424-2300

Baker

Michael Baker Jr., Inc.
A Unit of Michael Baker Corporation

801 Cromwell Park Drive, Suite 110
Glen Burnie, MD 21061

(410) 424-2210
FAX (410) 424-2300

September 24, 2001

Ms. Elizabeth Cole
Maryland Historical Trust
100 Community Place, Third Floor
Crownsville, MD 21032-2023

RE: Request for Historical Information, Holland Island, Maryland

Dear Ms. Cole:

Michael Baker Jr., Inc., has been contracted by the Maryland Environmental Service (MES) to prepare a Conceptual Study of Holland Island for potential beneficial use and habitat restoration. As part of this study, an environmental conditions investigation is being conducted to determine a variety of factors. Included in these factors is historical and cultural resource information.

The purpose of this letter is to formally request historical information at Holland Island, and to document the Maryland Historical Trust's response for the project's files. Any architectural or archaeological sites of significance on which you have information would be useful. A brief list of the sites and available information concerning Holland Island would be sufficient.

Please see the enclosed map of Holland Island and neighboring landmasses. It is located on two USGS topographic maps; Bloodsworth Island quadrangle, and Kedges Straits quadrangle. Thank you for your prompt reply to this request. If you have any questions, please call me at (410)424-2322 or Michele Monde, Project Manager, at (410)424-2317.

Sincerely,

MICHAEL BAKER JR., INC.

Sarah Weller

Sarah Weller
Environmental Scientist

Enclosure
cc: Ms. Tammy Banta
MES

NAS PATUXENT RIVER

OPERATIONAL ENVIRONMENTAL PLANNING OFFICE

OPERATIONAL ENVIRONMENTAL PLANNING OFFICE

Shore Station Management Center, 22473 Millstone Road, Building 505
Naval Air Station Pauxent River, Maryland 20670
Office phone number: 301.757.1728

FAX COVER SHEET

Date: 9/13/01 **Number of Pages including cover sheet:** 3

To: Sarah Weller
Company Name: Baker Environmental
Phone Number:
Fax Number: (410) -424- 2300

From: Russ Piovesan
Company Name: Camber Corp, NAS Patuxent River
Phone Number: 301-757-1724
Fax Number: 301.757.1703

Comments: Sarah let me know if I can provide you any further assistance

Russ

NAVAL AIR STATION

To: Sarah Weller
From: Don Shaver
Date: 6 September 2001

Re: Risk of Unexploded Ordnance (UXO) in the Holland Island Vicinity
Encl: 1) Map Bloodworth Island U.S. Naval Reservation Boundary

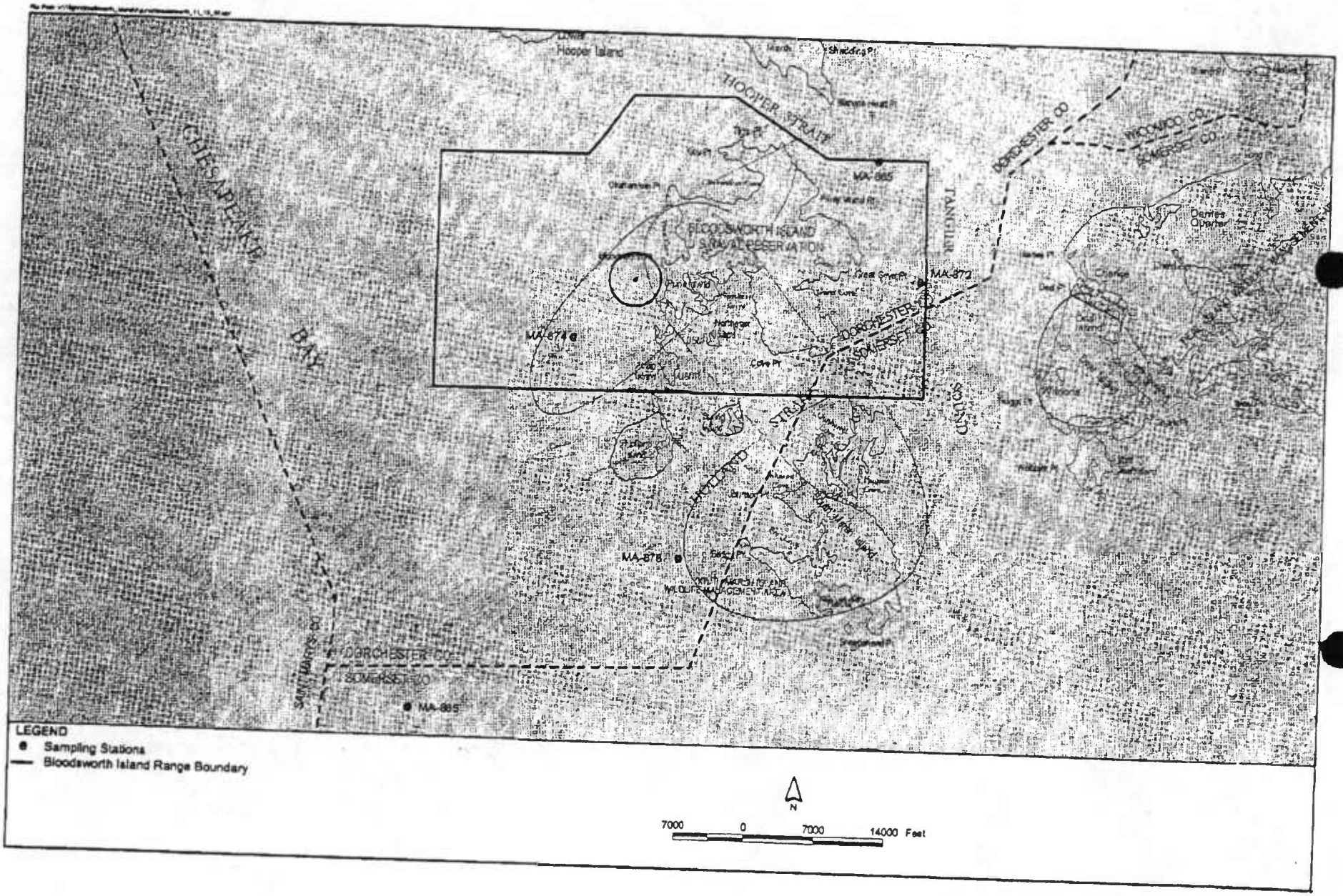
Upon reviewing the 12 sampling locations depicted in the Draft Boring Plan and comparing those locations with historical data, it is highly unlikely that any UXO would be encountered during the proposed sampling event. The Operational Environmental Planning Office has come to this conclusion based on the following information:

- All proposed sampling locations are located outside the Bloodsworth Island U.S. Naval Reservation Boundary.
- Available historic data on Bloodsworth, leads us to believe that there has never been any ordnance released outside of the Bloodsworth Island U.S. Naval Reservation Boundary.
- Background water samples and soil samples where taken from the same general areas as this proposed effort, during the Bloodsworth sampling that occurred earlier this year. The contractor performing the sampling had considered this area to be clear of UXO and operated with out a UXO specialist during this phase of sampling.

Sample location 1 is fairly close to the Bloodsworth Island U.S. Naval Reservation Boundary and it is advised that the individual in charge of sampling coordinate with NAS Patuxent River Range Operations (301.342.4607) two days prior to sampling at this location. This will eliminate any disturbance of sampling due to range clearance.

Based on the close proximity of Holland Island to the Bloodsworth Island U.S. Naval Reservation Boundary, NAS Paxtuxent River is requesting copies of any information/presentations available on the future plans for Holland Island

The enclosure shows the location of the Bloodsworth Island U.S. Naval Reservation Boundary for your reference. If you have any questions or concerns please contact Russ Piovesan at 301.757.1724.


Hooper Island
HOOPER STRAIT
CHESAPEAKE
BAY
BLOODSWORTH ISLAND
U.S. NAVAL RESERVATION
TANGIER
SOUND
DORCHESTER CO
WICOMICO CO
SOMERSET CO
MA-865
MA-872
MA-874
MA-878
MA-885
Deal Island
Dames Quarter
SAINT MARYS CO
LEGEND
Sampling Stations
Bloodsworth Island Range Boundary
N
7000
0
7000
14000 Feet

MICHAEL BAKER JR., INC.
PHONE CALL REPORT

PROJECT/LOCATION: Holland Island Conceptual Study	S.O. NO.: 25147-000-0000--04000 DATE: September 5, 2001 CONTRACT NO.:
To: Russell Piovesan Repres.: NAS Patuxent River Office of Environmental Planning Phone No. : 301-757-1724	From: Sarah Weller Repres.: Michael Baker Corporation Phone No.: 410-424-2322

SUBJECT: Holland Island UXO

Sarah Weller of Michael Baker Corporation contacted Russell Piovesan at the NAS Patuxent River Office of Environmental Planning to inquire about possible UXO information around Holland Island. Mr. Piovesan had been assigned by Mark Luncher to be my Point of Contact for issues regarding Holland Island UXO. Mr. Piovesan stated his information verbally, and said that he will be sending a written package as well. He stated that all UXO targets are north of the tower on Adams Island. Adams Island is south of Bloodsworth Island, before Holland Island. Because that tower is the boundary for any UXO targets, he stated that it is very unlikely that any UXO would be encountered during drilling operations around Holland Island. The majority of UXO has been found along the east coast of Bloodsworth Island. CH2Mhill apparently used a point at the northern tip of Holland Island as their background sampling location, and did not require a UXO official. Mr. Piovesan stated that a UXO specialist would probably not be necessary. He will be providing a map showing all UXO locations around Bloodsworth and Adams Island. He also said that no one could say definitely that UXO would not be present, but that it is highly unlikely. A package should be arriving next week.

MICHAEL BAKER JR., INC.
PHONE CALL REPORT

PROJECT/LOCATION: Holland Island Conceptual Study	S.O. NO.: 25147-000-0000--04000 DATE: August 29, 2001 CONTRACT NO.:
To: Mark Luncher Repres.: NAS Patuxent River Office of Environmental Planning Phone No. : 301-342-1689	From: Sarah Weller Repres.: Michael Baker Corporation Phone No.: 410-424-2322

SUBJECT: Holland Island UXO

Sarah Weller of Michael Baker Corporation contacted Mark Luncher at the NAS Patuxent River Office of Environmental Planning to inquire about possible UXO information around Holland Island. Mr. Luncher stated that they had little to no information specific to Holland Island, but that they were performing environmental studies/sampling at nearby Bloodsworth Island where UXO has a high potential to exist. He stated that CH2Mhill was performing this work, and that preliminary studies for contamination in the sediment at Bloodsworth Island indicated that the sediment passed criteria. (unclear what criteria is meant). He stated that UXO is known to wash up on the Bloodsworth Island Coast as a result of erosion. He also stated that the Navy has not done any live bombing at Bloodsworth Island for 5 years. He suggested that Baker notify the Navy (Central Operations) of their plans (dates) for being in the area of Holland Island. He will be getting back to us with specific information on who to contact about our specific field dates, and with safety precautions that other samplers have taken when working around Bloodsworth Island, with regard to the potential for encountering UXO. I faxed him a copy of the Draft Boring Plan, and gave him my and Michele Monde's contact information.

Baker

Michael Baker Jr., Inc.
A Unit of Michael Baker Corporation

801 Cromwell Park Drive, Suite 110
Glen Burnie, MD 21061

(410) 424-2210
FAX (410) 424-2300

August 24, 2001

Ms. Mary Ratnaswamy
Chesapeake Field Office
US Fish and Wildlife Service
177 Admiral Cochrane Drive
Annapolis, MD 21401

RE: Request for Rare, Threatened and Endangered species information, Holland Island, Maryland.

Dear Ms. Ratnaswamy:

Michael Baker Jr., Inc., has been contracted by the Maryland Environmental Service (MES) to prepare a Conceptual Study of Holland Island for potential beneficial use and habitat restoration. As part of this study, an environmental conditions investigation is being conducted to determine a variety of factors. Included in these factors are various habitat conditions, water quality, and Rare, Threatened and Endangered (RTE) species information.

We are requesting that your office provide any information regarding RTE species of plants and animals (including insects) on and in the vicinity of Holland Island. Holland Island is located off the southern part of Dorchester County, Maryland, south of Bloodsworth Island. Please see the enclosed map of Holland Island and neighboring landmasses.

Thank you for your prompt reply to this request. If you have any questions, please call me at (410)424-2322 or Michele Monde, Senior Engineer, at (410)424-2317.

Sincerely,

MICHAEL BAKER JR., INC.

Sarah Weller

Sarah Weller
Environmental Scientist

Enclosure

cc: Tammy Banta
MES

Baker

Michael Baker Jr., Inc.
A Unit of Michael Baker Corporation

801 Cromwell Park Drive, Suite 110
Glen Burnie, MD 21061

(410) 424-2210
FAX (410) 424-2300

August 24, 2001

Ms. Laurie Byrne
Maryland Department of Natural Resources
Wildlife and Heritage Division, E-1
580 Taylor Avenue
Annapolis, MD 21401

RE: Request for Rare, Threatened and Endangered species information, Holland Island, Maryland.

Dear Ms. Byrne:

Michael Baker Jr., Inc., has been contracted by the Maryland Environmental Service (MES) to prepare a Conceptual Study of Holland Island for potential beneficial use and habitat restoration. As part of this study, an environmental conditions investigation is being conducted to determine a variety of factors. Included in these factors are various habitat conditions, water quality, and Rare, Threatened and Endangered (RTE) species information.

We are requesting that your office provide any information regarding RTE species of plants and animals (including insects) on and in the vicinity of Holland Island. Holland Island is located off the southern part of Dorchester County, Maryland, south of Bloodsworth Island. Please see the enclosed map of Holland Island and neighboring landmasses.

Thank you for your prompt reply to this request. If you have any questions, please call me at (410)424-2322 or Michele Monde, Senior Engineer, at (410)424-2317.

Sincerely,

MICHAEL BAKER JR., INC.

Sarah Weller

Sarah Weller
Environmental Scientist

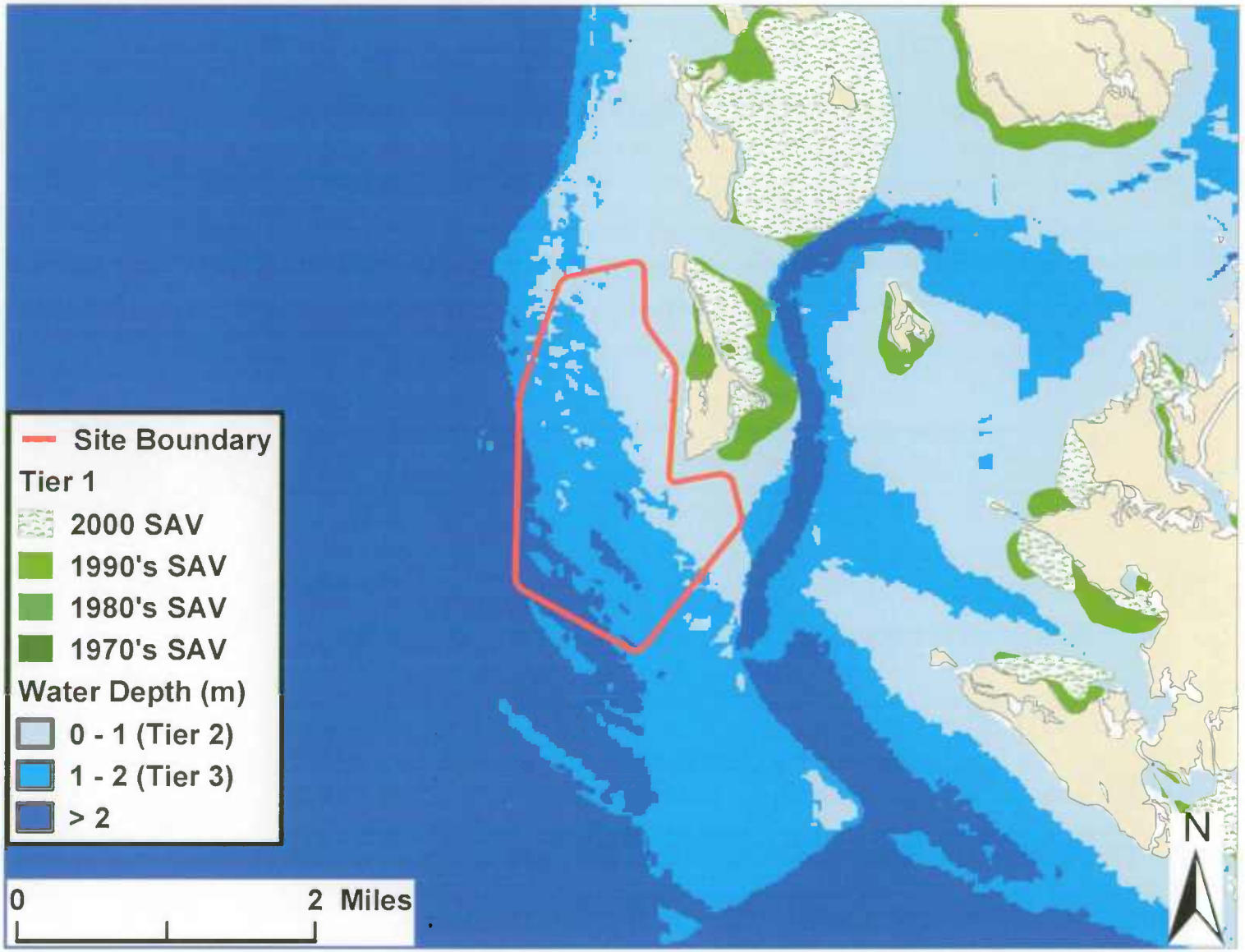
Enclosure

cc: Tammy Banta
MES

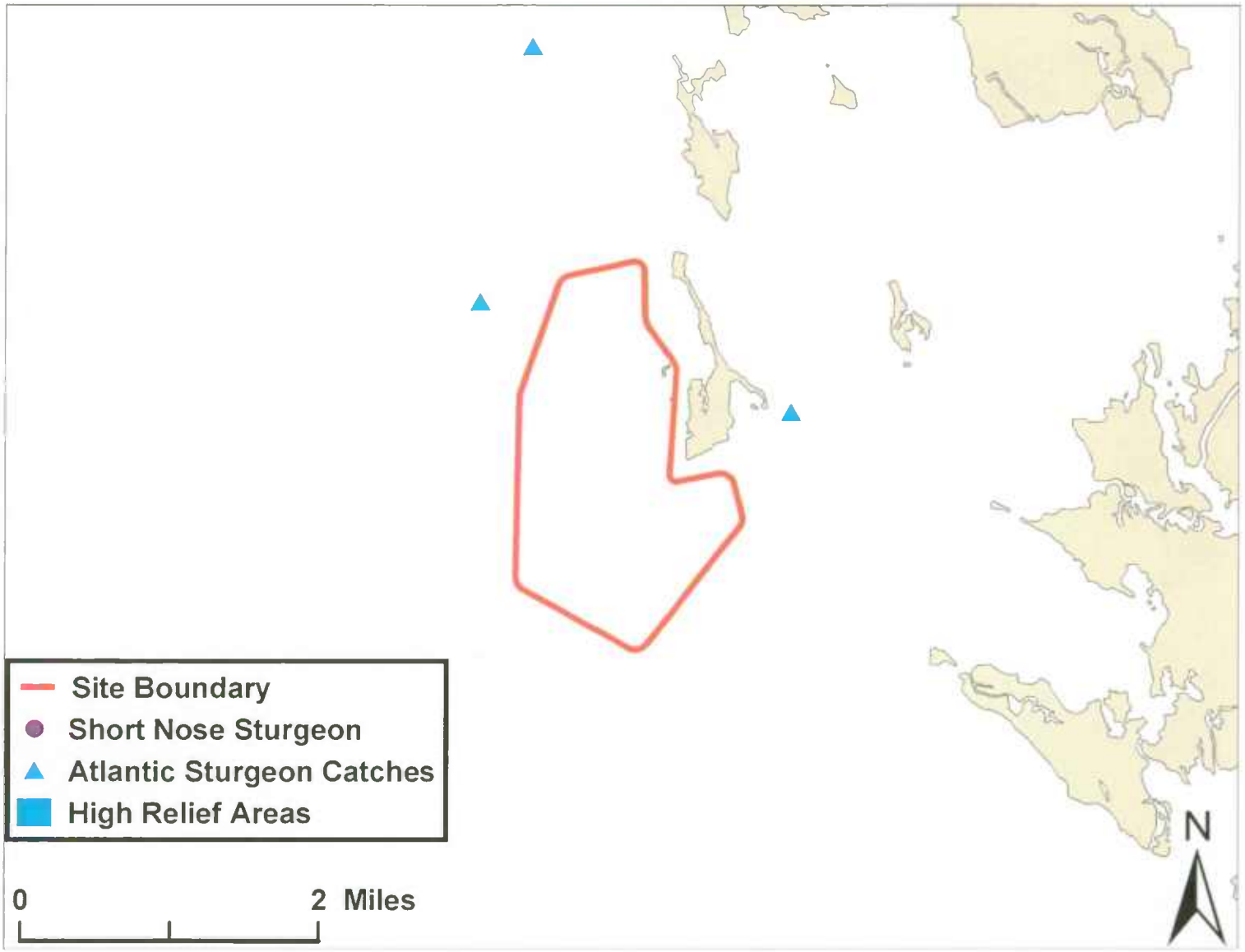
Appendix E

APPENDIX E

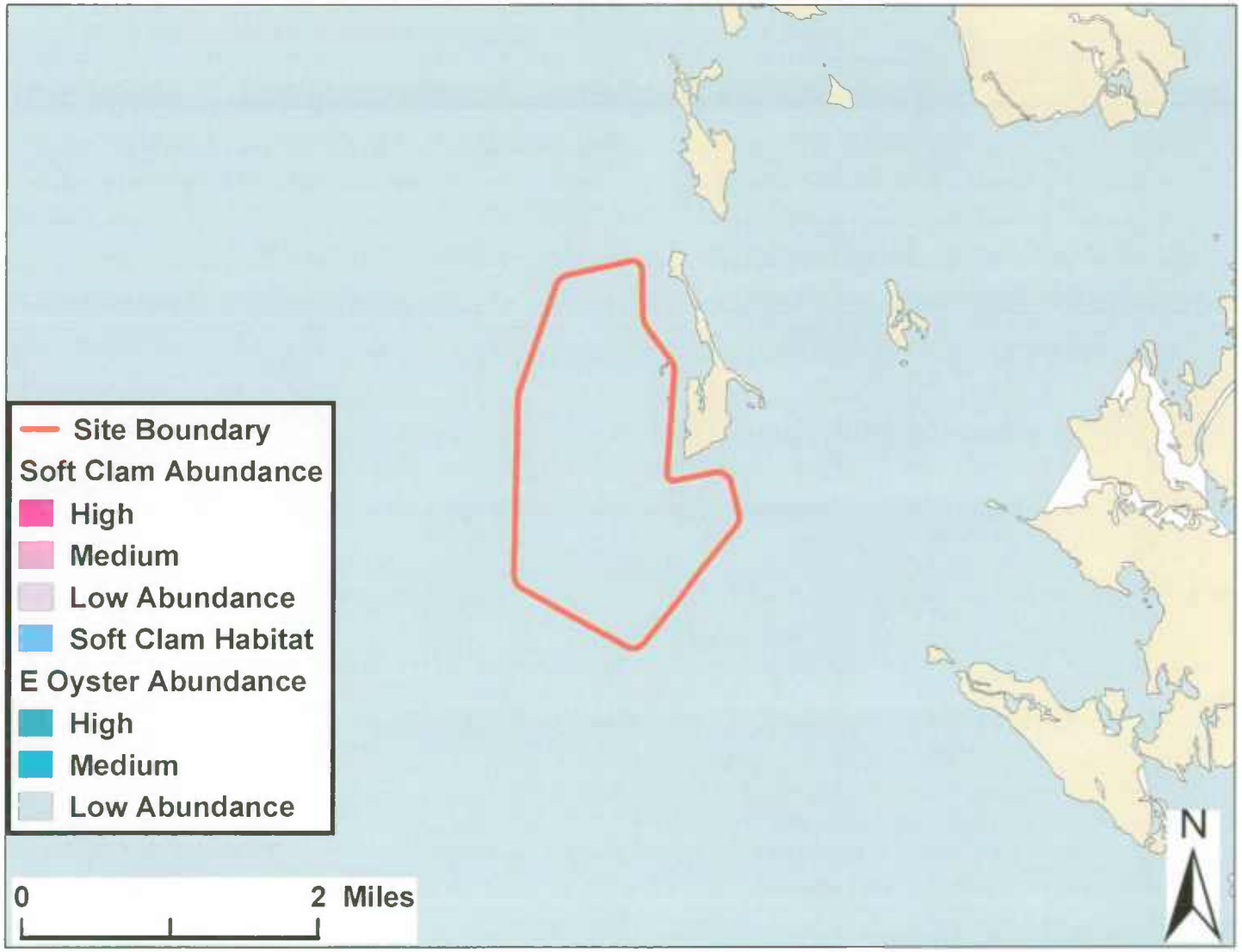
Holland Island (1:50,000):
Submerged Aquatic Vegetation with Tier 1 and Tier 2 Habitat



Holland Island (1:50,000): Critical Finfish Habitat

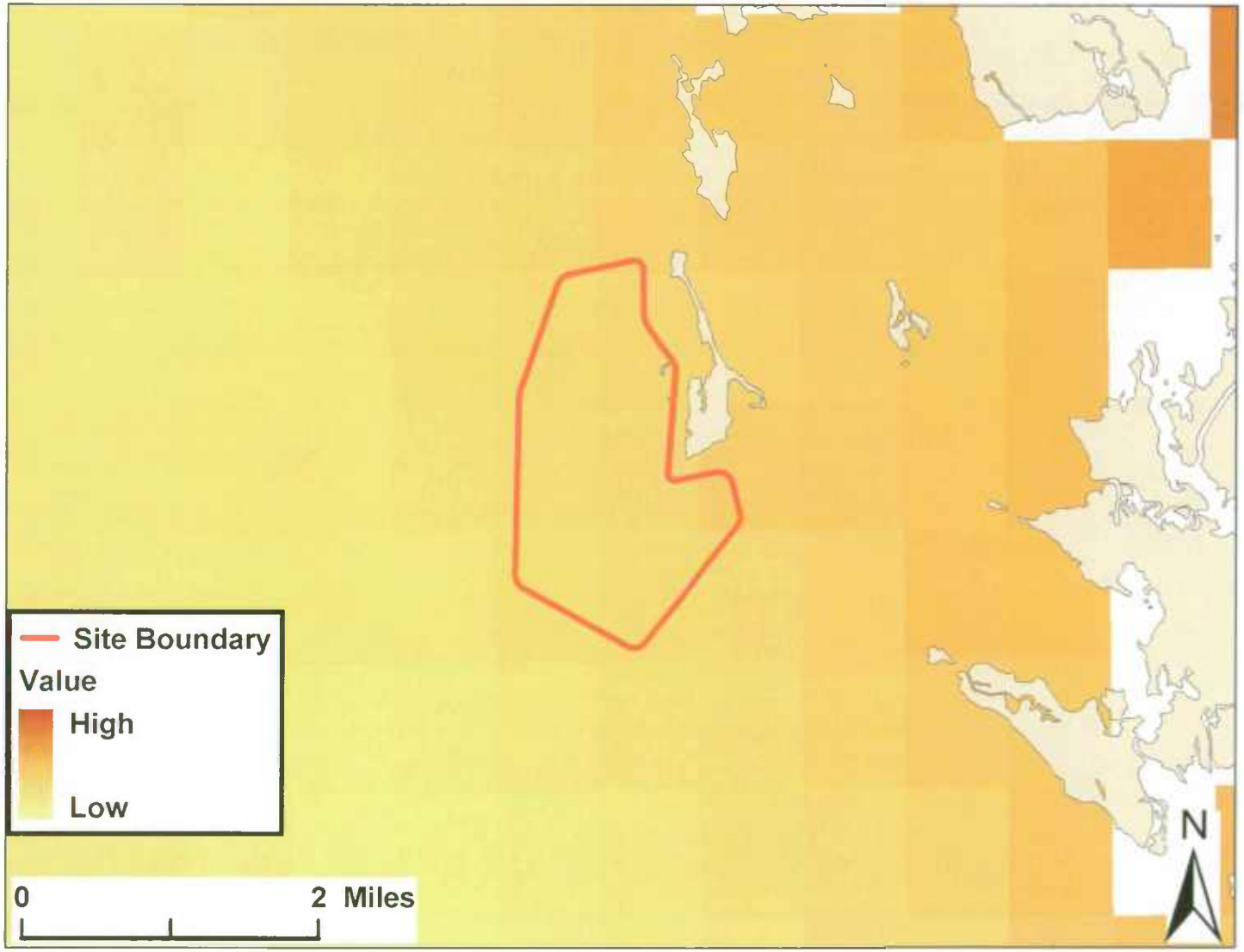


Holland Island (1:50,000): Classified Shellfish Areas



Holland Island (1:50,000): Oyster Bar Delineations

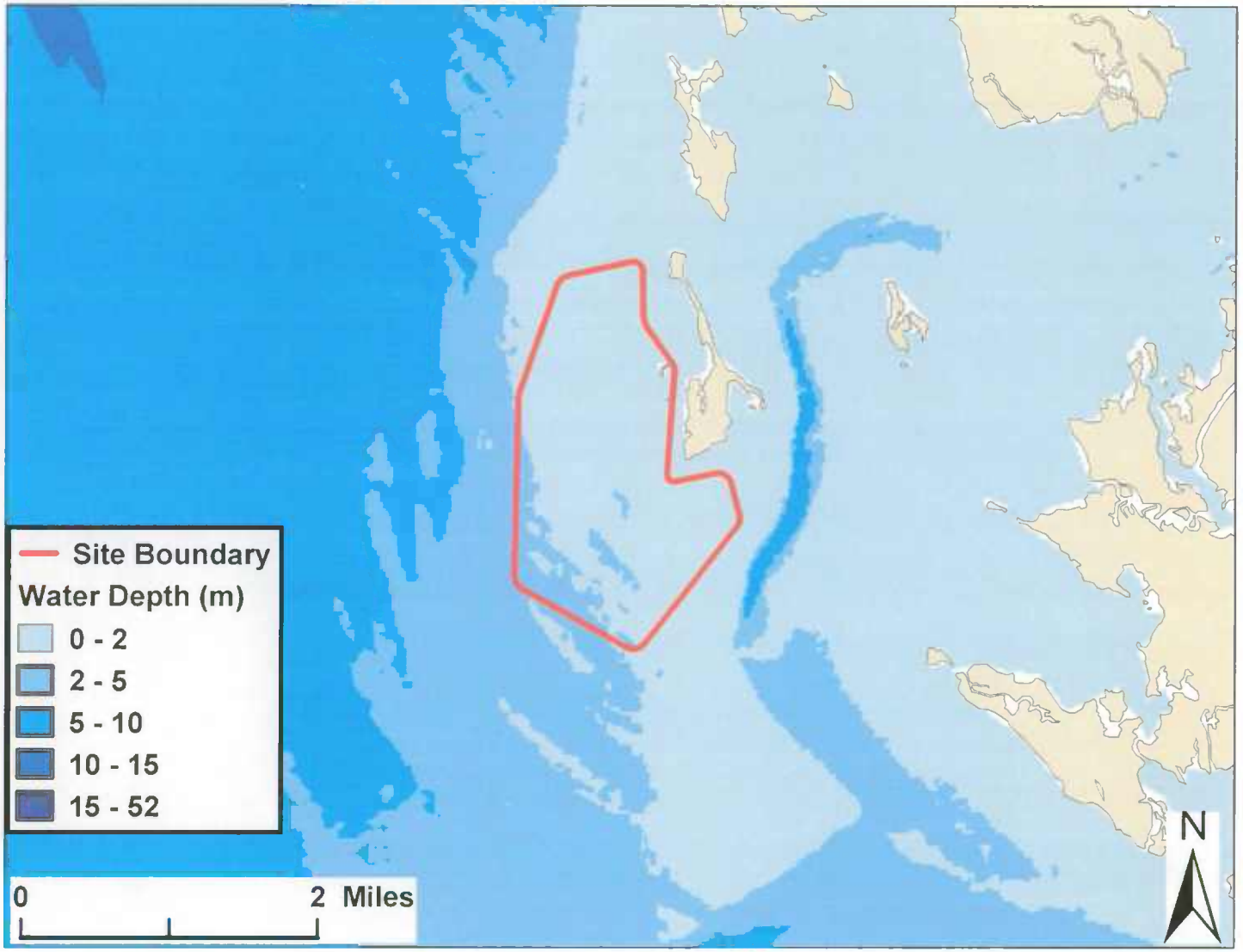
Holland Island (1:50,000): Winter Mean Crab Abundance (1990-1998)



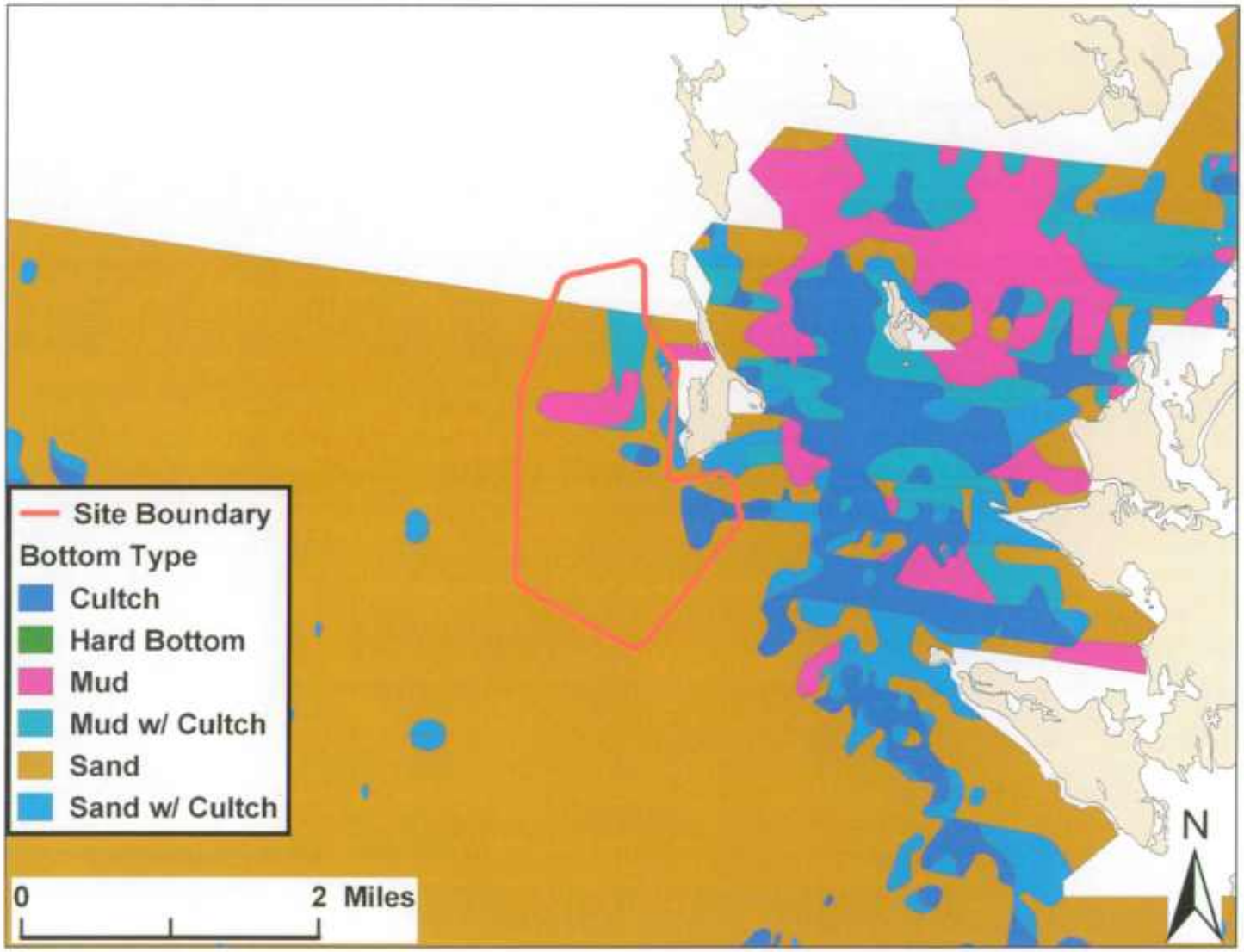
Holland Island (1:50,000): Commercial and Recreational Fishing Grounds

Holland Island (1:50,000): Cultural Resources

Holland Island (1:50,000): Water Depth



Holland Island (1:50,000): Bottom Type



Holland Island (1:50,000): Anadromous and Semi-anadromous Finfish Spawning Extents with Species Count

Holland Island (1:50,000): Potential Summer Flounder Habitat