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REGIONAL SHORELINE ELEMENT OF COMPREHENSIVE PLANS HAMPTON ROADS PLANNING DISTRICT (INTERM REPORT)

VOLUME I

PREPARED BY THE
HAMPTON ROADS PLANNING DISTRICT COMMISSION

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REGIONAL SHORELINE ELEMENT
OF
COMPREHENSIVE PLANS
HAMPTON ROADS PLANNING DISTRICT
(INTERIM REPORT)

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Prepared by the Staff of the
Hampton Roads Planning District Commission
in cooperation with staff from the
Cities, Counties and Towns of Hampton Roads

March 1994

INTRODUCTION

Hampton Roads is a region of nearly 3,000 square miles, of which 2,400 square miles is located in the Virginia Coastal Zone. Ocean, Bay and major river shorelines amount to more than 1,370 miles. Hundreds of additional miles of shoreline can be found on the tributaries to these major waterbodies. The Region is unique in that it includes a variety of shoreline types - ocean, bay, river, creek, and lake. These shorelines encompass the entire range of shoreline types found in coastal Virginia. They include sandy beaches, extensive and fringing tidal marshes, riverine swamps and intensely developed, hardened shorelines. Topography ranges from low, nearly flat shorelines to areas with steep bluffs. The shorelines are affected by water energy levels ranging from high wave energy along the ocean and bay shorelines to placid backwaters on many of the tributaries.

The coastal resources, and in particular, the shorelines and waterbodies of the Hampton Roads region are a major contributing factor to the region's attractiveness and growth. As a result, the region's shorelines and waterways are heavily used and pressure for further development and use is increasing. Not only do the region's shorelines and waterways serve the recreational needs of the residents, but they also provide an important recreational asset for other Virginians as well as residents of other states and countries.

The shorelines present a tremendous opportunity for commercial, industrial and residential development as well as recreational activity. However, this opportunity is tempered by the hazards presented to shoreline development by natural processes. Many of the shorelines are subject to intense wave action which causes erosion that may threaten existing and future shoreline developments.

Shoreline Situation Reports, prepared by the Virginia Institute of Marine Science for much of the area during the late 1970s, documented a variety of then-existing shoreline characteristics, including shoreline erosion, land ownership and shoreline structures for both erosion protection and access. Other studies of the characteristics of specific shoreline reaches were completed during the period from the late 1970s to the early 1990s. However, there was no consistent or comprehensive effort to update the information contained in the Shoreline Situation Reports on a regional basis during that period.

At project inception, the Virginia Institute of Marine Science in cooperation with the Department of Conservation and Recreation, Division of Soil and Water Conservation had recently completed an analysis of shoreline erosion control structures on the major tributaries (James, York, Rappahannock and Potomac) to the Chesapeake Bay (Bank Erosion Study). That study did not address private piers and docks, erosion conditions or conditions on the remaining rivers and estuaries in the Hampton Roads region.

Waterway access studies conducted by the Department of Conservation and Recreation - Division of Planning and Recreation Resources, the HRPDC and the region's local governments have focused historically on provision of additional public access to the Bay and its tributaries. Prior to this project, there had been no attempt to quantify the amount of existing private access to these waterways. Also, there had been no attempt to determine the impact of existing private access to the region's waterways on water quality or critical aquatic resources.

Each of the region's local governments is required by law to update its comprehensive plan on a five-year basis. In addition, the Chesapeake Bay Preservation Act and Regulations require that local governments in coastal Virginia specifically address shoreline erosion and private piers and docks in their comprehensive plans. It was recognized at project inception that, in the immediate future, each of the coastal communities in the Hampton Roads region would be updating its comprehensive plan to incorporate the CBPA planning requirements among others. Working with the Hampton Roads Chesapeake Bay Committee and the cognizant state agencies, the HRPDC staff determined that a regional project to develop the required information on a cooperative, comprehensive, and systematic basis would facilitate compliance with the planning requirements, while reducing the local financial and staff costs of doing so. It would also facilitate development of locality or waterway specific shoreline management plans addressing erosion and construction of waterfront structures.

In that context, a regional project was undertaken by the staff of the HRPDC, in cooperation with staff from the region's local governments, CBLAD and DEQ (VCRMP), to achieve the following objectives:

- To document shoreline characteristics, particularly shoreline erosion and private waterfront access, in a uniform manner for the fourteen coastal communities in the Hampton Roads region.

- To facilitate compliance by the region's fourteen coastal localities with the CBPA comprehensive planning requirements in a cost-effective manner.

- To continue development of a uniform, regional approach to implementation of state and federal stormwater and nonpoint source management programs.

- To develop shoreline erosion control practices that are integrated and compatible with stormwater and nonpoint source management practices.

- To develop cost-effective, reasonable approaches to management of private waterfront access to minimize long-term impacts on coastal water quality and aquatic resources.

During the initial stages of the project, the objectives and scope were expanded to address provision of public access to the region's waterways in a comprehensive fashion. This element of the study involved updating public access information contained in the 1988 study, The Waters of Southeastern Virginia, which addressed public access for the localities of Southside Hampton Roads. The information base and approach was expanded to encompass the localities of the Peninsula portion of Hampton Roads as well.

With respect to shoreline erosion control structures and private access facilities, the study built upon the field work undertaken in the Bank Erosion Study. That information base was expanded to include an inventory of shoreline erosion structures and private waterfront access structures, particularly piers and docks, throughout the Hampton Roads region. Shoreline videotape of the region's entire shoreline was obtained for use in this effort. In addition, the study has collected information on proper design and construction of waterfront structure.

The study involved the following major elements:

- Inventory of Shoreline Conditions, including aquatic resources, water quality, erosion rates and the presence of erosion control and access structures.

- Pier and Dock Density Standards, including analysis of perceived problems associated with the presence of piers and docks, legal approaches to regulation of piers and docks and development of a methodology for determining appropriate standards for such structures.

- Public Access, including inventory of existing facilities, projected demand for access, impacts associated with access facilities and recommendations for future access.

- Shoreline Management, including recommendations on a waterbody-specific and reach-specific basis addressing shoreline erosion as well as private and public access. General policy recommendations addressing legal and educational issues that are applicable throughout the region are also addressed.

This project was coordinated through the Hampton Roads Chesapeake Bay Committee. Other local government staff were involved where appropriate. In addition, work activities have been coordinated with staff from the following state agencies - Chesapeake Bay Local Assistance Department, Virginia Marine Resources Commission, Department of Conservation and Recreation, Divisions of Soil and Water Conservation and Planning and Recreation Resources and Department of Environmental Quality (formerly the State Water Control Board and the Virginia Council on the Environment). Certain elements of the Inventory phase of the project were undertaken by the Virginia Institute of Marine Science under contract to the HRPDC.

This interim report documents the current status of the project. It describes the methodology used in inventorying shoreline structures, public access, erosion conditions, water quality and other environmental resources and management options. Generally, the study process has proceeded from development and analysis of general information applicable to the entire region to analysis of site-specific information for waterbodies and reaches within an individual locality. York County serves as a prototype for locality-specific analysis and management recommendations. That approach is reflected in the organization and content of this Interim Report.

This Interim Report is organized into two Volumes. Both Volumes contain an outline of the ultimate scope of the Volume. The outlines are annotated to some degree to assist the reviewer in visualizing the eventual scope and content of the Volume. The two volumes of this report include:

- **Volume I.** This Volume addresses general study issues such as methodology as well as information and recommendations that are universally applicable throughout the region. This Volume contains the following information:

  - Methodological approaches, information sources and study issues.

  - Inventory of environmental resources, including water quality conditions and discussion of their role and importance in developing shoreline management options.

  - Inventory of physical conditions and discussion of their role and importance in developing shoreline management options.

  - Inventory of management options for shoreline erosion control.

  - Overview of public and private access issues and inventory of access facilities. Criteria for the siting of various types of public and private access facilities are also addressed.

  - Preliminary discussion of perceived problems associated with private waterfront access facilities such as piers and docks, legal issues associated with management of such facilities and management options.

- **Volume II.** This Volume will address water system specific issues and will be organized so that individual water system sections are stand-alone documents. The discussion, contained in the Interim Report Volume II, is the prototype for the balance of Volume II, which ultimately will address each locality in the region. Each water system and its components will be addressed in the same fashion to include inventory documentation, analysis and recommendations. It should be reviewed in conjunction with Volume I.

    - Documentation of water system and reach-specific information and shoreline characteristics for York County. York County serves as the prototype locality for this project. York County and HRPDC staff are presently working to develop specific management options for the County's shoreline.

Final documentation produced through this project will include the two volume report, map series for each waterbody and shoreline video. Volume I will be provided to all localities and the grantor agencies. Additionally, it will serve as the overall project documentation. Each locality will receive copies of that portion of Volume II (report, video and maps) which addresses water systems which lie within or adjacent to the locality. Because many water systems fall in more than one locality, the documentation of water system characteristics will be provided to all localities adjoining or containing the system. Finally, the grantor agencies will each receive final copies of the Volume II package for York County as an example of the work completed for each locality.

This interim report thoroughly documents the current status of this project. Activities which are underway but not documented in this report include review of shoreline inventory maps and video by the remaining participating localities and development of final inventory maps for the region. (It should be noted that in several instances, local governments have identified potential enforcement issues during review of the video and accompanying working maps.) It can be expected that considerable additional information will be finalized in the coming weeks. Staff from the Chesapeake Bay Local Assistance Department and the Department of Environmental Quality are invited/encouraged to review and comment on this interim material.

Comprehensive Shoreline Management Plan
Erosion Outline

Macro Document

I. Erosion Control Background
   A. Literature Review
      1. Coastal Erosion
      2. Large Tidal Waterbody Erosion - Chesapeake Bay and Major Tributaries
      3. Small Tidal Rivers and Creeks
   B. The Erosion Process
      1. Physical Factors Involved in the erosion process

II. Erosion Control and Water Quality

III. Erosion Control Law and Legislation
   A. In Virginia
   B. Elsewhere

IV. Erosion Control and Government Status and Current Trends
   A. Local Government and Erosion Control
      1. Local Wetlands Boards
      2. Chesapeake Bay Boards
   B. State Government
   C. Federal Government
   D. Other Agencies involved in Erosion Control
      1. Virginia Institute of Marine Science
      2. Shoreline Erosion Advisory Service (SEAS)
      3. US Army Corps of Engineers

V. Methods for Implementing Appropriate Erosion Control Measures
   A. Traditional approaches
      1. Land Use, Zoning, and Special Districts
   B. Environmental Issues
      1. Trade off between reduction in Sediment Loadings and disruption Sediment Transport Dynamics
   C. Legal Issues - Property Rights versus Public Interest

VI. Erosion Control Methods
   A. Background and Definitions
      1. Marsh Enhancement
      2. Shoreline Enhancement
      3. Offshore Structures
      4. Perpendicular Structures and Sand Traps
      5. Linear Structures - Revetments, Bulkheads, and Seawalls
   B. Applicability to Hampton Roads Shoreline

VII. Methodology
   A. Shoreline Inventory for Erosion Control Structures and Access Points/Areas
   B. Erosion Control Recommendation

Inventory of Existing Erosion Control Structures
and
Public and Private Access Facilities

A Revised Methodology for Video Interpretation

At the point of project inception, it was expected that the Hampton Roads Planning District Commission would follow the original guidelines and protocols for video based delineation used in previous shoreline studies. A delineation protocol was prepared for HRPDC use by the Center for Coastal Management and Policy, Virginia Institute of Marine Science, the College of William & Mary. (A copy of CMAP's *Analytical Protocols for Delineating Shoreline Structures* is attached.)

HRPDC staff were briefed and provided a training session by CMAP staff. The protocol as developed is fairly straight forward and easy to understand. The delineation required only a VCR, a set of stable base maps, several pencils of varying colors, and an ample amount of time. Past shoreline studies undertaken by VIMS had used this protocol to record the same data and information that the HRPDC was looking to update or create for those areas previously undocumented.

To achieve maximum utility of the updated information, the HRPDC planned on using the same map scale as the previous studies, the USGS 7.5 Minute Quadrangle Series. In relatively short order it was discovered that a) it was impossible to record the level of data present on the videotape to the USGS maps without significant data loss or generalization, and b) that the level of detail provided by the USGS maps would not be sufficient for local planning needs.

At its April, 1993 meeting. the Hampton Roads Chesapeake Bay Committee, through whom this project is coordinated, recommended that the map scale of the USGS Quadrangle was insufficient for their needs as well. HRPDC staff was supplied with copies of local planimetric maps or other maps as deemed appropriate by the local government. Several localities, lacking planimetric or other appropriate maps, opted to have shoreline information recorded on the USGS Quadrangles.

Actual recording of information on study area maps, as stated above, is quite simple. While watching the videotape with the corresponding map, the recorder first orients himself and begins to record the position of shoreline structures. In the case of shoreline hardening, the recorder would mark a beginning and end point along the shoreline and then place the appropriate code (from the following table) adjacent to the shoreline and between the beginning and ending marks. If the information to be recorded is a pier or dock, the recorder would place a point at the approximate position of the pier or dock on the map and code the point to the landward side of the shoreline.

Shoreline Structure Codes

Code Number	New Codes	Structure Type(s)
1		Riprap Revetment
2		Bulkhead (or seawall)
3		Jetty
4		Groin Field
5	✓	Breakwater(s) and Bulkhead
6	✓	Breakwater(s) and Groin Field
7		Breakwater(s)
8	✓	Bulkhead, Breakwater(s), and Groin Field
9		Groin Field and Bulkhead
10		Groin Field and Riprap Revetment
11		Groin Field, Bulkhead, and Riprap Revetment
12		Marina Facility
13		Bulkhead and Riprap Revetment
14		Wharfs (Structures parallel to the shore.)
15		Piers or Docks (Structure perpendicular to the shore.)
16		Abandoned or Failed Piers, Docks, or Wharfs
17		Piers or Docks with Covered Structures (e.g. boathouses)
18		No Structures on the Shore -Shoreline Erosional or Unstable
19		Piers or Docks with Failed Covered Structures
20		Miscellaneous - Sills, Tires, Concrete Blocks, Old Failed Structures
21		Closure Line (for use with Arc/Info only.)
22		No Structures - Shoreline Stable or Accretionary
23		No Aerial Coverage - Creeks, Ponds, and Lakes
24		Boat Ramp
25	✓	Boat Ramp and Pier
26	✓	Boat Ramp and Pier with Covered Structure
27		Unused Code
28		Unused Code
29		Unused Code
30	✓	Industrial or Commercial Pier, Dock, or Wharf

ANALYTICAL PROTOCOLS FOR DELINEATING SHORELINE STRUCTURES

Prepared for the Hampton Roads Planning District Commission
By the Center for Coastal Management and Policy
Virginia Institute of Marine Science
Gloucester Point, Virginia

Introduction

The following document outlines standard procedures to be followed for delineating shoreline structures from videography onto a stable-base map medium. The intent is to prepare a dataset for transfer into a Geographic Information System (GIS). Since GIS databases are spatially oriented, drafting information from video to base maps prepares the delineated data for inclusion in an automated system which is managed, to some degree, by spatial coordinates.

This exercise is considered phase 2 in a multi-phase process to build the GIS database. Phase 1 is to acquire the aerial video coverage. This phase is being conducted by the Center for Coastal Management and Policy (CMAP). Phase 3, which addresses the digitizing process, will be presented in a separate document at a later date.

The steps to be followed are being designed to generate a GIS database with maximum utility for shoreline management. It is important that the database be easily expandable as additional management needs are presented in the future. Change detection analyses may also be desirable from a management perspective. Since similar databases have been developed previously in 1985 and 1990, a foundation for change detection studies has already been established. Therefore, it is in the best interest of this project to design the 1993 database for the Planning District Commission to be compatible with the existing GIS coverages.

Equipment/Supplies

Previous coordination meetings between CMAP and the HRPDC have determined that the HRPDC currently operates the PC version of Arc/Info and has some digitizing device interfaced with a host computer for digital data entry. This will be important for Phase 3. The various coding levels presented here have been designed to be compatible with existing Arc/Info GIS coverages.

To perform the delineation of shoreline structures a color television monitor and a video cassette recorder (VCR) will be required. A remote control is handy, but not critical. The delineations will be drafted directly on the stable-base topographic maps. A large work space will be desirable. USGS topographic maps have been reproduced onto stable-base mylar material. This is the best material for a digitizing medium as it is resistant to stretching, shrinking, and other distortions. The reproductions were copied from original mylar maps to minimize accumulated distortions from multiple generations.

The drafting tools are simply standard lead pencils with fine points. The mylar material of the map may be brownish in color. A contrast color pencil may be preferred. Colored pencils are not really necessary, however, if this activity is expected to be repeated in future years, color pencils can be used to contrast different years of data collection. When selecting the drafting pencil, clarity is the most important consideration. Often the individual who drafts the maps is not the same individual who will digitize the maps. The delineation can become very confusing for the digitizer if the markings are not distinct.

Delineation Process

The delineation of shoreline structures is performed while viewing the video. Features common to the topographic base maps and the film should be used to geographically place the structures on the maps. These include, but are not limited to: buildings, road networks, creeks and tributaries, ponds or lakes, and occasionally piers. The general shape of the shoreline will be a tremendous help in areas where shoreline change is minimum.

Auxiliary data will prove to be very useful when available. Since the video is not static, it will be necessary to fast forward and reverse the tape frequently. A set of oblique slides shown concurrently can minimize some of this. A set of oblique slides from the 1970's was used for the Bank Erosion Study. These are available at VIMS, but cannot be removed from the campus. A working area with monitor and VCR can be provided if staff of the HRPDC choose to use the slides. The base maps used for the Bank Erosion Study have been provided by CMAP. This map set encompasses only the primary riverways. The river reaches, discussed below, can be delineated from these maps.

There will be two levels delineated on the mylar base maps to create the database. The first, and most complicated, is the delineation of the shoreline structures. Various structural types, and combinations of structural types are identified in Table 1. The structures have been identified and combined based on their individual and combined functions for erosion control. Each has a unique code which will be used for identifying the structures in the GIS. The structural breakdown is based upon the database format used by CMAP in developing the Bank Erosion Study for the Division of Soil and Water Conservation. Several elements have been added here to address the needs of this particular project. These include all elements referring to docks or piers, wharfs and boathouses which were not delineated as part of the Bank Erosion Study.

The second level is the delineation of the river reaches. The reaches were originally delineated to represent process similar sections of the shore defined by comparing historic NOS charts with the earliest topographic maps. Although today the reaches have limited utility geomorphically, they have since become a valuable database management tool. The reaches can be queried to request all the shoreline structures identified within the reach. It is a convenient way to subdivide the shoreline into analytically manageable sections. This is how the Bank Erosion Study and several other digital databases available at CMAP are internally managed. The river reaches are already plotted on topographic maps which have been provided by CMAP.

The mylar base maps can be overlaid onto topographic maps and the reaches can be traced with a pencil. Using a different pencil color from the structural delineation may be helpful. On the topographic maps supplied, the reaches are identified by long pencil lines extending seaward from the shoreline. They will usually have a number on either side of the line representing the reach number (Figure 1). The reach number should not be altered. They are reference numbers which apply to several existing shoreline databases. Most of these previous surveys examined the primary shorelines rather than the small tributaries and creeks. Some tributaries and creeks do have reach numbers assigned, which do not appear on these maps. Many creeks have been labelled with a #23 code which indicates no aerial coverage. Since this study will be looking at shoreline within tributaries and creeks, reaches numbers may be desirable. The Shoreline Situation Report series should be consulted for reach numbers which apply to creeks and tributaries. Generally, the reach number applies to the entire watershed of the creek. It may be desirable for the HRPDC to subdivide these creek reaches. The HRPDC may choose to separate one side of the creek from the other. This is one way to manage the data. If so, it is recommended that CMAP be consulted prior to doing so. When defining reaches, it is most important not to repeat reach numbers already labelled for other creeks.

Most structural and all river reaches delineated have a start and end point on the shoreline. A small tic line perpendicular to the shore marks the beginning and the end of the delineation of the structural items. Tic marks which represent the reaches should be somewhat longer to avoid confusion (Figure 2). The code should be clearly written in between the tic marks.

Structures such as piers, or piers with boathouses are points on the shore. Since they do not extend parallel to the coast like bulkheads or rip rap revetments, they cannot be delineated with tics marking the start and end points. They should be identified as single points and clearly labelled with the appropriate code from Table 1 (Figure 3). Small creeks in residential areas may have more piers than can be reasonably plotted within the map space. A separate drawing off to the side expanding the creek dimensions may be helpful. When digitizing, the operator can use the capabilities of Arc/Info to enlarge the digital image and plot the piers directly on the screen. It is important, however, that the digitizer be clearly aware of the number and general placement of the piers.

No deviations from the coding system outlined in Table 1 should be made. If the need to code or delineate an item that does not fit any of the coded elements in the table, additional codes can be added. Codes cannot be more than two digit characters.

It will prove to be extremely useful in the future if progress in this effort is carefully tracked. At a minimum, each map should be identified with the name(s) of the individuals responsible for drafting the delineations. It may be several years before funding becomes available for Phase 3; the transfer of this database into digital format. In the event that questions arise, the digitizer will be able to query records for personnel contacts on this project.

Table 1. SHORELINE STRUCTURES AND CODES

CODE	STRUCTURE TYPE(S)
0	boundary (for use with Arc/Info only)
1	riprap
2	bulkhead
3	jetty
4	groin field
7	breakwaters
9	groin field and bulkhead
10	groin field and riprap
11	groin field, bulkhead, and riprap
12	marina facility
13	bulkhead and riprap
14	wharfs (structures parallel to the shore)
15	piers/docks (structures perpendicular to the shore)
16	abandoned or failed docks, piers and wharfs
17	docks or piers with covered structures (e.g. boathouses)
18	no structures on the shore - shoreline erosional/unstable
19	docks or piers with failed covered structures
20	miscellaneous - sills, tires, concrete blocks, old failed structures
21	closure line (for use with Arc/Info only)
22	no structures - stable or accretional shore
23	no aerial coverage - creeks/ponds/lakes
24	boat ramp

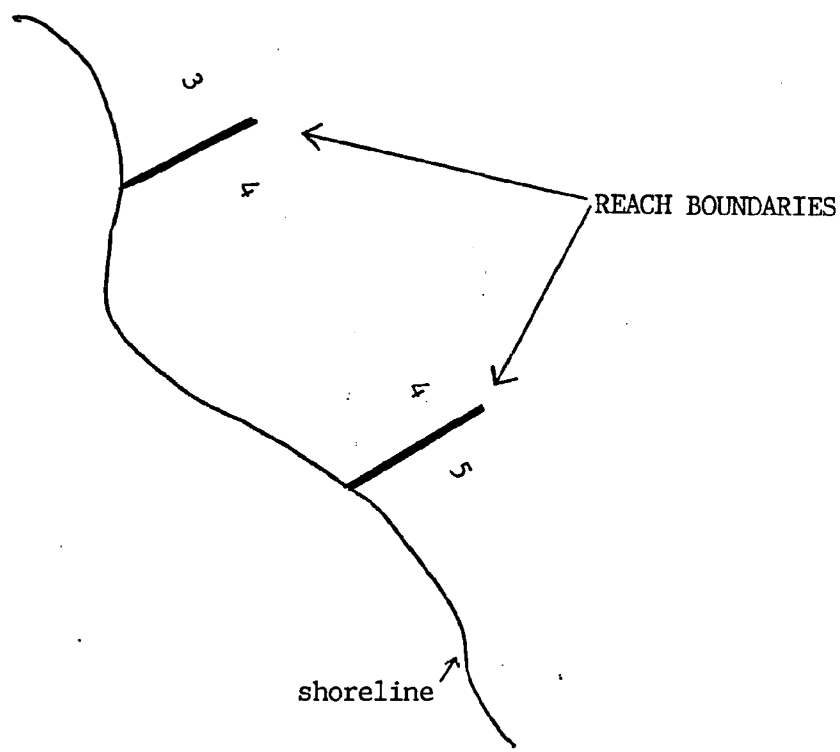

Figure 1. Delineating and Coding Reach Boundaries

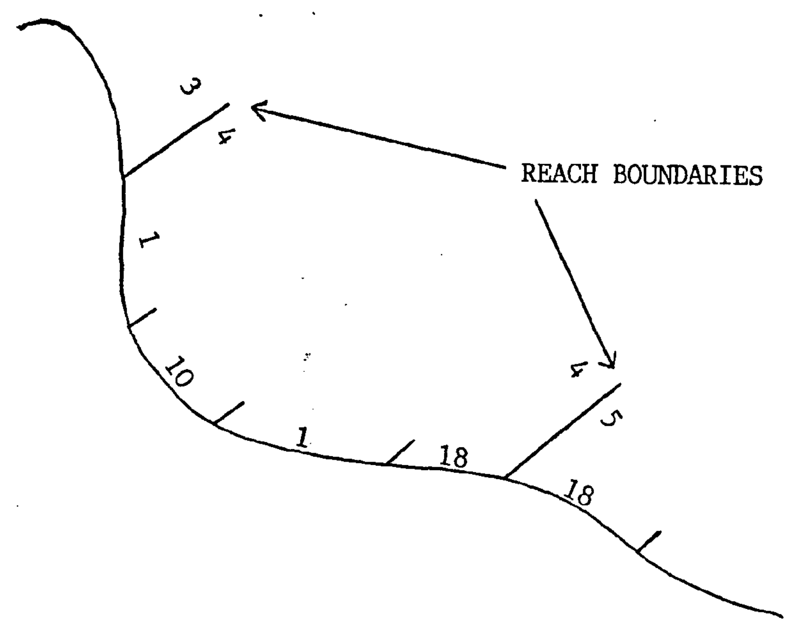

Figure 2. Delineations of Structures and River Reaches

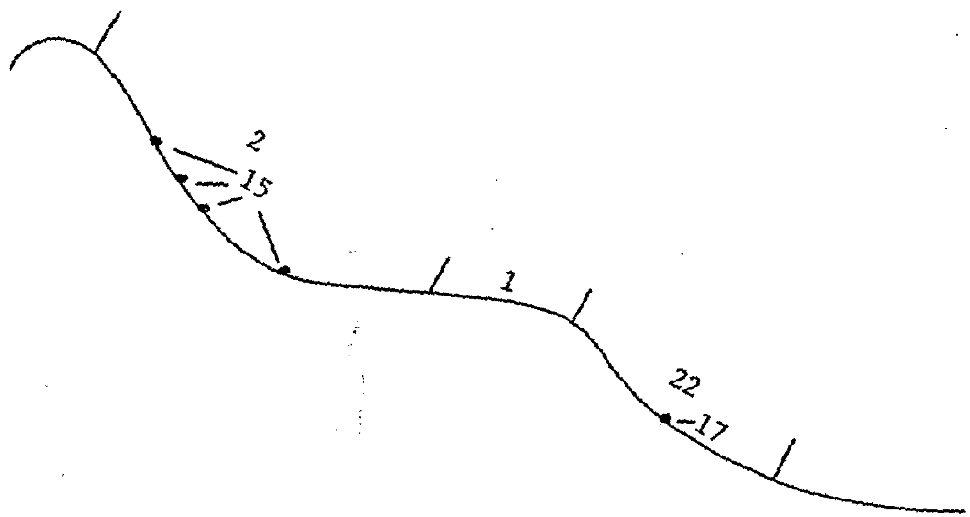

Figure 3. Delineating docks and piers

Preliminary Methodology for Applying Erosion Control Recommendations to Reaches based on Erosion Rate or Wave Energy Categories

Existing methods for determining appropriate erosion control techniques rely on a large set of parameters. These parameters include, but are not limited to the following:

1.) Average Fetch Length,
2.) Longest Fetch Length,
3.) Shoreline Orientation,
4.) Shoreline Geometry,
5.) Boat Traffic and Wake,
6.) Bank Composition,
7.) Soils,
8.) Offshore Topography,
9.) Shore Topography,
10.) Marsh Existence and Condition,
11.) Bank Height,
12.) Current Patterns,
13.) Nearshore Vegetation,
14.) Shoreline Slope.

Ultimately, what the interaction of these dynamic parameters yield at a given point is an erosion rate. By developing a decision model based on an easily measured, quantifiable item, the determination of the appropriate shoreline protection measure is simplified. Erosion rates are already available for much of the Hampton Roads shoreline, albeit at the reach level.

Many studies have previously categorized erosion rates as low, medium, and high. The erosion rate classification scheme developed in *Shoreline Situation Reports* has been widely accepted and used.

Erosion Category	Erosion Rate
Slight or None (Low)	Less than one foot per year.
Moderate	Between one foot and three feet per year.
Severe	Greater than three feet per year.

Preliminary Erosion Control Recommendations

Based on the ease of use allowed by the categorization of erosion rates, the following preliminary recommendations are based on the same scheme.

If erosion is less than one foot per year the preferred option is to do nothing. This can be modified to allow for low impact options such as beach/marsh enhancement measures including marsh revegetation, beach nourishment, bank grading, tree removal, etc.

If erosion rate is greater than one foot per year, but less than three feet per year, a moderate response is dictated. This response can include breakwaters, underwater sills, marsh toe protection, or a combination of these methods and the "softer" methods described above.

If the erosion rate is greater than three feet per year a stronger response is necessary to protect the shoreline. Appropriate measures would include stone revetments (rip-rap), bulkheads, and breakwaters. Due to the tendency of these structures to severely alter the existing sediment transport, caution must be exercised in their application.

There are however some problems associated with this approach. Primarily, no scientific literature links erosion control techniques with associated erosion rates. Secondarily, in the few cases that imply a relationship between structure types and erosion rate, no definitive thresholds from one category to the next have been established.

Other Approaches Considered

Wave Energy

A similar scheme examined was based on wave energy work done by the Shoreline Erosion Advisory Service. Their work does link wave energy classes with specific design criteria for hardened structures. Their wave energy classes are identical to the erosion rate classes developed by VIMS. SEAS reports their data over reaches and subreaches which makes their methodology enticing.

Comprehensive Decision Model or Matrix

The highest aspiration of this project was to develop a decision model or matrix that included ranges of all involved natural processes, human activities, land use, and other relevant information. Given the complexity of the equation and the limited time allotted for completion this effort has been set aside.

No one of these approaches has been settled upon, nor have they been finalized. Research continues to find the best method(s) possible.

Issues and Problems Raised in the Course of Development of the Methodologies

Issue 1 - Map Scale

As stated above, the map scale issue was the first of several assumption made in the preliminary phases of this project. The USGS 1:24,000 scale maps were unsuited for the level of detail expected by the localities from this study. Map information of less than certain distances could not be recorded due to scale considerations. It was determined that locally available planimetrics would be better suited for this task. Not only did this prove to be so, it was also easier to orient videotape to maps, thus making placement of on-ground structures more accurate. Several local maps also included property lines which assisted in the placement of beginning/ending lines for segments of hardened shoreline. Many erosion control structures, although not all, began or terminated at a property line.

Due to the increase in the shear number of maps and the ability to create high quality, detailed documentation of existing conditions, video interpretation time was significantly increased.

Issue 2 - Accuracy and Consistency of Existing Data

This project was designed to build upon, not recreate, much of the shoreline work that has been done throughout Hampton Roads in the past three decades. Much of the work had been done by a single entity, VIMS, and in scoping discussions much weight was placed on the missperseption that data collected in past studies was consistent with that of the more recent studies. In the course of time, reach boundaries and identifying numbers have shifted, changed, or been deleted. These processes are necessary given the knowledge obtained, but they create roadblocks to the historical component of the analysis.

The basic study unit for shoreline projects is the reach. Shoreline reaches were first designated for Hampton Roads waterbodies in *Shoreline Erosion in Tidewater Virginia* (Byrne & Anderson, VIMS, 1978). It was anticipated that these reaches were consistent throughout the ongoing shoreline work by VIMS. Comparing the *Shoreline Situation Reports* and *Shoreline Erosion in Tidewater Virginia* discrepancies were often noted. Reach definitions used in the *Bank Erosion Study* also differed from past work, as did essential information such as reach lengths.

Due to these inconsistencies, staff found it necessary to develop a hybrid set of reach definitions, relying most heavily upon the definitions found in *Shoreline Erosion in Tidewater Virginia* and those found on the working maps produced for the *Bank Erosion Study*. Much time has again been added in an effort to rectify these inconsistencies and make best use of available information.

Issue 3 - Ambiguity of Reach Level Recommendations

After the compilation of much data and in the course of the literature review, deficiencies in reach level recommendations, specifically for erosion management, were revealed. Throughout the literature, erosion control options are shown to be dependant on site specific parameters, often changing over frontages of less than five hundred feet. Rarely does a reach measure less than 1,000 feet and often exceeds 20,000 feet. Therefore, recommendations for a shoreline erosion control technique or method made on averaged or generalized reach conditions may, or may not, be appropriate for any given site within that reach.

PRELIMINARY

EROSION CONTROL

The shorelines of Virginia stretch over 5,000 miles of beaches, bays and tributaries. In these areas, nature's relentless effort to strike a dynamic equilibrium between land and water constantly occurs in what can be and frequently is a zone of high energy. Shoreline erosion is a gradual process, but with increased development and human activity, the effects of erosion become an increasingly important problem. It is interesting to note, however, that erosion is not perceived to be a problem until a property owner decides to build along a stretch of naturally eroding shoreline. Traditionally, this conflict between man and nature results in the implementation of some form of engineered structure, ignoring the probability that anything built on or near the shore usually increases the rate of erosion (Kaufman & Pilkey, Jr.:191). By identifying naturally eroding areas during the local comprehensive planning process, incompatible land uses and unsound post-development measures can be prevented and the need for future shoreline hardening efforts may be reduced (CBLAD 1989: VI-59). The desire is to satisfy a community's development plans without risking property or life, while simultaneously protecting its ecological resources (Chesapeake Bay Shoreline Erosion Study 1990:11).

Because the installation of shoreline erosion control structures can disrupt natural forces and drive shorelines away from the equilibrium state they seek, it is important to consider all possible alternatives when selecting an erosion control option. The final choice should be one that is most appropriate for a given situation and environmentally sensitive to problems such as increased downstream erosion and negative effects on water quality. With the exception of areas experiencing severe erosion, there are a number of options that allow safe and continued development of an eroding shoreline. Proper building setbacks, for example, can protect shoreline development from erosion during the structure's lifetime. However, if setbacks provide inadequate protection for existing or future shoreline development, an erosion control option must be chosen (CBLAD, 1989:VI-62). The choice of sound erosion control alternatives requires trade-offs among many advantages and disadvantages. It is important to analyze numerous site-specific characteristics to gauge the applicability of each option, and carefully consider the positive and negative consequences associated with the final control choice. In some cases the implementation of these structures can cause erosion to occur on adjacent property or elsewhere in the system. The cumulative effects of an extensively hardened shoreline can have a severe effect on the natural shoreline processes. Unnecessary structural change to the shoreline should and can be avoided through sound management decisions on the local level. No single alternative will apply in every case and each has to be considered on its own merits.

EROSION CONTROL ALTERNATIVES

There are three basic alternatives which can be used to address an erosion problem: do nothing, relocate endangered structures, or consider the use of structural or non-structural measures to halt erosion (Low Cost Shore Protection 1981, p.19).

When faced with an erosion problem, the first reaction is to take immediate action. In some cases erosion may be caused by temporary factors, therefore, it may be advisable to wait for the erosion rate to slow before taking any action. The "do-nothing" option is cost free and does not hinder the natural equilibrium processes of erosion and accretion; However, when structures exist on-site or erosion is exacerbated from off-site forces, other options must be considered. If undeveloped land or inexpensive structures are threatened, it is advisable to estimate the losses involved in the "no action" alternative before structural action is considered (Low Cost Shore Protection 1981, p.19). This option is especially applicable to situations where development incorporated adequate setbacks and other site design considerations to allow for naturally occurring erosion from on-site and off-site sources (CBLAD 1989:VI-63). To avoid future problems from historical erosion rates, site design should consider this criteria before construction.

If adequate setbacks do not exist, relocation becomes a possible option when structures are affected by "critical erosion". Before investing in shore protection, physical relocation of your house or other structure should be considered (Low Cost Shore Protection 1981, p.19). This option does not interfere with natural shoreline processes and once buildings are relocated, no control structures must be maintained; However, relocation may not be financially feasible or structurally possible and like the "do-nothing" option, does not control erosion. . If the "do nothing" or relocation options are not possible solutions, more intensive measures must be taken to mitigate the problem.

NON-STRUCTURAL AND STRUCTURAL EROSION CONTROL MEASURES

There are a variety of proven methods available today, both structural and non-structural, that are effective in solving an erosion problem. However, the success of each option is dependent upon a number of site specific factors and design considerations, therefore it is recommended that all possible alternatives be considered before selecting the most applicable choice.

Nonstructural erosion control measures

Along lower energy shorelines, it is often impractical to implement erosion control measures, particularly in areas where erosion has not yet reached catastrophic proportions. In these cases, it may be possible to counteract erosion by non-structural means. Structural mechanisms can exacerbate erosion by starving the littoral transport of sediment to downstream shorelines and can deflect wave energy to adjacent properties.

Vegetation -

Often referred to as a "soft barrier", the use of vegetation, where appropriate, is a preferable method of erosion control because of its ability to adapt to changing levels of erosive force (CBLAD 1989, p.VI-63). When properly applied, this method is generally a cost effective and easy approach to stabilize an eroding sediment bank where no marsh exists or to enhance existing areas of marsh. The proper planting of various species of vegetation along an eroding shore can curb erosion and tends to preserve the shoreline equilibrium. The marsh plants ability to establish dense root systems, trap and accumulate sediments, and baffle wave energy allows vegetation to act as a buffer against erosive forces (VMRC p. 7). In addition, "vegetation is especially effective in allowing wetlands to migrate with fluctuations in sea level (CBLAD 1989, p.VI-63)".

Vegetation serves as an effective buffer to areas experiencing low wave energy, but the use of vegetation is limited in a number of situations. Site specific characteristics such as climate, soil properties, wave exposure, and salinity regimes greatly reduce the applicability of this option (Low Cost Shore Protection 1981, p.61). Fertilization may be necessary to aid in the proper growth and ground cover of a soft barrier. Due to topography, it is often necessary to grade the bank back to create an adequate slope for vegetation to grow. Vegetative barriers need to be maintained more frequently and the replacement of dead or diseased plants is necessary. In addition, it is important to understand the intended use of the shore when considering the placement of vegetation. "Pedestrian and vehicular traffic will quickly destroy vegetation if proper access points are not provided" (CBLAD 1989 p. VI-63).

Though vegetation may provide adequate stabilization in shorelines experiencing low wave energy, in areas of extremely high tides and high wave energy, vegetation, alone, may not be effective in combatting shoreline erosion. It may be necessary to use vegetation in conjunction with structural control measures depending on site characteristics. Either as a substitute for, or supplement to, structural measures, vegetation should initially be considered because of the low costs of implementation and the limited adverse effects on the natural state of the shoreline.

Beach Nourishment -

This is another "soft barrier" option which involves the replacement of sand on a highly erosive beach. Sand replenishment projects are especially useful when undertaken for the creation and preservation of recreational beaches (CBLAD 1989:VI-63). Because nourishment does not control erosion, it may be appropriate to implement in conjunction with structural control options if the site allows for such action. Replaced beaches usually succumb to existing erosive forces, and because it is only a temporary solution at best and is expensive to implement and maintain, beach nourishment is generally unattractive to the average homeowner.

Tree Cutting and Trimming & Bank Grading:

Taken from "Shoreline Erosion Control Guidelines" SEAS/DCR

Trees and shrubs may be cut or trimmed to reduce the weight bearing on eroding banks or allow sunlight to promote wetlands vegetation growth. The Chesapeake Bay Preservation Ordinance provides guidelines on vegetation removal in the RPA and buffer area.

If bank grading is determined to be necessary for shoreline erosion control, banks should be graded to a 50% or 2:1 (horizontal/vertical) slope or flatter. Slope lengths greater than 75 feet may require runoff controls, as discussed in Chapter 6 of the Virginia Erosion and Sediment Handbook. Slopes steeper than 50% (2:1) will require an engineering analysis certifying slope stability. Land disturbance in the RPA or buffer area may require a plan of development, as specified in the Chesapeake Bay Preservation Ordinance. Bank revegetation is required following tree removal and bank grading activities.

A bluff slope may be flattened to enhance its stability when adequate room exists at the top and it does not interfere with the desired land use. Freshly excavated slopes should be planted to prevent erosion due to surface runoff. It may be necessary to build a revetment or bulkhead at the toe of the slope to protect against wave action(LCSP).

STRUCTURAL EROSION CONTROL MEASURES

The use of permanent erosion control structures generally tend to drive shorelines away from their natural state of equilibrium, but there are situations in which non-structural methods cannot mitigate an eroding shoreline . And while the placement of these structures may reduce the sustained nutrient and sediment input into adjacent waters, it is necessary to understand that ground preparation, installation and maintenance of these structures can have equally damaging effects on adjacent living resources" (VMRC p.7). On site, wetlands and shoreline vegetation can be adversely effected due to placement and construction of erosion control structures. Off site, because the natural shoreline processes such as the littoral transport system are disrupted, natural resources downdrift can also suffer. Furthermore, negative impacts to water quality can result from their use and the potential for increased erosion from improperly placed and constructed structures exists, making the use of permanent structures as a final option something which should be seriously considered.

Structural methods can be very effective in shielding land from various wave energy climates and erosion situations. Minimum design criteria are provided for a number of these control structures by the Department of Conservation and Recreation's Shoreline Erosion Advisory Service. This design criteria was developed based on tidal range and anticipated wave energy at the shoreline for reaches throughout the Tidewater area. These reaches were taken from the Shoreline Situation Reports (Shoreline Erosion in Tidewater Virginia) and were divided into high, medium and low wave energy categories based on anticipated average storm conditions (SEAS). The wave energy categories, adopted by SEAS, are as follows. A low energy wave is considered to be one foot or less, a medium energy wave is around two feet, and a high energy wave is greater than two feet. This regime especially applies to areas confined to the Chesapeake Bay and its tributaries. Other examples such as the Corp of Engineers erosion control guidelines consider wave energy as coastal in nature, therefore design considerations are for higher energy shorelines. The differing schools of thought are not clearly reflected in the literature.

It is important to remember that all structures built parallel to the shoreline will ultimately fail, so careful design and maintenance are critical to extend the life of the structure (CBLAD 1989, VI-65). Structures can be broken down into three categories:

On-shore: Seawalls, bulkheads and revetments -

Seawalls, bulkheads, and revetments are structures placed parallel, or nearly parallel, to the shoreline to separate a land area from a water area There are no precise distinctions between the three structures, except that they are used to separate land and water, and often the same type of structure in different localities will bear a different name(Shore Protection Manual 1984, Volume I, p. 5-2). For the purpose of this study, the main distinction lies in the structure's intended purpose.

Bulkheads and Seawalls:

Seawalls are often incorrectly referred to as the same structure as a bulkhead. In general, seawalls are designed to resist the full force of the waves. They are often concrete structures of massive size with a primary purpose to protect the backshore areas from high waves and strong currents ~~such~~ that ~~is~~ are limited to (found in) coastal environments. Due to their size, they are only needed in areas where large waves occur.

Bulkheads are effective in preventing erosion along particular shoreline segments. These structure are vertical retaining walls embedded below the base of the shoreline, held in place by landward tie-backs and backfilled with gravel, soil, or similar material to bring the upland level with the top of the bulkhead(CBLAD 1989,p.VI-66). The primary purpose of a bulkhead is to retain and prevent sliding of soil, with a secondary purpose to protect the land and upland areas from erosion and low wave energy. Generally, bulkheads are smaller and less expensive retaining walls used to protect the land immediately behind them from minimal wave action while Seawalls are designed to withstand the full force of waves such as is found in a coastal environment (VMRC p.17). Bulkheads are not designed to absorb oncoming wave energy, but "tend to transfer the wave energy laterally along the face of the structure or vertically up and down (VMRC p.18)." This reflected wave energy can cause "flanking" to occur around the structure and exacerbate erosion on adjacent properties. Their vertical faces may reflect wave energy upward and downward, causing increased scour in front of the structure. If a beach is to be retained adjacent to a bulkhead, additional structures, such as groins or breakwaters, may be required (Low Cost Shore Protection 19??:20)). The use of bulkheads can cause erosion to occur in areas further down the shoreline. Downdrift beaches that were previously nourished by the natural erosion of land upstream can be "starved" of sediment present in the longshore transport system with the placement of a bulkhead and cause unnecessary erosion downshore.

As with other erosion control structures, the applicability of a bulkhead is dependent upon many factors. Where severe wave action is present, a bulkhead, alone, would not be adequate to protect the shoreline. Bulkheads may also serve as moorings for boats and wharves for cargo transfer as well as other situations which would require the need for adequate water depths directly at the shore.

Revetments -

A revetment is comprised of wave absorbing materials of varying sizes such as rocks (riprap) or concrete blocks strategically placed on a graded slope to protect the shoreline against wave energy. Riprap is comprised of stone that is hard enough to withstand exposure to wave climate, weathering and other erosive forces. The use of riprap revetments as an erosion control option is preferred over the use of a bulkhead "due in part to their ability to absorb and dissipate wave energy, thereby reducing the transfer of these erosive forces to adjoining property" (VMRC p.11). In addition, the open spaces between the armor material can provide "suitable habitat for marine organisms and in some cases trap enough sediment to support wetland vegetation.

The proper function of a revetment is dependent upon the stability of the graded soil and its ability to support an adequate slope, therefore, design considerations must be suited to differing bank compositions. "Revetments should be used when natural vegetation cannot withstand the erosion forces of particularly dynamic and high energy shorelines" (CBLAD 1989, VI-66). The proper design of riprap structures is dependent upon specific site characteristics such as varying wave climates which determine the adequate size of the armor material. Like a bulkhead, revetments protect only the immediate shoreline. *{Protective structures for low energy climates are discussed in detail in U.S. Army, Corp of Engineers (1981).}

(Chesapeake Bay orientation) The Chesapeake Bay Local Assistance Department has this to say about revetments and bulkheads:

> "The construction of revetments and bulkheads behind wetlands is often viewed as an environmentally sensitive solution to shoreline erosion problems. In fact, revetments and bulkheads may actually cause wetland destruction due to increased wave energy created by the placement of permanent barriers that abruptly stop and reflect wave action. In addition, bulkheads and revetments prevent plants from migrating landward on a gently sloping bank where sea levels rise. A marsh toe revetment (i.e., a revetment constructed at the base of the marsh rather than behind the marsh), however, can provide protection against erosion while still allowing for the natural migration of wetlands. While bulkheads and revetments can be effective at halting bankland shoreline erosion, they cut off the supply of sediment to the littoral system, once available to replenish beaches naturally" (CBLAD 1989, p.VI-68).

(Coastal orientation) According to a book entitled Managing Shoreline Erosion by The National Research Council, "Properly engineered seawalls and revetments can protect the land behind them without causing adverse effects to the fronting beaches. Coastal armoring (e.g., a riprap or seawall) neither adds to nor removes sand from the sediment system but may be responsible for the redistribution of sand and can prevent sand from entering the system. Although armoring can cause additional localized scour during storms, both in front of and at the ends of the armoring, there are no factual data to support claims that armoring causes profile steepening, increased longshore transport, transport of sand to a substantial distance offshore, or delayed poststorm recovery"

Near-shore:Groins and jetties -

Groins -

A groin is a structure that is constructed perpendicular (or nearly so) to the shoreline and extending seaward whose sole purpose is to protect the shoreline from erosion by trapping sand moving in the littoral transport system. Either singly or in a "groin field", the structure collects the longshore material on the updrift side of a "cell" until filled where it then bypasses the structure and continues to feed sediment to downdrift areas. The resulting sediment buildup creates a buffer which acts as a protective barrier for the upland areas. This buffer absorbs the attack of erosive forces and prevents further erosion of the shoreline by raising the elevation of the nearshore area and may actually build a sand beach by accretion processes in the nearshore zone.

In choosing to implement a groin system, "it is important to evaluate the net direction and amount of longshore sediment transport" (LCSP). The effectiveness of a groin is dependent upon the presence of an adequate amount of material in the longshore transport zone. Without an adequate amount of material in the system, the formation of the protective buffer is hindered and the structure cannot function to its potential.

One problem that is seen with the use of this type of control option is the potential to negatively impact adjacent shorelines. Because of this, "it is often recommended to position groins away from property lines (Shoreline Development BMP's p.25). With the construction of a groin field, the sand that is trapped updrift of the groins greatly improves the shoreline but a consequence of this buildup is the resulting sand deprivation of downstream shorelines. The sand that is trapped in a groin field can no longer feed areas downdrift of the structure, thereby starving the littoral buildup process and increasing the rate of erosion. Because of this, it is recommended that the design height should match the beach profile and that each cell is partly filled with material to reduce the need for the material from the longshore current. In this way the areas downdrift are not "starved" of sediment that normally flows in the littoral transport system. In addition, this type of structure may hinder freedom of shoreline travel.

Jetties -

Jetties are structures which may appear similar to a groin, but whose primary purpose is to "stabilize the position of the navigation channel, to shield vessels from wave forces, and to control the movement of sand along the adjacent beaches so as to minimize the movement of sand into the channel" (Shore Protection Manual 1984, p.1-24). They are placed perpendicular to the shoreline to allow sedimentation on the updrift side, thereby preventing the shoaling of a channel. They can also reduce wave height in a channel, but like groins, can prevent the transverse movement of sediment and exacerbate erosion downstream in the process.

Off-shore:Breakwaters

Breakwaters -

In contrast to bulkheads and revetments, breakwaters are structures constructed parallel to and channelward of a shoreline rather than directly on shore (Low Cost Shore Protection 19??:23). They are barriers designed for the purpose of attenuating incoming wave energy by reducing the height and thereby reducing the erosive power of the waves before reaching the shoreline. Breakwaters may be composed of a single structure or a series of structures separated by gaps; thus, "they provide substantial protection to the shoreline without completely stopping longshore sand transport" (Managing Coastal Erosion p.60). They can be flowing breakwaters which filter energy from the incoming waves as they pass through the device, thereby reducing wave energy reaching a shoreline or harbor. As a result of the decrease in wave energy, the ability of the waves to transport sediments decreases and sand from the littoral transport system accumulates in areas behind the structure. The high energy environment that breakwaters are applicable to warrants materials capable of withstanding differing wave climates.

This option usually applies to erosion problems over a large segment of the shoreline. Because of the high costs associated with construction, breakwaters have been limited to use in navigational purposes and harbor protection. As with groins, breakwaters have the ability to disrupt the supply of sand to downstream. Downdrift beaches are deprived of normal sediment supplies and as a result may experience increased erosion rates. Because of this, the partial nourishment of the areas behind the breakwaters can help to minimize this disruption in the natural processes by allowing sand to insure the littoral transport of sand when the structure is at capacity. It is important that adequate materials exist in the littoral transport system to support the use of a breakwater.

Submerged sill -

A submerged sill is a low, detached structure constructed nearshore and parallel to the shoreline for the purpose of building up an existing beach by trapping and retaining sand in the littoral zone. Because a sill acts like a natural bar, it is more effective when constructed at or near the mean low water line and low enough to allow wave overtopping. They are usually constructed of sandbags, but may be constructed of riprap, gabion baskets, concrete, or timber. Gabion baskets are containers filled with stone, brick, shells or other material to give it a heavy weight suitable for use in constructing revetments or groins.

PRELIMINARY

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Shore Erosion Control: A Guide for Waterfront Property Owners in the Chesapeake Bay Area

I. ASSESSMENT OF EXISTING WATER QUALITY CONDITIONS

<<This section was already sent for review on 2/1/94.>>

Note: Elements A and B will be included in the general information "macro document."

A. 1992 305(b) Report
   1. Hampton Roads Water Quality Assessment Index
      a. York River Basin
      b. James River Basin
      c. Chowan River and Dismal Swamp Basins
      d. Chespeake Bay and Small Coastal Rivers Basins

Note: Summaries are included in System/Subarea/Waterbody/Mainstem Segment/Descriptions

B. 1993 Nonpoint Source Pollution Watershed Assessment Report
   1. Hampton Roads Watershed Assessment Index
      a. York River Basin
      b. James River Basin
      c. Chowan River and Dismal Swamp Basins
      d. Chespeake Bay and Small Coastal Rivers Basins
   2. Map of PDC NPS Priorities (Comprehensive)

Note: Summaries are included in System/Subarea/Waterbody/Mainstem Segment/Reach Descriptions

II. SENSITIVE LAND AND AQUATIC RESOURCES

Note: Elements A-G will be included in the general information "macro document." Specific locations are delineated on maps and described in System/Subarea/Waterbody/Mainstem Segment Descriptions.

A. Wetlands (Tidal/Nontidal)
B. Submerged Aquatic Vegetation
   1. Chesapeake Bay and Tributaries
   2. Back Bay
C. Spawning Grounds
D. Nursery Areas
E. Shellfish Growing Areas
F. Commercially- and Recreationally-Important Finfish and Shellfish (non-oyster or clam) Areas
G. Protected Areas and Estuarine Reserves

III. PHYSICAL AND OCEANOGRAPHIC CHARACTERISTICS OF THE SHORELINE

A. Bathymetry
B. Flushing Characterisitics
C. Current Patterns

Note: Items A-C are discussed generally in the "macro document." Specific information, including areas where dredging would be required to develop shoreline access facilities, is found in the Subarea/Waterbody/Mainstem Segment

Descriptions.

III. PUBLIC AND PRIVATE WATER ACCESS

A. General Introduction: Overview of the Hampton Roads Region, Problem Identification, and General State Recommendations for Improving Public Access to the Region's Water Resources

B. Strategies for Impoving Water Access

1. Land Use Controls
   a) Privately-Owned Land
      -- Traditional Zoning
      -- Development Proffers
      -- Overlay Zoning
      -- Special Districts
      -- PUD
      -- TDR
   b) Publicly-Owned Land

2. Land Acquisition Techniques
   a) Fee-Simple Aquisition
   b) Conservation Easements
   c) Land Banking
   d) Land Trusts

3. State and Federal Programs

4. Cooperative Agreements

<<Information on Items 1-4 to be taken and updated from the 1987 PDC study, The Waters of Southeastern Virginia.>>

B. Siting and Design Criteria for Water Access Facilities and Water-Enhanced Recreation Areas To Reduce Potentially-Adverse Impacts to Water Quality

<<This section was already sent for review on 2/1/94.>>

1. Water Access Facilities (Boat Access)
   a. Marinas and Community Facilities for Boat Mooring
   b. Boat Ramps
   c. Canoe Put-In/Take-Out Points

2. Water-Enhanced Recreation Areas (Shoreline Pedestrian Access Areas)
   a. Beachfront
   b. Fishing Areas
   c. Other Shoreline Recreation Areas

C. Summary of Existing Water Access Facilities and Water-Enhanced Recreation Areas, Demand Analysis by Jurisdiction, Existing Proposals and Other Recommendations for Improved Pubic

1. Existing Water Access Facilities (Boat Access)
   a. Marinas and Community Facilities for Boat Mooring
   b. Boat Ramps
   c. Canoe Put-In/Take-Out Points

2. Existing Water-Enhanced Recreation Areas (Shoreline Pedestrian Access Facilities)
   a. Swimming Beaches
   b. Fishing Areas
   c. Other Shoreline Recreation Areas

3. Public Access Demand Analysis by Jurisdiction

4. Proposed Public Water Access and Recreation Areas and Future Needs Assessment
   a) Local
   b) State
   c) Other Recommendations

Note: Tables and matrices showing existing and proposed public and private water access and recreation areas by jurisdiction, as well as jurisictional demand analysis, will be included in the general information "macro document;" however, specific information for items 1-4 above will be in the System/Subarea/Waterbody/Mainstem Segment descriptions.

D. Private Pier and Dock Density Standards

Issues to be addressed in this section include:

1. Problem Identification
2. Legal Discussion of Nonconsumptive Riparian Rights in Virginia: The Balance Between Private and Public Use of Waterways
2. Review of Existing Regulatory Framework in Virginia as it Relates to Private Pier and Dock Density
4. Discussion of Existing Private Pier and Dock Densities in Project Study Area
5. Discussion of Existing and Future Land Use, Zoning and Subdivision Ordinances by Jurisdiction as it Relates to Pier and Dock Density
6. Review of Density Control Standards/Waterway Management Plans Used by Other States
7. Recommendations for Density Standards and Water Use Compatibility and/or Waterway Management Plans by Waterbody and Jurisdiction
8. Recommended Changes to Existing Regulatory Framework

ASSESSMENT OF EXISTING WATER QUALITY CONDITIONS

The following discussion and data on existing water quality conditions within the project study area were taken verbatim from two sources: (1) The Virginia Water Quality Assessment for 1992 305(b) Report to EPA and Congress and the Virginia Department of Conservation and Recreation's 1993 Virginia Nonpoint Source Pollution Watershed Assessment Report. Changes made to this discussion and/or data, based on HRPDC staff review and updating of information, are marked in []. No additional water quality monitoring was conducted by the HRPDC to augment data found in these reports.

A. The Virginia Water Quality Assessment for 1992 (305(b) Report)

General

The Virginia Water Quality Assessment for 1992 (305(b) Report) describes surface water quality conditions for the project study area during the time period of July 1, 1989 through June 30, 1991. One of the primary purposes of this State-wide assessment is to determine how well the waters of Virginia meet the goals of the federal Clean Water Act (CWA) for swimmable and fishable waters. [The next Virginia Water Quality Assessment (305(b) Report) will be completed in 1994.]

The Virginia Water Control Board (VWCB) General Standard (VR680-21-01.2) states that all surface waters shall be maintained to support recreational use and the propagation and growth of all aquatic life reasonably expected to inhabit them. As defined for this report, these two uses correspond to the swimmable and fishable goals of the CWA, respectively. By protecting these two uses, it is assumed that other, usually less restrictive uses, such as industrial water supply, irrigation, and navigation, are also protected. Surface waters may also be designated for use as public water supplies. These waters must meet Virginia's numeric public water supply standards, in addition to the state-wide surface water quality standards. Appendix ___ contains the current Virginia water quality standards adopted by the VWCB which are applicable to the project study area (VWCB General Standards VR680-21-01, VR680-21-02, VR680-21-03, VR680-21-04, VR680-21-05, VR680-21-07 and VR680-21-08).

Numeric and narrative water quality standards have been established for the protection of the recreational and aquatic life uses. To meet the recreational use, and thus the CWA swimmable goal, the waterbody must meet the state fecal coliform bacteria standard. The primary method Virginia uses to assess the fishable status of its waters is to compare monitoring data to state numeric standards for dissolved oxygen (DO), pH and temperature (see Appendix ___). Other information, both monitored and evaluated, is also used to assess support of the fishable goal, including measures of nutrients and toxicants.

The VWCB is also responsible for classifying waterbodies as either effluent limited or water quality limited segments. [Effluent limited classifications apply to stream segments where water quality standards will be met by compliance with effluent limits contained in a waste discharge facility's Virginia Pollutant Discharge Elimination System (VPDES) Permit from the VWCB. In other words, these segment will meet water quality standards is BPT (best practicable technology) and BAT (best available technology) treatment levels are applied to municipal and industrial discharges, respectively. Effluent limits are established by the U.S. Environmental Protection Agency (USEPA) and are generally applicable on the basis of facility type. Water quality limited classifications apply to stream segments where water quality standards will not be met by compliance with effluent limits alone. More stringent treatment requirements will be necessary in order to achieve water quality standards in these segments. In other words, water quality standards will not be met after application of BPT and BAT levels of treatment and, therefore, require, higher effluent removal levels (HRPDC, 1993: 12; HRWQA, 1978:7).]

The analysis of surface water quality conducted for the 305(b) Report is based on two different categories of information: monitoring data and evaluations. VWCB monitoring data come primarily from the analysis of water column samples, with fish tissue and sediment samples, and other imformation also employed. In the absence of monitoring data, an evaluation has been made, where possible, of the attainment of the CWA fishable and swimmable goals.

Monitoring Data

Monitoring data collected by the VWCB at ambient water quality monitoring (AWQM) stations. are composed primarily of the measurement of four conventional pollutant parameters: dissolved oxygen (DO), pH, temperature, and fecal coliform bacteria. In addition to these, other types of monitoring data were used to assess whether Virginia's waters met the CWA fishable goal. Concentrations of toxic substances in the water column, fish tissue, and sediment samples were analyzed at a subset of the AWQM stations and reported. Surveys of macroinvertebrate benthic organisms provided direct information on the health of these aquatic communities. Fish/shellfish consumption advisories provide further information used in the assessments. If none of the monitoring data used to assess all or a portion of a waterbody indicated impairment, a waterbody (or portion) was considered to fully support the CWA fishable goal. If one parameter indicated partial support, while the others indicated no impairment, the waterbody was judged to be partially supporting of the fishable goal. If any one parameter indicated non-support, that waterbody was judged as non-supporting of the CWA fishable goal. Fecal coliform bacteria counts were the only monitoring data employed to assess support of the CWA swimmable goal.

[Based on telephone conversations with a VWCB official, a determination of which portions of each waterbody segment (in square miles) support, partially-support or do not support the fishable, swimmable and shellfish goals of the Clean Water Act is based on the following: how much area of each segment violates the state water quality standards, the total acreage of shellfish bed closures based on current VDH notices, the total area of public swimming areas closed by VDH based on fecal coliform bacteria standard violations, violoation data for DO, pH, temperature and fecal coliforms collected from AWQM and biological monitoring stations, and from the total area closed to fishing based on VDH bans. Best professional judgement and relevant water quality studies are also used in making these determinations.]

Described below is each type of monitoring data used to assess the fishable and swimmable goals:

Fecal Coliform Bacteria:

Fecal coliform bacteria limits are intended to protect human health. These bacteria dwell in the intestines of humans and other warm blooded animals in large numbers and can be used as indicators of the presence of improperly treated sewage. This type of indicator organism is employed because more virulent organisms are very difficult to detect and count in the aquatic environment. The presence of fecal coliform bacteria does not mean pathogens are present. It does mean that contamination by warm blooded animals exists and that there is a potential for pathogen contamination. While high fecal coliform bacterial counts can indicate improperly treated human wastes, there are many other sources of these organisms. Fecal coliform bacteria live in the intestines of all warm blooded animals, including livestock (cattle, swine, poultry) and wildlife (deer, ducks). Their presence does not in itself present a hazard, only a warning of potential hazard.

Virginia water quality standards set a bacteria standard for all state waters other than shellfish waters. This standard is intended to keep the state's waters safe for primary contact recreation, including swimming. Bacteria levels are the primary measure for determining whether or not a waterbody meets the swimmable goal of the CWA. Whether or not any waterbody is clean enough for swimming is determined by the Virginia Deparment of Health (VDH) and local health authorities. The VWCB sampling program is not used by the VDH for setting swimming restrictions.

The VWCB adopted revisions to the fecal coliform bacteria standard in November 1987 that have improved the state's ability to determine compliance and to institute enforcement actions. The revised standard contains both instantaneous and average maximum values. Any sample containing more than 1000 fecal coliform bacgeria cells per 100 ml of water at any time violates the instantaneous standard. A geometric mean of two or more samples collected within a 30-day period that exceeds 200 cells per 100 ml of smaple is a violation of the average maximum standard.

To be fully supporting of the swimmable goal, the bacteria standard must be met in at least 90% of the samples collected. A waterbody, or a portion of a waterbody, partially supports the CWA goal if the violation rate for the standard is in the range of 11%-25%. If more than 25% of the samples exceed the standard, the waterbody (or portion) is assessed as not supporting the swimmable goal.

Dissolved Oxygen (DO):

DO is necessary for the survival of a diverse assemblage of aquatic life. Fish and other aquatic organisms use DO for respiration by extracting it from the water. When oxygen levels are depressed due to the introduction of oxygen-consuming wastes, many naturally occurring species may decline in numbers or disappear from the affected area.

DO concentrations in water column samples were compared to Virginia's water quality standard. The standard is intended to maintain sufficiently high oxygen levels in streams to sustain fish and other aquatic organisms, and to avoid aesthetic degradation. Cold water fish (e.g., trout) require higher oxygen levels than warm water fish (e.g., bass) so the DO standard requires a higher level of oxygen in mountain streams compared to streams in the Piedmont and Coastal Plain.

To be considered fully supporting of the fishable goal, the standard for DO must be met in at least 90% of the samples collected. A waterbody, or a portion of a waterbody, partially supports the CWA goal if the violation rate for the standard is between 11%-25%. If more than 25% of the samples exceed the standard, the waterbody (or portion) is assessed as not supporting the fishable goal.

pH:

Acidity or alkalinity of a waterbody is measured as pH. The pH scale ranges from zero (highly acidic) to 14 (highly basic). A pH of 7 is neutral. Aquatic life can survive over only a limited range of the pH scale around the neutral point of 7. Waters that are either too basic or too acidic are harmful to aquatic life, so both a pH maximum standard and pH minimum standard are needed. Waters with a pH near 6.0 (mildly acidic) or near 9.5 (mildly basic) will support some species of aquatic life, but they are generally regarded as impoverished, unproductive habitats. Waters a little more acidic or basic than this may be lethal.

Like the DO standard, the pH standard varies with geographic location. For example, in hard water areas underlain by carbonate rock (e.g., limestone), the pH maximum is higher than in other areas with softer, naturally more acidic waters (e.g. swampy areas).

To be considered fully supporting of the fishable goal, the standard for pH must have been met in at least 90% of the samples collected. A waterbody, or a portion of a waterbody, partially supports the CWA goal if the violation rate for the standard is between 11%-25%. If more than 25% of the samples exceed the standard, the waterbody (or portion) is assessed as not supporting the fishable goal.

Temperature:

Temperature standards are established also with the primary purpose of protecting aquatic life. Like the DO and pH standards, temperature standards are habitat specific. The maximum allowable temperature is lower in trout streams and higher in streams that support a warm water fishery. Sustained temperature much above the maximum values given in the standards would be very detrimental to aquatic life in that particular habitat.

To be considered fully supporting of the fishable goal, the standard for temperature must have been met in at least 90% of the samples collected. A waterbody, or a portion of a waterbody, partially supports the CWA goal if the violation rate for the standard is between 11%-25%. If more than 25% of the samples exceed the standard, the waterbody (or portion) is assessed as not supporting the fishable goal.

Toxicants:

Substances that are toxic in aquatic environments include heavy metals and certain organic and inorganic substances. Elevated concentrations of these substances in the water column, in the tissues of living organisms, and in sediments can have adverse effects on aquatic life. Toxicants can also affect human health, resulting in the need for advisories or bans on fishing or shellfishing, swimming, or other recreational uses, and in restrictions on the use of drinking water supplies. The usefulness of a water supply for agriculture can also be impaired due to the presence of toxic substances at elevated levels.

Concentrations of toxic substances in water column samples collected at AWQM stations were compared to the appropriate Virginia water quality standards, Virginia chronic criteria for the protection of aquatic life, and to EPA acute and chronic criteria. In surface public water supply segments, toxics levels were compared to the Virginia drinking water standards.

Determining the status of each waterbody in terms of its support of designated uses and the CWA fishable goal is more difficult using toxicant data than for the conventional pollutants. In addition, Virginia had not adopted water quality standards for most toxic substancees at the time this report was being prepared, and there had been no criteria developed for sediment concentrations. Unlike the assessment of the conventional pollutants, exceedence rates were not used to determine goal support. Rather, toxics data were assessed in combination with discharger information, historical data (if any existed), and staff knowledge of other information regarding toxic pollution within the waterbody.

Biological Surveys:

The VWCB supports a biological sampling program to monitor the benthic macroinvertebrate communities in the rivers and estuaries within the state. Benthic communities can provide a practical means for evaluating impacts on water quality, as standards or criteria do not exist for many pollutants. In addition, they integrate the effects of different pollutants, thus providing a measure of the aggregate impact.

Begining in Fall 1990, the VWCB adopted EPA's Rapid Bioassessment Protocol II for use in conducting macroinvertebrate benthic surveys. Using this protocol, communities were characterized as nonimpaired, moderately impaired, or severely impaired. In assessing the degree of support of the CWA fishable goal within a waterbody, these three categories directly corresponded to fully supporting, partially supporting, and not supporting, respectively, this goal.

Fish/Shellfish Consumption Advisories and Restrictions:

The Virginia Department of Health (VDH) has the regulatory authority for issuing advisories and restrictions on the consumption of finfish. A fishing restriction allows sport fishing within the affected area, but the taking of fish for human consumption is prohibited. A health advisory warns of the dangerous levels of contamination found in fish tissues in an affected area, but does not prohibit consumption. Under health advisories, the population at risk and a safe maximum consumption rate may be specified. In accordance with EPA guidance, waterbodies were considered to be fully supporting of the CWA fishable goal if no advisories or restrictions were in effect. Waterbodies that have received health advisories warning against fish consumption were considered to be partially supporting. Waterbodies receiving a fishgin restriction were considered not supporting.

The VDH Bureau of Toxic Substances Information has five health advisories and one restriction currently in effect for fish consumption. [The following advisories are in affect for the Hampton Roads region]:

a) Kepone in the Lower James River

From 1966 through 1975 Allied Chemical Company and its subsidiary Life Science Products, Inc. produced a persistant chlorinated hydrocarbon insecticide called Kepone. During production, an estimated 90,720 kg of Kepone was released to the environment through atmospheric emissions, wastewater discharges, and bulk-disposal of off-specification batches. The James River and its tributaries from Richmond to Newport News were contaminated with Kepone. In 1975, the entire James River from Hopewell to the Chesapeake Bay, including all tributaries, was closed to the taking of any shellfish and/or finfish because of Kepone. From 1975 through 1988 various Kepone bans were in place. In 1988, all James River fishing bans due to Kepone were allowed to expire as Kepone levels in fish remained below the U.S. Food and Drug Administration (FDA) action level. This area is currently under a health advisory, covering 113 miles of the mainstem James River and an undetermined number of tributary miles.

From the onset of the contamination problem through the present, the VWCB has continually monitored Kepone levels in the James River. The major areas of concern were Kepone levels in the water column, finfish, and bed sediment of the James River and its tributaries, and in the groundwater in Hopewell. After continuous non-detectable results, water column monitoring was discontinued in 1981. Kepone levels in finfish, groundwater, and sediment have decreased since the onset of the problem. Continued monitoring will provide the state with an up-to-date portrayal of Kepone levels throughout the contaminated reach of the river. [Specific waterbodies affected by this health adivisory within the project study area have been noted in the System/Waterbody/Reach descriptions section of this report.]

b) Dioxin in the Blackwater and Nottoway Rivers

A health advisory has been issued for the Blackwater River from Sandy Landing to the confluence with the Nottoway River at the North Carolina border, and for the Nottoway River from the General Vaughn Bridge (U.S. 258) to the North Carolina border. Those fishing in these areas are advised to limit or discontinue consumption of bottom-feeding species due to dioxin contamination. [Specific waterbodies affected by this health adivisory within the project study area have been noted in the System/Waterbody/Reach descriptions section of this report.]

The VDH also designates areas as condemned for the taking of shellfish. These condemned areas include buffer zones surrounding certain point source discharges, restricted areas where shellfish may be harvested, but must be moved to approved waters for a certain length of time to allow for depuration before they are marketed, and prohibited areas where all shellfishing is banned. For this report, restricted areas and buffer zones were considered partially supporting of the CWA fishable goal, while prohibited areas were considered not in support of the goal.

Evaluative Data

Virginia's AWQM Network cannot cover all waters of the state. It concentrates on major tributaries and known problem areas. In addition, sampling stations are located only in mid-channel. As a result, assessments based solely on monitoring data fail to consider many waters of the state. To increase the assessment coverage and to provide a more accurate portrayal of water quality, assessment coverage was based on monitoring data and evaluative information such as knowledge and professional judgment of VWCB staff, using VWCB information on the location of point sources, known permit compliance problems, and other information including records of fish kills or toxic spills and certain land use information. NPS pollution information was provided by DCR-DSW.

Two volunteer citizen's monitoring networks, overseen by the Izaak Walton League of America and the Alliance for the Chesapeake Bay (ACB), also provided data that were used to evaluate use support of waterbodies in which data were collected. This 305(b) Report is the first in which such volunteer-collected data were considered when making water quality assessments. Parameters tested on a weekly basis are air and water temperature, secchi disk depth, total depth, salinity, pH, dissolved oxygen, ammonia, precipitation, field observations of water conditions and color, weather, and general conditions of the site. Benthic macroinvertebrate populations and physical stream charateristic assessments are also conducted.

[The ACB Citizen's Monitoring Program has 100 monitoring sites in Virginia, with 92 of those sites located along tidal waterways. Currently, there are 17 active monitoring sites within the project study area, as well as 11 inactive sites. The active sites are located as follows: Lynnhaven River - Virginia Beach (Hermitage Point, Ferebee Cove, Hebden Cove, Wolfsnare Creek and Sawpen Point); Seashore State Park - Virginia Beach (Whitehill Lake and 64th Street Boat Ramp); Elizabeth River - Norfolk, Portsmouth, Chesapeake (Great Bridge, New Mill, Jordan Bridge and Huntsman); York County (Thoroughfare Creek, Queen's Creek and Levy Pier); James City County (Taskinas Creek and Croaker Landing); and, Isle of Wight County (Smithfield) (ACB(a), 1994).

The ACB Citizen's Water Quality Monitoring Program has also recently begun nutrient sampling of orthophosphorus, ammonia, nitrite and nitrate at nearshore sites to document the relationship between nutrient levels and the presence of submerged aquatic vegetation (SAV). This effort is being undertaken to determine if there are any differences between mid-channel and near-shore water quality conditions. In general, preliminary findings have shown no significant differences; however, in one instance, pollutants were detected in the near-shore area that were not detected at mid-channel stations (ACB(b), 1993). Within the project study area, there is one monitoring station located along Goodwin Island in York County. Data has been collected from this site since April 1992 (ACB(a), 1994). VWCB officials are hopeful that continued near-shore monitoring and data collection will augment their mid-channel AWQM program to create a more comprehensive picture of water quality conditions in the Commonwealth.]

[Table ___ is an index of all river basins, subbasins (hydrologic units) and segements assessed in the 1992 Virginia Water Quality Assessment (305(b) Report) which fall within the project study area. Water quality information for each river basins, subbasin and segment has been included in the << System-Waterbody-Reach Descriptions>> section of this report.]

B. The 1993 Virginia Nonpoint Source Pollution Watershed Assessment Report

In March 1993, the Virginia Department of Conservation and Recreation, Division of Soil and Water Conservation published a revised nonpoint source pollution watershed assessment report, in compliance with Section 319 of the Clean Water Act. It is intended to provide a comparative evaluation of the state's waters, on a watershed basis, to assist in targeting NPS pollution protection activities. This report serves as a revision to the Virginia NPS Assessment Report dated May 1, 1989. It should be considered and utilized as a subcomponent of the Virginia Water Quality Assessment for 1992 (305(b) Report).

Data for this report were collected to address the NPS potential from three major land use categories: agricultural, urban and forestry. Figure ___ shows the overall NPS pollution priorities for the Hampton Roads PDC as identified in March 1993.

[Table __ is an index of all river basins, subbasins (hydrologic units) and watersheds assessed in the 1993 Nonpoint Source Pollution Watershed Assessment Report which fall within the project study area. Water quality information for each river basins, subbasin and watershed has been included in the << System-Waterbody-Reach Descriptions>> section of this report.]

TABLE ___

HAMPTON ROADS WATER QUALITY ASSESSMENT INDEX

The following index of river basins, subbasins (hydrologic units) and segments contains the information applicable to the project study area:

1. York River Basin

HUC02080107: York River Subbasin

Segment 107-08R: The Phil Bates Creek Waterbody
Segment 107-07E: The York River-West Point Waterbody
Segment 107-06E: The York River-Gloucester Waterbody
Segment 107-05L: The Waller Mill Reservoir Waterbody
Segment 107-04L: The Bigler Millpond Waterbody
Segment 107-03L: The Beaverdam Pond Waterbody
Segment 107-02L: The Jones Millpond Waterbody
Segment 107-01L: The Cheatham Lake Waterbody

2. James River Basin

HUC 02080206: James River Subbasin from the Fall Line to Hampton Roads

Segment 206-13L: The Little Creek Reservoir Waterbody
Segment 206-11E: The Chickahominy River Waterbody
Segment 206-10R: The Tributaries on the South Bank of the James River #4 Waterbody
Segment 206-09E: The James River-Williamsburg Area Waterbody
Segment 206-08E: The James River-Jamestown Island Waterbody
Segment 206-07L: The Skiffes Creek Reservoir Waterbody
Segment 206-06E: The Skiffes Creek Waterbody
Segment 206-05L: The Lee Hall Reservoir (Newport News Reservoir)
Segment 206-04E: The James River-Mulberry Island Waterbody
Segment 206-03E: The Pagan River Waterbody
Segment 206-02E: The Chuckatuck Creek Waterbody
Segment 206-01E: The James River-Newport News Shipyard Waterbody

HUC 02080208: Hampton Roads, Nansemond River and Elizabeth River Subbasin

Segment 208-20L: The Speights Run Lake Waterbody
Segment 208-19L: The Lake Kilby Waterbody
Segment 208-18L: The Lake Cahoon Waterbody
Segment 208-17L: The Lake Meade Waterbody
Segment 208-16L: The Lake Prince Waterbody
Segment 208-15L: The Lake Burnt Mills Waterbody
Segment 208-14L: The Western Branch Reservoir Waterbody
Segment 208-13E: The Nansemond River Waterbody
Segment 208-12E: The Streeter Creek and Hoffler Creek Waterbody
Segment 208-11E: The Southern Branch Elizabeth River-Great Bridge Waterbody
Segment 208-10E: The Southern Branch of Elizabeth River-Naval Shipyard Waterbody
Segment 208-09L: The Lake Taylor Waterbody
Segment 208-08E: The Eastern Branch Elizabeth River Waterbody
Segment 208-07E: The Elizabeth River-Berkley Waterbody

Segment 208-06E: The Western Branch of the Elizabeth River Waterbody
Segment 208-05E: The Elizabeth River-Lamberts Point Waterbody
Segment 208-04E: The Lafayette River Waterbody
Segment 208-03E: The Masons Creek Waterbody
Segment 208-02E: The Elizabeth River-Craney Island Waterbody
Segment 208-01E: The James River-Hampton Roads Waterbody

3. Chowan River and Dismal Swamp Basins

HUC 03010201: Nottoway River Subbasin

Segment 201-01R: The Nottoway River Waterbody

HUC 03010202: Blackwater River Subbasin

Segment 202-02R: The Blackwater River-Burdette Waterbody
Segment 202-01R: The Blackwater River-Below Franklin Waterbody

HUC 03010203: Somerton Creek Subbasin

Segment 203-01R: The Somerton Creek Waterbody

HUC 03010205: Dismal Swamp, Northwest River, North Landing River and Back Bay Subbasin

Segment 205-07L: The Lake Drummond and Great Dismal Swamp Refuge Waterbody
Segment 205-06R: The Northwest River Waterbody
Segment 205-05R: The North Landing River Waterbody
Segment 205-04L: The Stumpy Lake Waterbody
Segment 205-03E: The Back Bay Waterbody
Segment 205-02E: The Lake Tecumseh and Red Wing Lake (Dam Neck Area)
Segment 205-01C: The Coastal Shoreline from Red Wing Lake to the Virginia/North Carolina Line Waterbody

4. Chesapeake Bay and Small Coastal Rivers Basins

HUC 02080101 Mainstem Open Bay

Segment 101-05E Mouth of the James River
Segment 101-03CE Southwestern Portion of the Chesapeake Bay
Segment 101-04BE Mouth of the Chesapeake Bay
Segment 101-04AE Southern Portion of the Chesapeake Bay
Segment 101-02BE Mouth of the York River

HUC 02080108: Lower Western Shore Tributaries

Segment 108-01E: The Poquoson River Waterbody
Segment 108-02L: The Harwoods Mill Reservoir Waterbody
Segment 108-03E: The Plum Tree Island Waterbody
Segment 108-04E: The Back River Waterbody
Segment 108-05R: The Brick Kiln Creek Waterbody
Segment 108-06L: The Big Bethel Reservoir Waterbody
Segment 108-07R: The New Market Creek Waterbody
Segment 108-08E: The Little Creek (Channel and Inlet) Waterbody

Segment 108-09L: The Lake Whitehurst Waterbody
Segment 108-10L: The Little Creek Reservoir-Amphibious Base Waterbody
Segment 108-11L: The Lake Lawson Reservoir Waterbody
Segment 108-12L: The Lake Bradford Waterbody
Segment 108-13L: The Lake Smith Waterbody
Segment 108-14L: The Mount Trashmore Lake Waterbody
Segment 108-15L: The Lake Joyce Waterbody
Segment 108-16E: The Lynnhaven River Waterbody
Segment 108-17E: The Broad Bay and Linkhorn Bay Waterbody
Segment 108-18E: The Owl's Creek Waterbody
Segment 108-19C: The Coastal Shoreline at Virginia Beach Waterbody

TABLE ___

HAMPTON ROADS NONPOINT SOURCE WATERSHED ASSESSMENT INDEX

The following index of river basins, subbasins (hydrologic units) and watersheds contains the information applicable to the project study area:

1. York River Basin

HUC 02080107: York River Subbasin

Watershed F01
Watershed F02

2. James River Basin

HUC 020800206: James River Subbasin from the Fall Line to Hampton Roads

Watershed G03
Watershed G04
Watershed G05

HUC 02080208: Hampton Roads, Nansemond River, and Elizabeth River Subbasin

Watershed G01
Watershed G02

3. Chowan River and Dismal Swamp Basins

HUC 03010201: Nottoway River Subbasin

Watershed K13
Watershed K14
Watershed K16

HUC 03010202: Blackwater River Subbasin

Watershed K08
Watershed K09
Watershed K10
Watershed K11

HUC 03010203: Somerton Creek Subbasin

Watershed K06
Watershed K07

HUC 03010205: Dismal Swamp, Northwest River, and Back Bay Subbasin

Watershed K01
Watershed K02
Watershed K03
Watershed K04
Watershed K05

4. Small Coastal Rivers

HUC 02080108: Lower Western Shore Tributaries

Watershed C09
Watershed C10

Nonpoint Source Pollution Priorities for the Hampton Roads Planning District

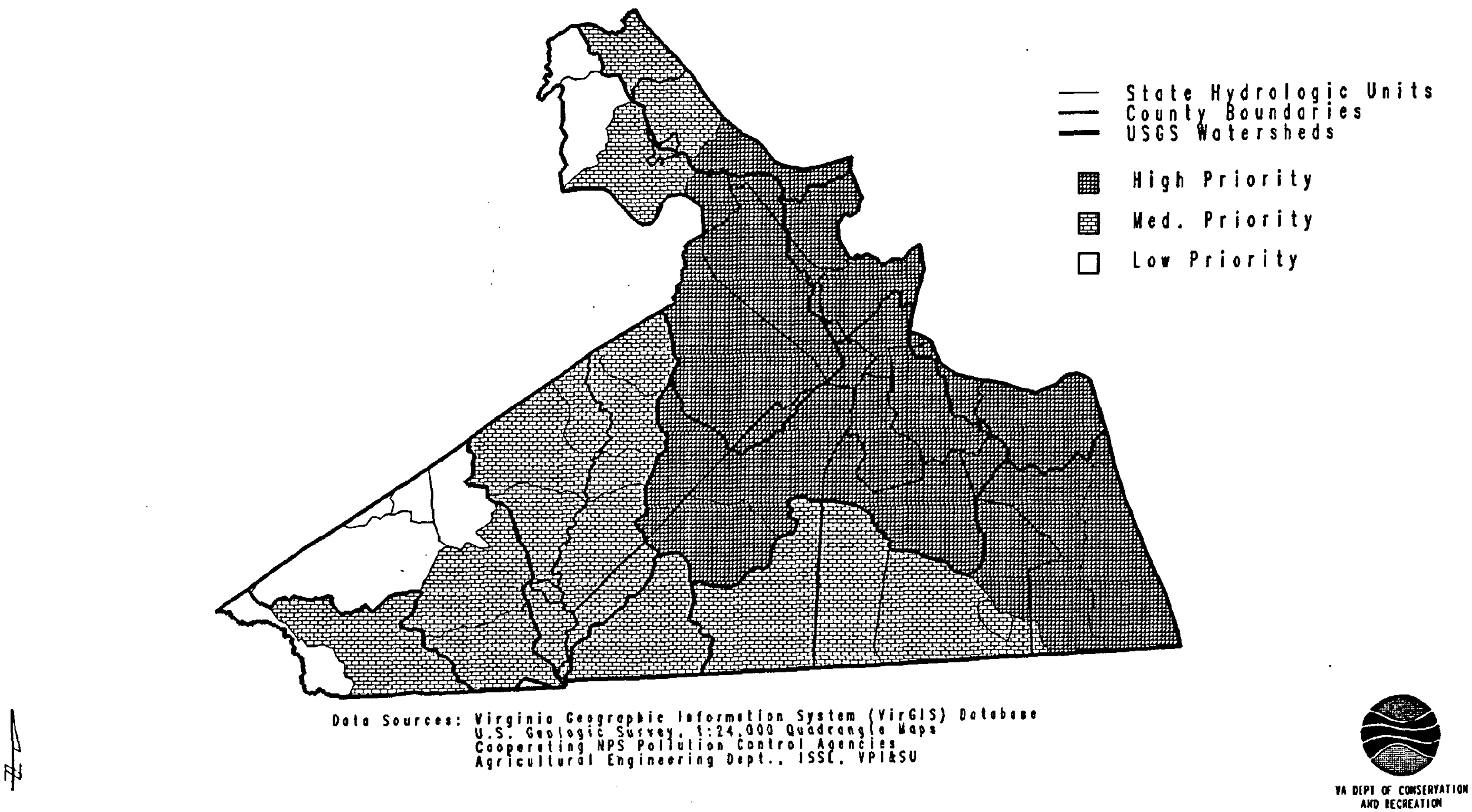

TABLE 1

WATER QUALITY CONDITION BY RIVER BRANCH

SEGMENT/ PARAMETER	MAIN STEM	WESTERN BRANCH	EASTERN BRANCH	SOUTHERN BRANCH
DO[1]	MARGINAL	MARGINAL	MARGINAL	MARGINAL
BOD[2]	MARGINAL	MARGINAL	MARGINAL	MARGINAL
CHL'A'[3]	GOOD	GOOD	GOOD	MARGINAL
FEC COL I[4]	POOR	POOR	POOR	POOR
TN[5]	GOOD	GOOD	GOOD	GOOD
TP[6]	GOOD	GOOD	GOOD	GOOD
ARSENIC	GOOD	GOOD	GOOD	GOOD
CADMIUM	MARGINAL	MARGINAL	MARGINAL	MARGINAL
CHROMIUM	GOOD	GOOD	GOOD	GOOD
COPPER	POOR	POOR	POOR	POOR
LEAD	POOR	POOR	POOR	POOR
MERCURY	POOR	MARGINAL	MARGINAL	MARGINAL
NICKEL	POOR	POOR	POOR	POOR
ZINC	MARGINAL	MARGINAL	MARGINAL	MARGINAL
PNAH[7]	GOOD	NO DATA	NO DATA	POOR
TBT[8]	LIMITED DATA	LIMITED DATA	LIMITED DATA	LIMITED DATA

NOTES:

1 Dissolved Oxygen
2 Biological Oxygen Demand - 5 day
3 Chlorophyl 'a'
4 Fecal Coliform
5 Total Nitrogen
6 Total Phosphorus
7 Polynuclear Aromatic Hydrocarbons
8 Tributyltin

Source: *HRWQA, Comprehensive Elizabeth River Water Quality Management Plan: Preliminary Management Recommendations, 1986.*

References Cited:

Alliance for the Chesapeake Bay.

(a) Data obtained on Virginia Citizen's Monitoring Program. Richmond, VA: January 3, 1994.

(b) Presentation by Marcy Judd on ACB Citizen Monitoring Program at "Virginia's Coastal Partners: Exchanging Grant Results" conference. Williamsburg, VA: November 16, 1993.

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____________. "State Water Quality Standards." Richmond, VA: VWCB, 1989, rev. 1990.

SENSITIVE LAND AND AQUATIC RESOURCE AREAS

The presence of living resources in sensitive land and aquatic ecosystems, such as finfish and shellfish, wildlife, plant communities, and benthic and planktonic communities, is closely linked to water quality conditions. Because of this relationship, living resources are good indicators of the overall health of an ecosystem and are continuously monitored by the scientific community and marine resource managers. Such monitoring in the waterways in and around the Hampton Roads region has generally determined that poor water quality conditions have brought about declines in critical habitat areas and, therefore, living resources that were once abundant. As a signatory of the 1987 Chesapeake Bay Agreement and its subsequent amendments and directives regarding restoration of historic living resource areas in the Chesapeake Bay watershed, the Commonwealth of Virginia has committed itself to halting a decline in water quality conditions. Local governments in the Hampton Roads region have also made similar commitments for other sensitive land and aquatic resource areas outside of the Bay watershed.

While many natural and human factors have played a role in this documented decline in water quality and, subsequently, in the decrease in the numbers and amount of living resources and their habitats, much of the problem has been attributed to the development of shoreline areas. Arguments have been made that the increased development of these areas, and the hardening of shoreline reaches and continuously-increasing densities of private and public access points into adjacent waterways that occurs along with such development, are having negative impacts on water quality. Evidence to support this argument includes loss of critical aquatic habitats of ecological and commercial significance which has directly resulted from physical alteration associated with improper or unnecessary placement of shoreline structures for erosion control and water access purposes, as well from unpermitted disposal of fill material. Evidence of a lesser noted degree, but no less significant, is water quality degradation associated with nonpoint source (NPS) pollution inputs from water use activities and surrounding land uses. It is important and recommended, therefore, that sensitive aquatic resource areas be identified and considered in the site planning and review process of undeveloped areas, in order to avoid future conflicts between land and water uses and further loss of living resources.

The purpose of this section is to describe and inventory critical land and aquatic habitat areas in the project study area that might be adversely affected by point and nonpoint source pollution inputs and improper siting of shoreline structures and water access facilities. Seven types of sensitive land and aquatic resources and habitat have been identified to the extent that information was available: tidal and nondtidal wetlands, submerged aquatic vegetation (SAV) beds, spawning grounds, nursery areas, shellfish growing areas (oyster, clam and blue crab), commercially- and recreationally-important finfish and shellfish (non-oyster or clam) areas, and protected areas and estuarine research reserves.

To assist in this effort, a series of maps entitled the _Environmental Sensitivity Map Atlas for the Commonwealth of Virginia_ prepared by the Virginia Institute for Marine Science (VIMS) for the National Oceanic and Atmospheric Administration (NOAA) was used in part. This atlas was developed to provide direction for U.S. Coast Guard oil spill response teams with regards to environmentally-sensitive coastal regions of the Chesapeake Bay. The maps depict the location and spatial distribution of habitats for various marine biota and other sensitive aquatic resource areas. However, all of this data was not included for the purposes of this study. The atlas is available at the U.S. Fish and Wildlife Service (USF&WS) in White Marsh, VA (Gloucester County) and has recently been converted to digital format by VIMS for inclusion in a GIS database. Posters were also developed for the U.S. Coast Guard Oil Spill Response Unit which show environmentally-sensitive areas by season throughout the Chesapeake Bay and its tributaries. A set of these posters has been included with this report. Previous water quality studies, prepared by the Southeastern Virginia Planning District Commission and the Hampton Roads Water Quality Agency, as well as other published reports were also used in this analysis.

A. Wetlands

Wetlands are transitional areas between land and water-based environmental communities. In general, wetlands are characterized by undrained wet soils, vegetation that is adapted to growing in water or saturated soils, and a periodic covering of shallow water. Tidal wetlands, which are usually vegetated marshes or nonvegetated mudflats, are found along creeks, rivers and bays that are affected by the lunar tide. Nontidal wetlands occur along freshwater streams or lakes, in flood plains or in areas of poor drainage (SVPDC(a), 1989: 114; SVPDC(b), 1989: 25).

One of the most important values of both tidal and nontidal wetlands is their ability to filter runoff from upland areas before it reaches open water. In doing this, wetlands reduce the adverse effects of NPS pollution by removing and retaining nutrients, breaking down chemicals and organic wastes, and reducing sediment loads. However, the ability of wetlands to perform a pollution control function is limited. Once the limit is exceeded, the productivity of wetlands and their ability to support dependent organisms will deteriorate. This is most likely to occur when stormwater runoff has been concentrated into channels that accelerate the flow of runoff into wetlands. Toxicants in runoff, such as farm or home use herbicides, many also damage wetland areas (SVPDC(a), 1989: 115; SVPDC(b), 1989: 26).

Tidal Wetlands

Tidal wetlands can be categorized into marsh types. The Virginia Institute for Marine Science (VIMS) has classified twelve different common marsh types, based on vegetational comparison. These marsh types have been evaluated according to certain values and are recorded in the VIMS study, Guidelines for Activities Affecting Virginia Marshes (Silberhorn, Dawes and Barnard, 1974). The following is a brief outline of the wetland types and their evaluation as found in that publication.

It is recognized that most wetland areas, with the exception of the relatively monospecific cordgrass marshes of the Eastern Shore, are not homogenously vegetated. Most marshes, are, however, dominated by a major plant. By providing the resource manager with the primary values of each community type and the means of identification, a useful and covenient tool can be used for weighing the relative importance of each marsh parcel. In Virginia, many wetlands management problems involve only a few acres or a fraction of an acre. The indentification of plant communities permits the resource manager to evaluate both complete marshes and subareas with a marsh (Silberhorn, 1974: 2; Silberhorn, Dawes and Barnard, 1974: 3).

Each marsh type may be valuated in accordance with five general values. These are: 1) production and detritus availability; 2) waterfowl and wildlife utilization; 3) erosion buffer; 4) water quality control; and 5) flood buffer.

1) Production and Detritus Availability

Previous VIMS reports have discussed the details of marsh production and the role of detritus which results when the plant material is washed into the water column. The term "detritus" refers to plant material which decays in the aquatic system and forms the basis of a major marine food web. The term "production" refers to the amount of plant material which is produced by the various types of marsh plants. Vegetative production of the major species has been measured and marshes have been rated in accordance with their average levels of productivity. If the production is readily available to the marine food web as detritus, a wetlands system is even more important than one of equal productivity where little detritus results. Availability of detritus is generally a function of marsh elevation and total flushing, with detritus more available to the aquatic environment in the lower, well-flushed marshes (Silberhorn, 1974: 2).

2) Waterfowl and Wildlife Utilization

Long before marshes were discovered to be detritus producers, they were known as habitats for various mammals and marsh birds and as food sources for migratory waterfowl. Some marsh types, especially mixed freshwater marshes, are more valuable because of diversity of the vegetation found there (Silberhorn, 1974: 2). Because of the highly productive nature of tidal marshes, many species of aquatic organisms use the waters adjacent to marshes as nurseries. Various species of marine birds, migratory waterfowl and mammals also depend on marsh systems for cover and breeding grounds, and may depend on both marshes and adjacent tidal flats for feeding areas (SVPDC(a), 1989: 115; SVPDC(b), 1989: 26).

3) Erosion Buffer

Erosion is a common coastal problem. Marshes can erode, but some, particularly the more saline types, erode much more slowly than do adjacent shores which are unprotected by marsh. The buffering quality is derived from the ability of the vegetation to absorb or dissipate wave energy or to establish a dense root system which stabilizes the soil. Generally, freshwater species are less effective than saltwater in this regard (Silberhorn, 1974: 3)

4) Water Quality Control

The dense growth of some marshes acts as a filter, trapping upland sediment before it reaches waterways and, thus, protecting shellfish beds and navigation channels from siltation. Marshes can also filter out sediments that are already in the water column. The ability of marshes to filter sediments and maintain water clarity is of particular importance to the maintenance of clam and oyster production. Excessive sedimentation can reduce the basic food supply of shellfish through reduction of the photic zone where algae grows. It can also kill finfish and shellfish by clogging their gills. Additionally, marshes can assimilate and degrade pollutants through complex chemical processes. Research has shown that marshes may act as a natural treatment system that is comparable to artificial tertiary treatment of sewage (Silberhorn, 1974: 3).

5) Flood Buffer

The peat substratum of some marshes acts as a giant sponge in receiving and releasing water. This characteristic is an effective buffer against coastal flooding, the effectiveness of which is a function of marsh type and size (Silberhorn, 1974: 3).

Research and marsh inventory work conducted by VIMS indicate that 10 species of marsh vegetation tend to dominate many marshes, the dominant plant depending on water salinity, marsh elevation, soil type and other factors. The term "dominant" is construed to mean that at least 50% of the vegetated surface of a marsh is covered by a single species. Brackish and freshwater marshes often have no cleaerly dominant species of vegetation. These marshes are considered to be highly value in environmental terms (Silberhorn, Dawes and Barnard, 1974: 4).

Marsh Types and Their Environmental Contributions

Type I: Saltmarsh Cordgrass Community

- o Average yield 4 tons per acre per annum.
- o Optimum availability of detritus to the marine environment.
- o Roots and rhizomes eaten by waterfowl and stems used in muskrat lodge construction. Also serves as nesting material for various birds.
- o Deterrent to shoreline erosion.
- o Serves as sediment trap and assimilates flood waters.

Type II: Saltmeadow Community

- o Yields 1-3 tons per acre per annum.
- o Food (seeds) and nesting areas for birds.
- o Effective erosion deterrent.
- o Assimilate flood waters.
- o Filters sediments and waste material.

Type III: Black Needlerush Community

- o Provides 3-5 tons per acre per year.
- o Highly resistant to erosion.
- o Traps suspended sediments but not as effective as Type II.
- o Somewhat effective in absorbing flood waters.

Type IV: Saltbush Community

- o About or less than 2 tons per acre per annum.
- o Nesting area for small birds and habitat for a variety of wildlife.
- o Effective trap for flotsam.

Type V: Big Cordgrass Community

- o Yields 3-6 tons per acre per annum.
- o Detritus less available than from Type I.

- Habitat for small animals and used for muskrat lodges.
- Effective erosion buffer.
- Flood water assimilation.

Type VI: Cattail Community

- 2-4 tons per acre per annum.
- Habitat for birds and utilized by muskrats.
- Traps upland sediments.

Type VII: Arrow Arum-Pickerel Weed Community

- 2-4 tons per acre per annum.
- Detritus readily available to marine environment.
- Seeds eaten by wood ducks.
- Fragility necessitates preservation.

Type VIII: Reed Grass Community

- 4-6 tons per acre per year.
- Little value to wildlife except for cover.
- Invades marshes and competes with more desirable species.
- Deters erosion on disturbed sites.

Type IX: Yellow Pond Lily Community

- Less than 1 ton per acre per annum.
- Cover and attachment site for aquatic animals and algae.
- Feeding territory for fish.

Type X: Saltwort Community

- Less than .5 tons per acre.
- Little value to aquatic or marsh animals.

Type XI: Freshwater Mixed Community

- Yields 3-5 tons per acre annually.
- High diversity of wildlife.
- High diversity of wildlife foods.
- Often associated with fish spawning and nursery grounds.
- Ranks high as a sediment trap and flood deterrent.

Type XII: Brackish Water Mixed Community

- Provides 3-4 tons per acre annually.
- Wide variety of wildlife foods and habitat.
- Deterrent to shoreline erosion.
- Serves as sediment trap and assimilates flood waters.
- Known spawning and nursery grounds for fish.

Evaluation of Wetland Types

For management purposes, the twelve types of wetlands identified above are grouped into five classifications below, based on the estimated total environmental value of an acre of each type (Silberhorn, 1974: 6,7).

Group One: Saltmarsh cordgrass (Type I)
Arrow Arum-Pickerel Weed (Type VII)
Freshwater Mixed (Type XI)
Brackish Water Mixed (Type XII)

Group One marshes have the highest value in productivity and wildfowl and wildlife utility and are closely associated with fish spawning and nursery areas. They also have high values as erosion inhibitors, important to the shellfish industry and valued as natural shoreline stabilizers. Group One marshes should be preserved.

Group Two: Big cordgrass (Type V)
Saltmeadow (Type II)
Cattail (Type VI)

Group Two marshes are of only slightly lesser value than Group One marshes. The major difference is that detritus produced in these marshes is less readily available to the marine environment due to higher elevations and consequently less tidal action to flush the detritus into adjacent waterways. Group Two marshes have very high values in protecting water quality and acting as buffers against coastal flooding. These marshes should also be preserved, but if development in wetlands is considered to be justified it would be better to alter Group Two marshes than Group One marshes.

Group Three: Yellow Pond lily (Type IX)
Black Needlerush (Type III)

The two marshes in the Group Three category are quite dissimilar in properties. The yellow pond lily marsh is not a significant contributor to the food web but it does have high values to wildlife and waterfowl. Black needlerush has a high productivity factor but a low detritus availability value. Black needlerush has little wildlife value but it ranks high as an erosion and flood buffer. Group Three marshes are important though their total value is less than Group One and Two marshes. If development in wetlands is considered necessary, it would be better to alter Group Three marshes than Groups One or Two.

Group Four: Saltbush (Type IV)

The saltbush community is valued primarily for the diversity and bird nesting area it adds to the marsh ecosystem. To a lesser extent it also acts as an erosion buffer. Group Four marshes should not be unnecessarily disturbed but it would be better to concentrate necessary development in these marshes rather than disturb any of Group One through Group Three marshes.

Group Five: Saltwort (Type X)
Reegrass (Type VIII)

Based on present information, Group Five marshes have few values of any significance. While Group Five marshes should not be unreasonably disturbed, it is preferable to develop in these marshes than in any other types.

Tidal wetlands (marshes) within the project study area were inventoried by VIMS for the following jurisdictions: York County and Poquoson (1974), Hampton (1975), Newport News and Fort Eustis (1977), James City County and Williamsburg (1980), Isle of Wight County (1981), Norfolk (1987), Portsmouth (1989), Virginia Beach: North Landing River and Tributaries (1976); Lynnhaven River, Lake Rudee and Their Tributaries (1979); and, Back Bay and Tributaries (1989), Chesapeake (1991), and Suffolk (1991). These inventories were used in the Environmental Sensitivity Index to show the location of extensive and fringe tidal marshes and tidal flats. VIMS is currently updating and digitizing the inventories into a GIS system using recent aerial photography; completed information was not available for use at the time of this study. Because tidal marsh inventories are available in local government planning offices, it was decided that replication of their location on the maps included with this report would not be undertaken; however, these inventories were used in staff analyses during the course of this study.

Nontidal Wetlands

Although nontidal wetlands normally do not have the productive value of tidal marshes, they do provide valuable fish and wildlife habitats. Many species of freshwater fish feed in nontidal wetlands or upon wetland produced food. Nontidal wetlands are also used as spawning and nursery grounds by a number of fish species. Even nontidal wetlands that are only seasonally flooded can be important breeding and foraging grounds for some freshwater species of fish. It has also been shown that detritus originating in bottomland hardwood forests can be important to the food chain of estuarine organisms. Nontidal wetlands are also essential breeding, nesting, feeding and shelter habitats for many species of waterfowl, mammals, reptiles and amphibians (SVPDC(a), 1989: 115; SVPDC(b), 1989: 26).

An inventory of nontidal wetlands was completed in 1973 by the USF&WS. This inventory, known as the National Wetlands Inventory (NWI) maps, identifies both tidal and nontidal wetlands areas, but field verification has noted inaccurate data. The USF&WS has recently updated these maps and drafts are currently being field verified. It is anticipated that the new NWI maps will become available, in map form and in digitized data in Fall 1994.

B. Submerged Aquatic Vegetation (SAV) Beds

Submerged aquatic vegetation (SAV), commonly called sea grasses, is comprised of rooted and unrooted underwater flowering plants that have colonized primarily soft sediments in coastal, estuarine, and freshwater habitats. Seagrasses are typically defined as the approximately 60 species of marine angiosperms; however, representatives of the several hundred species of freshwater macrophytes are often found in estuarine habitats (Dennison, Orth, Moore, Stevenson, Carter, Kollar, Bergstrom, and Batiuk, 1993: 86).

During the last two decades, there has been an increasing recognition of the importance of SAV in coastal and estuarine ecosystems. Like wetlands, SAV is vitally important to aquatic ecosystems because it serves as cover, food source, spawning ground and nursery area to many species of finfish, shellfish and other invertebrates. It also serves to maintain water clarity by filtering, trapping and stabilizing sediments, thereby reducing water turbidity, acts as a nutrient buffer by accumulating large quantities of nitrogen and phosphorus, and provides an important source of dissolved oxygen (DO). SAV also serves as the primary food source for many species of migratory water fowl (SVPDC(a), 1989: 116; SVPDC(b), 1989: 26).

SAV has declined in many areas along the East Coast of the United States. Declines in waters of Virginia are well known; the Chesapeake Bay, the Potomac River, and Back Bay are just a few examples. Declines in SAV vary with the waterbody and are thought to be influenced by disease, runoff from urban and rural areas, changes in salinity, turbidity, weather and various natural occurrences (Schwab, Settle, Halstead and Ewell, 1990: 265).

SAV requires water that is relatively clear so that there may be sufficient sunlight for photosynthesis to occur. NPS pollution is thought to be one of the major factors in the nonexistence or drastic decline of SAV beds in many of Hampton Roads' waterbodies. Nutrients are considered to be NPS pollutants when they exist in excess. Although nutrients are essential to the growth of SAV, the excessive quantities of nutrients often found in urban and agricultural runoff promote algal blooms which cloud the water and limit the ability of SAV to photosynthesize. Excessive sediment loads from agricultural and urban runoff compound the problem by combining with algal blooms to further prevent the penetration of sunlight. Without sufficient light, SAV eventually dies and primary aquatic habitat is eliminated (SVPDC(a), 1989: 116; SVPDC(b), 1989: 29).

Boat traffic also creates or exacerbates turbidity by increasing the physical energy in a waterway. Propeller wash and wakes suspend sediments and keep them in suspension for longer durations. This turbidity impacts the ecology of shallow marsh areas by reducing sunlight necessary for growth of submerged grasses, disturbing larval settlement, and affecting food supplies of marsh organisms. Along with this, pollutants resulting from the operation of boats include spilled petroleum products, non-biodegradable litter, and sanitary waste. Consequently, boating is generally recognized as a nonpoint source of pollution. EPA and

VMRC have concluded that although the impact from individual boats may be negligible, the cummulative impact in many cases may generate significant localized water quality problems (CBLAD, 1989: VI-80).

SAV Type and Distribution in the Chesapeake Bay Watershed:

In the Chesapeake Bay, seagrasses in saline regions and freshwater angiosperms that have colonized lower-salinity portions of the Bay constitute a diverse community of SAV, consisting of approximately twenty species. These plants have historically been one of the major factors contributing to the high productivity of the Bay, especially the abundance of waterfowl (Dennison, Orth, Moore, Stevenson, Carter, Kollar, Bergstrom, and Batiuk, 1993: 86). However, continued deteroration of water quality in the Bay and its tributaries due to poorly treated sewage, NPS pollution from urban and rural areas, and industrial discharges has caused SAV to decline in the Bay (VCRMP(a), Fall 1992: 2).

Scientists estimate that, prior to 1960, the Chesapeake Bay and its tributaries probably supported over 243,000 hectares (600,000 acres) of sea grasses. By 1978, the total acreage had decreased to approximately 16,200 hectares (40,000 acres), or about 1/15th the acreage historically supported in the Bay. By 1992, the annual survey identified approximately 25,920 hectares (64,000 acres) of SAV in the Bay, which was a 54% increase over the 1978 survey (VCRMP(a), Fall 1992: 2).

A variety of factors may have contributed to this improvement. Since 1978, most sewage treatment facilities have been upgraded to remove about 85% of organic pollutants before flows are discharged into the Bay. Prior to 1978, most wastewater treatment plants removed only about 50% of the pollutants (VCRMP(a), Fall 1992: 2).

In 1983, Virginia also began a program to control nonpoint source pollution from agricultural lands. Administered by the Department of Conservation and Recreation, the program annually enlists hundreds of farmers in cropland and animal waste Best Management Practices (BMPs). The BMP programs are designed to prevent erosion and the transport of sediments, nutrients, and toxic chemicals associated with pesticide use into surface waters (VCRMP(a), Fall 1992: 2).

In January 1988, a ban on phosphorus in laundry detergents sold in Virginia went into effect. Stricter controls also were placed on the kinds and amounts of chemicals that can be discharged into Virginia's waterways. The decade of the 1980s also was noted for less rainfall than historically normal, resulting in less runoff into the Chesapeake Bay and, thus, fewer sediments and nutrients in Bay waters that limit SAV growth and survival (VCRMP(a), Fall 1992: 2).

Also contributing to the SAV comeback has been the work of VIM's SAV Program. This program was established at the College of William and Mary in 1984 to (1) investigate the processes that limit the survival of SAV in the Chesapeake Bay, (2) annually map from aerial photography SAV growth in the Bay, and (3) conduct replanting and seeding of SAV in the Bay and its tributaries (VCRMP(a), Fall 1992: 2).

Since 1984, the program has been investigating the subtle relationships between SAV growth and survival, and environmental conditions. In addition, VIMS has investigated the various factors that regulate both the timing and rate of SAV seed germination. The program has transplanted and seeded approximately 75 acres of SAV around the Bay since 1984 with mixed results (VCRMP(a), Fall 1992: 2).

Most recently in 1989, the multi-state Chesapeake Bay Executive Council adopted the Chesapeake Bay Submerged Aquatic Vegetation Policy and Implementation Plan. The plan highlighted the need to develop SAV habitat requirements and the need for Bay-wide goals for SAV distribution and species diversity (VCRMP(a), Fall 1992: 3). This is discussed further in the subsection on SAV target restoration efforts.

SAV Monitoring Efforts

Living resources monitoring programs are being increasingly recognized as critical in contributing to our understanding of fluctuations in the abundance of these resources. In the Chesapeake Bay, monitoring of SAV has been recognized as necessary to assess the success of the Bay cleanup efforts. The baywide decline of SAV in the 1960's and 1970's, followed by a relatively rapid annual change from 1984 through 1990, supports the suggestion that SAV may be a good barometer of the overall health of the Bay. This is believed to be so because the plants depend upon the availability of light, which in turn is affected by the amount of sediments (suspended solids) and nutrients in the water. In turn, EPA's Chesapeake Bay Program has begun to focus more attention on SAV as an general indicator of water quality conditions in the Bay (VIMS(a), 1991: 1; VCRMP(a), Fall 1991:3).

More specifically, the habitat requirements of SAV are used to characterize the water quality of the Cheapeake Bay because of its widespread distribution in the Bay, important ecological role, and sensitivity to water quality parameters. SAV is particularly crucial as an indicator of water clarity and nutrient levels, because habitat requirements developed for various species of birds, fish, and shellfish in the Bay do not incorporate these conditions. The habitat requirements of these other organisms focus on chemical parameters (e.g. dissolved oxygen, pH, salinity, toxic compounds, and temperature). This is evident in that many of the restoration goals of birds, fish, and shellfish involve changes in both environmental quality and management of human harvesting activities. In contrast, SAV restoration goals can be linked solely to environmental quality, thus providing for more direct assessment of restoration progress (Dennison, Orth, Moore, Stevenson, Carter, Kollar, Bergstrom, and Batiuk, 1993: 87).

SAV communities in the Chesapeake Bay and its tributaries have been photographed and mapped, and the areas of the beds were digitized into a GIS system in 1978, 1984, 1985, 1986, 1987, 1989, and 1990. The lower Bay was mapped and digitized in 1980 and 1981. The bay shoreline was photographed in 1988 but was not mapped. Sections of the lower Bay were mapped and digitized in 1971 and 1974 (VIMS(a), 1991: 1).

Types of SAV Monitored

Data obtained on current SAV distribution encompasses 19 taxa from 10 vascular macrophyte families and 3 taxa from 1 freshwater macrophytic algal family, the Characeae, but excludes all other algae, both benthic and planktonic, which occur in the Chesapeake Bay and tributaries (VIMS(a), 1991: 2)

Ten species of submerged aquatic vegetation, exclusive of the algae, are commonly found in the Bay and its tributaries. Zostera marina (eelgrass) is dominant in the lower reaches of the Bay. Myriophyllum spicataum (Eurasian watermilfoil), Potamogeton pectinatus (sago pondweed), Potamogeton perfoliatus (redhead grass), Zannichellia palustris (horned pondweed), Vallisneria americana (wild celery), Elodea cnadensis (common elodea), Ceratophyllum demersum (coontail) and Najas guadalupensis (southern naiad) are less tolerant of high salinities and are found in the middle and upper reaches of the Bay. Ruppia maritima (widgeon grass) is tolerant of wide range of salinities and is found from the Bay mouth to the Susquehanna Flats. Approximately twelve other species are only occasionally found and, when present, occur primarily in the middle and upper reaches of the Bay and the tidal rivers. Hydrilla verticillata (hydrilla), a recently introduced species, presently dominates SAV beds in the tidal freshwater reaches of the Potomac River (VIMS(a), 1991: 2).

Crown Density

In addition to delineating SAV bed boundaries, an estimate of percent cover within each bed is made visually in comparison with an enlarged Crown Density Scale similar to those developed for estimating forest tree crown cover from aerial photography.

The Crown Density Scale used for determining density of SAV beds is as follows (VIMS(a), 1991: 10, 11):

Class 1 -- Very sparse, 0-10%
Class 2 -- Sparse, 10-40%
Class 3 -- Moderate, 40-70%
Class 4 -- Dense, 70-100%

SAV Distribution Data

SAV bed distribution is based on zones in the Chesapeake Bay. There are three zones: Upper, Middle and Lower. The project study area falls within the Lower Bay zone. In addition to the project study area, the Lower Bay zone also contains portions of the Rappahannock River, the south shore of the Potomac River at its confluence with the Bay, that portion of the Bay south of Tangier Island, as well as the whole of the Virginia portion of the Eastern Shore (VIMS(a), 1991: viii). For delineation of SAV distribution patterns, the Bay is divided into 21 major sections. The Lower Bay zone is comprised of Sections 14-21 (VIMS(a), 1991: x). The project study area is included in Sections 19-21 which are described below (VIMS(a), 1991: 7,9):

Section 19 **York River** -- all areas along the north shore from Clay Bank to the Guinea Marsh area and south of a line bisecting the large shoal area around the Guinea Marsh area, and along the south shore to include the north shore of Goodwin Island.

Section 20 **Lower Western Shore** -- includes all areas south of Goodwin Island to Broad Bay off Lynnhaven Inlet, excluding the James River.

Section 21 **James River** -- all SAV in the James River including the Chickahominy River.

SAV Data Mapping

SAV data is mapped on USGS 7.5 minute topographic quadrangles with corresponding code numbers. The project study area is contained on 25 quandrangles which are coded as follows (VIMS(a), 1991: 7,9):

#120 - Toano, VA
#121 - Gressit, VA
#127 - Brandon, VA
#128 - Norge, VA
#129 - Williamsburg, VA
#130 - Clay Bank, VA
#137 - Surry, VA
#138 - Hog Island, VA
#139 - Yorktown, VA
#140 - Poquoson West, VA
#141 - Poquoson East, VA
#144 - Bacons Castle, VA
#145 - Mulberry Island, VA
#146 - Newport News North, VA
#147 - Hampton, VA
#148 - Benns Church, VA
#149 - Newport News South, VA
#150 - Norfolk North, VA
#151 - Little Creek, VA
#152 - Cape Henry, VA
#153 - Chuckatuck, VA
#154 - Bowers Hill, VA
#155 - Norfolk South, VA
#156 - Kempsville, VA
#157 - Princess Anne, VA

General Summary of SAV Distribution in 1991

The most recent inventory of SAV distribution in the Chesapeake Bay was conducted by VIMS in 1992 and had not been published at the time of this study. Therefore, the data used for this study comes from the 1991 inventory, which was published in December 1992. The following is a general summary of the 1991 inventory data with some comparisons to recent historical data.

<<Note: PDC staff was recently made aware that the 1992 Inventory has just been published and this data will be added to the final study report.>>

In 1991, the Chesapeake Bay had 25,623 hectares (63,314.4 acres) of SAV, compared to 24,296 hectares (60,035.4 acres) in 1990 and 24,138 hectares (59,645 acres) in 1989. The general distribution of SAV within the Bay in 1991 was as follows: (1) Upper Bay Zone - 2,158 hectares (5,332.4 acres) or 8.4%; (2) Middle Bay Zone - 11,664 hectares (28,821.7 acres) or 45.5%; and (3) Lower Bay Zone - 11,802 hectares (29,162.7 acres) or 46.1% (VIMS(b), 1991: 20). Comparisons to 1990 data for these zones showed 2,353 hectares (5,814.3 acres) or 10%, 11,328 hectares (27,991.5 acres) or 47%, and 10,632 hectares (26,271.7 acres) or 44% occurring in the Upper, Middle, and Lower Bay zones, respectively (VIMS(a), 1990: 22). Thus, over the past three years, there has been an increase in SAV throughout the Bay in all three monitoring zones; however, the presence of SAV in the Lower Bay Zone constituted the greatest percentage of the overall distribution of SAV in the Bay in 1991, as compared to 1990 when the Middle Bay Zone had the greatest percentage.

Comparing 1991 data in the Lower Bay Zone with recent historical data, the distribution and abundance of SAV beds was almost identical to conditions in 1990 and 1989, with a slight increase in one area. In 1991, 48% (5,720 hectares or 14,134.1 acres) of SAV in this zone was found along the Lower Eastern Shore, compared to 45% (4,829 hectares or 11,932.5 acres) in 1990. Thirty-nine percent of the SAV mapped in the Lower Bay Zone was found along the western shore of the Bay, particularly in Mobjack Bay, in the Lower York River and along the Lower Western Shore, specifically in the Back River and Drum Flats area adjacent to Plum Tree Island; this is compared to 40% in 1990. Less than 2.5% of the SAV mapped in 1991 in the Lower Bay Zone was found in the James River, the same as in 1990 and a decrease from 1989 (VIMS(b), 1992: 37; VIMS(a), 1991: 40). Within the project study area of the Lower Bay Zone in both 1990 and 1991, SAV beds were concentrated in the nearshore areas of York County and the Cities of Poqoson, Hampton and Virginia Beach.

Detailed 1991 SAV Data by Section Compared with Recent Historical Data

Section 19 (York River), which is partially comprised of areas outside of the project study area, contained approximately 804 hectares (325.4 acres) of SAV in 1991, an increase from 791 hectares (1,954.6 acres) in 1990. Seventy-eight percent of the total coverage of this section was classified as dense (class 4), while 2% was moderately dense (class 3), 19.8% was sparse (class 2), and less than 1% was sparse (class 1). Dense beds, consisting of both Z. marina and R. maritima, were located principally along the north shore from Gloucester Point to the mouth of the river. SAV beds were absent upstream of Gloucester Point on the north shore, except for one small bed of Z. marina near Gloucester Point; a result of VIMS transplanting efforts using seeds in 1990. Except for one large bed located on the north side of the Goodwin Islands and a smaller bed adjacent to the Coast Guard Station, the south shore was unvegetated in 1991 (VIMS(b), 1992: 60).

There were 2,006 hectares (4,956.9 acres) of SAV mapped in 1991 in Section 20 (Lower Western Shore), also an increase from approximately 1,797 hectares (4,440.4 acres) mapped in 1990 and from 1,670 hectares (4,126.57 acres) reported in 1989. Ground truth surveys reported both Z. marina and R. maritima. Forty-one percent of the total coverage in Section 20 was mapped as dense (class 4), 28% as moderate (class 3), 17% as sparse (class 2), and 14% as very sparse (class 1) in 1991. In 1990 and 1989, 60% of the total coverage in this section remained dense. SAV was mapped in Broad Bay, Back River, the mouth of the Poquoson River off Pasture and Hunts Neck, Drum Island Flats, Poquoson Flats, adjacent to Crab Neck just south of Goodwin Island, and on the south side of Goodwin

Island. No SAV was present in the southwest and northwest branches of Back River, or in the Poquoson River, Chisman Creek, and Back Creek (VIMS(b), 1992: 64, 65; VIMS(a), 1991: 65).

There were 2.74 hectares (6.8 acres) of SAV mapped in Section 21 (Mainstem James River) in 1991, compared to 2.73 hectares (6.745 acres) in 1990 and 4 hectares (9.88 acres) in 1989. This moderately dense bed, located at the mouth of Hampton Creek (Hampton River) adjacent to the Veteran's Hospital, had no ground truthing in 1991, but has been reported to consist predominantly of Z. marina in previous ground surveys (VIMS(a), 1990: x, 17; VIMS(b), 1991: 65).

A comparison of SAV bed data in the project study area from 1989 to 1991 is shown in Tables __ and __. SAV beds as mapped by VIMS on reduced topographic quadrangle sheets in the 1991 Submerged Aquatic Vegetation in the Chesapeake Bay have been reproduced on the maps attached to this study.

SAV Restoration Targeting Efforts in the Chesapeake Bay and its Tributaries and Continuing Research on Water Quality Levels Necessary for SAV Survival

After the establishment of the SAV Program at VIMS in 1984, VIMS found that attempts to establish SAV in the middle and upper reaches of the York and Rappahannock Rivers met with little success. SAV transplanted in the Fall was well established by the Spring; however, monitoring in June indicated reduced growth and vigor. This pattern was observed for several years leading VIMS to conclude that spring and summer water quality levels in these river areas still are inadequate to support longterm SAV survival (VCRMP(a), Fall 1992: 2).

The time and efforts invested in attempting to re-establish SAV in the York and Rappahannock Rivers demonstrated the need to establish water quality conditions necessary for SAV to survive; and, in response to the Cheaspeake Bay Program Executive Council's SAV policy and commitments, a working group of scientists began compliling data that related specific levels of water quality to SAV survival. Scientists also established criteria for SAV growth and targeted SAV restoration goals throughout the Bay region. The results of these efforts are contained in the December 1992 report entitled Submerged Aquatic Vegetation Habitat Requirements and Restoration Targets: A Technical Synthesis (Chesapeake Bay) (VCRMP(a), Fall 1992: 3).

Data for the report was complied from four study sites-- the mouth of the York River, the upper Potomac River, upper Chesapeake Bay at the mouth of the Susquehanna River, and the Choptank River on the Delmarva Peninsula. These study areas represent regions where in the past ten years there has been constant monitoring of water quality and SAV growth, density, and distribution (VCRMP(a), Fall 1992: 3).

Scientists related the growth of sea grasses to five water quality conditions: (1) light attenuation, (2) total suspended solids (floating matter in the water), (3) chlorophyll and the presence

SAV Distribution in Project Area
of Lower Bay Zone by Section -- 1989-1991

		Area (hectares)			Area (acres)		
#	Section	1991	1990	1989	1991	1990	1989
19	York River	803.53	790.87	676.89	1,985.52	1,954.24	1,672.60
20	Lower Western Shore	2,005.75	1,796.84	1,670.08	4,956.21	4,439.99	4,126.77
21	James River	2.74	2.73	3.86	6.77	6.75	9.54
	Lower Bay Zone Total	11,801.72	10,626.56	10,169.17	29,160.27	26,258.23	25, 128.02
	Cheapeake Bay Total	25,623.47	24,295.79	24,137.61	63,315.59	60,034.90	59,644.03

Source: Distribution of Submerged Aquatic Vegetation in the Chesapeake Bay - 1990, 1991.
VIMS, 1990: 29; 1991: 26.

SAV Distribution in the Project Area of Lower Bay Zone by Topographic Quadrangle – 1989-1991

Code #	Quadrangle	Area (in hectares) 1991	1990	1989	Area (in acres) 1991	1990	1989
120	Toano, VA	...	...	...	...	...	...
121	Gressit, VA	...	...	...	...	...	...
127	Brandon, VA	#	...	#		...	
128	Norge, VA	...	**	0**	...		
129	Williamsburg, VA	...	...	...	...	...	...
130	Clay Bank, VA	0	1.48	#	0	3.66	
137	Surry, VA	#	...	...		...	...
138	Hog Island, VA	...	...	...	...	...	...
139	Yorktown, VA	0.71	1.68	1.58	1.75	4.15	3.9
140	Poquoson West, VA	554.65	540.4	411.99	1,370.54	1,337.63	1,018.03
141	Poquoson East, VA	1,151.47	1,007.92	994.84	2,845.28	2,489.53	2,458.25
144	Bacons Castle	...	...	...	...	...	...
145	Mulberry Island	...	...	...	...	...	...
146	Newport News South, VA	...	...	...	...	...	...
147	Hampton, VA	381.24	342.1	304.06	942.04	845.08	751.33
148	Benns Church, VA	...	...	...	...	...	...
149	Newport News South, VA	...	0	0	...	0	0
150	Norfolk North, VA	...	0	0	...	0	0
151	Little Creek, VA	0	0	0	0	0	0
152	Cape Henry, VA	23.66	28.31	36.47	58.46	70	90.12
153	Chuckatuck, VA	...	...	...	...	...	...
154	Bowers Hill, VA	...	...	...	...	...	...
155	Norfolk South, VA	...	...	...	...	...	...
156	Kempsville, VA	...	...	...	...	...	...
157	Princess Anne, VA	0	0.73	0	0	1.8	0

Notes: ... Indicates quadrangle not photographed and assumed to have no SAV.
0 Indicates quadrangle photographed and no SAV noted.
** Indicates area was photographed in 1987 and 1989, and was known to have SAV both years but was not mapped because SAV beds were too narrow and obscured by shoreline at 1:24,000 scale. Ground truthing in 1987 revealed narrow beds fringing the shoreline of small tributaries of the Chickahominy River (area was not photographed in 1990).
# Indicates SAV beds not detected from aerial photography but from ground truthing only.

Source: Distribution of Submerged Aquatic Vegetation in the Chesapeake Bay, 1990, 1991. VIMS, 1990: 26-28; 1991: 24, 25).

of nutrients, (4) dissolved inorganic nitrogen and (5) dissolved inorganic phosphorus (VCRMP(a), Fall 1992: 3).

Varying salinity ranges determine to what degree these conditions affect the plants. For example, scientists found that plants in the upper Bay, in tidal fresh waters, require less light for survival than those in the lower Bay (higher saline) waters. Plants in tidal freshwater areas also can survive consistently high concentrations of nitrogen; plants in the lower Bay, in higher salinity areas, require greater amounts of light and cannot tolerate high nitrogen levels. Nitrogen, a typical component of lawn and garden fertilizers, is a nutrient that promotes growth of algae in Bay tributaries. Algae prevents sunlight from reaching the sea grasses, which die from lack of sunlight (VCRMP(a), Fall 1992: 3).

These differences in salinity ranges, added to the diversity of the SAV communities within the Bay, led the study group to identify separate habitat requirements for each of the four salinity regimes within the Bay. The Technical Synthesis also established a set of restoration "targets" for SAV distribution throughout the Chesapeake Bay. Using a geographic overlay of the Chesapeake Bay, which delineates actual and potential SAV habitats, the study group established three tiers or areas for re-establishing SAV. Each tier is based upon different water quality conditions (VCRMP(a), Fall 1992: 3).

The three tier targets are (1) restoration of SAV to areas currently or previously inhabited by SAV as mapped through regional and baywide aerial surveys from 1971 through 1990; (2) restoration of SAV to all shallow water areas delineated as existing or potential SAV habitat down to the one meter depth contour or approximately 3 feet of water; and (3) restoration of SAV to all shallow water areas delineated as existing or potential SAV habitat down to the two meter depth contour or in the 6-foot depth range (Batiuk, Richard A., Robert J. Orth, Kenneth A. Moore, William C. Dennison, J. Court Stevenson, Lorie W. Staver, Virginia Carter, Nancy B. Rybicki, R. Edward Hickman, Stan Kollar, Steven Bieber and Patsy Heasly, 1992: 112, 117). The second and third tiers were established to provide management agencies with quantitative measures of progress in SAV distribution in response to improvements, such as current reductions in nutrient loadings, whereas potential areas in the 6-foot range will require additional reductions in the loading (nutrient) rates (VCRMP(a), Fall 1992: 3). Table ___, Figures __ ,__ &____, and Tables __ & __ show the Chesapeake Bay SAV habitat requirements for one meter and two meter restoration and Tier I and Tier III restoration target areas and target status, respectively.

The Technical Synthesis represents the first comprehensive effort to link requirements for a living resource with water quality restoration targets. This habitat requirement approach is different from the traditional so-called "dose and response method" wherein different levels of toxicity are applied to determine the tolerance level of living organisms. As a result of this research, the 1992 Chesapeake Bay Agreement Amendments declare that it is now possible to demonstrate a link between water quality conditions and specific to results from a single study area. Tidal fresh and oligohaline SAV habitat requirements are based on upper Chesapeake Bay and upper Potomac River studies (Chapter V). Mesohaline and polyhaline SAV habitat requirements are based on Choptank River and York River studies (Chapter V).

ity conditions that support SAV survival.

This type of analysis (referred to as correspondence analysis) was strengthened by factors common to each of the case studies. Field data was collected over several years (almost a decade in the Potomac River) in varying meteo-

Table IV-1. Chesapeake Bay SAV Habitat Requirements.

	SAV Habitat Requirements For One Meter Restoration[1]						SAV Habitat Requirements For Two Meter Restoration[1]	
	Habitat Requirements Which Effect Water Column/Leaf Surface Light Attenuation							
Salinity[2] Regime	Light[3] Attenuation Coefficient (m^{-1})	Total Suspended Solids (mg/l)	Chlorophyll *a* (µg/l)	Dissolved Inorganic Nitrogen (mg/l)	Dissolved Inorganic Phosphorus (mg/l)	Critical Life Period	Light[3] Attenuation Coefficient (m^{-1})	Critical Life Period
Tidal Fresh	<2	<15	<15	—	<0.02	April-October	<0.8	April-October
Oligohaline	<2	<15	<15	—	<0.02	April-October	<0.8	April-October
Mesohaline	<1.5	<15	<15	<0.15	<0.01	April-October	<0.8	April-October
Polyhaline	<1.5	<15	<15	<0.15	<0.02	March-November	<0.8	March-November

1. The SAV habitat requirements are applied as median values over the April-October critical life period for tidal fresh, oligohaline, and mesohaline salinity regimes. For polyhaline salinity regimes, the SAV habitat requirements are applied as median values from combined March-May and September-November data. Light attenuation coefficient should be applied as the primary habitat requirement; the remaining habitat requirements should be applied to help explain regional or site specific causes of water column and leaf surface light attenuation which can be directly managed.
2. Tidal fresh=<0.5ppt; oligohaline=0.5-5ppt; mesohaline=>5-18ppt; and, polyhaline=>18ppt.
3. For determination of Secchi depth habitat requirements, apply the conversion factor Secchi depth=1.45/light attenuation coefficient.

Source: Tech Syn, 1992

Chesapeake Bay Program Segments

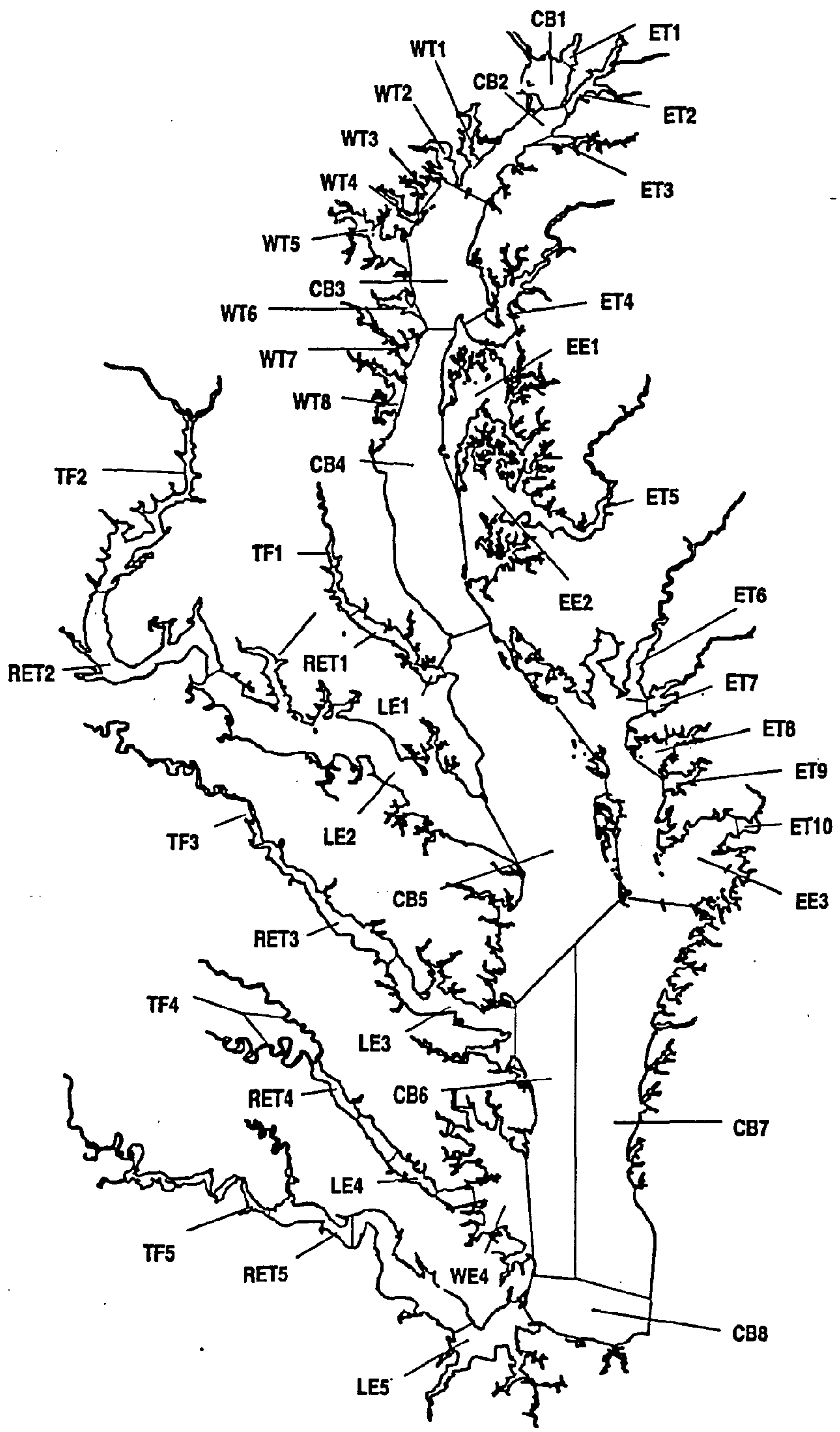

Figure VI-2. Chesapeake Bay Program segmentation scheme used to report the SAV distribution restoration targets.

Table VI-3. Chesapeake Bay SAV Distribution Restoration Tier I and Tier III Targets by Chesapeake Bay Program Segment.

CBP Segment	1990 SAV Distribution (Hectares)	Tier I SAV Restoration Target (Hectares)	1990 SAV Distribution as a Percentage of the Tier I SAV Restoration Target	Tier III SAV Restoration Target (Hectares)	1990 SAV Distribution as a Percentage of the Tier III SAV Restoration Target
CB1	1780	3101	57%	6975	26%
CB2	19	139	14%	3086	<1%
CB3	36	817	4%	3426	1%
CB4	5	103	5%	3496	<1%
CB5	4981	6309	79%	15083	33%
CB6	511	783	65%	2923	17%
CB7	3112	4624	67%	11803	26%
CB8	29	86	34%	1928	2%
WT1	0	24	0%	1836	0%
WT2	87	353	25%	3056	3%
WT3	3	349	<1%	839	<1%
WT4	0	0	0%	1061	0%
WT5	0	53	0%	1452	0%
WT6	0	240	0%	838	0%
WT7	0	189	0%	883	0%
WT8	0	78	0%	1970	0%
TF1	0	6	0%	890	0%
RET1	0	16	0%	959	0%
LE1	0	132	0%	2653	0%
TF2	1642	3098	53%	8304	20%
RET2	1367	1847	74%	7443	18%
LE2	51	282	18%	18012	<1%
TF3	0	0	0%	3293	0%
RET3	0	0	-	5928	0%
LE3	401	1714	23%	9342	4%
TF4	0	0	-	1614	0%
RET4	0	0	-	2915	0%
LE4	79	309	26%	4822	2%
WE4	4192	5902	71%	12529	33%
TF5	0	0	-	5780	0%
RET5	0	13	0%	4987	0%
LE5	3	16	19%	13841	<1%
ET1	0	7	0%	1207	0%
ET2	364	467	78%	2967	12%
ET3	39	167	24%	1515	3%
ET4	33	1506	2%	5812	<1%
ET5	0	191	0%	3009	0%
ET6	0	0	-	4082	0%
ET7	0	0	-	2648	0%
ET8	103	271	38%	3763	3%
ET9	128	363	35%	2044	6%
ET10	0	0	-	495	0%
EE1	391	2474	16%	8815	4%
EE2	188	3646	5%	11648	2%
EE3	4849	6350	76%	35686	14%
TOTALS	24393	46025	53%	247658	10%

Table VI-4. Chesapeake Bay SAV Density Restoration Targets Status by Chesapeake Bay Program Segments.

CBP Segment	1990 SAV Distribution (Hectares)	1990 SAV Distribution (and%) within 70-100% Density Category (Hectares)		Tier I SAV Restoration Target (Hectares)	1990 SAV Distribution within 70-100% Density Category as Percentage of Tier I SAV Restoration Target
CB1	1780	84	(5%)	3101	3%
CB2	19	0	(0)%	139	0%
CB3	36	<1	(1%)	817	1%
CB4	5	0	(0%)	103	0%
CB5	4981	1512	(30%)	6309	24%
CB6	511	303	(59%)	783	39%
CB7	3112	1412	(45%)	4624	31%
CB8	29	<1	(1%)	86	1%
WT1	0	0	(-)	24	0%
WT2	87	27	(31%)	353	8%
WT3	3	0	(0%)	349	0%
WT4	0	0	(-)	0	0%
WT5	0	0	(-)	53	0%
WT6	0	0	(-)	240	0%
WT7	0	0	(-)	189	0%
WT8	0	0	(-)	78	0%
TF1	0	0	(-)	6	0%
RET1	0	0	(-)	16	0%
LE1	0	0	(-)	132	0%
TF2	1642	1187	(72%)	3098	38%
RET2	1367	824	(60%)	1847	45%
LE2	51	5	(10%)	282	2%
TF3	0	0	(-)	0	-
RET3	0	0	(-)	0	-
LE3	401	50	(13%)	1714	3%
TF4	0	0	(-)	0	-
RET4	0	0	(-)	0	-
LE4	79	60	(76%)	309	19%
WE4	4192	2635	(63%)	5902	45%
TF5	0	0	(-)	0	-
RET5	0	0	(-)	13	0%
LE5	3	3	(100%)	16	19%
ET1	0	0	(-)	7	0%
ET2	364	0	(0%)	467	0%
ET3	39	0	(0%)	167	0%
ET4	33	1	(3%)	1506	1%
ET5	0	0	(-)	191	0%
ET6	0	0	(-)	0	0%
ET7	0	0	(-)	0	0%
ET8	103	0	(0%)	271	0%
ET9	128	53	(41%)	363	15%
ET10	0	0	(-)	0	0%
EE1	391	5	(1%)	2474	1%
EE2	188	33	(18%)	3646	1%
EE3	4849	3047	(63%)	6350	48%
TOTALS	24393	11243	(46%)	46025	24%

INSERT 2 MAPS

OF TIER I and TIER III

CHESAPEAKE BAY SAV

DISTRIBUTION RESTORATION

TARGETS

(need color to show)

the survival and health of critically important SAV (VCRMP(a), Fall 1992: 3, 8).

In 1989, the Chesapeake Bay Commission's Executive Council agreed to a policy calling for a net gain in SAV distribution, abundance and species diversity, and to set restoration goals in the future (Blankenship, October 1993: 6). With the Chesapeake Bay cleanup effort entering its second decade, the Executive Council approved a series of directives in September 1993 in an attempt to further stem nutrient pollution, reduce toxics, set goals for the restoration of Bay grasses, and the opening of rivers for spawning fish. The following directive related to SAV restoration was issued:

> "Therefore, to further our commitments made in the Chesapeake Bay Agreement, we the undersigned:
>
> o Agree to work to restore SAV to their historical levels.
>
> o Further agree to an interim SAV restoration goal of 114,000 acres Baywide as documented through regional and Baywide aerial surveys from 1971 through 1990. At the current rate of recovery, this acreage will be achieved by 2005.
>
> o Direct that a further target level be developed for the restoration of SAV to all shallow water areas delineated as existing or potential SAV habitat down to the 1 meter depth contour."

As a member of the Executive Council, the Commonwealth of Virginia was a signatory to this directive and, as such, has agreed to do its part in meeting these restoration targets. Local governments in Tidewater Virginia should, therefore, take the target restoration areas into consideration during the site planning and review process for future development of shoreline areas in order to avoid potential conflicts between land and water uses and these critical aquatic habitats.

Submerged Aquatic Vegetation in the Back Bay Basin:

General

SAV is an important part of a healthy Back Bay ecosystem. SAV helps to stabilize sediments that enter the system and to deter shoreline erosion, as well as perform many of the same functions cited earlier in the general discussion of SAV. In Back Bay, the added physical characteristics of the plants within the aquatic environment allow for a greater diversity of wildlife species, when compared to habitats not supporting SAV (Schwab, Settle, Halstead and Ewell, 1990: 265).

In general, growth patterns of SAV in Back Bay have followed a pattern of introduction, colonization, stabilization, depletion, and decline. This cycle has been observed over the last century for several different species of SAV. In the history of the Bay, no species has ever substantially repopulated after its initial decline (HRPDC, 1992).

Vegetation sampling transects in Back Bay were established in 1958 and surveys have been conducted annually except for the years 1979, 1981-82, and 1985-86. The survey originally included measures of volume; however, in 1974 the volume measurement was deleted. Since then, only SAV species and their frequencies have been recorded. Sampling has generally occurred during the September to November period. Frequency and species composition are determined through collection of bottom samples taken at 500-foot intervals along eight transect lines with modified oyster tongs (Schwab, Settle, Halstead and Ewell, 1990: 265).

Prior to the establishment of the transects in 1958 and the first data collection effort between then and 1965, little quantitative data were available. The natural closing of the Currituck Sound Inlet in 1830 changed Back Bay from a saltwater estuary to a brackish/freshwater ecosystem. In 1951 the U.S. Army Corps of Engineers reported that, during 1923-24, SAV noticeably began to disappear. In August of 1956 it was reported that SAV was very scarce in Back Bay, having undergone a 95% decline from 1955. However, while there was considerable interest in the Back Bay ecosystem, no large scale surveys were undertaken until 1958 (Schwab, Settle, Halstead and Ewell, 1990: 265).

In 1958 the U.S. Fish and Wildlife Service (USF&WS) and the states of Virginia and North Carolina began an extensive survey of the Back Bay/Currituck Sound ecosystems. The survey on vegetation, waterfowl, fish and environmental parameters from 1958 through 1964, resulted in four volumes of data, (also known as the Back Bay-Currituck Sound Data Report), little of which has been published. Data reported here for 1958 through 1964 were taken from that report. The data available after 1964 have been gathered from VDGIF Annual Pittman-Robertson Reports (Schwab, Settle, Halstead and Ewell, 1990: 265).

Findings

SAV monitoring in Back Bay has shown two periods of high frequency and two of decline during the period of 1954-1990. The Back Bay-Currituck Sound Data Report covered a seven year period. This period documented SAV frequency in 1958 at 51%, followed by a peak at 81% in 1962 and then a drop to 14% in 1964. The dominant SAV species during five years of the survey period was southern naiad (Najas guadalupensis). In 1963, naiad was the second most common species and, by 1964, had nearly disappeared from the transects (Schwab, Settle, Halstead and Ewell, 1990: 265).

In hopes of reversing water quality declines in Back Bay, the City of Virginia Beach operated a salt water pumping facility at Little Island Coast Guard Station from 1964 to 1987 that discharged seawater into the Shipps Bay subregion of Back Bay. Increasing the average salinity of the Bay from 0.7 ppt to 3 ppt was expected to increase water clarity and to stimulate SAV growth without significantly impacting the freshwater species inhabiting the Bay. However, the average baywide salinity remained well below the stated goal (HRPDC, 1992).

The years 1965 and 1966 had the lowest frequencies (12%) recorded for the Bay prior to 1984. A new species, Eurasian milfoil (Myriophyllum spicatum), was noted in small trace amounts for the first time in 1966 and occurred on 12% of the survey points in 1967. Over the following decade, the new grass had spread across the entire Bay. It flourished in areas not thought to be able to support plant life and grew so dense that it had to be cut back in areas of regular boat traffic (HRPDC, 1992).

SAV frequency dropped from 72% in 1978 to 50% in 1980; milfoil was present on 44% of the points surveyed, and remained the most common SAV species encountered (Schwab, Settle, Halstead and Ewell, 1990: 265,266). In 1983, due to a few pumping interruptions and low rainfall, the average baywide salinity increased to 1.5-1.8 ppt. Due to the circulation patterns of the Bay, however, the average monthly salinity in North and Shipps Bays was nearly 3 ppt and a daily high of 6.42 ppt was recorded in North Bay. While this appears high, average salinity after a storm overwash event often reached 22.5 ppt. Due to a lack of demonstrated positive effects on the Bay's resources, the pumping of saltwater into the Bay ceased in August 1987 (HRPDC, 1992).

The survey was again conducted in 1983 and the frequency of aquatic vegetation had dropped to 14%, with only scattered stands and colonies of milfoil remaining in the eastern expanses of the Bay. In 1984 the Bay was nearly void of SAV species with only 8% of the points having any vegetation present. However, in Buck Island Bay, Major Cove and Horse Island Creek, areas not surveyed by the transects, good growths of milfoil, wildcelery (Vallisneria americana) and muskgrass (Chara spp.) were noted (Schwab, Settle, Halstead and Ewell, 1990: 266).

The decline of vegetation in Back Bay through the mid 1980's paralleled the experience of Eurasian milfoil in the Chesapeake Bay only a few years prior. The decline in Eurasian milfoil in the Chesapeake Bay was attributed to the effects of two diseases: Northeast Disease and Lake Venice Disease. Northeast Disease is believed to be produced by a virus, a virus-like particle, or a toxin produced within and released by an infected plant. Lake Venice Disease modifies the celluar structure of the leaf surface which susbequently allows extensive algal buildup to occur on the leaf surface. This buildup reduces the ability of the plant to photosynthesize, eventually stopping transpiration and smothering the plant. Both diseases have been identified in Back Bay (HRPDC, 1992).

In 1986 an attempt to introduce hydrilla (Hydrilla verticillata) to Back Bay was undertaken in hopes of establishing some SAV in the system. Hydrilla is an exotic species (as is milfoil) and first appeared in the United States in the 1960s. Though hydrilla is considered a nuisance species by some due to its growth habit of forming surface mats, it can increase carrying capacity for both waterfowl and fish (Schwab, Settle, Halstead and Ewell, 1990: 266). This attempt was relatively unsuccessful because of problems with waterfowl eating the new plantings. When seedlings were subsequently placed in crab pots to keep them from being eaten by waterfowl, they were not able to adequately establish themselves and flourish.

In 1987 the survey was conducted during 8 of the 12 months in an attempt to determine if SAV frequencies fluctuated from month to month. In July of 1987 the SAV frequency was 5%, the November frequency was 1%, and the June 1988 survey had a coverage of 4%. The 1% reading in November was the lowest for the 12 month period. Milfoil was the predominant species present, with wildcelery and sago pondweed (Potamogeton pectinatus) present in only trace amounts. During the 1988 survey period, the frequency of SAV increased over 1987 by 3%; however, the 1989 and 1990 distributions were 1% and 0% respectively, representing a 50% decline from 1980 (Schwab, Settle, Halstead and Ewell, 1990: 266).

In conclusion, current research has proposed another hypothesis to explain the decline of SAV along the East Coast. In response to elevated nutrient levels from surrounding land uses, particularly nitrogen, SAV tends to grow so fast that stems become fragile and crumble readily under their own weight, causing the plants to break off near their roots and die. These "corpses" can be seen commonly in Back Bay and south into the North Carolina Sounds (HPRDC, 1993).

Figures __ and __ show the SAV transects in Back Bay that are used for sampling and the SAV frequency trends in Back Bay from 1958 through 1990, respectively. Due to the lack of SAV reported in 1990 transect sampling, distribution of SAV beds in Back Bay is not shown on the maps attached to this study.

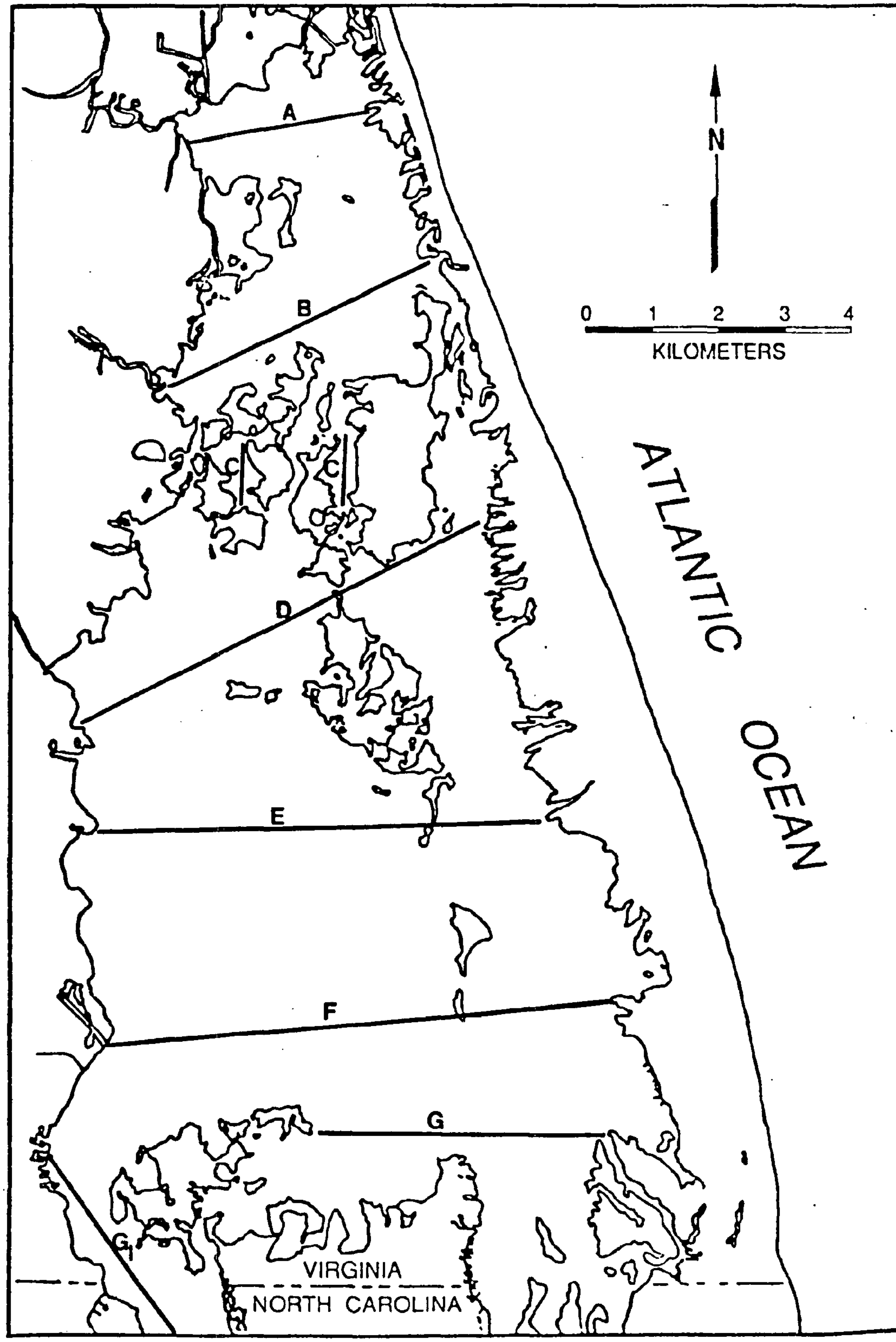

Figure 1. Submerged Aquatic Vegetation Transects, established 1958.

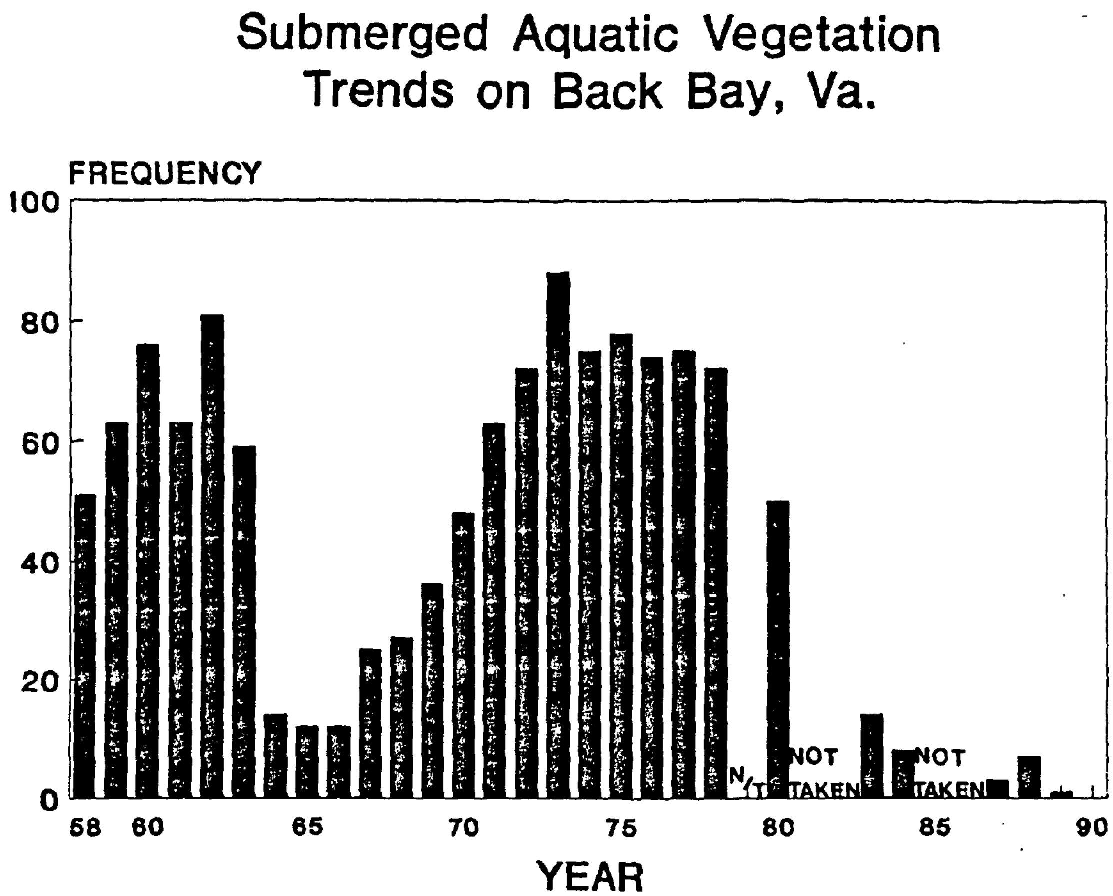

Figure 2. Frequency of Submerged Aquatic Vegetation on Back Bay, Va. 1958-1990.

C. Spawning Grounds

Spawning grounds are those areas in which the eggs of finfish and shellfish are released and larval development occurs. In most species, spawning by the female and the subsequent fertilization of the eggs by the male occur in the same location. In a few species, such as the blue crab, fertilization occurs prior to egg release and the female migrates to the spawning grounds. Most species of marine finfish common to Hampton Roads spawn and spend most of their lives in the open ocean, but enter estuaries during the summer to feed. Estuarine species of finfish spend their entire lives in estuaries but may migrate to the Chesapeake Bay or the downstream areas of tributaries to spawn. The larvae of both marine and estuarine species are transported from their respective spawning grounds by tides, winds and currents to nursery areas in the upper reaches of tidal estuaries (SVPDC(a), 1989: 116; SVPDC(b), 1989: 29).

A number of anadromous and semi-anadromous fish species spawn in the waters of the Hampton Roads region. Anadromous fish spend their adult lives in the Atlantic Ocean, but migrate to freshwater estuaries during the spring and early summer to spawn. Anadromous fish common to the Hampton Roads region include American shad, alewife, blueback herring and striped bass. Semi-anadromous fish, such as the white perch, yellow perch and several species of catfish, live in brackish water estuaries and migrate to freshwater to spawn (SVPDC(a), 1989: 116; SVPDC(b), 1989: 29).

NPS pollution can adversely affect the success of estuarine and marine spawners in several ways. First, the entire spawning process may be impossible if spawning adults are unable to find suitable spawning habitat as a result of dissolved oxygen (DO) depletion from NPS-induced nutrient enrichment. Second, the survival of fertilized eggs and newly hatched larvae requires a proper balance of a number of environmental conditions including sunlight, oxygen, water agitation, salt and chemicals, and water temperature. NPS pollution can disrupt this balance and prevent the hatching of eggs or the survival of larvae (SVPDC(a), 1989: 117; SPVDC(b), 1989: 29).

For example, low DO concentrations resulting from nutrient enrichment may harm egg and larval development, or may alter phytoplankton communities, thus affecting the type and amount of zooplankton available as food to larvae. Surges of freshwater runoff into estuaries during major storm events may also disrupt, in the short term, the delicate balance required for successful spawning by lowering salinity to levels that threaten the survival of eggs and larvae. A third way in which NPS pollution can affect spawning success is by the introduction of toxic contaminants such as pesticides, heavy metals and organic chemicals. Toxics in runoff can be lethal to newly hatched larvae or can induce sublethal effects including changes in swimming, feeding or predator avoidance (SVPDC(a), 1989: 117; SVPDC(b), 1989: 29,30).

As mentioned above, many species of marine fish common to the waterways of the Hampton Roads region spawn in the open ocean. However, several estuarine species which are year long residents of the Chesapeake Bay and its tributaries spawn in the lower Chesapeake Bay/Hampton Roads/lower James River area. Some of these species are resident to these waters, while others migrate from upstream tributaries. Estuarine species include bay anchovy, gobies, killifish, silverside and hogchoker. Although not commercially important, these fish are important forage species for marine finfish that enter estuaries during the summer to feed. The exact locations of the spawning areas for these fish will depend on a number of factors including salinity, water temperature, and bottom charateristics. At least two species of forage fish depend on abandoned shells for spawning. The killifish spawns during the spring tide, depositing its eggs in shells above the normal high tide line. The eggs then hatch during the next month's spring tide. Gobies spawn from May to October by forming nests and laying eggs in dead oyster shells. Males then guard the nest until the eggs hatch. The interdependence of fish reproduction and SAV is illustrated by the silverside. Silversides spawn in the early spring. Their eggs have adhesive filaments which attach themselves to grasses where they remain until they are hatched (SVPDC(a), 1989: 117).

Table __ summarizes the general environmental conditions for and the environmental constraints to successful spawning of anadromous and semi-anadromous fish found in Southeastern Virginia. The Environmental Sensitivity Map Atlas for the Commonwealth of Virginia and the seasonal Chesapeake Bay Environmentally Sensitive Areas maps attempt to show the location of spawning areas and/or nursery areas in the waterways of Hampton Roads. VIMS has recently digitized these areas by U.S.G.S. topographic quadrangle sheets into a GIS database. These areas have been replicated for the project study area on the maps attached to this report. However, because of the variability in location due to fluctuating water quality conditions over time, it is recommended that the atlas and maps be used as general guides.

The blue crab spawns in an area along the south side of the mouth of the Chesapeake Bay. Spawning occurs from mid-spring through summer. Juvenile crabs are dispersed throughout the Bay. As adults, the females mate only once, as soft crabs during the final shedding of their shells. A female will carry the sperm throughout the winter and use it the following summer to fertilize her eggs. After mating, which occurs in late summer and fall, the females move toward the lower Bay, but the males remain distributed throughout the tributaries (SVPDC(a), 1989: 117; Cronin, 1993: 9).

In terms of fisheries management, scientific reports presented to the Chesapeake Bay Commission in November 1993 stated that, if salinity is below 20 ppt, blue crab larvae will not survive. Thus, harvesting egg-bearing females from up-Bay locations will have no impact on spawning stock. However, the number of spawning crabs is not known, nor whether the quantity of spawning has any effect on the future stock. Scientists have also not determined the "prudent minimum" size of spawning stock that should be left so as not to overfish crabs. It has been recommended by scientists that Maryland and Virginia set a "prudent minimum" for the spawning population, which will serve as an estimate until more is known about how the spawning stock affects future populations (Cronin,

TABLE 1

ENVIRONMENTAL CONDITIONS FOR SPAWNING OF COMMON ANADROMOUS AND SEMI-ANADROMOUS FISH IN SOUTHEASTERN VIRGINIA

Species	Temperature (°C) and Salinity Conditions	Spawning Areas	Spawning Season	Environmental Constraints
Anadromous				
Alewife	Water temperature: minimum 10.5; peak 18; maximum 29-31. Salinity: Freshwater to salinities less than 0.5 ppt.	Large rivers, small streams and ponds over detritus-covered bottom with vegetation; sometimes at depths about 3 m. Usually ascend streams further than blueback herring.	Late March through April with spawning lasting only a few days for each spawning group.	Usually spawn in sluggish water 15-30 cm deep. The greatest spawning activity occurs at night.
American Shad	Water temperature: minimum 8; peak 17; (Spawning generally occurs at 12°-21°C). Salinity: Tidal-freshwater to 0.5 ppt.	Primarily in tidal-fresh water of rivers with areas of extensive flats; also over sand or pebbly bottom; often near mouths of creeks.	April - May Mid-May and July	Currents less than 0.3 or greater than 0.9 m sec^{-1}; depths of 0.9-12.2 m; eggs absent at less than 5 ppm oxygen.
Blueback Herring	Water temperature: minimum 14; peak 21-26; maximum 27. Salinity: Fresh to brackish waters.	Fresh and brackish rivers and tributaries, never far above tidewater; over bottoms of clean swept sand and gravel to boulders.	April - May	Areas of relatively wide and deep ingress with swift flow.
Striped Bass	Water temperature: minimum 11; peak 14-19; maximum 23. Salinity: Freshwater to salinity less than 3 ppt.	Large rivers and the upper portion of the Bay; spawning is concentrated within the first river kilometer above salt water.	Spawning occurs from the beginning of April through mid-June.	A minimum current of 30 cm sec^{-1} is needed to keep eggs in suspension; optimal currents are 1 - 2 m sec^{-1}. Maximum survival of eggs before water hardening occurs at about 1 ppt salinity.

Source: SVPDC Elizabeth River Basin Environmental Mgmt. Plan Appendices / SVPDC Regional Stormwater Mgmt. Plan.

TABLE 1 (Continued)

ENVIRONMENTAL CONDITIONS FOR SPAWNING OF COMMON ANADROMOUS AND SEMI-ANADROMOUS FISH IN SOUTHEASTERN VIRGINIA

Species	Temperature (°C) and Salinity Conditions	Spawning Areas	Spawning Season	Environmental Constraints
Semi-Anadromous				
White Perch	Water temperature: minimum 7.2-10; peak 11-16; maximum about 20, Salinity: Freshwater to 4 ppt.	Fresh, tidal fresh, or slightly brackish water in rivers, tributary streams, and shallow coves.	Late March to early June: eggs are not released all at once, and ovulation may continue for 10 to 21 days.	A sudden drop in temperature of 2.2 to 2.8°C may kill eggs.
Yellow Perch	Water temperature: minimum 5; peak 8.5-11; maximum 23. Salinity: Freshwater to 2.5 ppt.	Tidal or non-tidal portions of rivers near shore, over substrates of sand, rock, gravel or rubble; typically at depths of 1.5 to 3 m.	Spawning occurs from the end of February to April, with peak activity in mid-March.	Significant growth reduction at 2.0 ppm dissolved oxygen.
White Catfish	Water temperature: peak about 21. Salinity: Freshwater.	Still or running water; nests usually built near sand or gravel banks.	Late May	No information
Brown Bullhead	Water temperature: peak 21-25. Salinity: Freshwater.	Sluggish, weedy, muddy streams and lakes; nests occur in shelter of logs, rocks, or vegetation.	Early April to August throughout the range.	Spawning occurs in early morning to early afternoon. Eggs exposed to sunlight have poor hatching success.
Channel Catfish	Water temperature: minimum 21; peak 27; maximum 29. Salinity: Freshwater to 2ppt.	Nests occur in weedy areas near lake shores, in protected sites, small streams, sometimes in very swift water.	March through July, possibly September; sometimes have two spawning peaks per season.	Growth reduction at less than 3.5 ppm dissolved oxygen.

Source: Environmental Protection Agency, Chesapeake Bay: A Profile of Environmental Change, Appendix C (Philadelphia, Pennsylvania: EPA, 1985).

1993: 9,10). To protect spawning blue crabs near the mouth of the Chesapeake Bay, a 130-square mile "crab sanctuary" has been designated in Section 28.2-709 of the Code of Virginia in which harvests are prohibited between June 1 and September 15. The Environmental Sensitivity Map Atlas for the Commonwealth of Virginia and the seasonal Chesapeake Bay Environmentally Sensitve Areas maps also show the general vicinity of blue crab habitat (spring summer, fall only). These areas have been replicated for the project study on maps attached to this report.

D. Nursery Areas

Nursery areas are those aquatic habitats where the inital growth and development of finfish and shellfish occur. Nursery areas for finfish are usually shallow, have organic bottom types and, as previously mentioned, are often dependent on SAV beds or wetlands for nourishment. Fish larvae of marine species are produced in the open ocean and are transported by tides, winds and currents to nursery grounds in less saline, upstream areas of tidal rivers, creeks and bays. The larvae of estuarine species of finfish and the bluecrab may remain in the Chesapeake Bay or be transported from the Bay or the downstream portions of its tributaries to upstream nurseries. The larvae of anadromous and semi-anadromous fish are transported in the opposite direction from the freshwater headwaters of estuaries to nursery areas in more saline, downstream areas. Freshwater fish usually nurse their young in nests found along the shoreline. The locations of nursery areas for individual species of finfish are determined by salinity levels and the presence of food sources (SVPDC(a), 1989: 121; SVPDC(b), 1989: 30).

In the case of shellfish species such as the commercially-important eastern oyster and hard clam, nursery areas are located in already established shellfish beds. Oyster larvae are intially found floating in the open ocean or estuaries (pelagic) but eventually attach themselves to hard substrate, usually existing oyster shell. Hard clam larvae are also initially pelagic, but, during the later stages of the larval stage, they alternate between a planktonic and benthic existence occasionally attaching themselves to firm substrate. By the time they reach the juvenile stage, they have burrowed permanently in soft substrate (SVPDC(a), 1989: 121; SVPDC(b), 1989: 30).

Nursery areas have been identifed as critical habitat because the early life stages of shellfish and finfish are more sensitive to the adverse affects of NPS pollution than adult organisms. NPS pollution may adversely affect nursery areas in the following ways (SVPDC(a), 1989: 121; SVPDC(b), 1989: 30,31):

- Nutrient enrichment may cause algal blooms which may depress DO levels and/or cause the disappearance of SAV beds.
- Toxics carried in runoff may have lethal or sublethal affects on juvenile populations.
- Wetlands loss due to runoff may lead to the disappearance of suitable nursery habitat.
- Turbidity resulting from excessive sediment loads in runoff may cause a rise in water temperature to a point that threatens juvenile populations.
- Sediment suspended in turbid water may clog the gills of juvenile fish or the gills of invertebrates that are their food sources.

- Excessive quantities of freshwater runoff may decrease salinity levels to a point where juvenile populations are threatened.

It is impossible to identify specific locations of estuarine and marine fish nurseries in specific waterbodies because schools of juveniles relocate frequently in response to a number of factors including salininty, temperature, time of day, food supply and oxygen levels. Also, the juveniles of many species migrate gradually downstream as they mature. In general, however, the nursery areas of most species are associated with certain ecological zones defined by sanility levels. These zones and their corresponding salinity ranges are as follows: polyhaline (16.5 - 30.0 ppt), mesohaline (3.0 - 16.5 ppt), oligohaline (0.5 - 3.0 ppt) and freshwater (less than 0.5 ppt). Salinity regimes migrate with the tides, freshwater inflow and weather conditions (SVPDC, 1989: 122).

The Environmental Sensitivity Map Atlas for the Commonwealth of Virginia and the seasonal Chesapeake Bay Environmentally Sensitive Areas maps attempt to show the location of spawning areas and/or nursery areas in Virginia's waterways. VIMS has recently digitized these areas by U.S.G.S. topographic quadrangle sheets into a GIS database. However, as with spawning areas, because of the variability in the location of these areas due to fluctuating water quality conditions over time, it is recommended that the atlas and maps be used as general guides.

E. Shellfish Growing Areas

General

The Food & Drug Administration's (FDA) National Shellfish Sanitation Program (NSSP) Manual defines shellfish as "all edible molluscan shellfish species of oysters, clams and mussels." Commercially important shellfish species harvested in the waters of the Hampton Roads region include the eastern oyster and the hard clam. Virginia's tidal waters also produce significant quantities of surf clams and soft shell clams (SVPDC(a), 1989: 122; SVPDC(b), 1989: 31; VWCB, 1980: A-1).

The oysters found in Virginia's tidal waters are the molluscan shellfish species of Crassostrea virginica. Shellfish are immobile bottom dwellers that are generally found in densely populated beds. Oyster beds are found on firm bottom surfaces in relatively shallow (less than 8-10 meters) water with relatively low salinity. A firm substrate is required to support the massive and heavy clusters of oysters found in a bed (SVPDC(a), 1989: 122; SVPDC(b), 1989: 31; VWCB, 1980: A-1).

Unlike the oyster which attaches itself to hard bottom surfaces, the mature clam burrows in penetrable bottom sediment. Hard clams require slightly higher salinities than the oyster and can be found anywhere from intertidal mudflats to a depth of 10 meters or more. Hard clams, especially juveniles, are important food sources for a number of fish, crabs, waterfowl and marine birds (SVPDC(a), 1989: 122; SVPDC(b), 1989: 31).

For centuries, the shellfish industry has held a position of high esteem in Virginia. Because the industry represents a way of life, its survival has become an important issue among the public and at all levels of government. It is strongly felt that the oyster industry in Virginia may be close to extinction, however. Beginning in about 1960, the Virginia oyster harvest dropped dramatically to about a tenth of its historic average catch. Recent additional declines have had further negative affects on the industry (VCRMP(b), 1991: 1). See Figure __ for historical trends in Virginia's oyster harvest.

Statistics available from the Virginia Department of Health's Division of Shellfish Sanitation (VDH-DSS) during Spring 1991 indicate a net loss of 6,039 acres of shellfish waters for 1989-1991. In 1989, 344 acres were opened; 2,247 acres were closed. In 1990, 1,663 acres were opened, but 5,772 were closed. This increase in the number of acres open to harvesting in 1990 was partially a result of the adoption of more stringent standards during that year (VCRMP(b), 1991: 1).

According to studies conducted by the National Oceanic and Atmospheric Administration (NOAA), shellfish harvests in the mid-Atlantic region, including Virginia, are limited as a consequence of poor water quality by (in descending order) (1) sewage treatment plants, (2) boating, (3) urban runoff, (4) wildlife, (5) industrial discharges, (6) agricultural runoff, and (7) failing shoreline septic systems. Each of these, including other factors which have been shown to contribute to poor water quality, are examined in more detail below (VCRMP(b), 1991: 1-3).

(1) Sewage Treatment

The Commonwealth of Virginia has made significant advances to improve and upgrade municipal sewage treatment facilities. Every city and town in the state has or is nearing completion of facilities that treat wastewater to the secondary level. Secondary treatment is a biological process that removes approximately 85% of pollutants and is a federal requirement under the federal Clean Water Act (CWA). With the exception of the City of Franklin, the Hampton Roads Sanitation District (HRSD) is responsible for wastewater treatment in Hampton Roads. All HRSD facilities use secondary treatment or beyond.

But, while the Commonwealth meets the requirements of the CWA, it may fall short of maintaining water clean enough to grow and harvest shellfish. In other words, there may be fewer highly polluted waters but, at the same time, there are few waters sufficiently pristine for shellfish harvesting. Even worse than this is the fact that while advances are made in one area, such as sewage treatment, setbacks are created by other, more widespread pollution sources. Most significant of these is nonpoint source pollution.

(2) Urban Runoff -- Nonpoint Source (NPS) Pollution

During the 1980's, all small sewage treatment systems in the Lynnhaven area of Virginia Beach, for example, were taken off line and connected to the HRSD regional wastewater treatment facility. Sewage treatment was upgraded and discharges were removed from the inlet; but, there was no subsequent improvement in shellfish waters. The reason for this was determined to be NPS pollution from residential and commercial developments in the drainage area. The overall suburbanization which brought about development of new shopping centers, parking lots, and roads, is creating urban runoff which degrades water quality.

To counteract this, the Commonwealth is implementing the Chesapeake Bay Preservation Act which requires counties, cities and towns to designate shoreline preservation areas that include vegetative buffer zones between development and the receiving water. Conceptually, these buffer zones act as filter strips, trapping NPS pollutants in runoff and, thereby, reducing NPS pollution entering the Bay and its tributaries.

(3) Boating and Marinas

The significance of sewage discharge from boats has been controversial nationwide. The VDH-DSS, as a matter of policy, condemns shellfish waters within a minimum of one-quarter mile from an operating marina (which is defined as any mooring designed for ten or more boats that provides marine services). The size of the condemnation area increases proportionally with the number of slips at the marina.

The disposal of human wastes from recreational and commercial vessels directly into the Bay and its tributaries is widespread, and constitutes an ongoing and significant problem. On any given weekend during the boating season, as many as 6,000 vessels are out in the Chesapeake Bay and its tributaries. By the most conservative estimate provided by the VDH, these vessels discharge a minimum of 20,000 gallons of raw sewage overboard each day. A raw sewage spill of this magnitude from any other source would create a great amount of public concern; however, since recreational boats are dispersed throughout the Bay, individual discharges of raw sewage do not receive the same level of attention.

State agencies, on the other hand, have long recognized that pollution from boating is a major factor in the depletion of oxygen from the Bay. Such pollution has been linked to the loss of habitat for fish and animal species dependent on the Bay, especially SAV beds, and the closure of shellfish beds. It also poses a health threat to swimmers, fishermen and others who may be in contact with waters containing raw sewage.

Regulations adopted by the VDH require that adequate onshore sanitary facilities-- a dump station for portable toilets and pump-out facilities for boats with holding tanks-- be provided at each marina or other place where boats are moored. As of January 1990, there were 933 marinas or places where boats were moored. Of this number, 773 were covered by Virginia regulations. Approximately 50% of the latter, which did not have a variance or alternative sewage disposal equipment, were out of compliance with current regulations.

An additional concern is related to the fact that a number of toxic substances such as oil, gas, anti-freeze and antifoulant paints are essential for vessel maintenance. To the degree these substances reach the water, they represent a serious potential threat to shellfish and other living resources. This issue is discussed in more detail in the "Private and Public Water Access" section, "Siting and Design of Water Access Facilities" subsection on marinas and recreational boating of this study.

The 1987 Chesapeake Bay Agreement, to which the Commonwealth of Virginia is a signee, includes the commitment to eliminate pollutant discharges from recreational boats as one of its water quality objectives.

(4) Waterfowl

Surprising to many people, the presence of large nubmers of waterfowl, such as migrating ducks and geese, result in the closure of hundreds of acres of productive shellfish waters annually. Waterfowl related closures have occured along the Potomac and Rappahannock Rivers and areas surrounding Tangier Island in the Chesapeake Bay. It is believed that the contribution of waterfowl to shellfish closures would not present a problem, however, if the decline of other productive waters was not so extensive.

(5) Industrial Pollution

According to a 1989 National Oceanic and Atmoshperic Administration (NOAA) survey entitled The Quality of Shellfish Growing Waters on the East Coast of the United States, some 50,000 acres of shellfish waters in the lower James River were closed due to heavy industrial development (in addition to effects from sewage treatment plants and urban runoff). Industrial discharges are of particular concern to public health officials because of the potential effects of toxics and heavy metals. Although pretreatment of industrial wastes is required before conveyance to a wastewater treatment facility, a significant portion of industrial pollutants simply "pass through" both treatments systems and end up in the Bay tributaries and, eventually, the Bay itself. In addition, pollution from seafood, poultry and meat processing plants continues to be a problem in Virginia.

(6) Agricultural Runoff

According to the Virginia Department of Conservation and Recreation's (DCR) revised 1989 Nonpoint Source Pollution Assessment Report, some 489 square miles of estuarine waters were affect by agricultural runoff during 1988. The Department's 1993 update of that report states that agriculture accounts for approximately 30% of Virginia's land use and, while this percentage is significantly lower than the national average, agricultural activities consitute a significant source of NPS pollution in the Commonwealth. The 1992 305(b) Virginia Water Quality Assessment reports that crops and pasture land and other agricultural activities were the largest sources of pollutants causing non-attainment of state water quality standards for designated uses in Virginia's rivers. Sources of contamination included elevated levels of fecal coliform bacteria from animal wastes, nutrients and organic chemicals from fertilizers, pesticides, and heavy siltation and sedimentation.

The DCR has made significant progress enlisting farmers to implement Best Management Practices (BMPs) to conserve, manage, and control erosion, sedimentation, nutrients, fertilizer application and animal wastes. It is felt at the state and federal level, however, that the volunteer program may not be enough. A panel convened by the Chesapeake Bay Program to study NPS pollution has recommended that BMPs become mandatory for lands earmarked as major contributors of nutrient loading in the Bay.

(7) Shoreline Sanitation

Between 1984 and 1989, the Department of Housing and Community Development's (DHCD) Residential Shoreline Sanitation program provided approximately $150,000 each year either to repair or install new sanitary facilities in productive shellfish areas identified as threatened by fecal coliform contamination. The shoreline sanitation program was highly successful in re-opening several thousand acres of productive shellfish grounds. As time progressed, however, the "easy" cleanup was completed, and it became increasingly difficult to find ways to re-open additional grounds. The program ended in 1989.

Beginning in FY 1990, the DHCD began the statewide Indoor Plumbing Initiative. The program has an annual budget of $2.5 million. Approximately $1.2 million of these funds have gone to Tidewater localities for installation of new indoor plumbing, including sanitary septic systems. A measure of the need for the Indoor Plumbing Initiative is reflected in the total first year requests, which totaled $8.4 million, in contrast to available funds of $2.5 milllion.

(8) Population Growth and Development

Population growth within and migration to Tidewater Virginia has and is continuing to increase at a rapid rate. Increased population brings a host of competing interests and pressures for development, such as new residential and commercial development, expanded highway systems, and recreational developments including marinas. As these uses increase in density, it will become even more difficult to maintain shoreline water quality at a level that will support Virginia's shellfish industry.

In conclusion, therefore, the decline of shellfish harvests in the Chesapeake Bay and its tributaries is attributable to several factors, including overharvesting, shellfish mortatility from diseases and predation, and increased closures due to NPS pollution. For this reason, in 1991, the Virginia Coastal Resources Management Program in coordination with the Commonwealth's Shellfish Enhancement Taskforce (SENTAF) undertook a project to determine whether Virginia has an effective process for preventing, identifying, and remediating water quality problems that result in closure of shellfish grounds. The study is being undertaken by VIMS staff in close conjunction with SENTAF. VIMS staff will analyze the legal, regulatory and administrative structures currently in place for the purpose of managing the water quality of productive and potentially productive shellfish grounds. From this information, it was anticipated that staff would identify what options, including their associated costs, are available to the Commonwealth to improve shellfish waters (VMRC(b), 1991: 1).

Despite preliminary recommendations from VIMS scientists and VMRC oyster management specialists that public shellfish beds in the Chesapeake Bay be closed to harvesting, in the hopes of allowing the shellfish population to recover, VMRC decided not to impose a moratorium. Instead, VMRC opted in November 1993 for new restrictions and a sharply curtailed public oyster grounds harvesting season, opening October 15 and ending on December 31. VMRC also capped 1993 harvests for the James River, the last major public oyster ground in Virginia's portion of the Bay, at 6,000 bushels; this number represents a fraction of the 1992 record-low catch of 46,000 bushels, two-thirds of which came from public oyster grounds. In addition, VMRC restricted the length of tongs used to harvest oysters, a measure aimed at protecting oysters in deeper water, and required that harvesting halt at noon each day. VMRC's actions do not affect harvesting on private grounds (ACB, 1993: 3). Enforcement of this decision has been met with much controversy from watermen and the VMRC has been asked to revisit the length of the harvesting season.

In an attempt to colonize oyster larvae and ultimately produce more young oysters or seed, oyster management specialisists at VMRC have recently begun constructing reefs made of oyster shells and ordinary marine construction materials in the Piankitank River, and the next project will be done in the James River. In the past, shells have been placed in the water to give oyster larvae a hard substrate to which they can attach, develop shells, and live out their lives. But, in 1993 shells were hauled to the Piankitank River and dumped in large piles to simulate the reefs that once filled the Bay. Historically, those reefs were built as larvae colonized the tops of existing oysters. Colonists reported oyster reefs in the Bay that would reach above water surface during low tides; ships sometimes ran aground on them. Since that time, commercial and harvesting dredges have leveled most of the beds, oysters were overharvested, the Bay became more polluted, and the diseases MSX and dermo devastated the remaining population (Blankenship(b), 1993: 1).

The reef re-establishment experiment in the Piankatank and the James Rivers is expected to help scientists and fisheries managers learn whether reefs provide a habitat that significantly improves oyster survival. It is thought that oysters which can grow higher on a reef may have a competitive advantage over those on the river floor; there may be more food and water conditions are different. An oyster filters large amounts of water, consuming algae as it does. Oysters on the bottom filter more silt than those higher in the water column; therefore, in effect, they have to work harder to get the same amount of food. In addition, water closer to the surface is influenced by rainfall so it may be cleaner than bottom water. Water near the surface is also slightly less salty, which may give oysters an edge against the diseases which require higher salinity concentrations than oysters to survive. Temperatures are also warmer nearer the surface (Blankenship(b), November 1993: 3).

Answers from this experiment are not expected for at least one year. Once colonized, the reef will become a sanctuary which will not be harvested, though some young oysters may be used to seed other areas. By leaving the oysters alone, scientists from VMRC and VIMS are also hoping to see if the oysters develop any resistance to MSX and dermo (Blankenship(b), November 1993: 3).

Regulation and Classification of Shellfish Waters

While there are several state agencies which hold responsibility for shellfish resource management, the Virginia Marine Resources Commission (VMRC) and the Virginia Department of Health-Division of Shellfish Sanitation (VDH-DSS) share the bulk of this responsibility.

The VMRC has been designated by the Virginia General Assembly as the lead agency for shellfish resources. It accomplishes its mission through (1) fisheries management, (2) habitat protection, and (3) law enforcement.

In 1892 the General Assembly passed an act to protect the oyster industry of the Commonwealth. This act provided for a survey of shellfish growing waters where oysters grew naturally and were considered the best for oyster culture. The survey was conducted in 1894 by Lt. James E. Baylor and it delineated public shellfish grounds that cannot be leased by private interests. This survey became known as the "Baylor Survey" or "Baylor Grounds." Public clamming grounds are not considered Baylor Grounds.

Areas which are not included in the Baylor Survey are also considered public grounds; however, portions of these areas can be leased from the Commonwealth by private individuals or corporations for which a certain rent is charged per acre. Leases are granted through VMRC for 20-year periods with the option of reñewing. Therefore, through a system of public and private oyster culture, there is dual management of subaqueous bottomlands in the Commonwealth.

The VMRC is also the lead agency for replenishment activities, such as placement of shell to provide cultch for oysters. Within Baylor Grounds, certain areas have also been restricted to the public for harvesting where oyster larvae is being cultivated under the supervision of VMRC. Seed from these areas is then taken to other areas within the Baylor Grounds and planted as cultch. Private lease holders may also obtain seed from these restricted areas for re-establishment in leased beds (Nielson, 1991).

The VMRC, in most cases, sets the time and size of the harvest for each major species and issues licenses. The nature of the harvest regulations varies from species to species, with elements of the regulations incorporated into the enabling legislation in some instances. For example, only certain types of gear are permitted for the harvest of oysters and clams (Nielson, 1991).

VMRC Marine Patrol Officers monitor fishing activities to ensure compliance with regulations. In addition, they oversee the harvest of shellfish from shellfish condemnation areas. Shellfish stock from these areas may be moved, or relayed, to clean waters or may be transported to an approved depuration facility. Relayed shellfish must remain in the clean waters for a specified period, with the duration longer during cool weather. In 1991, there were no facilities in Virginia for the controlled cleansing, or depuration, of shellfish, although several other states have plants, especially for clams (Neilson, 1991).

It is the responsibility of the VDH-DSS to ensure that shellfish taken from Virginia waters (public grounds and leased beds) are safe for human consumption. Because Virginia shellfish are transported to other states, FDA regulations apply and high water quality standards are set by the NSSP (Nielson and Wilson, 1991).

The NSSP Manual of Operations provides standards and guidance for the VDH-DSS in carrying out its responsibilities for proper classification of shellfish waters. Continuous data collection on shellfish growing area water quality and shoreline studies of actual and potential waste sources provide the background and basis for VDH-DDS determinations of proper classification of these waters (VWCB, 1980: A-2).

The four types of classifications identified in the NSSP Manual of Operations are (VWCB, 1980: A-2):

1. **Approved** -- areas from which shellfish may be taken for direct marketing at all times;

2. **Conditionally approved** -- areas in which the sanitary quality of that area may be affected by a seasonal population, occasional sewage treatment plant operation malfunctions, or sporadic use of a dock or harbor facility. Direct harvesting is allowed under predictable conditions. Closing occurs when criteria are not met (i.e. following a rainfall).

3. **Restricted** -- areas which a sanitary survey indicates a limited degree of pollution which would make it unsafe to harvest shellfish for direct marketing. Shellfish from such areas must be relayed to approved areas for depuration or placed in purification tanks for specified periods of time.

4. **Prohibited** -- areas which the sanitary survey indicates that dangerous numbers of pathogenic microorganisms or other contaminants which might reach these areas, and the taking of shellfish from these areas for direct marketing, relaying or depuration is prohibited.

As a point of clarification, when areas are referred to as being "shellfish condemnation areas," such areas may consist of both restricted and prohibited classifications. In an area which has been classified as "restricted", it is unlawful for any person, firm, or corporation to take shellfish for any purpose, except by permit granted by the VMRC. In an area which has been classified as "prohibited"-- which, in addition to being areas where water quality has historically been extremely poor, now also includes a specified radius around the outfall of any sewage or wastewater treatment facility-- it shall be unlawful for any person, firm or corporation to take shellfish for any purpose. Condemnation areas for which condemnation notices are on record with the VDH-DSS are considered to be permanent or, in other words, are condemended on a year-round, as opposed to a seasonal, basis. Approximately every six months, VDH re-evaluates the status of such condemnation areas. Seasonal condemnation areas are delineated only around specified marina facilities.

For resource conservation reasons and because the public oyster harvest in Virginia is at an all time low, the VMRC voted in December 1994 to suspend the state's oyster season beginning December 31. The season normally lasts from October 15 to March 31. VMRC officials were concerned that further harvests would dangerously deplete the remaining stocks. Closing a fishery is a last resort to restoring a resource.

In addition, the VMRC has the authority to establish Shellfish Managment Areas and to regulate the havest of clams from those areas.

Evaluation of Factors Affecting Seafood Growing Waters

In general, conditions which can cause adverse effects on oyster culture are predators, microbe parasites, floods, drought, fungi, water impoundments, thermal effects, and discharges of sewage and other wastes (including toxic substances, silt, nutrients, insecticides, and herbicides). Sewage or other pollutants reaching such growing areas must be so treated, diluted, or aged that it will be of negligible public health significance. This implies an element of time and distance to permit the mixing of waste with the receiving waters so that dilution or dispersion occurs (VWCB, 1980: A-1).

More specifically, oysters and hard clams are particularly susceptible to NPS pollution because they are immobile and unable to escape unfavorable water quality conditions. Sediment carried in runoff can blanket and suffocate oyster and clam beds. Sediment may also eliminate the hard, clean surfaces required for the attachment of oyster larvae. In addition, excessive nutrient loads in runoff may significantly lower DO levels. Low DO can severely stress shellfish populations, thus lowering disease resistance and reproductive success. In cases of sustained DO depletion, entire beds may be eliminated (SVPDC(a), 1989: 122; SVPDC(b), 1989: 31).

Shellfish may also be susceptible to toxics contained in NPS pollution. Contamination of bed sediments and overlying water by toxics can adversely affect the physiological processes of shellfish and possibly make them unfit for human consumption. Frequent freshwater discharge from stormwater runoff is another limiting factor to the survival of shellfish populations. Such discharges may result in long term reduction in salinity levels which could either eliminate shellfish populations or lower their resistance to disease and predation. Finally, shellfish may ingest and concentrate bacteria contained in urban runoff that is harmful to humans when consumed. Bacterial contamination and the automatic condemnation of shellfish grounds near marinas and point source discharges are the reasons why many portions of waterways in the Hampton Roads region are closed to shellfish harvesting (SVPDC(a), 1989: 123; SVPDC(b), 1989: 31,32).

In order for shellfish to be harvested for direct marketing, the waters must not only be of high quality, but there also must be limited potential for water quality pollution. For example, in harbors such as Hampton Roads, areas adjacent to anchorages are closed because vessels could anchor there and, while anchored, could dishcarge sewage overboard. Although the anchorage may be used infrequently, there is always the possibility that it will be used and that water quality will be impacted. While some may object that these precautions are not needed, it is typical of public health officials to be very cautious and to guard against all possible avenues for disease (Nielson and Wilson, 1991).

Degraded water quality can mean contamination with fecal matter or pollution of a chemical nature. Both can be the cause of a shellfish closure, but in practice, most condemnations and closures are due to fecal contamination. The mean fecal coliform count of approved growing waters must be no higher than 14 MPN per 1000 milliliters of water; MPN (most probable number) is a statistical estimate of number of fecal coliform organisms in the water using the results of laboratory incubations. When the numbers are greater than 14, this "red flag" indicates the possible presence of disease-causing organisms (Nielson and Wilson, 1991).

Considerable judgment plays an important role in the evaluation of sources of actual or potential pollution to a shellfish growing area. Effectiveness and reliability of treatment, distances of pollutants from shellfish areas, the effects of winds, runoff, stream flow, and tidal currents are important aspects of consideration. It must be recognized that all receiving waters are not equally efficient from the standpoint of dilution, dispersion, salinity, etc. and bacteriological standards are not indicative of relative safety. Each estuary receiving pollution must be considered as a separate case. Any variation in the pollution source will affect the sanitary quality of the water in the estuary. In the same manner, shellfish will rapidly reflect any deterioration in the quality of their environment but are slower to reflect improvement (VWCB, 1980: A-3).

Shellfish growing areas near marinas, wharves, docks, beaches, and population centers are often subject to potential pollution hazards from small amounts of fresh sewage which are not ordinarily revealed by the bacteriological examination. It is also evident that the presence of people in an area creates certain pollution problems. This often is referred to as the effects of "people activity" and it is associated with increased runoff, sewage disposal problems, recreation facilities, and other related conditions which result from population expansions, all of which inadvertently affect the quality of adjacent shellfish growing waters. While intermittent in nature, the effect of pollution from these activities are, nonetheless, potential threats to the sanitary quality of shellfish for direct marketing (VWCB, 1980: A-3,5).

In order to assure that shellfish harvested for direct marketing and possible consumption as a raw product are safe, it is often necessary to establish a "buffer or safety zone" around known or potential sources of pollution. Sources of pollution around which the establishment of a "safety zone" might be required are: sewage treatment plants, industrial waste discharges, marinas, docks, wharves, harbors, shipping channels, areas receiving animal discharges, recreational areas, and those areas subject to "people activity." In addition, toxic materials, heavy metals, radionuclides, etc. from industrial waste require safety zones around such discharges as shellfish readily assimilate these materials (VWCB, 1980: A-3-5).

These "safety zones" allow for the mixing and diluting of the pollutants, give time for bacterial die-off and provide time for control agencies to take action to prevent shellfish harvesting from adjacent areas should a variance in established conditions make it necessary to do so. The pollution source is the dominant factor in determining the need for or the size of such a "safety zone" and is dependent upon a predetermined level of quantity and quality. The need for such zones is not determined by bacteriological values alone but is based on a thorough evaluation of the overall situation. These zones coincide with the "prohibited areas" discussed previously. All of these evaluations are conducted in accordance with the requirements found in the NNSP Manual of Operations as administered by VDH-DSS (VWCB, 1980: A-3-5).

Shellfish Condemnation Areas in Hampton Roads

In the waterways of the Hampton Roads region, several types of shellfish condemnation areas can be identified. First, much of the waterbody called Hampton Roads on the Bay side of Newport News Point is closed due to vessel traffic and anchorages for commercial freighters. Second, areas with heavy industrial activity and/or industrial discharges are closed. Third, parts of the James River, especially along the Newport News shoreline, are closed due to the discharges from large wastewater treatment plants, as is a portion of the lower York River. As with anchorages, the condemned areas around sewage treatment plant outfalls exist more because of the potential for problems than due to degraded water quality (Nielson and Wilson, 1991).

Most of the remaining closures are within smaller systems. Although some are closed in their entirety, many others have condemnation zones only in the upper reaches (e.g. the Nansemond, Poquoson and Back Rivers). In general, this is due to physical factors. Because a large portion of the drainage basin usually lies above the head of the tide, the freeflowing river delivers most of the freshwater entering the estuary along with all the associated pollutants. When the river flow reaches the tidal portion of the river, there is a decrease in water velocity due to the tides and the broad channels. This combination of sluggish water movement and large pollutant loads in river flow results in degraded water quality in many upstream segments of larger systems. Water quality often improves downstream, where tidal currents are stronger and large volumes of water are available to dilute the pollutants. An exacerbating factor is the presence of towns and cities at the head of tide (e.g. Richmond, Petersburg, Fredericksburg, Smithfield, and Suffolk). These population centers produce wastewaters and urban runoff, both of which can significantly degrade water qualtiy at this vulnerable location (Nielson and Wilson, 1991).

A list of permanent shellfish condemnation areas within the project study area as of October 15, 1993 follows, categorized by locality and waterbody. These areas have also been shown on the maps attached to this report. Table ___ is a current list of the marina facilities necessitating seasonal shellfish condemnations each year between April 1 and October 31. These are facilities that otherwise do not warrant automatic condemnations and are not monitored under the regular VDH-DSS process, but which have been identified as having the potential for fecal coliform bacteria contamination. In using this information, it is important to remember that these areas will change over time and updated information should be obatined from the VDH-DSS.

SHELLFISH AREA CONDEMNATION -- YORK COUNTY			
Number	Affected Area	Condemnation Status	Effective Date
6	York River and Wormley Creek	(see 6A & 6B below)	(see 6A & 6B below)
6A	York River and Wormley Creek	*	10/12/93
6B	York River	**	10/12/93
35	York River: Queen Creek	*	5/11/92
39	York River at Cheatam Annex	*	5/11/92
40	York River at Naval Weapons Station	*	4/27/89
79	York River: Carter Creek	*	4/27/89
87	York River: Skimino Creek	*	7/12/93
130	York River: Indian Field Creek	*	11/27/91
134	York River: King and Felgates Creeks	*	11/27/91
137	Poquoson River	*	7/6/93
151	Back Creek	*	7/6/92

Notes:

(*) = It shall be unlawful for any person, firm, or corporation to take shellfish from this area for any purpose, except by permit granted by the Virginia Marine Resources Commission, as provided in Section 28.1-179 of the Code of Virginia.

(**) = It shall be unlawful for any person, firm or coporation to take shellfish from this area for any purpose.

SHELLFISH AREA CONDEMNATION - JAMES CITY COUNTY			
Number	Affected Area	Condemnation Status	Effective Date
23	James River: Opposite Fort Eustis	*	3/30/89
67	James River: Opposite Tribell Shoal Channel	*	4/27/89
69	Upper James River	*	4/27/89
73	York River: Ware Creek	*	4/27/89
166	York River: Taskinas Creek	*	4/27/89

Notes:

(*) = It shall be unlawful for any person, firm, or corporation to take shellfish from this area for any purpose, except by permit granted by the Virginia Marine Resources Commission, as provided in Section 28.1-179 of the Code of Virginia.

(**) = It shall be unlawful for any person, firm or coporation to take shellfish from this area for any purpose.

SHELLFISH AREA CONDEMNATION -- POQUOSON			
Number	Affected Area	Condemnation Status	Effective Date
21	Back River	*	7/9/93
137	Poquoson River	*	7/6/93

Notes:

(*) = It shall be unlawful for any person, firm, or corporation to take shellfish from this area for any purpose, except by permit granted by the Virginia Marine Resources Commission, as provided in Section 28.1-179 of the Code of Virginia.

(**) = It shall be unlawful for any person, firm or coporation to take shellfish from this area for any purpose.

SHELLFISH AREA CONDEMNATION -- HAMPTON			
Number	Affected Area	Condemnation Status	Effective Date
7	Hampton Roads	(see 7A-7E below)	(see 7A-7E below)
7A	Hampton Roads	*	10/8/93
7B-7E	Hampton Roads	**	10/8/93
21	Back River	*	7/9/93
158	Back River: Long and Grunland Creeks	*	9/7/90

Notes:

(*) = It shall be unlawful for any person, firm, or corporation to take shellfish from this area for any purpose, except by permit granted by the Virginia Marine Resources Commission, as provided in Section 28.1-179 of the Code of Virginia.

(**) = It shall be unlawful for any person, firm or coporation to take shellfish from this area for any purpose.

SHELLFISH AREA CONDEMNATION -- NEWPORT NEWS			
Number	Affected Area	Condemnation Status	Effective Date
7	Hampton Roads	(see 7A-7E below)	(see 7A-7E below)
7A	Hampton Roads	*	10/8/93
7B-7E	Hampton Roads	**	10/8/93
23	James River: Opposite Fort Eustis	*	3/30/89
34	Warwick and James Rivers	(see 34A & 34B below)	(see 34A & 34B below)
34A	Warwick and James Rivers	*	10/1/93
34B	Warwick and James Rivers	**	10/1/93
183	James River: Swash Hole	*	12/6/91

Notes:

(*) = It shall be unlawful for any person, firm, or corporation to take shellfish from this area for any purpose, except by permit granted by the Virginia Marine Resources Commission, as provided in Section 28.1-179 of the Code of Virginia.

(**) = It shall be unlawful for any person, firm or coporation to take shellfish from this area for any purpose.

SHELLFISH AREA CONDEMNATION -- VIRGINIA BEACH			
Number	Affected Area	Condemnation Status	Effective Date
17	Little Creek	**	8/24/90
25	Lynnhaven, Broad and Linkhorn Bays and Tributaries	*	12/30/92
60	Chesapeake Bay: Adjoining Little Creek	(see 60A & 60B below)	(see 60A & 60B below)
60A	Chesapeake Bay: Adjoining Little Creek	*	10/12/93
60B	Chesapeake Bay: Adjoining Little Creek	**	10/12/93
74	Rudee Inlet	*	4/27/89
162	Atlantic Ocean	*	4/27/89

Notes:

(*) = It shall be unlawful for any person, firm, or corporation to take shellfish from this area for any purpose, except by permit granted by the Virginia Marine Resources Commission, as provided in Section 28.1-179 of the Code of Virginia.

(**) = It shall be unlawful for any person, firm or coporation to take shellfish from this area for any purpose.

SHELLFISH AREA CONDEMNATION -- CHESAPEAKE			
Number	Affected Area	Condemnation Status	Effective Date
7	Hampton Roads	(see 7A-7E below)	(see 7A-7E below)
7A	Hampton Roads	*	10/8/93
7B-7E	Hampton Roads	**	10/8/93

Notes:

(*) = It shall be unlawful for any person, firm, or corporation to take shellfish from this area for any purpose, except by permit granted by the Virginia Marine Resources Commission, as provided in Section 28.1-179 of the Code of Virginia.

(**) = It shall be unlawful for any person, firm or coporation to take shellfish from this area for any purpose.

SHELLFISH AREA CONDEMNATION -- NORFOLK			
Number	Affected Area	Condemnation Status	Effective Date
7	Hampton Roads	(see 7A-7E below)	(see 7A-7E below)
7A	Hampton Roads	*	10/8/93
7B-7E	Hampton Roads	**	10/8/93
17	Little Creek	**	8/24/90
60	Chesapeake Bay: Adjoining Little Creek	(see 60A & 60B below)	(see 60A & 60B below)
60A	Chesapeake Bay: Adjoining Little Creek	*	10/12/93
60B	Chesapeake Bay: Adjoining Little Creek	**	10/12/93

Notes:

(*) = It shall be unlawful for any person, firm, or corporation to take shellfish from this area for any purpose, except by permit granted by the Virginia Marine Resources Commission, as provided in Section 28.1-179 of the Code of Virginia.

(**) = It shall be unlawful for any person, firm or coporation to take shellfish from this area for any purpose.

SHELLFISH AREA CONDEMNATION -- PORTSMOUTH			
Number	Affected Area	Condemnation Status	Effective Date
7	Hampton Roads	(see 7A-7E below)	(see 7A-7E below)
7A	Hampton Roads	*	10/8/93
7B-7E	Hampton Roads	**	10/8/93
19	Hoffler Creek	*	4/27/89

Notes:

(*) = It shall be unlawful for any person, firm, or corporation to take shellfish from this area for any purpose, except by permit granted by the Virginia Marine Resources Commission, as provided in Section 28.1-179 of the Code of Virginia.

(**) = It shall be unlawful for any person, firm or coporation to take shellfish from this area for any purpose.

SHELLFISH AREA CONDEMNATION -- SUFFOLK			
Number	Affected Area	Condemnation Status	Effective Date
8	Nansemond River	*	10/14/92
18	Streeter Creek	*	4/27/89
19	Hoffler Creek	*	4/27/89
46	Nansemond River: Bennett's Creek	*	9/24/93
77	Nansemond River: Knotts Creek	*	4/27/89
80	Chuckatuck Creek	*	10/12/93
182	Nansemond River: Bleakhorn Creek	*	9/24/93

Notes:

(*) = It shall be unlawful for any person, firm, or corporation to take shellfish from this area for any purpose, except by permit granted by the Virginia Marine Resources Commission, as provided in Section 28.1-179 of the Code of Virginia.

(**) = It shall be unlawful for any person, firm or coporation to take shellfish from this area for any purpose.

SHELLFISH AREA CONDEMNATION - ISLE OF WIGHT COUNTY			
Number	Affected Area	Condemnation Status	Effective Date
64	Pagan River and Jones Creek	*	11/19/92
69	Upper James River	*	4/27/89
80	Chuckatuck Creek	*	10/12/93
164	Kings and Ballard Marsh Creeks	*	8/31/93

Notes:

(*) = It shall be unlawful for any person, firm, or corporation to take shellfish from this area for any purpose, except by permit granted by the Virginia Marine Resources Commission, as provided in Section 28.1-179 of the Code of Virginia.

(**) = It shall be unlawful for any person, firm or coporation to take shellfish from this area for any purpose.

MARINA FACILITIES NECESSITATING SEASONAL SHELLFISH CONDEMNATIONS BETWEEN APRIL 1 AND OCTOBER 31 AS OF 11/16/93

Wildey Marina -- Chisman Creek, York County
Thomas Marina -- Chisman Creek, York County
Belvin Boat Builders -- The Thorofare, York County
Poquoson Marina -- White House Cove, Poquoson
Rens Road Pier (Public Ramp and Pier) -- White House Cove, Poquoson
York Haven Marina -- White House Cove, Poquoson
Messick Point Public Landing -- Back River, Poquoson
W. Haywood Forrest Seafood Co. -- Back River, Poquoson
Poquoson Yacht Club -- Back River, Poquoson
Back River Seafood -- Back River, Poquoson
Bill's Fish Deck -- Back River, Poquoson
Digg's Seafood -- Back River, Poquoson
Bill Forrest Seafood -- Back River, Poquoson
Salt Ponds on the Bay Marina -- Salt Ponds, Hampton
Southall Landings Condominium -- Salt Ponds, Hampton
Marina Cove Boat Basin -- Back River/Harris River, Hampton
Dandy Haven Marina -- Wallace Creek, Hampton
B. J. Wallace Marina -- Wallace Creek, Hampton
Back River Marina -- Wallace Creek, Hampton

Shellfish Management Areas in Hampton Roads

In January 1994, the VMRC issued regulations re-designating the York, Poquoson and Back River Shellfish Management Areas and provisions to control the harvest of hard clams from those areas in order to protect and promote the resource. These regulations became effective on 1/1/94. The lawful season for the harvest of clams by patent tong from these areas shall be January 1 through March 31. A shell planting area in the Back River will be closed at the end of the 1994 season for evaluation by the VMRC Fisheries Management Division. Shellfish Management Areas and shellfish seed beds within the project study area have been replicated on maps attached to this report.

Conclusion

The Mid-Atlantic region had led the nation in oyster and clam landings until the early 1980's. Since then, due to a number of natural and human-induced factors, watermen have been forced out of business or have switched to other types of seafood to harvest. Market deamnd has been met by increased imports and increased Gulf Coast production.

The SENTAF believes that it is a worthwhile objectve to seek ways to minimize the impacts of water quality degradation. What has been concluded from case studies in Tidewater Virginia is that shellfish bioaccumulate pollutants from the water in which they live. In most instances, they concentrate these pollutants toelevated levels. Consequently, the shellfish growing waters must be very clean, and current water quality standards and shellfish harvesting regulations reflect that fact.

Chemical contamination can be a problem, as seen with oysters harvested in the Elizabeth River, but much more common are shellfish bed closures due to fecal contamination. The numbers of bacteria and viruses in fecal matter are extremely large; therefore, small sources can impact rather large volumes of water. The case studies have also shown that point source controls can produce measurable and significant improvements in water quality, but NPS pollution inputs from surrounding land uses continue to cause declines in water quality. Until ways are found to address those issues, the benefits of current point source controls will be limited.

The results of case studies in Lynnhaven Bay, a once plentiful shellfish growing area, could be construed to be a harbinger of what future conditions will be. Although the water quality impacts of urban runoff preclude direct harvesting of shellfish much of the time, the waters of that system are not grossly polluted. Shellfish culture remains a viable activity, at least from the biological perspective if not economically. The relaying of clams in cages has been efficient and cost-effective, but comparable techniques are needed for oysters. Controlled purification and depuration plants also warrant attention, in part because consumers appear willing to pay a premium for a product known to be of high quality (Neilson and Wilson, 1991).

F. Commercially- and Recreationally- Important Finfish and Shellfish (non-oyster or clam) Areas

Finfish

Depending on where they are located, commercially- and recreationally-important finfish species may be regulated by a number of agencies. States are responsible for managing fish stocks within their coastal waters, which extend three miles offshore. On the Atlantic Coast, there are 17 management jurisdictions, which include 15 states, the District of Columbia, and the Potomac River Fisheries Commission. All of these jurisdictions are members of the Atlantic States Marine Fisheries Commission (ASMFC), which provides a forum for cooperative management of fish that migrate across state lines. The ASMFC has developed management plans for the following species: striped bass, bluefish, weakfish, spotted sea trout, summer flounder, Atlantic menhaden, American shad/river herring, red drum, croaker, spot, sturgeon, winter flounder and Spanish mackerel. State adoption of the plans is currently voluntary, except for striped bass (Blankenship(c), 1993: 4,5).

The National Marine Fisheries Service (NMFS), part of the National Oceanic and Atmospheric Administration (NOAA) and the Department of Commerce, has regulatory and enforcement authority for fisheries in the United States' "exclusive economic zone (EEZ)," which extends from 3 to 200 miles off the coast. This zone was created by the Magnuson Act in 1976 to protect fish stocks from foreign fishing fleets. The Act also created Regional Fishery Management Councils, composed of citizens and state representatives, which develop management plans for fish species in those waters. There are three councils off the East Coast: the Mid-Atlantic, South Atlantic, and New England (Blankenship(c), 1993: 4).

Nationwide, the commercial harvest in the EEZ exceeds the near shore harvest, according to figures from the NMFS. About 2.8 million metric tons of fish are harvested annually in those waters, compared with 1.8 million metric tons within 3 miles of the coast (Blankenship(c), 1993: 4).

In the Commonwealth of Virginia, there was an estimated 8,500 working watermen and 900,000 sports fishermen in 1991. In 1980, the commercial catch for saltwater food fish in the Commonwealth amounted to 28.1 million pounds; in 1990 that total plummeted to 11.6 million pounds, more than a 50% drop in ten years. Recreational totals took a similar downturn. The losses were mainly in weakfish, or sea trout, and flounder. In 1980 sports fishermen caught an estimated 10 million flounder; by 1990 the catch plummeted to 1.3 million. The estimated cash value (dockside) of fish and shellfish landings in 1980 was just under $65 million; in 1990 it was $73 million (VCRMP(c), 1991: 4,5).

As stocks have decreased, the market value of fishes, particularly shellfish (including oysters), has increased. Some Virginia Marine Resource Commission (VMRC) officials believe that law enforcement statistics can be used as a barometer of the fishing industry. That is, as stocks of the resource are reduced and competition for those stocks increases, there will likely be more code violations by watermen trying to make a living and sports fishermen seeking a good catch. In recent years, approximately 1,500 summonses have been written annually by Marine Patrol Officers. For finish, it was for exceeding the daily bag limit and undersized fish. Another view is that, as the resource diminishes, fewer persons will opt to "work" the water, thus there will be fewer potential violations, even with the added finfish regulations (VCRMP(c), 1991: 4,5).

Fisheries staff at the VMRC have the difficult task of maintaining the viability of the Commonwealth's fishing industry while preserving and maintaining the spawning stock of critical species. In the past, this has been accomplished through various management measures such as size restrictions, fish quotas, daily catch limits, season limits, and guidelines and restrictions on gear, such as minimum mesh size for fishing nets. Concern regarding reduced numbers of critical fish species has reached the point, however, that within the next few years, it is estimated that there will be management plans in place and restrictions enforced for every commercial and recreational species of fish and shellfish in the Commonwealth (VCRMP(c), 1991: 4,5).

The extent to which fishing pressures, loss of habitat and biological factors have affected various fish species still is not completely understood. VMRC fisheries management officials feel that one of their biggest challenges is to assesmble a data base suitable for management decisions. They also feel that in order to have the data necessary to manage critical fisheries, mandatory reporting for all commercial and recreational catches will be necessary (VCRMP(c), 1991: 4).

In 1990, VMRC staff recommended and the Commission approved a first-time fishing season and gear restrictions for American shad; minimum size limits and daily bag limits for Spanish mackerel and king mackerel; and on flounder catches. In 1991, VMRC fisheries staff were working with the State of Maryland to produce Chesapeake Bay-wide managment plans for summer flounder, eel, spot and croaker. In addition, management plans are scheduled for red drum, black drum, tautog, and Spanish and king mackerel (VCRMP(c), 1991: 4).

Shellfish (non-oyster or clam)

The ASMFC has developed management plans that can be adopted on a voluntary basis for the following shellfish species: hard clam, interstate shellfish transport, lobster and northern shrimp. Management plans for interstate shellfish transport have also been developed by ASMRC. VMRC officials feel that the Virginia shellfish industry will survive with the surge in off-bottom culture and aquaculture (moving and culturing shellfish in clean water cages), but it will be smaller than the finfish industry and will consist of fewer people. Of the approximately 1,500 summonses written annually by Marine Patrol Officers for shellfish harvesting violations, most citations were written for oyster cull violations (too many small oysters and too much oyster shell on board) and exceeding crab dredging catch limits (VCRMP(c), 1991: 5).

Reports from scientists to the Chesapeake Bay Commission presented facts about the history and status of blue crabs in the Chesapeake Bay and its tributaries at September and November 1993 meetings of the Commission. The blue crab has become the largest single commercial fishery in the Chesapeake Bay, partly because of controls on or declines in other fisheries. It is also the single largest recreational fishery in the Bay in both the number of people participating and pounds caught. Soft crabs, in particular, are becoming an extremely important component of the crab fishery (Jensen, 1993: 9).

Commercial landings of blue crabs in recent years have been 75-100 million pounds Bay-wide, representing 200-300 tons of crabs at a $40-$50 million dockside value. It is estimated that there are 25,000 commercial crabbers. Recreational crabbing represents 30%-50% of the total commercial harvest . In the Commonwealth of Virginia, the 1992 crab catch was valued at $9 million, down from $16 million in 1990 and the total number caught in 1992 was 40% below the 1991 total catch (Cronin, 1993: 8; Jensen, 1993: 9).

Blue crab harvests varied in regular cycles through the early years of the 20th century, a period when there was far less harvest pressure. Peaks and crashes occurred and continue to occur frequently. Each time there is a crash, concern is raised and governmental panels are convened; however, when the harvest goes up, the concern disappears. What is of greatest concern recently, however, is that even though the catch has again gone up, the catch per unit of effort has been going steadily down. As a result, crabbers are using more pots and better gear, and recreational crabbing is increasing (Cronin, 1993: 9).

With commercial fishermen turning to blue crabs as other commercial species decline, and a growing regional population adding to the recreational demand, fisheries officials have become concerned that fishing pressure may become great enough to affect the blue crab spawning stock (Blankenship(d), 1993: 6)

Management Options

Until very recently, neither the states nor the federal government had the authority to impose restrictions a particular state's harvest without legislation. However, recognizing the severity of the problem that the depleted fishing industry currently faces, and the lack of progress from non-unified management programs across state boundaries, Congress passed the "Atlantic Coastal Fisheries Cooperative Management Act" in November 1993. This bill requires states to enact any management plans developed by the ASMFC, including those previously mentioned, most of which have never been fully implemented. The legislation is aimed at managing fish stocks, from their spawning grounds through their migratory routes, "to ensure that no species is fished beyond sustainable levels and that no jurisdiction's actions impact a particular species to the detriment of fishermen elsewhere." Under the law, the ASMFC has 90 days to determine a schedule by which states must come into compliance with existing ASMFC management plans. ASMRC could give states up to a year from the end of the 90-day period to comply with the plans. The law requires the ASMFC to hold public hearings before adopting a plan (Blankenship(e), 1994: 3).

This move alters a traditional area of state authority, where states control the stocks within three miles of their coast. However, while the bill was supported by most coastal states, Virginia strongly opposed it over concerns about costs, potential lack of public input, and the increased federal authority that might result from the legislation (Blankenship(e), 1994: 3).

Proponents of the Act argued that interjurisdictional fisheries, or those commercially- or recreationally-valuable fish species that migrate across state line, must be cooperatively managed to prevent the actions of a single state to adversely affect a resource it shares with others. A case in point is weakfish. Spawning stock of weakfish, or sea trout, are by some estimates at 5% of their historic levels. While many states have acted to curb harvests, North Carolina has only enacted minimal measures (Blankenship(c), 1993: 1,4).

It was also felt by proponents of the legislation that this added tool would also be important for the protection and restoration of many Chesapeake Bay fish populations, including striped bass, weakfish, summer flounder, shad, river herring, spot, croaker, and other species, which migrate along the Atlantic Coast, spending only a portion of the lives in the Bay. Since the Chesapeake Bay serves as spawning and nursery ground for many of the Atlantic Coast migratory species, VMRC officials felt most coastal states would benefit greatly from a strict regulation of Virginia's fisheries. Lower fishing mortality rates in the Bay would allow for much higher rates of fishing elsewhere along the coast (Blankenship(c), 1993: 4).

Scientists have recommended that the blue crab fishery be managed Bay-wide to protect potential breeding females while allowing the maximum harvest of adult males and spent or surplus females. The winter dredge fishery comprises about 20% of the gravid (pregnant) adult females harvested Bay-wide (Cronin, 1993: 9).

To date, Maryland and Virginia have not managed the crab in a unified way. The two states are, however, moving individually to restrict harvest of blue crabs in an effort to stabilize fishing pressure on blue crabs and to head off what some fear could be a future crisis. By enacting restrictions now, state officials hpe to maintain a healthy, harvestable population and to avoid population crashes like those that resulted in moratoriums on striped bass and shad in the Bay. Maryland's plan, adopted in December 1993 by a panel convened under the Maryland Department of Natural Resources, calls for a series of regulatory and legislative changes that would cap the blue crab harvest at existing levels (Blankenship(g), 1994: 4). Also in June, the VMRC approved the first measure in a package of proposals designed to protect the blue crab from excessive commercial harvest in Virginia's portion of the Bay. In December 1993, the VMRC adopted a pair of measures aimed at reducing fishing pressure on the blue crab as part of an effort to comply with a Baywide managemenet plan.

To stablize the catch, Maryland's panel adopted a number of measures, most of which must either go through the state's regulatory approval process of be enacted by its General Assembly. For commercial fishermen, the plan would limit the number of crabs per licensee; restrict commercial crabbing to certain hours of the day; establish a minimum separation distance between trotlines and crab traps; limit the nubmer of commercial licenses to the current number; require commercial crab pots to have an opening to allow small crabs to escape; and license soft-shell crab shredding operations. For recreational crabbing, the plan would require for the first time a minimum age for obtaining licenses; limiting trotline lengths; limiting recreational traps and rings on a per person basis, restricting crabbing hours; limiting the number and design of pots that land owners can have; and limiting catches on a per person/per boat/per day basis (Blankenship(d), 1993: 6).

In Virginia, VMRC drew up proposal to limit the number of crab dredges allowed to work in Virginia waters, prohibit crab potters from working during certain times of the day and during certain seasons, and ask the General Assembly to restrict the use of wide dredges that rake crabs out of the mud and scar Bay and river bottoms (Blankenship(d), 1993: 1,6).

In December 1993, the VMRC approved measures that would limit the number of people participating in the blue crab dredge fishery and backed a proposal that would lower the daily dredge catch limit per boat. Under the new regulation, only those watermen who are licensed when the season concludes at the end of March 1994 will be allowed to participate in the 1994-95 season, which begins December 31. No new dredge licenses will be issued until the number of people with licenses declines to 225; a number that will then serve as a cap. The VMRC staff has recommended that any licenses that become avilable later be distributed by lottery.
A second measure which was adopted reduces the daily dredge catch limit and is expected to spread the catch season out longer, increase the value of the catch, and possibly reduce the crab harvest. Some scientists feel, however, that neither of these actions are comprehensive enought to cap the fishery but were a good start. The VMRC put off action on a proposal that would have curbed the peeler pot crab fishery by limiting the number of pots per fisherman.(Blankenship(f), 1994: 10).

Beginning in January 1994, Virginia required watermen to install escape holes in their crab pots so crabs smaller than the legal limit can escape. This requirement followed a May 1993 VMRC action to limit recreational crabbers to five pots. Other proposals are currently being developed for review. In general, however, VMRC Commissioners feel that the commercial crab fishery in Virginia is going to undergo much regulatory scrutiny (Blankenship(d), 1993: 1,6).

Officials are optimistic that the proposals could trigger a quick recovery for the blue crab. It is also felt that the interstate Chesapeake Bay Commission can play a unique role in advocating more unified management, with management objectives addressing economics, harvest size, population size and Bay culture. A prudent spawning stock needs to be preserved, with the remaining crabs used efficiently. To a reasonable degree, regulation should be uniform. Finally, science and data surveys necessary for good management must be supported (Cronin, 1993: 9).

Examples of how efforts are being made, at the local level, to help the ailing fishing and seafood industry can be found in the Cities of Poquoson and Newport News. Because small work boats are being pushed out of other places on the Peninsula and in an effort to save its struggling seafood industry, the City of Poquoson is considering large public investments over the course of the next few years to build a "home" for area watermen. A committee has been formed by the Poquoson City Council to study the City's seafood industry and to discuss the feasibility of dredging a channel to Back Creek to make it easier for Chesapeake Bay boats to maneuver into the city's seafood industry hub, as well as potentially drawing more watermen to the port. Unlike the City of Hampton and other areas, where downtown development has driven out much of the seafood industry, Poquoson wants to encourage watermen and small work boats to use its port. By investing in its port and aiding seafood processors already located there, Poquoson also hopes to attract other water-related or water-enhanced businesses to the port area (Andes, 1993). The City of Newport News is using federal grants to expand its Seafood Industrial Park and to set up a loan program for businesses there that want to expand. The grant money is meant to help create jobs for people put out of work by cuts in defense spending (Goldstein, 1993).

The location of commercially- and recreationally- important finfish and blue crab areas is documented in the Environmental Sensitivity Map Atlas for the Commonwealth of Virginia and the seasonal Chesapeake Bay Environmentally Sensitive Areas maps. However, as with spawning and nursery grounds, because of the variability in the location of these areas due to fluctuating water quality conditions over time, it is recommended that the atlas and maps be used as general guides. Virginia also maintains a blue crab sanctuary at the mouth of the Chesapeake Bay to protect against dredging during the spawning season.

G. PROTECTED LAND AREAS AND ESTAUARINE RESEARCH RESERVES

Certain lands within the project study area have been designated as "protected areas." These areas are protected by federal and/or state law, or private interests. Such areas include federal- and state-owned parks, refuges and wildlife management areas with valuable coastal wildlife habitats or other important natural and cultural resources.

Section 315 of the federal Coastal Zone Management Act of 1972 established the National Estuarine Research Reserve System (originally called the National Estuarine Sanctuary Program) as a federal/state cooperative venture. Federal matching grants are made available to coastal states to develop and manage a national system of estuarine research reserves which are representative of the various regions and estuarine types in the United States. In addition, annual grants for research and education projects are available. The goal of the program is to protect areas of representative esturaries, including valuable wetland habitat, for use as natural field laboratories. National Estuarine Research Reserves are established to: 1) provide opportunities for long-term estuarine reserach and monitoring; 2) provide opportunities for estuarine education and interpretation; 3) provide a basis for more informed coastal management decisions; and 4) promote public awareness, understanding, and appreciation of estuarine ecosystems and their relationships to the environment as a whole (USDC/VIMS, 1991: 1).

The States of Maryland and Virginia are developing and administering individual reserves in the Chesapeake Bay Natioanl Estuarine Research Reserve System (CBNERRS). The Virginia Institute of Marine Science (VIMS) within the College of William and Mary has been designated as the lead agency for Virginia. Virginia proposed a multi-component program for the CBNERRS in Virginia of reserves that will initially consist of four representative sites in the York River. Two of these reserves are located within the project study area: Goodwin Islands (at the mouth of the York River, representing polyhaline conditions) and Taskinas Creek (in the transition zone of the York River, representing oligohaline conditions)(USDC/VIMS, 1991: 1).

The Goodwin Islands site is located in York County, in the southwestern portion of Mobjack Bay on the lower western shore of the Chesapeake Bay. Landowners include the College of William and mary and the Commonwealth of Virginia. The College received the Goodwin Islands as a gift, thus enabling VIMS to use the appraised value of the property as state match for acquisition and development awards (USDC/VIMS, 1991: 1).

The Taskinas Creek site is located in James City County on the south shore of the York River. It is owned and managed by the Virginia Department of Conservation and Recreation (DCR), through the Division of State Parks. A memorandum of understanding between VIMS and DCR, acknowledging long-term use of the Taskinas Creek reserve for resource management, research, and education has been signed (USDC/VIMS, 1991: 2).

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PHYSICAL AND OCEANOGRAPHIC CHARACTERISTICS OF THE SHORELINE: Bathymetry, Flushing Characteristics and Current Patterns

A. Bathymetry

Bathymetry is the measurement of water depth. Bathymetric data for this study was obtained from the most recent (1990) NOAA-National Ocean Service charts, which show "soundings in feet at mean lower low water." Soundings were taken for the mainstem tributaries but, in most cases, not for the smaller waterways such as creeks within the tributary watersheds. Therefore, the available data obtained from these charts for the project study area is not all-inclusive and, thus, limits physical analysis in off-mainstem waterways. Bathymetric data is important for the siting and design of both shoreline erosion control structures and water access facilities, and the latter, in particular, are generally sited in off-mainstem areas. For the purposes of future water access facility planning, it is also important to identify areas which may require dredging in order to gain adequate access to channels, as well as to identify areas in which dredging will not be necessary. In some cases, U.S.G.S Topographic Quadrangle sheets show off-mainstem soundings and this data was relied upon where available; however, this information is current only to the most recent quadrangle photorevision date. More comprehensive bathymetric data is available from NOAA at a considerable expense.

<<PDC staff will be meeting will DCR-SEAS staff during March in an attempt to create unofficial bathymetric data in off-mainstem waterways where no data currently exists, based on prior knowledge of general stream conditions and other parameters normally used to determine appropriate shoreline erosion control structure options.>>

B. Flushing Characteristics

Flushing characteristics refer to the movement of water and its constituents into and out of a particular waterbody or larger system. Another term for this is circulation, and it is an important factor in determining the dispersion and transport of waste waters and other pollutants into or out of waterways (Neilson, 1976: 14). General information on flushing characteristics is available for the larger coastal basins and tributaries to the Chesapeake Bay in the Hampton Roads Water Quality Management Plan, which was developed by the Hampton Roads Water Quality Agency during the 1970's and early 1980's. Flushing characteristics of the smaller tributaries, which are included in the watersheds of these larger systems, can be inferred from this data as it is the best available published information. Studies to better qualify flushing characteristics of these smaller tributaries are currently being conducted by the Virginia Institute for Marine Science (VIMS), but results have not been published to date.

For free flowing streams and rivers, the general path of a pollutant can be predicted easily, but for estuaries, the circulation patterns can be very complex since addtional factors come into play. When there is either a very small tidal range or a large freshwater flow, the flow of freshwater controls the dispersion and transport of materials. When freshwater flow is small and/or tide range is large, tidal flushing predominates (Neilson, 1976: 1). In a freeflowing river, biological oxygen demanding (BOD) substances discharged to the waterway are carried downstream. The oxygen demand is exerted as the material is transported away from the source, resulting in decreased dissolved oxygen (DO) levels. Eventually, the rate of oxygen utilization decreases and natural reaeration is able to replenish the DO more rapidly than it is consumed. The result is a so-called "oxygen sag." In a tidal river or estuary, polluants are transported upstream as well as downstream from a discharge point. Consequently, impacts are felt upstream as well as downstream of the discharge. The extent of the upstream transport increases when freshwater flows are small and tidal mixing plays a major role in dispersing the waste (Neilson and Ferry: 1978: 10).

<u>Lower Western and Southern Shore Chesapeake Bay Small Coastal Basins: Back and Poquoson Rivers, Little Creek Harbor and Lynnhaven Bay</u>

The Small Coastal Basins portion of Hampton Roads, as defined in the <u>Hampton Roads Water Quality Management Plan</u>, includes the Back and Poquoson Rivers on the Virginia Peninsula and the Little Creek Harbor and the Lynnhaven Bay system on the southern shore of the Chesapeake Bay, as shown in Figure ___. For the lower portion of the Chesapeake Bay, the mean tidal range is on the order of 75 centimeters (cm) and the spring tide range is roughly 90 cm. While these ranges are not especially large, they are of sufficient magnitude to promote mixing. For example, during periods of low runoff, even Hampton Roads proper tends to be well-mixed (Neilson, 1976: 1,14). A waterbody that is well-mixed, however, does not necessarily mean that it is also well-flushed.

None of the four basins is large in drainage area. Because the sediments of the Coastal Plain are unconsolidated, they erode easily. Therefore, the coastal rivers have dendritic patterns and the tidal influence extends to reaches that are far upriver. In addition, many of the tributaries of the coastal rivers are dammed for water supply reservoirs. The Big Bethel Reservoir on the Back River, the Harwood's Mill Reservoir on the Poquoson River and the Little Creek Reservoir, Lake Whitehurst, Lake Lawson and Lake Smith in the Little Creek basin all impound water for use by the nearby urban areas. Since much of the freshwater from upland runoff which comes down the tributaries is diverted for this purpose, only during periods with abundant rainfall is there any flow over the spillways. Thus, for some branches of these estuaries, freshwater flow may be non-existent during parts of the year. At these times, the concentration of salt will increase as the small volume of freshwater is mixed with the saltier Bay-derived water (Neilson, 1976: 14,15).

In general, when tidal mixing is strong, the longitudinal salinity gradient is mild (less than one part per thousand per kilometer), vertical stratification is often nearly eliminated and variations in salinity during the tidal cycle are not great. Historical slack water data for the Back River show how the salinity varies with distance upriver. The longitudinal salinity gradient is on the order of 1 ppt for every 2 kilometers (km). The Back River channel is only about 4 meters (m) deep and surface to bottom differences were usually less than one ppt. If this salinity gradient were to apply to the entire river, then freshwater would be reached 35 to 40 km upriver. However, most arms of these estuaries are much shorter than this and, therefore, one must assume that all of the open areas have brackish waters and only in the very small rills far upriver is freshwater found (Neilson, 1976: 15).

The data for the Poquoson River show very similar characteristics. Little Creek Harbor also is generally similar, but since it is smaller in area and has a smaller drainage basin, salinity variations are even smaller than those seen in the Back River. This is due in part to a location close to the mouth of the Chesapeake Bay and, therefore, a greater influence of the Atlantic Ocean. Furthermore, the saltier sea water is able to enter Little Creek more easily because of the greater depth. Historical water quality studies conducted in this basin have shown that, in general, the upper 4 or 5 m of the water column are well-mixed with only minor variations (around 1/2 ppt) within the harbor. The salinity concentrations at greater depths, 5-9 m, were usually 3-5 ppt greater than those measured in the upper layer (Neilson, 1976: 17,19).

The Lynnhaven System, with its numerous branches and several bays, is more complex. Generally, the Eastern and Western Branches of Lynnhaven Bay behave in a manner similar to the Back River. Longitudinal salinity gradients comparable to that in the Back River occur up both branches. Broad Bay also has a longitudinal gradient since the northwestern portion is influenced by the waters flowing through Long Creek. Linkhorn Bay, on the other hand, is far enough removed from Lynnhaven Inlet so that the tidal range is only one-half that which occurs at Lynnhaven Inlet, and the exchange of waters between Linkhorn Bay and Chesapeake Bay is not rapid or great (Neilson, 1976: 19).

In addition to tidal circulation, there can be a net non-tidal circulation due to density of gradients. However, since most of these rivers are shallow, vertical stratification is normally weak and the gravitational circulation will be weak, too. Only Little Creek Harbor, with depths of 7-9 m, shows strong vertical salinity stratification. For this case, there would be a net flow of salty water into the harbor near the bottom and a net flow of fresher water out of the harbor near the surface. This circulation pattern will greatly increase flushing and remove pollutants from the area (Neilson, 1976: 22).

In general, waterbodies with characteristics such as those described above are able to assimilate wastewaters primarily by dispersion and mixing of these wastewaters throughout the waterbody. Since freshwater flow is small, there is no driving force to push the wastewaters through and out of the system. Rather, transport occurs due to tidal exchange. Therefore, the residence time of a substance within the system may be long and on the order of weeks. Therefore, these estuaries have a very limited capacity to assimilate wastewaters without serious degradation of water quality.

Mainstem Tributaries to the Chesapeake Bay: York and James Rivers

Because of their size, the York and James River behave in a manner more similar to that of free flowing streams and rivers than that of the Small Coastal Basins just described. While tidal flushing occurs in these estuaries, there is also a large volume of freshwater which flows downstream from their headwaters. Therefore, these tributaries have more capacity to assimilate wastewaters without serious degradation to water quality. It is also felt that, in some cases and based on the orientation of smaller tributaries to these mainstem tributaries, the rate of water flow in the mainstem is such that water flowing into or out of the smaller tributaries is somewhat stymied; and, while mixing may occur at the mouths of these smaller tributaries, it is felt that flushing of these tributaries generally does not occur at a high rate.

Water quality studies conducted on the York River which were reported in the Hampton Roads Water Quality Management Plan found that, owing to a combination of thermal and salinity stratification in the reach between the mouth of the York River and the Coleman Bridge, DO concentration below the surface layer in the deep waters of the river tends to be critically low during the summer months. Studies have determined these below standard DO levels to be caused by a "tidal prism effect," and that this is a natural phenomena for which no solution is known at the present time. The tidal prism for the York River is very large and has been calculated to be on the order of 4 billion cubic feet at the mouth and 1 billion cubic feet at West Point. This clearly indicates that an enormous volume of water is available at each flood tide to dilute and carry away the few wastewater streams which are discharged to the river. materials discharged to the river (Sturm and Neilson, 1977: 8,16,17).

It is also felt that the reason that nutrient enrichment and eutrophication is not a problem in the York River is probably because tidal mixing and dilution are very great. This tidal flushing does not guarantee, however, that algal levels and nutrient concentrations will always be small, since nutrients can be stored in sediments and released at later times. In fact, in many instances, the recycling of nutrients in an area represents a greater flow than that through the segment. In turn, BOD is low given the huge tidal prism available for diluting the few and relatively small loadings which the river receives. In summary, it appears that aspects of the physical environment in the York River, such as mixing and transport of dissolved substanced throughout the water column, are controlling the low DO conditions which contribute to poor water quality conditions more than external inputs of oxygen demanding material (Sturm and Neilson, 1977: 17-19).

Water quality studies conducted on the James River, as part of the Hampton Roads Water Quality Management Plan, have shown that salinities are greatest near the mouth, of course. since the ocean is the source of nearly all of the salt. Near Old Point Comfort, the salinity at the surface ranges from 16-18 ppt in the spring to 21 or 22 ppt in late summer. Bottom salinities vary in the range of 24-28 ppt. Vertical stratification is usually reasonably strong at the mouth since the river is very deep there, and there has been little opportunity for the denser salt water to be mixed with the freshwater. Stratification throughout the rest of the estuary varies in response to freshwater runoff and tides (Neilson and Ferry, 1978: 4). The dominant flow of the James River during ebb tide is down the natural channel south of Middle Ground (Neilson and Sturm, 1978: 15).

The estuarine portion of the James River has characteristics much different from the tidal riverine reaches. Tidal currents are strong and enormous volumes of water are available to dilute wastes. Consequently, DO levels usually are good even though BOD discharges can be large. In the James River 3-C Report (Planning Bulletin 217-B), for the reach between the Chickahominy River and Mulberry Island, it was noted that waste discharges were limited. However, DO sags did occur occasionally due to nonpoint loadings, with marsh inputs suspected as being the major component of these loads. Below Mulberry Island, sevel large waste discharges exist, but the strength of the tidal action combined with the massive amount of dilution water available result in a rather steady DO level after the natural background variations due to changes in temperature and salinity are removed. In summary, then, although large volumes of wastewaters are discharged to the estuarine portion of the James River, the natural assimilation capacity of the river is great and DO levels are generally well above water quality standards (Neilson and Ferry, 1978: 16,17).

South Shore James River Tributaries: Elizabeth, Nansemond and Pagan Rivers

Water quality studies conducted for the Elizabeth River, as part of the Hampton Roads Water Quality Management Plan, showed the water mass between the Lafayette River and the Southern Branch to be nearly homogenous. This indicated that tidal mixing was strong and that materials discharged to the river would be widely dispersed throughout the system. However, since the longitudinal salinity gradient was weak, gravitation circulation was limited and the dominant mechanism for removing material from the system was the tidal exchange. Since only a small fraction of the water is exchanged on any given tide, the residence times for the system are long. Flushing is poor in the upper reaches of the river. As a result, materials discharged near the mouth of the river are removed from the system relatively rapidly. Materials discharged further upstream were dispered relatively rapidly, but were removed from the system slowly. Therefore, the further a wastewater discharge is from the mouth, the longer it will take to be flushed out of the system. Observations made by engineers over the years lend support to this argument by indicating that the residence time of pollutants has increased (or the flushing time has decreased) as a result of construction of the Craney Island dredge spoil disposal area. Since the dominant flow of the James River during ebb tide is down the natural channel south of Middle Ground, it is likely that tidal exchange was greater before the dikes at Craney

Island were built. The presence of the disposal area has, in effect, lengthened the river, thereby increasing the distance and time over which a pollutant must travel to leave the system (Neilson and Sturm, 1978: 12-15).

The Nansemond River is a small tributary of the James River, entering Hampton Roads at an angle along the southern shore. Freshwater flow to the river is not great because the drainage area is small and nearly two-thirds of this drainage area is upstream of water supply reservoirs which impound much of the runoff. Consequently, brackish waters often reach all thé way upstream to downtown Suffolk and there is little stratification in the water column. During winter and spring, the freshwater runoff usually increases, resulting in some salinity stratification and a downriver migration of the brackish water. The rapid narrowing of the river channel from the mouth towards the headwaters results in a reflection of the tidal wave and an increase in the mean tidal range. The range near the mouth is only 0.85 m (2.8 ft) but increases to 1.16 m (3.8 ft) at the head. There also is a phase lag of about one hour between the river mouth and the head. Tidal currents are reasonably uniform throughout the estuary (Kilch and Neilson, 1977: 1-4).

The Pagan River is a small estuary which enters the south side of the James River at an angle. Tidal circulation rather than freshwater runoff generally controls the physical characteristics of the river. The tide range is around 90 cm (3 ft.) and tidal currents exceed 0.3 meters per second (1 ft./sec.). Since the river is only about 17 km (10.5 mi.) long, the tidal wave propagates the length of the river in a matter of minutes. Yet, water quality in the Pagan River is quite poor, due to waste discharges from meat packaging plants, poorly treated waste waters and BOD. It is believed that the base freshwater flow to the river is small so that pollutants are flushed through the system and out into the James River very slowly. A pronounced sag in DO levels with distance upriver from the mouth indicates that the point source loadings of BOD have an observable impact on water quality. Water quality is sufficiently poor in the upper reaches of the river (Rosenbaum and Neilson, 1977: 1-21).

Just as assimilation of municipal and industrial wastewater is driven primarily by the flushing characteristics or circlation patterns of a particular waterbody, so is assimilation of waste discharge from marine vessels. The Commonwealth of Virginia is currently seeking to develop a policy which would regulate the discharge of waste from vessels within state waters. Specifically, the policy will delineate areas within the Chesapeake Bay where discharge of vessel waste shall be prohibited. Authority for such designations comes from Sections 312(f)(3) and (f)(4) of the federal Clean Water Act. The act establishes a framework for states to apply to the EPA for the authority to prohibit all sewage discharge from vessels equipped with Marine Sanitation Devices (MSDs).

As defined by the U.S. Coast Guard, MSDs fall into three primary categories based on their characteristics of operation. Type III devices are by far the most prolific and least costly of the three types. They usually consist of a holding tank which retains the waste on board and must be periodically pumped-out at an on-shore pump-out facility. Discharge from a Type III MSD is permitted only in waters unrestricted for discharge of waste.

The EPA has generally found the existence of adequate pump-out facilities on a particular waterbody to be the most crucial factor in approving discharge prohibitions; that is to say, that discharge of wastes from a Type III MSD into state waters is unnecessary given the presence of pump-out facilities in the area. State health law now requires that all marinas built after a certain date be equipped with pump-out facilities. In the opposite respect, while the existence of environmentally-sensitive areas within a waterbody may merit its designation as a "no discharge zone," the waterbody may be excluded from being designated due to lack of available pump-out facilities within a reasonable travel distance (assumed to be a 3-mile radius).

A State-commissioned study is currently underway to develop a standard methodology for delineating appropriate no discharge zones in state waters. As one component in the development of this methodology, a simplified formula to derive flushing classifications for specific estuaries (poorly flushed, moderately flushed or highly flushed) will be employed. It is anticipated that this methodology, if or when applied to waterbodies in Hampton Roads outside of the commissioned study area, will provide flushing characteristics that can be used to better qualify the information provided in the historical water quality studies referred to above.

Flushing characteristics are also a primary factor in determining the most appropriate location and design of marina facilities. Poorly-flushed marina basins and entrance channels and dead-end segments can contribute to degradation of water quality by increasing the residence time of certain point and nonpoint sources of pollutants generated by activities associated with marinas.

C. Current Patterns

Current patterns refer to the direction and velocity which flood and ebb tides move within a tidal stream or other waterbody, as well as the velocity at which free-flowing streams move. In tidal areas, slack current times are times at which the current has stopped setting in a given direction and is about to begin to set in the opposite direction. Offshore, where the current is rotary and flows continually with the direction of flow changing through all points of the compass during the tidal period, slack water denotes the time of minimum current. Beginning with the slack water before flood, the current increases in speed until the strength or maximum speed of the flood current is reached; it then decreases until the following slack water or slack before ebb. The ebb current now begins, increases to a maximum speed, and then decreases to the next slack. There are usually four slacks and four maximums each day. The terms flood and ebb do not in all cases clearly indicate the direction of the current. The relation of current to tide is not constant, but varies from place to place, and the time of slack water does not generally coincide with the time of high or low water, nor does the time of maximum speed of the current usually coincide with the time of most rapid change in the vertical height of the tide (Geis, 1993: 247-249). Daily current predictions, as well as velocity of current at any time, can be obtained from current tables and diagrams in a boater's almanac.

Current pattern information is important for predicting erosional activity along a shoreline and for the proper location and design of both erosion control structures and water-access facilities. For that part of the project study area which is located in the Chesapeake Bay watershed, the current patterns for all waterbodies downstream of surface water impoundments are based on the tidal cycle of the Bay. Those waterbodies outside of the Chesapeake Bay watershed which flow into North Carolina may or may not be wind-influenced by the Albemarle-Currituck-Pamlico Sound estuarine system. For the purposes of this study, waterbody- and reach-specific current patterns were obtained from the Hampton Roads Water Quality Management Plan and the most recent ______ charts/maps.

Final

PRIVATE AND PUBLIC WATER ACCESS

Introduction

The Chesapeake Bay and several smaller bays and estuaries in Virginia cover almost 2,400 square miles. Combined with Virgnia's 115-mile Atlantic Coast, they provide over 5,300 miles of shoreline and collectively represent one of the state's most important resources. In spite of this abundance, public access to tidal waters for water-based and water-enhanced recreational uses is somewhat restricted and is very restricted to the general public. It is estimated that less than 1% of the shores are in public ownership, and much of this publicly-owned waterfront consists of marshlands and/or tidal flats that have limited recreational potential (VDCR(a), 1989: 153).

The coastal landscapes of the Hampton Roads region, in particular, and the natural areas that they harbor provide for a unique quality of life and many opportunities to recreate. This is evidenced in that this region is one of the fastest growing areas in the United States, and in the fact that a large share of Virginia's seasonal tourist and recreational revenues are generated within this region. Rapid population growth has resulted in greater participation in water-based recreation, and a corresponding demand for additional public water access and water-enhanced facilities where private access to the water is not available. Use demands also stem from the seasonal tourist population.

According to the draft 1994 Virginia Outdoor Plan, developed by the Virginia Department of Conservation and Recreations's (VDCR) Division of Planning and Recreation Resources, the most popular recreational activities in the region are boating, walking and biking for pleasure, and beach use. Based on this, the draft plan identifies the most pressing recreational needs for the Hampton Roads region as being additional boating facilities and public access points (VDCR(b), 1993). However, due to the concentration of new development along the region's shorelines and the escalation of the value of waterfront property, local governments have found it increasingly difficult to meet identified public water access needs.

At the same time, the region's local governments, along with state and federal agencies, have committed themselves to halting a decline in water quality conditions in the Chesapeake Bay watershed and other sensitive ecosystems. Poor water quality conditions have brought about subsequent declines in living resources that were once abundant. While other factors have played a role in this decline, arguments have been made that the increased development of shoreline areas is having negative water quality impacts. Shoreline areas are being developed at a rapid rate in response to the region's year-round and seasonal population influxes. As these areas have been and continue to be developed, the density of private water access points continues to rise.

One of the purposes of this study has been to explore the validity of a proposed argument that an unlimited array of piers and docks for private water access should be discouraged because of the impacts that these structures and their associated activities have on water quality, while central access points should be encouraged in areas best suited for those uses. The rationale behind this argument is that there is a greater opportunity for water resource management in areas where rights to water access have been concentrated, in contrast with private access points dotting the shoreline. Under such a scenario, potential degradation to water resources associated with construction and maintenance of water access facilties and their related water-based recrational activities, such as boat operation, maintenance and storage, can be controlled to a greater extent than on the individual lot level.

In general, because any type of water access facility has the potential to impact or be impacted by the surrounding environment, whether private or public, development of such facilities must take into account a number of environmental, social and economic issues. Many of these issues are addressed through federal, state and local regulatory procedures, while other non-regulated issues can be resolved through the careful siting and design of water access projects.

Therefore, there are some basic conflicts that need to be addressed in future public and private water access planning. On the one hand, a need for additional public water access has been identified because of the lack of publicly-owned waterfront property in the region; while demand for additional public access has increased, the supply of areas which can be used for this purpose has decreased. One of the major initiatives of the 1987 Cheasapeake Bay Agreement involves the improvement of public access to the tidal waters of the Bay. It is hoped that this commitment will earmark substantial resources for the future improvement of water-dependent and water-enhanced recreational opportunities in the coming years. However, whereas there is a demonstrated need to develop additional boating facilities, public water access points and areas which encourage water-enhanced recreational activities, there are also many existing resources within the region which can be enhanced to better meet current and projected recreational needs. In addition, upon review of parks and recreation planning literature in Virginia, it is also apparent that in the course of trying to meet the demand for public water access facilities, little if any mention is made of the potential conflict between the improper siting, potentially-conflicting water uses, and use intensity of these facilities in relation to potential water resource degredation, and this should be a very important consideration.

On the other hand, where private access is made available through ownership of waterfront property as more shoreline areas are developed, there is concern about the uncontrolled density of piers and docks and the effect that such density has on the water quality conditions and overall carrying-capacity of a particular waterbody. A potential solution lies in limiting the supply of private access points and, instead, concentrating them in shoreline areas which have been identified as best-suited for such uses. Another option is to develop a standard for determining the appropriate density of piers and docks for a given waterbody. However, as pier and dock density is tied to density of land use as prescribed in local zoning ordinances, it is important to consider that any density regulations or density standards that might be developed must be rooted in land use planning, which is currently the domain of local governments and their appointed entities, such as local wetlands boards and planning commissions, as opposed to the state or federal government.

The dilemma with which land use planners are faced is how to increase, or maintain through modification, the same opportunities for both public and private water access, respectively, while at the same time not contributing further to declines in water quality and living marine resources ~~and, subsequently,~~ water use conflicts. In order to achieve these goals, the application of a broad mix of strategies will be necessary. This can include identification of appropriate shoreline areas for specified uses, various land use controls, land acquisition techniques, state and federal assistance, existing facility enhancement, development programs and cooperative agreements for joint facility use between federal, state, local entities and the private sector, and potentially expanding state and local legal authority to control the siting and density of public and private water-access facilities.

In its conclusion, The 1989 Virginia Outdoor Plan recommends the following actions that will be required at all levels of government and in the private sector to provide adequate public access to the region's water resources (VDCR, 1989: 154). In prioritizing such actions, potential impacts to water quality and catalysts of water use conflicts should be avoided.

- Each Tidewater locality should carefully evaluate waterfront parcels and determine their potential for future boating access. Mutiple use of space should be considered whenever practical.

- Local governments should look for opportunities to encourage private enterprise to develop quality marinas, dry storage facilities, and fee landings.

- The state agencies involved in regulating marine resources sould develop a methodology for complete coordination in areas of health, sport fisheries, commercial fisheries, water quality, safety, and law enforcement.

- The Virginia Department of Game and Inland Fisheries (VDGIF) needs to accelerate its program of providing high capacity boat access sites in Tidewater.

- The VDGIF and local governments should develop a priority system for improving and, in some cases, expanding existing facilities.

- The VDCR should encourage the development of water access opportunities in all waterfront parks in which the Department assists with acquisition and/or development.

- The VDCR should coordinate with local, state, and federal agencies to develop and expedite plans which would lead to more acces to tidal water resources.

- The VDCR should acquire land for one or more major state parks which could provide access to the Bay or the state's major river resources.

- The National Park Service should assist the state in identifying and obtaining the use of recreational boating access on federal properties, as an element of multiple use management.

- The Virginia Association of Marine Industries should assist marina operators in expanding or streamlining their operations to achieve maximum benefit and provide optimum levels of service to recreational boaters while ensuring environmental safeguards and water quality.

- The Department of Transportation, the VDGIF, and Tidewater localities should jointly explore the feasibility of adding pedestrian walkways beneath (or attached to) new bridges, for use by fishermen.

- Federal, state, and local agencies as well as the private sector should attempt to retrofit existing water access points with portable water supplies and appropriate sanitary facilities. All future sites should incorporate these features into development plans. This would be another important step in the effort to improve the water quality of the Commonwealth.

STRATEGIES FOR IMPROVING WATER ACCESS

This chapter identifies and briefly describes a number of strategies that local governments can use to improve water access. These strategies have been divided into four categories: land use controls, land acquisition techniques, state and federal programs and cooperative agreements for joint use.

LAND USE CONTROLS

A number of traditional and innovative land use controls can be implemented by local governments to promote public shoreline access. These strategies can be used to control development on privately owned land, or on publicly owned land to be sold, leased or donated for private development.

PRIVATELY OWNED LAND

Under a local government's "police powers" to regulate the use of privately owned land, a number of techniques exist to encourage public shoreline access. These techniques follow.

Traditional Zoning

In recognizing that the waterfront is a unique area deserving special treatment, a local government may adopt a "waterfront zone" as part of its existing zoning ordinance. This zoning classification would regulate waterfront development by specifying permitted as-of-right and conditional shoreline uses, and by establishing design and siting criteria that are appropriate to waterfront development. It could also be employed to insure that physical and/or visual water access opportunities are maintained or created. Because of the environmental sensitivity of shoreline areas, a locality may also want to consider the inclusion of performance standards in a waterfront zoning classification. Performance standards permit land use activities up to the point at which they begin to interfere with or harm environmental processes.

Waterfront zoning would be most effective if implemented in conjunction with the adoption of special waterfront planning areas. These planning areas would be incorporated into the city or county comprehensive plan and would be subject to area-specific goals, objectives and policies established by the community to govern waterfront development.

EXCERPTED FROM: The Waters of Southeastern Virginia, 1988

Concessions from Developers

Developers of waterfront properties can be encouraged to provide water access through the following techniques:

- Open Space Dedication Requirement. In some Southeastern Virginia localities, as a condition for approval of a final subdivision plat, a city or county may require a developer to reserve or dedicate land for parks, schools or similar public uses. If a proposed subdivision is located on the water, an open space dedication requirement may be used to acquire and develop a water access site.

- Rezoning Negotiations. During rezoning negotiations, a developer of a waterfront site may be encouraged by a locality to provide water access as a condition for the desired rezoning.

- Density Bonuses. Zoning ordinances might be revised to allow the granting of development bonuses to developers who provide some type of public benefit. For example, a waterfront developer who incorporates public waterfront access into his project would be allowed an increase in the project's floor area ratio or in the number of allowable units per acre.

Overlay Zoning

Overlay zoning offers an alternative to the sometimes static nature of traditional zoning. Overlay zones "float" over a community and are placed in specific locations, such as waterfront areas, when they are needed. These zones are not intended to replace existing zoning. Instead, they impose additional regulatory provisions to strengthen existing zoning. If current zoning is outdated or inefficient, it would be better to undertake a comprehensive rezoning than to apply an overlay zone. In a waterfront area, overlay zoning is typically used to promote public access to the water, improve scenic and aesthetic controls, and encourage compatibility among shoreline uses.

Special Districts

Special districts are sub-units of local government which are created to provide services to or to govern the development of a specified area. These districts are formed when the needs of an area cannot be adequately met by local governmental processes. Created through state enabling legislation, special districts often have powers similar to those held by local governments, including eminent domain, taxation powers, and controls over planning and urban design. Special districts have specific boundaries and the powers granted to the appointed or elected officials of the district apply only within these boundaries. In waterfront areas, the special district is often used to address a variety of community issues including public shoreline access. Other issues might include economic development, historic preservation, recreation, and open space conservation.

Planned Unit Development

A strategy that is particularly effective in preserving waterfront open space and creating water access opportunities is planned unit development (PUD). PUD is a land use control technique in which subdivision and zoning regulations apply to an entire project area rather than to individual lots. Through the PUD approach, development density criteria are applied to the whole project area rather than to specific parcels. This allows a PUD designer to cluster development and maximize areas available for the development of public facilities and the preservation of open space. In a waterfront setting, PUD can be used to preserve environmentally critical shoreline areas, and to leave shoreline open for the development of waterfront parks and/or boat access facilities.

Transfer of Development Rights

Another method for preserving waterfront open space is through the transfer of development rights (TDR). The TDR process allows a property owner to transfer (sell) his development rights to a developer of another site. That developer would then be allowed to increase the density or size of his development. The advantage to this approach is that the loss of development potential due to governmental action does not result in financial loss to the property owner. Like PUD, this technique could be used to preserve the shoreline environment and improve public water access. Before TDR can be implemented, however, a city or county ordinance must be adopted which delineates eligible transfer and receiving properties, and clearly defines the restrictions and criteria guiding the process.

PUBLICLY OWNED LAND

If a locality decides to sell, lease or donate waterfront property to a private developer, there are two ways that it can insure that the property is developed in such a manner that public physical and visual access to the water is maintained or created. First, any land transfer agreement between public and private entities could include stipulations that dictate the amount, location and types of public access to be provided; any design criteria to be used in the development of water access facilities; and any waterfront property that is to remain in public ownership. Second, where land is disposed of through a competitive bid process, the use of a Request for Proposals (RFP) can be effective in exacting development concessions. An RFP can stipulate that, for a proposal to be considered, it must meet certain water access and facility design criteria.

LAND ACQUISITION TECHNIQUES

This section identifies and briefly describes a variety of techniques that can be used by local governments to acquire waterfront land for the purpose of developing water access facilities.

FEE-SIMPLE ACQUISITION

Fee simple acquisition is the assumption of complete ownership of land through outright purchase, gift, condemnation or purchase with donated funds. Unless land is acquired through donation, this is the most expensive way of acquiring land. It does assure, however, that a locality will have full control over the use of the purchased land.

One variation of fee-simple acquisition is a purchase/leaseback arrangement. Under this arrangement, a local government will purchase land and lease it back to a private interest which will develop it. There are several advantages to this approach. First, the local government can defray acquisition costs with revenues from the leaseback arrangement. Second, the costs of improvements are assumed by the developer. Finally, and most important in the context of waterfront access, a local government can attach stipulations to the lease requiring that the developer provide public benefits, including physical and visual access.

CONSERVATION EASEMENTS

A conservation easement is a technique by which certain rights to the use of land are granted, through sale or donation, by a landowner to a public agency or a conservation organization. Private property ownership is retained by the landowner. Only those rights which he specifically agrees to forego are transferred to the recipient of the easement. An easement is signed and recorded like other deeds and is a covenant running with the property title. The State Open Space Land Act of 1966 enables all public landholding bodies in Virginia to use conservation easements. The 1988 Virginia General Assembly passed a bill creating the Virginia Conservation Easement Act. This Act enables private, tax-exempt conservation organizations to acquire conservation easements.

In waterfront areas, conservation easements are used to protect environmentally critical shoreline, to provide public access to or along the shoreline, and/or to provide visual access by restricting building heights or creating setbacks. Conservation easements benefit property owners by providing tax breaks and assurances that land will remain perpetually undeveloped. They can provide public benefits by achieving conservation and water access objectives without having to commit funds for fee-simple land acquisition.

LAND BANKING

Land banking is the public purchase of land which is held in reserve for resale or future public development. Land banking can be used by a locality as a hedge against predicted inflation in land values, to control the pattern of private development or to obtain optimum locations for future public facilities. Large scale land banking is generally impractical for most localities because it requires large capital outlays, is often politically unpopular and takes property off the tax rolls. Small scale land banking, however, is more feasible in that it can provide specific sites for future public water access facilities, and it can allow localities to control and attach appropriate deed restrictions and covenants to the eventual disposition of public waterfront land for private development.

LAND TRUSTS

Land trusts are similar to land banks. The principal difference is that land is acquired for conservation only, without intentions for eventual resale or development. Limited public waterfront access can often be developed on land held for conservation purposes. Land trusts are usually established by state governments or private nonprofit organizations. The primary role of many private land trusts is to pre-acquire conservation land for conveyance to public agencies. In this way, private land trusts can offset the limited land acquisition funding capacity of the public sector. The creation of land trusts by local governments is not common, but it may be worth investigating. The prime disadvantage in establishing a public land trust is finding a dependable, long term funding source. Many public trusts are funded by periodic bond authorizations. Other potential sources include general funds, recreation user fees and rental fees from environmentally appropriate uses of land trust properties.

STATE AND FEDERAL PROGRAMS

A number of state, federal and joint state/federal programs exist which can be used to develop local water access facilities. Some of these programs were created specifically to provide water access. Others were devised to achieve other objectives, but water access may be realized as a secondary benefit.

Federal Aid in Sport Fish Restoration Prograrm

The Federal Aid in Sport Fish Restoration Program has been the principal source of public funds for the development of water access facilities. This program diverts the federal excise taxes on fishing tackle, motorboat fuel taxes and impart duties on tackle and boats to state fishery agencies for the development of sport fisheries and boat access projects. The Sport Fish Restoration Program is administered by the U.S. Fish and Wildlife Service (FWS) at the federal level. At the state level, the Department of Game and Inland Fisheries (VGIF) receives program funds from the FWS, combines them with fishing license revenues and then provides grants to eligible recipients for Federally approved projects. A variety of water access projects can be approved for funding as long as they promote state fishery management objectives. These projects might include boat ramps, docking and marina facilities, breakwaters, restrooms, parking areas and maintenance of existing facilities. Eligible recipients include other state agencies, county or municipal governments, universities or private organizations.

Sport Fish Restoration funds are provided as a 75% reimbursement for completed projects. This means that the VGIF must fund 100% of a project up-front. The VGIF has indicated that chances for acceptance of a project into the program will be greatly enhanced if a local recipient rather than the State provides the 25% share not covered by Sport Fish Restoration funding. The VGIF is also more inclined to consider sites that are readily available and do not have to be acquired by the State.

The development of a number of boat ramp facilities in Southeastern Virginia was made possible by the Sport Fish Restoration Program. For a proposed boat ramp to be accepted into the program, it must meet certain VGIF siting and design criteria (See Table 6). In addition, once a proposed boat ramp site has been accepted into the program, the VGIF reserves the right to conduct all design and construction activities. The locality will be responsible for maintaining and operating the ramp.

Virginia Board on Conservation and Development of Public Beaches Grant Program

The Virginia Board on Conservation and Development of Public Beaches was created under the Public Beach Conservation and Development Act of 1980 to conserve, protect, improve, maintain and develop public beaches for the benefit, use and enjoyment of the citizens of the Commonwealth. In keeping with this mandate, the Board administers a grant program to provide local governments with up to 50% fund assistance for erosion abatement projects on public beaches. A public beach is defined by the Act as a sandy beach located on a tidal shoreline suitable for bathing and open to indefinite public use. To qualify for a beach development grant, a local government must have an erosion advisory commission.

Projects funded by this program often provide water access as well as erosion control benefits. For example, the City of Norfolk recently applied for a beach development grant to construct elevated beach accessways over the dunes to the Chesapeake Bay beachfront. This project will serve the dual purpose of protecting the fragile dune system and increasing beach access opportunities. Other eligible erosion control projects may serve to protect beachfront recreational facilities and/or to ensure adequate beach width for beachfront recreational activities.

State Scenic Rivers Program

The Scenic Rivers Program is administered by the Virginia Division of Parks and Recreation (VDPR) of the Department of Conservation and Historic Resources. The purpose of this program is to identify and protect those rivers or streams whose scenic beauty, historic importance and natural free-flowing characteristics make them resources of particular statewide importance. Although the VDPR has conducted a number of preliminary assessments of potential scenic rivers, formal designation of a river must be initiated by the city or county in which that river is located.

Enabling legislation for this program was passed in 1970 in the form of the Scenic Rivers Act (Title 10, Chapter 15 of the Code of Virginia). Although this Act does not contain specific provisions for the development of water access, it does include provisions which promote preservation of a river's recreation, scenic, historic and biological resources. In addition, the Act prohibits the construction of any structure which impedes the natural flow of a scenic river without authorization from the General Assembly. It also authorizes the Director of the Department of Conservation and Historic Resources, or other administering agency, to acquire, through gift or purchase but not through eminent domain, any property which is necessary or desirable for the protection of a scenic river. This provision could lead to the acquisition of property that is suitable for water access facilities.

Legislation to include a portion of the North Landing River and several of its tributaries in the Virginia Scenic Rivers System was passed by the 1988 General Assembly. This is the first time a Southeastern Virginia waterway has been granted State Scenic River status. A portion of the Blackwater River has been found to qualify for inclusion in the system, but no action has been taken.

Virginia Outdoors Fund

The Virginia Outdoors Fund (VOF) is administered by the VDPR and is a supplemental source of funding for the acquisition and development of recreation lands at the state and local levels. The VOF is comprised of state funds appropriated by the General Assembly, and funds allocated to the State from the National Park Service's Land and Water Conservation Fund (LWCF). At least 50% of the LWCF allocation must go to local projects. For individual local projects, the VDPR may allocate up to 50% fund assistance through the VOF. The remainder of the project's cost is the responsibility of the local government.

Because of decreasing Federal LWCF allocations, VOF allocations to localities are able to finance only a small portion of local recreation needs. At one time, the LWCF was the single most important source of funding for the acquisition and development of recreational facilities. The Fund has provided almost $3 billion in assistance to state and local governments nationwide since 1965. However, federal budget cuts since 1980 have led to a severe decrease in LWCF appropriations. For example, in 1979, Virginia received $7.5 million from the LWCF. By 1986, the State's LWCF allocation had declined to $723,000. Nonetheless, if a proposed water access facility is consistent with VDPR's policies and criteria, a VOF grant is worth pursuing.

Virginia Outdoors Foundation

The Virginia Outdoors Foundation is a private entity established under state charter by the General Assembly in 1966. The Foundation, which is housed in the Virginia Division of Historic Landmarks, is authorized to solicit and accept gifts of money, securities, property or property easements in order to preserve open space resources. Since its inception, the Foundation has solicited easements on over 30,000 acres of open space and protects another 4,000 acres through fee-simple ownership. In many instances, waterfront property or water access easements have been acquired by the Foundation. A locality might further its conservation and water access objectives by informing the Foundation of acquisition opportunities within its jurisdiction.

Virginia Department of Transportation Programs

There are several Virginia Department of Transportation (VDOT) programs which might either directly or indirectly provide water access opportunities. These programs are as follows:

- The VDOT, the VDPR and the VGIF have initiated a cooperative agreement aimed at increasing public access to rivers, streams and estuaries. Potential bridge replacement and road realignment projects are screened by all three agencies to determine the feasibility and desirability of incorporating water access into the project.

- State enabling legislation permits the VDOT to construct fishing piers or attach fishing structures to bridges in conjunction with bridge construction projects. However, the costs associated with such projects must be borne by others.

- The VDOT administers a Recreation Access Fund which is used to provide road or bikeway access to public recreation sites or to the major attractions within such sites. Although this program does not directly provide water access, it may be used to construct roads or bikeways to waterfront recreation areas, or to water access facilities within recreation areas.

- The VDOT will often allow the development of water access facilities on VDOT owned waterfront property. Before such development occurs, however, a local government would have to apply for and be granted a VDOT special use permit.

Chesapeake Bay Youth Conservation Corps Program

The goal of the Chesapeake Bay Youth Conservation Corps (YCC) program is to improve the waters and the environment of the Chesapeake Bay and its tributaries through conservation projects that employ youth, with an emphasis on the employment of the economically-disadvantaged. Through this program, which is administered by the VDPR, a total of $300,000 in grant funds is made available annually to eligible recipients and projects for the hiring of YCC workers. Eligible recipients include all political subdivisions in the Tidewater area. For a project to be eligible for funding, it must provide a direct benefit to the waters and environment of the Bay. Eligible projects generally involve such activities as erosion control, shoreline stabilization and clearance of dumpsites. Consideration will be given, however, to projects which incorporate the development of water access facilities into these activities.

The Chesapeake Bay Agreement

The Chesapeake Bay Agreement was signed in 1987 by the States of Virginia, Maryland, and Pennsylvania, the District of Columbia and the U.S. Environmental Protection Agency. This Agreement consists of a number of initiatives which constitute a ten year plan for cleaning up the Bay. One of these initiatives calls upon the participating governments to improve and expand public access opportunities to the Bay. Commitments contained in this initiative include (1) the preparation of an inventory, by December 1988, of the States' existing and potential water access sites, and (2) the development of a strategy, by December 1990, which would encourage state and federal governments to secure additional tidal shorefront along the Bay and its tributaries. In response to these commitments, the Virginia Department of Conservation and Historic Resources has directed the VDPR to begin working with local governments to compile an inventory of water access sites. This study should provide the information necessary to complete the Southeastern Virginia portion of this inventory. The VDPR has also proposed a public access grant program which would make available $5 million per year in grants to Tidewater localities for the purpose of constructing or developing additional boat launching, fishing, swimming and sunbathing facilities. It is proposed that participating localities would be required to provide 25% of each project's cost.

Coastal Resources Management Grant Program

Coastal Resource Management (CRM) grants are allocated to state governments through the National Oceanic and Atmospheric Administration's Office of Coastal Resource Management. The CRM grant program is authorized by the Coastal Zone Management Act of 1972. The purpose of the CRM grant program is to provide funding to state, regional and local governments for coastal resource planning and technical assistance. For a state to qualify for CRM grants, it must establish a coastal resource management program that is approved by the Secretary of Commerce. In Virginia, this program is the Virginia Coastal Resources Management Program (VCRMP) administered by the Virginia Council on the Environment (VCOE). One of the stated goals of the VCRMP is "to provide and increase public recreational access to coastal waters and shorefront lands."[23]

The VCOE has committed to allocating up to one-half of federal CRM funds to the 44 localities and nine planning district commissions (PDCs) in the Tidewater area. The remaining funds are used to assist state agency bay and coastal activities. There are two sources of CRM funding available to local governments and PDCs through the VCRMP - basic formula grants and competitive grants. The basic formula grants are allocated to the PDCs primarily for providing technical assistance to local governments. The competitive grants are available to both local governments and PDCs and may be used for a variety of planning projects including those dealing with water access improvement. The conduct of this water access study was made possible through a VCRMP competitive grant. In addition, several of the Southeastern Virginia localities bordering the Chesapeake Bay or its tributaries are currently engaged in CRM projects funded by competitive grants.

Design Arts Program

The Design Arts Program is administered by the National Endowment for the Arts and is authorized by the National Foundation of the Arts and the Humanities Act of 1965. The aim of this program is to encourage communities to integrate art into the design of public places through the collaboration of design professionals and visual artists. Funds are therefore used to select appropriate designers and artists and to support the integrated design/art process. The City of Norfolk applied for, but did not receive, a Design Arts Grant for a proposed waterfront park on the abandoned Lambert's Point Landfill on the Elizabeth River.

Miscellaneous Federal Programs

There are other federal grant programs that represent potential indirect funding sources for water access facilities. These programs, which are targeted at other problems (e.g. water quality, community development, etc.), may fund water access facilities if they are consistent with grant regulations and contribute to overall program goals. Funding sources fitting into this category include Community Development Block Grants and Urban Development Action Grants.

COOPERATIVE AGREEMENTS

Nearly twenty percent of the region's ocean and bay beaches, as well as other shoreline areas with significant recreational potential, are closed to public recreation by virtue of their control by the military. Similarly, other public entities and private corporations own large undeveloped or under-used shoreline areas. Joint use of such areas would greatly enhance the region's ability to satisfy resident and tourist demand for water-oriented recreation.

Coöperative agreements between local governments and the state or federal government or the private sector represent a vehicle for achieving joint facility use. At the present time, 0.2 miles of military-controlled beaches have been opened for public recreation through such agreements. Similar agreements have permitted long-term public use of military lands for other forms of public recreation and for various public services including education, fire training and youth homes. Camping and other outdoor recreation opportunities have been made available to the Boy Scouts, Girl Scouts and similar groups through cooperative agreements with the military. The private sector has participated in similar agreements for joint use of waterfront lands. In other communities, long-term recreational use of public lands earmarked for development has been achieved. Similarly, land being held for future development has been used for recreational purposes through agreements between the local government and the private developer. Southeastern Virginia does not have a conserted ongoing program, under the auspices of landowners or the pubic, to obtain joint use agreements.

Joint use agreements cover the terms of the shared use of lands. These terms include lease costs, security, nature of facilities provided, duration of agreement and time restrictions on joint use. For example, the U.S. Army permits weekend summertime use of only a portion of the Fort Story beach and may close the beach to avoid potential conflict with training activities. Agreements with the private sector have provided for public use only during special events. Lease costs are generally minimal. Obviously any agreement must be "tailored" to the specific circumstances.

The use of cooperative agreements may enable the locality to meet additional recreational needs in a cost-effective manner. This is especially true for shoreline access facilities which are not capital intensive. They may enhance community goodwill toward major shoreline landowners. Unfortunately, the cooperative agreement approach may require protracted negotiations with landowners. Time restrictions on joint use and short durations due to planned development will tend to preclude this approach from being a long-term solution, on a site-specific basis, to the community's recreation needs.

The Siting and Design of Water Access Facilities and Water-Enhanced Recreation Areas to Reduce Potentially Adverse Impacts to the Shoreline and Nearshore Marine Environment

Water-dependent recreational activities fall into two categories. The first category contains those activities that are dependent on boat access points (marinas and other community facilities for boat mooring, ramps and canoe put-in/take-outs), including boat fishing, power boating, waterskiing, sailing and canoeing. The second category contains those activities that depend on access to and use of the shoreline, and includes beach swimming, surfing and shore fishing. This category also includes passive activities which might not require, but are generally enhanced by shoreline access, such as sunbathing, wildlife observation, environmental education, sight-seeing and picnicing; these are also referred to as "water-enhanced recreation activities."

All of these activities have the potential to impact or be impacted by the surrounding environment. Any alteration to or change in the physiographic features of the shoreline and surrounding waterways to accommodate these activities may also result in public detriment due to a loss of natural resource values, such as marine and wildlife habitat and aesthetic quality. Many of the potential problems associated with such changes are addressed through federal, state and local regulatory procedures, while other non-regulated issues can be resolved through careful siting and design.

The purpose of this section is to discuss the potentially adverse impacts to natural shoreline features and the nearshore marine environment and water quality associated with the development of water access facilties or water-enhanced recreation areas in order to meet public demands for increased recreational opportunities. While regulatory agencies such as the Army Corps of Engineers (Corps) and the Virginia Marine Resources Commission (VMRC) are ultimately responsible for reviewing water-dependent facilities and issuing use permits, it would benefit local planners, wetlands boards and project developers to become familiar with these potential impacts before projects are first submitted and reviewed at the local level. It is also important to become familiar with the review criteria and guidelines for the siting and design of these facilities that these agencies use when issuing permits. Therefore, this section also provides an overview of the existing regulations governing water-access facility development, along with the criteria and guidelines used by the Corps, VMRC and other state regulatory agencies. Some additional siting and design criteria are also proposed.

This section is divided into separate discussions for boat access facilities (marinas, boat ramps and canoe put-in/take-out points) and shoreline pedestrian access areas (beachfront, fishing areas and other shoreline recreation areas).

A. Boat Access Facilities

1. Marinas and Community Facilities for Boat Mooring

a) General

For the purposes of standardization, the definition of marinas and community facilities for boat mooring found in the Virginia Marine Resources (VMRC) Regulation VR 450-01-0047 entitled, "Criteria for the Siting of Marinas or Community Facilities for Boat Mooring," is used here. This definition states that:

> Marina means any installation operating under public or private ownership, which provides dockage or moorage for boats (exclusive of paddle or row boats) and provides, through sale, rental or fee basis, any equipment, supply or service (fuel, electricity or water) for the convenience of the public or its leasee, renters or users of its facilities. Other places where boats are moored means any installation operating under public or private ownership which provides dockage, moorage or mooring for boats (exclusive of paddle or row boats) either on a free rental or fee basis or for the convenience of the public.

For the purposes of this discussion, "other places where boats are moored" and "community facility for boat mooring" are interchangable.

Although generally privately-managed, marinas provide public social benefits, such as major access points to recreational waters and focal points for the development of restaurants, shops, and residential communities (NCDEHNR(a), 1990: 1). Marinas also provide an economic asset to local communities through employment and tax revenues. Another positive feature of marinas and community facilities is that they provide for the concentration of boating activities, storage, and access, as opposed to many scattered private piers and docks along a shoreline (Chmura and Ross, 1978: 3,4).

On the other hand, because of the severe and complex potential adverse impacts to the sensitive coastal environment associated with their improper siting and design, marinas and other places where boats are moored have been the subjects of a vast amount of water quality literature moreso than any other type of water access facility. Their construction and operation also have the potential for severe environmental impacts. These impacts can include loss of upland, wetland or benthic habitat due to dredging or filling activities, decline in water quality due to increased stormwater runoff, discharges from boats or bottom paint dissolution, and degradation of aesthetic values (SVPDC(a), 1988: 44). In addition, automatic shellfish closures may result and the character of the waterbody can be permanently changed (VMRC(a): 3).

While each of these variables is discussed in more detail futher in this section as they are affected by siting, design and construction, the general impacts associated with this type of shoreline development can be categorized into habitat loss, basin and near shore water quality impacts, and aesthetic (visual) pollution (Chmura and Ross, 1978: 4).

Habitat Loss:

To provide protection for its facilities and safe moorings for boats, most marinas are located on calm, sheltered shorelines. At one time, tidal marshes were preferred sites for marinas because they exist on sheltered shorelines and were regarded as wastelands. People now recognize that tidal marshes are important marine ecosystems which provide valuable wildlife habitat and nursery grounds for many species. If a tidal marsh is removed or covered over to make room for a marina, this important marine habitat is lost. Loss of marsh vegetation production can be estimated, but adequately estimating the loss of values associated with marsh communities is nearly impossible. Once altered, natural habitat cannot be returned to its original condition. A marina can, however, provide an artificial habitat with its own unique environment (Chmura and Ross, 1978: 4).

Water Quality Impacts:

Many studies have shown that marinas can have undesirable effects on water quality. Several parameters used to measure water quality conditions can be significantly affected by pollution sources associated with marinas and other boat mooring facilities. They include turbidity, dissolved oxygen (DO), nutrients, bacteria, metals, and hydrocarbons. Of these, the key parameter of concern is DO. DO is important because aquatic organisms need it to exist and because oxygen conditions affect water chemistry. Anaerobic conditions (anoxia) are undesirable, because they increase the toxicity of some compounds. Anoxia also enhances the release of nutrients and some heavy metals from sediments. DO concentrations in marinas respond to inputs of oxygen-demanding substances from boat discharges, stormwater runoff and other nonpoint sources, and entrained sediments (NCDEHNR(a), 1990: 11).

The introduction of nonpoint source pollutants into marina basins and surrounding nearshore waters via stormwater runoff is a particular problem. The construction of land-based marina facilities may necessitate the removal of natural vegetative cover and its replacement with impervious surfaces such as building rooftops, pavement and parking lots, which reduces available area for stormwater infiltration and causes increased surface runoff. This runoff can carry a variety of nonpoint source pollutants, including sediment, pesticides, oil and other road dirt, and heavy metals and nutrients, which are all capable of degrading water quality (Chmura and Ross, 1978: 4).

While water quality impacts associated with marina facilities have been well-documented and are discussed in more detail in the next section, the types and extent of such impacts are not well-documented across the range of marina locations, designs and operating procedures. The State of North Carolina has attempted to address this information gap in recent studies. Findings and recommendations from these studies, which should be taken into consideration by project reviewers and local wetlands boards, are also presented in the next subsection.

In addition, in order to better plan for the future development of shoreline areas, project reviewers need a good existing water quality database and effective planning tools to assist in evaluating the actual effects that all aspects of a proposed marina or other place where boats are moored can have on water quality (Chmura and Ross, 1978: 4). While the Commonwealth of Virginia is required to provide a detailed summary of existing surface water quality conditions to EPA and Congress every two years under the federal Clean Water Act 305(b) program, this data is provided at a scale and in a manner that does not allow for site specific analysis when used by local government planners, wetlands boards, and state and federal permitting agencies to review existing water quality conditions and assess potential impairments to water quality associated with marina facility proposals.

Aesthetics:

The coastal zone is regarded as a valuable aesthetic resource. The presence of a marina may change the shoreline's aesthetic value by introducing sights, sounds, and smells foreign to the natural environment. Poorly maintained marinas may further degrade aesthetic values. Both aesthetic considerations and alterations to the aesthetic environment are difficult to quantify. However, it may be assumed that a marina situated on a pristine shoreline will have a negative effect on aesthetic value, while one placed on a developed or urban waterfront may actually improve the appearance and environmental quality of that shoreline area (Chmura and Ross, 1978: 5).

In conclusion, the significance of these various impacts will not be the same for every marina or other type of facility where boats are moored. The extent of adverse impacts to natural shoreline features and the nearshore marine environment associated with marina facilities is a function of many interrelated, project-specific variables. They include the degree of dredging and filling activities, existing hydrologic conditions (e.g., flushing rates, basin and ambient (adjacent) water depths, and wave heights), site orientation, existing water quality, upland soil conditions and shoreline features, the presence of sensitive plant and animal communities, the size and design of a marina, the types of services offered, the cumulative environmental impacts of other shoreline uses, and the existing uses and navigation patterns of the adjacent waterbody (SVPDC(a), 1988: 44). The following discussion takes a closer look at these variables and at the overall impacts to water quality that can result from improper siting, design, construction and operation practices.

b) Summary of Marina and Boating Activities Which Can Result in Water Quality, Ecological and Other Potentially-Adverse Environmental Impacts

For baseline information on potentially adverse water quality impacts that may result from improper marina siting, design, construction, operation and maintenance practices, as well as from various activities associated with recreational boating, the U.S. Environmental Protection Agency (EPA) provides an excellent resource with its 1985 Coastal Marinas Assessment Handbook. It is strongly recommended that this handbook be consulted during initial review of marina facility proposals. Table __, reprinted from the handbook, demonstrates clearly that the effect of a marina on surrounding water quality is determined by many factors.

A 1990 report based on a study conducted by the North Carolina Department of Environment, Health and Natural Resources, Division of Environmental Management also provides an excellent assessment of the water quality of selected coastal marinas. As part of that study, however, methodologies were also developed for evaluating the water quality impacts of various types of marina proposals which can be useful to marina project plan reviewers in Hampton Roads. Much of the discussion on siting and design considerations that follows later has been extracted from that report.
Based on a review of available literature, the primary sources of pollution in and around marina facilities and the various activities activities associated with recreational boating that have the potential to degrade water quality can be narrowed to include dredging, sanitary waste discharges, nonpoint source pollution runoff, and boat operation, marina use and maintenance activities (NCDEHNR(a), 1990: 1,3; Chmura and Ross, 1978; Miliken and Lee, 1990).

Dredging:

The waters of many marinas are not deep enough to accommodate all recreational craft, and sites are often dredged during their initial construction. The most common dredging practices in marinas, however, are "spot" and maintenance dredging to remove sediments from small problem areas in boat channels or near docks (Chmura and Ross, 1978: 6).

A wealth of literature has been published regarding the effects of dredging and dredge material disposal on water quality, but most of these studies are concerned with the dredging of rivers and large boat harbors, rather than small, recreationally-oriented marinas. For this reason, the specific effects of marina-related dredging are difficult to define and often misrepresented (Chmura and Ross, 1978: 6).

In general, what is known is that dredging during marina construction and subsequent maintenance resuspends sediment, resulting in increased turbidity and the release of pollutants such as bacteria and viruses, heavy metals, hydrocarbons, oil and grease, hydrogen sulfide, methane, organic acids, and nutrients. Marina sediments also contain oxygen-demanding substances, and dredging often results in temporary DO reductions in the water column (NCDEHNR(a), 1990: 1,3). Dredging may also alter marina and ambient waters by disrupting and removing bottom habitat and causing the buildup of sediments and subsequent burial of benthic or bottom-dwelling organisms where dredge spoils are deposited, as well as creating stagnant deepwater areas and altering water circulation patterns (Chmura and Ross, 1978: 7).

ENVIRONMENTAL IMPACT CONSIDERATIONS

Water Quality — Ecological — Other

Impact Source Considerations	Turbidity	Dissolved Oxygen	Nutrients	Bacteriological	Metals	Hydrocarbons	Toxic Substances	Other Pollutants	Erosion	Hydrological	Endangered Species	Birds/Rookeries	Benthos	Shellfish	Other Aquatic Organisms	Grassbeds	Wetlands	Nursery Areas	Terrestrial Habitats	Aesthetics	Historical/Archaeological	Navigation	Marine Resources	Local Economy	Local Land Use	Public Access
Marina Location										S	S	S		S		S	S	S	S	S	S	S	S	S	S	S
Marina Size & Services																							S	S	S	S
Dredging	S	S	S		S	S	S	S		S	S		S	S	S	S	S	S								
Spoil Disposal	S	S			S	S					S	S	S	S	S	S	S	S	S	S						
Filling	S	S	S					S		S	S	S	S	S	S	S	S	S	S	S						
Grading & Clearing	C		C						C			C							C	C						
Hydrological Modification	D	D	D	D	D	D	D	D		D							D					D				
Structures									D	D				D			D	D	D			D				
Point Wastewater Discharge	D	D	D	D	D						D		D	D						D						
Non-point Source Runoff	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D						
Boat Operation	E								E		E			E		E	E	E		E						
Boat Discharges		E	E	E										E						E						
Spills						O						O	O	O	O			O		O						
Boat Maintenance			E			O	O	O						O												
Litter											E	.								E						
Noise												O								O						

Primary Environmental Solutions

S = Environmentally Sound Marina Site Selection
D = Design of Marina with Environmental Considerations
C = Environmentally Guided Marina Construction Techniques
O = Proper Operation and Maintenance of Marina Systems and Boats
E = Enforcement of Rules and Regulations and Education of Marina Users in the Environmental Impacts or Their Actions

Figure 1-1. Environmental impacts, sources and primary solutions.

Therefore, both the act of dredging and the disposal of dredge spoils may adversely affect the marine environment. The severity of this effect is not always the same and is dependent upon the dredging method used and the characterisitics of the bottom sediment and its inhabitants (Chmura and Ross, 1978: 7). The following discussion presents research findings on the relationships between dredging activities and impacts on the marine environment (Chmura and Ross, 1978: 7,8):

i) Turbidity

Most investigators conclude that the temporary increase in the turbidity of nearshore waters attributed to dredging activities does not represent a significant impact on the marine environment. This conclusion is probably made in part because increases in turbidity generally occur in localized areas which can be avoided by pelagic (oceanic) species, and periodic, high levels of turbidity are natural in estuarine systems.

ii) Temporary Reduction of Oxygen Content

One study found that during the dredging of a tidal waterway, the oxygen content was reduced to levels ranging between 16% and 33% below normal. It was proposed that this reduction was due to the oxidation of resuspended sediments and a decrease in the amount of light available for oxygen-producing photosynthesis by local flora.

iii) Burial of Organisms

Some burrowing organisms may withstand burial by up to 21 cm of sediment when dredge spoils are deposited within the waterway, but those benthic species which are sessile (permanently attached to the substrate, e.g., oysters) may be easily killed by such burial.

iv) Disruption and Removal of Botttom Sediments and Change in Benthic Community Characteristics

Studies of bottom communities within a boat harbor in Southern California for three years after its construction, which included initial dredging of adjacent upland areas, found that within one year, the soft, gray, clay bottom had been coloznied by communities similar to those existing in other portions of the same waterbody. Some marine biologists have noted the possibility that, in an estuary subject to repeated dredging, bottom communities may become modified into a relatively resistant community. A study of dredging in the Atlantic Intracoastal Waterway in Georgia supports this, where in a muddy bottom area, the benthic community was completely removed by hydraulic dredging. However, little change in the sediment composition occurred and, within two months, the dredged area supported a benthic community similar to the original.

v) Creation of Stagnant Water Conditions

There is a possiblity for water stagnation in marinas with dead-end, finger or Venetian canals. This type of marina development is common in the Southeastern U.S..

vi) General Water Quality

A study of the effect of dredging in a tidal salt marsh estuarine environment of the Atlantic Intracoastal Coastal Waterway which analyzed DO, chemical and BOD, pH, suspended sediment concentration, mercury, iron, and phosphate in the water from the surrounding area before, during, and after dredging indicated that there was no significant change in water quality attributable to the dredging (Chmura and Ross, 1978: 8).

vii) Dredge Spoil Disposal

The effects of dredge spoils disposal on the environment is relative to the nature of the sediments (whether or not they contain toxic substances) and the selection of the dump site. When open-water sites are selected, the benthic habitat may be drastically altered and large volumes of sediment may be resuspended in the water column. Disposal in wetlands can destroy these valuable habitats, and disposal on upland areas may cause pollution of groundwater depening on the nature of the sediments, as well as alter topographic features and upland vegetation to the detriment of native wildlife.

A study of the diffusion of heavy metals into water from polluted and unpolluted dredge spoils revealed that reduced iron (which is soluble) was oxidized to iron hydroxide (insoluble) in suspended sediments during dredging. The presence of hydroxide encouraged the precipitation of heavy metals out of solution and allowed them to concentrate in sediments deposited on a salt marsh. As conditions favoring a reduction reaction again increased, the trapped metals became soluble and were released into overlying waters. On the basis of this and other phases of that study, the following conclusions were drawn:

- In natural and relatively unpolluted areas dredging has no significant effect on water quality whether diked or undiked (dredge spoil) confinement techniques are used.

- In polluted marine areas, the water quality impairment caused by dredging does not necessarily bear any simple relation to the composition of the sediments to be dredged.

- The length of time which water mixed with other dredge spoil is allowed to stay in the spoil area will greatly influence the quality of the effluent from the spoil bank.

- The dredging of polluted sediments does not necessarily impair water quality in estuarine environments.

In point of fact, dredging does not always have adverse impacts. It may help to improve circulation in choked inlets, increase the availability of food to fish and shellfish, and help to flush and dilute polluted waters. Dredge spoils are sometimes suitable as sand and gravel for construction or for use in creating artificial habitat. Dredge materials have successfully been used to build salt marshes and to create islands suitable for colonization by important bird species (Chmura and Ross, 1978: 9).

In conclusion, marina designers may reduce or eliminate the need for and cost of dredging by good planning. For example, slips for boats of deep draft should be built in the naturally deeper waters of the marina, and piers and docks should be extended as far as possible into deep water, without posing a hazard to navigation routes, to minimize the need for dredging around them. If maintenance dredging is expected, the plans must include a choice of sites for the drying and disposal of dredge spoil. The spoil may be spread on the surface of parking lots or storage areas, or even used to recreate marsh communities, along or adjacent to the marina shoreline. When dredging must be done, it should be planned to prevent dead-end channels or finger canals and restricted inlets. Flushing should be encouraged by increasing the width and depth of the marina channels or canals out into navigable waters, but not deeper than the main channel (Chmura and Ross, 1978: 9).

In addition, bottom community and sediment charactéristics should be taken into account and dredging activities timed so as not to conflict with critical periods in the life cycles of important animal species. Special consideration should be given to the reproductive cycle of any commercially- and recreationally-important finfish and shellfish within the proposed area. Proper timing can also help to reduce the impact of oxygen reduction by dredging in colder months, when oxygen concentrations are not critical (Chmura and Ross, 1978: 9). Refer to the seasonal Chesapeake Bay Environmentally-Sensitive Area maps attached to this report to identify critical finfish and shellfish habitats and anadromous finfish spawning and nursery areas.

Most reports which discuss the effects of dredging generally stress the need for more research before accurate predictions can be made regarding the effects of dredging at a specific site. It must be emphasized, therefore, that the impact of dredging on coastal and estuarine environments is site-specific. This means that the results of studies in one area may be quite different from those in another. Therefore, conclusions drawn from studies of the effects of dredging on a given coastal or estuarine area cannot be applied to predict the effects in another without a degree of uncertainty (Chmura and Ross, 1978: 9).

Sanitary Waste Discharges:

Sanitary waste can enter marinas from shoreside facilities and boat discharges. Sewage inputs would be expected to increase bacteria, biological oxygen demand (BOD) and nutrients, and to lower DO in marinas (NCDEHNR(a), 1990: 3). Concerns regarding the high potential for fecal contamination from boat discharges were the impetus behind the Virginia Department of Health's (VDH) policy for establishing shellfish buffer zones around marinas and automatic closure of shellfish areas surrounding marinas. This is discussed later in this section as it relates to regulatory requirements and also in the section on sensitive aquatic resources (shellfish).

The federal Clean Water Act requires recreational boats to be equipped with approved Type III marine sanitation devices (holding tanks) or portable toilets for sewage, because the discharge of untreated sewage by boaters is prohibited under federal law in all areas within the navigable waters of the U.S. Despite these federal laws, and even though Virginia law requires all new marinas to have on-site sanitary facilities, dockside pump-out facilities and sewage dump stations, boaters still discharge treated waste legally and untreated waste illegally into coastal waters. The discharge of these sanitary wastes from boats may impact water quality by locally increasing biological oxygen demand (BOD) and by introducting microbial pathogens into the environment (Miliken and Lee, 1990: 1).

i) BOD

BOD is a measure of the dissolved oxygen (DO) required to decompose the organic matter in the water by aerobic processes. When the loading of organic matter increases, the BOD increases, and there is a subsequent reduction in the DO available for respiration by aquatic organisms. Although the volume of wastewater discharged from recreational boats is small, the organics in this wastewater are concentrated, and therefore the BOD is much higher than that of raw or even treated municipal sewage. Sewage discharged from recreational boats will, thus, increase the BOD in the vicinty of the boats. When this occurs in poorly flushed waterbodies, the DO concentrations of the water may decrease. In temperate regions, such as Hampton Roads, the effect of boat sewage on DO levels is exacerbated because the peak of the boating season coincides with the highest water temperatures and, thus, the lowest solubilities of oxygen in seawater and the highest rates of metabolism of marine organisms (Miliken and Lee, 1990: 1).

For any given waterbody, it is possible to predict the impact of BOD loading by boats by estimating the amount of BOD discharged from recreational boats into the water, the volume of the waterbody, the flushing rate, and the ambient DO. The estimated boat BOD loading can then be combined with sediment oxygen demand (SOD) to provide an esimate of the total oxygen depletion in the waterbody (Miliken and Lee, 1990: 1). An example of an equation used to determine an oxygen mass balance over one tidal cycle is provided in EPA's Coastal Marinas Assessment Handbook.

ii) Pathogens

A potentially serious problem resulting from the discharge of sewage from recreational boats is the introduction of disease-carrying microorganisms from fecal matter into the coastal environment. Humans are put at risk either by swimming in polluted waters or by eating shellfih (raw or partially cooked) taken from polluted waters. The major disease-carrying agents are bacteria and viruses, and the most common serious ailment is acute gastroenteritis. Other water-borne diseases that can be attributed to sewage pollution include hepatitis, typhoid, and cholera (Miliken and Lee, 1990: 1).

While there have been no studies which directly link the discharge of boat sewage to disease incidence, numerous studies have found elevated levels of fecal coliform bacteria where there are concentrations of recreational boats. Studies have shown, however, that coliform levels increase in the water column and in shellfish in direct relation to the number of boats in an area. To compensate for this potential problem, the Virginia Department of Health automatically closes waters to shellfish harvesting within a certain radius of a marina or other boat mooring facility depending on the number of slips at the facility. This is discussed in more detail later in the section on regulatory requirements.

Based on similar information and related studies, Congress recently determined that there is currently an inadequate number of pumpout stations and waste reception facilities (dump stations) for boaters to properly dispose of their sewage. Therefore, an interim rule was passed by Congress in July 1993 under the Clean Vessel Act Program to provide funds to states for the construction, renovation, operation, and maintenance of pumpout and dump stations to improve water quality. Section 5604 of the Act authorizes the U.S. Fish and Wildlife Service to make grants to coastal states for conducting surveys of the status of existing facilities and need for additional facilities, and developing plans for the provision of facilities; and to all states for constructing/renovating pumpout and dump stations and for implementing associated education programs (Vol. 58, No. 129, Federal Register, 36619, July 8, 1993).

Nonpoint Source Runoff

As mentioned previously, upland areas and natural vegetation is usually replaced with impervious surfaces during marina construction. This allows for an increase in stormwater runoff which carries nonpoint source pollutants into marina basins and coastal waters. These nonpoint source pollutants can include sediment, bacteria, oil and grease, heavy metals, nutrients, detergents, and pesticides. Stormwater runoff also tends to transport oxygen-demanding substances into receiving waters, resulting in reduced DO. With proper design, nonpoint source pollutants in runoff reaching marinas can be minimized (NCDEHNR(a), 1990: 3).

Retaining as much marshland as possible along the water margin of a marina will provide a natural buffer to stormwater runoff and prevent the release of untreated runoff directly into marina and coastal waters. A 1976 NOAA report, "Coastal Facility Guidelines" suggests the following:

- o drainage systems should be designed to regulate the release of water back into the environment;
- o stormdrain outfall sites should be chosen so that effluents return into well-flushed waters such as the mouth of a marina or adjacent open coastal water; and
- o the volume of water entering storm drains should be reduced by minimizing the amount of impervious cover at the site.

Acceptable alternatives to impervious cover are crushed stones or shells. If a marina is designed with as much porous land surface and vegetative cover as possible, stormwater runoff and its impact may be significantly reduced.

A well-landscaped and well-kept marina is also an important consideration for enhancing or maintaining the aesthetic quality of the area. Ill-kept marinas may discourage business and create safety hazards, making poor economic sense for the marina operator. Investments in attractive, low-input, native vegetation can be returned several times over in good will and sales income. Therefore, both the marina operator and plan reviewers should be concerned with pride, planning and maintenance of marinas. A good reference which discusses landscaping in marinas is Marinas: A Working Guide to Their Development and Design by Donald Adie.

Boat Operation and Marina Use

i) Boat Operation

Water quality degradation from boating activities is generally localized and makes a relatively small contribution to the overall pollutant loads entering coastal waters. However, marinas are often located near environmentally-sensitive areas, increasing the likelihood that boating activities could introduce nonpoint source pollutants to these areas (NCDEHNR(a), 1990: 3). Nonpoint source pollutants from boat operation include exhaust and unburned fuel, engine lubricants, and lead. Hydrocarbons can also be released in exhaust and bilge water.

Pollution associated with boat engines and their exhaust is a primary concern. Reports on boat engine pollution have focused on the effects of two-cycle outboard engines. Because two-cycle engines accomplish fuel intake and exhaust in the same cycle, they tend to release unburned fuel along with the exhaust gases. Older engines, manufactured prior to about 1972, drain excess fuel from the crankcase directly into the water while newer engines have scavenger devices to recycle this lost fuel. Two-cycle engines also have lubricant oil mixed in with the fuel, and this oil is released into the water along with the unburned fuel. There are over 100 hydrocarbon compounds in gasoline, as well as additives such as lead, while lubricant oils contain elements such as zinc, sulfur, and phosphorus (Miliken and Lee, 1990: 5).

The most obvious effects of pollutants from marine engines include odor, an off taste in fish, and toxic effects on marine organisms. Estimates vary as to the exact thresholds of these effects. Outboard motor exhaust water in high concentrations can exhibit toxic effects on various species of fish and wildlife. The nature and degree of these effects varies by species. For example, the lighter, more refined petroleum products, such as diesel oil, are taken up more quickly by shellfish than are the heavy, more viscous refined products. Other studies have found that gill tissue damage in mussels occurred more quickly than in oysters because the oysters were able to close their shells and exclude hydrocarbons while the mussels were not able to do so (Miliken and Lee, 1990: 5; Chmura and Ross, 1978: 19).

Although normal levels of outboard motor usage have not been shown to have a toxic effect on aquatic communities, toxic effects have been demonstrated from sustained low concentrations of petroleum in estuaries. Table 2 indicates the concentrations of hydrocarbons considered toxic to various types of marine organisms. Concentrations in excess of these toxic levels occur in the water column and sediment in many urbanized estuaries, and elevated hydrocarbon levels also occur in marina sediments. Petroleum hydrocarbon pollution from boats may thus contribute to already toxic concentrations of hydrocarbons in the water column and sediment and increase long-term effects. However, researchers have discovered that in one boating harbor, concentrations of aromatic hydrocarbons, probably from petroleum fuels, actually decreased during the boating season. It was suggested that these hydrocarbons might be removed from the water by evaporation, or possibly degraded biologically or photochemically during the summer (Miliken and Lee, 1990: 5,6; Chmura and Ross, 1978: 19,20).

Little can be done to reduce the impact of boat motor emission other than reducing boating pressure. Results of boat motor exhaust studies suggest that threshold guidelines cannot be generalized, and any management of motorboat use must consider each waterway individually by reviewing the use and characteristics of each sytsem (Miliken and Lee, 1990: 5).

Another source of pollution associated with boating activity is petroleum from the discharge of oily bilge water. Once discharged into the water, petroleum hydrocarbons may concentrate at the surface, remain suspended in the water column, or settle to the bottom. Many of these hydrocarbon compounds will not persist for very long because of their immiscibility, volatility, or biodegradability, or because of the effects of weathering. However, petroleum and particularly lead components from gasoline additives that sink reach the bottom sediments may persist for several years (Miliken and Lee, 1990: 5).

ii) Marina Activities

Marinas often provide fuel docks as one of their boater services. Fuel docks may also be a source of pollution through small but numerous spills of gas and diesel fuel. Oil spills can be minimized by equipping fuel pumps with back-pressure, automatic-shutoff nozzles, which prevent fuel overflow. Constant maintenance of pumps, hoses and other fueling equipment by careful fuel attendants will also help reduce spills. Similarly, sloppy maintenance practices may also contribute to the pollution of marina waters. For example, when docks and other shoreline structures are painted, care should be taken to keep paint from dripping into the water. Spray painting, in particular, should be avoided where it may come in contact with marina waters and become toxic to marine organisms (Chmura and Ross, 1978: 14).

As marinas are the center of boat-related activities, they are also centers of the noise and disturbance associated with these activities. Boat engines contribute to noise, but this disturbance is limited to brief periods when boats leave or enter the marina. Another noise typically associated with marinas is the incessant clang of sailboat rigging which can be remedied with tie-downs. Noise levels from outboard motors can reach not high, but annoying

Table 3. *Estimated Toxic Concentrations of Soluble Aromatic Fractions of Petroleum Hydrocarbons for Marine Organisms*[a]

Class of organisms	Toxic concentration (ppm)
Larvae (all species)	0.1 – 1.0
Swimming crustaceans	1 – 10
Bottom-dwelling crustaceans	1 – 10
Other bottom-dwelling organisms (worms, etc.)	1 – 10
Snails	1 – 100
Finfish	5 – 50
Bivalves	5 – 50
Flora	10 – 100

[a]United Nations, 1982.

Source: U.S. Environmental Protection Agency. 1985. Coastal Marinas Assessment Handbook. Region IV EPA, Atlanta, Georgia.

levels. Since sound travels easily across the water, marina operators should show consideration for neighbors as well as customers by posting and enforcing rules against unecessary noise (Chmura and Ross, 1978: 14).

Boat Maintenance Activities

Regular and seasonal maintenance of boats involves washing, draining bilge water, sanding and painting, and engine and hull repairs. All of these activities may have minor, but potentially adverse, effects on the marine environment.

i) Washing

The amount of detergent introduced into marina waters when washing boats may be small, but it can cause increased nutrient levels and eventually cause a decrease in DO concentrations. Reductions in nutrient loads to marina and nearshore waters can be minimized if phosphorous-free detergents are used. In addition, washing of boats should occur, when possible, on land where runoff is directed into a sanitary sewer system rather than to a stormdrain which discharges directly and without pre-treatment into the marina basin.

ii) Draining Bilge Water

Individual boat owners can reduce the amount of petroleum pollutants introduced into the marina when emptying bilge water. In fact, EPA and Coast Guard regulations prohibit the discharge of any oil or oily waste that causes a visible film or sheen on the surface of the water. This form of oil pollution can be controlled by the use of oil filtration devices on boat bilge pumps, or devices such as oil-absorbent pads placed in the bilge to soak up fuel and oil before bilge water is discharged. Though pollution by visible oil may be controlled, some petroleum compounds may be dissolved in bilge water and transferred unnoticed to the marine environment.

iii) Painting and Hull Repairs

Antifouling paints are used on boat hulls to prevent fouling by marine organisms. Active ingredients in these paints may also have toxic effects on non-target organisms. Copper and organotin compounds are the most common active ingredients in antifouling paints. Other toxic compounds, such as mercury, arsenic, and polychlorinated biphenols (PCBs), are no longer approved for use due to their toxicity (Miliken and Lee, 1990: 6).

Elevated copper concentrations have been found in the marine environment in the vicinty of shipyards where hull scraping and painting occur. Scientists have considered the risk from the metals to be minimal, however, while vessels are at sea due to the high dilution capacity of the ocean (Miliken and Lee, 1990: 6).

Tributylins (TBTs) are a class of organic tins that have been used recently as the biocides in antifouling paints. There are two classes of TBT paints: conventional (also called free association), which leach continously from the painted surface, and copolymer, which are released at a controlled, slower rate. Due to the rapid leaching of TBT from boat hulls into the water, elevated levels of TBT and its breakdown products have been found in the water, in sediment, and in organisms where there are concentrations of recreational boats. Recreational boats were the main users of TBT paints until use of TBT was recently regulated (see below). A 1987 survey found that 97% of TBT use was on boats of 65 feet or less and 93% of this use was on recreational boats (Miliken and Lee, 1990: 6).

Unlike copper, TBT degrades quickly in seawater. TBT is removed from the water column by adsorption to lipids and particulate matter, metabolism by plants and animals, and photolysis. Within the water column, the primary means of degradation in the presence of light appears to be debutylation by planktonic algae, especially diatoms, while in the absense of light degradation is primarily by bacteria. Due to its lipophilic (fatty/waxy) properties, TBT tends to concentrate in the surface microlayer, where it has been found at up to 27 times subsurface concentrations. Once TBT adsorbs to particulates and sinks into the sediment, it tends to concentrate and degrade slowly (Miliken and Lee, 1990: 6,7).

TBT has been reported to cause acute and chronic toxicity in marine organisms, especially bivalves and small crustaceans such as copepod zooplankton. Significant declines in oyster and clam populations occurred in areas where there were concentrations of boats using TBT paints, and these populations recovered quickly after TBT was banned. Bivalves are especially susceptible because of their limited ability to metabolize the compound and because they are found in nearly anoxic sediments that lack the bacteria necessary to degrade TBT. Sublethal effects have also been noted for a variety of fish species (Miliken and Lee, 1990: 7).

High levels of bioaccumulation of TBT have also been reported. Bacteria and phytoplankton bioaccumulate TBT at concentrations of 600 to 30,000 times the exposure concentration, while bioaccumulations levels as high as 4,000 times have been reported for bivalves. Despite the high bioaccumulation rate by shellfish, however, there are no indications that human consumption of shellfish contaminated with TBT is of concern (Miliken and Lee, 1990: 7).

The use of TBT antifouling paints is now restricted in the United States by the Organotin Antifouling Paint Control Act of 1988. This act bans the use of organotin paints on all boats of less than 25 meters, except for those with aluminum hulls, and limits the use of anitfouling paints on other vessels to those paints that are certified by EPA as releasing less than 4 micrograms per square centimeter per day into the water. In 1990, at least 13 states had also enacted their own legislation regulating the use of TBT paints (Miliken and Lee, 1990: 7). The Commonwealth of Virginia has adopted the above-stated federal legislation.

c) **Siting, Design and Construction Considerations to Minimize Impacts to the Shoreline and Nearshore Marine Environment**

This section provides marina siting and design guidelines and other recommendations that can be used project developers, plan reviewers and wetlands boards to help minimize the potential for negative impacts to the marine environment and water quality as discussed above.

~~General Siting and Design Considerations~~

Initial site selection is very important. From a water quality perspective, desirable site features include favorable hydrographic characteristics, access to dredge spoil sites and access to public waste disposal systems.

i) Siting

When building a new marina or expanding an old one, the optimal choice of a location would be a protected area of shoreline that does not include tidal marsh areas. This option is often not available, however. Guidelines for marina development in a marsh environment include (Chmura and Ross, 1978: 5):

- using dredge spoil from the marsh to establish new productive marshes elsewhere;
- providing adequate flushing to promote water circulation, which cycles nutrients and prevents eutrophication;
- providing contact areas within the marina so fouling communities, an organic food source, can prosper and multiply; and,
- controlling water quality so that estuarine species can thrive in the marina.

Fouling communities may actually complement neighboring salt marsh systems by serving as an important food supplement for juvenile and adult finish, particularly at seasons when marsh nutrient export is lowest. It has been suggested that although fouling communities in marinas contribute to biological production, they may not adequately replace other valuable components of tidal marsh ecosystems. It is also felt that mammal and waterfowl populations would rest in, or make extensive use of, marinas. Some wildlife species, such as mallard ducks, which have adapted to human presence, may be able to utilize marina areas. In order to maintain fish and wildlife habitat, as much marsh area as possible should be retained at the marina site (Chmura and Ross, 1978: 5).

add Figure X

ii) Design

Marina design is another important factor. Marina size, shape, depth, and orientation influence water circulation, and hence the fate of pollutants.

Areas with favorable hydrologic features require minimal modification. In general, modification of an area's natural flushing characteristics increases the potential for water quality impacts. Flushing has been shown to have a major influence on marina water quality, because flushing disperses pollutants and reaerates the water column. Marinas with better natural flushing ability tend to have fewer water quality problems; therefore, sites with high tidal amplitude or flow and high flushing rates are preferred (NCDEHNR(a), 1990: 3).

EPA's Coastal Marina Assessment Handbook states that precise information on flushing and circulation usually is not readily available during the marina site selection and design process. However, methods exist for providing estimates of expected flushing capability (EPA(b), 1985: 4-3).

The method chosen to estimate expected flushing from a marina site depends upon the hydrographic characteristics of the siting location. Marinas anticipated to be located within a confined area with one or two relatively narrow openings would have flushing characteristics considerably different from marinas located directly on larger estuaries or bays or along river shorelines. Two openings may improve flushing in semi-enclosed marina basins. Two lock-controlled marinas on Hilton Head, SC use inlet and outlet wiers and pipes located at opposite ends of the marina to flush the basin by natural tidal forces. Other methods that may be used to enhance circulation and reduce the potential for buildup of pollutants include tide gates or one-way valves, creating a tidal prism and entrance channel design. Where possible, however, flushing should be accomplished through basin design without the assistance of mechanical devices because they may be costly and will require maintenance (EPA(b), 1985: 5-8).

Open marinas located on existing channels will generally have the same flushing rate as the channel. Semi-enclosed marinas or marinas with dredged basins should be designed to maximize tidal exchange and mixing within the marina.

A classification system based on "segments" was developed by North Carolina in its aforementioned study to distinguish between different marina configurations (Figure 1). "One-segment" refers to a marina whose long axis is parallel to the shoreline. "Two-segment" marinas consist of distinct basin and channel segments. A marina whose longest dimension is perpendicular to the shoreline, such as a finger canal, is considered to contain two or more segments depending on the length to width ratio (Figure 2) (NCDEHNR(a), 1990: 3,4).

Flushing efficiency is inversely proportional to the number of segments. For example, one-segment marinas should not flush as well as marinas in open water. Two-segment marinas should not flush as well as one-segment designs. For two-segment marinas, design and placement of the entrance channel also affects water circulation (Figure 3) Wide channels are recommended over narrow ones, as are channels whose depth increases away from the basin toward the adjacent waterway. Structural elements such as bulkheads and breakwaters can significantly alter siltation and

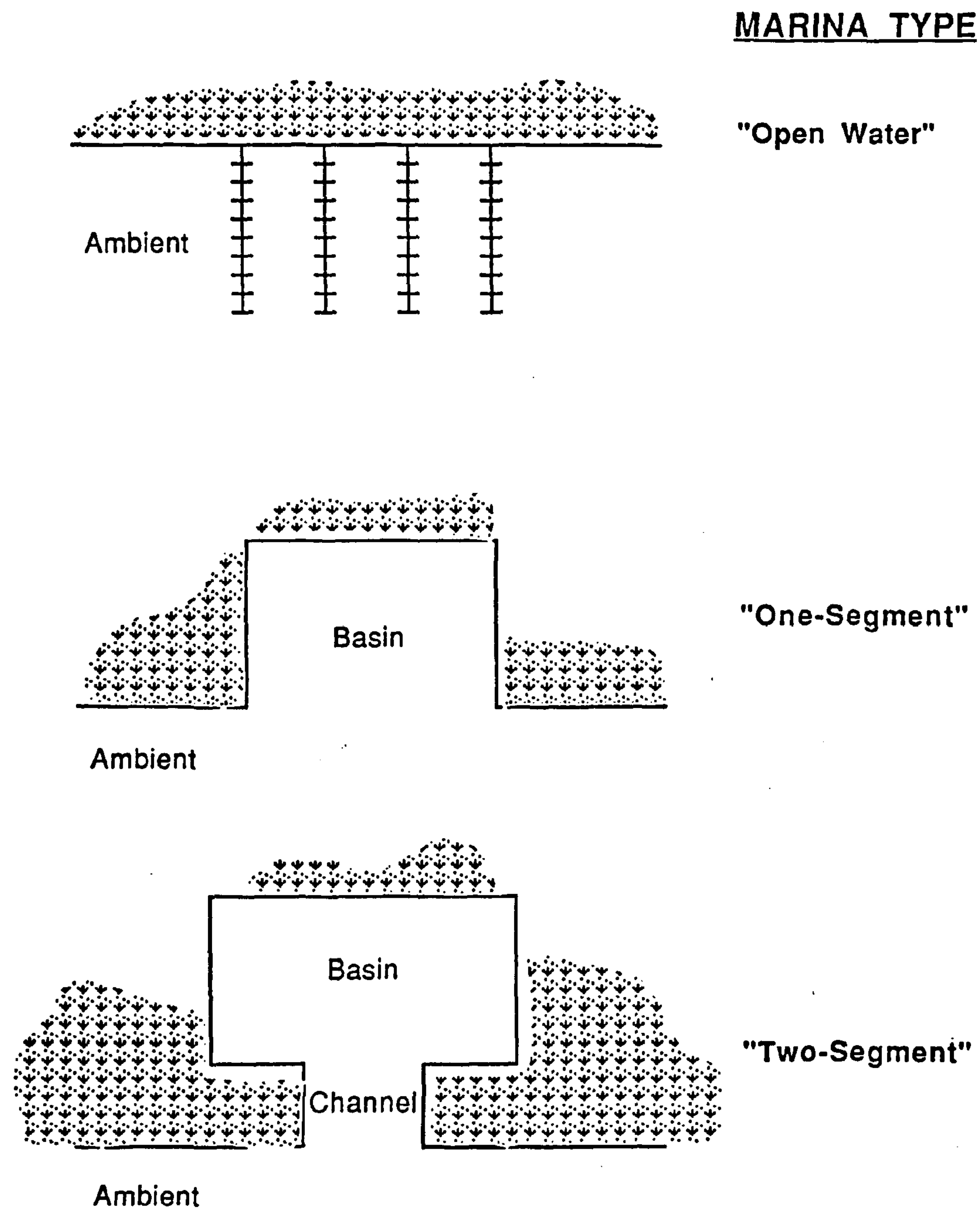


Figure 2. Classification of marina designs and segments.

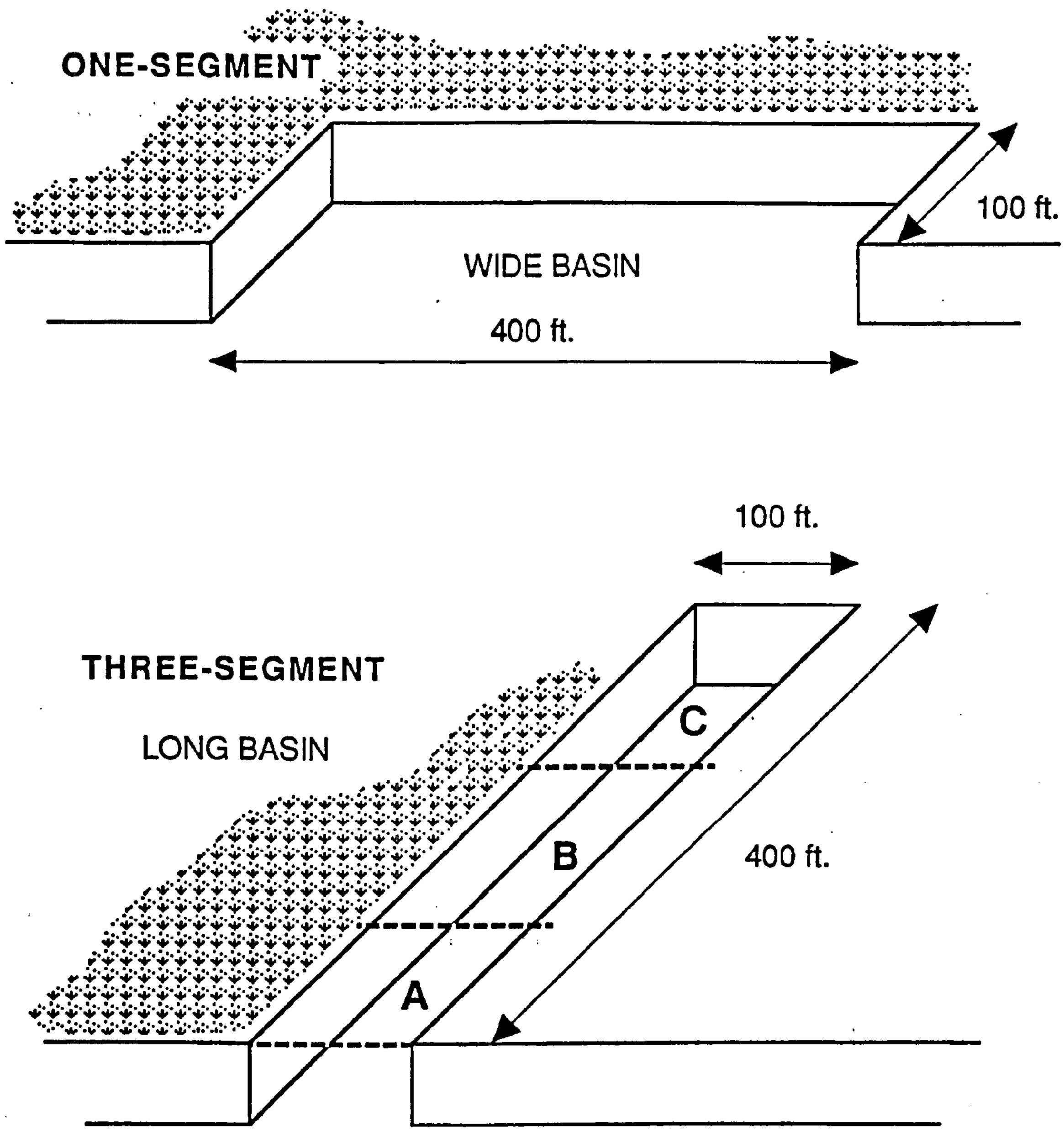


Figure 10. One and three-segment configurations.

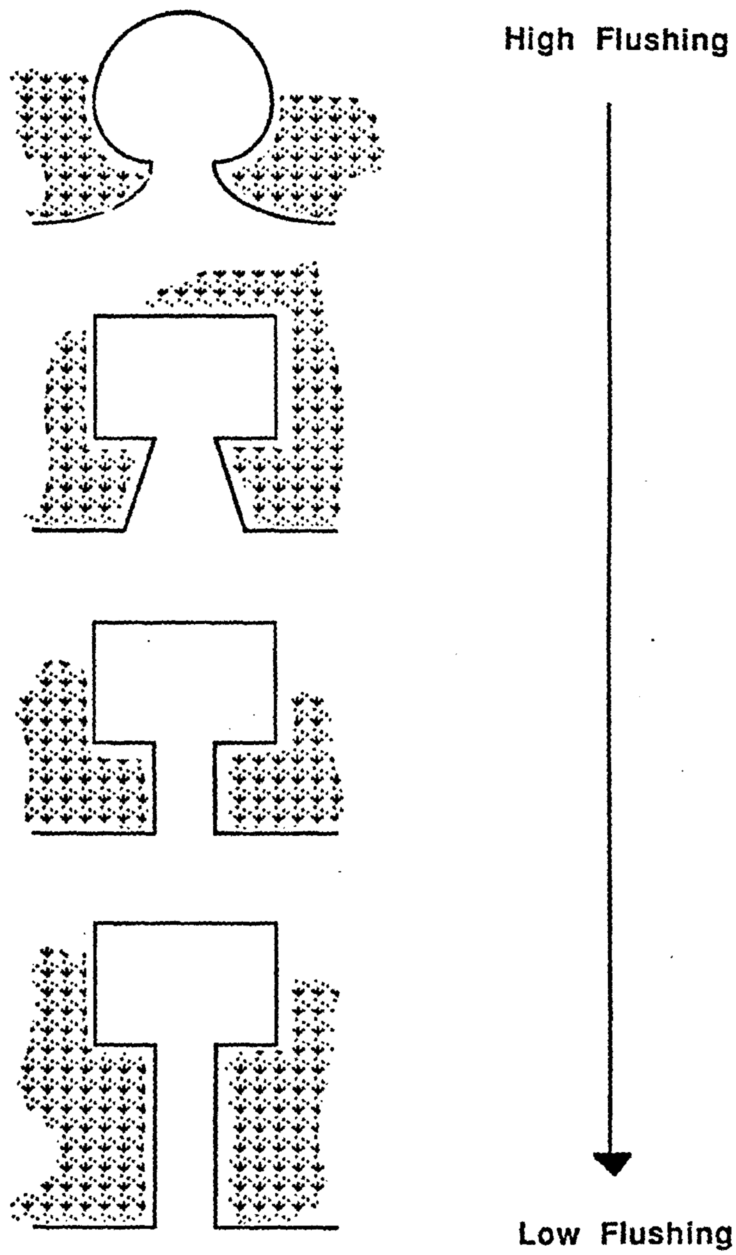


Figure 5. Channel variations for two segment marinas.

water circulation patterns. If bulkheads are necessary for certain projects, they should be minimized and placed so that water mixing is not restricted. Man-made structures such as creosote- or salt-treated plilings can also leach preservatives or antifouling compounds into marina waters, therby affecting water quality and non-target marine organisms (NCDEHNR(a), 1990: 6). This is discussed in more detail later in this section.

Because of these considerations, EPA recommends the following design features thought to promote flushing. ~~(see also Figures ___ & ___)~~ (NCDEHNR(a), 1990: 6; EPA(b), 1985: 5-7,8):

- basin depths that are not deeper than the open water or channels to which the basin is connected and never deeper than the marina access channel;
- basin and channel depths that gradually increase toward open water;
- two openings at opposite ends of the marina to establish flowthrough currents;
- single entrances that are centered in rectangular basins rather than at one corner to minimize stagnant areas;
- basins with few vertical walls and gently rounded corners or circular or oval shaped; and,
- even bottom contours, gently sloping toward the entrance with no pockets or depressions.

The flushing potential of several marina basin configurations is illustrated in Figures 4-7.

Flushing rates for the region's waterbodies have been analyzed and described in the **<<Section on Waterbody Descriptions>>** where data was available. Data is generally available for the major tributaries and creeks within the Bay watershed but is scarce for smaller waterbodies. Because of limited data availability, flushing rates could not be determined for all waterbodies within the project study area.

EPA concluded that further data collection would be needed to understand interactions between marina design, flushing, and resultant water quality, since there had been only limited field verification of expected relationships (NCDEHNR(a), 1990: 6). The North Carolina report attempted to investigate water quality at several marinas to correlate siting and design features with water quality data. That information is summarized below.

iii) Interactions Between Marina Design, Flushing and Resulant Water Quality

Because dissolved oxygen (DO) has been identified as the key water quality parameter of concern in marina siting and design, the North Carolina study attempted to confirm this relationship. Several characteristics of marina location and design related to water DO

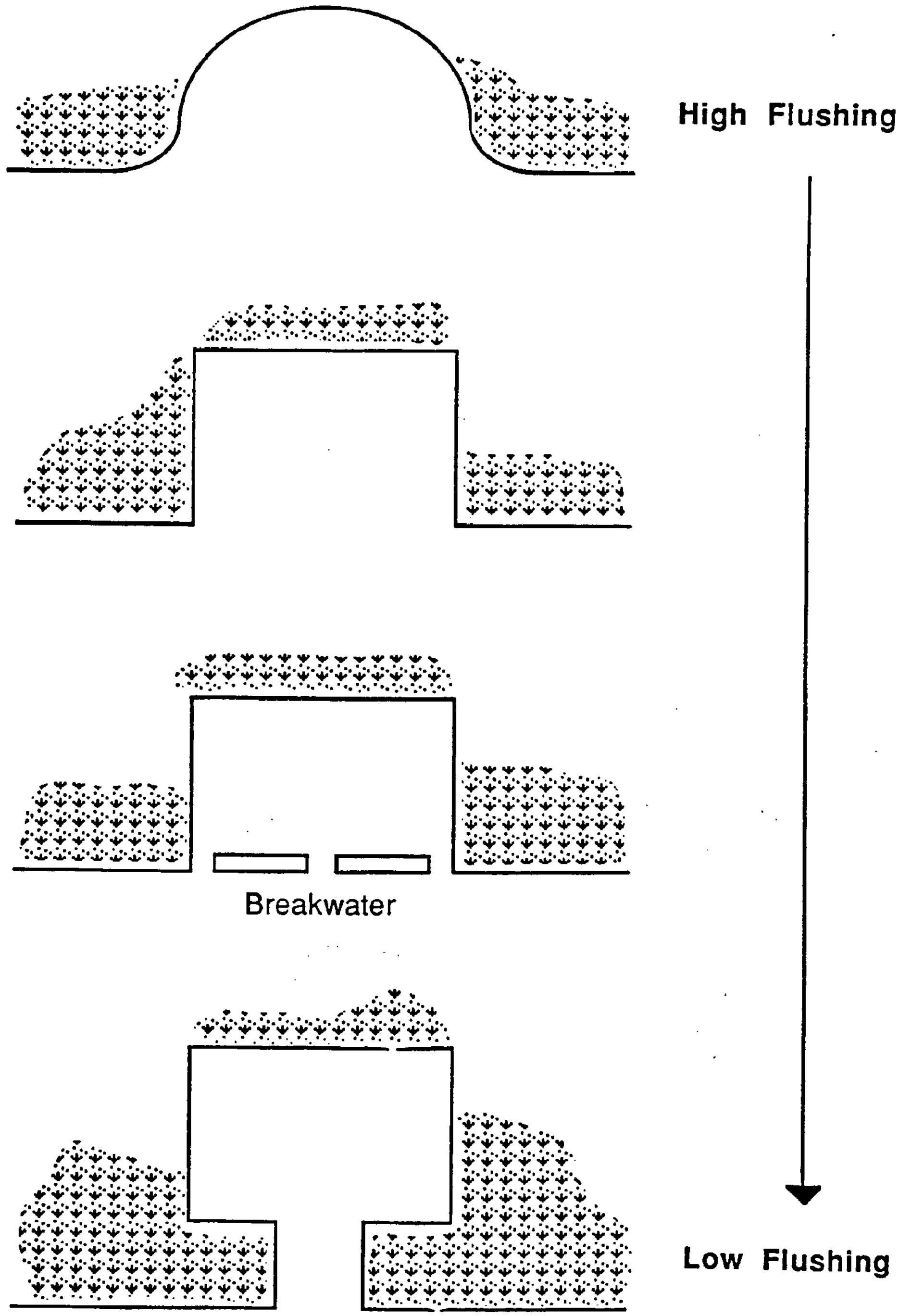


Figure 4. Basin and entrance configuration.

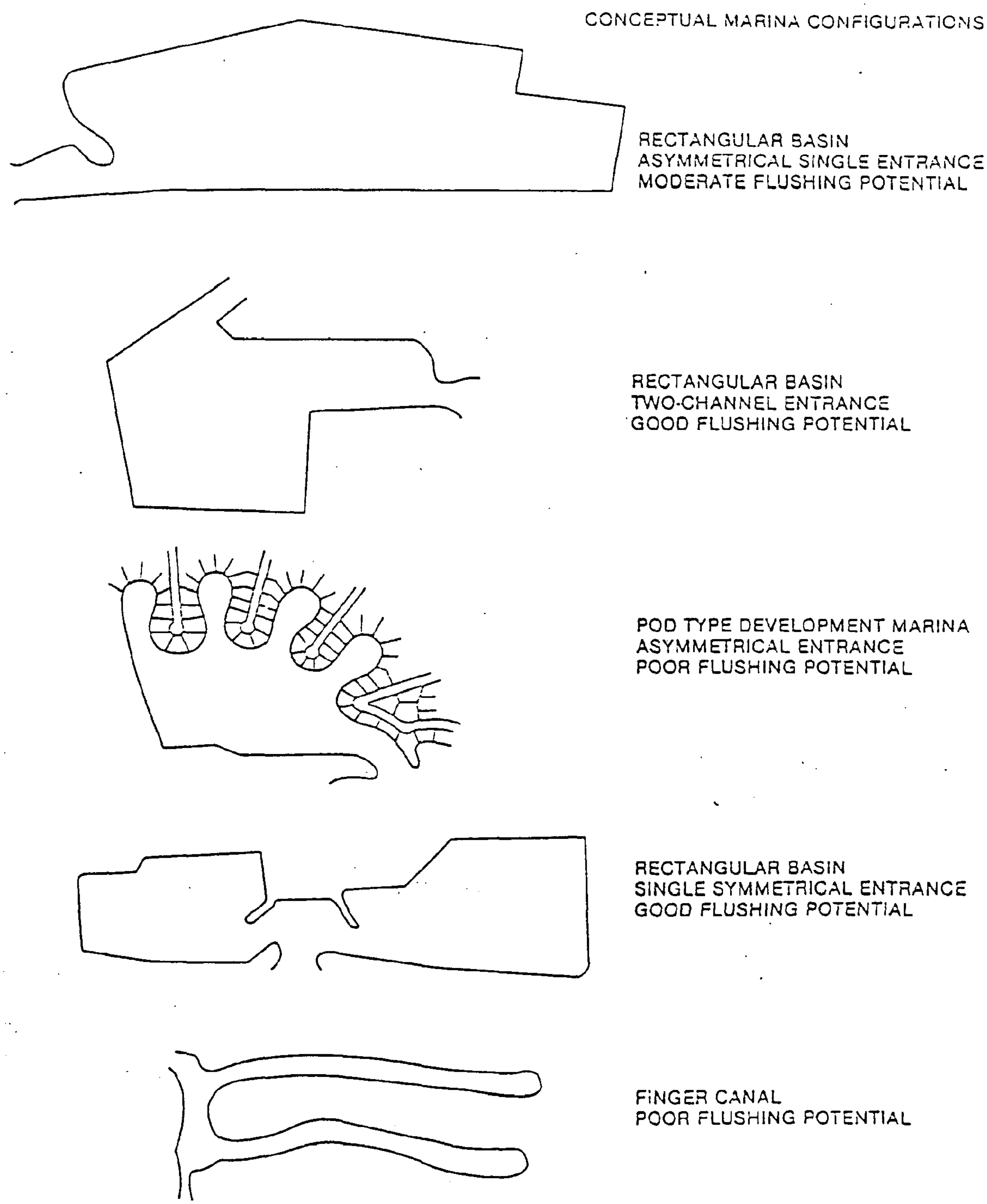
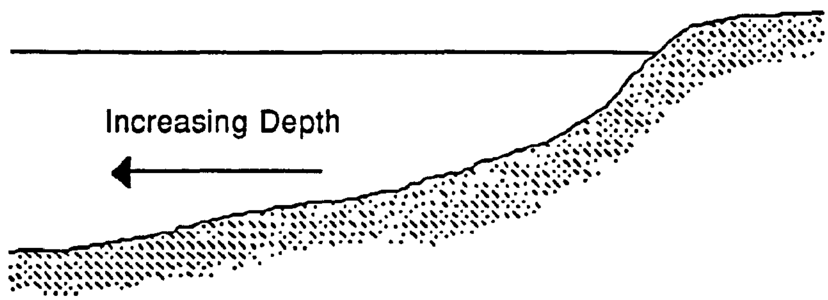
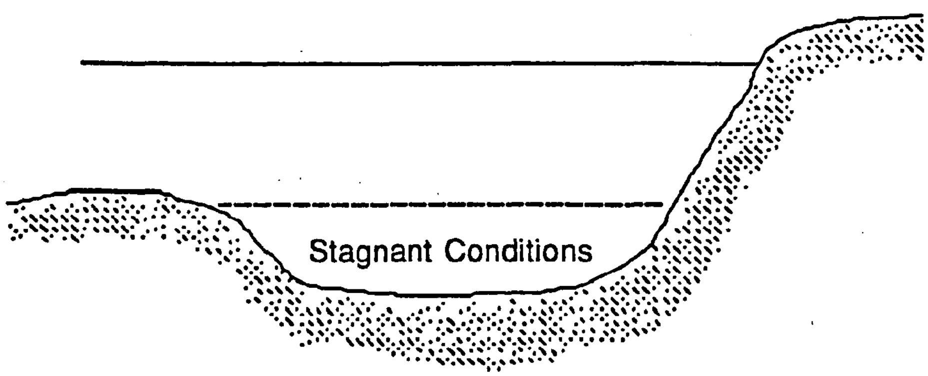


Figure 5-1. Comparison of the flushing potential of several marina configurations, (SCCC, 1983).



Good Flushing



Poor Flushing

Figure 3. Marina bottom contours and flushing potential.

AWPA Recommended Treatment Levels (pcf)		
	CCA-C, ACZA or ACA	Creosote
Lumber		
Above ground	0.25	8
Soil contact and freshwater use	0.40	10
Permanent wood foundation	0.60	NR
Salt water use	2.50	25
Piles		
Land or freshwater use and foundations	0.80	12
Salt water	2.5 (0 to .5 inches) & 1.5 (.5 to 2 inches)	20

NR= Not recommended

conditions were also observed in the North Carolina study. Primarily, the study found that features which promote flushing were associated with better DO.

Two factors related to marina siting that seemed to influence the observed DO were tidal amplitude and proximity to an inlet. Low wave amplitude areas showed the greatest tendency to stratify and to become anoxic, and to decrease marina flushing potential. Differences between basin and ambient (adjacent waterway) DO were minimal at marinas located close to inlets. Marinas farther away from inlets showed greater DO depletion. Results of this study suggest that higher tidal amplitude and siting near inlets optimizes DO conditions by enhancing marina flushing (NCDEHNR(a), 1990: 20).

Marina design also appeared to be important. Theoretically, any design that impedes flushing would favor stagnation and the accumulation of oxygen-demanding substances in a marina basin, resulting in depleted DO. The study found that marina basins which were deeper than adjacent waters had significantly less DO than ambient or adjacent water. EPA recommends that marina bottoms should be no more than one foot deeper than ambient waters. Ideally, basins should be no deeper than ambient water depth to promote flushing. Channel design also appeared to be important. Water quality monitoring showed that marinas with long, narrow, and shallow channels had low DO (NCDEHNR(a), 1990: 20).

The study also showed that deep basins and narrow, shallow channels restricted water movement out of the basin. Results supported basin depth and channel depth and width as design components that influence marina flushing, and hence water quality. In addition, the study showed that flushing was reduced when wind was blowing directly into the marina channel; therefore, orientation is also an important design feature (NCDEHNR(a), 1990: 20).

The types and quantities of pollution entering a marina are also directly related to marina siting and design. Point source discharges of wastewater and stormwater would be an obvious source of pollution. Nonpoint source runoff can also affect many water quality parameters, including DO, suspended solids, fecal coliforms, and nutrients. Most marinas receive some type of freshwater drainage. In fact, many marinas are designed to capture runoff from surrounding areas. In these cases, marinas may not be an original source, but rather a point of entry for exogenous pollutants to the estuary. Some marinas also receive marsh drainage which would be expected to lower DO (NCDEHNR(a), 1990: 20).

The study results supported earlier observations that hydrologic modification seems to have a much greater effect on DO than boat activity. Although boats are a potential source of oxygen-demanding wastes, the number or types of boats present in a marina had no noticeable effect on DO. Because monitoring waste discharges from boats is difficult, however, regulatory emphasis must be placed on proper operation of marine sanitation devices and disposal facilities. Boat maintenance activities, however, are a potential source of hydrocarbons, toxic substances, and other pollutants (NCDEHNR(a), 1990: 20).

In conclusion, DO modeling efforts by North Carolina were used to develop methodoligies for reviewing marina permits. Modelling showed that the most important siting factor to consider is the major influence of sediment oxygen demand (SOD) on marina DO. SOD can strongly influence oxygen conditions in a water column; therefore, SOD is an important component of models that predict oxygen concentrations. SOD rates are highly site specific and are influenced by substrate composition, sediment organic content, and other environmental factors such as temperature. Although sediment resuspension can cause temporary DO reductions, properly conducted sediment removal may help mitigate long term depletion of water column DO in cases where shallow, organic-rich sediments have been deposited over sand. Because dredging has been associated with numerous deleterious effects, however, dredging plans should include careful evaluation of benefits versus possible environmental damage (NCDEHNR(a), 1990: 22). This highlights the importance of obtaining accurate values of SOD to estimate the DO content of a proposed marina.

Modelling efforts also showed that the discharge of sewage from boats had a negligible impact on DO for many situations. Therefore, except for situations with numerous slips in a poorly-flushed marina, the number of boats should not be a critical factor with respect to DO. SOD and flushing characteristics are far more important. Finally, marina shape was shown to have a significant impact on DO; increasing the number of segments in a marina design (finger canal shape) decreased the basin DO (NCDEHNR(a), 1990: 32).

10) <u>Use of Bulkheads, Breakwaters, Piers, Wharves, and Docks in Marina Design and Construction</u>

The use of bulkheading, breakwaters, piers, wharves and docks in marina design and construction has also been shown to influence water quality conditions within a marina basin and in nearshore waters. While a discussion of the design and use of bulkheads and breakwaters has been developed in **<<the section of this report related to shoreline erosion control structures>>**, it is necessary to include similar information on these structures here as it relates to marina design and construction.

Bulkheads:

Bulkheads are vertical, walled structures built parallel to the shoreline to protect it from erosion or to provide boat docking convenience. Bulkheads are usually constructed of stone, concrete, sheet metal, or wood. The most severe effects of bulkheads occur when they are constructed within or along the shores of wetlands and used to hold fill deposited on the wetland. As well as preventing free water circulation to any wetland behind it, a bulkhead can also prevent the natural seepage of groundwater into adjacent waterways. The vertical face of a bulkhead protects the upland by taking the brunt of wave energy, but in doing so, it creates reflection waves which disturb sediments. Reflected waves may also result in increased marina maintenance costs and discomfort for pleasure boaters (Chmura and Ross, 1978: 10).

One study found that bulkheads which protrude too far out into the water may increase predation on migrating fish species because shallow water, which is required for protection from large predators, is absent. Vertical structures which replace shallow water habitat may have similar effects on other animals adapted to shallow water (Chmura and Ross, 1978: 10).

Bulkheads are expensive to build and for that reason should be kept to a minimum. If erosion on the marina waterfront is a problem, a sloping riprap wall with underlying filter cloth is the preferable form of shore protection. Riprap walls can be less expensive, provide more surface area for the growth of fouling communities, and create habitat. Problems of scouring and wave reflection are less severe with riprap because wall surfaces are irregular and sloping. Since the structure is not solid, it also allows seepage of groundwater into the marina. Sloping riprap walls do require more space than vertical bulkheads, which can result in space limitations and certain marina services (e.g., travel lift wells) may preclude their use (Chmura and Ross, 1978: 10).

If bulkheads or riprap walls are deemed necesary, they should be located behind all marshland and as far upland as possible with access over wetlands on piers. Features such as "weepholes" in bulkheads will allow water to pass through. Where there are deep waters, young fish or other animals which require shallow water may be subject to increased predation. Therefore, it has been suggested that bulkheads be placed at a water level where they will be wetted more than one foot deep approximately 10% or less of the time during critical migration periods (Chmura and Ross, 1978: 11).

Breakwaters:

Breakwaters are linear structures which extend out into the water and provide sheltered conditions for craft and marina facilities by dissipating wave energy. They may be composed of a wide variety of materials and constructed to either sit on the bottom (fixed position) or float on the surface (movable). Since breakwaters provide for calm water, they may also increase the amount of shoreline available for salt marsh building. The fouling commmunities which grow on breakwaters can add to the biological productivity of the area and attract fish.

In contrast, studies at Marina Del Ray found that a breakwater constructed around the marina entrance accumulated organic debris. The breakdown of this material resulted in the depletion of DO in the bottom water, which harmed the benthic fauna. Certainly, breakwaters can be traps for larger floating debris which becomes an aesthetic problem as well. Breakwaters can also act a barriers for migrating fish and culverts installed in breakwaters to aid fish passage might not be readily used (Chmura and Ross, 1978: 11).

Breakwaters can also interrupt longshore currents and the movement of sediments. Many researchers mention that solid (surface to bottom) breakwaters, which restrict the opening for water circulation within a marina, will alter sedimentation patterns and the natural flushing which can help remove pollutants from marina waters. However, the impact of such a disturbance is difficult to measure and probably unique to each marina (Chmura and Ross, 1978: 11).

A floating breakwater can be a cheaper and more environmentally-sound alternative to the common, solid breakwater, although it does not provide the same degree of protection. These may be constructed from a variety of materials; one example might be the use of attached, floating tires. The floating breakwater is preferred for shore protection because it allows free passage of fish, does not alter current and sediment patterns, and therefore does not have the adverse effects of a solid breakwater (Chmura and Ross, 1978: 12).

When solid breakwaters are used, their location must be planned with consideration of natural current and sediment flow, wave patterns, and overall flushing characteristics of the marina basin. Modelling studies are useful in this regard and may be used to plan for adequate flushing of new marinas, or to remedy problems at existing ones. From modelling work already studied, it has been suggested that breakwaters include as many openings as possible to maximize wave protection while allowing adequate water flow and fish passage. Sloping riprap type breakwaters are preferable to vertical structures because irregular surfaces provide protective habitat for small fish passing around the structure and are more effective in dissipating wave energy (Chmura and Ross, 1978: 12).

An example of a creative alternative to traditional breakwater design is being used at a project at Jamestown Settlement in James City County, VA. This project involved the design of a new mooring facility for the replicas of historic ships and includes the use of two, rubble-mound breakwaters, one of which is to be planted with trees, shrubs and grasses native to the area. The new breakwaters will be constructed of riprap and stone and will replace the original concrete breakwater, as well as provide a visual barrier which will help in the educational mission of the Jamestown Settlement (Glenn and Sadler Associates, Inc., 1993).

Piers, Docks and Wharves:

Piers, docks and wharves can have detrimental effects on water quality by blocking light and water flow. As happens with bulkheads and breakwaters, water flow within the marina basin may be altered, especially if piers are supported by closed (solid) bases. In Virginia, open-pile piers are generally required in both marina and private, non-commercial pier construction.

Wood is a major component of many piers, pilings and docks. The use of wood in marine related construction has always been complicated by the actions of marine borers in addition to the normal decay processes of bacteria and fungi. There are two main groups of marine boreres: shipworms (mollusks) and gribbles (crustaceans). In Virginia the primary concern is with shipworms and, to a much lesser extent, the bribble. The distribution of these organisms is highly dependent on water temperature and salinity. Although generally more common in high salinity areas, they can penetrate well into estuaries particularly during periods of drought when salinity levels are unusually high (Priest, 1994: 7).

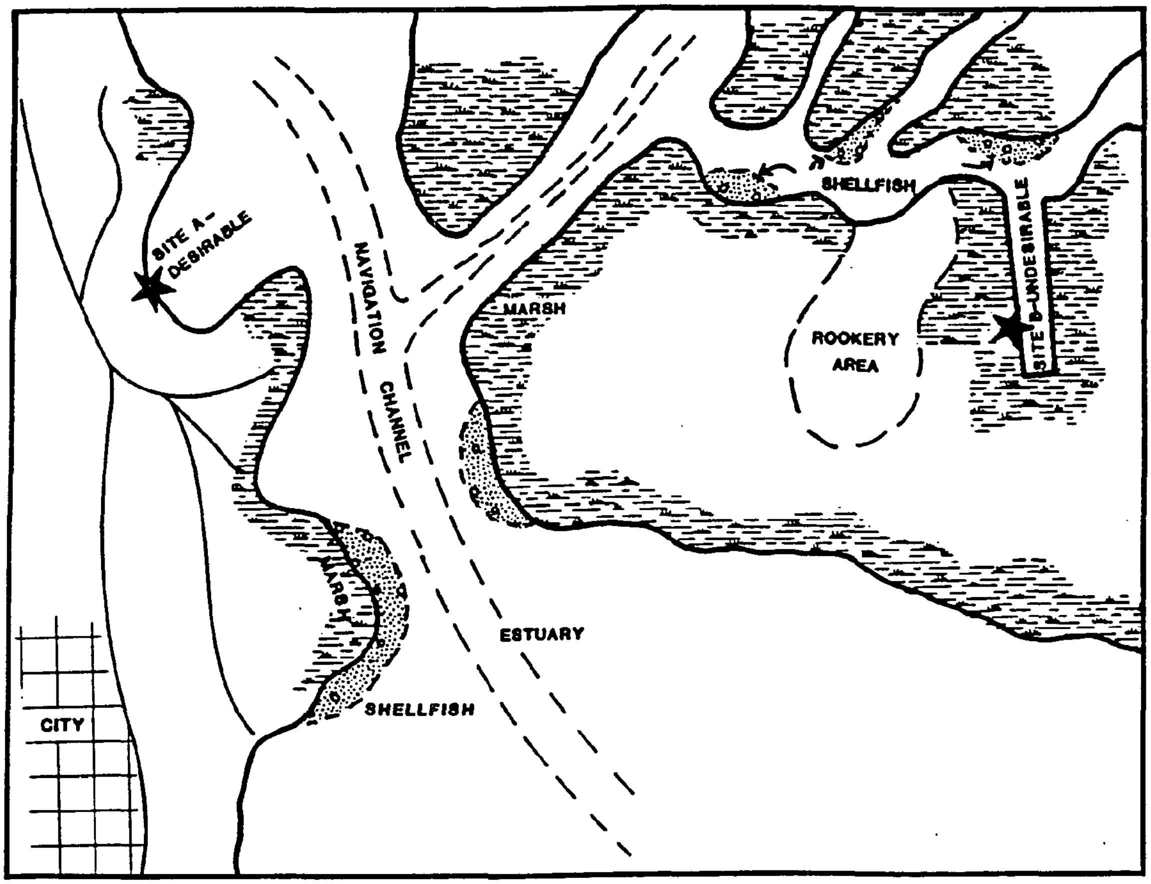
In order to protect wooden structures, treatments have been developed that make the wood unpalatable to these organisms as well as bacteria and fungi. The two most commonly encountered treatments are creosoted and salt-treated. In these processes, the wood is pressure-treated with creosote, a coal tar distillate, or one of several inorganic salt solutions. There are several levels of treatment depending on the intended use. These treatment levels are expressed in terms of the pounds of preservative retained per cubic foot of wood (pcf). Table __ provides the levels of treatment recommended by the American Wood Preservers Association for different uses of wooden piles and lumber that would typically apply to Virginia (Priest, 1994: 7).

The uptake of these preservatives is greatest in the sapwood with considerably lesser amounts absorbed by the heartwood. Consequently, it is important to seal and/or cover the tops of pilings and treat all cut surfaces with additional preservative to prevent the deterioration of the wood from the inside out. The useful life of the structure can also be increased by minimizing the direct exposure of the heartwood to shipworms (Priest, 1994: 7).

To be effective, these preservatives must also be of a poisonous nature and of low water solubility, which results in a slow leaching rate. Most studies have concentrated on the effectiveness of preservatives, but not on the environmental effects. A report published by a wood products company which discusses the toxicity of creosote to non-target organisms stated that, although laboratory tests found that creosote was moderately toxic by EPA standards, toxic effects to selected fish species under normal field conditions were not explored (Chmura and Ross, 1978: 12).

The effects of docks, piers and wharves can be minimized if they are constructed high enough above marshes and open water areas to allow light to reach the surface. These structures should also extend out far enough to reach adequate water depths so that dredging will not be required for boat acces. Floating docks and pile/timber piers will have the least effect on water circulation and, therefore, should be used in preference to solid structures (Chmura and Ross, 1978: 13). In Virginia, the VRMC design guidelines for pier and dock structures also recommends the same.

Because these structures provide additional substrate for the growth of fouling communities, marina operators should avoid painting the underwater surfaces with anti-fouling paints. Further studies on the environmental effects of wood preservatives are necessary but, until results are available, their use should not be banned. Meanwhile, prudent use of long-lasting materials such be encouraged. For example, when creosote preservatives are used, a highly refined variety is preferred. Numerically higher creosote grades have a higher tar content and leach faster. A newer and increasingly popular colorless preservatice (CCA salt) leaches more slowly and is estimated to be effective for approximately 50 years. Metal, fiberglass, or concrete can be used for docks, piles and



Desirable and Undesirable Marina Sites A and B

piers, but historical use patterns, lower cost, ease of handling and availability have made wood the preferred material for marina use (Chmura and Ross, 1978: 13).

Docks are most commonly kept afloat with plastic foam logs or billets. Metal barrels, fiberglass tanks and reinforced concrete (foam or air filled) chambers are less commonly used. Many marina owners seem to prefer the use of the more expensive petroleum-resistant polystyrene foam over the expanded bead foam, because the former lasts longer, does not absorb water, resists burrowing by marine animals, and does not break apart easily. Since the latter breaks up more easily with resulting white beads floating off and accumulating along the shore or being swallowed by marine organisms, it is recommended that the former be used where it is to be exposed under docks. There has been little research on the environmental effects of various flotation materials (Chmura and Ross, 1978: 13).

d) Regulatory Requirements

Because of the potential severity and complexities of the environmental impacts associated with marinas and other mooring facilities, this type of shoreline development is subject to strict regulatory procedures at the federal, state and local levels.

The Commonwealth of Virginia is historically a key shellfish producing state. Current shellfish leasing practices encourage the acquisition of shellfish leases by developers in order to eliminate or reduce opposition to seasonal shellfish closures which may result from the siting of marina facilities (VMRC(a): 3).

In order to protect the public health, the Virginia Department of Health, Division of Shellfish Sanitation (VDH-DSS) has established a policy which requires the establishment of buffer zones around boating facilities within which shellfish cannot be harvested for direct marketing during the months of April through October. These buffer zones are as follows (VMRC(a): 3):

0-50 slips	-	1/8 mile in all directions
51-100 slips	-	1/4 mile in all directions
> 100 slips	-	1/2 mile in all directions

As a result of this policy, the Virginia Department of Environmental Quality (DEQ), also as a matter of policy, considers it a violation of water quality standards if a proposed facility will result in a seasonal shellfish closure. The Virginia Marine Resources Commission (VMRC) is required by law to give due consideration to water quality standards established by DEQ and to enforce the shellfish closures established by the VDH-DSS (VMRC(a): 3).

In addition, a comprehensive siting review process for marinas and other boat mooring facilities requiring permits from VMRC is necessary to insure that permit decisions comply with statutory requirements and the legislative mandate that the Commonwealth's natural resources be maintained and conserved for present and future generations. All public and private interests are carefully considered in this review. As the size, density, complexity and range of services offered by a proposed facility increase, so must the detail in design and implementation of best management practices in its siting, construction and operation. Minimizing adverse environmental impacts must be the ultimate goal in all phases of planning, site construction and operation. Furthermore, the acquisition of shellfish leases which may be affected by a seasonal shellfish closure around a proposed facility will be given no weight and, absent mitigating circumstances, will be viewed as a negative factor by VMRC in its evaluation of the facility (VMRC(a): 4).

Since community marina or dockage facilities significantly increase the value of the upland property they are intended to serve, VMRC has a long standing policy that such facilities are classified as commercial in nature. Accordingly, only non-commercial, private piers placed by individual owners of riparian lands in the waters adjacent to such riparian lands are considered statutorily exempt from public interest review (VMRC(a): 4).

Depending on the nature, scope, and potential deleterious effects of a marina project, therefore, the following federal, state and local permits may be required (SVPDC(a), 1988: 44,45):

- A federal permit from the U.S. Army Corps of Engineers (COE) for the discharge of dredged or fill materials in navigable waters, their tributaries and adjacent wetlands **<<add applicable nationwide and regional permit #'s>>.**

- A Water Protection Permit from the DEQ certifying that no adverse water quality impacts will be required before a permit is granted. This permit require water quality monitoring for DO, temperature, and pH for both surface and bottom waters. All new or expanding marinas are also required to have either pumpout or dumpout facilities, depending on the marina size, as part of this permit application (VDCR(c), 1993: 5-13).

- A state permit from the VMRC for all non-exempt activities affecting State-owned subaqueous lands. Also, before a permit can be granted for the development of a marina, VMRC requires each facility using subaqueous land to provide a Virginia Department of Health (VDH) approved permit for all sanitary and sewage facilities (VDCR(c), 1993: 5-13,14).

- A state or local permit is required for any activities which alter vegetated or nonvegetated tidal wetlands. This permit is obtained from local authorities when a locality has adopted a State-approved wetlands ordinance and established a wetlands board. The permit is processed through VMRC when a locality has elected not to adopted an ordinance establishing a wetlands board. In Hampton Roads, the Cities of Chesapeake, Hampton, Newport News, Norfolk, Poquoson, Portsmouth, Suffolk, Virginia Beach and Williamsburg, and the Counties of Isle of Wight, James City and York have wetlands boards. The City of Franklin and Southampton County do not have tidal wetlands and are, therefore, not subject to the permitting process under state law. Local government development activity on publicly-owned land is also exempt from this permitting requirement.

- The Virginia Sanitary Regulations for Marinas and Boat Moorings of the VDH require all marinas and other places where boats are moored to have a permit to operate. In order to obtain the permit to operate, the establishment must have on-site sanitary facilities, pumpout facilities and a sewage dump station. There are special provisions for facilities which do not allow boats with installed toilets to use their mooring facilities. The VDH approved permit may not be issued until the requirements of the on-site sewage regulations and/or the Sewage Collection and Treatment Regulations have been met (VDH, 1990; VDCR(c), 1993: 5-14).

- At the local level, a marina developer will, in most cases, have to obtain a rezoning and/or a conditional use permit and an erosion and sediment control permit before a building permit is issued.

In addition, if a marina project is located within a locally-designated Chesapeake Bay Preservation Area, a water quality impact assessment (WQIA) must be conducted because the activity will be occurring within an RPA. Also, various best management practices for marina siting and operation might be encouraged or required under federal and state nonpoint source control programs.

In conclusion, the intensive development of the region's shoreline has eliminated many suitable locations for marina development, particularly in the more urbanized localities. As a result, sites proposed for marinas are often environmentally-marginal and do not satisfactorily meet the criteria necessary to obtain federal, state or local permit approval. Table 4 is a check list of siting criteria which will be considered by VMRC in determining whether, and upon what condition, to issue any permit for a marina or other type of boat mooring facility. Use of this checklist by local plan reviewers and wetlands boards when deliberating the issuance of a local permits is encouraged. In addition, VMRC may consider other factors relevant to a specific project or application.

Table ___ is a more comprehensive synthesis of criteria used by VMRC and other federal, state and local authorities in evaluating the siting and design in marina development proposals in Virginia. Many of these criteria will be considered by VMRC, in particular, during the public interest review of each application for recreational marinas or community facilities for boat mooring. In addition to those guidelines proposed in the above discussion, these criteria should be given consideration early in the process of siting and design of any marina facility (SVPDC(a), 1988: 45,47,48).

VMRC will also require the applicant to demonstrate how appropriate BMPs will be incorporated into both the upland development plan associated with the facility as well as the Erosion and Sediment (E&S) Control Plan required by local government in order to reduce the discharge of nonpoint source pollutants into State waters. VMRC may also require, as a condition of any permit issued, that BMP structures be completed before any slips can be occupied and that the permittee cooperate fully with local governmental agencies in complying with the E&S Plan, including maintenance of any required BMP structures. An appropriate surety bond or letter of credit may be required to ensure proper installation, stabilization and maintenance of any vegetative or structural measures (VMRC(a); 6).

TABLE ___

CRITERIA	DESIRABLE	UNDESIRABLE
Water Depth	Greater than 3 ft. at mean low water.	Less than 3 ft. at mean low water.
Salinity	Unsuitable for shellfish growth.	Suitable for shellfish growth.
Water Quality	Closed for direct marketing of shellfish. Little or no potential for future productivity.	Approved, conditionally approved, or seasonally approved for shellfish harvesting.
Designated Shellfish Grounds	No private leases or public ground within affected area. No potential for future productivity.	Private leases or public oyster ground in proximity.
Maximum Wave Height	Less than 1 ft.	Greater than 1 ft.
Current	Less than 1 knot.	Greater than 1 knot.
Dredging	Does not require frequent maintenance; suitable site for all dredged material.	Requires frequent dredging; no suitable site for dredged material.
Flushing Rate	Adequate to maintain water quality.	Inadequate to maintain water quality.
Proximity to Natural or Improved Channel	Less than 50 ft. to navigable channel.	Greater than 50 ft. to navigable water depths.
Threatened or Endangered Species	Absent; project will not affect.	Present as defined in existing regulations, or project has potential to affect habitat.
Adjacent Wetlands	Suitable buffer to be maintained.	Cannot maintain suitable buffer.
Navigation and Safety	Navigation not impeded.	Waterbody difficult to navigate or presently overcrowded conditions exist.
Existing Use of Site	Not presently used for waterskiing, fishing, swimming or other recreational use.	Presently used for waterskiing, crabbing, fishing, swimming or other poentially conflicting uses.
Submerged Aquatic Vegetation	Absent.	Present.
Shoreline Stabilization	Shoreline protected by natural or planted vegetation or riprap.	Bulkheading required.
Erosion Control Structures	No artifical structures needed.	Groins and/or jetties necessary.
Finfish Habitat Usage	Unimportant area for spawning or nursery for any commercially or recreationally valuable species.	Important spawning and nusery area.

Source: Virginia Marine Resources Commission. "Criteria for the Siting of Marinas or Community Facilities for Boat Mooring." VR 450-01-0047.

TABLE ___
GUIDELINES FOR THE SITING AND DESIGN OF MARINAS
AND OTHER BOAT MOORING FACILITIES

Location

- The need for a marina facility should be clearly demonstrated.

- The physical dimensions and characteristics of a waterway (i.e., depth, current, tide range, fetch, suface area, flushing rate) should be compatible with the size and design of a marina and the type of vessels it will berth. For example, a shallow cove or basin is not an appropriate site for a deep draft sailboat marina.

- Convex shorelines at the mouths of waterways are preferred locations. Also, deep water sites are preferred over sites where dredging is required.

- All marinas should be located in areas with good natural flushing to minimize the build-up of organic material and other pollutants on the bottom.

- Vessel movement in and out of a facility should not infringe on the riparian waters of adjacent properties, existing physical or visual access, or interfere with navigation on the receiving waterway.

- The additional vessels drawn to a waterway by a new facility should not exceed the carrying capacity of that waterway. Carrying capacity is based on the number of water access rights that would be granted to private riparian property owners along a waterway.

- Marinas should be sited away from areas of very high natural resource value (e.g., productive or actively-worked shellfish areas, submerged aquatic vegetation communities, finfish spawning and nursery areas, and areas frequented by endangered species).

- The transfer of control of shellfish leases in order to accommodate marina development is generally unacceptable.

- Projects that, by their cumulative impact, will result in dense concentrations of boats in one area will be critically evaluated as to their impacts on natural resources; however, in densely populated areas, concentration of slips in a single facility may be justified to prevent disturbance at undeveloped shorelines.

- The site should be served by public water and sewer services.

- A marina should be compatible with adjacent land and water uses.

Design

- The dredging of access channels and basins should be limited to the minimum dimensions necessary for navigation and should avoid sensitive areas such as wetlands, shellfish grounds and sumberged aquatic vegetation beds. Where channels and basins are necessary, dead-end or finger canals and restricted inlets should be avoided and depths of basins and channels should not exceed ambient (adjacent waterway) depth.

- Dredged areas should be no more than one foot deeper than controlling depths in the waterway (ambient) and should be connected to natural channels of similar depth. Where possible, depths of basins and channels should not exceed ambient depth.

- An upland or deep water site should be clearly defined and designated for construction and maintenance dredge spoils.

- Structures should not extend more than one-third the distance across a waterway and should not impede existing navigation.

- If a site contains tidal wetlands, all structures except those needed for access should be located landward or channelward of wetland vegetation. The dredging or filling of wetlands should always be kept to an absolute minimum.

- Piers and wharves crossing vegetated wetlands and submerged aquatic vegetation areas should be limited to the minimum necessary for water access.

- Where vegetated areas are crossed, the height of the pier above the substrate should be equal to one foot less than its width with a three foot minimum required.

- All structures should be open-pile or floating.

- For community piers and marina facilities which are appurtenances to residential developments, the number of slips will not necessarily be predicated by the number of units on the property.

- Slips for deep draft boats should be built in the naturally deeper waters of the marina.

- Site specific stormwater management BMPs are required, such as buffer strips, grassed swales, wet detention ponds and permeable parking surfaces.

- Sanitary facilities and pumpout facilities convenient to marina users should accompany development plans.

- o All fuel facilities must incorporate automatic shutoff valves and must have spill contingency plans.

- o Methods of insuring against the discharge of wastes, gray water, bilge wastes and the use of TBT paints shall be provided.

- o Marinas must have sufficient upland area to provide all necessary parking, stormwater management BMPs, fuel, and sanitary facilities without filling wetlands or subaqueous bottoms.

- o A solid waste disposal and recovery plan with facilitied marina user access must accompany marina development plans.

- o Facilities incorporating boat maintenance operations shall include plans for the efficient collection and removal of sand blasting material, paint chips and other by-products of maintenance operations.

- o Design of breakwaters should permit adequate water circulation within the facility.

- o Dry storage facilities are encouraged to minimize environmental impacts.

Sources:
(1) SVPDC(a), 1988: 47-48.
(2) Existing VMRC regulations.
(3) VMRC(b), 1979 (rev. 1986): 8,9.
(4) "Wetlands Guidelines." VIMS/VMRC.
(5) COE, EPA, FWS, and NMFS permit evaluation criteria.

2. Boat Ramps

Like marina development, the construction and operation of boat ramp facilities is likely to have an adverse impact on the shoreline environment. In general, however, boat ramp impacts are much less significant than marina impacts. This is because boat ramp facilities are generally smaller in scale, accommodate less noxious uses and usually require less encroachment on subaqueous land. Boat ramp development is subject to the same federal COE, State subaqueous, state/local wetlands, and Chesapeake Bay Preservation Area requirements described above for marinas (SVPDC(a), 1988: 46).

As with marina development, there is a scarcity of shoreline that is both environmentally-suitable for boat ramp development and located in an area where boat ramp access is deficient. The Virginia Departmnet of Game and Inland Fisheries (VDGIF) has developed criteria to assist in the identification of suitable landing sites and to ensure the proper design and construction of boat ramps. These criteria are listed in Table ____. It has been suggested that localities work with the Virginia Department of Transportation (VDOT) and the VDGIF to identify ends of public rights-of-way adjacent to shoreline areas that may be developed as boat ramp launch sites (SVPDC(a), 1988: 46). Such areas have been identified as potential public access points on **<<the maps attached to this report>>.**

TABLE ___
GUIDELINES FOR THE SITING AND DESIGN OF BOAT RAMPS

Location

1. Primary consideration should be given to sites in areas where the demand for boat ramp facilities exceeds the supply.

2. Sites should be at least three to five acres in size with two or more acres suitable for parking.

3. Water depth should be minimum of two feet at the end of the ramp at mean low water.

4. Avoid sites with excessive siltation or erosion.

5. Sites requiring extensive dredging or filling should be avoided.

6. Sites should be close to a public road to avoid the expense of access road construction.

Design

1. Build ramps at a slope of eleven to thirteen percent with lane widths between twelve and sixteen feet.

2. Ramps constructed on flowing rivers should enter the river at an angle to facilitate boat launching and reduce siltation.

3. Extend the ramp to a depth of five feet, install riprap at the end of the ramp or increase the slope for the last ten to fifteen feet of the ramp to protect the end of the ramp.

4. Provide about thirty-five car-trailer spaces for each launching lane. Each car-trailer space should be ten feet wide and forty feet long, and the parking lot should provide adequate maneuvering room.

5. If two launch lanes are constructed, build a pier between the two to serve both lanes and to insure that one user cannot tie up both lanes.

6. Support facilities should include litter receptables, restrooms, and handicapped access.

Sources:
(1) SVPDC(a), 1988: 49.
(2) Virginia Department of Game and Inland Fisheries, 1986.

3. Canoe Put-In/Take-Out Points

Because the development of canoe put-in/take-out points does not normally involve filling or dredging activities, encroachment on subaqueous land or the alteration of wetlands, the permits discussed in the previous sections are usually not required. Many existing informal canoe access points are located next to bridge crossings on land owned by the Virginia Department of Transportation (VDOT). The VDOT does not encourage the use of these locations for water access, but will not prohibit access unless negligent use occurs. Should a locality wish to develop a formal canoe access point on VDOT-owned land, a special use permit must be obtained from the VDOT (SVPDC(a), 1988: 50).

Compared to marinas and boat ramps, canoe access points have few adverse environmental impacts, require little in the way of construction and maintenance work, and are relatively inexpensive to develop (SVPDC(a), 1988: 50). Table ___ contains siting and design criteria for canoe access points.

TABLE ___
GUIDELINES FOR THE SITING AND DESIGN OF
CANOE PUT-IN/TAKE-OUT FACILITIES

Location

1. Facility should be on a waterway that is suitable for canoeing and along a stretch of that waterway that is deficient in canoe access opportunities.

2. Access point should be within a short portage of parking area.

3. Facility should not be located on water that is too shallow, has an extreme drop-off, has severe currents, has underwater obstructions, or where large boat traffic is frequent.

Design

1. Approach to waterway should not be too steep and should be clear of brush. If banks are steep, consideration should be given to reconstructing the bank through grading and possible the installation of steps.

2. Site should provide adequate and safe parking, preferably in an off-road location.

3. Site should have picnic tables, litter repceptables, restrooms, handicapped access, an information kiosk and signs which designate the site as a canoe access facility.

Source: SVPDC(a), 1988: 51).

B. Shoreline Pedestrian Access Areas

1. Beachfront

In Hampton Roads, nearly all of the unrestricted beachfront has been developed for public beach use. There are, however, extensive segments of restricted and closed beaches which are suitable for development as public beaches. Should these beaches ever become available for public use, there are a number of factors which must be considered in their development (SVPDC(a), 1988: 51).

Public beaches require extensive support facilities. These facilities include restrooms, showers, drinking fountains, litter receptacles, handicapped access, rental equipment and food concessions, as well as lifeguard facilities. Public beach development may also require the construction of facilities that impact or alter the primary dune system. Such facilities might include access roads to the beach site, parking lots, and pedestrian and/or emergency vehicle access points to the waterfront through the dune line. The State, in recognizing the environmental importance of coastal primary dunes, has promulgated strict development guidelines and permitting procedures for activities which alter dunes. Under State enabling legislation, a locality which has a State-approved wetlands ordinance and a wetlands board may adopt a primary sand dunes ordinance and entrust its wetlands board with the permitting process. In Hampton Roads, the Cities of Hampton, Norfolk and Virginia Beach have locally-administered sand dune permitting programs. It should be noted, however, that local government activity on publicly-owned or leased property is exempt from the permitting requirements (SVPDC(a), 1988: 51,52).

2. Fishing Areas

Development of a fishing area might be as simple as opening up a stretch of publicly-owned shoreline to fishing or as extensive as constructing an open-water pier. For the most part, the development of fishing areas is not as heavily regulated as the development of other water access facilities. The development of shoreline fishing areas is not subject to federal COE, state subaqueous or state/local wetlands permits unless dredging or filling of wetlands or subaqueous land is required. The construction of noncommercial fishing piers does not require a wetlands permit or a subaqueous permit from VMRC, but may require a federal COE permit. VMRC does retain the right to review all noncommercial fishing pier proposals for obstacles to navigation. The construction of commercial fishing piers, however, is subject to all three permitting procedures (SVPDC(a), 1988: 53). Table ___ lists suggested guidelines for siting and designing fishing facilities

TABLE ___

GUIDELINES FOR THE SITING AND DESIGN OF FISHING FACILITIES

Location

1. Facility should be lcoated on a waterbody with a productive fishery and acceptable water quality.

2. Consideration should be given to potential conflicts with adjacent land use and other water activities.

3. A shore fishing area should be free of obstructions such as steep banks, dense brush or low hanging tree limbs. Also, the water fronting a fishing area should be of sufficient depth and devoid of underwater obstructions that would interfere with fishing.

4. Consideration should be given to incorporating fishing facilities into water-related construction projects. For example, catwalks and platforms can be built into bridge projects, or fishing areas can be developed in areas adjacent to bridge approaches. Safety considerations must be integral to the location and design of such facilities. Fishing areas may also be developed at park sites, next to boat ramp launching areas, on breakwaters, along bulkheading projects or at highway waysides. Adequate space for safe parking must exist or be easily provided.

Design

1. Support facilities appropriate to fishing areas include parking areas, restrooms, handicapped access, drinking fountains, litter receptacles, picnic tables, fish cleaning facilities, and boat rental, bait and food concessions.

2. Fishing structures should be of barrier-free design to afford fishing opportunities for the widest range of participants.

3. Piers should be of open-pile construction, and piers constructed over vegetated wetlands should be high enough to prevent loss of existing vegetation through shading.

Sources:
(1) Existing VMRC Regulations.
(2) SVPDC(a), 1988: 53.

3. Other Shoreline Recreation Areas

Beacuse these shoreline facilities accommodate recreational activities that do not require direct access to the water, their development generally has minimal impact on the marine enviornment. It may be desirable at some facilities, however, to construct elevated walkways and/or observation platforms over wetlands or open water for nature observation or to provide scenic vistas. Construction of such facilities by a local government may require a federal COE and/or a state subaqueous permit, but not a state/local wetlands permit (SVPDC(a), 1988: 52). Guidelines for the siting and design of shoreline facilities that do not provide boat access and are unsuitable for swimming or fishing are found in Table ___.

TABLE ___
GUIDELINES FOR THE SITING AND DESIGN OF SHORELINE RECREATION AREAS

(Includes areas that provide waterfront access but do not provide boat access and are not physically or environmentally-suitable for swimming or fishing.)

Location

1. Site should offer special qualities that will attract public usage (e.g., scenic vistas or nature observation).

2. Public access to the shoreline (either pedestrian or visual) should be incorporated whenever possible into public and private waterfront development projects. Such projects might include waterfront retail, office, residential or mixed use developments, marinas, public parks, and highways.

Design

1. Conflicts between public shoreline access facilities and adjacent uses might be mitigated by design techniques such as grade separation, landscaping and natural buffering, and fences.

2. Recreational facilities that might be included in public shoreline areas include piers and observation decks, telescopes, playgrounds, amphitheatres, walkways or bike paths along the waterfront and picnic tables. Support facilities might include parking areas, handicapped access, park benches, food concessions, restrooms and litter receptacles. Facilities should be barrier-free.

3. Publicly-accessible waterfront in downtown areas should be well lit, patrolled frequently by law enforcement personnel and designed so as to provide an overall sense of security.

Source: SVPDC(a), 1988: 54.

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CONTROLLING THE DENSITY OF PIERS AND DOCKS

As the Hampton Roads region has experienced rapid development of its vast shoreline area, an increase in the number of piers and docks for private access to adjacent waterways has simultaneously occurred. Under Virginia riparian law, every riparian owner is entitled to access the water adjacent to his property. However, there is a perceived problem that uncontrolled densities of piers and docks is contributing to water quality problems. This perception stems from the various water-dependent activities associated with the use of piers and docks, such as boat operation, maintenance, storage and, in particular, discharge of bilge water and wastewater, that have the potential to degrade water quality. Local governments have the opportunity to control the densities of private piers and docks, and thus the activities and intensity of water quality impacts associated with them, through local land use ordinances and mooring requirements. Examples of how such control can be achieved include minimum shoreline frontage requirements and clustering of water access rights and boat mooring in areas most suited to that purpose.

Before exercising these controls, however, the following issues should be considered:

- Research is lacking as to whether or not there is a direct correlation between the density of piers and docks in a particular waterway and any water quality problems that are occurring therein. Research has shown that the construction practices and materials used in the building of piers and docks can have a negative impact on water quality, but little if anything is mentioned regarding the cumulative impacts of many structures in a given area.

- Current permitting requirements in Virginia for water access facilities include project review criteria that are strictly related to the design, construction and location of such facilities. While they encourage minimization of impacts to shoreline features and subaqueous bottomlands, they do not to impacts to water quality, per se. In addition, construction of piers and docks for private use is exempt from this permitting process, except for a cursory review by the state for public safety purposes to ensure that the location of such a structure does not impede navigation in the waterway, as well as any permits which might be required under the local building code.

- Non-consumptive uses of water by riparian property owners is subject to Virginia riparian water law. At the same time, shoreline frontage and access to the water is strictly tied to local land use regulation through zoning and subdivision ordinances. Any proposals to restrict access are intextricably linked to the existing framework of state and local water and land use law, as well as private property rights and, as a result, might be politically undesirable.

- Water access can also provide for participation in more passive activities and does not always involve boating.

- Proposals to restrict access are only feasible in areas with undeveloped shorelines.

- Controlling the density of piers and docks to minimize negative impacts to water quality will address only a small part of a more comprehensive issue involving uncontrolled uses of waterways. The uncontrolled uses which occur along waterways in Virginia contribute to a hybrid problem of user conflicts, resulting in impacts to public safety, recreation, and natural resources. Therefore, a hybrid solution, such as a waterway management plan, which might require expansion of state and local regulatory authority, would be necessary to balance recreational activities, protection of the environment and increased safety on the water.

The following discussion attempts to identify the problem more clearly. In addition, this section will discuss the legal nonconsumptive rights of riparian owners and public water users, provide a review of the existing regulatory framework in Virginia as it relates to private pier and dock density, discuss existing private pier and dock densities within the project study area, discuss existing and future land use, zoning and subdivision ordinances by jurisdiction as it relates to pier and dock density, provide a review of density control standards and waterway management plans used by other States, provide recommendations for generic density standards and/or water use compatibility/waterway management plans, and identify areas in the existing regulatory framework at the state and local level that could be changed to better address this issue.

A. Piers and Docks vs. Water Quality

Research efforts to draw a correlation between the density of pier and dock structures in a particular waterway and water quality problems which might be occurring therein have, to date, not been able to determine that such a correlation exists. While construction practices and materials used in building access structures can potentially impact the immediate shoreline and nearshore environment at the time such structures are being built, large numbers of these structures, in and of themselves, have not been linked to specific water quality problems over time.

1. Pier and Dock Construction and Water Quality Impacts

A review of existing laws in Virginia governing the construction of private piers and docks reveals that such structures are statutorily exempt from the state permitting process; only a review of the project's impact on public safety and not water quality, per se, is required. Required nationwide or regional permits must be obtained from the Army Corps of Engineers (ACOE), however, prior to construction. In addition, each project is reviewed, by federal and state permitting agencies and local wetlands boards, on a case-by-case basis, as opposed to a cummulative impact basis which would take into consideration the project's impacts on other structures already present in a given area.

Under Title 28.2-1203(A) of the Code of Virginia, related to fisheries and habitat of tidal waters, it shall be unlawful for any person to build, dump, trespass or encroach upon or over, or to take or use any materials from the beds of the bays, ocean, rivers, streams, or creeks which are the property of the Commonwealth, unless such act is perfomed pursuant to a permit issued by the Virginia Marine Resources Commission (VMRC) or is necessary for the following:

- the construction of piers, docks, marine terminals, and port facilities owned or leased by or to the State or any of its political subdivisions; or
- the placement of private piers for non-commercial purposes by owners of riparian lands in the waters opposite those lands, provided that the piers do not extend beyond the navigation line or private pier lines established by VMRC or the Corps.

However, Title 28.2-1204 and the Subaqueous Guidelines developed by VMRC state that:

> "while placement of open-pile private piers for non-commercial purposes by owners of riparian lands in the riparian waters opposite such lands does not require a VMRC permit, VMRC does require the submission of an application on all piers in order that a determination can be made by VMRC staff as to the nature of the structure and its status with regard to qualifying for the statutory exemption, as well as to determine that such piers will not interfere with navigation."

VMRC utilizes the following definitions to make a determination regarding pier status:

- a private pier is generally held to be an appurtenance to riparian property constructed in the waters opposite said property whose use is non-commercial by definition and designed to provide navigable access and/or mooring for the riparian owner;

- non-commercial use means a pier which is for individual property owner use only, and does not support the sale of goods or services; and,

- community piers are generally held to be an appurtenance to riparian property for which ownership interest in the property is divided between two or more property owners in the adjoining subdivision or parcel (this also includes dock facilities associated with condominium-type dwellings because they increase the value of units offered for sale); community piers are therefore, by definition, commercial.

The Subaqueous Guidelines further state that:

- utilization of open-pile type structures for gaining access to navigable waters is strongly favored over construction of solid fill structures;

- the constructuion material and design being used should ensure stability and safety; and

- any piers constructed over vegetated wetlands should be high enough to prevent loss of existing vegetaton through shading.

This is the only place where a reference is made to the project's potential impact on the nearshore environment.

In addition, Title 28.2-1302 authorizes that any application received by VMRC for a water access structure that will occur in a wetland to be forwarded to the local wetlands board for permit issuance. The law provides that the following uses of and activities in wetlands are permitted: the construction and maintenance of non-commercial catwalks, piers, boathouses, boat shelters, fences, duckblinds, wildlife management shelters, footbridges, observation decks and shelters and other similar structures, provided that such structures are constructed on pilings as to permit the reasonably unobstructed flow of the tide and preserve the natural contour of the wetlands; and, non-commercial outdoor recreational activities, including boating, hunting, fishing, shellfishing, swimming, et als. provided that no structure shall be constructed excepts as permitted above, as well as other outdoor recreational activities, provided that they do not impair the natural functions or alter the natural contour of the wetlands.

Wetlands Guidelines developed by VMRC and the Virginia Institute of Marine Science (VIMS) state that:

"provided significant marine fisheries, wetlands and wildlife resources are not unreasonably or detrimentally affected, alteration of the shoreline for construction of shoreline facilities may be justified to gain access to navigable waters by: 1) commercial, industrial, and recreational interests for which it has been clearly demonstrated that waterfront facilities are required; and 2) owners of land adjacent to waters of navigable depth or water which can be made navigable with only minimal adverse impact on the environment."

The Wetlands Guidelines go on to state that:

"Utilization of open-pile type structures for gaining access to adequate water depths is generally preferred over the construction of solid structures, dredging or filling. The rationale for this is that construction of solid structures, or the conduct of dredging and filling operations, often causes irretrievable loss of wetlands through their direct displacement or by indirect effects of sedimentation or altered water currents. Open-pile structures permit continued tidal flow over existing wetlands and subtidal areas, avoid potential sedimentation problems, future maintenance dredging, and have less effect on existing water current patterns. Also, channels, fills and structures should be designed to withstand the maximum stresses of the marine environment, e.g. wind and wave action and corrosion of materials, and also to minimize the frequency of future maintenance activities. The rationale for this is that shoreline alterations often change currents, affect shoreline stability and cause biological damage. Unsuccessful structures or channels generate demands for remedial action which can compound initial adverse effects. Designs which minimize the dredging frequency in channels are particularly important. Dredging destroys or displaces bottom-dwelling organisms of value to the aquatic food web and, while such organisms can be expected to recolonize a dredge area after a period of time, too frequent dredging can inhibit recolonization."

Where a VMRC and/or wetlands board is not given authority to regulate construction or piers and docks through a permitting process, such construction does require a nationwide or regional Corps permit. For installation of private, non-commercial piers and mooring piles in certain navigable waters of the U.S., Regional Permit (RP) #17 must be obtained (if located in Broad Bay in Virginia Beach, RP #13 must be obtained). These are considered non-reporting activities by the Corps, provided that all of the permit conditions are met. The intent is to allow the open-pile structures (piers and mooring piles) to be built in locations that would not individually or cumulatively impact general navigation. This regional permit applies to residential developments only, with commercial and/or industrial development projects reviewed under individual permit criteria. In addition, any ~~all~~ open-pile piers associated with the construction or operation of new or expanded community, commercial or government facilities for recreational use must apply for RP #19.

Other approvals which may be required include a permit from VMRC to encroach on State-owned bottoms for the placement of isolated mooring piles and a building permit from the appropriate county, city or town. Finally, a water quality impact assessment (WQIA) shall be required for any proposed development within the RPA. The purpose of the WQIA is to identify the impacts of proposed development on water qualtiy and land in RPAs consistent with the goals and objectives of the Cheasapeake Bay Preservation Act, the regulations and local programs, and to determine specific measures for mitigation of those impacts. The specific content and procedures for the WQIA is established by local governments.

For installation of private riparian and non-riparian moorings, a permit must be obtained from VMRC because this activity falls outside of those given statutory exemptions. Concerning such structures, the Subaqueous Guidelines state that VMRC will normally grant a permit request by a riparian owner for a single mooring to be placed in accordance with the following general conditions:

- Mooring buoys should not normally be located:

  a) on private shellfish leases or designated public shellfish grounds
  b) in submerged cable-crossing areas
  c) in or near desginated navigation channels
  d) within 200 feet of a public or commercial bathing beach
  e) so as to interfere with the operation of or access through any bridge
  f) so as not to infringe on the riparian rights of adjacent properties

- Moorings should be marked and maintained in accordance with the "Uniform State Waterway Marking System."

- All permits granted by VMRC will contain a stiuplation that the permittee agrees to remove said structure from State-owned subaqueous bottomland within 90 days after written notification by VMRC.

VMRC will normally grant a permit request by a riparian owner for a single mooring to be placed in accordance with the general conditions outlined above and which is located within his riparian waters. VMRC may also grant a permit requested by an individual who does not own waterfront property for a single mooring buoy if certain conditions are met. VMRC may also consider a permit request for a group mooring under unusual circumstances.

For the installation, maintenance and repair of mooring piles in Broad Bay in Virginia Beach, RP #13 must be obtained from the Corps. In addition, for installation or construction of mooring piles/dolphins, fender piles and camels (wooden floats serving as fenders alongside piers), RP #19 must be obtained from the Corps.

In order for the proposed activity to qualify for this regional permit, the applicant must obtain a permit (not a waiver) from VMRC and/or the local wetlands board before the proposed work may begin. In the event the proposed project or any portion of the project receives a waiver (or is exempted through a grandfather clause), the project would not qualify for this regional permit and an individual Corps permit would be required. Also, Nationwide Permit (NP) #19 must be obtained if dredging of less than 25 cubic yards is to occur in the process of pier construction. When this is the case, VMRC or local wetlands board approval is also required.

Finally, the Subaqueous Guidelines state that any local government or state or federal agency may recommend to VMRC that the placement of moorings in the waters that fall within their political jurisdiction be restricted in certain areas or that certain areas be designated as mooring areas. However, the only purposes stated for which such a designation can be requested are to protect public safety and welfare, recreational and commercial interests.

Therefore, with the exception of a brief statement in the Subaqueous Guidelines and a general discussion found in the Wetlands Guidelines regarding water access structures and the rationale behind the preferred use of open-pile piers, and the WQIA requirements of the Chesapeake Bay Preservation Act, there is nothing within the existing federal, state and local regulatory framework which speaks to the relationship between the construction of piers and docks and their impacts to water quality per se, nor to the preferred density of such structures in a given waterway. Where location is a concern, such as review of project plans by the State and local requests for designation of community mooring areas, it stems from a public safety, commercial recreational interest.

To date, PDC staff research efforts have only found studies on the use of piers, docks and wharves in the design and construction of marina facilities to highlight potential water quality problems associated with use of such structures. These findings could be transferred to the construction of private piers and docks. For a discussion of these study findings, refer to the section of this report entitled, **"The Siting and Design of Water Access Facilities and Water-Enhanced Recreation Areas to Reduce Potentially Adverse Impacts to the Shoreline and Nearshore Marine Environment, Subsection A.1.(c)(ii): Use of Bulkheads, Breakwaters, Piers, Wharves, and Docks in Marina Design and Construction."**

PDC staff will be attending a conference in March on Marine and Estuarine Shallow Water Management, where research will be presented from other states on the evaluation of pier effects on fish, impacts of Chromate-Copper-Arsenate (CCA)-Treated wood in shallow water estuarine systems, and potential impacts of marina construction on shallow water primary productivity and fishery habitats in order to better address this issue.

2. Pier and Dock Density and Related Water Quality Impacts

Rather than the actual presence of piers and docks in a waterway being the source of water quality problems, a more significant source of water pollution appears to be the uncontrolled activities that occur in the vicinity of such structures and, in particular, those which are related to boating. It can be argued, therefore, that the more piers and docks there are in a particular waterway, the greater the potential for water quality problems to occur. The question is whether or not these activities can be better controlled at the individual lot level by the environmentally-consious boat owner or in an area where boats are concentrated, such as private community or commercial marina facilities and other mooring areas.

On the one hand, concentrating activities which have the potential to cause water pollution serves only to concentrate the pollutants being discharged into one area. At the same time, concentration of boating activities in an area can better provide for water resource management by controlling the activities which contribute to water qualtiy degradation. For example, for newly-permitted marina facilities, pump-out facilities are now required and, therefore, the dumping of bilge and wastewater overboard is discourgaged or not permitted. As well, the various practices involved in maintenance of boats, such as painting and scraping, can be better mangaged when such activities are governed by a facility's operation and use rules. However, under current Virginia law as cited above, community mooring areas can only be desigated by a locality for the purposes of protecting public safety and welfare, and recreational and commercial interests. No specific authority is given that allows designation of such areas for the purposes of controlling impacts to water quality.

On the other hand, scattered placement of piers and docks and associated activites along a shoreline might provide for better dispersal and dillution of pollutants associated with boating activities which could enter the water. However, if a waterway is not well-flushed, residence time of pollutants in the water column and entrapment in bottom sediments will be longer. This could also be the case if a community marina facility were located along a waterway than is not adequately flushed. Since riparian rights to access the water must be exercised on the riparian parcel and in the waterway adjacent to that parcel, and cannot be transferred to another parcel or waterway, relocation of access to another riparian parcel more suited to that purpose is not possible. Therefore, it has not been determined which approach is the preferred alternative to minimizing impacts to water quality.

Another issue is the determination of an adequate density of piers and docks in a given waterway. If density were to be tied, for example, to the carrying capacity of a particular waterway, the carrying capacity would be determined by that amount of water access legally prescribed under Virginia riparian law. Since Virginia riparian law states that each riparian property is entitled to one access point into the adjacent waterway, the number of riparian parcels along a waterway would be equivalent to the carrying capacity of that waterway. Therefore, by law, each riparian parcel owner would be entitled to access the water and the number of riparian parcels allowed along a given waterway will be determined under local land use zoning and subdivision ordinances.

The number of access points in a given waterway is determined by the development unit per acre density at which a given riparian parcel is zoned. The riparian parcel can be subdivided according to the density which the zoning allows. Subsequently, the number of piers and docks legally allowed in a given waterway can be reduced through minimum shoreline width requirements placed in the local subdivision ordinance. In larger subdivisions, riparian rights to access adjacent waters can also be stripped from waterfront lots prior to sale and transferred to a central access point, and deed restrictions can be placed on the lots which prohibit lot purchasers from building water access structures. In this case, the riparian owner can access the water adjacent to his property from his land only, and for passive uses only, and more water-intensive uses, such as mooring of boats, can only occur at a central location. Lots can also be clustered around central access areas, with the same deed restrictions, leaving more open space in the plan of development. Local subdivision ordinances often provide credits to developers of large subdivisions or planned unit developments for areas dedicated to open space. Another option is to hold shoreline areas in large developments in common by the developer, to later be transferred to ownership by the property owners association, so that no individual lots can be legally defined as riparian. In any case, these options will only work in jurisdicitons with undeveloped shoreline areas and, in particular, where large tracts of riparian land are available; thus, they provide little oppotunity for control of pier and dock density in more developed areas.

In a preliminary conclusion, whether or not access to the water occurs from individual riparian parcels or from a central location, the potential will still exist for water pollution to occur, although introduction of pollutants to the water might receive more oversight at a central access area. In addition, access to the water cannot be legally denied to riparian property owners under any circumstances unless so stated in the deed transfer.

the literature appears to indicate that

REGIONAL SHORELINE ELEMENT
OF
COMPREHENSIVE PLANS
HAMPTON ROADS PLANNING DISTRICT
(INTERM REPORT)

VOLUME II

PREPARED BY THE
HAMPTON ROADS PLANNING DISTRICT COMMISSION

HAMPTON ROADS
PLANNING DISTRICT COMMISSION

MARCH 1994

Comprehensive Shoreline Management Plan
System/Subarea Breakdown Outline

Findings and Recommendations Document

I. System Information
   A. General Description and Location
   B. Water Quality Data
   C. Sensitive Lands and Aquatic Resources
   D. Existing Water Access Facilities and Water Enhanced Recreation Areas
   E. Proposed Public Water Access and Recreation Areas and Future Needs Assessment
   F. System Shoreline Condition
      1. Direct Frontage Shoreline
         a. Shoreline Length
         b. Percentage of Hardened Shoreline
         c. Number of Piers and Docks
         d. Pier and Dock Density
      2. Total Shoreline Within the System
         a. Shoreline Length
         b. Percentage of Hardened Shoreline
         c. Number of Piers and Docks
         d. Pier and Dock Density

II. Subarea Information (Note: There may be several subareas per system)
   A. General Description and Location
   B. Water Quality Data
   C. Sensitive Lands and Aquatic Resources
   D. Existing Water Access Facilities and Water Enhanced Recreation Areas
   E. Proposed Public Water Access and Recreation Areas and Future Needs Assessment
   F. Subarea Shoreline Condition
      1. Shoreline Length
      2. Percentage of Hardened Shoreline
      3. Number of Piers and Docks
      4. Pier and Dock Density

III. Mainstem Segment (Note: There may be several mainstem segments per subarea.)
   A. General Description and Location
   B. Water Quality Data
   C. Sensitive Lands and Aquatic Resources
   D. Existing Water Access Facilities and Water Enhanced Recreation Areas
   E. Proposed Public Water Access and Recreation Areas and Future Needs Assessment
   F. Mainstem Shoreline Condition (Note: Mainstem information may be one reach, an overview of several reaches, or several separate reaches.)
      1. Shoreline Length
      2. Percentage of Hardened Shoreline

3. Number of Piers and Docks
4. Pier and Dock Density
5. Erosion Rate (Where Applicable and Available.)
6. Average Bank Height (Where Applicable and Available.)
7. Predominant Adjacent Land Use (Where Applicable.)
8. Erosion Control Recommendation (Where Applicable.)

G. Reach Information (Note: There may be several reaches per mainstem segment.)
1. Shoreline Length
2. Percentage of Hardened Shoreline
3. Number of Piers and Docks
4. Pier and Dock Density
5. Erosion Rate (Where Available.)
6. Average Bank Height (Where Available.)
7. Predominant Adjacent Land Use
8. Erosion Control Recommendation

IV. Waterbody Information (Note: There may be several Waterbodies per subarea.)

A. General Description and Location

B. Water Quality Data

C. Sensitive Lands and Aquatic Resources

D. Existing Water Access Facilities and Water Enhanced Recreation Areas

E. Proposed Public Water Access and Recreation Areas and Future Needs Assessment

F. Waterbody Shoreline Condition (Note: Tidal waterbody information may be one reach, an overview of several reaches, or several separate reaches. Isolated waterbody information may not be available or reported.)
1. Shoreline Length
2. Percentage of Hardened Shoreline
3. Number of Piers and Docks
4. Pier and Dock Density
5. Erosion Rate (Where Applicable and Available.)
6. Average Bank Height (Where Applicable and Available.)
7. Predominant Adjacent Land Use (Where Applicable.)
8. Erosion Control Recommendation (Where Applicable.)

G. Reach Information (Note: There may be several reaches per mainstem segment.)
1. Shoreline Length
2. Percentage of Hardened Shoreline
3. Number of Piers and Docks
4. Pier and Dock Density
5. Erosion Rate (Where Available.)
6. Average Bank Height (Where Available.)
7. Predominant Adjacent Land Use
8. Erosion Control Recommendation

Relationships Between Data Levels

I. Hampton Roads **Study Area**
   A. Large Water **Systems** (York River System, James River System, etc.)
      1. **Subareas** - are defined by mainstream segments. There may be several subareas per system.
         a. **Mainstem segments** - designated stretches of shoreline along the controlling body of water (System).
            (1) **Reach** - the reach is the ultimate level of information in this report. There may be several reaches within a mainstem segment.
               (a) Site Specific Information - not available in this study.
         b. **Waterbodies** - are connected via surface flow to the system and the discharge point enters the system within the subarea.
            (1) **Reach** - There may be several reaches per waterbody. In some situations isolated waterbodies may not have information to the reach level.
               (a) Site Specific Information

SHORELINE INVENTORY DESCRIPTIONS -- METHODOLOGY

The following section provides a comprehensive inventory of shoreline features, water quality, shoreline erosion control structures, sensitive land and aquatic resources, and public and private water access points for the project study area. This inventory has been categorized according to the methodology below:

- System
- Subarea
  - Mainstem Segment
  - Waterbody
  - Reach

The System inventory includes all shoreline reaches, tributaries, and other waterbodies with connected surface flow to the larger tributaries of the Chesapeake Bay and has been categorized as follows: York River (Ware Creek to Tue Point), Lower Western Shore Chesapeake Bay (Sandbox to Old Point Comfort), James River (North Shore - Chickahominy River to the Monitor-Merrimac Bridge/Tunnel) (South Shore - Lawnes Creek to the Monitor-Merrimac Bridge/Tunnel), Hampton Roads (North Shore - Monitor-Merrimac Bridge/Tunnel to to Old Point Comfort) (South Shore - Monitor Merrimac Bridge/Tunnel to the Hampton Roads Bridge/Tunnel), South Shore Chesapeake Bay (Willougby Spit to Cape Henry), and Non-Chesapeake Bay Watershed (Atlantic Shore - Cape Henry to North Carolina Line, Albemarle-Chesapeake Canal/North Landing River and Back Bay). A qualitative summary is provided for each System.

For ease of analysis, each System is subdivided into Subareas. For example, the York River System is subdivided into three Subareas: Subarea A: Ware Creek to Queens Creek; Subarea B: Queens Creek to Coleman Bridge; Subarea C: Coleman Bridge to Tue Point. A qualitative summary is provided for each Subarea.

For further ease of analysis, each Subarea is subdivided into three categories: 1) mainstem segments, which comprise the shoreline of the larger system; 2) waterbodies, which include the smaller tributaries to the larger system, and any lakes, ponds and reservoirs within the subarea with connected surface flow to the larger system; and 3) shoreline reaches as defined for the purposes of this study; a reach may include an entire mainstem segment, an entire waterbody, or any combination thereof and may cross Subarea boundaries. A qualitative summary is provided for each category.

The rationale for selecting this methodology is that shoreline management needs to occur on a comprehensive shoreline or water area basis and not be limited to jursidicitonal boundaries. This methodolgy provides for description and analysis of entire systems, subareas, waterbodies, mainstem segments and reaches which can then be compared categorically and across jurisdictional boundaries for comprehensive planning purposes.

Tables are included which show shoreline conditions by System, Subarea, Waterbody and Reach. These tables also categorize data information by jurisdiction. Data quantified in these tables include: total shoreline lengths, lengths and percentages of hardened shoreline. numbers of piers and docks (this data also includes marina facilities, with each facility counted as one pier/dock--total numbers of slips at each marina facility is included elsewhere in the report), pier and dock densities per thousand feet of shoreline, bank heights and erosion rates.

<<Note: For the purposes of an interim product, only the York County portion of the York River and Lower Western Shore Chesapeake Bay Systems has been completed. Information on York County has been included at all category levels, whereas information as it pertains to other jurisdictions (e.g., James City County and the Cities of Poquoson and Hampton) has only been included in the System and Subarea summaries as applicable.>>

SYSTEM: LOWER WESTERN SHORE CHESAPEAKE BAY

General Description and Location

For the purposes of this study, the Lower Western Shore Chesapeake Bay System encompasses the shoreline and all small coastal tributaries and other waterbodies connected by surface flow to the Chesapeake Bay from the Sandbox at the confluence of The Thorofare and the York River to Old Point Comfort at the confluence of Hampton Roads and the Chesapeake Bay including: The Thorofare, Back Creek, Claxton Creek, Bay Tree Creek, Chisman Creek, Cabin Creek, Goose Creek, Boathouse Creek, the Poquoson River, Hodges Cove, Patricks Creek, Quarter March Creek, Harwoods Mill Reservoir, Moores Creek, Lambs Creek, Roberts Creek, Lyons Creek, White House Cove, Bennett Creek, Easton Cove, Easton Creek, Lloyd Bay, Sandy Bay, Fire Pine Creek, Gum Hammock Creek, Thorofare Creek, the Back River, Northwest Branch Back River, Flat Gut, High Cedar Creek, Bells Oyster Gut, Front Cove, Messick Creek, Back Cove, Long Creek, Fore Landing Creek, Watts Creek, Topping Creek, Cedar Creek, Oxford Run, Brick Kiln Creek, Big Bethel Reservoir, Tabbs Creek, Southwest Branch Back River, Mill Creek, Newmarket Creek, the Harris River, Wallace Creek, White Pond Swamp and Salt Ponds. This system is located within the York River Basin and the Chesapeake Bay and Small Coastal Rivers Basins and is within York County and the Cities of Poquoson, Hampton and Newport News. A centerline in the Poquoson River and in Lambs Creek forms the corporate boundary between York County and the City of Poquoson. A centerline in the Back River, the Northwest Branch Back River and Brick Kiln Creek forms the corporate boundary between the Cities of Poquoson and Hampton.

Water Quality Data

Existing water quality data for this system is as follows:

<u>HUC 02080101 Mainstem Open Bay</u>

The VWCB conducts monitoring in the Chesapeake Bay mainstem as part of the Federal-Interstate Chesapeake Bay Program (CBP). The CBP Monitoring Program collects basic water quality parameters and also monitors the status and trends in benthic, phytoplankton, and zooplankton communities.

The water quality assessment performed here relied on four main sources of information. The first major source of information was an examination of monitoring data in relation to established water quality standards for Class II, estuarine waters. DO values were compared to the minimum DO standard. Ammonia data were compared to the state criterion, which is calculated based on water temperature and pH. Fecal coliform bacteria samples are not collected as part of the CBP Monitoring Program. Given the lack of bacterial data for comparison against the standard, support of the CWA swimmable goal was determined by best professional judgment.

The second major basis of this assessment was the use of information from the Virginia Department of Health on shellfish harvesting condemnation areas. These areas were designated as partially supporting of the fishable goal.

The third major source of information for this assessment was an examination of the distribution of SAV. There has been a general decline in distribution of SAV throughout the Bay, which has resulted from declining water quality conditions. The Chesapeake Bay Program has established the return of SAV populations as a measure of restoration of the Bay and proposed a set of tiered goals. Tier I goals are the re-establishment of SAV populations in areas in which the presence of SAV has been well documented at some time in the past. For this assessment, areas of the Bay that have not achieved the Tier I goal have been designated as partially supporting of the CWA goal for fishable waters.

The fourth major basis of this assessment was monitoring data analysis done as part of the 1991 re-evaluation of the Chesapeake Bay nutrient reduction goals, henceforth referred to as the 1991 re-evaluation analysis. The 1991 re-evaluation analysis involved an examination of all water quality information collected as part of the CBP Monitoring Program during the period of 1984 through 1990. For this 1991 re-evaluation analysis, water quality of Chesapeake Bay segments was compared to other Bay segments, as well as examined for recent trends. There are no standards or criteria established for most of the parameters monitored by the CBP (e.g. nutrients, water clarity) and it is difficult to use this information for determining CWA goal status. Therefore, results were not used in determining the CWA goal status; however, environmentally undesirable conditions or trends are noted.

Segment 101-03CE (Southwestern Portion of the Chesapeake Bay)

This segment encompasses 123 square miles of water located in the southwestern portion of the Bay, from Mobjack Bay to Back River. The VWCB maintains 2 water quality stations in this segment. Depths at these stations average approximately 5-7 meters. Salinities were 16-20 ppt, with slight stratification present.

Water quality in this segment was characterized by average levels of total nitrogen and phosphorus and low levels of inorganic nutrients. Light levels were good. Chlorophyll levels were generally not excessive, however there was a moderately increasing trend during the period of 1984-1990. Bottom water DO levels were fairly good. There were no significant inter-annual trends in total nitrogen, total phosphorus, water clarity or DO during the period of 1984-1990.

The shallow water areas of this segment are potential habitat for SAV. Approximately 7 square miles of this segment are estimated to have had the documented presence of SAV but do not have any SAV now. Because of this decline in SAV, 7 square miles of this waterbody segment are considered to only partially meet the CWA goal for fishable waters.

The DO standard was violated in 0.5% of the samples collected. The pH standard and the ammonia criterion were not violated in any samples during this reporting period. All of this segment was evaluated as fully supporting the CWA goal for swimmable waters.

In summary, 116 square miles of this segment fully support the CWA goal for fishable waters, 7 square miles partially support the CWA goal for fishable waters, and all (123 square miles) of this segment fully support the CWA goal for swimmable waters.

<u>HUC 02080108: Lower Western Shore Tributaries; Segment 108-01E: The Poquoson River Waterbody</u>

Encompasses an area from The Thorofare near the York River to Lloyd Bay at Big Salt Marsh, including The Thorofare, Back Creek, the Poquoson River, Chisman Creek, Patricks Creek, Lambs Creek, Lyon Creek, Boathouse Creek, Lloyd Bay, and other associated tributaries.

Citizen members of the Alliance for the Chesapeake Bay sampled two stations. The data indicated no violations for DO, temperature, or pH.

Seven industrial facilities (mainly seafood processors) discharge to this waterbody. Problems in the area can be attributed mainly to NPS pollutants.

The Poquoson River area is included in Watershed C10 (HUC 02080108) in the 1993 Virginia Nonpoint Source Pollution Watershed Assessment. This 22 square mile hydrologic unit includes the eastern Virginia mainland that drains into the Chesapeake Bay south of the York River Basin, north of the Chowan River Basin, and excluding the James River Basin. It encompasses part of York County and portions of the cities of Norfolk, Virginia Beach, Poquoson, Hampton and Newport News. The primary tributaries in this hydrologic unit are the Poquoson, Back and Lynnhaven Rivers.
Urban land uses dominate this watershed, as reflected in it being ranked in the top 5% statewide for urban pollution potential. The watershed is rated low priority for both agricultural and ~~forestal~~ contributions of nonpoint source pollution. Water quality data for C10 exhibits elevated levels of bacteria and phosphorus which are partially attributable to stormwater runoff from urban areas. Urban nonpoint sources are also considered responsible for numerous shellfish condemnations in C10. This watershed is also an important area for commercial fishing, shellfish harvesting, and shellfish relaying grounds.

Watershed C10 has a final rank of High+ in Virginia's Overall Nonpoint Source Pollution Priorities for 1993.

The CWA fishable goal for this waterbody, which covers 7.62 square miles of surface water, is fully supported for 5.69 square miles and partially supported for 1.93 square miles. The swimmable goal is fully supported for the entire waterbody.

Segment 108-02L: The Harwoods Mill Reservoir Waterbody

Located [west] of the Poquoson River, and encompasses an area from the headwaters near Fort Eustis Boulevard to a dam at George Washington Memorial Highway (U.S. 17). The reservoir is located in York County and owned and used by the City of Newport News as a public water supply. Harwoods Mill covers a surface area of 300 acres and is classified as mesotrophic. This waterbody was not assessed during the current reporting period for its support of the CWA fishable and swimmable goals.

Segment 108-04E: The Back River Waterbody

Encompasses an area from the headwaters of Back River and its tributaries to the confluence with the Bay, including the Northwest Branch, Southwest Branch, Long Creek, Grunland Creek, Harris River, Wallace Creek, and other surrounding tributaries.

Eight point sources (2 domestic, 6 industrial) discharge to this waterbody. Other influences on the water quality of the area can be attributed to NPS pollutants.

The Back River area is included in Watershed C10 (HUC 02080108) in the 1993 Virginia Nonpoint Source Pollution Watershed Assessment. Refer to the Poquoson River Waterbody discussion above for information on Watershed C10.

The CWA fishable goal for this waterbody, which covers 10.03 square miles of surface water, is fully supported for 8.20 square miles and partially supported for 1.83 square miles. The swimmable goal is fully supported for the entire waterbody.

Segment 108-05R: The Brick Kiln Creek Waterbody

Encompasses the area from the Lower Big Bethel Dam to the confluence with the Northwest Branch of Back River, including the lower mainstem of Brick Kiln Creek, and all associated tributaries. This waterbody is classified as effluent limited.

The VWCB maintains a AWQM station on Brick Kiln Creek at the Route 134 Bridge. There were no violations above a 10% rate for temperature, DO or pH; however, the station exhibited a 42% violation rate of the fecal coliform bacteria standard.

Three industrial facilities discharge to Brick Kiln Creek and to an unnamed tributary. However, the main influence on the water quality of this waterbody can be attributed to NPS pollutants.

The CWA swimmable goal for this waterbody, which covers 11.30 river miles, is fully supported for 7.30 river miles and unsupported for 4.00 river miles. The fishable goal is fully supported for the entire waterbody.

Segment 108-06L: The Big Bethel Reservoir Waterbody

Located [west] of the Northwest Branch of Back River and encompasses an area from the headwaters of the upper Brick Kiln Creek down to the Lower Big Bethel Dam, including associated tributaries and ponds. This reservoir is owned by the U.S. Army and is used by the military as a public water supply. Big Bethel covers a surface area of 266 acres, and has been classified as eutrophic. This waterbody was not assessed during the current reporting period for its support of the CWA fishable and swimmable goals.

NOTE: Back Creek has also been included in HUC 02080107 (York River Subbasin), Segment 107-06E (The York River-Gloucester Waterbody) of the 1992 305(b) Virginia Water Quality Assessment Report. Refer to the York River System discussion for this information.

Sensitive Land and Aquatic Resources

The following sensitive land and aquatic resources are present in this system: extensive tidal marshes, fringing tidal marshes, tidal flats, SAV beds, shellfish producing areas, shellfish management areas, condemned shellfish areas, and two protected areas.

An inventory of tidal marshes in this system can be found in the following publications: York County-Town of Poquoson Tidal Marsh Inventory (1974) and City of Hampton Tidal Marsh Inventory (1975). These inventories show that there were approximately ____ acres of tidal marshes located within this system at the time the inventory was conducted. Evaluation of wetland types, based on total environmental value of an acre of each type, ranged from ____ to ____; this is out of five groups, with Group One being of highest value and Group Five being of least value.

SAV beds were mapped fairly extensively in 1991 in this system along the Chesapeake Bay face from Green Point on The Thorofare to York Point, off of Hunts and Pasture Necks at the mouth of the Poquoson River, in Poquoson and Drum Island Flats, off of Plum Tree Island, and in the Back River. Some nearshore areas in this system have been included in the Tier I Chesapeake Bay SAV Distribution Restoration Target and the entire system, with the exception of the Chesapeake Bay beach face in Hampton, has been included in the Tier III Chesapeake Bay SAV Distribution Restoration Target.

Shellfish producing areas can be found off the mouth of the Poquoson River, and in the Chesapeake Bay off of Plum Tree Island south to Old Point Comfort in Hampton Roads. The Poquoson and Back River Shellfish Management Areas were designated and became effective on 1/1/94 to protect and promote the hard clam resource. There are several Condemned Shellfish Areas throughout the system (#151, #137, #21 and #158) in many of the smaller tributaries. There are 19 marina facilities within this system which necessitate a seasonal shellfish condemnation between April 1 and October 31.

Anadromous finfish spawning and nursery areas are located...? Commercially-and recreationally-important fishing areas can be found...? They include...?

Plum Tree Island National Wildlife Refuge in the City of Poquoson and Grandview Natural Preserve are the only protected areas in this system. The Refuge is currently seeking to expand its western boundary to include the Black Walnut Ridge area but the Poquoson City Council has not reached agreement on the expansion.

Existing Water Access Facilities and Water-Enhanced Recreation Areas

There are 18 water access facilities and water-enhanced recreation areas in this system, including public boat launch areas, private/commercial marina facilities, private boat ramps, county-and city-owned parks, and natural areas with opportunities for nature study. The 1990 Chesapeake Bay Program Public Access Plan states that sailing is probably more popular in this area than in other areas of the Chesapeake Bay. There is intense pressure in the Cities of Poquoson and Hampton, in particular, to develop additional public water access sites. Many of the existing marina facilities in these localities are operating at capacity and have waiting lists for berth space. During peak periods, some locations on the Back River are congested.

Proposed Public Water Access and Recreation Areas and Future Needs Assessment

The 1990 Chesapeake Bay Program Public Access Plan suggests that additional boating sites are needed on the Poquoson River to relieve heavy boat traffic near the mouth of the York River. Additional access is also needed on the Back River to disperse boat traffic and to meet future demand from residents and visitors. It is also recommended that sites be identified to provide additional recreational access on the Poquoson River, Back River, and the beachfront area along the Bay in Hampton. The 1991 York County Comprehensive Plan identifies expansion of existing recreation facilities and development of additional water access facilities in this system. York County is also working with the business community to encourage the development of public/private partnerships to meet recreational needs in the County. In addition, this southeastern portion of York County is the more populated area of the County and, therefore, experiences more public water access and recreation demands from both county residents and visitors.

<Add Poquoson and Hampton Comprehensive Plan info..>>

Shoreline Condition (Lower Western Shore of the Chesapeake Bay System)

The York County portion of the Lower Western Shore of the Chesapeake Bay System (Thorofare to Old Point Comfort) contains 20.11 miles of direct shoreline frontage to the Thorofare, Chesapeake Bay, or the Poquoson River. The average pier and dock density for the direct frontage is 1.43 docks and piers per 1000 feet of shoreline and a total of 152 piers and docks. Within this portion of the system, 19.77 percent of the shoreline is hardened.

The York County portion of the Lower Western Shore of the Chesapeake Bay System (Thorofare to Old Point Comfort) contains 96.93 miles of total shoreline. The average pier and dock density for the total shoreline is 1.25 docks and piers per 1000 feet of shoreline and a total of 639 piers and docks. Within this portion of the system, 14.87 percent of the shoreline is hardened.

For ease of analysis, this system has been subdivided into five subareas as follows: 1) Subarea A: Sandbox to York Point (The Thorofare); 2) Subarea B: York Point to Sandy Bay (Poquoson River); 3) Subarea C: Sandy Bay to Plum Tree Point; 4) Subarea D: Plum Tree Point to Northend Point (Back River); and 5) Subarea E: Northend Point to Old Point Comfort.

SUBAREA A: SANDBOX TO YORK POINT (The Thorofare)

General Description and Location

For the purposes of this study, this subarea has been delineated as beginning at Sandbox at the confluence of The Thorofare and the York River, then south along western shoreline of The Thorofare to York Point on the Chesapeake Bay shoreline. The major tributaries to The Thorofare in this subarea include Back Creek, Claxton Creek and Bay Tree Creek. This subarea is located entirely within York County.

Water Quality Data

Refer to above for HUC 02080101 (Mainstem Open Bay), Segment 101-03CE (Southwestern Portion of the Chesapeake Bay), HUC 02080108 (Lower Western Shore Tributaries), Segment 108-01E (The Poquoson River Waterbody). Refer to the York River System discussion for information on HUC 02080107 (York River Subbasin), Segment 107-06E (The York River-Gloucester Waterbody).

Sensitive Land and Aquatic Resources

The following sensitive land and aquatic resources are present in this subarea: fringing tidal marshes, tidal flats, SAV beds, and a condemned shellfish area.

This subarea is partially within the Goodwin Island-Back Creek and partially within the Poquoson River Area-Chisman Creek Areas of the York County and Town of Poquoson Tidal Marsh Inventory. The tidal marsh inventory shows that there were approximately 356 acres of tidal marsh present in this subarea at the time the inventory was conducted. Evaluation of wetland types in this subarea, based on total environmental value of an acre of each type, ranged from Group One to Group Three; this is out of five groups, with Group One being of highest value and Group Five being of least value (Silberhorn, 1974: 33-40).

SAV beds were mapped in 1991 adjacent to Crab Neck just south of Goodwin Island from the mouth of Claxton Creek to York Point. No SAV beds were mapped in Back or Claxton Creeks. Much of this subarea has been included in the Tier I-Tier III Chesapeake Bay SAV Distribution Restoration Targets.

Commercially- and recreationally-important fishing grounds?
There are ___ seafood processing plants (commercial fisheries) located in this system.

There is one shellfish condemnation area is this subarea: #151. There is one marina facility within this system which necessitates a seasonal shellfish condemnation between April 1 and October 31.

Existing Water Access Points and Water-Enhanced Recreation Areas

There are 4 water access and water-enhanced recreation areas located in this subarea. They include one public boat ramp at a county-owned park and 3 private/commercial marinas (one with a boat ramp).

Proposed Public Water Access and Recreation Areas and Future Needs Assessment

The 1991 York County Comprehensive Plan has identified one site which could be developed into a public boat launch area. The County is also working with the business community to enhance an existing county-owned park area through development of a public/private partnership. The 1990 Chesapeake Bay Program Public Access Plan identifies one potential public access site. The Plan also suggests that the large tidal marshes along the tidal creeks in York County could be made more accessible for activities such as nature study and environmental education. Canoe put-in/take-out points could also be identified in these same areas.

<Add 1989, 1994 VOP reco's.>>

Shoreline Condition (Subarea A - Thorofare to York Point)

Subarea A contains 6.17 miles of direct shoreline frontage and 16 piers and docks. The average pier and dock density in the subarea is 0.49 piers and docks per 1000 linear feet of shoreline. Within the subarea 20.86 percent of the shoreline is hardened. Subarea A also contains the associated non-direct shoreline waterbodies of Back Creek, Claxton Creek, and Bay Tree Creek.

For the purposes of analysis, this subarea is subdivided into three categories: 1) waterbodies, which include the smaller tributaries of the York River, and any lakes, ponds and reservoirs within the subarea with connected surface flow to the York River; 2) mainstem segments, which comprise the southern shoreline of the York River between identified waterbodies; and 3) shoreline reaches as defined for the purposes of this study; a reach may include an entire waterbody, a mainstem segment, or any combination thereof and may cross subarea boundaries.

MAINSTEM SEGMENT: SANDBOX TO BACK CREEK (Reach 112)

General Description and Location

This mainstem segment has been delineated as beginning at Sandbox on the western shore of Thorofare at its confluence with the York River then south along the western shoreline of the Thorofare to Back Creek.

Water Quality Data

Refer to above for HUC 02080101 (Mainstem Open Bay), Segment 101-03CE (Southwestern Portion of the Chesapeake Bay), HUC 02080108 (Lower Western Shore Tributaries), Segment 108-01E (The Poquoson River Waterbody).

Sensitive Land and Aquatic Resources

The following sensitive land and aquatic resources are present in this segment: fringing tidal marshes and a seasonal shellfish condemnation area.

The tidal marsh inventory shows that there were approximately 3.9 acres of tidal marsh located in this segment at the time the inventory was conducted. Subdivided acreage of tidal marshes were: 1.4 acres at Sandbox and 2.5 on the western shoreline of The Thorofare. Evaluation of wetland types in this segment, based on total environmental value of an acre of each type, was Group One; this is out of five groups, with Group One being of highest value and Group Five being of least value (Silberhorn, 1974: 33-40).

There were no SAV beds mapped in this segment in 1991. However, a small nearshore area around the halfway point in this segment has been included in the Tier I Target for Chesapeake Bay SAV Distribution Restoration and the entire segment has been included in the Tier III Target for Chesapeake Bay SAV Distribution Restoration down to the 2-meter depth contour or in the 6-foot depth range.

There is one marina facility located in this waterbody which necessitates a seasonal shellfish bed closure between April 1 and October 31 of 1/8 mile and covering approximately 6 acres: Belvin Marine.

There is one seafood processing facility (commercial fishery) located in this subarea.

Existing Water Access Facilities

There is one commercial marina and boat repair facility located in this segment just inside the Sandbox: Belvin Marine (203 Belvin Ln.).

Existing Water-Enhanced Recreation Areas

None.

Proposed Public Water Access and Recreation Areas and Future Needs Assessment

No additional public water access and recreation areas have been proposed in this segment.

Bathymetry

NOAA-National Ocean Service charts and USGS topographic maps shows soundings of 1-13 feet from the shoreline out to the main channel in The Thorofare.

Flushing Rates

Based on the previous general discussion of flushing characteristics of the Lower Western and southern Shore Chesapeake Bay Small Coastal Basins, it can be inferred that this segment is not well-flushed.

Current Patterns

Shoreline Condition (Reach 112)

Reach 112 contains 6,600 feet of shoreline and 15 piers and docks (Pier and Dock Density = 1.14 piers/docks per thousand feet of shoreline). The erosion rate for reach 112 is 1.70 feet per year as reported by the Virginia Institute of Marine Science in *Shoreline Erosion in Tidewater Virginia*, 1978. The average bank height is reported to be five feet by the same source. The predominant land use adjacent to this reach is (landuse). 45.45 percent of the reach's shoreline was hardened at the time of the aerial survey. Based on observed conditions, it would appear that (appropriate erosion control recommendation).

WATERBODY: BACK CREEK (Reach 111)

General Description and Location

This waterbody is one of two major tributaries to The Thorofare and enters along its west side.

Water Quality Data

Refer to above for HUC 02080108 (Lower Western Shore Tributaries), Segment 108-01E (The Poquoson River Waterbody). Refer also to the York River System discussion for information on HUC 02080107 (York River Subbasin), Segment 107-06E (The York River-Gloucester Waterbody).

Sensitive Land and Aquatic Resources

The following sensitive land and aquatic resources are present in this waterbody: fringing tidal marshes and a condemned shellfish area.

The tidal marsh inventory shows that there were approximately 21 acres of tidal marsh present in this waterbody at the time the inventory was conducted. The marshes of Back Creek are mainly small cove and fringing marshes, except for the 10 acre pocket marsh at the headwaters of the creek. This marsh is mostly vegetated by highly productive saltmarsh cordgrass, a highly value marsh type. Evaluation of wetland types in this waterbody, based on total environmental value of an acre of each type, was Group One; this is out of five groups, with Group One being of highest value and Group Five being of least value (Silberhorn, 1974: 33-35).

There were no SAV beds mapped in this waterbody in 1991. An area at the mouth of Back Creek has been included in the Tier I Target for Chesapeake Bay SAV Distribution Restoration and all of Back Creek has been included in the Tier III Target for Chesapeake Bay SAV Distribution Restoration down to the 2-meter depth contour or in the 6-foot depth range.

Shellfish Condemnation Area #151, which includes all of Back Creek, went into effect 7/6/92. This is a restricted area where it is unlawful to take shellfish for any purpose, except by a VMRC permit.

There is one seafood processing facility (commercial fishery) for scallops located in this waterbody: Seaford Scallops (at the end of Shirley Rd.).

Existing Water Access Facilities

There are 4 water access facilities located in this waterbody. There is one county-owned public boat landing located on the north shore of Back Creek at Back Creek Park (Goodwin Neck Rd.). There are 2 private/commercial marinas located on the north shore of Back Creek: Seaford Yacht Club and Mills Marina (Goodwin Neck Rd). Mills marina also has a boat ramp. Seaford Scallops operates a seafood processing facility and wharf on the south shore of Back Creek (at the end of Shirley Rd).

Existing Water-Enhanced Recreation Areas

Back Creek Park provides opportunities for pier and bank fishing and picnicking.

Proposed Public Water Access and Recreation Areas and Future Needs Assessment

The 1991 York County Comprehensive Plan identifies a VDOT right of way at the end of Shirley Rd. adjacent to the Seaford Scallops wharf that could be transferred to the county for development of an additional public boat launch area closer to the mouth of Back Creek. The bathymetry of this area is of sufficient depth for this purpose. This site could also provide opportunities for pier and bank fishing. The access road to this site would need improvement. The County is also working with the Amoco Oil Refinery to develop an interpretive boardwalk over a marsh area located on refinery property which would connect to Back Creek Park. The 1990 Chesapeake Bay Public Access Plan suggests that the large tidal marsh areas along tidal creeks in the County, such as Back Creek, could be made more accessible for activities such as nature study and environmental education; additional canoe put-in/take-out points could also be developed in these marshes.

Bathymetry

NOAA-National Ocean Service charts and USGS topographic maps shows soundings of 1-10 ft. in this waterbody, with the greater depths at the mouth of the creek near the Seaford Scallops wharf.

Flushing Characteristics

Based on the previous general discussion of flushing characteristics of the Lower Western and Southern Shore Chesapeake Bay Small Coastal Basins, it can be inferred that this waterbody is not well-flushed.

Current Patterns

Shoreline Condition (Back Creek - Reach 111)

Back Creek contains 54,400 feet of shoreline and 63 piers and docks (Pier and Dock Density = 1.16 piers/docks per thousand feet of shoreline). The erosion rate for Back Creek is zero feet per year as reported by the Virginia Institute of Marine Science in *Shoreline Erosion in Tidewater Virginia*, 1978. The average bank height is reported to be four feet by the same source. The predominant land use adjacent to this reach is (landuse). 8.82 percent of the reach's shoreline was hardened at the time of the aerial survey. Based on observed conditions, it would appear that (appropriate erosion control recommendation).

WATERBODY: CLAXTON CREEK (Reach 110)

This waterbody is one of two major tributaries to The Thorofare and enters on the south side.

Water Quality Data

Refer to above for HUC 02080108 (Lower Western Shore Tributaries), Segment 108-01E (The Poquoson River Waterbody).

Sensitive Land and Aquatic Resources

The following sensitive land and aquatic resources are present in this waterbody: fringing tidal marshes.

The tidal marsh inventory shows that there were 220 acres of tidal marsh in Claxton Creek and including an area along The Thorofare east of and adjacent to mouth of Claxton Creek at Green Point at the time the inventory was conducted. Claxton Creek marsh is best described as a shallow bay with a ragged, marshy shoreline. Characteristically, the shoreline margins are vegetated with saltmarsh cordgrass. The higher areas of the marsh are dominated by black needlerush with associated patches of saltgrass meadow. The marsh is in a largely untouched natural state. The numerous crab pots that were observed in the creek at the time indicated that the area is a productive blue crab habitat. Evaluation of wetland types in this waterbody, based on total environmental value of an acre of each type, was Group One; this is out of five groups, with Group One being of highest value and Group Five being of least value (Silberhorn, 1974: 33,36).

No SAV beds were mapped in Claxton Creek in 1991. However, this entire waterbody has been included in the Tier III Target for Chesapeake Bay SAV Distribution Restoration down to the 2-meter depth contour or in the 6-foot depth range.

Existing Water Access Facilities

None.

Existing Water-Enhanced Recreation Areas

None.

Proposed Public Water Access and Recreation Areas and Future Needs Assessment

There are no existing proposals for development of public water access or recreation areas in this waterbody. However, the 1990 Chesapeake Bay Program Public Access Plan suggests that the large tidal marshes along the tidal creeks in York County, such as Claxton Creek, could be made more accessible for activities such as nature study and environmental education. Canoe put-in/take-out points could also be identified.

Bathymetry

NOAA-National Ocean Service charts and USGS topographic maps show soundings of 1-6 ft. in this waterbody.

Flushing Characteristics

Based on the previous general discussion of flushing characteristics of the Lower Western and Southern Shore Chesapeake Bay Small Coastal Basins, it can be inferred that this waterbody is not well-flushed.

Current Patterns

Shoreline Condition (Claxton Creek - Reach 110)

Claxton Creek contains 30,000 feet of shoreline and 1 pier or dock (Pier and Dock Density = 0.03 piers/docks per thousand feet of shoreline). The erosion rate for reach 110 is zero feet per year as reported by the Virginia Institute of Marine Science in *Shoreline Erosion in Tidewater Virginia*, 1978. The average bank height is reported to be three feet by the same source. The predominant land use adjacent to this reach is (landuse). 1.33 percent of the reach's shoreline was hardened at the time of the aerial survey. Based on observed conditions, it would appear that (appropriate erosion control recommendation).

MAINSTEM SEGMENT: GREEN POINT TO BAY TREE CREEK (Reach 109)

General Description and Location

This mainstem segment has been delineated as beginning at Green Tree Point on the southwestern shore of The Thorofare then southeast along the Chesapeake Bay shoreline to Bay Tree Creek.

Water Quality Data

Refer to above for HUC 02080108 (Lower Western Shore Tributaries), Segment 108-01E (The Poquoson River Waterbody), and HUC 02080101 (Mainstem Open Bay), Segment 101-03CE (Southwestern Portion of the Chesapeake Bay).

Sensitive Land and Aquatic Resources

The following sensitive land and aquatic resources are present in this segment: fringing tidal marshes and SAV beds.

The tidal marsh inventory shows that there were 1.5 acres of tidal marsh located along this segment in the Bay Tree Point area at the time the inventory was conducted. Evaluation of wetland types in this segment, based on total environmental value of an acre of each type, was Group One; this is out of five groups, with Group One being of highest value and Group Five being of least value (Silberhorn, 1974: 40).

Extensive SAV beds were mapped along this segment in 1991. This segment has bee included in the Tier I and Tier III Targets for Chesapeake Bay SAV Distribution Restoration down to the 2-meter depth contour or in the 6-foot depth range.

Existing Water Access Facilities

None.

Existing Water-Enhanced Recreation Areas

None.

Proposed Public Water Access and Recreation Areas and Future Needs Assessment

None.

Bathymetry

NOAA-National Ocean Service charts and USGS topographic maps show 1-2 ft. soundings waterward of the tidal marsh system.

Flushing Characteristics

Based on the previous general discussion of flushing characteristics of the Lower Western and Southern Shore Chesapeake Bay Small Coastal Basins, it might be inferred that this waterbody is not well-flushed. However, because this segment lies along the shoreline of the mainstem open bay, flushing along this segment is likely to occur at a more rapid rate than in the inland coastal creeks and rivers included in this basin.

Current Patterns

Shoreline Condition (Reach 109)

Reach 109 contains 12,800 feet of shoreline and no piers or docks. The erosion rate for reach 109 is 3.90 feet per year as reported by the Virginia Institute of Marine Science in *Shoreline Erosion in Tidewater Virginia*, 1978. The average bank height is reported to be three feet by the same source. The predominant land use adjacent to this reach is (landuse). No shoreline hardening had occurred within this reach prior to the aerial survey. Based on observed conditions, it would appear that (appropriate erosion control recommendation).

WATERBODY: BAY TREE CREEK (Reach 108)

General Description and Location

This waterbody is the only tributary to the mainstem open Chesapeake Bay in this subarea and is comprised of an extensive marsh system.

Water Quality Data

Refer to above for HUC 02080101 (Mainstem Open Bay), Segment 101-03CE (Southwestern Portion of the Chesapeake Bay).

Sensitive Land and Aquatic Resources

The following sensitive land and aquatic resources are present in this waterbody: fringing tidal marshes and tidal flats.

The tidal marsh inventory shows that there were 100 acres of tidal marsh located in this waterbody at the time the inventory was conducted. Bay Tree Creek is mostly vegetated by black needlerush. The substratum here is mainly sand which is the typical soil type associated with black needlerush communities. There is a residential area at the headwaters of the creek with dredged channels and spoil deposits on the surface of a marsh peninsula. Evaluation of wetland types in this waterbody, based on total environmental value of an acre of each type, was Group Three; this is out of five groups, with Group One being of highest value and Group Five being of least value (Silberhorn, 1974: 37,40).

SAV beds were mapped at the mouth of Bay Tree Creek in 1991. This entire waterbody has been included in the Tier I and Tier III Targets for Chesapeake Bay SAV Distribution Restoration down to the 2-meter depth contour or in the 6-foot depth range.

Existing Water Access Facilities

None.

Existing Water-Enhanced Recreation Areas

None.

Proposed Public Water Access and Recreation Areas and Future Needs Assessment

There are no existing proposals for development of public water access or recreation areas in this waterbody. However, the 1990 Chesapeake Bay Program Public Access Plan suggests that the large tidal marshes along the tidal creeks in York County, such as Bay Tree Creek, could be made more accessible for activities such as nature study and environmental education. Canoe put-in/take-out points could also be identified.

Bathymetry

NOAA-National Ocean Service charts show soundings of 1-2 ft. in this waterbody.

Flushing Characteristics

Based on the previous general discussion of flushing characteristics of the Lower Western and Southern Shore Chesapeake Bay Small Coastal Basins, it can be inferred that this waterbody is not well-flushed.

Current Patterns

Shoreline Condition (Bay Tree Creek - Reach 108)

Bay Tree Creek contains 27,600 feet of shoreline and four piers and docks (Pier and Dock Density = 0.14 piers/docks per thousand feet of shoreline). The erosion rate for reach 108 is zero feet per year as reported by the Virginia Institute of Marine Science in *Shoreline Erosion in Tidewater Virginia*, 1978. The average bank height is reported to be three feet by the same source. The predominant land use adjacent to this reach is (landuse). 1.45 percent of the reach's shoreline was hardened at the time of the aerial survey. Based on observed conditions, it would appear that (appropriate erosion control recommendation).

MAINSTEM SEGMENT: BAY TREE CREEK TO YORK POINT (Reach 107)

General Description and Location

This mainstem segment has been delineated from the mouth of Bay Tree Creek then south along the Chesapeake Bay shoreline to York Point at the mouth of Chisman Creek.

Water Quality Data

Refer to above for HUC 02080101 (Mainstem Open Bay), Segment 101-03CE (Southwestern Portion of the Chesapeake Bay).

Sensitive Land and Aquatic Resources

The following sensitive land and aquatic resources are present in this segment: fringing tidal marshes and SAV beds.

The tidal marsh inventory shows that there were 11.5 acres of tidal marsh located in this segment at the time the inventory was conducted. Evaluation of wetland types in this segment, based on total environmental value of an acre of each type, was Group Three; this is out of five groups, with Group One being of highest value and Group Five being of least value (Silberhorn, 1974: 40).

Extensive SAV beds were mapped in the nearshore areas of this segment in 1991. This segment has been included in the Tier I and Tier III Targets for Chesapeake Bay SAV Distribution Restoration down to the 2-meter depth contour or in the 6-foot depth range.

Existing Water Access Facilities

None.

Existing Water-Enhanced Recreation Areas

None.

Proposed Public Water Access and Recreation Areas and Future Needs Assessment

There are no existing proposals for development of public water access or recreation areas in this segment.

Bathymetry

NOAA-National Ocean Service charts show soundings of 1-3 ft. waterward of the marsh system.

Flushing Characteristics

Based on the previous general discussion of flushing characteristics of the Lower Western and Southern Shore Chesapeake Bay Small Coastal Basins, it might be inferred that this segment is not well-flushed. However, because this segment lies along the shoreline of the mainstem open bay, flushing along this segment is likely to occur at a more rapid rate than in the inland coastal creeks and rivers included in this basin.

Current Patterns

Shoreline Condition (Reach 107)

Reach 107 contains 6,600 feet of shoreline and 1 pier or dock (Pier and Dock Density = 0.15 piers/docks per thousand feet of shoreline). The erosion rate for reach 107 is 2.20 feet per year as reported by the Virginia Institute of Marine Science in *Shoreline Erosion in Tidewater Virginia*, 1978. The average bank height is reported to be three feet by the same source. The predominant land use adjacent to this reach is (landuse). 12.12 percent of the reach's shoreline was hardened at the time of the aerial survey. Based on observed conditions, it would appear that (appropriate erosion control recommendation).

SUBAREA B: YORK POINT TO SANDY BAY (Poquoson River)

General Description and Location

For the purposes of this study, this subarea has been delineated as beginning at York Point at the mouth of Chisman Creek then west and south along the shoreline of Chisman Creek and the Poquoson River mainstem to the northern boundary of Plum Tree Island at Big Salt Marsh on Sandy Bay. The major tributaries and other waterbodies in this subarea include: Cabin Creek, Chisman Creek mainstem, Goose Creek, Boathouse Creek, the Poquoson River mainstem, Hodges Cove, Patrick's Creek, Quarter March Creek, Moore's Creek, Lamb's Creek, Robert's Creek, Lyons Creek, White House Cove, Bennett Creek mainstem, Floyds Bay, Easton Cove, Lloyd Bay and Sandy Bay. This subarea is located partially in York County and partially in the City of Poquoson; Lamb's Creek form the corporate boundary between these two jurisdictions.

Water Quality Data

Refer to above for HUC 02080108 (Lower Western Shore Tributaries), Segment 108-01E (The Poquoson River Waterbody), and HUC 02080101 (Mainstem Open Bay), Segment 101-03CE (Southwestern Portion of the Chesapeake Bay).

Sensitive Land and Aquatic Resources

The following sensitive land and aquatic resources are present in this subarea: fringing tidal marshes, extensive tidal marshes, tidal flats, SAV beds, shellfish producing areas, a shellfish management area for hard clams, a condemned shellfish area, and a protected area.

This subarea is partially within the Poquoson River Area of the York County and Town of Poquoson Tidal Marsh Inventory. The Poquoson River area of the tidal marsh inventory is divided into three parts: 1) Chisman Creek Area; 2) Poquoson River Proper; and 3) Bennett Creek Area. The tidal marsh inventory shows that there were approximately 348 acres of tidal marsh located in this subarea at the time the inventory was conducted. Evaluation of wetland types in this subarea, based on total environmental value of an acre of each type, ranged from Group One to Group Four; this is out of five groups, with Group One being of highest value and Group Five being of least value (Silberhorn, 1974: 37-57).

SAV beds were mapped in 1991 at York Point along the nearshore area to the mouth of Cabin Creek, along the nearshore area west of Cabin Creek, off Pasture and Hunts Necks, at the mouth of Chisman Creek between Ship Point and Hodges Cove, at the mouth of Lyons Creek, at the mouth of Bennett Creek, in the nearshore areas of Cow and Plum Tree Islands at the mouth of Sandy and Lloyd Bays, and offshore in Drum Island Flats and

Poquoson Flats. No SAV was mapped in the Poquoson River mainstem or Chisman Creek mainstem. A large percentage of this subarea has been included in the Tier I and Tier III Chesapeake Bay SAV Distribution Restoration Targets.

There is one shellfish condemnation area in this subarea (#137) and includes Cabin Creek, a large portion of the Chisman Creek mainstem, Goose Creek, Patricks Creek, the Poquoson River Mainstem, including Quarter March Creek and Moores Creek, Lambs Creek, part of Robert's Creek, Lyons Creek, White House Cove, the headwaters of Bennett Creek, and Easton Cove. There are also three marina facilities and public boat landings within this subarea which necessitate seasonal shellfish condemnations between April 1 and October 31.

The Poquoson River Shellfish Management Area was redesignated on 1/1/94 to better protect and promote the hard clam resource. Each boat or vessel engaged in the harvesting of clams by patent tong from this management area must first obtain a permit from a Marine Patrol Officer. The lawful season for the harvest of clams by patent tong from this management area is January 1 through March 31, between sunrise and 2 p.m. only.

Plum Tree Island is a national wildlife refuge owned by the federal government and is a protected area.

Commercially- and Recreationally-Important Finfishing Grounds?
There are ___ seafood processing plants (commercial fisheries) in this subarea.

Existing Water Access Facilities and Water-Enhanced Recreation Areas

There are 12 water access and water-enhanced recreation areas located in this system. They include 2 public boat ramps, 2 private/commercial boat ramps, 7 marinas (3 with boat ramps), and one county-owned park.

Proposed Public Water Access and Recreation Areas and Future Needs Assessment

The 1990 Chesapeake Bay Program Public Access Plan states that sailing is probably more popular in this area than in other areas of the Bay. The plan suggests that additional boating sites are needed on the Poquoson River to relieve heavy boat traffic near the mouth of the York River and to meet future demand from a growing number of residents and visitors in this area. The plan identifies four potential public water access and recreation areas in this subarea. It also suggests that the large tidal marshes along the tidal creeks in York County could be made more accessible for activities such as nature study and environmental education. Canoe put-in/take-out points could also be developed in these marsh systems. **<<Add Poquoson and Hampton Comprehensive Plan info and VOP info...>>**

Shoreline Condition (Subarea B - Poquoson River)

The York County Portion of Subarea B contains 13.94 miles of direct shoreline frontage and 136 piers and docks. The average pier and dock density in the subarea is 1.85 piers and docks per 1000 linear feet of shoreline. Within the subarea 19.29 percent of the shoreline is hardened. The York County portion of Subarea B also contains the associated non-direct shoreline waterbodies of Cabin Creek, Goose Creek, Boathouse Creek, Chisman Creek, Hodges Cove, Patricks Creek, Quarter March Creek, Moores Creek, and the western shoreline of Lambs Creek. Two nameless creeks are also included.

For the purposes of analysis, this subarea is subdivided into three categories: 1) waterbodies, which include the smaller tributaries of the York River, and any lakes, ponds and reservoirs within the subarea with connected surface flow to the York River; 2) mainstem segments, which comprise the southern shoreline of the York River between identified waterbodies; and 3) shoreline reaches as defined for the purposes of this study; a reach may include an entire waterbody, a mainstem segment, or any combination thereof and may cross subarea boundaries.

MAINSTEM SEGMENT: YORK POINT TO CABIN CREEK

General Description and Location

This mainstem segment has been delineated from York Point at the mouth of Chisman Creek the west along the Chisman Creek shoreline to the Cabin Creek.

Water Quality Data

Refer to above for HUC 02080108 (Lower Western Shore Tributaries), Segment 108-01E (The Poquoson River Waterbody).

Sensitive Land and Aquatic Resources

The following sensitive land and aquatic resources are present in this segment: fringing tidal marshes and SAV beds.

SAV beds were mapped in 1991 at York Point and along the nearshore area to the mouth of Cabin Creek. This same area has been included in the Tier I Target for Chesapeake Bay SAV Distribution Restoration and the entire segment has been included in the Tier III Target for Chesapeake Bay SAV Distribution Restoration down to the 2-meter depth contour or in the 6-foot depth range.

Existing Water Access Facilities

None.

Existing Water-Enhanced Recreation Areas

None.

Proposed Public Water Access and Recreation Areas and Future Needs Assessment

There are no existing proposals for development of public water access or recreation areas in this segment.

Bathymetry

NOAA-National Ocean Service charts show a 2-ft. sounding waterward of the marsh system.

Flushing Characteristics

Based on the previous general discussion of flushing characteristics of the Lower Western and Southern Shore Chesapeake Bay Small Coastal Basins, it might be inferred that this segment is not well-flushed. However, because this segment lies along the shoreline of the mouth of a large coastal river, flushing along this segment is likely to occur at a more rapid rate than in the inland coastal creeks and rivers included in this basin.

Current Patterns

Shoreline Condition (Reach 106)

Reach 106 contains 7,200 feet of shoreline and 46 piers and docks (Pier and Dock Density = 1.36 piers/docks per thousand feet of shoreline). The erosion rate for reach 106 is 0.90 feet pèr year as reported by the Virginia Institute of Marine Science in *Shoreline Erosion in Tidewater Virginia,* 1978. The average bank height is reported to be three feet by the same source. The predominant land use adjacent to the shoreline within this reach is residential. 80.56 percent of the reach's shoreline was hardened at the time of the aerial survey. It should be noted that most of this reach consists of canals dug perpindicular to the shoreline. These canals are highly protected to prevent sedimentation. Based on observed conditions, it would appear that (appropriate erosion control recommendation).

WATERBODY: CABIN CREEK (Reach 104)

General Description and Location

This waterbody is enters the Chisman Creek mainstem from the north at the mouth of Chisman Creek.

Water Quality Data

Refer to above for HUC 02080108 (Lower Western Shore Tributaries), Segment 108-01E (The Poquoson River Waterbody).

Sensitive Land and Aquatic Resources

The following sensitive land and aquatic resources are present in this waterbody: fringing tidal marshes and SAV beds.

The tidal marsh inventory shows that there were 37 acres of tidal marsh located in and near this waterbody at the time the inventory was conducted. Saltmarsh cordgrass usually occupies the intertidal marsh edge habitat. Evaluation of wetland types in this waterbody, based on total environmental value of an acre of each type, was Group Three; this is out of five groups, with Group One being of highest value and Group Five being of least value (Silberhorn, 1974: 37,40).

SAV beds were mapped in 1991 in the nearshore areas east and west of the mouth of Cabin Creek. This same area has been included in the Tier I Target for Chesapeake Bay SAV Distribution Restoration. This same area and all of Cabin Creek have been included in the Tier III Target for Chesapeake Bay SAV Distribution Restoration down to the 2-meter depth contour or in the 6-foot depth range.

Shellfish Condemnation Area #137, which includes almost all of Cabin Creek, went into effect 7/6/93. This is a restricted area where it is unlawful to take shellfish for any purpose, except by a VMRC permit.

Existing Water Access Facilities

None.

Existing Water-Enhanced Recreation Areas

None.

Proposed Public Water Access and Recreation Areas and Future Needs Assessment

There are no existing proposals for development of public water access or recreation areas in this waterbody. However, the 1990 Chesapeake Bay Program Public Access Plan suggests that the large tidal marshes along the tidal creeks in York County, such as Cabin Creek, could be made more accessible for activities such as nature study and environmental education. Canoe put-in/take-out points could also be identified.

Bathymetry

NOAA-National Ocean Service charts show soundings of 3-5 ft. in this waterbody.

Flushing Characteristics

Based on the previous general discussion of flushing characteristics of the Lower Western and Southern Shore Chesapeake Bay Small Coastal Basins, it can be inferred that this waterbody is not well-flushed.

Current Patterns

Shoreline Condition (Cabin Creek - Reach 104)

Cabin Creek contains 19,400 feet of shoreline and no piers or docks. The erosion rate for reach 104 is zero feet per year as reported by the Virginia Institute of Marine Science in *Shoreline Erosion in Tidewater Virginia,* 1978. The average bank height is reported to be three feet by the same source. The predominant land use adjacent to the shoreline within this reach is (landuse). No shoreline hardening had occurred within this reach prior to the aerial survey. Based on observed conditions, it would appear that (appropriate erosion control recommendation).

WATERBODY: CHISMAN CREEK (Reach 101), GOOSE CREEK (Reach 103), AND BOATHOUSE CREEK (Reach 102)

General Description and Location

This waterbody is a major tributary to the Poquoson River and enters it from the northwest. Goose Creek is a tributary to the Chisman Creek mainstem and enters it from the north. Boathouse Creek is a tributary to the Chisman Creek mainstem and enters it from the south.

Water Quality Data

Refer to above for HUC 02080108 (Lower Western Shore Tributaries), Segment 108-01E (The Poquoson River Waterbody). Chisman Creek is a Superfund site and, while the cleanup process has been completed, it remains on the Superfund list for continued pollution monitoring.

Sensitive Land and Aquatic Resources

The following sensitive land and aquatic resources are present in this waterbody: fringing tidal marshes, tidal flats and SAV beds.

The tidal marsh inventory shows that there were approximately 53 acres of tidal marshes in this waterbody at the time the inventory was conducted. Subdivided acreage of tidal marsh were: 1.5 acres in Evergreen Shores, 3.1 acres in Goose Creek, 41.09 acres in the Chisman Creek mainstem, and 6.83 acres in Boathouse Creek. The marshes of the Chisman Creek mainstem are mainly small cove, pocket and fringing marshes dominated by saltmarsh cordgrass. Several of the small coves at the headwaters of Chisman Creek have been dredged and spoil has been piled on the marsh. Evaluation of wetland types in this waterbody, based on total environmental value of an acre of each type, ranged from Group One to Group Three; this is out of five groups, with Group One being of highest value and Group Five being of least value (Silberhorn, 1974: 37-44).

There were no SAV beds mapped in this waterbody in 1991. All of Chisman Creek and its tributaries have been included in the Tier III Target for Chesapeake Bay SAV Distribution Restoration down to the 2-meter depth contour or in the 6-foot depth range.

Shellfish Condemnation Area #137, which includes Chisman Creek and Goose Creek, but not Boathouse Creek, went into effect 7/6/93. This is a restricted area where it is unlawful to take shellfish for any purpose, except by a VMRC permit. There are 2 marina facilities on Chisman Creek which necessitate a collective seasonal shellfish bed closure between

April 1 and October 31 covering approximately 40 acres: Thomas Marina and Wildey Marina.

Existing Water Access Facilities

There are 4 private/commercial marina facilities located on Chisman Creek: Thomas Marina (Presson Rd.), Wildey Marina (Crockett Rd.), Smith's Marine Railway (Railway Rd.) and Chisman Creek Marina (Railway Rd.).

Existing Water-Enhanced Recreation Areas

None.

Proposed Public Water Access and Recreation Areas and Future Needs Assessment

There are no existing proposals for development of public water access or recreation areas in this waterbody. However, the 1990 Chesapeake Bay Program Public Access Plan suggests that the large tidal marshes along the tidal creeks in York County, such as Chisman, Goose and Boathouse Creeks, could be made more accessible for activities such as nature study and environmental education. Canoe put-in/take-out points could also be identified.

Bathymetry

NOAA-National Ocean Service charts and USGS topographic maps show soundings of 4-11 ft. in the Chisman Creek mainstem, and 3-4 ft. soundings in Goose and Boathouse Creeks.

Flushing Characteristics

Based on the previous general discussion of flushing characteristics of the Lower Western and Southern Shore Chesapeake Bay Small Coastal Basins, it can be inferred that this waterbody is not well-flushed.

Current Patterns

Shoreline Condition (Chisman Creek Mainstem Shoreline - Reach 101)

Chisman Creek Mainstem Shoreline includes all shoreline found within the confines of Chisman Creek with the exception of the shoreline contained in Boathouse Creek and Goose Creek. Chisman Creek contains 108,000 feet of shoreline and 185 piers and docks (Pier and Dock Density = 1.71 piers/docks per thousand feet of shoreline). The erosion rate for reach 101 is zero feet per year as reported by the Virginia Institute of Marine Science in *Shoreline Erosion in Tidewater Virginia,* 1978. The average bank height is reported to be four feet by the same source. The predominant land use adjacent to the shoreline within this reach is (landuse). 22.62 percent of the reach's shoreline was hardened at the time of the aerial survey. Based on observed conditions, it would appear that (appropriate erosion control recommendation).

Shoreline Condition (Goose Creek - Reach 103)

Goose Creek contains 30,200 feet of shoreline and 83 piers and docks (Pier and Dock Density = 2.75 piers/docks per thousand feet of shoreline). The erosion rate for reach 103 is zero feet per year as reported by the Virginia Institute of Marine Science in *Shoreline Erosion in Tidewater Virginia,* 1978. The average bank height is reported to be four feet by the same source. The predominant land use adjacent to the shoreline within this reach is (landuse). 31.79 percent of the reach's shoreline was hardened at the time of the aerial survey. Based on observed conditions, it would appear that (appropriate erosion control recommendation).

Shoreline Condition (Boathouse Creek - Reach 102)

Boathouse Creek contains 20,400 feet of shoreline and 22 piers and docks (Pier and Dock Density = 1.08 piers/docks per thousand feet of shoreline). The erosion rate for reach 102 is zero feet per year as reported by the Virginia Institute of Marine Science in *Shoreline Erosion in Tidewater Virginia,* 1978. The average bank height is reported to be three feet by the same source. The predominant land use adjacent to the shoreline within this reach is (landuse). 8.82 percent of the reach's shoreline was hardened at the time of the aerial survey. Based on observed conditions, it would appear that (appropriate erosion control recommendation).

MAINSTEM SEGMENT: BOATHOUSE CREEK TO HODGES COVE

General Description and Location

This mainstem segment has been delineated as beginning at the mouth of Boathouse Creek then east along the Chisman Creek shoreline to Ship Point then south along the Poquoson River mainstem to Hodges Cove.

Water Quality Data

Refer to above for HUC 02080108 (Lower Western Shore Tributaries), Segment 108-01E (The Poquoson River Waterbody).

Sensitive Land and Aquatic Resources

The following sensitive land and aquatic resources are present in this segment: fringing tidal marshes and SAV beds.

The tidal marsh inventory shows that there were approximately 3 acres of tidal marsh located in this segment at the time the inventory was conducted. Subdivided acreages of tidal marsh were: 2.8 near and at Ship Point and .5 acres along the Poquoson River mainstem near Hodges Cove. Evaluation of wetland types in this segment, based on total environmental value of an acre of each type, was Group One; this is out of five groups, with Group One being of highest value and Group Five being of least value (Silberhorn, 1974: 39,44-46).

Two SAV beds were mapped in 1991 along this segment. This entire segment has been included in the Tier I and Tier III Targets for Chesapeake Bay SAV Distribution Restoration down to the 2-meter depth contour or in the 6-foot depth range.

Existing Water Access Facilities

None.

Existing Water-Enhanced Recreation Areas

None.

Proposed Public Water Access and Recreation Areas and Future Needs Assessment

There are no existing proposals for development of public water access or recreation areas in this segment.

Bathymetry

NOAA-National Ocean Service charts show a 2-ft. sounding waterward of the marsh system.

Flushing Characteristics

Based on the previous general discussion of flushing characteristics of the Lower Western and Southern Shore Chesapeake Bay Small Coastal Basins, it might be inferred that this segment is not well-flushed.

Current Patterns

Shoreline Condition (Reach 100 - Ship Point to Hodges Cove)

Reach 100 contains 4,600 feet of shoreline and 3 piers and docks (Pier and Dock Density = .65 piers/docks per thousand feet of shoreline). The erosion rate for reach 100 is 1.80 feet per year as reported by the Virginia Institute of Marine Science in *Shoreline Erosion in Tidewater Virginia*, 1978. The average bank height is reported to be five feet by the same source. The predominant land use adjacent to the shoreline within this reach is (landuse). 30.43 percent of the reach's shoreline was hardened at the time of the aerial survey. Based on observed conditions, it would appear that (appropriate erosion control recommendation).

WATERBODY: HODGES COVE (Reach 99)

General Description and Location

This waterbody is a tributary to the Poquoson River and enters it from west.

Water Quality Data

Refer to above for HUC 02080108 (Lower Western Shore Tributaries), Segment 108-01E (The Poquoson River Waterbody).

Sensitive Land and Aquatic Resources

The following sensitive land and aquatic resources are present in this waterbody: fringing tidal marshes.

The tidal marsh inventory shows that there were approximately 4.3 acres of tidal marshes in this waterbody at the time the inventory was conducted. The Hodges Cove area is stressed by development as is evidenced by artificial canals and deposits of spoil on the marsh surface. Evaluation of wetland types in this waterbody, based on total environmental value of an acre of each type, was Group One; this is out of five groups, with Group One being of highest value and Group Five being of least value (Silberhorn, 1974: 38,45-46).

There were no SAV beds mapped in this waterbody in 1991. However, this entire waterbody has been included in the Tier I and Tier III Targets for Chesapeake Bay SAV Distribution Restoration down to the 2-meter depth contour or in the 6-foot depth range.

Existing Water Access Facilities

None.

Existing Water-Enhanced Recreation Areas

None.

Proposed Public Water Access and Recreation Areas and Future Needs Assessment

There are no existing proposals for development of public water access or recreation areas in this waterbody.

Bathymetry

NOAA-National Ocean Service charts show a sounding of 1 ft. at the mouth of Hodges Cove.

Flushing Characteristics

Based on the previous general discussion of flushing characteristics of the Lower Western and Southern Shore Chesapeake Bay Small Coastal Basins, it can be inferred that this waterbody is not well-flushed.

Current Patterns

Shoreline Condition (Hodges Cove - Reach 99)

Hodges Cove contains 17,400 feet of shoreline and 20 piers and docks (Pier and Dock Density = 1.15 piers/docks per thousand feet of shoreline). The erosion rate for reach 99 is zero feet per year as reported by the Virginia Institute of Marine Science in *Shoreline Erosion in Tidewater Virginia,* 1978. The average bank height is reported to be four feet by the same source. The predominant land use adjacent to the shoreline within this reach is (landuse). 16.09 percent of the reach's shoreline was hardened at the time of the aerial survey. Based on observed conditions, it would appear that (appropriate erosion control recommendation).

MAINSTEM SEGMENT: HODGES COVE TO PATRICKS CREEK (Reaches 98, 97, 96, and 95)

General Description and Location

This mainstem segment has been delineated as beginning at the mouth of Hodges Cove then south along the Poquoson River shoreline to the mouth of Patricks Creek, including Howard's Landing and several unnamed tributaries east of and near Patrick's Creek.

Water Quality Data

Refer to above for HUC 02080108 (Lower Western Shore Tributaries), Segment 108-01E (The Poquoson River Waterbody).

Sensitive Land and Aquatic Resources

The following sensitive land and aquatic resources are present in this segment: fringing tidal marshes.

The tidal marsh inventory shows that there were approximately 7.8 acres of tidal marsh located in this segment at the time the inventory was conducted. Evaluation of wetland types in this segment, based on total environmental value of an acre of each type, was Group One; this is out of five groups, with Group One being of highest value and Group Five being of least value (Silberhorn, 1974: 39,44-46).

No SAV beds were mapped in 1991 along this segment. Some nearshore areas in this segment have been included in the Tier I Target for Chesapeake Bay SAV Distribution Restoration and the entire segment has been included in the Tier III Target for Chesapeake Bay SAV Distribution Restoration down to the 2-meter depth contour or in the 6-foot depth range.

Existing Water Access Facilities

None.

Existing Water-Enhanced Recreation Areas

None.

Proposed Public Water Access and Recreation Areas and Future Needs Assessment

There are no existing proposals for development of public water access or recreation areas in this segment. However, there are many state-owned right of ways ending along this segment which could be considered for development of public access areas to the Poquoson River mainstem.

Bathymetry

NOAA-National Ocean Service charts and USGS topographic maps show soundings of 2-5 ft. along this segment.

Flushing Characteristics

Based on the previous general discussion of flushing characteristics of the Lower Western and Southern Shore Chesapeake Bay Small Coastal Basins, it might be inferred that this segment is not well-flushed.

Current Patterns

Shoreline Condition (Reach 98 - Hodges Cove to approx. Howards Landing)

Reach 98 contains 2,600 feet of shoreline and six piers and docks (Pier and Dock Density = 2.31 piers/docks per thousand feet of shoreline). The erosion rate for reach 98 is unavailable. (X) feet per year as reported by the Virginia Institute of Marine Science in *Shoreline Erosion in Tidewater Virginia*, 1978. The average bank height is reported to be (X) feet by the same source. The predominant land use adjacent to the shoreline within this reach is (landuse). 53.85 percent of the reach's shoreline was hardened at the time of the aerial survey. Based on observed conditions, it would appear that (appropriate erosion control recommendation).

Shoreline Condition (Reach 97 - Mainstem Face along Howards Landing)

Reach 97 contains 5,000 feet of shoreline and ten piers and docks (Pier and Dock Density = 2.00 piers/docks per thousand feet of shoreline). The erosion rate for reach 97 is one foot per year as reported by the Virginia Institute of Marine Science in *Shoreline Erosion in Tidewater Virginia*, 1978. The average bank height is reported to be five feet by the same source. The predominant land use adjacent to the shoreline within this reach is (landuse). 24.00 percent of the reach's shoreline was hardened at the time of the aerial survey. Based on observed conditions, it would appear that (appropriate erosion control recommendation).

Shoreline Condition (Reach 96 - Mainstem Face from nameless point north of Howards Landing to nameless creek)

Reach 96 contains 2,400 feet of shoreline and four piers and docks (Pier and Dock Density = 1.67 piers/docks per thousand feet of shoreline). The erosion rate for reach 96 is (X) feet per year as reported by the Virginia Institute of Marine Science in *Shoreline Erosion in Tidewater Virginia*, 1978. The average bank height is reported to be (X) feet by the same source. The predominant land use adjacent to the shoreline within this reach is (landuse). No shoreline hardening had occurred within this reach prior to the aerial survey. Based on observed conditions, it would appear that (appropriate erosion control recommendation).

Shoreline Condition (Reach 95 - nameless creek)

Reach 95 contains 5,200 feet of shoreline and seven piers and docks (Pier and Dock Density = 1.35 piers/docks per thousand feet of shoreline). The erosion rate for reach 95 is zero feet per year as reported by the Virginia Institute of Marine Science in *Shoreline Erosion in Tidewater Virginia*, 1978. The average bank height is reported to be four feet by the same source. The predominant land use adjacent to the shoreline within this reach is (landuse). 3.85 percent of the reach's shoreline was hardened at the time of the aerial survey. Based on observed conditions, it would appear that (appropriate erosion control recommendation).

WATERBODY: PATRICKS CREEK (Reaches 94, 93, and 92)

General Description and Location

This waterbody is a tributary to the Poquoson River mainstem and enters it from west.

Water Quality Data

Refer to above for HUC 02080108 (Lower Western Shore Tributaries), Segment 108-01E (The Poquoson River Waterbody).

Sensitive Land and Aquatic Resources

The following sensitive land and aquatic resources are present in this waterbody: fringing tidal marshes.

The tidal marsh inventory shows that there were 20 acres of tidal marshes in this waterbody at the time the inventory was conducted. Evaluation of wetland types in this waterbody, based on total environmental value of an acre of each type, was Group One; this is out of five groups, with Group One being of highest value and Group Five being of least value (Silberhorn, 1974: 45,47-48).

There were no SAV beds mapped in this waterbody in 1991. However, this entire waterbody has been included in the Tier III Targets for Chesapeake Bay SAV Distribution Restoration down to the 2-meter depth contour or in the 6-foot depth range.

Shellfish Condemnation Area #137, which includes all of Patricks Creek, went into effect 7/6/93. This is a restricted area where it is unlawful to take shellfish for any purpose, except by a VMRC permit.

Existing Water Access Facilities

None.

Existing Water-Enhanced Recreation Areas

None.

Proposed Public Water Access and Recreation Areas and Future Needs Assessment

There are no existing proposals for development of public water access or recreation areas in this waterbody. However, the 1990 Chesapeake Bay Program Public Access Plan suggests that the large tidal marshes along the tidal creeks in York County, such as Patricks Creek, could be made more accessible for activities such as nature study and environmental education. Canoe put-in/take-out points could also be identified.

Bathymetry

NOAA-National Ocean Service charts and USGS topographic maps show soundings of 2-4 ft. in this waterbody.

Flushing Characteristics

Based on the previous general discussion of flushing characteristics of the Lower Western and Southern Shore Chesapeake Bay Small Coastal Basins, it can be inferred that this waterbody is not well-flushed.

Current Patterns

Shoreline Condition (North Shore of Patricks Creek from nameless creek to northward bend - Reach 94)

Reach 94 contains 4,800 feet of shoreline and eight piers and docks (Pier and Dock Density = 1.67 piers/docks per thousand feet of shoreline). The erosion rate for reach 94 is (X) feet per year as reported by the Virginia Institute of Marine Science in *Shoreline Erosion in Tidewater Virginia*, 1978. The average bank height is reported to be (X) feet by the same source. The predominant land use adjacent to the shoreline within this reach is (landuse). 12.50 percent of the reach's shoreline was hardened at the time of the aerial survey. Based on observed conditions, it would appear that (appropriate erosion control recommendation).

Shoreline Condition (Patricks Creek Mainstem - Reach 93)

Reach 93 contains 24,800 feet of shoreline and 12 piers and docks (Pier and Dock Density = 0.48 piers/docks per thousand feet of shoreline). The erosion rate for reach 93 is 1.8 feet per year as reported by the Virginia Institute of Marine Science in *Shoreline Erosion in Tidewater Virginia*, 1978. The average bank height is reported to be four feet by the same source. The predominant land use adjacent to the shoreline within this reach is (landuse). 2.42 percent of the reach's shoreline was hardened at the time of the aerial survey. Based on observed conditions, it would appear that (appropriate erosion control recommendation).

Shoreline Condition (Unnamed Cove on the South Shore of Patricks Creek to Patrick Creek Mouth - Reach 92)

Reach 92 contains 3,400 feet of shoreline and two piers and docks (Pier and Dock Density = 0.59 piers/docks per thousand feet of shoreline). ~~The erosion rate for reach 92 is (X) feet per year as reported by the Virginia Institute of Marine Science in *Shoreline Erosion in Tidewater Virginia*, 1978. The average bank height is reported to be (X) feet by the same source.~~ The predominant land use adjacent to the shoreline within this reach is (landuse). No shoreline hardening had occurred within this reach prior to the aerial survey. Based on observed conditions, it would appear that (appropriate erosion control recommendation).

MAINSTEM SEGMENT: PATRICKS CREEK TO QUARTER MARCH CREEK (Reaches 91, 90, 89, and 88)

General Description and Location

This mainstem segment has been delineated as beginning at the mouth of Patricks Creek then south along the Poquoson River shoreline to the mouth of Quarter March Creek, including an unnamed tributary between Patricks Creek and Quarter March Creek.

Water Quality Data

Refer to above for HUC 02080108 (Lower Western Shore Tributaries), Segment 108-01E (The Poquoson River Waterbody).

Sensitive Land and Aquatic Resources

The following sensitive land and aquatic resources are present in this segment: fringing tidal marshes.

The tidal marsh inventory shows that there were 4.65 acres of tidal marsh located in this segment at the time the inventory was conducted. Evaluation of wetland types in this segment, based on total environmental value of an acre of each type, ranged from Group One to Group Three; this is out of five groups, with Group One being of highest value and Group Five being of least value (Silberhorn, 1974: 45,48).

No SAV beds were mapped in 1991 along this segment. However, the entire segment has been included in the Tier III Target for Chesapeake Bay SAV Distribution Restoration down to the 2-meter depth contour or in the 6-foot depth range.

Shellfish Condemnation Area #137, which includes all this segment and the Poquoson River mainstem to the south, went into effect 7/6/93. This is a restricted area where it is unlawful to take shellfish for any purpose, except by a VMRC permit.

Existing Water Access Facilities

None.

Existing Water-Enhanced Recreation Areas

None.

Proposed Public Water Access and Recreation Areas and Future Needs Assessment

There are no existing proposals for development of public water access or recreation areas in this segment.

Bathymetry

NOAA-National Ocean Service charts and USGS topographic maps show soundings of 4-6 ft. along this segment.

Flushing Characteristics

Based on the previous general discussion of flushing characteristics of the Lower Western and Southern Shore Chesapeake Bay Small Coastal Basins, it might be inferred that this segment is not well-flushed.

Current Patterns

Shoreline Condition (Reach 91 - Mainstem Face between Patricks Creek and nameless point)

Reach 91 contains 1,800 feet of shoreline and two piers and docks (Pier and Dock Density = 1.11 piers/docks per thousand feet of shoreline). Reach 91 is accreting at one foot per year as reported by the Virginia Institute of Marine Science in *Shoreline Erosion in Tidewater Virginia*, 1978. The average bank height is reported to be five feet by the same source. The predominant land use adjacent to the shoreline within this reach is (landuse). 22.22 percent of the reach's shoreline was hardened at the time of the aerial survey. Based on observed conditions, it would appear that (appropriate erosion control recommendation).

Shoreline Condition (Reach 90 - Mainstem Face along Piney Point Estates)

Reach 90 contains 1,200 feet of shoreline and two piers and docks (Pier and Dock Density = 1.67 piers/docks per thousand feet of shoreline). The erosion rate for reach 90 is one foot per year as reported by the Virginia Institute of Marine Science in *Shoreline Erosion in Tidewater Virginia*, 1978. The average bank height is reported to be five feet by the same source. The predominant land use adjacent to the shoreline within this reach is (landuse). Fifty percent of the reach's shoreline was hardened at the time of the aerial survey. Based on observed conditions, it would appear that (appropriate erosion control recommendation).

Shoreline Condition (Reach 89 - Nameless Creek between Quarter March Creek and Piney Point Estates)

Reach 89 contains 5,400 feet of shoreline and 11 piers and docks (Pier and Dock Density = 2.04 piers/docks per thousand feet of shoreline). The erosion rate for reach 89 is zero feet per year as reported by the Virginia Institute of Marine Science in *Shoreline Erosion in Tidewater Virginia*, 1978. The average bank height is reported to be four feet by the same source. The predominant land use adjacent to the shoreline within this reach is (landuse). 37.04 percent of the reach's shoreline was hardened at the time of the aerial survey. Based on observed conditions, it would appear that (appropriate erosion control recommendation).

Shoreline Condition (Reach 88 - Mainstem Shoreline between nameless creek and Quarter March Creek)

Reach 88 contains 2,400 feet of shoreline and ten piers and docks (Pier and Dock Density = 4.17 piers/docks per thousand feet of shoreline). The erosion rate for reach 88 is (X) feet per year as reported by the Virginia Institute of Marine Science in *Shoreline Erosion in Tidewater Virginia*, 1978. The average bank height is reported to be (X) feet by the same source. The predominant land use adjacent to the shoreline within this reach is (landuse). 33.33 percent of the reach's shoreline was hardened at the time of the aerial survey. Based on observed conditions, it would appear that (appropriate erosion control recommendation).

WATERBODY: QUARTER MARCH CREEK (Reach 87)

General Description and Location

This waterbody is a tributary to the Poquoson River mainstem and enters it from west.

Water Quality Data

Refer to above for HUC 02080108 (Lower Western Shore Tributaries), Segment 108-01E (The Poquoson River Waterbody).

Sensitive Land and Aquatic Resources

The following sensitive land and aquatic resources are present in this waterbody: fringing tidal marshes.

The tidal marsh inventory shows that there were 12.2 acres of tidal marshes in this waterbody at the time the inventory was conducted. Evaluation of wetland types in this waterbody, based on total environmental value of an acre of each type, was Group One; this is out of five groups, with Group One being of highest value and Group Five being of least value (Silberhorn, 1974: 45,48-49).

There were no SAV beds mapped in this waterbody in 1991. However, this entire waterbody has been included in the Tier III Target for Chesapeake Bay SAV Distribution Restoration down to the 2-meter depth contour or in the 6-foot depth range.

Shellfish Condemnation Area #137, which includes all of Quarter March Creek, went into effect 7/6/93. This is a restricted area where it is unlawful to take shellfish for any purpose, except by a VMRC permit.

Existing Water Access Facilities

There are no public water access facilities located in this waterbody but there is a large number of private piers and docks.

Existing Water-Enhanced Recreation Areas

None.

Proposed Public Water Access and Recreation Areas and Future Needs Assessment

There are no existing proposals for development of public water access or recreation areas in this waterbody.

Bathymetry

NOAA-National Ocean Service charts show a sounding of 6 ft. at the mouth of this waterbody.

Flushing Characteristics

Based on the previous general discussion of flushing characteristics of the Lower Western and Southern Shore Chesapeake Bay Small Coastal Basins, it can be inferred that this waterbody is not well-flushed.

Current Patterns

Shoreline Condition (Quarter March Creek - Reach 87)

Reach 87 contains 20,400 feet of shoreline and eleven piers and docks (Pier and Dock Density = 2.04 piers/docks per thousand feet of shoreline). The erosion rate for reach 87 is zero feet per year as reported by the Virginia Institute of Marine Science in *Shoreline Erosion in Tidewater Virginia,* 1978. The average bank height is reported to be four feet by the same source. The predominant land use adjacent to the shoreline within this reach is (landuse). 22.55 percent of the reach's shoreline was hardened at the time of the aerial survey. Based on observed conditions, it would appear that (appropriate erosion control recommendation).

MAINSTEM SEGMENT: QUARTER MARCH CREEK TO HARWOODS MILL RESERVOIR (Reach 86)

General Description and Location

This mainstem segment has been delineated as beginning at the mouth of Quarter March Creek then south along the Poquoson River shoreline then west along the north shore of the Poquoson River to the spillway at Harwoods Mill Reservoir at U.S. Rt. 17.

Water Quality Data

Refer to above for HUC 02080108 (Lower Western Shore Tributaries), Segment 108-01E (The Poquoson River Waterbody).

Sensitive Land and Aquatic Resources

The following sensitive land and aquatic resources are present in this segment: fringing tidal marshes.

The tidal marsh inventory shows that there were 60.3 acres of tidal marsh located in this segment at the time the inventory was conducted. The largest marsh on the Poquoson River is located in this segment at the upper end of the river, just below the Harwoods Mill Reservoir spillway and U.S. Rt. 17. This is a mixed brackish water marsh community of 56 acres. Evaluation of wetland types in this segment, based on total environmental value of an acre of each type, ranged from Group One to Group Three; this is out of five groups, with Group One being of highest value and Group Five being of least value (Silberhorn, 1974: 38,45,49).

No SAV beds were mapped in 1991 along this segment. However, the entire segment has been included in the Tier III Target for Chesapeake Bay SAV Distribution Restoration down to the 2-meter depth contour or in the 6-foot depth range.

Shellfish Condemnation Area #137, which includes all this segment and the Poquoson River mainstem, went into effect 7/6/93. This is a restricted area where it is unlawful to take shellfish for any purpose, except by a VMRC permit.

Existing Water Access Facilities

There is a **(private/public)** boat landing located at the end of Lindsay Landing Lane.

Existing Water-Enhanced Recreation Areas

None.

Proposed Public Water Access and Recreation Areas and Future Needs Assessment

There are no existing proposals for development of public water access or recreation areas in this segment. However, a canoe put-in/take-out area could be developed adjacent to the U.S. Rt. 17 to access the large marsh system below the spillway at Harwoods Mill Reservoir.

Bathymetry

NOAA-National Ocean Service charts and USGS topographic maps show soundings of 1-2 ft. along this segment.

Flushing Characteristics

Based on the previous general discussion of flushing characteristics of the Lower Western and Southern Shore Chesapeake Bay Small Coastal Basins, it might be inferred that this segment is not well-flushed except in the event of a freshwater release from Harwoods Mill reservoir over the spillway.

Current Patterns

Shoreline Condition (Reach 86)

Reach 86 contains 17,200 feet of shoreline and 24 piers and docks (Pier and Dock Density = 1.40 piers/docks per thousand feet of shoreline). The erosion rate for reach 86 is 1.80 feet per year as reported by the Virginia Institute of Marine Science in *Shoreline Erosion in Tidewater Virginia,* 1978. The average bank height is reported to be five feet by the same source. The predominant land use adjacent to the shoreline within this reach is (landuse). 9.30 percent of the reach's shoreline was hardened at the time of the aerial survey. Based on observed conditions, it would appear that (appropriate erosion control recommendation).

WATERBODY: HARWOODS MILL RESERVOIR

General Description and Location

This waterbody is located in York County but is owned and operated by the City of Newport News as a drinking water supply. It is connected by surface flow to the Poquoson River via a spillway.

Water Quality Data

Refer to above for HUC 02080108 (Lower Western Shore Tributaries), Segment 108L (The Harwoods Mill Reservoir Waterbody).

Sensitive Land and Aquatic Resources

The following sensitive land and aquatic resources are present in this waterbody: palustrine wetland communities and wooded parkland which serves as a watershed protection buffer area for the reservoir.

Existing Water Access Facilities

The City of Newport News Park operates a boat rental and boat launch facility on Harwoods Mill Reservoir for canoes, paddleboats and small boats propelled by electric motor only.

Existing Water-Enhanced Recreation Areas

The City of Newport News Park, which surrounds Harwoods Mill Reservoir, provides opportunities for hiking, biking, fitness trails, and nature study.

Proposed Public Water Access and Recreation Areas and Future Needs Assessment

There are no existing proposals for development of additional public water access or recreation areas in this waterbody.

Bathymetry

USGS topographic maps show a sounding of 20 ft. near the dam.

MAINSTEM SEGMENT: HARWOODS MILL RESERVOIR TO MOORES CREEK (Reaches 85 and 84)

General Description and Location

This mainstem segment has been delineated as beginning at the spillway at Harwoods Mill Reservoir then east along the south shore of the Poquoson River mainstem to Moores Creek.

Water Quality Data

Refer to above for HUC 02080108 (Lower Western Shore Tributaries), Segment 108-01E (The Poquoson River Waterbody).

Sensitive Land and Aquatic Resources

The following sensitive land and aquatic resources are present in this segment: fringing tidal marshes.

The tidal marsh inventory shows that there were 61.68 acres of tidal marsh located in this segment at the time the inventory was conducted. The largest marsh on the Poquoson River is located in this segment at the upper end of the river, just below the Harwoods Mill Reservoir spillway and U.S. Rt. 17. This is a mixed brackish water marsh community of 56 acres. Other marshes along this segment consist of fringe and pocket marshes. Evaluation of wetland types in this segment, based on total environmental value of an acre of each type, was Group One; this is out of five groups, with Group One being of highest value and Group Five being of least value (Silberhorn, 1974: 38,45,49).

No SAV beds were mapped in 1991 along this segment. However, the entire segment has been included in the Tier III Target for Chesapeake Bay SAV Distribution Restoration down to the 2-meter depth contour or in the 6-foot depth range.

Shellfish Condemnation Area #137, which includes all this segment and the Poquoson River mainstem, went into effect 7/6/93. This is a restricted area where it is unlawful to take shellfish for any purpose, except by a VMRC permit.

Existing Water Access Facilities

There is one county-owned/DGIF public boat landing located on the Poquoson River near the mouth of Moores Creek at the end of Rt. 600 (Tide Mill Rd.): Rodgers A. Smith (a/k/a Tide Mill Landing). Because of a limited number of public boat landings in the northern portion of York County, this facility is currently experiencing overcrowding.

Existing Water-Enhanced Recreation Areas

Opportunities for nature study exist at the Rodgers A. Smith public boat landing area.

Proposed Public Water Access and Recreation Areas and Future Needs Assessment

There are no existing proposals for development of public water access or recreation areas in this segment. However, improvements could be made to the Rodgers A. Smith public boat landing to increase access and reduce current launch waiting time. A Canoe put-in/take-out area could be developed adjacent to the U.S. Rt. 17 to access the large marsh system below the spillway at Harwoods Mill Reservoir.

Bathymetry

NOAA-National Ocean Service charts and USGS topographic maps show soundings of 1-2 ft. along this segment.

Flushing Characteristics

Based on the previous general discussion of flushing characteristics of the Lower Western and Southern Shore Chesapeake Bay Small Coastal Basins, it might be inferred that this segment is not well-flushed except in the event of a freshwater release from Harwoods Mill reservoir over the spillway.

Current Patterns

Shoreline Condition (Reach 85 - Poquoson River Headwaters to Unnamed Point)

Reach 85 contains 14,000 feet of shoreline and three piers and docks (Pier and Dock Density = 0.21 piers/docks per thousand feet of shoreline). ~~The erosion rate for reach 85 is (X) feet per year as reported by the Virginia Institute of Marine Science in *Shoreline Erosion in Tidewater Virginia*, 1978. The average bank height is reported to be (X) feet by the same source.~~ The predominant land use adjacent to the shoreline within this reach is (landuse). 1.43 percent of the reach's shoreline was hardened at the time of the aerial survey. Based on observed conditions, it would appear that (appropriate erosion control recommendation).

Shoreline Condition (Reach 84 - Unnamed Point to Moores Creek)

Reach 84 contains 1,600 feet of shoreline and two piers and docks (Pier and Dock Density = 1.25 piers/docks per thousand feet of shoreline). The erosion rate for reach 84 is 1.40 feet per year as reported by the Virginia Institute of Marine Science in *Shoreline Erosion in Tidewater Virginia*, 1978. The average bank height is reported to be five feet by the same source. The predominant land use adjacent to the shoreline within this reach is (landuse). No shoreline hardening had occurred within this reach prior to the aerial survey. Based on observed conditions, it would appear that (appropriate erosion control recommendation).

WATERBODY: MOORES CREEK (Reach 83)

General Description and Location

This waterbody is a tributary to the Poquoson River mainstem and enters it from the south.

Water Quality Data

Refer to above for HUC 02080108 (Lower Western Shore Tributaries), Segment 108-01E (The Poquoson River Waterbody).

Sensitive Land and Aquatic Resources

The following sensitive land and aquatic resources are present in this waterbody: fringing tidal marshes and tidal flats.

The tidal marsh inventory shows that there were 17.83 acres of tidal marshes in this waterbody at the time the inventory was conducted. The Moores Creek area is stressed by development, which is evidenced by artificial canals and deposits of spoil on the marsh surface. Evaluation of wetland types in this waterbody, based on total environmental value of an acre of each type, was Group One; this is out of five groups, with Group One being of highest value and Group Five being of least value (Silberhorn, 1974: 45,48-49).

There were no SAV beds mapped in this waterbody in 1991. However, this entire waterbody has been included in the Tier III Target for Chesapeake Bay SAV Distribution Restoration down to the 2-meter depth contour or in the 6-foot depth range.

Shellfish Condemnation Area #137, which includes all of Moores Creek, went into effect 7/6/93. This is a restricted area where it is unlawful to take shellfish for any purpose, except by a VMRC permit.

Existing Water Access Facilities

There are no public water access facilities located in this waterbody but there are several private piers and docks.

Existing Water-Enhanced Recreation Areas

None.

Proposed Public Water Access and Recreation Areas and Future Needs Assessment

There are no existing proposals for development of public water access or recreation areas in this waterbody. However, the 1990 Chesapeake Bay Program Public Access Plan suggests that the large tidal marshes along the tidal creeks in York County, such as Moores Creek, could be made more accessible for activities such as nature study and environmental education. Canoe put-in/take-out points could also be identified.

Bathymetry

NOAA-National Ocean Service charts show a sounding of 1 ft. at the mouth of this waterbody.

Flushing Characteristics

Based on the previous general discussion of flushing characteristics of the Lower Western and Southern Shore Chesapeake Bay Small Coastal Basins, it can be inferred that this waterbody is not well-flushed.

Current Patterns

Shoreline Condition (Moores Creek - Reach 83)

Moores Creek contains 14,800 feet of shoreline and twelve piers and docks (Pier and Dock Density = 1.20 piers/docks per thousand feet of shoreline). The erosion rate for reach 83 is x feet per year as reported by the Virginia Institute of Marine Science in *Shoreline Erosion in Tidewater Virginia*, 1978. The average bank height is reported to be x feet by the same source. The predominant land use adjacent to the shoreline within this reach is (landuse). 2.70 percent of the reach's shoreline was hardened at the time of the aerial survey. Based on observed conditions, it would appear that (appropriate erosion control recommendation).

MAINSTEM SEGMENT: MOORES CREEK TO LAMBS CREEK (Reach 82)

General Description and Location

This mainstem segment has been delineated as beginning at the mouth of Moores Creek then north along the western shoreline of the Poquoson River mainstem at Calthrop Neck to Lambs Creek.

Water Quality Data

Refer to above for HUC 02080108 (Lower Western Shore Tributaries), Segment 108-01E (The Poquoson River Waterbody). The ACB Citizen's Monitoring Program has one inactive monitoring station (#14)
along this segment.

Sensitive Land and Aquatic Resources

The following sensitive land and aquatic resources are present in this segment: fringing tidal marshes.

The tidal marsh inventory shows that there were 6.63 acres of tidal marsh located in this segment at the time the inventory was conducted. Evaluation of wetland types in this segment, based on total environmental value of an acre of each type, was Group One; this is out of five groups, with Group One being of highest value and Group Five being of least value (Silberhorn, 1974: 45,50).

No SAV beds were mapped in 1991 along this segment. However, a small nearshore area near the mouth of Lambs Creek has been included in the Tier I Target for Chesapeake Bay SAV Distribution Restoration and the entire segment has been included in the Tier III Target for Chesapeake Bay SAV Distribution Restoration down to the 2-meter depth contour or in the 6-foot depth range.

Shellfish Condemnation Area #137, which includes a portion of this segment along the Poquoson River mainstem from Moores Creek to a point just south of the tip of Calthrop Neck, went into effect 7/6/93. This is a restricted area where it is unlawful to take shellfish for any purpose, except by a VMRC permit.

Existing Water Access Facilities

None.

Existing Water-Enhanced Recreation Areas

None.

Proposed Public Water Access and Recreation Areas and Future Needs Assessment

There are no existing proposals for development of public water access or recreation areas in this segment.

Bathymetry

NOAA-National Ocean Service charts and USGS topographic maps show soundings of 1-2 ft. along this segment.

Flushing Characteristics

Based on the previous general discussion of flushing characteristics of the Lower Western and Southern Shore Chesapeake Bay Small Coastal Basins, it might be inferred that this segment is not well-flushed.

Current Patterns

Shoreline Condition (Reach 82)

Reach 82 contains 13,600 feet of shoreline and 24 piers and docks (Pier and Dock Density = 1.76 piers/docks per thousand feet of shoreline). The erosion rate for reach 82 is 1.70 feet per year as reported by the Virginia Institute of Marine Science in *Shoreline Erosion in Tidewater Virginia*, 1978. The average bank height is reported to be four feet by the same source. The predominant land use adjacent to the shoreline within this reach is (landuse). 5.88 percent of the reach's shoreline was hardened at the time of the aerial survey. Based on observed conditions, it would appear that (appropriate erosion control recommendation).

WATERBODY: LAMBS CREEK

General Description and Location

A centerline in this waterbody forms the corporate boundary between York County and the City of Poquoson. It is a tributary to the Poquoson River mainstem and enters it from the south.

Water Quality Data

Refer to above for HUC 02080108 (Lower Western Shore Tributaries), Segment 108-01E (The Poquoson River Waterbody).

Sensitive Land and Aquatic Resources

The following sensitive land and aquatic resources are present in this waterbody: fringing tidal marshes and tidal flats.

The tidal marsh inventory shows that there were 9.2 acres of tidal marshes in this waterbody at the time the inventory was conducted. The Lambs Creek area is stressed by development, which is evidenced by artificial canals and deposits of spoil on the marsh surface, as well a many private piers and docks. Evaluation of wetland types in this waterbody, based on total environmental value of an acre of each type, was Group One; this is out of five groups, with Group One being of highest value and Group Five being of least value (Silberhorn, 1974: 38,45,50).

There were no SAV beds mapped in this waterbody in 1991. However, this entire waterbody has been included in the Tier III Target for Chesapeake Bay SAV Distribution Restoration down to the 2-meter depth contour or in the 6-foot depth range.

Shellfish Condemnation Area #137, which includes all of Lambs Creek, went into effect 7/6/93. This is a restricted area where it is unlawful to take shellfish for any purpose, except by a VMRC permit.

Existing Water Access Facilities

There are no public water access facilities located in this waterbody but there are many private piers and docks.

Existing Water-Enhanced Recreation Areas

None.

Proposed Public Water Access and Recreation Areas and Future Needs Assessment

There are no existing proposals for development of public water access or recreation areas in this waterbody. However, the 1990 Chesapeake Bay Program Public Access Plan suggests that the large tidal marshes along the tidal creeks in York County, such as Lambs Creek, could be made more accessible for activities such as nature study and environmental education. Canoe put-in/take-out points could also be identified.

Bathymetry

NOAA-National Ocean Service charts show a sounding of three feet. at the mouth of this waterbody.

Flushing Characteristics

Based on the previous general discussion of flushing characteristics of the Lower Western and Southern Shore Chesapeake Bay Small Coastal Basins, it can be inferred that this waterbody is not well-flushed.

Current Patterns

Shoreline Condition (Lambs Creek Western Shore - Reach 81)

The western shore of Lambs Creek contains 19,200 feet of shoreline and 23 piers and docks (Pier and Dock Density = 1.20 piers/docks per thousand feet of shoreline). The erosion rate for reach 81 is zero feet per year as reported by the Virginia Institute of Marine Science in *Shoreline Erosion in Tidewater Virginia*, 1978. The average bank height is reported to be three feet by the same source. The predominant land use adjacent to the shoreline within this reach is (landuse). 12.50 percent of the reach's shoreline was hardened at the time of the aerial survey. Based on observed conditions, it would appear that (appropriate erosion control recommendation).

MAINSTEM SEGMENT: LAMBS CREEK TO ROBERTS CREEK

WATERBODY: ROBERTS CREEK

MAINSTEM SEGMENT: ROBERTS CREEK TO LYONS CREEK

WATERBODY: LYONS CREEK

MAINSTEM SEGMENT: LYONS CREEK TO WHITE HOUSE COVE

WATERBODY: WHITE HOUSE COVE

WATERBODY: BENNETT CREEK

WATERBODY: EASTON COVE

MAINSTEM SEGMENT: EASTON COVE TO MARSH ISLAND

WATERBODY: LLOYD BAY

WATERBODY: SANDY BAY

SYSTEM: YORK RIVER

General Location and Description

For the purposes of this study, the York River System encompasses the York River mainstem and southern shoreline from Ware Creek to the mouth of the York River at Tue Point, including all southern shore tributaries and other waterbodies with connected surface flow to the York River as follows: Ware Creek, France and Cow Swamps, Taskinas Creek, Skimino Creek, Barlow's Pond, Old Mill Pond, Skimino Pond, Powell Lake, Carter Creek, Bigler Mill Pond, Beaverdam Pond, Queen Creek, Cheatham Pond, Jones Pond, Queens Lake, Waller Mill Reservoir, King Creek, Penniman Lake, Felgates Creek, Black Swamp, Lee Pond, Indian Field Creek, Yorktown Creek, Wormley Creek and Wormley Pond. The extensive marsh system that comprises the Goodwin Island complex is also included. This system is located within a subbasin of the York River Basin and the Chesapeake Bay and Small Coastal Rivers Basins. A portion of James City and York Counties is included in this system. A large percentage of the shoreline in this system is owned by the federal government.

Water Quality Data

Existing water quality data for this system is as follows:

HUC 02080107: York River Subbasin

This hydrologic unit includes the York River watershed from the confluence of the Mattaponi and Pamunkey Rivers at West Point to its mouth at the Chesapeake Bay. A portion of the mainstem of the York River is water quality limited and the tributaries are effluent limited.

The York River has been designated as nutrient enriched waters in the estuarine portion of the river from West Point to the mouth of the York River (Tue Marsh Light), including all tributaries that enter the estuarine portion of the river.

Segment 107-07E: The York River-West Point Waterbody

Consists of the mainstem and tributaries from the confluence of the Mattaponi and Pamunkey Rivers at West Point to river mile 22.4 just below the Poropotank River, including the York River mainstem, Goalders Creek, Bakers Creek, Hockley Creek, Poropotank River, and all surrounding tributaries. The waterbody is classified as water quality limited.

The VWCB has 2 AWQM stations in the upper reaches of the York River. Neither station exhibited any violations of the standards for temperature or pH. The violation rate for DO at one station was below 10%. The other station indicated a violation rate for the DO standard of 11%. No fecal coliform bacteria data were collected. Citizen members of the Alliance for the Chesapeake Bay sampled one additional station. Their data indicated no violations for DO, temperature, or pH.

Shellfish condemnations on the upper York River near the confluence with the Mattaponi and Pamunkey Rivers can be attributed to the buffer zones surrounding the Town of West Point's STP and Chesapeake Corporation, as well as from NPS pollutants. One industrial facility discharges to this segment.

The CWA fishable goal for this waterbody, which covers 13.07 square miles of surface water, is fully supported for 5.99 square miles and partially supported for 7.08 square miles. The swimmable goal is fully supported for the entire waterbody.

Segment 107-06E: The York River-Gloucester Waterbody

Encompasses an area from river mile 22.4, just below the Poropotank River, to the confluence with the Chesapeake Bay at Sandy Point and Tue Point, including the York River, Taskinas Creek, Adams Creek, Bland Creek, Purtan Bay, Carter Creek (Powell Lake), Queens Creek, King Creek, Felgates Creek, Jones Creek, Timberneck Creek, Wormley Creek, Back Creek, and other surrounding tributaries. This waterbody is classified as effluent limited.

The VWCB maintains 2 ambient stations and one Core station on the mainstem of the York River. Neither AWQM station indicated violation rates over 10% for the standards during the two-year reporting period prior to April 1992. Water column samples indicated the presence of copper above the detection limit but below the criteria level. Sediment samples taken at the Core station indicated no significant concentrations of metals. Fish tissue samples contained arsenic at concentrations above the EPA trigger value. Citizen members of the Alliance for the Chesapeake Bay sampled six additional stations. Their data indicated no violations for DO, temperature, or pH.

Shellfish condemnations on the York River are related to the buffer zones surrounding the discharges from HRSD-York River STP and Cheatham Annex STP on the mainstem while the closures on Carter Creek and its tributaries are related to discharges from Camp Peary. Additionally, 10 industrial facilities discharge to the mainstem and various tributaries to the York River. NPS pollutants also influence water quality in the area.
The York River Mainstem - Sandbox to Coleman Bridge System is included in Watershed F01 (HUC 02080107 - York River Subbasin) in the 1993 Virginia Nonpoint Source Pollution Watershed Assessment. Forestry and agriculture are the primary land uses in the York River subbasin; however, portions of the subbasin are intensively urbanized. In fact, although agriculture and forestry nonpoint sources affect water quality, urban sources are probably the most significant sources of nonpoint pollution in this subbasin. Monitoring data in the 305(b) report also indicates a possible problem with metal contamination. Biological data is not available for this watershed. Watershed F01 has a high priority rating for urban pollution potential, and has a final rank of High+ in Virginia's Overall Nonpoint Source Pollution Priorities for 1993.

The CWA fishable goal for this waterbody, which covers 50.78 square miles of surface water, is fully supported for 43.41 square miles and partially supported for 7.37 square miles. The swimmable goal is fully supported for the entire waterbody.

Segment 107-08R: The Phil Bates Creek Waterbody

Contains Phil Bates Creek and Ware Creek, and totals 16.0 river miles. There are no point source discharges to this segment. The only discharger in this segment, an industrial facility, discharges to France Swamp, a tributary to Ware Creek.

Data from one AWQM station on Phil Bates Creek, at State Route 600, are used to assess water quality for this segment. This station exhibited no water quality problems during this reporting period. The total 16.0 river miles fully support the CWA fishable/swimmable goals.

Segment 107-04L: The Bigler Millpond Waterbody

Located at Camp Peary and includes the drainage from this area to the dam at the York River. The millpond covers 121 acres, and is owned and used by Camp Peary. No known point sources discharge to this segment. The millpond is designated as eutrophic. This waterbody was not assessed during the current reporting period for support of the CWA fishable and swimmable goal.

Segment 107-03L: The Beaverdam Pond Waterbody

Located to the south of Bigler Millpond and includes the drainage from the surrounding area to the confluence with the York River. The pond covers 51 acres. Like Bigler Millpond, this pond is owned and used by Camp Peary. No known point sources discharge to this segment. The millpond is designated as eutrophic. This waterbody was not assessed during the current reporting period for support of the CWA fishable and swimmable goal.

Segment 107-05L: The Waller Mill Reservoir Waterbody

Encompasses an area from the confluence of the tributary to Queens Creek at Route 132 to the dam at Waller Mill Road, including Waller Mill Reservoir and the tributary at the end of Queens Creek. The reservoir covers 315 acres and is classified as mesotrophic. Waller Mill Reservoir is used as a public water supply reservoir for the City of Williamsburg. One industrial facility discharges to the tributary Queens Creek. NPS pollutants also impact water quality. This waterbody was not assessed during the current reporting period for support of the CWA fishable and swimmable goal.

Segment 107-01L: The Cheatham Lake Waterbody

Encompasses the drainage area surrounding the lake, to the confluence with Queens Creek at the Cheatham Lake Dam. The lake covers 108 acres, and is owned and used by the U.S. Navy. No point sources discharge to this segment. The lake is designated as eutrophic. This waterbody was not assessed during the current reporting period for support of the CWA fishable and swimmable goal.

Segment 107-02L: The Jones Millpond Waterbody

Includes the drainage surrounding the lake, to the confluence with a tributary to Queens Creek at the Jones Millpond Dam. The millpond covers 65.2 acres. No data are available for this millpond to determine its classification. The millpond is owned and used by the U.S. Navy. No point sources discharge to this segment. This waterbody was not assessed during the current reporting period for support of the CWA fishable and swimmable goal.

HUC 02080101 Mainstem Open Bay

The VWCB conducts monitoring in the Chesapeake Bay mainstem as part of the Federal-Interstate Chesapeake Bay Program (CBP). The CBP Monitoring Program collects basic water quality parameters and also monitors the status and trends in benthic, phytoplankton, and zooplankton communities.

The water quality assessment performed here relied on four main sources of information. The first major source of information was an examination of monitoring data in relation to established water quality standards for Class II, estuarine waters. DO values were compared to the minimum DO standard. Ammonia data were compared to the state criterion, which is calculated based on water temperature and pH. Fecal coliform bacteria samples are not collected as part of the CBP Monitoring Program. Given the lack of bacterial data for comparison against the standard, support of the CWA swimmable goal was determined by best professional judgment.

The second major basis of this assessment was the use of information from the Virginia Department of Health on shellfish harvesting condemnation areas. These areas were designated as partially supporting of the fishable goal.

The third major source of information for this assessment was an examination of the distribution of SAV. There has been a general decline in distribution of SAV throughout the Bay, which has resulted from declining water quality conditions. The Chesapeake Bay Program has established the return of SAV populations as a measure of restoration of the Bay and proposed a set of tiered goals. Tier I goals are the re-establishment of SAV populations in areas in which the presence of SAV has been well documented at some time in the past. For this assessment, areas of the Bay that have not achieved the Tier I goal have been designated as partially supporting of the CWA goal for fishable waters.

The fourth major basis of this assessment was monitoring data analysis done as part of the 1991 re-evaluation of the Chesapeake Bay nutrient reduction goals, henceforth referred to as the 1991 re-evaluation analysis. The 1991 re-evaluation analysis involved an examination of all water quality information collected as part of the CBP Monitoring Program during the period of 1984 through 1990. For this 1991 re-evaluation analysis, water quality of Chesapeake Bay segments was compared to other Bay segments, as well as examined for recent trends. There are no standards or criteria established for most of the parameters monitored by the CBP (e.g. nutrients, water clarity) and it is difficult to use this information for determining CWA goal status. Therefore, results were not used in determining the CWA goal status; however, environmentally undesirable conditions or trends are noted.

Segment 101-03CE (Southwestern Portion of the Chesapeake Bay)

This segment encompasses 123 square miles of water located in the southwestern portion of the Bay, from Mobjack Bay to Back River. The VWCB maintains 2 water quality stations in this segment. Depths at these stations average approximately 5-7 meters. Salinities were 16-20 ppt, with slight stratification present.

Water quality in this segment was characterized by average levels of total nitrogen and phosphorus and low levels of inorganic nutrients. Light levels were good. Chlorophyll levels were generally not excessive, however there was a moderately increasing trend during the period of 1984-1990. Bottom water DO levels were fairly good. There were no significant inter-annual trends in total nitrogen, total phosphorus, water clarity or DO during the period of 1984-1990.

The shallow water areas of this segment are potential habitat for SAV. Approximately 7 square miles of this segment are estimated to have had the documented presence of SAV but do not have any SAV now. Because of this decline in SAV, 7 square miles of this waterbody segment are considered to only partially meet the CWA goal for fishable waters.

The DO standard was violated in 0.5% of the samples collected. The pH standard and the ammonia criterion were not violated in any samples during this reporting period. All of this segment was evaluated as fully supporting the CWA goal for swimmable waters.

In summary, 116 square miles of this segment fully support the CWA goal for fishable waters, 7 square miles partially support the CWA goal for fishable waters, and all (123 square miles) of this segment fully support the CWA goal for swimmable waters.

Segment 101-02BE (Mouth of the York River)

This segment encompasses 10 square miles of water located off the mouth of the York River. The VWCB maintains one water quality monitoring station, where the average depth is 14 meters. This station is also monitored for status and trends of phytoplankton and zooplankton communities. Salinities were in the 19-25 ppt range and salinity stratification ranged from 1-5 ppt difference between surface and bottom water.

Water quality in this segment was characterized by about average levels of total nitrogen and phosphorus and low levels of inorganic nutrients. Light levels were good and chlorophyll levels were generally not excessive. Bottom water DO levels were poor. There were no significant inter-annual trends in total nitrogen, total phosphorus, water clarity, DO, or chlorophyll observed for the period of 1984-1990. Biological monitoring in this segment indicated no adverse effects due to water quality.

The DO standard was violated by 18.5% of the monitoring observations. The standard for pH was violated by 1.4% of the monitoring observations. The ammonia criterion was not violated in any samples during this reporting period. All of this segment was evaluated as fully supporting the CWA goal for swimmable waters.

In summary, all 10 square miles of this segment partially support the CWA goal for fishable waters and fully support the CWA goal for swimmable waters.

Sensitive Land and Aquatic Resources

The following sensitive land and aquatic resources are present in this system: extensive tidal marshes, fringing tidal marshes, tidal flats, freshwater marshes and swamps, submerged aquatic vegetation (SAV) beds, shellfish producing areas, condemned shellfish areas, anadromous finfish spawning and nursery areas, commercially- and recreationally-important finfishing areas, habitats and rookeries for birds of special concern, protected areas and estuarine research reserves.

An inventory of tidal marshes in this system can be found in the following publications: James City County Tidal Marsh Inventory (1980) and York County-Town of Poquoson Tidal Marsh Inventory (1974). These inventories show that, at time of publication, there were approximately 2,345 acres of tidal marshes located within this system. Evaluation of wetland types, based on total environmental value of an acre of each type, ranged from Group One to Group Two; this is out of five groups, with Group One being of highest value and Group Five being of least value.

SAV beds were mapped in 1991 in this system, primarily surrounding the Goodwin Islands complex. Some nearshore areas in this system have been included in the Tier I Chesapeake Bay SAV Distribution Restoration Target and the entire system has been included in the Tier III Chesapeake Bay SAV Distribution Restoration Target.

Shellfish producing areas can be found in the York River mainstem just east of the Coleman Bridge to the mouth of the river. There are several Condemned Shellfish Areas throughout the system (#6, #35, #39, #40, #73, #79, #87, #130, #134 and #166) surrounding wastewater discharge outfalls and military access piers, as well as in many of the smaller tributaries to the York River mainstem.

Anadromous finfish spawning and nursery grounds are located west of the Coleman Bridge in the several of the smaller tributaries to the York River mainstem. Species which use these areas during the Fall season include: white perch, striped bass and other species. **Commercially- and recreationally-important fishing areas can be found .....They include:.......**American bald eagle and heron habitats and rookies have also been observed in this system.

Protected land areas in this system include federal and state lands comprising the Colonial National Historic Park and Parkway and York River State Park. There are 2 estuarine research reserves in this system which are part of the National Estuarine Research Reserves System; one is located at York River State Park and the other is located in the Goodwin Islands.

Existing Water Access Facilities and Water-Enhanced Recreation Areas

There are 16 water access facilities and water-enhanced recreation areas located in this system. These include 2 public boat landings, several private boat landings, several restricted landings for military personnel only, 3 private/commercial marina facilities, a public beach, and several scenic overlooks and canoe put/in-take-out areas along the Colonial Parkway. Water-enhanced recreation areas at county, state and federal-owned parks include opportunities for pier and bank fishing, canoeing, swimming, hiking, biking, picnicking, camping and environmental education.

Proposed Public Water Access and Recreation Areas and Future Needs Assessment

In general, there are few opportunities for boating access upstream of the Coleman Bridge. The 1990 Chesapeake Bay Program Public Access Plan suggests that the large tidal marshes along the tidal creeks in this system could be made more accessible for activities such as nature study and environmental education; additional canoe put-in/take-out areas could also be developed in these marshes. However, the large presence of military facilities in this system limits, if not precludes, additional development of public access and recreation areas along many of these tidal creeks, even in the upper reaches which lie outside of the boundaries of these facilities. York County is not pursuing development of these upstream areas for recreational purposes. The Chesapeake Bay Program Public Access Plan also suggests that agreements that would make recreational boating opportunities available in the Cheatham Pond Wilderness area should be considered; this area is currently owned by the National Park Service with cooperative management by the U.S. Navy. There is a possibility that the Cheatham Pond Wilderness area might be transferred or leased to York County at a later date for development of additional recreational uses.

Some areas along the National Park Service's Colonial Parkway are emerging as recreational destinations in their own right. The 1993 Colonial National Historic Park Master Plan states that such use of these areas has been determined to be compatible with the parkway purpose, but actions will be taken to give better support to recreation. Using "limits of acceptable change" principles, the Park Service will determine optimal levels of recreational use consistent with public health, resource protection, and desired visitor experiences. On the basis of study results, actions will be initiated to protect natural resources while better accommodating visitors at designated areas. If studies reveal unacceptable impacts, actions may be taken for better management of public use e.g. limiting parking. The Chesapeake Bay Program Public Access Plan also suggests that further analysis of the lands along the Colonial Parkway be made to determine if water access can be enhanced by providing additional parking areas and recreational opportunities.

The Colonial National Historic Park Master Plan identifies specific means by which the National Park Service will seek to strengthen the Colonial National Historic Park's goals of conservation and visitor understanding and enjoyment, such as improving visitor awareness to distinguish it from other attractions in the area through improved signage and educational kiosks, establishment of recreational bikeways and walking/jogging trails in the Park and along the Parkway corridor in conjunction with state and local programs, protection of land and scenic vistas, management of specific properties, and management of cultural and natural resources.

The 1991 York County Comprehensive Plan has identified additional sites for water access facilities or enhancement of existing recreation areas in this system. The 1993 Yorktown Master Plan identifies public improvement projects along the Yorktown Waterfront area, in particular. York County is also working with the business community to encourage the development of public/private partnerships to meet recreational needs in the County.

<<Add 1991 James City Comprehensive Plan information...>>

Shoreline Condition (System)

The York River System, within York County, contains 99.87 miles of shoreline and 97 piers and docks. These figures represent the immedite York River shoreline within York County and that of the major tributaries. The average pier and dock density is 0.18 piers and docks per 1000 linear feet of shoreline. Within the system 9.84 percent of the shoreline is hardened.

For ease of analysis, this system has been subdivided into three subareas as follows: 1) Subarea A: Ware Creek to Queens Creek; 2) Subarea B: Queens Creek to the Coleman Bridge; 3) Subarea C: Coleman Bridge to Tue Point.

SUBAREA A: WARE CREEK TO QUEENS CREEK

General Description and Location

For the purposes of this study, this subarea has been delineated as beginning at and including Ware Creek, which forms the corporate boundary between New Kent and James City Counties, then east along the York River mainstem to the mouth of Queens Creek at the U.S. Naval Reservation-Camp Peary. The major tributaries to the York River mainstem in this subarea include: France Swamps, Cow Swamp, Bird Swamp, Taskinas Creek, Skimino Creek and Carter Creek. Other waterbodies in this subarea include: Lake Norvell, Barlow's Pond, Old Mill Pond, Skimino Pond, Lake Powell, Bigler Mill Pond, Beaverdam Pond and Richardson Mill Pond. This subarea is located partially in York County and predominantly in James City County; Skimino Creek forms the corporate boundary between these two counties. A large percentage of the shoreline in this system is owned by the federal or state government.

Water Quality Data

Refer to above for HUC 02080107 (York River Subbasin), Segment 107-07E (The York River-West Point Waterbody), Segment 107-08R (The Phil Bates Creek Waterbody), Segment 107-06E (The York River-Gloucester Waterbody), Segment 107-04L (The Bigler Mill Pond Waterbody) and Segment 107-03L (The Beaverdam Pond Waterbody).

Sensitive Land and Aquatic Resources

The following sensitive land and aquatic resources are present in this subarea: extensive tidal marshes, fringing tidal marshes, freshwater marshes and swamps, anadromous finfish spawning and nursery areas, shellfish condemnation areas, habitats and rookeries for birds of special concern, a protected area, and an estuarine research reserve site.

Tidal marshes in this subarea have been inventoried in the York River-Ware Creek, the York River-Taskinas Creek, and the York River-Skimino Creek Areas of the James City County Tidal Marsh Inventory, and in the Skimino Creek-Carter Creek, York River Shoreline: Carter Creek to Queens Creek and Queens Creek Areas of the York County-Town of Poquoson Tidal Marsh Inventory. At the time these inventories were conducted there were approximately 1,085 acres of tidal marsh in this subarea. Evaluation of wetland types, based on total environmental value of an acre of each type, ranged from Group One to Group Two; this is out of five groups, with Group One being of highest value and Group Five being of least value (Silberhorn, 1974: 13-20; Moore, 1980: 84-98).

In 1991 there were no SAV beds mapped in this subarea. However, this entire subarea has been included in the Tier III Target for Chesapeake Bay SAV Distribution Restoration down to the 2-meter depth contour or in the 6-foot depth range.

There are 4 shellfish condemnation areas in this subarea: #73, #79, #87 and #166. Anadromous finfish species which use this subarea for spawning and nursery grounds during the Fall season include: white perch, striped bass and other species. **Commercially- and recreationally-important fishing areas can be found .....They include:.......**American bald eagle and heron habitats and rookies have also been observed in this system.

York River State Park is the only protected area in this subarea. An estuarine research reserve, which is part of the National Estuarine Research Reserves System, is located at York River State Park.

Existing Water Access Points and Water-Enhanced Recreation Areas

There are 5 water access and water-enhanced recreation areas located in this system. They include: a public boat ramp, opportunities for pier and bank fishing, hiking, picnicking and nature study at Croaker Landing at York River State Park on the York River and Taskinas Creek; a **(private/public)** landing (Sycamore Landing) on the York River; and, 3 camping areas along the upper reaches of Skimino Creek below Old Mill and Barlow's Ponds. In addition, there are several water access points, boat landings, piers and mooring areas in this subarea which are restricted to military personnel only.

Proposed Public Water Access and Recreation Areas and Future Needs Assessment

Despite the many miles of tidal shoreline in this subarea, public access to the water, especially for recreational boating, is limited. The York River north of York River State Park is lightly used for recreation as no public access exists above Croaker Landing at York River State Park. A number of residential development proposals have been prepared in recent years in the northern portion of James City County. The 1990 Chesapeake Bay Program Public Access Plan suggests that any future public or private development should afford public recreational access for boating, fishing, nature study, and other forms of water-dependent recreation. The plan also suggests that the large tidal marshes along the tidal creeks in York County could be made more accessible for activities such as nature study and environmental education; canoe put-in/take-out areas could also be identified. James City County has applied for a federal permit to impound Ware Creek to create a reservoir that would serve as a drinking water supply for the County; to date, no permit has been issued. Public water access and water-enhanced recreation activities have been included in the reservoir project proposal. **Need 1989 and 1994 VOP reco's....**

Shoreline Condition (Subarea A)

Subarea A of the York River System contains 5.68 miles of mainstem shoreline within York County. Within the York County portion of the subarea there are no piers and docks and no shoreline hardening had occurred prior to the aerial survey.

For the purposes of analysis, this subarea is subdivided into three categories: 1) waterbodies, which include the smaller tributaries of the York River, and any lakes, ponds and reservoirs within the subarea with connected surface flow to the York River; 2) mainstem segments, which comprise the southern shoreline of the York River between identified waterbodies; and 3) shoreline reaches as defined for the purposes of this study; a reach may include an entire waterbody, a mainstem segment, or any combination thereof and may cross subarea boundaries.

WATERBODY: WARE CREEK, FRANCE SWAMP AND COW SWAMP

MAINSTEM SEGMENT: WARE CREEK TO TASKINAS CREEK

WATERBODY: TASKINAS CREEK

WATERBODY: LAKE NORVELL

General Description

Looks like a residential lake for the Riverview Plantation subdivision...is it connected by surface flow to York River?

MAINSTEM SEGMENT: TASKINAS CREEK TO SKIMINO CREEK

WATERBODY: SKIMINO CREEK, BARLOW'S POND, OLD MILL POND AND SKIMINO POND

General Location and Description

Skimino Creek forms the corporate boundary between James City and York Counties. Barlow's Pond is located on Skimino Creek and is the first impoundment upstream from the mouth of the creek. Old Mill Pond is also located on Skimino Creek and is the second impoundment upstream from the mouth of the creek. Both of these ponds are privately-owned. The U.S. Naval Reservation-Camp Peary is located on both sides of the mouth of Skimino creek to a point approximately halfway between the mouth of the creek and Barlow's Pond. Skimino Pond is connected to Skimino Creek via a spillway and is located within the boundary of U.S. Naval Reservation-Camp Peary in York County.

Water Quality Data

Refer to above for HUC 02080107 (York River Subbasin), Segment 107-06E (The York River-Gloucester Waterbody).

Sensitive Land and Aquatic Resources

The following sensitive land and aquatic resources are present in this waterbody: fringing tidal marshes, a condemned shellfish area, finfish nursery grounds and habitat for birds of special concern.

The tidal marsh inventory for this waterbody shows that there were 458.6 acres of tidal marsh in Skimino Creek at the time the inventory was conducted. The Skimino Creek tidal marsh system extends some distance upstream from the mouth of the creek along the York River shoreline, as well as downstream from the mouth of the creek along the York River shoreline to the spillway at Lake Powell. Subdivided acreage of tidal marshes were: 220 acres in York County and 238.6 acres in James City County. The creek has been stressed very little by human activity, primarily because it is partially located in a military reservation, which limits access and development. Skimino Creek is typical of the large creek marshes along the southern shoreline of the York River. Like these others, Skimino Creek presents an interesting gradation of marsh types, due primarily to salinity, from its head to its mouth. The creek is generally of low elevation and supports large stands of saltmarsh cordgrass, particularly along the lower one-third of its length. The higher areas in this wetlands system are largely dominated by saltmeadow grass communities. In the upper part of the creek, where salinity levels are lower, the dominant plant community is typically mixed freshwater with such species as big cordgrass, cattails and arrow arum. There is a large network of mosquito ditches which criss-cross through the lower end of the marsh system; most of these ditches are fringed with saltmarsh cordgrass. This practice, however, is considered ineffectual in controlling mosquito populations, many of which come from the adjacent low woodlands and not the tidal marshes. The entire creek system also presents an excellent, natural area for wildlife. Evaluation of wetland types in this waterbody, based on total environmental value of an acre of each type, range from Group One to Group Two; this is out of five groups, with Group One being of highest value and Group Five being of least value (Silberhorn, 1974; 13,14; Moore, 1980: 87-90).

No SAV beds were mapped in this waterbody in 1991. However, this entire waterbody has been included in the Tier III Target for Chesapeake Bay SAV Distribution Restoration down to the 2-meter depth contour or in the 6-foot depth range.

Shellfish Condemnation Area #87, which includes that part of Skimino Creek below Barlow's Pond, went into effect 7/12/93. This is a restricted area where it is unlawful to take shellfish for any purpose, except by a VMRC permit.

According to surveys made by the Department of Ichthyology at VIMS, the Skimino Creek marsh system is a valuable nursery ground for white perch and striped bass. Nesting pairs of American bald eagles have also been observed in tall loblolly pines along the upland marsh boundary of the marsh.

Existing Water Access Facilities

There are no public water access facilities located in this waterbody. **<<Video shows a marina facility/pier/mooring area at the western border of Camp Peary on Skimino Creek>>.** Restricted access along that portion of the Skimino Creek shoreline that is adjacent to U.S. Naval Reservation-Camp Peary is for military personnel only.

Existing Water-Enhanced Recreation Areas

That portion of the Skimino Creek shoreline that is adjacent to U.S. Naval Reservation-Camp Peary is a restricted area for military personnel only. There are 3 campgrounds located in York County along the upper reaches of Skimino Creek: Camp Skimino is located just below Old Mill Pond on Rt. 602; KOA Campground is located just below Barlow's Pond on Rt. 785; and, Colonial Campground is also located off of Rt. 785 along a tributary to Skimino Creek.

Proposed Public Water Access and Recreation Areas and Future Needs Assessment

Because of the classified nature of federal operations at Camp Peary, future development of public water access and recreation areas in this portion of Skimino Creek, as well as the upper reaches of the creek, is not likely. Public water access points might be identified along Old Mill and Barlow's Ponds but uncertainty of pond ownership could hamper this effort.

Bathymetry

Bathymetric data for Skimino Creek is not available on NOAA- National Ocean Service charts or USGS topographic maps. USGS topographic maps show a 9 ft. sounding in Barlow's Pond, a 22 ft. sounding in Old Mill Pond and a 4 ft. sounding in Skimino Pond.

Flushing Characteristics

Based on the previous general discussion of flushing characteristics in the York River and its smaller tributaries, it can be inferred that Skimino Creek is not well-flushed.

Current Patterns

Shoreline Condition (Skimino Creek)

The York County portion of Skimino Creek contains 11.74 miles of shoreline and 1 pier. The average pier and dock density is 0.02 piers and docks per 1000 linear feet of shoreline. No shoreline hardening had occurred within this portion of Skimino Creek prior to the aerial survey.

MAINSTEM SEGMENT: SKIMINO CREEK TO CARTER CREEK (Reach 11)

General Description

This mainstem segment begins at the mouth of Skimino Creek then continues east along the York River shoreline to the mouth of Carter Creek. This segment is adjacent to the U.S. Naval Reservation-Camp Peary. Data available for this segment is limited because of the classified nature of federal operations at Camp Peary.

Water Quality Data

Refer to above for HUC 02080107 (York River Subbasin), Segment 107-06E (The York River-Gloucester Waterbody).

Sensitive Land and Aquatic Resources

Sensitive land and aquatic resources found in this segment include: fringing tidal marshes. The tidal marsh inventory for this segment shows that there were .75 acres of tidal marsh in this segment at the time the inventory was conducted. Portions of this fringing marsh have been eroded by wave action and large peat blocks are commonly found strewn in the water near the marsh. Evaluation of wetland types in this marsh, based on total environmental value of an acre of each type, was Group One; this is out of five groups, with Group One being of highest value and Group Five being of least value (Silberhorn, 1974; 13,14).

No SAV beds were mapped in 1991 in this segment. However, this entire segment has been included in the Tier III Target for Chesapeake Bay SAV Distribution Restoration down to the 2-meter depth contour or in the 6-foot depth range.

Existing Water Access Facilities

There are no public water access facilities located in this segment. Restricted access in this segment is for military personnel only.

Existing Water-Enhanced Recreation Areas

This is a restricted area for military personnel only.

Proposed Public Water Access and Recreation Areas and Future Needs Assessment

Because of classified federal operations at the U.S. Naval Reservation-Camp Peary, future development of public water access facilities and recreation areas is not likely.

Bathymetry

NOAA-National Ocean Service charts and USGS topographic maps show 1-15 ft. soundings in this segment waterward of the tidal marsh system to the main channel. At this point in the York River, the main channel is very close to the Gloucester County shoreline and has an depth range of 22-40 ft.

Flushing Characteristics

Based on the previous general discussion of flushing characteristics in the York River and its smaller tributaries, it can be inferred that this mainstem segment is well-flushed.

Current Patterns

Shoreline Condition (Reach 11)

Reach 11 contains 10,000 feet of shoreline and has no piers or docks. The erosion rate for reach 11 is 2.2 feet per year as reported by the Virginia Institute of Marine Science in *Shoreline Erosion in Tidewater Virginia*, 1978. The average bank height is reported to be ten feet by the same source. The predominant land use adjacent to this reach is (landuse). No shoreline hardening had occurred within reach 11 prior to the aerial survey. Based on observed conditions, it would appear that (appropriate erosion control recommendation).

WATERBODY: LAKE POWELL

General Description

Located within the U.S. Naval Reservation-Camp Peary. Data available for this waterbody is limited because of the classified nature of federal operations at Camp Peary.

Bathymetry

USGS topographic maps show a 6 ft. sounding in Lake Powell.

WATERBODY: CARTER CREEK

General Description and Location

Carter Creek is located almost entirely within the boundary of the U.S. Naval Reservation-Camp Peary, except for uppermost portion of the creek located the west side of Rt. 604. Data available for this waterbody is limited because of the classified nature of federal operations at Camp Peary.

Water Quality Data

Refer to above for HUC 02080107 (York River Subbasin), Segment 107-06E (The York River-Gloucester Waterbody).

Sensitive Land and Aquatic Resources

Data on sensitive land and aquatic resources in this waterbody limited due to accessibility problems. However, the tidal marsh inventory for this area does state that Carter Creek has been altered by a dam at the mouth, but otherwise remains a natural system with 183 acres tidal marsh present at the time the inventory was conducted. The dam limits this system as a fish nursery area when the gates are closed. Evaluation of wetland types, based on total environmental value of an acre of each type, was Group One; this is out of five groups, with Group One being of highest value and Group Five being of least value (Silberhorn, 1974; 13,14).

No SAV beds were mapped in 1991 in this waterbody. However, this entire waterbody has been included in the Tier III Target for Chesapeake Bay SAV Distribution Restoration down to the 2-meter depth contour or in the 6-foot depth range.

Shellfish Condemnation Area #79 includes the lower portion of Carter Creek and went into effect 4/27/89. This is a restricted area where it is unlawful to take shellfish for any purpose, except by a VMRC permit.

Existing Water Access Facilities

There are no public water access facilities located in this waterbody. Restricted access in this waterbody within the boundary of Camp Peary is for military personnel only.

Existing Water-Enhanced Recreation Areas

That portion of this waterbody within the boundary of Camp Peary is a restricted area for military personnel only.

Proposed Public Water Access and Recreation Areas and Future Needs Assessment

Because of classified federal operations at the U.S. Naval Reservation-Camp Peary, future development of public water access and recreation areas is not likely. York County is not pursuing development of water access or recreation areas along that portion of this waterbody outside the boundary of Camp Peary because of proximity to Camp Peary.

Bathymetry

Bathymetric data for Carter Creek is not available on NOAA-National Ocean Service charts or USGS topographic maps.

Flushing Characteristics

Based on the previous general discussion of flushing characteristics in the York River and its smaller tributaries, it can be inferred that Carter Creek is not well-flushed.

Current Patterns

Shoreline Condition (Carter Creek)

Carter Creek contains 13.64 miles of shoreline and 1 pier. The average pier and dock density is 0.01 piers and docks per 1000 linear feet of shoreline. No shoreline hardening had occurred within Carter Creek prior to the aerial survey.

MAINSTEM SEGMENT: CARTER CREEK TO QUEENS CREEK (Reaches 12, 13, 14, and 15)

General Description and Location

This segment begins at the mouth of Carter Creek then east along the York River shoreline to Queens Creek. This shoreline area is adjacent to the U.S. Naval Reservation-Camp Peary. Data availability for this area is limited at best because of the classified nature of federal operations at Camp Peary.

Water Quality Data

Refer to above for HUC 02080107 (York River Subbasin), Segment 107-06E (The York River-Gloucester Waterbody), and Segment 107-07E (The York River-West Point Waterbody).

Sensitive Land and Aquatic Resources

The following sensitive land and aquatic resources are present in this mainstem segment: fringing tidal marshes.

The tidal marsh inventory shows that this segment contained nearly 3 miles of discontinuous fringing marshes, comprising 33 acres, at the time the inventory was conducted. Subidivided acreages of tidal marsh were: 6.25 acres along the York River shoreline east of Carter Creek, 20 acres between the York River and Bigler Mill Pond, 4.7 acres near the airstrip at Camp Peary, and 2 acres along the York River shoreline near Queens Creek. The largest of these marshes is the extensive fringe between the York River and Bigler Mill Pond. This marsh is typical of the large fringing marshes along this section of the York River. These marshes have developed a distinct zonation pattern of Spartina communities. The intertidal area is usually vegetated by a narrow band of saltmarsh cordgrass. The higher elevations are typically dominated by stands of big cordgrass. In many cases, the saltmarsh cordgrass fringe has been eroded away, leaving large blocks of peat in the intertidal zone and overhanging margins of peat near the mean high tide line. In these areas, the remaining big cordgrass communities function as the sole natural shoreline defense against erosion. Because of limited accessibility to the marsh area near the airstrip, the vegetation could not be adequately determined. Evaluation of wetland types, based on total environmental value of an acre of each type, range from Group One to Group Two; this is out of five groups, with Group One being of highest value and Group Five being of least value (Silberhorn, 1974; 15-20).

No SAV beds were mapped in 1991 in this segment. However, this entire segment has been included in the Tier III Target for Chesapeake Bay SAV Distribution Restoration down to the 2-meter depth contour or in the 6-foot depth range.

Existing Water Access Facilities

There are no public water access facilities located in this waterbody. Restricted access in this segment is for military personnel only.

Existing Water-Enhanced Recreation Areas

This is a restricted area for military personnel only.

Proposed Public Water Access and Recreation Areas and Future Needs Assessment

Because of classified federal operations at the U.S. Naval Reservation-Camp Peary, future development of public water access and recreation areas is not likely.

Bathymetry

NOAA-National Ocean Service charts and USGS topographic maps show 1-17 ft. soundings in this segment waterward from the tidal marsh system to the main channel. At this point in the York River, the main channel is very close to the Gloucester County shoreline with a depth range of 20-40 ft.

Flushing Characteristics

Based on the previous general discussion of flushing characteristics in the York River and its smaller tributaries, it can be inferred that this mainstem segment is well-flushed.

Current Patterns

Shoreline Condition (Reach 12)

Reach 12 begins at the mouth of Carter Creek and extends to Bigler Mill Point. Reach 12 contains 7,000 feet of shoreline and no piers or docks. The erosion rate for reach 12 is 2.6 feet per year as reported by the Virginia Institute of Marine Science in *Shoreline Erosion in Tidewater Virginia*, 1978. The average bank height is reported to be 10 feet by the same source. The predominant land use adjacent to this reach is (landuse). No shoreline hardening had occurred within reach 12 prior to the aerial survey. Based on observed conditions, it would appear that (appropriate erosion control recommendation).

Shoreline Condition (Reach 13)

Reach 13 begins at Bigler Mill Point and extends to Beaverdam Pond. Reach 13 contains 2,000 feet of shoreline and no piers or docks. The erosion rate for reach 13 is 0.9 feet per year as reported by the Virginia Institute of Marine Science in *Shoreline Erosion in Tidewater Virginia*, 1978. The average bank height is reported to be 5 feet by the same source. The predominant land use adjacent to this reach is (landuse). No shoreline hardening had occurred within reach 13 prior to the aerial survey. Based on observed conditions, it would appear that (appropriate erosion control recommendation).

Shoreline Condition (Reaches 14 and 15)

Reaches 14 and 15 extend from Beaverdam Pond to the mouth of Queen Creek. Reaches 14 and 15 contain 11,000 feet of shoreline and no piers or docks. The erosion rate for reaches 14 and 15 is 1.11 feet per year as reported by the Virginia Institute of Marine Science in *Shoreline Erosion in Tidewater Virginia*, 1978. The average bank height is reported to be 10 feet by the same source. The predominant land use adjacent to this reach is (landuse). No shoreline hardening had occurred within reaches 14 or 15 prior to the aerial survey. Based on observed conditions, it would appear that (appropriate erosion control recommendation).

WATERBODY: BIGLER MILL POND AND BEAVERDAM POND

General Description and Location

Bigler Mill Pond and Beaverdam Pond are located within the boundary of the U.S. Naval Reservation-Camp Peary. Data available for this waterbody is limited because of the classified nature of federal operations at Camp Peary.

Water Quality Data

Refer to above for HUC 02080107 (York River Subbasin), Segment 107-04L (The Bigler Millpond Waterbody) and Segment 107-03L (The Beaverdam Pond Waterbody).

Sensitive Land and Aquatic Resources

Data on sensitive land and aquatic resources in this waterbody is not available due to accessibility problems.

Existing Water Access Facilities

There are no public water access facilities located in this waterbody. Restricted access in this waterbody is for military personnel only.

Existing Water-Enhanced Recreation Areas

This is a restricted area for military personnel only.

Proposed Public Water Access and Recreation Areas and Future Needs Assessment

Because of classified federal operations at the U.S. Naval Reservation-Camp Peary, future development of public water access and recreation areas is not likely.

Bathymetry

USGS topographic maps show a 7 ft. sounding in Bigler Mill Pond and a 4 ft. sounding in Beaverdam Pond.

SUBAREA B: QUEENS CREEK TO THE COLEMAN BRIDGE

General Location and Description

For the purposes of this study, this subarea has been delineated as beginning at and including Queens Creek then east along the York River shoreline to the Coleman Bridge at Yorktown. The major tributaries to the York River mainstem in this subarea include: King Creek, Felgates Creek, Indian Field Creek, Ballard Creek and Yorktown Creek. Other waterbodies in this subarea include: Waller Mill Reservoir, Queens Lake, Jones Pond, Cheatham Pond, Penniman Lake, Ponds #10 and #12 at the U.S. Naval Weapons Station, Lee Pond and Roosevelt Pond. This subarea is predominantly located in York County and partially in the City of Williamsburg. A large percentage of the shoreline in this subarea is owned by the federal government.

Water Quality Data

Refer to above for HUC 02080107 (York River Subbasin), Segment 107-06E (The York River-Gloucester Waterbody), Segment 107-05L (The Waller Mill Reservoir Waterbody), Segment 107-01L (The Cheatham Lake Waterbody), and Segment 107-02L (The Jones Millpond Waterbody). The ACB Citizen's Monitoring Program maintains one active monitoring station (#15) on Queens Creek.

Sensitive Land and Aquatic Resources

The following sensitive aquatic resources are present in this subarea: extensive tidal marshes, fringing tidal marshes, anadromous finfish spawning and nursery areas, condemned shellfish areas, habitats and rookeries for birds of special concern, and two protected areas.

This subarea is partially within the York River-Queens Creek Area of the James City County Tidal Marsh Inventory and partially within the Queens Creek, King Creek-Felgate Creek, and Indian Field Creek-Yorktown Creek Areas of the York County-Town of Poquoson Tidal Marsh Inventory. There were approximately 950 acres of tidal wetlands in this subarea at the time the inventories were conducted. Evaluation of wetland types in this system, based on total environmental value of an acre of each type, range from Group One to Group Two; this is out of five groups, with Group One being of highest value and Group Five being of least value (Moore, 1980: 86; Silberhorn, 1974: 19-28).

There were no SAV beds mapped in 1991 in this subarea. However, two small nearshore areas have been included in the Tier I Chesapeake Bay SAV Restoration Distribution Target and the entire system has been included in the Tier III Chesapeake Bay Restoration Target.

There are 5 shellfish condemnation areas in this subarea: #40, #130, #134, #39 and #35. Anadromous finfish species which use this subarea for spawning and nursery grounds during the Fall season include: white perch, striped bass and other species. **Commercially- and**

recreationally-important fishing areas can be found .....They include:........ American bald eagle habitats and rookies have also been observed in the area.

The Colonial Parkway and Colonial National Historic Park are the only protected areas in this subarea.

Existing Water Access Points and Water-Enhanced Recreation Areas

There are 7? water access points and water-enhanced recreation areas located in this system. They include: opportunities for hiking, biking and nature study at a county-owned park, a restricted boat landings/piers/mooring area at the U.S. Naval Reservation-Camp Peary, the U.S. Naval Weapons Pier-Cheatham Annex and the U.S. Naval Weapons Center for use by military personnel only, 4 scenic overlooks along the Colonial National Historical Parkway, and a private/commercial marina facility. The Colonial National Historic Parkway and Park are open to the public and provide areas for camping, picnicking and parking, as well as canoe put-in/take-out areas. In general, however, there are few opportunities for boating access upstream of the Coleman Bridge.

Proposed Public Access and Recreation Areas and Future Needs Assessment

The 1990 Chesapeake Bay Program Public Access Plan suggests that agreements that would make recreational boating, beach swimming and camping opportunities available at Cheatham Pond Wilderness Area should be considered. The plan also suggests that further analysis of the lands along the Colonial Parkway be made to determine if water access can be enhanced by providing additional parking areas and recreational opportunities. The plan also suggests that the large tidal marshes along the tidal creeks in York County could be made more accessible for activities such as nature study and environmental education; canoe put-in/take-out areas could also be identified.

Shoreline Condition (Subarea B)

Subarea B contains 8.33 miles of mainstem shoreline and four piers and docks. The average pier and dock density in the subarea is 0.09 piers and docks per 1000 linear feet of shoreline. Within the subarea 48.86 percent of the shoreline is hardened.

For the purposes of analysis, this subarea is subdivided into three categories: 1) waterbodies, which include the smaller tributaries of the York River, and any lakes, ponds and reservoirs within the subarea with connected surface flow to the York River; 2) mainstem segments, which comprise the southern shoreline of the York River between identified waterbodies; and 3) shoreline reaches as defined for the purposes of this study; a reach may include an entire waterbody, a mainstem segment, or any combination thereof and may cross subarea boundaries.

WATERBODY: QUEENS CREEK, HARING SWAMP, JONES POND AND CHEATHAM POND

General Location and Description

Queens Creek is one of the larger tributaries to the York River and its shoreline comes under several jurisdictions. The north shore of Queens Creek, from the mouth to a point upstream where it intersects Rt. 132 is owned by the U.S. Naval Reservation-Camp Peary. The north shore from Rt. 132 west to the City of Williamsburg's Waller Mill Reservoir is owned by the Colonial Williamsburg Foundation. Haring Swamp is a tributary to Queens Creek and is located entirely within Camp Peary. The south shore of Queens Creek, from the mouth to just east of Queens Lake, consists of parkland owned by York County and the National Park Service. The south shore from the county park western boundary to the dam at Waller Mill Reservoir is partially in York County, partially in the City of Williamsburg, and partially adjacent to lands owned by the Colonial Williamsburg Foundation. Queens Lake is surrounded by a residential area. Waller Mill Reservoir and its surrounding open space protection area is located on Queens Creek near its headwaters in York County; the reservoir is owned and operated by the City of Williamsburg as a drinking water supply. The headwaters of Queens Creek above the reservoir are located in York County. Jones Pond is located within the U.S. Naval Weapons Station and is connected by surface flow to Queens Creek. Cheatham Pond is adjacent to land owned by the National Park Service and the U.S. Naval Supply Center-Cheatham Annex near the mouth of Queens Creek.

Water Quality Data

Refer to above for HUC 02080107 (York River Subbasin), Segment 107-06E (The York River-Gloucester Waterbody), Segment 107-01L (The Cheatham Lake Waterbody), and Segment 107-02L (The Jones Millpond Waterbody). The ACB Citizen's Monitoring Program maintains one active monitoring station (#15) on Queens Creek.

Sensitive Land and Aquatic Resources

The following sensitive land and aquatic resources are present in this waterbody: extensive tidal marshes, fringing tidal marshes, a shellfish condemnation area, a fish nursery area, habitat for birds of special concern, and a protected area.

The tidal marsh inventories for this waterbody show that there were approximately 552 acres of tidal marsh in Queens Creek at the time the inventories were conducted. Subdivided acreages of tidal marsh were: 528 acres (York County) and 24.4 acres along lands owned by the Colonial Williamsburg Foundation. Queens Creek Marsh is the largest wetland system of marsh creek in York County. Some parts of the marsh have been disturbed by the digging of mosquito ditches, heavy military vehicles and erosion caused by boat traffic between the Queen's Lake Marina and the mouth of the creek. The system is mainly a grass dominated brackish water marsh with abundant stands of saltmarsh cordgrass through the lower reaches of the marsh system. In the lower saline areas, and at higher elevations farther upstream, big cordgrass and saltbushes predominate. At the upper reaches of the creek, near the Rte. 132 bridge, the dominant vegetation is largely arrow arum, indicating freshwater conditions. Further development is expected along these upper reaches of the creek on land owned by the Colonial Williamsburg Foundation. This is a highly productive marsh which is also regarded as a major fish nursery area. Evaluation of wetland types in this waterbody, based on total environmental value of an acre of each type, ranged from Group One to Group Two; this is out of five groups, with Group One being of highest value and Group Five being of least value (Silberhorn, 1974: 19-23; Moore, 1980: 84-86).

No SAV beds were mapped in this waterbody in 1991. However, this entire waterbody has been included in the Tier III Target for Chesapeake Bay SAV Distribution Restoration down to the 2-meter depth contour or in the 6-foot depth range.

Shellfish Condemnation Area #35 includes a portion of Queens Creek upstream from the mouth and Cheatham Pond to an area upstream of Queens Lake and went into effect 5/11/92. Both #39 and #35 are restricted area where it is unlawful to take shellfish for any purpose, except by a VMRC permit.

The Colonial National Historic Park and Parkway are protected areas. American bald eagle habitats and rookies have been observed along the Colonial Parkway.

Existing Water Access Facilities

There are 2 water access facilities located in this waterbody. There is a private marina on Queens Creek at Queens Lake (Queens Lake Marina Corp.) and a restricted landing (Hawtree Landing) at Camp Peary for use by military personnel only. Siltation at the mouth of Queens Creek makes navigation difficult except at high tide.

Existing Water-Enhanced Recreation Areas

There county-owned New Quarter Park is located on Queens Creek, which provides opportunities for hiking, biking and picnicking, and has restroom facilities. The Colonial Parkway is adjacent to New Quarter Park on the south side.

Proposed Public Water Access and Recreation Areas and Future Needs Assessment

The National Park Service also owns the Cheatham Pond Wilderness Area (Cheatham Pond Tract) along Queens Creek between New Quarter Park and Cheatham Annex and adjacent to the Colonial National Historical Parkway. The <u>Colonial National Historic Park Master Plan</u> states that both York County and the U.S. Navy have asked the National Park Service to consider their needs for long-term use of the Cheatham Pond Wilderness Area (Cheatham Pond Tract). The National Park Service will not enter into any agreements or initiate development at the Cheatham Pond area until all necessary natural and cultural resource mitigation is completed. As an initial step, the National Park Service has developed the following management objectives for the tract to define the range of options available for future management of the area: protect and manage natural and cultural resources; ensure protection of the adjacent Colonial Parkway; accommodate U.S. Navy security needs; and, provide for compatible recreational uses. The following options have been considered for future management of the Cheatham Pond area:

a. As at present, continue ownership by the National Park Service with cooperative management by the Navy.

b. Return of ownership to the Navy. The Navy has requested consideration of this option because it needs a rustic bivouac area, a security buffer for the adjacent naval supply center, and more recreational facilities for military personnel.

c. Transfer of the tract by an act of Congress to York County, which owns and operates New Quarter Park. This park adjoins the Cheatham Pond area tract on the west. The County Administrator has requested transfer of the tract to the County to meet the growing demand for outdoor recreation. The county would plan to build a boat launching ramp and allow low-intensity recreation on the site. The Virginia Department of Conservation and Recreation, Division of Planning and Recreational Resources supports this request, citing the <u>1989 Virginia Outdoors Plan</u> which refers to a major need for more recreation in this vicinity.

d. Leasing of the property to York County.

e. Management of the tract by York County, the Navy, and the National Park Service, with ownership remaining with the Park Service. The Navy would manage the (roughly) eastern part of the property and York County would manage the (roughly) western part. The Park Service would continue to manage the part closest to the Colonial Parkway.

The final National Park Service recommendation in the <u>Master Plan</u> for management of this area is that the tract be divided into parcels (Option E above), with long-term leases or long-term management agreements with both the Navy and York County. The <u>Master Plan</u> further recommends that the Navy, York County, and the National Park Service work together to develop boundaries and operating procedures that would meet the needs of all parties, including specific provisions for protection of natural and cultural resources.

The <u>1990 Chesapeake Bay Program Public Access Plan</u> suggests that agreements that would make recreational boating opportunities available at Cheatham Pond Wilderness Area should be considered. The plan has identified this tract as a potential boat ramp, swimming beach and camping area.

The <u>Public Access Plan</u> also suggests that further analysis of the lands along the Colonial Parkway be made to determine if water-enhanced activities can be improved by providing additional parking areas and recreational opportunities.

The Colonial Williamsburg Foundation proposes to build an office park along lands recently acquired at the headwaters of Queen Creek just below Waller Mill Reservoir, west of Rt. 132. Potential passive recreation areas and boardwalks over the marsh could be incorporated into the plan of development for this area.

Bathymetry

Bathymetric data for this waterbody is available on NOAA-National Ocean Service charts and USGS topographic maps. Soundings in Queens Creek range from 3-4 ft. at the mouth, from 5-9 ft. between Cheatham Pond and Hawtree Landing, from 3-5 ft. between Hawtree Landing and below the dam at Waller Mill Reservoir, and 6 ft. at Queens Lake Marina. USGS topographic maps show soundings of 10 ft. in Queens Lake, 21 ft. in Jones Pond, and 8 ft. in Cheatham Pond.

Flushing Characteristics

Based on the previous general discussion of flushing characteristics in the York River and its smaller tributaries, it can be inferred that Queens Creek is not well-flushed.

Current Patterns

Shoreline Condition (Queen's Creek)

Queen's Creek contains 15.15 miles of shoreline and no piers or docks. Within the waterbody no shoreline hardening had occurred prior to the aerial survey.

WATERBODY: WALLER MILL RESERVOIR

General Description and Location

Waller Mill Reservoir is an impoundment on Queens Creek and is located in York County. It is owned and operated by the City of Williamsburg as a drinking water supply. The land area surrounding the reservoir is an open space protection area for the reservoir and consists primarily of upland woodland.

Water Quality Data

Refer to above for HUC 02080107 (York River Subbasin), Segment 107-05L (The Waller Mill Reservoir Waterbody).

Sensitive Land and Aquatic Resources

<<Nontidal wetlands... Watershed Protection Area.....??>>

Existing Water Access Facilities

There is a boat ramp for car-top boats only. Paddle boating and pier and bank fishing are also available.

Existing Water-Enhanced Recreation Areas

Biking, hiking and fitness trails, picnic areas and playgrounds are available.

Proposed Water Access and Recreation Areas and Future Needs Assessment

The City of Williamsburg has proposed the development of a golf course within the open space reservoir protection area surrounding the reservoir. Water quality problems in the reservoir could result from intensive landscape maintenance practices associated with golf course operation.

Bathymetry

USGS topographic maps show a 35 ft. sounding near the dam.

MAINSTEM SEGMENT: QUEENS CREEK TO PENNIMAN SPIT (Reach 16) and PENNIMAN SPIT (Reach 17)

General Description and Location

This mainstem segment has been delineated as beginning at the mouth of Queens Creek then east along the York River shoreline to Penniman Spit at the mouth of King and Felgates Creeks, including the U.S. Naval Supply Center Pier-Cheatham Annex. The shoreline in this segment is owned by the U.S. Naval Supply Center-Cheatham Annex.

Water Quality Data

Refer to above for HUC 02080107 (York River Subbasin), Segment 107-06E (The York River-Gloucester Waterbody).

Sensitive Land and Aquatic Resources

The following sensitive land and aquatic resources that are present in this segment: fringing tidal marshes.

The tidal marsh inventory shows that there were 8.83 acres of tidal marsh in this segment at the time the inventory was conducted. Evaluation of wetland types in this waterbody, based on total environmental value of an acre of each type, are Group One; this is out of five groups, with Group One being of highest value and Group Five being of least value (Silberhorn, 1974: 22-23).

No SAV beds were mapped in this segment in 1991. However, a small nearshore area at Penniman Spit has been included in the Tier I Chesapeake Bay Restoration Distribution Target. This entire segment has been included in the Tier III Target for Chesapeake Bay SAV Distribution Restoration down to the 2-meter depth contour or in the 6-foot depth range.

Shellfish Condemnation Area #39 has been delineated around the U.S. Naval Supply Center Pier-Cheatham Annex and went into effect 5/11/92. This is a restricted area where it is unlawful to take shellfish for any purpose, except by a VMRC permit.

Existing Water Access Facilities

There are no public water access facilities located in this segment. Restricted access in this segment is for military personnel only.

Existing Water-Enhanced Recreation Areas

This is a restricted area for military personnel only.

Proposed Public Water Access and Recreation Areas and Future Needs Assessment

Because of the nature of federal operations along this segment, the development of public water access or recreation areas is unlikely.

Bathymetry

NOAA-National Ocean Service charts and USGS topographic maps show 1-9 ft. soundings in this segment waterward from the tidal marsh system to the main channel. At this point in the York River, the main channel is located in the central portion of the river with a depth range of 20-53 ft.

Flushing Characteristics

Based on the previous general discussion of flushing characteristics in the York River and its smaller tributaries, it can be inferred that this mainstem segment is well-flushed.

Current Patterns

Shoreline Condition (Reach 16)

Reach 16 contains 12,000 feet of shoreline and has two piers and docks (Pier and Dock Density = 0.17 per thousand feet of shoreline). The erosion rate for reach 16 is 1.9 feet per year as reported by the Virginia Institute of Marine Science in *Shoreline Erosion in Tidewater Virginia,* 1978. The average bank height is reported to be 20 feet by the same source. The predominant land use adjacent to this reach is (landuse). Fifty percent of the reach's shoreline was hardened at the time of the aerial survey. Based on observed conditions, it would appear that (appropriate erosion control recommendation).

Shoreline Condition (Penniman Spit)

Reach 17 contains 4,500 feet of shoreline and no piers or docks. The erosion rate for reach 17 is 0.00 feet per year as reported by the Virginia Institute of Marine Science in *Shoreline Erosion in Tidewater Virginia,* 1978. The average bank height is reported to be 3 feet by the same source. No shoreline hardening had occurred on Penniman Spit prior to the aerial survey. Based on observed conditions, it would appear that (appropriate erosion control recommendation).

WATERBODY: KING CREEK (Reach 18)

General Location and Description

This is one of the larger tributaries to the York River. King Creek converges with Felgates Creek to the south at Penniman Spit. The headwaters of King Creek form the western boundary of the U.S. Naval Weapons Station and the shoreline is characterized by steep slopes. A small tributary in the headwaters has been impounded for use by Water Country Water Park. Along the south shore of King Creek within the U.S. Naval Weapons Station, Ponds #10 and #12 are connected by surface flow to King Creek.

Water Quality Data

Refer to above for HUC 02080107 (York River Subbasin), Segment 107-06E (The York River-Gloucester Waterbody).

Sensitive Land and Aquatic Resources

The following sensitive land and aquatic resources are present in this waterbody: fringing tidal marshes, nursery areas for finfish, a condemned shellfish area, and a protected area.

The tidal marsh inventory shows that there were 180 acres of tidal marsh located in this waterbody at the time the inventory was conducted. The King Creek Marsh is classified as a brackish water marsh, with no one plant community dominating. However, rather large stands of saltmarsh cordgrass predominate towards the mouth of the creek where more saline conditions exist. A marsh community that is noticeably absent or infrequent in King Creek Marsh is black needlerush; typically, this saline rush is one of the typical components of a mixed brackish water marsh. King Creek remains largely undisturbed due to the efforts of environmental managers at the U.S. Naval Weapons Supply Center-Cheatham Annex, the U.S. Naval Weapons Station and the National Park Service. Evaluation of wetland types in this waterbody, based on total environmental value of an acre of each type, was Group One; this is out of five groups, with Group One being of highest value and Group Five being of least value (Silberhorn, 1974: 21-23).

No SAV beds were mapped in this waterbody in 1991. However, this entire waterbody has been included in the Tier III Target for Chesapeake Bay SAV Distribution Restoration down to the 2-meter depth contour or in the 6-foot depth range.

Shellfish Condemnation Area #134 includes both King and Felgates Creeks and went into effect 11/27/91. This is a restricted area were it is unlawful to take shellfish for any purpose, except by VMRC permit.

Kings Creek is considered to be a nursery area for striped bass, white perch and other species.

The Colonial National Historic Park and Parkway are adjacent to the south shore of King Creek east to its confluence with Felgates Creek and are protected areas.

Existing Water Access Facilities

There are no water access facilities located in this waterbody. **There might be canoe put-in/take-out areas at Colonial National Historic Park at Ringfield Plantation?** There is a marina/mooring facility/pier at the mouth of King Creek inside Penniman Spit adjacent to Cheatham Annex for use by military personnel only.

Existing Water-Enhanced Recreation Areas

The Ringfield picnic area in Colonial National Historic Park is located along the south shore of King Creek at its confluence with Felgates Creek, adjacent to the Colonial National Historical Parkway.

Proposed Public Water Access and Recreation Areas and Future Needs Assessment

The 1990 Chesapeake Bay Program Public Access Plan suggests that further analysis of the lands along the Parkway be made to determine if water-enhanced activities can be improved by providing additional parking areas and recreational opportunities. The 1993 Colonial National Historic Park Master Plan states that the Ringfield picnic area, which is not visible from the Parkway, is underused and suggests that access to the shoreline from this area may be too restrictive. The Master Plan also suggests that the Ringfield plantation site could become a major interpretive feature in the future. To ensure its availability for interpretation, needed stabilization work will be done, and the exposed foundation protected from the elements and from casual visitor use.

Bathymetry

NOAA-National Ocean Service charts show a sounding of 2 ft. at the mouth of King Creek at Penniman Spit.

Flushing Characteristics

Based on the previous general discussion of flushing characteristics in the York River and its smaller tributaries, it can be inferred that King Creek is not well-flushed.

Current Patterns

Shoreline Condition (Reach 18)

King's Creek contains 51,000 feet of shoreline and 1 pier (Pier and Dock Density = 0.02 per thousand feet of shoreline). The predominant land use adjacent to this reach is (landuse). No shoreline hardening had occurred within King's Creek prior to the aerial survey. Based on observed conditions, it would appear that (appropriate erosion control recommendation).

WATERBODY: FELGATES CREEK (Reach 19)

General Description and Location

This is one of the larger tributaries to the York River. Felgates Creek converges with King Creek to the north at Penniman Spit. Black Swamp and Lee Pond are located at the headwaters of Felgates Creek within the boundary of the U.S. Naval Weapons Station. The Colonial National Historical Parkway is adjacent to mouth of Felgates Creek. This waterbody is located entirely within the U.S. Naval Weapons Station within York County and is closed to the public.

Water Quality Data

Refer to above for HUC 02080107 (York River Subbasin), Segment 107-06E (The York River-Gloucester Waterbody).

Sensitive Land and Aquatic Resources

Sensitive land and aquatic resources found in this waterbody include: fringing tidal marshes, nursery areas for finfish and a protected area.

The tidal marsh inventory shows that there were 150 acres of tidal marsh located in this waterbody at the time the inventory was conducted. Felgate Creek branches into three prongs approximately 1.75 miles from its very narrow mouth. From the mouth to the general area where the creek divides, the marsh vegetation is largely dominated by saltmarsh cordgrass. For the most part, the marshes of the three branches where the creek divides are commonly made up of big cordgrass, cattails, sedge and saltmarsh bulrush. Evaluation of wetland types in this waterbody, based on total environmental value of an acre of each type, was Group One; this is out of five groups, with Group One being of highest value and Group Five being of least value (Silberhorn, 1974; 21,25).

No SAV beds were mapped in this waterbody in 1991. However, this entire waterbody has been included in the Tier III Target for Chesapeake Bay SAV Distribution Restoration down to the 2-meter depth contour or in the 6-foot depth range.

Shellfish Condemnation Area #134 includes both Felgates and King Creeks and went into effect 11/27/91. This is a restricted area were it is unlawful to take shellfish for any purpose, except by VMRC permit.

Felgates Creek is considered to be a nursery area for striped bass, white perch and other species.

The Colonial National Historical Parkway and Park are protected areas.

Existing Water Access Facilities

There are no public water access facilities in this waterbody. Restricted access area are for military personnel only.

Existing Water-Enhanced Recreation Areas

This is a restricted area for military personnel only. Camping is permitted in this area.

Proposed Public Water Access and Recreation Areas and Needs Assessment

Since the shoreline of Felgates Creek is a restricted area for military personnel only, future development of public water access and recreation areas is not likely.

Bathymetry

NOAA-National Ocean Service charts show a 9 ft. sounding at the mouth of Felgates Creek at Penniman Spit.

Flushing Characteristics

Based on the previous general discussion of flushing characteristics in the York River and its smaller tributaries, it can be inferred that Felgates Creek is not well-flushed.

Current Patterns

Shoreline Condition (Reach 19)

Felgate's Creek contains 64,000 feet of shoreline and no piers or docks. The predominant land use adjacent to this reach is (landuse). No shoreline hardening had occurred within Felgate's Creek prior to the aerial survey. Based on observed conditions, it would appear that (appropriate erosion control recommendation).

MAINSTEM SEGMENT: FELGATES CREEK TO INDIAN FIELD CREEK

General Description and Location

This mainstem segment has been delineated as beginning at Poley Point at the mouth of King and Felgates Creek then east along the York River shoreline to Indian Field Creek. The Colonial Parkway is located along the shoreline of this segment.

Water Quality Data

Refer to above for HUC 02080107 (York River Subbasin), Segment 107-06E (The York River-Gloucester Waterbody).

Sensitive Land and Aquatic Resources

No sensitive land and aquatic resources found in this segment, other than Parkway which is a protected area. Bellfield Plantation is also included in this protected area.

No SAV beds were mapped in this mainstem segment in 1991. However, this entire segment has been included in the Tier III Target for Chesapeake Bay SAV Distribution Restoration down to the 2-meter depth contour or in the 6-foot depth range.

Existing Water Access Facilities

There are no public water access facilities located in this segment.

Water-Enhanced Recreation Areas

There are two scenic overlook areas with picnic tables located in this segment along the Colonial Parkway.

Proposed Public Water Access and Recreation Areas and Future Needs Assessment

The 1990 Chesapeake Bay Program Public Access Plan suggests that further analysis of the lands along the Parkway be made to determine if water-enhanced activities can be improved by providing additional parking areas and recreational opportunities.

Bathymetry

NOAA-National Ocean Service charts and USGS topographic maps show 2-17 ft. soundings in this segment waterward to the main channel. At this point in the York River, the main channel is located in the central portion of the river with a depth range of 19-50 ft.

Flushing Characteristics

Based on the previous general discussion of flushing characteristics in the York River and its smaller tributaries, it can be inferred that this mainstem segment is well-flushed.

Current Patterns

Shoreline Condition
FELAGTES CREEK TO SANDY POINT (Reach 20)

Reach 20 contains 10,000 feet of shoreline and has 1 pier (Pier and Dock Density = 0.1 per thousand feet of shoreline). The erosion rate for reach 20 is 1.5 feet per year as reported by the Virginia Institute of Marine Science in *Shoreline Erosion in Tidewater Virginia,* 1978. The average bank height is reported to be 25 feet by the same source. The predominant land use adjacent to this reach is (landuse). 85 percent of the reach's shoreline was hardened at the time of the aerial survey. Based on observed conditions, it would appear that (appropriate erosion control recommendation).

WATERBODY: INDIAN FIELD CREEK (Reach 21)

General Description and Location

This waterbody is located within the U.S. Naval Weapons Station in York County and is closed to the public.

Water Quality Data

Refer to above for HUC 02080107 (York River Subbasin), Segment 107-06E (The York River-Gloucester Waterbody).

Sensitive Land and Aquatic Resources

The following sensitive land and aquatic resources are present in this waterbody include: fringing tidal marshes, nursery areas for fish, and a protected area.

The tidal marsh inventory shows that there were 12.8 acres of tidal marshes located in this waterbody at the time the inventory was conducted. The fringing marshes in Indian Field Creek are dominated by saltmarsh cordgrass. This marsh system is also regarded as a nursery area for fish. Evaluation of wetland types in this waterbody, based on total environmental value of an acre of each type, was Group One; this is out of five groups, with Group One being of highest value and Group Five being of least value (Silberhorn, 1974; 27,28).

No SAV beds were mapped in this waterbody in 1991. However, this entire waterbody has been included in the Tier III Target for Chesapeake Bay SAV Distribution Restoration down to the 2-meter depth contour or in the 6-foot depth range.

Shellfish Condemnation Area #130 includes all of Indian Field Creek and went into effect 11/27/91. This is a restricted area where it is unlawful to take shellfish for any purpose, except by a VMRC permit.

The Colonial Parkway crosses the mouth of this waterbody and is a protected area.

Water Access Facilities

There are no public water access facilities located in this waterbody. **<<Video shows a marina/mooring facility/pier on the south shore.>>** Restricted access areas are for military personnel only.

Existing Water-Enhanced Recreation Areas

This is a restricted area for military personnel only.

Proposed Public Water Access and Recreation Areas and Future Needs Assessment

Since the shoreline of Indian Field Creek is a restricted area for military personnel only, future development of public recreation areas is not likely. The Colonial National Historic Parkway is located along the mouth of this waterbody. The 1993 Colonial National Historic Park Master Plan states that the Indian Field Creek overflow parking will be improved or removed.

Bathymetry

No bathymetric data is available for this waterbody.

Flushing Characteristics

Based on the previous general discussion of flushing characteristics in the York River and its smaller tributaries, it can be inferred that Indian Field Creek is not well-flushed.

Current Patterns

Shoreline Condition (Reach 21)

Indian Field Creek contains 24,000 feet of shoreline and no piers or docks. The predominant land use adjacent to this reach is (landuse). No shoreline hardening had occurred within Indian Field Creek prior to the aerial survey. Based on observed conditions, it would appear that (appropriate erosion control recommendation).

MAINSTEM SEGMENT: INDIAN FIELD CREEK TO BALLARD CREEK

General Description and Location

This mainstem segment has been delineated as beginning at the mouth of Indian Field Creek then east along the York River shoreline to Ballard Creek, including Sandy and Stony Points, and the U.S. Naval Weapons Station Pier. The Colonial Parkway is adjacent to this shoreline segment.

Water Quality Data

Refer to above for HUC 02080107 (York River Subbasin), Segment 107-06E (The York River-Gloucester Waterbody).

Sensitive Land and Aquatic Resources

The following sensitive land and aquatic resources are present in this segment: fringing tidal marshes and a protected area.

The tidal marsh inventory shows that there were approximately 4 acres of tidal marsh in this segment at the time the inventory was conducted. Subdivided acreage of tidal marsh were: 1.4 acres at Sandy Point, .5 acres east of Sandy Point and 2.2 acres near and at the Naval Weapons Pier. Evaluation of wetland types in this waterbody, based on total environmental value of an acre of each type, ranged from Group One to Group Two; this is out of five groups, with Group One being of highest value and Group Five being of least value (Silberhorn, 1974; 28).

No SAV beds were mapped in this segment in 1991. However, this entire segment has been included in the Tier III Target for Chesapeake Bay SAV Distribution Restoration down to the 2-meter depth contour or in the 6-foot depth range.

The Colonial Parkway is a protected area.

Existing Water Access Facilities

At Sandy Point overlook along the Colonial Parkway, canoe access is available. Restricted access at the U.S. Naval Weapons Center Pier is limited to military personnel only.

Existing Water-Enhanced Recreation Areas

There are two scenic overlook areas with picnic tables located along the Colonial Parkway; one is at Sandy Point and one at the U.S. Naval Weapons Center Pier.

Proposed Public Water Access and Recreation Areas and Future Needs Assessment

The 1990 Chesapeake Bay Program Public Access Plan suggests that further analysis of the lands along the Parkway be made to determine if water-enhanced activities can be improved by providing additional parking areas and recreational opportunities.

Bathymetry

NOAA-National Ocean Service charts and USGS topographic maps show 1-17 ft. soundings in this segment waterward of the tidal marsh system to the main channel. At this point in the York River, the main channel is located in the central portion of the river with a depth range of 23-66 ft.

Flushing Characteristics

Based on the previous general discussion of flushing characteristics in the York River and its smaller tributaries, it can be inferred that this mainstem segment is well-flushed.

Current Patterns

Shoreline Condition
SANDY POINT (Reach 22)

Reach 22 contains 1,000 feet of shoreline and has no piers or docks. The erosion rate for Sandy Point is 0 feet per year as reported by the Virginia Institute of Marine Science in *Shoreline Erosion in Tidewater Virginia*, 1978. The average bank height is reported to be 25 feet by the same source. No shoreline hardening had occurred on Sandy Point prior to the aerial survey. Based on observed conditions, Sandy Point (spit) has eroded considerably. The severe erosion experienced on the spit may have rendered protection measures infeasible.

SANDY POINT TO STONEY POINT (Reach 23)

Reach 23 contains 9,000 feet of shoreline and no piers or docks. The erosion rate for reach 23 is 0.00 feet per year as reported by the Virginia Institute of Marine Science in *Shoreline Erosion in Tidewater Virginia*, 1978. The average bank height is reported to be 9 feet by the same source. The predominant land use adjacent to this reach is (landuse). 33.3 percent of the reach's shoreline was hardened at the time of the aerial survey. Based on observed conditions, it would appear that (appropriate erosion control recommendation).

STONEY POINT TO YORKTOWN CREEK (Reach 24)

Reach 24 contains 7,500 feet of shoreline and has 1 pier (Pier and Dock Density = 0.13 per thousand feet of shoreline). The erosion rate for reach 24 is 0.7 feet per year as reported by the Virginia Institute of Marine Science in *Shoreline Erosion in Tidewater Virginia*, 1978. The average bank height is reported to be 40 feet by the same source. The predominant land use adjacent to this reach is (landuse). 53.33 percent of the reach's shoreline was hardened at the time of the aerial survey. Based on observed conditions, it would appear that (appropriate erosion control recommendation).

WATERBODY: ROOSEVELT POND

General Description and Location

This waterbody is located within the boundary of the U.S. Naval Weapons Station and is connected by surface flow to the York River. Because of restricted access, data availability is limited for this waterbody.

Water Quality Data

Refer to above for HUC 02080107 (York River Subbasin), Segment 107-06E (The York River-Gloucester Waterbody).

Sensitive Land and Aquatic Resources

Data on sensitive land and aquatic resources in this waterbody is not available due to accessibility problems.

Existing Water Access Facilities

There are no public water access facilities located in this waterbody. Restricted access in this waterbody is for military personnel only.

Existing Water-Enhanced Recreation Areas

This is a restricted area for military personnel only.

Proposed Public Water Access and Recreation Areas and Future Needs Assessment

Because of federal operations at the U.S. Naval Weapons Station, future development of public water access and recreation areas in this waterbody is not likely.

Bathymetry

There is no bathymetric data available for this waterbody.

WATERBODY: BALLARD CREEK

General Description and Location

This waterbody is located partially within the Colonial National Historic Park and Parkway and forms the southern boundary of the U.S. Naval Weapons Station.

Water Quality Data

Refer to above for HUC 02080107 (York River Subbasin), Segment 107-06E (The York River-Gloucester Waterbody).

Sensitive Land and Aquatic Resources

The following sensitive land and aquatic resources are present in this waterbody: freshwater pocket marshes and a protected area.

The tidal marsh inventory shows that there was one acre of tidal marsh located in this waterbody at the time the inventory was conducted. Evaluation of wetland types in this waterbody, based on total environmental value of an acre of each type, was Group Two; this is out of five groups, with Group One being of highest value and Group Five being of least value (Silberhorn, 1974; 28).

The Colonial National Historic Park and Parkway are adjacent to and crosses this waterbody and are protected areas.

Existing Water Access Facilities

There are no public water access facilities located in this waterbody. Restricted access along the north shore is for military personnel only.

Existing Water-Enhanced Recreation Areas

The restricted area along the north shore is for use by military personnel only. The southern shoreline adjacent to Colonial National Historic Park is open to the public.

Proposed Public Water Access and Recreation Areas and Future Needs Assessment

Because one shore of this waterbody is adjacent to a military facility, the development of public water access and recreation areas is unlikely.

Bathymetry

No bathymetric data is available for this waterbody.

Flushing Characteristics

Based on the previous general discussion of flushing characteristics in the York River and its smaller tributaries, it can be inferred that Ballard Creek is not well-flushed.

Current Patterns

MAINSTEM SEGMENT: BALLARD CREEK TO YORKTOWN CREEK

General Description and Location

This mainstem segment has been delineated as beginning at Ballard Creek then continues east along the York River shoreline and York River Cliffs to Yorktown Creek. The shoreline of this segment is adjacent to Colonial National Historic Park.

Water Quality Data

Refer to above for HUC 02080107 (York River Subbasin), Segment 107-06E (The York River-Gloucester Waterbody).

Sensitive Land and Aquatic Resources

<<Yorktown Cliffs Area...>>

There were no SAV beds mapped in this mainstem segment in 1991. However, a portion of this segment has been included in the Tier I Target for Chesapeake Bay SAV Distribution Restoration and the entire segment has been included in the Tier III Target for Chesapeake Bay SAV Distribution Restoration down to the 2-meter depth contour or in the 6-foot depth range.

Colonial National Historical Park is a protected area.

Existing Water Access Facilities

There are no public water access facilities located in this segment.

Existing Water-Enhanced Recreation Facilities

This segment is located within the Colonial National Historic Park which is open to the public.

Proposed Public Water Access and Recreation Areas and Future Needs Assessment

The 1993 Yorktown Master Plan recommends constructing a walkway to connect the Yorktown Victory Center to the Yorktown Waterfront at the Watermen's Museum.

Bathymetry

NOAA-National Ocean Service charts and USGS topographic maps show 1-10 ft. soundings in this segment waterward to the main channel. At this point in the York River, the main channel is located relatively close to the York County shoreline as the York River mainstem becomes narrower and has a depth range of 23-73 ft.

Flushing Characteristics

Based on the previous general discussion of flushing characteristics in the York River and its smaller tributaries, it can be inferred that this mainstem segment is well-flushed.

Current Patterns

WATERBODY: YORKTOWN CREEK

General Description and Location

This waterbody is located just east of the Coleman Bridge within the Colonial National Historic Park.

Water Quality Data

Refer to above for HUC 02080107 (York River Subbasin), Segment 107-06E (The York River-Gloucester Waterbody).

Sensitive Land and Aquatic Resources

The following sensitive land and aquatic resources are present in this waterbody: a creek marsh and a protected area.

The tidal marsh inventory shows that there were 34.7 acres of creek marsh located in this waterbody at the time the inventory was conducted. Yorktown Creek is classified as a mixed brackish water marsh. Nearly all of the upper reach of the marsh is dominated by cattails. This type of vegetation is typical of low freshwater marshy areas in which stagnant water has accumulated from upland seepage; dense stands of cattails may indicate high loads of nutrients. Cattail marshes are often found adjacent to tilled cropland.

The Colonial National Historic Park is adjacent to this waterbody and is a protected area.

Existing Water Access Facilities

There are no public water access facilities located in this waterbody.

Existing Water-Enhanced Recreation Areas

Colonial National Historic Park, which is adjacent to this waterbody, is open to the public.

Proposed Public Water Access and Recreation Areas and Future Needs Assessment

The 1993 Yorktown Master Plan recommends constructing a walkway to connect the Yorktown Victory Center to the Yorktown Waterfront at the Watermen's Museum. This walkway would cross the Yorktown Creek marsh system.

Bathymetry

No bathymetric data is available for this waterbody.

Flushing Characteristics

Based on the previous general discussion of flushing characteristics in the York River and its smaller tributaries, it can be inferred that Yorktown Creek is not well-flushed.

Current Patterns

MAINSTEM SEGMENT: YORKTOWN CREEK TO COLEMAN BRIDGE

This mainstem segment has been delineated as beginning at the mouth of Yorktown Creek then east along the York River shoreline to the Coleman Bridge at Yorktown.

Water Quality Data

Refer to above for HUC 02080107 (York River Subbasin), Segment 107-06E (The York River-Gloucester Waterbody).

Sensitive Land and Aquatic Resources

The following sensitive land and aquatic resources are present in this segment: tidal flats and beach.

This entire segment has been included in the Tier III Target for Chesapeake Bay SAV Distribution Restoration down to the 2-meter depth contour or in the 6-foot depth range.

Existing Water Access Facilities

There are no public water access facilities located in this segment. **<<Video shows a pier/mooring facility at the Watermen's Museum??>>**

Existing Water-Enhanced Recreation Areas

The Watermen's Museum at the foot of the Coleman Bridge is open to the public. **<<Any public beach frontage along this segment?>>**

Proposed Public Water Access and Recreation Areas and Future Needs Assessment

The 1993 Yorktown Master Plan has recommends that the proposed riverwalk along the Yorktown Waterfront be extended under the Coleman Bridge to the Waterman's Museum.

Bathymetry

The segment is located adjacent to the main channel of the York River and, therefore, beyond the immediate beach area, the water depth increases rapidly. NOAA-National Ocean Service charts show 28-73 ft. soundings in the channel along this segment.

Flushing Characteristics

Based on the previous general discussion of flushing characteristics in the York River and its smaller tributaries, it can be inferred that this mainstem segment is well-flushed.

Current Patterns

SUBAREA C: COLEMAN BRIDGE TO TUE POINT

General Description and Location

For the purposes of this study, this subarea has been delineated as beginning on the east side of the Coleman Bridge at Yorktown then east along the York River shoreline to Tue Point at Goodwin Island at the mouth of the York River and its confluence with the Chesapeake Bay, including the U.S. Coast Guard Reserve Training Center Pier, the HRSD Wastewater Treatment Facility, and the Amoco Oil Refinery Pier. Wormley Creek is the only major tributary to the York River mainstem in this subarea. The only other waterbody in this subarea is Wormley Pond. A large percentage of this shoreline is owned by the federal government.

Water Quality Data

Refer to above for HUC 02080107 (York River Subbasin), Segment 107-06E (The York River-Gloucester Waterbody), HUC 02080101 (Mainstem Open Bay), Segment 101-03CE (Southwestern Portion of the Chesapeake Bay) and Segment 101-02BE (Mouth of the York River).

Sensitive Land and Aquatic Resources

The following sensitive aquatic resources are present in this subarea: extensive tidal marshes, fringing tidal marshes, tidal flats, SAV beds, shellfish producing areas, a condemned shellfish area, a protected area and an estuarine research reserve.

This subarea is within the Wormley Creek and Goodwin Island-Back Creek Areas of the York County-Town of Poquoson Tidal Marsh Inventory. At the time the inventory was conducted there were approximately 311 acres of tidal wetlands in this system. Evaluation of wetland types in this system, based on total environmental value of an acre of each type, was Group One; this is out of five groups, with Group One being of highest value and Group Five being of least value (Silberhorn, 1974: 29-36).

SAV beds were mapped in 1991 just east of the U.S. Coast Guard Reserve Training Center Pier and at Sandbox at the confluence of The Thorofare and the York River. Some near shore areas, particularly at the mouth of Wormley Creek, have been included in the Tier I SAV Restoration Distribution Target. The entire subarea has been included in the Tier III Chesapeake Bay SAV Distribution Restoration Target.

The York River mainstem from the Coleman Bridge east to the Mouth of the York River is a shellfish producing area. There is one shellfish condemnation area in this subarea: #6 (#6A & #6B).

Nursery/Spawning Areas (Summer)??
Commercial- and Recreationally-Important Finish Areas??

The Colonial National Historic Park is the only protected area in this subarea. An estuarine research reserve, which is part of the National Estuarine Research Reserves System, is located at Goodwin Island.

Existing Water Access Points and Water-Enhanced Recreation Areas

There are 5 water access points and water-enhanced recreation areas located in this system. They include one public boat ramp, one public beach, one public park, and 2 private/commercial marina facilities.

Proposed Public Water Access and Recreation Areas and Future Needs Assessment

The 1993 Yorktown Master Plan provides for major public improvements to the Yorktown Waterfront Area which would enhance existing public water access and recreation areas and establish new area for these purposes.

Shoreline Condition (Subarea C)

Subarea C contains 8.75 miles of mainstem York River shoreline and 13 piers and docks. The average pier and dock density in the subarea is 0.28 piers and docks per 1000 linear feet of shoreline. Within the subarea 44.59 percent of the shoreline is hardened.

For the purposes of analysis, this subarea is subdivided into three categories: 1) waterbodies, which include the smaller tributaries of the York River, and any lakes, ponds and reservoirs within the subarea with connected surface flow to the York River; 2) mainstem segments, which comprise the southern shoreline of the York River between identified waterbodies; and 3) shoreline reaches as defined for the purposes of this study; a reach may include an entire waterbody, a mainstem segment, or any combination thereof and may cross subarea boundaries.

MAINSTEM SEGMENT: COLEMAN BRIDGE TO WORMLEY CREEK

General Description and Location

This mainstem segment has been delineated as beginning at the east side of the foot of the Coleman Bridge then east along the York River shoreline to Wormley Creek, including the Yorktown Beach and Waterfront Area, the Colonial National Historic Park and Point of Rocks, and the U.S. Coast Guard Reserve Training Center Pier. With the exception of the Yorktown Waterfront Area and a small residential subdivision (Moore House) located just to the west of the U.S. Coast Guard Pier, the shoreline within this segment is owned by the federal government.

Water Quality Data

Refer to above for HUC 02080107 (York River Subbasin), Segment 107-06E (The York River-Gloucester Waterbody).

Sensitive Land and Aquatic Resources

The following sensitive land and aquatic resources are present in this mainstem include: a beach area, an SAV bed, shellfish producing areas, a condemned shellfish area, and a protected area. There is a beach located along the Yorktown Waterfront that requires continual replenishment efforts due to high erosion rates.

There was a small SAV bed mapped in 1991 just east of the U.S. Coast Guard Reserve Training Center Pier. Most of the nearshore areas in this mainstem segment have been included in the Tier I Target for Chesapeake Bay SAV Distribution Restoration and the entire segment has been included in the Tier III Target for Chesapeake Bay SAV Distribution Restoration Distribution down to the 2-meter depth contour or in the 6-foot depth range.

A shellfish producing area extends from the east side of the Coleman Bridge to the mouth of the York River along the central portion of the York River mainstem. Shellfish Condemnation Area #6, which has been delineated as #6A and #6B, includes that part of this segment east of the U.S. Coast Guard Reserve Training Center Pier to Wormley Creek and went into effect 10/12/93. This segment is included in #6A and is a restricted area where it is unlawful to take shellfish for any purpose, except by VMRC permit.

Colonial National Historic Park is adjacent to Yorktown's east side and is a protected area.

Existing Water Access Facilities

There is one public beach on the York River located at the Yorktown Waterfront where swimming, fishing and picnicking is currently permitted. There is a mooring area for boat just beyond the swimming area near the existing breakwater structure.

Existing Water-Enhanced Recreation Areas

Water Street in Yorktown is a popular walking area adjacent to the York River. Colonial National Historic Park provides opportunities for picnicking and hiking.

Proposed Public Water Access and Recreation Areas and Future Needs Assessment

The 1993 Yorktown Master Plan provides for major public improvements to the Yorktown Waterfront Area which would enhance existing public water access and recreation areas and establish new area for these purposes. A public wharf would be constructed near the foot of the Coleman Bridge with a riverwalk/boardwalk extending east to the existing public beach area. The riverwalk would also be extended under the Coleman Bridge along the shoreline in front of the Waterman's Museum.

The 1991 York County Comprehensive Plan has identified this same area for additional public access through a proposed boat landing and fishing pier. In February 1994, the County applied for necessary improvements to the public beach area through creation of a new breakwater and modification of existing breakwaters for the purposes of beach replenishment, as well as riprap toe reinforcement at the base of the Yorktown Seawall.

The 1993 Colonial National Historic Park Master Plan states that legislation is needed to make it legally possible for the National Park Service to transfer to York County the sewer systems for the Moore House Subdivision and Yorktown. The Park Service feels that such a transfer would be in the public interest, because York County could manage and maintain those community sewer systems more effectively.

Bathymetry

NOAA-National Ocean Service charts and USGS topographic maps show soundings of .5-16 feet waterward from the shoreline to the main channel in the York River. The channel is very close to the shoreline along this mainstem segment with soundings ranging from 20-83 ft.

Flushing Characteristics

Based on the previous general discussion of flushing characteristics in the York River and its smaller tributaries, it can be inferred that this mainstem segment is well-flushed.

Current Patterns

Shoreline Condition
YORKTOWN CREEK TO WORMLEY CREEK (Reaches 25 and 26)

Reach 25 begins at the mouth of Yorktown Creek and ends at the eastern edge of the USGS Yorktown quadrangle (7.5 minute series). Reach 26 begins at the western edge of the USGS Poquoson West Quadrangle (7.5 minute series) and ends at the mouth of Wormley Creek. These reaches together contain 16,000 feet of shoreline and has 5 piers and docks (Pier and Dock Density = 0.31 per thousand feet of shoreline). The erosion rate for these combined reaches is 1.31 feet per year as reported by the Virginia Institute of Marine Science in *Shoreline Erosion in Tidewater Virginia*, 1978. The average bank height is reported to be 36.56 feet by the same source. The predominant land use adjacent to this reach is (landuse). 68.75 percent of the reach's shoreline was hardened at the time of the aerial survey. Based on observed conditions, it would appear that (appropriate erosion control recommendation).

WATERBODY: WORMLEY CREEK AND WORMLEY POND

General Description and Location

Wormley Creek consists of a main branch and a western branch. Wormley Pond is an impoundment in the headwaters of the western branch. The north shoreline of the western branch is owned by the U.S. Coast Guard Reserve Training Center. Wormley Pond is entirely within the Colonial National Historic Park. The south shoreline of the western branch is partially adjacent to the Colonial National Historic Park and partially adjacent to a residential subdivision. The main branch of Wormley Creek is surrounded by a residential subdivision.

Water Quality Data

Refer to above for HUC 02080107 (York River Subbasin), Segment 107-06E (The York River-Gloucester Waterbody). The ACB Citizen's Monitoring Program has one inactive monitoring station (#20) located in Wormley Creek.

Sensitive Land and Aquatic Resources

The following sensitive land and aquatic resources are present in this waterbody: fringing tidal marshes, tidal flats and a protected area.

The tidal marsh inventory shows that Wormley Creek contained 12.81 acres of pocket and fringe marshes at the time the inventory was conducted. The steep banks of the creek allow very few areas for marshes to develop except near the upper reaches of branches and in small coves. Narrow fringing marshes of saltmarsh cordgrass, varying from 3 to 20-feet wide, are found throughout the creek. The largest of these extends continuously for more than a mile along the northern shoreline of the west branch. All of the marshes in Wormley Creek, however small, are nevertheless Type I marshes, which are highly valued as detritus contributors to the marine food web and deterrents to shoreline erosion. Evaluation of wetland types in this system, based on total environmental value of an acre of each type, was Group One; this is out of five groups, with Group One being of highest value and Group Five being of least value (Silberhorn, 1974: 29-32).

There were no SAV beds mapped in 1991 in Wormley Creek. However, an area at the mouth of the creek has been included in the Tier I Target for SAV Distribution Restoration and the entire creek has been included in the Tier III Target for SAV Distribution Restoration down to the 2-meter depth contour or in the 6-foot depth range.

Shellfish Condemnation Area #6, which has been delineated as #6A and #6B, includes this entire waterbody and went into effect 10/12/93. Wormley Creek is included in #6A and is a restricted area where it is unlawful to take shellfish for any purpose, except by a VMRC permit.

The Colonial National Historic Park, adjacent to Wormley Pond and the western branch of Wormley Creek, is the only protected area adjacent to this waterbody.

Existing Water Access Facilities

There are 3 water access facilities located in this waterbody. There is a county-owned public boat landing (Old Wormley Creek Landing) located at the end of Old Wormley Creek Rd. There are two private/commercial marina facilities located on Wormley Creek mainstem: Wormley Creek Marina Corp. (Waterview Rd) and Marlbank Cove Marina (?). There is a dockside pumping station at Wormley Creek Marina Corp.

Existing Water-Enhanced Recreation Areas

There are opportunities for pier and bank fishing and picnicking, at the Old Wormley Creek public landing; restrooms and handicapped access are also available. The Colonial National Historic Park, which is open to the public, is adjacent Wormley Pond and the western branch of Wormley Creek.

Proposed Public Water Access and Recreation Areas and Future Needs Assessment

The 1990 Chesapeake Bay Program Public Access Plan suggests that the large tidal marshes along the tidal creeks could be made more accessible for activities such as nature study and environmental education. The steep slopes along Wormley Creek preclude development of canoe put-in/take-out areas.

Bathymetry

USGS topographic sheets show soundings of 1-5 ft. at the mouth of Wormley Creek, 1-5 ft. in the main branch of Wormley Creek and 1-3 ft in the western branch. There is no bathymetric data available for Wormley Pond.

Flushing Characteristics

Based on the previous general discussion of flushing characteristics in the York River and its smaller tributaries, it can be inferred that Wormley Creek is not well-flushed.

Current Patterns

Shoreline Condition
NORTH AND SOUTH SHORELINE OF WESTERN BRANCH - MAINBODY (Reach 27)

Reach 27 contains 8,900 feet of shoreline and 19 piers and docks (Pier and Dock Density = 2.13 per thousand feet of shoreline). The erosion rate for reach 27 is (X) feet per year as reported by the Virginia Institute of Marine Science in *Shoreline Erosion in Tidewater Virginia*, 1978. The average bank height is reported to be (X) feet by the same source. The predominant land use adjacent to this reach is (landuse). X percent of the reach's shoreline was hardened at the time of the aerial survey. Based on observed conditions, it would appear that (appropriate erosion control recommendation).

NORTH AND SOUTH SHORELINE OF WESTERN BRANCH - HEADWATERS (Reach 28)

Reach 28 contains 10,000 feet of shoreline and has x piers and docks (Pier and Dock Density = X per thousand feet of shoreline). The erosion rate for reach 28 is 0.0 feet per year as reported by the Virginia Institute of Marine Science in *Shoreline Erosion in Tidewater Virginia*, 1978. The average bank height is reported to be five feet by the same source. The predominant land use adjacent to this reach is (landuse). 30 percent of the reach's shoreline was hardened at the time of the aerial survey. Based on observed conditions, it would appear that (appropriate erosion control recommendation).

WORMLEY CREEK SHORELINE (Reach 29)

Reach 29 contains 35,200 feet of shoreline and has 58 piers and docks (Pier and Dock Density = 1.65 per thousand feet of shoreline). The erosion rate for reach 29 is (X) feet per year as reported by the Virginia Institute of Marine Science in *Shoreline Erosion in Tidewater Virginia*, 1978. The average bank height is reported to be (X) feet by the same source. The predominant land use adjacent to this reach is (landuse). 13.07 percent of the reach's shoreline was hardened at the time of the aerial survey. Based on observed conditions, it would appear that (appropriate erosion control recommendation).

MAINSTEM SEGMENT: WORMLEY CREEK TO SANDBOX (Reach 30)

General Description and Location

This mainstem segment has been delineated as beginning at Wormley Creek then east along the York River shoreline to the Sandbox at the confluence of The Thorofare and the York River, including the Amoco Oil Refinery and Pier, the jettied-HRSD/Virginia Power wastewater discharge outfall area, and Goodwin Neck Estates.

Water Quality Data

Refer to above for HUC 02080107 (York River Subbasin), Segment 107-06E (The York River-Gloucester Waterbody).

Sensitive Land and Aquatic Resources

The following sensitive land and aquatic resources are present along this segment: fringing tidal marshes, an SAV bed, and shellfish growing areas.

The tidal marsh inventory shows that there were 5.4 acres of tidal marsh located along this segment at the time the inventory was conducted. Subdivided acreages of tidal marsh were: 1 acre between the mouth of Wormley Creek and the west jetty at the Amoco Oil Refinery, 3 acres located on either side of the Amoco Oil Refinery Pier, and 1.4 acres located at Sand Box. Evaluation of wetland types in this mainstem segment, based on total environmental value of an acre of each type, was Group One; this is out of five groups, with Group One being of highest value and Group Five being of least value (Silberhorn, 1974: 29-35).

One SAV bed was mapped in 1991 just west of Sandbox. The nearshore areas near the mouth of Wormley Creek and around the Amoco Oil Refinery Pier have been included in the Tier I Target for SAV Distribution Restoration. This entire mainstem segment has been included in the Tier III Target for SAV Distribution Restoration down to the 2-meter depth contour or in the 6-foot depth range.

The central portion of York River mainstem from the Coleman Bridge east to the mouth of the York River is a shellfish producing area. Shellfish Condemnation Area #6, which has been delineated as #6A and #6B, includes this entire waterbody and went into effect 10/12/93. #6A is a restricted area where it is unlawful to take shellfish for any purpose, except by a VMRC permit. #6B is a 500-yard "buffer/safety zone" surrounding an HRSD discharge outfall; this is a prohibited area where it is unlawful to take shellfish from this area for any purpose.

Existing Water Access Facilities

There is restricted access at the HRSD/Virginia Power jetty and Amoco Oil Refinery pier for personnel only.

Existing Water-Enhanced Recreation Areas

There are no recreation areas in this segment.

Proposed Public Water Access and Recreation Areas and Future Needs Assessment

There are no existing proposals for potential public water access or recreation areas in this segment.

Bathymetry

NOAA-National Ocean Service charts and USGS topographic sheets show 1-18 ft. soundings waterward from the shoreline and tidal marsh system to the main channel of the York River. Along this segment, the main channel is closer to the York County shoreline with soundings of 20-83 ft.

Flushing Characteristics

Based on the previous general discussion of flushing characteristics in the York River and its smaller tributaries, it can be inferred that this mainstem segment is well-flushed.

Current Patterns

Shoreline Condition (Reach 30)

Reach 30 contains 18,200 feet of shoreline and has 8 piers and docks (Pier and Dock Density = 0.44 per thousand feet of shoreline). The erosion rate for reach 30 is 3.5 feet per year as reported by the Virginia Institute of Marine Science in *Shoreline Erosion in Tidewater Virginia*, 1978. The average bank height is reported to be 10 feet by the same source. The predominant land use adjacent to this reach is (landuse). 52.75 percent of the reach's shoreline was hardened at the time of the aerial survey. Based on observed conditions, it would appear that (appropriate erosion control recommendation).

MAINSTEM SEGMENT: SANDBOX TO TUE POINT - GOODWIN ISLAND SHORELINE (Reaches 31, 32, and 33)

General Description and Location

This mainstem segment has been delineated as beginning at the western tip of the Goodwin Islands at the confluence of The Thorofare and the York River then east along the York River shoreline to the western tip of the Goodwin Islands at Tue Point at the mouth of the York River and its confluence with the Chesapeake Bay. This segment consists of an extensive marsh island complex.

Water Quality Data

Refer to above for HUC 02080107 (York River Subbasin), Segment 107-06E (The York River-Gloucester Waterbody), HUC 02080101 (Mainstem Open Bay), Segment 101-03CE (Southwestern Portion of the Chesapeake Bay) and Segment 101-02BE (Mouth of York River). The ACB Citizen's Monitoring Program maintains one active monitoring station (#136) at Goodwin Island along The Thorofare; this station has also been included in the ACB nutrient-sampling program.

Sensitive Land and Aquatic Resources

The following sensitive land and aquatic resources are present in this segment: extensive tidal marshes, fringing tidal marshes, tidal flats, SAV beds, shellfish producing areas, and an estuarine research reserve.

The tidal marsh inventory shows that there were 293 acres of tidal marsh in the Goodwin Islands marsh system at the time the inventory was conducted. The low archipelago of marsh islands in the Goodwin Group is also referred to as the Toe Marshes. Much of Goodwin Island proper is fastland vegetated with pine and other upland vegetation. The intertidal areas of Goodwin Island and the associated marsh islands are vegetated mainly with tall form saltmarsh cordgrass. The marshes of this system are very valuable to the estuarine environment and an effort should be made to preserve them. The waters surrounding these islands are well-known clamming areas. Several different species of waterfowl and marsh birds have been observed here in large numbers. Evaluation of wetland types in this waterbody, based on total environmental value of an acre of each type, was Group One; this is out of five groups, with Group One being of highest value and Group Five being of least value (Silberhorn, 1974: 33-36).

SAV beds were extensively mapped in 1991 in nearshore areas of the Goodwin Islands and this segment has been included in both the Tier I and Tier III Targets for Chesapeake Bay SAV Distribution Restoration down to the 2-meter depth contour or in the 6-foot depth range.

The central portion of the York River from the Coleman Bridge to the mouth of the York River at its confluence with the Chesapeake Bay is a shellfish producing area.

The Goodwin Islands are the site of an estuarine research reserve which is part of the National Estuarine Research Reserve System.

Existing Water Access Facilities

There are no public water access facilities along this segment. However, small recreational craftsmen frequent this area.

Existing Water-Enhanced Recreation Areas

There are no formal recreational areas along this segment but this marsh system does provide opportunities for nature study if accessed by boat.

Proposed Public Water Access and Recreation Areas and Future Needs Assessment

There are no existing proposals for potential public water access or recreation areas in this segment.

Bathymetry

NOAA-National Ocean Service charts and USGS topographic maps show soundings of .5-17 ft. waterward of the tidal marsh system to the main channel of the York River. Along this mainstem segment, the channel is located in the central portion of the York River with soundings of 19-67 ft.

Flushing Characteristics

Based on the previous general discussion of flushing characteristics in the York River and its smaller tributaries, it can be inferred that this mainstem segment is well-flushed.

Current Patterns

GOODWIN ISLAND SHORELINE (Reaches 31, 32, and 33)

The Goodwin Islands contains 12,000 feet of York River shoreline and no piers or docks. The erosion rate for the Goodwin Islands is 0.0 feet per year as reported by the Virginia Institute of Marine Science in *Shoreline Erosion in Tidewater Virginia*, 1978. The average bank height is reported to be 3.3 feet by the same source. The predominant land use adjacent to this reach is open space. As stated above, the Goodwin Islands are an established estuarine research reserve and part of the National Estuarine Research Reserve System. No shoreline hardening had occurred on the Goodwin Islands prior to the aerial survey. Based on observed conditions, it would appear that no erosion control structures are neccesary.

York County Shoreline Condition By System and Subarea

System	Subarea	Reach #	Name	Total Shoreline Length (feet)	Hardened Length (feet)	Shoreline Percentage Hardened	Miles of Shoreline	No. of Piers & Docks	P&D Density per 1000'	Bank Height (feet)	Erosion rate (ft/year)
LWSCB	Subarea A	107	York Point to Bay Tree Creek	6,600	800	12.12%	1.25	1	0.15	3.00	2.20
LWSCB	Subarea A	109	Bay Tree Creek to Green Point	12,800	0	0.00%	2.42	0	0.00	3.00	3.90
LWSCB	Subarea A	112	Mouth of Back Creek to Sand Box	13,200	6,000	45.45%	2.50	15	1.14	5.00	1.70
			Subarea A Total	32,600	6,800	20.86%	6.17	16	0.49		
LWSCB	Subarea B	82	Western Mouth of Lambs Creek to Northern Mouth of Moores Creek	13,600	800	5.88%	2.58	24	1.76	4.00	1.70
LWSCB	Subarea B	84	Southern Mouth of Moores Creek to Unnamed Point (Mainstem face along Smith Landing)	1,600	0	0.00%	0.30	2	1.25	5.00	1.40
LWSCB	Subarea B	85	South Shore of the Poquoson River from Unnamed Point to Headwaters	14,000	200	1.43%	2.65	3	0.21		
LWSCB	Subarea B	86	North Shore of the Poquoson River from Headwaters to Quarter March Creek	17,200	1,600	9.30%	3.26	24	1.40	5.00	1.80
LWSCB	Subarea B	88	Mouth of Quarter March Creek to Nameless creek	2,400	800	33.33%	0.45	10	4.17		
LWSCB	Subarea B	90	Poquoson River Mainstem along Piney Point Estates	1,200	600	50.00%	0.23	2	1.67	5.00	1.00
LWSCB	Subarea B	91	Mainstem Face between ? Point and Mouth of Patricks Creek	1,800	400	22.22%	0.34	2	1.11	5.00	-1.00
LWSCB	Subarea B	96	Mainstem face from nameless creek to nameless point	2,400	0	0.00%	0.45	4	1.67		
LWSCB	Subarea B	97	Mainstem Face along Howards Landing	5,000	1,200	24.00%	0.95	10	2.00	5.00	1.00
LWSCB	Subarea B	98	Howards Landing to Mouth of Hodges Cove	2,600	1,400	53.85%	0.49	6	2.31		
LWSCB	Subarea B	100	Mouth of Hodges Cove to Ship Point	4,600	1,400	30.43%	0.87	3	0.65	5.00	1.80
LWSCB	Subarea B	106	Cabin Creek to York Point (Canals at Mouth of Chisman Creek and Poquoson River)	7,200	5,800	80.56%	1.36	46	6.39	3.00	0.90
			Subarea B Total	73,600	14,200	19.29%	13.94	136	1.85		
			Direct Shoreline Frontage (Thorofare, Chesapeake Bay, or Poquoson River)	106,200	21,000	19.77%	20.11	152	1.43		
LWSCB	LWSCB Waterbody	81	Lambs Creek Headwaters to Mouth	19,200	2,400	12.50%	3.64	23	1.20	3.00	0.00
LWSCB	LWSCB Waterbody	83	Moores Creek	14,800	400	2.70%	2.80	12	0.81		
LWSCB	LWSCB Waterbody	87	Quarter March Creek	20,400	4,600	22.55%	3.86	34	1.67	5.00	0.00
LWSCB	LWSCB Waterbody	89	Nameless creek between Quarter March Creek and Piney Point Estates	5,400	2,000	37.04%	1.02	11	2.04	4.00	0.00
LWSCB	LWSCB Waterbody	92	South Shore of Patricks Creek - Unnamed Cove	3,400	0	0.00%	0.64	2	0.59		
LWSCB	LWSCB Waterbody	93	Mainstem Patricks Creek	24,800	600	2.42%	4.70	12	0.48	4.00	1.80
LWSCB	LWSCB Waterbody	94	North Shore of Patricks Creek to nameless creek	4,800	600	12.50%	0.91	8	1.67		
LWSCB	LWSCB Waterbody	95	nameless creek	5,200	200	3.85%	0.98	7	1.35	4.00	0.00
LWSCB	LWSCB Waterbody	99	Hodges Cove	17,400	2,800	16.09%	3.30	20	1.15	4.00	0.00
LWSCB	LWSCB Waterbody	101	Chisman Creek (Mainstem)	108,200	24,480	22.62%	20.49	185	1.71	4.00	0.00
LWSCB	LWSCB Waterbody	102	Boathouse Creek	20,400	1,800	8.82%	3.86	22	1.08	3.00	0.00
LWSCB	LWSCB Waterbody	103	Goose Creek	30,200	9,600	31.79%	5.72	83	2.75	4.00	0.00
LWSCB	LWSCB Waterbody	104	Cabin Creek	19,400	0	0.00%	3.67	0	0.00	3.00	0.00
LWSCB	LWSCB Waterbody	108	Bay Tree Creek	27,600	400	1.45%	5.23	4	0.14	3.00	0.00
LWSCB	LWSCB Waterbody	110	Claxton Creek	30,000	400	1.33%	5.68	1	0.03	3.00	0.00
LWSCB	LWSCB Waterbody	111	Back Creek	54,400	4,800	8.82%	10.30	63	1.16	4.00	0.00
			Lower Western Shore of the Chesapeake Bay Waterbodies Total	405,600	55,080	13.58%	76.82	487	1.20		
	Lower Western Shore of the Chesapeake Bay System Total			511,800	76,080	14.87%	96.93	639	1.25		

York County Shoreline Condition By System and Subarea

System	Subarea	Reach #	Name	Total Shoreline Length (feet)	Hardened Length (feet)	Shoreline Percentage Hardened	Miles of Shoreline	No. of Piers & Docks	P&D Density per 1000'	Bank Height (feet)	Erosion rate (ft/year)
York River	Subarea A	11	Skimino Creek to Carter Creek	10,000	0	0.00%	1.89	0	0.00	10.00	2.20
York River	Subarea A	12	Mouth of Carter Creek to Bigler Mill Point	7,000	0	0.00%	1.33	0	0.00	10.00	2.60
York River	Subarea A	13	Bigler Mill Point to Beaverdam Pond	2,000	0	0.00%	0.38	0	0.00	5.00	0.90
York River	Subarea A	14/15	Beaverdam Pond to Queens Creek	11,000	0	0.00%	2.08	0	0.00	10.00	1.11
			Subarea A Total	30,000	0	0.00%	5.68	0	0.00		
York River	Subarea B	16	Mouth of Queens Creek to Penniman Spit	12,000	6,000	50.00%	2.27	2	0.17	20.00	1.90
York River	Subarea B	17	Penniman Spit	4,500	0	0.00%	0.85	0	0.00	3.00	0.00
York River	Subarea B	20	Poley Point to Sandy Point	10,000	8,500	85.00%	1.89	1	0.10	25.00	1.50
York River	Subarea B	22	Sandy Point	1,000	0	0.00%	0.19	0	0.00	3.00	0.00
York River	Subarea B	23	Sandy Point to Stony Point	9,000	3,000	33.33%	1.70	0	0.00	9.00	0.00
York River	Subarea B	24	Stony Point to Yorktown Creek	7,500	4,000	53.33%	1.42	1	0.13		
			Subarea B Total	44,000	21,500	48.86%	8.33	4	0.09		
York River	Subarea C	25/26	Mouth of Yorktown Creek to Wormley Creek	16,000	11,000	68.75%	3.03	5	0.31	36.56	1.32
York River	Subarea C	30	Wormley Creek to Sandbox	18,200	9,600	52.75%	3.45	8	0.44	10.00	3.50
York River	Subarea C	31	York River Face of Large Goodwin Island	4,000	0	0.00%	0.76	0	0.00	4.00	0.00
York River	Subarea C	32	York River Face of Intermediate Goodwin Island	6,000	0	0.00%	1.14	0	0.00	3.00	0.00
York River	Subarea C	33	York River Face of Tue Point Island	2,000	0	0.00%	0.38	0	0.00	3.00	0.00
			Subarea C Total	46,200	20,600	44.59%	8.75	13	0.28		
	Direct Shoreline Frontage (York River)			120,200	42,100	35.02%	22.77	17	0.14		
York River	York Waterbody	11.1	Skimino Creek	62,000	0	0.00%	11.74	1	0.02		
York River	York Waterbody	12.1	Carter Creek	72,000	0	0.00%	13.64	1	0.01		
York River	York Waterbody	16.1	Queens Creek	80,000	0	0.00%	15.15	0	0.00		
York River	York Waterbody	18	King Creek	51,000	0	0.00%	9.66	1	0.02		
York River	York Waterbody	19	Felgates Creek	64,000	0	0.00%	12.12	0	0.00		
York River	York Waterbody	21	Indian Field Creek	24,000	0	0.00%	4.55	0	0.00		
York River	York Waterbody	27	North & South shoreline of West Branch (mouth)	8,900	2,200	24.72%	1.69	19	2.13		
York River	York Waterbody	28	North & South shoreline of West Branch (headwaters)	10,000	3,000	30.00%	1.89	0	0.00	5.00	0.00
York River	York Waterbody	29	Wormley Creek Shoreline	35,200	4,600	13.07%	6.67	58	1.65		
	York River Waterbodies Total			407,100	9,800	2.41%	77.10	80	0.20		
	York River System Total			**527,300**	**51,900**	**9.84%**	**99.87**	**97**	**0.18**		
	Lower Western Shore of the Chesapeake Bay System Total			**511,800**	**76,080**	**14.87%**	**96.93**	**639**	**1.25**		
York County Waterbodies (Indirect) Shoreline Total				812,700	64,880	7.98%	153.92	567	0.70		
York County Direct Shoreline Frontage Total				226,400	63,100	27.87%	42.88	169	0.75		
York County Grand Total				***1,039,100***	***127,980***	***12.32%***	***196.80***	***736***	***0.71***		