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Shoreline Situation Report Henrico, Chesterfield, and Richmond

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CHAPTER 1

INTRODUCTION
1.1 PURPOSES AND GOALS

It is the objective of this report to supply an assessment, and at least a partial integration, of those important shoreland parameters and characteristics which will aid the planners and the managers of the shorelands in making the best decisions for the utilization of this limited and very valuable resource. The report gives particular attention to the problem of shore erosion and to recommendations concerning the alleviation of the impact of this problem. In addition we have tried to include in our assessment some of the potential uses of the shoreline, particularly with respect to recreational use, since such information could be of considerable value in the way a particular segment of coast is perceived by potential users.

The basic advocacy of the authors in the preparation of the report is that the use of shorelands should be planned rather than haphazardly developed in response to the short term pressures and interests. Careful planning could reduce the conflicts which may be expected to arise between competing interests. Shoreland utilization in many areas of the country, and indeed in some places in Virginia, has proceeded in a manner such that the very elements which attracted people to the shore have been destroyed by the lack of planning and forethought.

The major man-induced uses of the shorelands are:

-- Residential, commercial, or industrial development

-- Recreation

-- Transportation

-- Waste disposal

-- Extraction of living and non-living resources

Aside from the above uses, the shorelands serve various ecological functions.

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The role of planners and managers is to optimize the utilization of the shorelands and to minimize the conflicts arising from competing demands. Furthermore, once a particular use has been decided upon for a given segment of shoreland, both the planners and the users want that selected use to operate in the most effective manner. A park planner, for example, wants the allotted space to fulfill the design most efficiently. We hope that the results of our work are useful to the planner in designing the park by pointing out the technical feasibility of altering or enhancing the present configuration of the shore zone. Alternately, if the use were a residential development, we would hope our work would be useful in specifying the shore erosion problem and by indicating defenses likely to succeed in containing the erosion. In summary our objective is to provide a useful tool for enlightened utilization of a limited resource, the shorelands of the Commonwealth.

Shorelands planning occurs, either formally or informally, at all levels from the private owner of shoreland property to county governments, to planning districts and to the state and federal agency level. We feel our results will be useful at all these levels. Since the most basic level of comprehensive planning and zoning is at the county or city level, we have executed our report on that level although we realize some of the information may be most useful at a higher governmental level. The Commonwealth of Virginia has traditionally chosen to place, as much as possible, the regulatory decision processes at the county level. The Virginia Wetlands Act of 1972 (Chapter 2.1, Title 62.1, Code of Virginia), for example, provides for the establishment of County Boards to act on applications for alterations of wetlands. Thus, our focus at the county level is intended to interface with and to support the existing or pending county regulatory mechanisms concerning activities in the shorelands zone.

1.2 ACKNOWLEDGEMENTS

This report was prepared with funds provided by the Research Applied to National Needs Program (RANN) of the National Science Foundation through the Wetlands/Edges Program of the Chesapeake Research Consortium, Inc. The report was published with funds provided to the Commonwealth by the Office of Coastal Zone Management, National Oceanic and Atmospheric Administration, Grant Number 04-5-156-50001. Gaynor Williams assisted with data reduction. Beth Marshall typed the manuscript. Bill Jenkins and Ken Thornberry prepared the photographs. We would like to thank the numerous other persons in Virginia and Maryland who have assisted our work with their suggestions and criticisms of our ideas and methods.
CHAPTER 2

APPROACH USED AND ELEMENTS CONSIDERED
CHAPTER II
APPROACH TO THE PROBLEM

In the preparation of this report the authors utilized existing information wherever possible. For example, for such elements as water quality characteristics, zoning regulations, or flood hazard, we reviewed relevant reports by local, state, or federal agencies. Much of the desired information, particularly with respect to erosional characteristics, shoreland types, and use was not available, so we performed the field work and developed classification schemes. In order to analyze successfully the shoreline behavior we placed heavy reliance on low altitude, oblique, color, 35 mm photography. We photographed the entire shoreline of each county and cataloged the slides for easy access at VIMS, where they remain available for use. We then analyzed those photographic materials, along with existing conventional aerial photography and topographic and hydrolgraphic maps, for the desired elements. We conducted field inspection over much of the shoreline, particularly at those locations where office analysis left questions unresolved. In some cases we took additional photographs along with the field visits to document the effectiveness of shoreline defenses.

The basic shoreline unit considered is called a subsegment, which may range from a few hundred feet to several thousand feet in length. The end points of the subsegments were generally chosen on physiographic consideration such as changes in the character of erosion or deposition. In those cases where a radical change in land use occurred, the point of change was taken as a boundary point of the subsegment. Segments are a grouping of subsegments. The boundaries for segments also were selected on physiographic units such as necks or peninsulas between major tidal creeks. Finally, the county itself is considered as a sum of shoreline segments.

The format of presentation in the report follows a sequence from general summary statements for the county (Chapter 3) to tabular segment summaries and finally detailed descriptions and maps for each subsegment (Chapter 4). The purpose in choosing this format was to allow selective use of the report since some users' needs will adequately be met with the summary overview of the county while others will require the detailed discussion of particular subsegments.

2.2 CHARACTERISTICS OF THE SHORELANDS INCLUDED IN THE STUDY

The characteristics which are included in this report are listed below followed by a discussion of our treatment of each.

a) Shorelands physiographic classification
b) Shorelands use classification
c) Shorelands ownership classification
d) Zoning
e) Water quality
f) Shore erosion and shoreline defenses
g) Potential shore uses
h) Distribution of marshes
i) Flood hazard levels
j) Shellfish leases and public shellfish grounds
k) Beach quality

The shorelands of the Chesapeake Bay System may be considered as being composed of three interacting physiographic elements: the fastlands, the shore, and the nearshore. A graphic classification based on these three elements has been devised so that the types for each of the three elements portrayed side by side on a map may provide the opportunity to examine joint relationships among the elements. As an example, the application of the system permits the user to determine miles of high bluff shoreline interfacing with marsh in the shore zone.

For each subsegment there are two length measurements, the shore-nearshore interface or shoreline, and the fastland-shore interface. The two interface lengths differ most when the shore zone is embayed or extensive marsh. On the subsegment maps, a dotted line represents the fastland-shore interface when it differs from the shoreline. The fastland-shore interface length is the base for the fastland statistics.

Definitions:

Shore Zone
This is the zone of beaches and marshes. It is a buffer zone between the water body and the fastland. The seaward limit of the shore zone is the break in slope between the relatively steeper shoreline and the less steep nearshore zone. The approximate landward limit is a contour line representing one and a half times the mean tide range above mean low water (refer to Figure 1). In operation with topographic maps the inner fringe of the marsh symbols is taken as the landward limit.

The physiographic character of the marshes has also been separated into three types (see Figure 2). Fringe marsh is that which is less than 400 feet in width and which runs in a band parallel to the...
shore. Extensive marsh is that which has extensive acreage projecting into an estuary or river. An embayed marsh is a marsh which occupies a reentrant or drowned valley. The purpose in delineating these marsh types is that the effectiveness of the various functions of the marsh will, in part, be determined by type of exposure to the estuarine system. A fringe marsh may, for example, have maximum value as a buffer to wave erosion of the fastland. An extensive marsh, on the other hand, is likely a more efficient transporter of detritus and other food chain materials due to its greater drainage density than an embayed marsh. The central point is that planners, in the light of ongoing and future research, will desire to weight various functions of marshes and the physiographic delineation aid their decision making by denoting where the various types exist.

The classification used is:

Beach
Marsh
Fringe marsh, < 400 ft. (122 m) in width along shores
Extensive marsh
Embayed marsh, occupying a drowned valley or reentrant
Artificially stabilized

Fastland Zone

The zone extending from the landward limit of the shore zone is termed the fastland. The fastland is relatively stable and is the site of most material development or construction. The physiographic classification of the fastland is based upon the average slope of the land within 400 feet (122 m) of the fastland - shore boundary. The general classification is:

Low shore, 20 ft. (6 m) or less of relief; with or without cliff
Moderately low shore, 20-40 ft. (6-12 m) of relief; with or without cliff
Moderately high shore, 40-60 ft. (12-18 m) of relief; with or without cliff
High shore, 60 ft. (18 m) or more of relief; with or without cliff.

Two specially classified exceptions are sand dunes and areas of artificial fill.

Nearshore Zone

The nearshore zone extends from the shore zone to the 12-foot (MLW datum) contour. In the smaller tidal rivers the 6-foot depth is taken as the reference depth. The 12-foot depth is probably the maximum depth of significant sand transport by waves in the Chesapeake Bay area. Also, the distinct drop-off into the river channels begins roughly at the 12-foot depth. The nearshore zone includes any tidal flats.

The class limits for the nearshore zone classifications were chosen following a simple statistical study. The distance to the 12-foot underwater contour (isobath) was measured on the appropriate charts at one-mile intervals along the shorelines of Chesapeake Bay and the James, York, Rappahannock, and Potomac Rivers. Means and standard deviations for each of the separate regions and for the entire combined system were calculated and compared. Although the distributions were non-normal, they were generally comparable, allowing the data for the entire combined system to determine the class limits. The calculated mean was 919 yards with a standard deviation of 1,003 yards, As our aim was to determine general, serviceable class limits, these calculated numbers were rounded to 900 and 1,000 yards respectively. The class limits were set at half the standard deviation (500 yards) each side of the mean. Using this procedure a narrow nearshore zone is one 0-400 yards in width, intermediate 400-1,400, and wide greater than 1,400.

The following definitions have no legal significance and were constructed for our classification purpose:

Narrow, 12-ft. (3.7 m) isobath located <400 yards from shore
Intermediate, 12-ft. (3.7 m) isobath 400-1,400 yards from shore
Wide, 12-ft. (3.7 m) isobath >1,400 yards

Subclasses: with or without bars
with or without tidal flats
with or without submerged vegetation

Figure 1

An illustration of the definition of the three components of the shorelands (cross-section).

Figure 2

A generalized illustration of the three different marsh types (map view).
b) Shorelands Use Classification:

**Fastland Zone**

**Residential**
Includes all forms of residential use with the exception of farms and other isolated dwellings. In general, a residential area consists of four or more residential buildings adjacent to one another. Schools, churches, and isolated businesses may be included in a residential area.

**Commercial**
Includes buildings, parking areas, and other land directly related to retail and wholesale trade and business. This category includes small industry and other anomalous areas within the general commercial context. Marinas are considered commercial shore use.

**Industrial**
Includes all industrial and associated areas. Examples: warehouses, refineries, shipyards, power plants, railyards.

**Government**
Includes lands whose usage is specifically controlled, restricted, or regulated by governmental organizations: e.g., Camp Peary, Fort Story.

**Recreation and Other Public Open Spaces**
Includes designated outdoor recreation lands and miscellaneous open spaces. Examples: golf courses, tennis clubs, amusement parks, public beaches, race tracks, cemeteries, parks.

**Preserved**
Includes lands preserved or regulated for environmental reasons, such as wildlife or wildfowl sanctuaries, fish and shellfish conservation grounds, or other uses that would preclude development.

**Agricultural**
Includes fields, pastures, croplands, and other agricultural areas.

**Unmanaged**
Includes all open or wooded lands not included in other classifications:

a) Open:
   - brush land, dune areas, waste-lands; less than 40% tree cover.

b) Wooded:
   - more than 40% tree cover.

The shoreland use classification applies to the general usage of the fastland area to an arbitrary distance of half mile from the shore or beach zone or to some less distant, logical barrier. In multi-usage areas one must make a subjective selection as to the primary or controlling type of usage.

**Nearshore Zone**

- **Bathing**
- **Boat launching**
- **Bird watching**
- **Waterfowl hunting**

**Shore Zone**

- **Fishing**
- **Sport fishing**
- **Extraction of non-living resources**
- **Boating**
- **Water sports**

a) Shorelands Ownership Classification:
The shorelands ownership classification used has two main subdivisions, private and governmental, with the governmental further divided into federal, state, county, and town or city. Application of the classification is restricted to fastlands alone since the Virginia fastlands ownership extends to mean low water. All bottoms below mean low water are in State ownership.

d) Water Quality:
In areas where it is applicable, we have utilized the Virginia Bureau of Shellfish Sanitation Commission’s water quality data and classification. Their data consist of coliform and fecal coliform counts at stations near shellfish grounds. In areas such as the fresh water, tidal James where the Commission does not maintain sample stations, we have been forced to seek other data.

For the Henrico-Richmond-Chesterfield Shoreline Situation Report we have used the slack water data collected on December 13th, 1974, by V.I.M.S. This data consists of dissolved oxygen (D.O.) content, Biological Oxygen Demand (B.O.D.), and water temperature. The data are discussed elsewhere in the text.

e) Zoning:
In cases where zoning regulations have been established the existing information pertaining to the shorelands has been included in the report.

f) Shore Erosion and Shoreline Defenses:
The following ratings are used for shore erosion:
slight or none - less than 1 foot per year
moderate - - - - 1 to 3 feet per year
severe - - - - greater than 3 feet per year
The locations with moderate and severe ratings are
further specified as being critical or noncritical.

The erosion is considered critical if buildings,
roads, or other such structures are endangered.

The degree of erosion was determined by several
means. In most locations the long term trend was
determined using map comparisons of shoreline po­
sitions between the 1850's and the 1940's. In
addition, aerial photographs of the late 1930's and
recent years were utilized for an assessment of
more recent conditions. Finally, in those areas
experiencing severe erosion field inspections and
interviews were held with local inhabitants.

The existing shoreline defenses were evaluated
to their effectiveness. In some cases repeti­
tive visits were made to monitor the effective­
ness of recent installations. In instances where
existing structures are inadequate, we have given
recommendations for alternate approaches. Fur­
thermore, recommendations are given for defenses
in those areas where none currently exist. The
primary emphasis is placed on expected effective­
ness with secondary consideration to cost.

h) Distribution of Marshes:
The acreage and physiographic type of the
marshes in each subsegment is listed. These esti­
mates of acreages were obtained from topographic
maps and should be considered only as approxima­
tions. Detailed county inventories of the wetlands
are being conducted by the Virginia Institute of
Marine Science under the authorization of the
Virginia Wetlands Act of 1972 (Code of Virginia
62.1-13.4). These surveys include detailed acre­
ages of the grass species composition within indi­
vidual marsh systems. The material in this report
is provided to indicate the physiographic types of
marshes and to serve as a rough guide on acreages
until detailed surveys are completed. Additional
information of the wetlands characteristics may be
found in Coastal Wetlands of Virginia: Interim
Report by Marvin L. Wass and Thomas D. Wright,
SHANOE Report No. 10, Virginia Institute of Ma­
rine Science, 1969, and in other VIMS publia­
cations.

i) Flood Hazard Levels:
The assessment of tidal flooding hazard for the
whole of the Virginia tidal shoreline is still in­
complete. However, the United States Army Corps
of Engineers has prepared reports for a number of
localities which were used in this report. Two
tidal flood levels are customarily used to portray
the hazard. The Intermediate Regional Flood is
that flood with an average recurrence time of
about 100 years. An analysis of past tidal floods
indicates it to have an elevation of approximately
8 feet above mean water level in the Chesapeake
Bay area. The Standard Project Flood level is es­
established for land planning purposes which is
placed at the highest probable flood level.

j) Shellfish Leases and Public Grounds:
The data in this report show the leased and
public shellfish grounds as portrayed in the Vir­
ginia State Water Control Board publication
"Shellfish growing areas in the Commonwealth of
Virginia: Public, leased and condemned," November,
1971, and as periodically updated in other similar
reports. Since the condemnation areas change with
time they are not to be taken as definitive. How­
ever, some insight to the conditions at the date
of the report are available by a comparison be­
tween the shellfish grounds maps and the water
quality maps for which water quality standards
for shellfish were used.

k) Beach Quality:
Beach quality is a subjective judgment based
on such considerations as the nature of the beach
material, the length and width of the beach area,
and the general aesthetic appeal of the beach
setting.
CHAPTER 3

PRESENT SHORELINE SITUATION
CHAPTER 3

PRELIMINARY SURVEY OF SITUATION

3.1 THE SHORELANDS OF HENRICO AND CHESTERFIELD COUNTIES

This study is concerned with that part of the James River in Henrico and Chesterfield Counties that is below the fall line and thus, subject to tidal influences. For the purposes of this study, the starting point is the I-95 bridge at Richmond. The James River here is 900 feet wide, though it rapidly narrows to 500 feet. The river then slowly increases in width, reaching 1,100 feet just before Turkey Island. At Bermuda Hundred, the river is 2,100 feet wide.

The study area consists of the two counties separated by the James River: Chesterfield and Henrico Counties. The City of Richmond is Subsegment 1A in Henrico and Segment 1 in Chesterfield. Richmond has 5.9 miles of shore on the Chesterfield side of the river and 1.2 miles of shore on the Henrico side. The rest of Henrico County contains 31.5 miles of fastland and 35.0 miles of shoreline. Chesterfield County has 43.6 miles of fastland and 45.2 miles of shoreline.

Over half (56%) of Henrico County’s shorelands are low shore. Twenty-five percent of the fastland is moderately low shore, ten percent is moderately high shore, with or without bluffs, and three percent is high shore, with or without bluffs.

All areas of high shore are located along the nearly straight stretches of the river from the end of the Richmond City Limits to Dutch Gap. The fastlands in the City of Richmond are equally divided between low and moderately low shore.

The shore zone of Henrico County is mostly fringe marsh (75%). The bulk of the rest of Henrico’s shore is extensive marsh (20%). Four percent is embayed marsh. Along the nearly straight stretch of the river from Richmond to Dutch Gap, ninety-eight percent of the shore is fringe marsh. The other two percent is artificially stabilized.

On the Chesterfield side of the river, sixty-three percent of the fastland is low shore. Fourteen percent of the shorelands are moderately low shore, ten percent are moderately high shore, with or without bluffs, and thirteen percent are high shore, with or without bluffs. In the City of Richmond, eighty-three percent is low shore and eleven percent is moderately high shore with bluff. The other seven percent is divided among moderately low shore (5%), moderately high shore (1%), and high shore (2%).

The majority (63%) of Chesterfield County’s shore zone is fringe marsh. Thirty-four percent of the shore is extensive marsh, the rest being about equally divided between artificially stabilized and embayed marsh.

Data collected by V.I.M.S. on December 13, 1974 at five stations along the James between miles 68 (Bermuda Hundred) and 83 (near Richmond) indicated no water quality problems at that time. The D.O. ranged from 11.2 to 13.1 ppm, B.O.D. from 1.7 to 4.2 ppm, and water temperature from 5.8 to 4.9°C. The D.O.’s were near saturation level for the water temperature and the B.O.D.’s showed no significant depression.

On December 17, 1975, the James River basin was closed to all shellfish and finfish harvesting for an indefinite time. This was due to chemical contamination from “Xopeno”, which had been manufactured at one of Hopewell’s chemical plants.

The shorelands of Richmond in both Chesterfield and Henrico Counties are used for industrial purposes. Richmond is a customs port of entry. There are two city-owned wharves: Richmond Deepwater Terminal and Richmond Upper Marine Terminal. These two facilities handle a variety of cargo from ocean-going vessels. There are other, private barge wharves which mainly handle gravel and construction material. Another major facility is the Sewage Treatment Plant, which is located along the Chesterfield side of the river. All of the shorelands in Richmond are zoned for heavy industrial use.

South of the Richmond City Limits, there is a very abrupt reduction in the type and amount of formal land usage. Both Henrico and Chesterfield Counties are part of the National Flood Insurance Program. As such, development in the flood plains is restricted, or at least very limited. In Henrico, the flood plains are classified as Environmental Protection Areas (See Map 1B). Generally, no major construction can take place on the flood plains. The area is usually unmanaged, wooded or is used for agriculture. In Chesterfield County, forty-one percent of the shorelands are unmanaged, wooded. Thirty-nine percent of the lands are currently used for agriculture. Of the remaining lands, the Presquile National Wildlife Refuge accounts for nine percent of the shorelands, residential usage five percent, and industrial usage six percent. Less than one percent of the shorelands are used as recreational
areas.

In Henrico County, sixty-one percent of the shorelands are used for agriculture. Included in this figure is the Curles Neck Farm, which encompasses most of the Curles Neck area. Thirty percent of the shorelands are unmanaged, wooded. Residential usage accounts for six percent of the shore, the other three percent being used for industrial purposes. As in Chesterfield, less than one percent of the county's shorelands are used for recreational purposes. In Richmond, commercial and industrial concerns control the use of the shoreline. Virtually no land is available or suitable for recreational development. If recreational areas for the metropolitan Richmond area are to be developed, they will have to be located in the surrounding lesser-developed counties.

Within Richmond's boundaries, one percent of the James's northern bank and thirty percent of the southern bank are city-owned. The rest of Richmond's shoreline is privately owned. Over ninety-nine percent of Henrico County's shorelands are privately owned, with less than one percent being federally owned. In Chesterfield County, ninety-one percent of the shorelands are privately owned and nine percent are federally owned.

The James River channel is used by ships going to the city-owned docks located at Richmond. The river is also heavily traveled by barges carrying sand, gravel, and construction materials to private wharves along the James. Sport boating and fishing are prevalent from Dutch Gap south, especially in the shallower meanders of the river.

3.2 SHORE EROSION SITUATION

The processes causing shoreline erosion along this portion of the James River are fairly limited. Compared to the open ocean, Chesapeake Bay, or even areas closer to the river mouths, the James River at Richmond, Chesterfield and Henrico is a lower energy water body. Wave erosion is generally not a significant problem.

In other areas of the James, a primary agent of erosion is wind generated waves. The growth and power of the waves is dependent upon several factors: (1) The fetch, or the over water distance across which the wind blows, (2) the depth of the water, (3) the velocity of the wind, and (4) the duration of the wind. Along the James River in Henrico and Chesterfield Counties, the fetch is very limited, due to the narrowness of the river and the many meanders. Thus, this agent of erosion has little effect on the area's shorelands.

Watershed runoff and flood events are the principal erosion agents in the subject area. Flooding affects the low areas in and around the river. The primary example of flood erosion here is in the meanders of the river. When the river rises so as to cover existing land in the meanders, the water attempts to follow the straightest course. Instead of following the existing river bed, the water will cut across the neck of land in the meanders. The Dutch Gap Cutoff was opened in 1870 by one such flood. (The other cutoffs forming Turkey Island, Hatcher Island, and James Neck along the James River are the results of the Corps of Engineers' channel improvements, not natural scour. These cutoffs would have been made naturally over the course of time.)

Most of the erosion and accretion found along the upper James occurs at the bends in the river. The river current is fastest on the outside of the meanders and is much less on the inside. As a result, the outside bends erode while the inside bends accrete. Figure 3 is a drawing of a typical river meander. The amount and rate of erosion depends upon both the composition of the land in the bends and the speed of the current there. (The dotted line in Figure 3 represents pre-existing land.)
Much of the erosion along the banks of the river is due to "weathering," as it is largely a simple downslope wasting of the bluffs by rain runoff. The erosion is compounded when trees along the bluffs fall, carrying with them large amounts of soil. The Drewry's Bluff area (Figure 6) is one such example. The river has very little effect on most of this type of erosion. Only in times of extreme high water would the river become an erosive agent along parts of the bluff areas.

Man is also a common erosive force along the upper James River. Boat wake erosion is man's primary contribution. Large ships traveling the channel to Richmond leave a considerable wake. In the narrow portions of the river, the wakes can be very erosive. Along the meanders not used by large ships, tugs towing barges also leave considerable wakes. Though not a major erosion cause, wakes from ships and smaller craft do contribute to erosion.

The portion of Presque Island bordering Turkey Island Cutoff is severely eroding (see Figure 10). Erosion here can be attributed to a combination of factors. The island is situated in the last bend in the river above Hopewell. To the west, the river is about 1,100 feet wide; to the east, the river is 2,100 feet wide. On the west side of Presque Island, the fetch is S to N - 2.8 nautical miles. During storms, wind generated waves from the south are an important erosive agent to the east side of the cutoff.

Normal meander current trends also affect this part of the shoreline. Since the Turkey Island Cutoff is in a bend in the river, the current is fastest on the outside of the bend, in this case the Presque Island shoreline. This area, as stated before, will erode.

There are other contributing factors in the erosion of the island, mainly boat wakes and flood waters. These elements, though, are not as destructive or prevalent as the other forces described.

In summary, erosion is not a critical problem along the upper James River. The normal river current is a primary agent of erosion. In the meanders, the outside of the bends are eroded. This erosion, plus erosion caused by flood waters, tend to cut a new channel across the narrow neck of land in the meanders. This occurred at Dutch Gap in 1870, though the other cutoffs were man-made. Table 1 is a summary of flood levels at several stations along the river. Weathering of the bluffs by rain runoff is another type of erosion common along the James River.
and portions of the South Side. Sections of these areas have deteriorated and some businesses have shut down. If such flooding is allowed to continue, further deterioration will occur and, ultimately, the businesses will be forced to relocate. This would have a very severe economic impact on Richmond.

The U.S. Army Corps of Engineers has made a feasibility study of protecting the Richmond area from flooding to the height of the 100-year storm flood level. Their report, completed in October, 1974, presents a series of suggestions aimed at protecting those areas where it is economically feasible and at lessening the losses of those areas where protection is too costly. The areas where protection is feasible include the Shockoe Creek area and parts of the South Side. The study is currently under review, but it will probably be at least eight to ten years before any construction is initiated, given that the proposals are passed and funding is appropriated.

For those areas where protection is too costly, a series of nonstructural measures could be implemented. Such measures would include improved building codes, improved zoning regulations, and flood proofing. Although such measures would not eliminate flooding, they would diminish the extent of the flood damage. The National Flood Insurance Program, now available to businesses located in the flood plain, is another such nonstructural aid.

3.32 Potential Shore Use for Chesterfield County

The closeness of the metropolitan center of Richmond and the good access to that center via I-95 and Route 301 would seem to make Chesterfield County a prime target for development by industrial and business concerns and by residential developers. As already stated, the shorelands of Richmond are heavily developed by industrial and commercial endeavors. However, the amount of shoreland in Chesterfield County suitable for development is limited.

Development in Chesterfield County has taken place along the two major highways, I-95 and Route 301, which parallel one another from Richmond to Petersburg. Businesses, commercial, industrial, and trucking concerns have all located here. Most of the shorelands close to Richmond are flood plains, where development is restricted by the county. The islands further downstream in the meanders are also too low for development. Of those left, the land along the old channel of the James River, south of Farner Island, has a moderate development potential. However, the elevation of the land (at least 100 feet) would make access to the water very difficult and expensive. Formal development here would not be because of the usual water related potential but because of the scenic qualities of the land and its location.

Development further south of Richmond is possible, though the distance from the city detracts from commuter residence here. It is possible that lands here could be developed for residential use for commuters to Hopewell and its chemical plants. Though possible, the distance is still restrictive for such development.

Much of the land which is unsuitable for formal development in Chesterfield County is ideal for low intensity recreational parks. Richmond, like most metropolitan areas, has a shortage of recreational facilities. The county's flood plains could be easily developed to accommodate picnickers and hikers. The flood waters could do only minor damage if no permanent structures are built along the shore in the lowlands.

It is logical to expect most development in Chesterfield to continue to be located on or near the major highways and I-95 interchanges rather than on the shoreline. Low intensity usage along most of the county's shoreline seems best suited for the area. Though flood prone, the lowlands along much of the shoreline could become needed recreational parks serving both the county and Richmond with only a minimum of expense.

3.33 Potential Shore Use for Henrico County

Our study area in Henrico County is served by only one major road, Route 5. Though heavily traveled, businesses and industry have, for the most part, ignored this section of the county. The area from the James River inland to Route 5 is characterized by much unused land and many acres of farmland. Curles Neck Farm occupies the entire Curles Neck area. Only in the areas adjoining the City of Richmond are there any industrial and major residential developments.

Various industries have located on the shoreline directly bordering Richmond. The Fulton Railroad Yards of the Chesapeake and Ohio Railroad lines are located behind the industries in this section, providing ready transportation for goods to and from industries. The industries, but not the railroad yards, are located in the flood plain and are very susceptible to flooding in the James.

The Richmond Heights area is located about
nine miles from Richmond. From here north to Richmond, the land has been developed for residential usage. This area has good, quick access to the city and is ideal for commuters. Houses along this part of the river are placed at least 3,000 feet into the fastland. Cliffs rising from 50 to 150 feet are located about 1,800 feet into the fastland. The lands toward the river from the cliffs either are wooded or are used for agriculture. There is no good access to this sparsely used area. This site has the potential to become a much needed public recreational park. There are only limited shorelands left in the area suitable for recreational development. The major drawback for any type of development here is the lack of access. Any road has to cross the cliffs further inland in order to reach the area. This would be costly. However, with few places along the shoreline available for public use, this area could prove worth the investment.

Residential development will probably continue at Richmond Heights, as there is still much land available. This area already has one major subdivision. Other subdivisions or extensions of the existing one are very likely to be built in the future.

Further from Richmond, at Dutch Gap, Route 5 is over four miles inland from the shore. There are only secondary roads located near the shoreline. The lands generally are used for agriculture. This area is probably too far from Richmond to have a prime residential development potential. Of course, there are probably numerous residents here who do commute to jobs in the city. The area’s prime development potential would be for low density recreational parks. Fort Brady, part of the Richmond National Battlefield Park, is located just across from Hatcher Island. A park in the adjacent area for camping, picnicking, and other activities is a possible use here. For the most part, the area is probably best left as a low density agricultural and residential community.

Most of the Curles Neck area is currently controlled by Curles Neck Farm. Any development would be at the expense of the present agricultural usage. This area being prime agricultural land, development here seems highly unlikely.

It can be expected, then, that most development in Henrico County will continue to be located close to Richmond. The currently unused land between Richmond Heights and the river holds promise as a recreational area. Though access to the area would be costly, these lands would meet some of the demands for public recreational facilities for Richmond and Henrico.
TABLE 1

FLOOD LEVELS OF JAMES RIVER
(CITY OF RICHMOND, CHESTERFIELD AND HENRICO COUNTIES)

<table>
<thead>
<tr>
<th>Miles Above Mouth</th>
<th>Area Name</th>
<th>Floods From 1877-1944 (Average Ft. Above M.S.L.)</th>
<th>August, 1969</th>
<th>June, 1972</th>
</tr>
</thead>
<tbody>
<tr>
<td>104.0</td>
<td>Richmond City Lock</td>
<td>-</td>
<td>28.7</td>
<td>-</td>
</tr>
<tr>
<td>103.8</td>
<td>Richmond Lock Gage</td>
<td>29.0</td>
<td>28.6</td>
<td>36.5</td>
</tr>
<tr>
<td>103.6</td>
<td>Eastern Steamship Co.</td>
<td>24.8</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>103.4</td>
<td>Rocketts Gage</td>
<td>24.1</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>99.7</td>
<td>DuPont Pumping Plant</td>
<td>19.4</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>99.0</td>
<td>Deep Water Terminal</td>
<td>-</td>
<td>20.9</td>
<td>-</td>
</tr>
<tr>
<td>98.0</td>
<td>I-95 Bridge, Interchange 7</td>
<td>-</td>
<td>19.3</td>
<td>-</td>
</tr>
<tr>
<td>97.5</td>
<td>Mouth Falling Creek</td>
<td>16.9</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>94.0</td>
<td>Lone Star Industries</td>
<td>-</td>
<td>-</td>
<td>19.3</td>
</tr>
<tr>
<td>92.2</td>
<td>Dutch Gap Power Plant</td>
<td>-</td>
<td>13.7</td>
<td>-</td>
</tr>
<tr>
<td>91.8</td>
<td>Aiken Swamp</td>
<td>11.2</td>
<td>-</td>
<td>18.9</td>
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<tr>
<td>87.8</td>
<td>Meadowville</td>
<td>8.5</td>
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<tr>
<td>85.1</td>
<td>Deepbottom Boat Landing</td>
<td>-</td>
<td>-</td>
<td>12.2</td>
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<tr>
<td>82.3</td>
<td>Jones Neck</td>
<td>5.7</td>
<td>-</td>
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<tr>
<td>73.6</td>
<td>Bermuda Hundred</td>
<td>-</td>
<td>-</td>
<td>6.5</td>
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<tr>
<td>72.7</td>
<td>Bermuda Hundred</td>
<td>4.3</td>
<td>-</td>
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</tbody>
</table>

FIGURE 4: Concrete and steel boat ramp facility near Richmond. This marina, seriously damaged from flood waters in the Camille storm of August, 1969, has never reopened. Across the river is the Richmond Upper Marine Terminal.

FIGURE 5: A composite photo showing part of the Richmond Upper Marine Terminal facility. The wooden bulkhead fronting an alongside pier no longer has any protective value.

FIGURE 6: Drewrys Bluff area, Chesterfield County. Cliff erosion here is caused by downhill rain runoff.

FIGURE 7: Across from Drewrys Bluff, Henrico County. This area is experiencing moderate erosion, as evidenced by the falling trees.
FIGURE 10: Shoreline of Presquile National Wildlife Refuge bordering Turkey Island Cut-off. This stretch of shoreline has recently been experiencing severe erosion.

FIGURE 11: Across Turkey Island Cut-off from Presque Isle. Erosion here is very minor and is not a problem.
MAP 1A
HENRICO COUNTY
CHESTERFIELD COUNTY
CITY OF RICHMOND

BRIDGE

SEGMENT AND MAP INDEX
\= Segment Boundary
/ = Subsegment Boundary

CHESTERFIELD
C-1 CITY OF RICHMOND
C-2A ORKEWEYS BLUFF AREA
C-2B FARRAR ISLAND AREA
C-3A JONES NECK AREA
C-3B PRESQUILE NATIONAL WILDLIFE REFUGE
C-3C BERMUDA HUNDRED
C-4 APPOMATTOX RIVER

HENRICO
H-1A CITY OF RICHMOND
H-2B RICHMOND HEIGHTS AREA
H-2A CHAFFIN BLUFF AREA
H-3 CURLES NECK

SCALE
IN MILES
1/2 2
MAP 1E
HENRICO COUNTY
ENVIRONMENTAL PROTECTION AREA

FROM HENRICO COUNTY LANDUSE PLAN—BASED ON 100 YEAR FLOOD LEVEL
TABLE 2. CHESTERFIELD COUNTY, VIRGINIA SHORELANDS PHYSIOGRAPHY, FASTLANDS USE, OWNERSHIP (STATUTE MILES)

<table>
<thead>
<tr>
<th>Ownership, use and physiographic classification</th>
<th>Subsegment</th>
<th>Low Shore</th>
<th>Moderate Low Shore</th>
<th>Moderately Early Flat Shore</th>
<th>Early Flat Shore</th>
<th>High Shore with Reserve</th>
<th>Artifically Stabilized Shore</th>
<th>Fence Mesh</th>
<th>Egged Trench</th>
<th>Extensive</th>
<th>Nursery</th>
<th>Intermediate</th>
<th>Agricultural</th>
<th>Residential</th>
<th>Transient</th>
<th>Preserved</th>
<th>wooded</th>
<th>Federal</th>
<th>Pond or City</th>
<th>Total Shoreline</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ownership, SHORELANDS PHYSIOGRAPHY, FASTLANDS USE, OWNERSHIP TOTAL MILE3</td>
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<tr>
<td>% of FASTLAND 6%</td>
<td>14%</td>
<td>7%</td>
<td>3%</td>
<td>3%</td>
<td>10%</td>
<td>2%</td>
<td>62%</td>
<td>1%</td>
<td>34%</td>
<td>75%</td>
<td>3%</td>
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<tr>
<td>CITY OF RICHMOND</td>
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<tr>
<td>1 Does not include mutual nearshore with Subsegment 3C.</td>
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<tr>
<td>Ownership, use and physiographic classification</td>
<td>SHORELANDS PHYSIOGRAPHY</td>
<td>FASTLANDS USE</td>
<td>OWNERSHIP</td>
<td>TOTAL MILES</td>
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<tr>
<td>Subsegment</td>
<td>FASTLANDS</td>
<td>SHORE</td>
<td>NEARSHORE</td>
<td>FASTLANDS</td>
<td>USE</td>
<td>OWNERSHIP</td>
<td>TOTAL MILES</td>
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<tr>
<td>1A</td>
<td>0.6</td>
<td>0.6</td>
<td>0.2</td>
<td>1.0</td>
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<td>2B</td>
<td>2.4</td>
<td>2.1</td>
<td>5.1</td>
<td>5.7</td>
<td>2.1</td>
<td>1.0</td>
<td>0.1</td>
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<tr>
<td>2A</td>
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<td>7.6</td>
<td>5.5</td>
<td>0.6</td>
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<td>2B</td>
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<td>TOTAL</td>
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</tr>
<tr>
<td>% of FASTLANDS</td>
<td>56%</td>
<td>25%</td>
<td>6%</td>
<td>27%</td>
<td>33%</td>
<td>27%</td>
<td>0%</td>
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<tr>
<td>% of SHORELANDS</td>
<td>1%</td>
<td>75%</td>
<td>4%</td>
<td>20%</td>
<td>72%</td>
<td>99%</td>
<td>0%</td>
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</tbody>
</table>

1 City of Richmond.
2 City of Richmond Water: Henrico Land.
CHAPTER 4

4.1 TABLE OF SUBSEGMENT SUMMARIES

4.2 SEGMENT AND SUBSEGMENT DESCRIPTIONS

4.3 SEGMENT AND SUBSEGMENT MAPS
### TABLE 4. SHORELINE SITUATION REPORT SUBSEGMENT SUMMARY FOR CHESTERFIELD COUNTY, VIRGINIA

<table>
<thead>
<tr>
<th>Subsegment</th>
<th>Subshoreline Type</th>
<th>Subshoreline Use</th>
<th>Ownership</th>
<th>Zoning</th>
<th>Flood Hazard</th>
<th>Beach Quality</th>
<th>Shore Erosion Situation</th>
<th>Potential Use Constraints</th>
</tr>
</thead>
<tbody>
<tr>
<td>C-1 CITY OF RICHMOND</td>
<td>Low shore 65%, moderately low shore 20%, moderately high shore 15%, totally high shore with bluff 11%, and high shore 2%</td>
<td>Private, except public</td>
<td>Heavy industrial</td>
<td>Severe, critical</td>
<td>No beaches</td>
<td>Moderate, non-critical</td>
<td>Slight or no change. Accretion from Goose Creek south to City limits. There is 1,400 feet of effective bulkhead at Deepwater Terminal.</td>
<td>Low. The already high density of industrial and commercial usage plus the severe flood hazard limits the extent and scope of new development along Richmond's shorelands.</td>
</tr>
<tr>
<td>C-2 BERKELEY SHOOP AREA</td>
<td>Low shore 65%, moderately low shore 20%, moderately high shore 15%, totally high shore with bluff 11%, and high shore 2%</td>
<td>Private, except public</td>
<td>Mostly industrial, some agricultural</td>
<td>Mostly non-critical</td>
<td>No beaches</td>
<td>Moderate, non-critical</td>
<td>Slight or no change. Several areas in the meander and for the islands in the meander are critical. The shorelands are already developed as residential. Development potential is very low.</td>
<td>Low for the islands in the meander and for the VEPCO area. These islands along the old channel of the James River, south of Porter Island, have moderate development potential.</td>
</tr>
<tr>
<td>C-3 BERKELEY SHOOP AREA</td>
<td>Low shore 65%, moderately low shore 20%, moderately high shore 15%, totally high shore with bluff 11%, and high shore 2%</td>
<td>Private, except public</td>
<td>Mostly industrial ; some recreational</td>
<td>Mostly non-critical</td>
<td>No beaches</td>
<td>Moderate, non-critical</td>
<td>Slight or no change to moderate, non-critical. Some areas are critical. A thin beach at top of Chesapeake Bank.</td>
<td>Since the area's status as a National Wildlife Refuge precludes any development on the island.</td>
</tr>
<tr>
<td>C-4 APPOMATTOX RIVER</td>
<td>Low shore 65%, moderately low shore 20%, moderately high shore 15%, totally high shore with bluff 11%, and high shore 2%</td>
<td>Private, except public</td>
<td>Mostly industrial, some agricultural</td>
<td>Mostly non-critical</td>
<td>No beaches</td>
<td>Moderate, non-critical</td>
<td>Slight or no change to severe, non-critical. Some areas in the meander and for the islands in the meander are critical. Development potential is moderate.</td>
<td>Low. Present low density agricultural usage limits is suited for the area.</td>
</tr>
<tr>
<td>TABLE 5. SHORELINE SITUATION REPORT SUBSEGMENT SUMMARY FOR HENRICO COUNTY, VIRGINIA</td>
<td></td>
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<tr>
<td>SUBSEGMENT</td>
<td>SHORELANDS TYPE</td>
<td>SHORELANDS USE</td>
<td>INFRASTRUCTURE</td>
<td>Flood Hazard</td>
<td>Beach Quality</td>
<td></td>
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</tr>
<tr>
<td>CITY OF RICHMOND</td>
<td>Low shore 75%, moderately low shore 25%</td>
<td>Industrial</td>
<td>Private except for City-owned</td>
<td>Severe, critical</td>
<td>No beaches</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1-1/2 miles</td>
<td>Artificially stabilized 33% and fringe marsh 67%</td>
<td>Commercial shipping</td>
<td>Heavy industrial</td>
<td>Severe, critical</td>
<td>No beaches</td>
<td></td>
<td></td>
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</tr>
<tr>
<td>NEARSHORE: Barrow Creek and Barrow Creek</td>
<td>Moderate, critical and noncritical</td>
<td>Severe, critical</td>
<td>Dutch Gap has eroded at a rate of 6.1 feet per year</td>
<td>Moderate, critical and noncritical</td>
<td>Slight or no change to severe, noncritical</td>
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<tr>
<td>5,1 miles</td>
<td>Low shore 43%, moderately low shore 38%, and high shore with bluff 19%</td>
<td>Commercial shipping</td>
<td>Severe, critical and noncritical</td>
<td>Slight or no change to severe, noncritical</td>
<td>Slight or no change to severe, noncritical</td>
<td></td>
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<tr>
<td>6,3 miles</td>
<td>Low shore 68%, moderately low shore 25%, and high shore with bluff 7%</td>
<td>Commercial shipping</td>
<td>Severe, critical and noncritical</td>
<td>Slight or no change to severe, noncritical</td>
<td>Slight or no change to severe, noncritical</td>
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<tr>
<td>PATTISON: Industrial</td>
<td>Low shore 53%, moderately low shore 40%, and high shore with bluff 7%</td>
<td>Commercial shipping</td>
<td>Severe, critical</td>
<td>Slight or no change to severe, noncritical</td>
<td>Slight or no change to severe, noncritical</td>
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<tr>
<td>7,4 miles</td>
<td>Low shore 64%, moderately low shore 16%, and high shore with bluff 1%</td>
<td>Commercial shipping</td>
<td>Severe, critical</td>
<td>Slight or no change to severe, noncritical</td>
<td>Slight or no change to severe, noncritical</td>
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<tr>
<td>PATTISON: Agricultural</td>
<td>Low shore 53%, moderately low shore 40%, and high shore with bluff 7%</td>
<td>Commercial shipping</td>
<td>Severe, critical</td>
<td>Slight or no change to severe, noncritical</td>
<td>Slight or no change to severe, noncritical</td>
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<tr>
<td>8,3 miles</td>
<td>Low shore 68%, moderately low shore 25%, and high shore with bluff 7%</td>
<td>Commercial shipping</td>
<td>Severe, critical</td>
<td>Slight or no change to severe, noncritical</td>
<td>Slight or no change to severe, noncritical</td>
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<tr>
<td>9,3 miles</td>
<td>Low shore 46%, moderately low shore 40%, and high shore with bluff 14%</td>
<td>Commercial shipping</td>
<td>Severe, critical</td>
<td>Slight or no change to severe, noncritical</td>
<td>Slight or no change to severe, noncritical</td>
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<tr>
<td>11,5 miles</td>
<td>Low shore 68%, moderately low shore 25%, and high shore with bluff 7%</td>
<td>Commercial shipping</td>
<td>Severe, critical</td>
<td>Slight or no change to severe, noncritical</td>
<td>Slight or no change to severe, noncritical</td>
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<tr>
<td>12,5 miles</td>
<td>Low shore 68%, moderately low shore 25%, and high shore with bluff 7%</td>
<td>Commercial shipping</td>
<td>Severe, critical</td>
<td>Slight or no change to severe, noncritical</td>
<td>Slight or no change to severe, noncritical</td>
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<tr>
<td>14,1 miles</td>
<td>Low shore 68%, moderately low shore 25%, and high shore with bluff 7%</td>
<td>Commercial shipping</td>
<td>Severe, critical</td>
<td>Slight or no change to severe, noncritical</td>
<td>Slight or no change to severe, noncritical</td>
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<tr>
<td>15,7 miles</td>
<td>Low shore 68%, moderately low shore 25%, and high shore with bluff 7%</td>
<td>Commercial shipping</td>
<td>Severe, critical</td>
<td>Slight or no change to severe, noncritical</td>
<td>Slight or no change to severe, noncritical</td>
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<tr>
<td>17,6 miles</td>
<td>Low shore 68%, moderately low shore 25%, and high shore with bluff 7%</td>
<td>Commercial shipping</td>
<td>Severe, critical</td>
<td>Slight or no change to severe, noncritical</td>
<td>Slight or no change to severe, noncritical</td>
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Note: The land near the water is very susceptible to flooding. Though not suitable for formal development, some of these lands could be used as public recreational nature trails or parks.

Low. Area already high intensity industrial usage. Hanover Canal could be remedied for pleasure boating and sight-seeing trips.

Low. Though most lands are suitable for development, they are too far from Richmond and Route 5 to be considered prime targets for expansion. The present low density usage seems best suited for the area's present needs.

Low. Curles Neck is a prime agricultural area. Little or no development would take place unless the agricultural lands were to be sacrificed.
CITY OF RICHMOND, HENRICO COUNTY PORTION
SUBSEGMENT H-1A (Map 2)

EXTENT: 6,400 feet (1.2 mi.) of shoreline from
the I-95 bridge to the Richmond City Limits.
The subsegment also includes 6,400 feet (1.2
mi.) of fastland.

SHORELANDS TYPE
FASTLAND: Low shore 50% (3,200 ft.) and moder­
ately low shore 50% (3,200 ft.).
SHORE: Artificially stabilized 17% (1,100 ft.)
and fringe marsh 83% (3,300 ft.).
NEARSHORE: Narrow. There is a dredged channe l
up to the Kanawha Channe l maintained to a depth
of 18 feet.

SHORELANDS USE
FASTLAND: Industrial. The Richmond Upper
Marine Terminal is situated just south of
Gillie Creek.
SHORE: The shore zone here is very narrow.
The only usage would be access to boats, espe­
cially for loading and unloading cargo and
supplies at the Richmond Upper Marine Terminal.
NEARSHORE: Commercial shipping to Richmond
Upper Marine Terminal wharf, barges to private
wharves just south. The Kanawha Canal is gen­
erally used as a docking and dock for small
boats.

Suggested Action: Repair areas of bulkheading
presently in disrepair.

OTHER SHORE STRUCTURES: There is a 750 foot mar­
ginal wharf at the Upper Marine Terminal and
several smaller piers just south of there.

POTENTIAL USE ENHANCEMENT: The highly intensified
industrial usage of the subsegment precludes
any other usage for most of the area. The Ka­
nawha Canal, listed on the National Register of Historic Places, could be reopened for pleasure
boating and sight-seeing trips.

MAPS: USGS, 7.5 Min. Ser. (Topo.), RICHMOND
Quadr., 1964, Pr. 1968.
C&GS, #531, 1:20,000 scale, JAMES RIVER,
Jordan Point to Richmond, 1971.
PHOTOS: Aerial-VIMS 24Jan75 C-H-1-1A/05-08.
Ground-VIMS 13Aug75 HR-1A/1-8, 16-18.

BEACH QUALITY: There are no beaches in the sub­
segment.

RECOMMENDATION SITUATION
SHORELINE DRAINAGE: No data available.
ENDANGERED STRUCTURES: No data available.
SHORE PROTECTIVE STRUCTURES: There is about
200 feet of bulkheading at the Upper Marine
Terminal primarily for retaining fill. Much
of it is concrete and in good condition.
The wooden bulkheading fronting a marginal
wharf here is in a state of deterioration and
is now of little value. There is approximately
200 feet of bulkheading at the mouth of the
Kanawha Canal. Thin lower section of the canal
is now used as a navigable harbor and dock for
small boats.

Suggested Action: Repair areas of bulkheading
presently in disrepair.

SUBSEGMENT H-1B (Maps 2 and 3)

EXTENT: 27,000 feet (5.1 mi.) of shoreline from
the end of Richmond City Limits to the end of
Richmond City water. The subsegment includes
27,000 feet (5.1 mi.) of fastland.

SHORELANDS TYPE
FASTLAND: Low shore 46% (12,400 ft.), moder­
ately low shore 41% (11,000 ft.), high shore
7% (1,800 ft.), and high shore with bluff 7%
(1,800 ft.).
SHORE: Entirely fringe marsh (27,000 ft.).
NEARSHORE: Narrow. There is a dredged channe l
maintained to depths of 18 and 25 feet
from north to south respectively.

SHORELANDS USE
FASTLAND: Agricultural 42% (11,400 ft.),
in­
dustrial 19% (5,200 ft.), and unmanaged, 'wood­
ed 39% (10,400 ft.).
SHORE: Some fishing, mostly unused.
NEARSHORE: Commercial shipping to the Rich­
mond Deepwater Terminal and Upper Marine Ter­
minal. Barges carrying gravel and construc­
tion materials go to privately owned wharves
upstream.

SHORELINE TREND: The shoreline trends basically
N-S in this subsegment.

OWNERSHIP: Private.

ZONING: Mostly general industrial to .5 miles
from the subsegment end. Agricultural zoning
from there to the end of the subsegment.

FLOOD HAZARD: Moderate, critical and noncritical.
Flooding here, as in Subsegment H-1A, can be
the result of severe summer storms, upstream
storm runoff, or remnants of tropical storms.
The shorelands along this narrow part of the
river are very vulnerable to flooding. The
industries along the river suffered greatly
from the Agnes and Camille floods of 1969 and
1972 respectively.

BEACH QUALITY: There are no beaches in this sub­
segment.

RECOMMENDATION SITUATION
SHORELINE DRAINAGE: No data available.
ENDANGERED STRUCTURES: No data available.
SHORE PROTECTIVE STRUCTURES: There is about
200 feet of bulkheading at the Upper Marine
Terminal primarily for retaining fill. Much
of it is concrete and in good condition.
The wooden bulkheading fronting a marginal
wharf here is in a state of deterioration and
is now of little value. There is approximately
200 feet of bulkheading at the mouth of the
Kanawha Canal. Thin lower section of the canal
is now used as a navigable harbor and dock for
small boats.

Suggested Action: Repair areas of bulkheading
presently in disrepair.

OTHER SHORE STRUCTURES: There is a 750 foot mar­
ginal wharf at the Upper Marine Terminal and
several smaller piers just south of there.

POTENTIAL USE ENHANCEMENT: The highly intensified
industrial usage of the subsegment precludes
any other usage for most of the area. The Ka­
nawha Canal, listed on the National Register of Historic Places, could be reopened for pleasure
boating and sight-seeing trips.

MAPS: USGS, 7.5 Min.Ser. (Topo.), RICHMOND
Quadr., 1964, Pr. 1968.
C&GS, #531, 1:20,000 scale, JAMES RIVER,
Jordan Point to Richmond, 1971.
PHOTOS: Aerial-VIMS 24Jun75 C-H-1-1A/05-08.
Ground-VIMS 13Aug75 HR-1A/1-8, 16-18.
PRESENT SHORE EROSION SITUATION

EROSION RATE: Slight or no change for the northern portion of the subsegment. The remaining part has been accreting at an historical rate of 2.9 feet per year.

ENDANGERED STRUCTURES: None.

SHORE PROTECTIVE STRUCTURES: None.

Suggested Action: No action is needed.

OTHER SHORE STRUCTURES: None.

POTENTIAL USE ENHANCEMENT: Low. Though this area has a great deal of land currently either unused or under agricultural usage, this land, especially near the river, is susceptible to flooding. Any development should be placed well into the fastland. Some of the lands near the shore could be used for public recreational nature trails or other such low intensity recreational usage.

USGS, 7.5 Min.Ser. (Topo.), DREWRY'S BLUFF Quadr., 1969.
C&GS, #531, 1:20,000 scale, JAMES RIVER, Jordan Point to Richmond, 1971.

CHAFFIN BLUFF AREA, HENRICO COUNTY, VIRGINIA
SUBSEGMENT H-2A (Maps 3 and 4)

EXTENT: 52,600 feet (10.0 mi.) of shoreline from the end of Richmond City water to Dutch Gap. The subsegment also includes 52,800 feet (10.0 mi.) of fastland.

SHORELANDS TYPE
FASTLAND: Low shore 64% (34,000 ft.), moderately low shore 3% (1,800 ft.), moderately low shore with bluff 1% (7,000 ft.), high shore 1% (600 ft.), and high shore with bluff 14% (7,600 ft.).
SHORE: Fringe marsh 98% (52,000 ft.) and artificially stabilized 2% (800 ft.).
NEARSHORE: Narrow 71% (37,600 ft.). The rest of the subsegment's waters are less than 12 feet in depth.

SHORELANDS USE
FASTLAND: Agricultural 55% (28,800 ft.), unmanaged, wooded 37% (19,800 ft.), residential 7% (3,600 ft.), and recreational 1% (600 ft.). There is a marina at the end of Kingsland Road and one at Fort Brady. This commercial usage is too small to be tabulated.
SHORE: Mostly unused. The Tidewater Yacht Agency shore is used for access to the water.
NEARSHORE: Commercial shipping to Richmond comprises most nearshore usage. There is also sport fishing around Hatcher Island.

SHORELINE TEND: The shoreline trends basically NW - SE.

OWNERSHIP: Private, except for Fort Brady, part of a Civil War Battlefield, which is federally owned.

ZONING: The section from the start of the subsegment almost to Chaffin Bluff is zoned light industrial. The Chaffin Bluff area is zoned residential. The rest of the subsegment is zoned agricultural.

FLOOD HAZARD: Moderate, critical and noncritical. Most residences in the subsegment are on land sufficiently high to withstand flooding. However, several places, namely the Tidewater Yacht Agency and several residences along the shoreline, are endangered by flood waters.

BEACH QUALITY: There are no beaches in this subsegment.

PRESENT SHORE EROSION SITUATION
EROSION RATE: Slight or no change to moderate, noncritical. The two areas of erosion are around Chaffin Bluff and near Fort Brady. The area north of Cornelius Creek has lost an average of 1.5 feet per year historically. The area west of Fort Brady has a retreat of 2.0 feet per year. There are also several areas which have been accreting at rates from 1.5 to 2.5 feet per year.

ENDANGERED STRUCTURES: None.
SHORE PROTECTIVE STRUCTURES: There is approximately 800 feet of riprap at a residence south of Kingsland Road. It seems effective at the present.

Suggested Action: None at present.

POTENTIAL USE ENHANCEMENT: Moderate. Several areas in the subsegment offer room for some development. The area from the subsegment start to Chaffin Bluff, though mostly undeveloped, is currently used for agriculture. Development pressures will increase for this land as other spots are developed. If development for residential use does take place here, several things should be taken into consideration. First, one third of this area is below the 10-foot contour. This land is very susceptible to flooding and thus, development here should be cautioned. Also, any development in the area should be set back into the fastland to be protected from erosion of the shoreline. Some type of low intensity recreational activities could take place along the shorelands. Nature trails for hiking and picnicking, and camping facilities are some alternatives. Such low investment recreational areas are much needed in the Richmond area.
DUTCH GAP TO DEEP BOTTOM, HENRICO COUNTY, VIRGINIA
SUBSEGMENT H-2B (Maps 4 and 5)

EXTENT: 33,400 feet (6.3 mi.) of shoreline from Dutch Gap to Deep Bottom. The subsegment includes 23,800 feet (5.6 mi.) of fastland.

SHORELANDS TYPE
FASTLAND: Low shore 68% (20,400 ft.), moderately low shore with bluff 6% (2,400 ft.), and moderately high shore with bluff 23% (7,000 ft.).
SHORE: Fringe marsh 90% (30,000 ft.) and extensive marsh 10% (3,400 ft.).
NEARSHORE: Narrow 62% (20,800 ft.). The remaining nearshore is too shallow to be classified.

SHORELANDS USE
FASTLAND: Agricultural 74% (22,200 ft.), residential 7% (2,000 ft.), and unmanaged, wooded 19% (5,600 ft.).
SHORE: Parts of the shore are used for private recreation. Most of the shoreland is unused.
NEARSHORE: Commercial shipping in the channel.

WIND AND SEA EXPOSURE: The shoreline first trends basically E - W, then NE - SW. At Dutch Gap, there is a fetch from the east of 2.1 nautical miles.

OWNERSHIP: Private.

FLOOD HAZARD: Moderate, noncritical. Flooding here, as in the other segments, is due to the runoff of heavy upstream rains. The marsh area from just northwest of Deep Bottom to the channel is susceptible to flooding, but no structures are endangered.

BEACH QUALITY: There are no beaches in the subsegment.

PRESENT SHORE EROSION SITUATION
EROSION RATE: Slight or no change to severe, noncritical. Though most of the subsegment is fairly stable, Dutch Gap is experiencing severe erosion, losing 6.1 feet per year historically.

OTHER SHORE STRUCTURES: There are several piers located in the Varina Farm area.

SUGGESTED ACTION: No action is deemed necessary at this time. The eroding area at Dutch Gap is uninhabited so protective devices there are not feasible at this time.

OTHER SHORE STRUCTURES: None.

POTENTIAL USE ENHANCEMENT: Low. The majority of the shorelands here are used for agricultural purposes. These lands, though suitable for development, are not located close enough to Richmond or to Route 5 to be considered a prime area of potential development. The present low density residential - agricultural usage seems best suited for the area's present needs.

MAPS: USGS, 7.5 Min. Ser. (Topo.), DUTCH GAP Quadr., 1969, C&GS, #531, 1:20,000 scale, JAMES RIVER, Jordan Point to Richmond, 1971.
CURLES NECK, HENRICO COUNTY, VIRGINIA
SEGMENT H-3 (Maps 5 and 6)

EXENT: 71,800 feet (13.6 mi.) of shoreline from Deep Bottom to the head of Turkey Island Creek. The segment also includes 56,600 feet (10.8 mi.) of fastland.

SHORELANDS TYPE
FASTLAND: Low shore 46% (26,400 ft.), moderately low shore 47% (26,900 ft.), moderately high shore 5% (3,000 ft.), and moderately high shore with bluff 1% (600 ft.).
SHORE: Fringe marsh 40% (29,000 ft.), embayed marsh 12% (8,600 ft.), and extensive marsh 48% (34,200 ft.).
NEARSHORE: Narrow 64% (46,000 ft.). The rest of the nearshore is too shallow to be classified.

SHORELANDS USE
FASTLAND: Agricultural 70% (39,600 ft.), residential 7% (4,000 ft.), and unmanaged, wooded 23% (13,200 ft.).
SHORE: In the Curles Neck Swamp, there is sport boating and fishing. Elsewhere, usage is limited to access to the nearshore waters.
NEARSHORE: There is commercial shipping to Richmond in the dredged channel. Elsewhere, sport boating and fishing, and other water sports constitute the nearshore usage.

SHORELINE TREND: The shoreline meanders around a NW - SE trend.

OWNERSHIP: Private, except for a state-owned boat landing west of Bailey Creek.

ZONING: Agricultural.

FLOOD HAZARD: Moderate, noncritical. The segment is subject to flooding caused by heavy upstream rains. Most of the fastland here is of sufficient height to be little affected by the waters. The flood waters of the Agnes storm in June, 1972, crested at 12.3 feet above M.S.L. at Deep-bottom Landing. Usually, only the Curles Neck Swamp and other marsh areas are inundated by flood waters. No structures are endangered.

BEACH QUALITY: There are no beaches in the segment.

PRESENT SHORE EROSION SITUATION
EROSION RATE: Slight or no change to severe, noncritical. There has been severe erosion on the east side of Curles Neck Swamp, just south of the mouth of the creek. Here, the marsh has lost 5.0 feet per year historically. At the southern bank of the creek mouth, the marsh has lost 1.0 feet per year. Picketts Wharf also has moderate erosion. Elsewhere in the segment, Point Bromo, Turkey Island Creek mouth, and the southeastern part of Curles Neck Swamp have been accreting at rates of 2.2 to 2.8 feet per year.

ENDANGERED STRUCTURES: None.

SHORE PROTECTIVE STRUCTURES: None. There may be some sort of defense structures at the numerous wharves located in the segment, but none could be ascertained from VIMS aerial photography of the area.

Suggested Action: None. The cost of protecting the eroding marsh areas would probably be prohibitive. Erosion to the fastland here is mainly due to rain runoff down the steep cliffs found along much of the shorelines.

OTHER SHORE STRUCTURES: There is a boat ramp just to the west of Bailey Creek. There are numerous piers spaced throughout the segment.

POTENTIAL USE ENHANCEMENT: Low. Curles Neck is a prime agricultural area. Little or no significant development could take place here unless the agricultural area were to be sacrificed.

MAPS: USGS, 7.5 Min.Ser. (Topo.), ROXBURY Quadr., 1965.
USGS, 7.5 Min.Ser. (Topo.), DUTCH GAP Quadr., 1969.
USGS, 7.5 Min.Ser. (Topo.), HOPSWELL Quadr., 1969.
C&GS, #531, 1:20,000 scale, JAMESTOWN RIVER, Jordan Point to Richmond, 1971.

PHOTOS: Aerial-VIMS 24Jan75 H-C 3-3A/67-89.
Ground-VIMS 90ct75 HR-3/64-68.
CITY OF RICHMOND, CHESTERFIELD COUNTY PORTION  
SEGMENT C-1 (Maps 2 and 3)

EXTENT: 31,200 feet (5.9 mi.) of shoreline from the I-95 bridge, south, to the Richmond City limits. The subsegment also includes 31,200 feet (5.9 mi.) of fastland.

SHORELANDS TYPE
FASTLAND: Low shore 85% (25,800 ft.), moderately low shore 3% (800 ft.), moderately high shore 1% (400 ft.), moderately high shore with bluff 1% (3,600 ft.), and high shore 2% (600 ft.).

SHORE: Artificially stabilized 4% (1,400 ft.) and fringe marsh 96% (29,800 ft.).

NEARSHORE: Narrow. There is a maintained, dredged channel to the Richmond Lock. Dredged depths are 18 feet from the Lock, south, to Richmond Deepwater Terminal and 25 feet from there to the mouth of the river.

SHORELANDS USE
FASTLAND: Industrial. Industries in the segment include the Richmond Deepwater Terminal and the Sewage Treatment Plant near the bridge.

SHORE: The shore here is very thin, having no beaches or extensive or embayed marshes. Usage would consist of boat access, especially at the Deepwater Terminal.

NEARSHORE: Usage consists mainly of commercial shipping to the city wharves. Upstream from the wharves, usage is restricted to small boats.

SHORELINE TREND: The shoreline trends N - S in this segment.

OWNERSHIP: Private, except for the Sewage Treatment Plant and Richmond Deepwater Terminal, which are city owned.

ZONING: The entire segment is zoned heavy industrial.

FLOOD HAZARD: Severe, critical. Though the James River here is considered tidal, flooding is due to upstream runoff from severe storms. This area was inundated with flood waters by both the Agnes and Camille storms of 1972 and 1969 respectively. The Agnes flood waters crested at 36.51 feet above M.S.L.; the Camille waters crested at 28.61 feet above M.S.L. Both storms caused heavy damage to the Southside area businesses and industries.

BEACH QUALITY: There are no beaches in this segment.

PRESENT SHORE EROSION SITUATION
EROSION RATES: Historically, accretion has been from 2.9 to 3.2 feet per year from just north of Goode Creek, south, to the city limits.

ENDANGERED STRUCTURES: None.

SHORE PROTECTIVE STRUCTURES: 1,400 feet of effective bulkheading, mostly at the Richmond Deepwater Terminal. Some bulkheading of steel interlocking sheet pile is located at the entrance to an unused concrete boat ramp - marine facility. This is mainly to combat boat wake erosion which could cause washing behind the marine's structures.

Suggested Action: No further action seems necessary, since the segment's shoreline is either relatively stable or accreting.

OTHER SHORE STRUCTURES: There is a 1,250 foot pier parallel to the shore at the Richmond Deepwater Terminal. Another pier is located at the sewage treatment plant.

POTENTIAL USE ENHANCEMENT: Low. This area is already densely developed for various industries and businesses. If any development should take place here, much effort and consideration should be given to the area's severe flood hazard. Buildings should be flood proofed to limit the damage caused by floods.

MAPS: USGS, 7.5 Min. Ser. (Topo.), RICHMOND Quadr., 1964, Pr. 1968.

USGS, 7.5 Min. Ser. (Topo.), DREWRY'S BLUFF Quadr., 1969.

C&GS, #531, 1:20,000 scale, JAMES RIVER, Jordan Point to Richmond, 1971.

PHOTOS: Aerial-VIMS 24Jan75 C-H 1-1A/05-19.


13Aug75 CP-1/10-15.
DREWRY'S BLUFF AREA, CHESTERFIELD COUNTY, VIRGINIA

SUBSEGMENT C-2A (Maps 3 and 4)

EXTENT: 35,600 feet (6.7 mi.) of shoreline from the end of Richmond City Limits to Proctor's Creek. The subsegment also includes 40,800 feet (7.7 mi.) of fastland.

SHORELANDS TYPE

FASTLAND: Low shore 69% (28,000 ft.), moderately low shore 9% (3,800 ft.), moderately high shore 4% (1,600 ft.), moderately high shore with bluff 4% (1,600 ft.), high shore 3% (1,200 ft.), and high shore with bluff 1% (4,600 ft.).

SHORE: Fringe marsh 92% (32,800 ft.), embayed marsh 6% (2,000 ft.), and artificially stabilized 2% (800 ft.).

NEARSHORE: Narrow for the entire length of the subsegment.

SHORELANDS USE

FASTLAND: Agricultural 36% (14,600 ft.), recreational 3% (1,200 ft.), industrial 11% (4,400 ft.), and unmanaged, wooded 50% (20,600 ft.).

SHORE: Where the power plant is located, the shore usage is industrial. Elsewhere in the subsegment, especially along the Old Channel, usage is recreational.

NEARSHORE: There is commercial shipping through the Aiken Swamp-Dutch Gap cutoff to the VPICO power plant wharf and to the terminals in Richmond. Around Hatcher Island and along the Old Channel at Farrar Island, nearshore usage consists of boating, sport fishing, and other water sports.

SHORELINE TREND: The shoreline trends basically NW - SE.

OWNERSHIP: Private, except for the federally owned Richmond National Battlefield Park (Fort Darling, a Civil War fort).

ZONING: Mostly zoned industrial. The area around Fort Darling is zoned agricultural.

FLOOD HAZARD: Moderate, noncritical. Heavy upstream rains cause flooding in areas of the subsegment. An average of historical flood levels here range from 16.9 feet to 11.8 feet above M.S.L. The Agnes flood of June, 1972 crested at a level of 19.3 feet above M.S.L. at the Lone Star Industries property on Willis Road.

BEACH QUALITY: There are no beaches in this subsegment.

PRESENT SHORE EROSION SITUATION

EROSION RATE: Slight or no change to moderate, noncritical. The area of most erosion is approximately 0.5 mile north of Proctor's Creek, where the historical rate has been 1.1 feet per year.

ENDANGERED STRUCTURES: None.

SHORE PROTECTIVE STRUCTURES: There is 800 feet of bulkheading near the gravel pits about 0.5 miles north of Proctor's Creek. It seems to be working satisfactorily.

Suggested Action: None for the present.

POTENTIAL USE ENHANCEMENT: Low. Except for the immediate area around Drewry's Bluff, most of the area's shorelines are flood plains. These areas are very susceptible to flooding and caution should be used in any type of development here.

FARRAR ISLAND AREA, CHESTERFIELD COUNTY, VIRGINIA

SUBSEGMENT C-2B (Map 4)

EXTENT: 72,600 feet (13.8 mi.) of shoreline from Proctor's Creek to Dutch Gap. The subsegment includes 72,600 feet (13.8 mi.) of fastland.

SHORELANDS TYPE

FASTLAND: Low shore 61% (44,400 ft.), moderately low shore 7% (5,200 ft.), moderately high shore 11% (7,800 ft.), moderately high shore with bluff 2% (1,800 ft.), high shore 1% (800 ft.), and high shore with bluff 17% (12,600 ft.).

SHORE: Fringe marsh 66% (47,800 ft.), extensive marsh 27% (19,800 ft.), artificially stabilized 6% (4,000 ft.), and embayed marsh 1% (1,000 ft.).

NEARSHORE: Narrow for the entire length of the subsegment.

SHORELANDS USE

FASTLAND: Agricultural 36% (26,200 ft.), residential 3% (2,000 ft.), industrial 9% (6,600 ft.), and unmanaged, wooded 52% (37,800 ft.).

SHORE: Where the power plant is located, the shore usage is industrial. Elsewhere in the subsegment, especially along the Old Channel, usage is recreational.

OWNERSHIP: Private, except for commercial shipping through the Aiken Swamp-Dutch Gap cutoff to the VPICO power plant wharf and to the terminals in Richmond. Around Hatcher Island and along the Old Channel at Farrar Island, nearshore usage consists of boating, sport fishing, and other water sports.

SHORELINE TREND: The channel trends basically NW - SE. The shoreline has several wide meanders, combined making a figure 8.

OWNERSHIP: Private, except for a county-owned boat ramp near the VPICO power plant.

ZONING: Mostly zoned industrial on the James. Along the Old Channel across from Farrar Island, zoning ranges from agricultural to business, with some residential.

FLOOD HAZARD: Moderate, noncritical for most of the subsegment; severe, critical for three
structures on Hatcher Island and for one house on Farrar Island. The flood waters of the Camille storm (1969) crested at 13.7 feet above M.S.L. at the VEPCO Power Plant at Dutch Gap. The Agnes flooding (1972) crested at 18.9 feet above M.S.L. at the Aiken Swamp gage. Historically, flood waters at Aiken Swamp have averaged 11.2 feet above M.S.L.

BEACH QUALITY: There are no beaches in this subsegment.

PRESENT SHORE EROSION SITUATION
EROSION RATES: The erosion rate ranges from slight or no change to moderate, noncritical. There are also several areas of accretion. The area of most erosion has been the far westernly side of Farrar Island, which historically, has lost 2.7 feet per year. The tips of Hatcher and Farrar Islands at Dutch Gap have been losing 1.6 feet per year historically. Elsewhere, the northern-most part of Hatcher Island has been gaining 2.0 feet per year; the area of Farrar Island southwest of the power plant +4.7 feet per year, and the area almost at the subsegment's end +4.5 feet per year.

ENDANGERED STRUCTURES: None at present. One house on the southwestern tip of Hatcher Island is encountering moderate erosion, and in several years if protective measures are not taken, will be endangered.

SHORE PROTECTIVE STRUCTURES: There is a dredged and riprapped slip to the west of VEPCO's power plant. About half of VEPCO's shoreline is riprapped.

Suggested Action: No action is necessary at the present time.

OTHER SHORE STRUCTURES: To the back of VEPCO is its outfall canal, which was dredged, then riprapped, with jetties at its mouth. Elsewhere, there is a pier at VEPCO, and one west of there, in the dredged slip. Below VEPCO's pier, there is a public boat landing.

POTENTIAL USE ENHANCEMENT: Low for Hatcher Island and Farrar Island. Both islands are too low to be safely developed. The VEPCO Power Plant is already located to the east of Proctors Creek. No other development here would be possible. The area along the old channel of the James River, south of Farrar Island, has a moderate development potential. This land has an elevation of at least 100 feet, making it safe from any flooding. However, access to the water here would prove very difficult and expensive. Any development here would be due to the scenic qualities of the particular location and not to the usual water related development potential.

MAPS: USGS, 7.5 Min. Ser. (Topo.), HOPEWELL Quad., 1969.
USGS, 7.5 Min. Ser. (Topo.), CHESTER Quad., 1969.
USGS, 7.5 Min. Ser. (Topo.), DREWRY'S BLUFF Quad., 1969.
USGS, 7.5 Min. Ser. (Topo.), DUTCH GAP Quad., 1969.
C&GS, #531, 1:20,000 scale, JAMES RIVER, Jordan Point to Richmond, 1971.

JONES NECK AREA, CHESTERFIELD COUNTY, VIRGINIA
SUBSEGMENT C-3A (Maps 4, 5, and 6)

EXTENT: 56,800 feet (11.2 mi.) of shoreline from Dutch Gap to Turkey Island. The subsegment also includes 56,800 feet (11.2 mi.) of fastland.

SHORELANDS TYPE

FASTLAND: Low shore 59% (34,800 ft.), moderately low shore 18% (10,600 ft.), moderately high shore 7% (4,000 ft.), high shore 6% (3,600 ft.), and high shore with bluff 9% (5,200 ft.).

SHORE: Fringe marsh 55% (31,800 ft.) and extensive marsh 45% (26,400 ft.).

NEARSHORE: Narrow 97% (56,200 ft.). The rest of the subsegment's nearshore has less than 12-foot depths.

SHORELANDS USE

FASTLAND: Agricultural 58% (34,200 ft.), residential 4% (2,400 ft.), industrial 2% (1,000 ft.), and unmanaged, wooded 36% (21,200 ft.).

SHORE: Mostly unused.

NEARSHORE: Commercial shipping along the subsegment through Jones Neck Cutoff to various wharves nearer Richmond. There is also sport boating, fishing, and other water sports throughout the subsegment's waters.

SHORELINE TREND: The shore line is trending basically NW - SE in the subsegment. There is a large meander (Jones Neck) and several other curves.

OWNERSHIP: Private.

ZONING: Agricultural from Dutch Gap to Meadowville Channel. Jones Neck and most of the rest of the subsegment is zoned heavy industrial.

FLOOD HAZARD: Low, noncritical. Any flooding here would be a result of heavy upstream rain runoff. Even in cases of heavy flooding, the only area susceptible to the water would be the extensive marsh just east of Dutch Gap. All fastland in the subsegment is of sufficient height to preclude any flooding. No structures are endangered.

NEARSHORE: Fringe marsh 55% (31,800 ft.) and extensive marsh 45% (26,400 ft.).

FLOOD HAZARD: Like other segments along the upper James River, flooding here is a result of heavy upstream rains. The marsh areas are susceptible to the flood waters, but the fastlands are high enough to withstand the flooding. There are no endangered structures.

BEACH QUALITY: There are no beaches in this subsegment.

PRESQUILE NATIONAL WILDLIFE REFUGE, CHESTERFIELD COUNTY, VIRGINIA
SUBSEGMENT C-3B (Map 6)

EXTENT: 37,200 feet (7.0 mi.) of shoreline around Turkey Island. The subsegment also contains 20,000 feet (3.8 mi.) of fastland.

SHORELANDS TYPE

FASTLAND: Entirely low shore.

SHORE: Extensive marsh 67% (24,800 ft.) and fringe marsh 33% (12,400 ft.).

NEARSHORE: Narrow 97% (56,200 ft.). The rest of the subsegment's nearshore is included in the figures for Subsegment C-3C.

SHORELANDS USE

FASTLAND: The entire subsegment is preserved as a National Wildlife Refuge.

SHORE: Mostly unused. There is a ferry dock along the cutoff.

NEARSHORE: Commercial shipping to Richmond along the Turkey Island Cutoff. The rest of the subsegment's nearshore is used for sport boating and fishing, and for water sports.

SHORELINE TREND: The subsegment is an island located in a meander of the James River. It has no specific shoreline trend.

OWNERSHIP: Federal.

ZONING: Agricultural.

FLOOD HAZARD: Like other segments along the upper James River, flooding here is a result of heavy upstream rains. The marsh areas are susceptible to the flood waters, but the fastlands are high enough to withstand the flooding. There are no endangered structures.

BEACH QUALITY: There are no beaches in this subsegment.
experiencing severe erosion problems. Most of the eastern side of the island has been experiencing accretion ranging from 4.5 to 7.3 feet per year. The western side has experienced slight or no change in its shoreline. ENDANGERED STRUCTURES: There are no structures endangered by erosion. SHORE PROTECTIVE STRUCTURES: There is about 100 feet of wood bulkheading and rubble riprap located at the ferry dock on Presquile. It is in good condition and is effective. Suggested Action: The severely eroding shoreline bordering the Turkey Island Cutoff should be studied with the view toward creating a system of shoreline defenses. Probably the best defenses here would be to riprap or bulkhead the endangered area.

OTHER SHORE STRUCTURES: The Presquile Ferry dock.

POTENTIAL USE ENHANCEMENT: None. The area's status as a National Wildlife Refuge precludes any development on the island.

USGS, 7.5 Min. Ser. (Topo.), WESTOVER Quadr., 1965.
USGS, 7.5 Min. Ser. (Topo.), DUNDEE GAP Quadr., 1969.
USGS, 7.5 Min. Ser. (Topo.), HOPEWELL Quadr., 1969.
OGS, #531, 1:20,000 scale, JAMES RIVER, Jordan Point to Richmond, 1971.


BERMUDA HUNDRED, CHRISTENBURG COUNTY, VIRGINIA

SUBSEGMENT 0-30 (Maps 6 and 7)

EXTENT: 14,200 feet (2.7 mi.) of shoreline from west of the Turkey Island Cutoff to Shand Creek. The subsegment also includes 14,200 feet (2.7 mi.) of fastland.

SHORELINES TYPE
FASTLAND: Low shore 79% (11,200 ft.), moderately low shore 11% (1,600 ft.), and moderately high shore 10% (1,400 ft.).
NEARSHORE: Narrow 62% (11,600 ft.) and intermediate 18% (2,600 ft.).

SHORELINES USE
FASTLAND: Agricultural 69% (9,800 ft.), residential 7% (1,000 ft.), industrial 11% (1,600 ft.), and unmanaged, wooded 13% (1,800 ft.).

OWNERSHIP: Mostly urban. There is a dock for the Presquile Ferry.

WIND AND SEA EXPOSURE: The shoreline trends basically N-S. The fetch is 22-32 nautical miles.

FLOOD HAZARD: Flooding here is a result of heavy upstream rains. Very little fastland is affected by such flooding, and no structures are endangered. The Agnes flood of June, 1972, the worst flood here since 1771, crested at 6.3 feet above M.N.L., flooding little land and endangering no structures.

BEACH QUALITY: There are no beaches in this subsegment.

PRESENT SHORE EROSION SITUATION
EROSION RATE: Slight or no change to moderate, noncritical. Erosion of 1.1 feet per year has taken place along the shoreline east of Shand Creek. The shoreline just south of Turkey Island Cutoff has been accreting at a rate of 7.3 feet per year, historically.

ENDANGERED STRUCTURES: None.

SHORE PROTECTIVE STRUCTURES: There is approximately 100 feet of wooden bulkhead along the ferry dock at Turkey Island Cutoff.

Suggested Action: None for the present time. Erosion is not a significant problem in this subsegment.

OTHER SHORE STRUCTURES: The Presquile Ferry dock.

POTENTIAL USE ENHANCEMENT: Low. Most of the land here is used for agricultural purposes. Any significant development would sacrifice the present usage. VRECO has a substation just south of Bermuda Hundred, which precludes any other development there.

OGS, #531, 1:20,000 scale, JAMES RIVER, Jordan Point to Richmond, 1971.

PHOTOS: No VIMS aerial photos.
EXTENT: 21,000 feet (4.0 mi.) of shoreline from Shand Creek to Point of Rocks. The segment includes 23,000 feet (4.4 mi.) of fastland.

SHORELANDS TYPE
FASTLAND: Moderately low shore 59% (13,600 ft.), moderately high shore 14% (3,200 ft.), moderately high shore with bluff 8% (1,800 ft.), high shore 10% (2,400 ft.), and high shore with bluff 9% (2,000 ft.).
SHORE: Entirely extensive marsh.
NEARSHORE: Narrow 77% (16,200 ft.) and intermediate 23% (4,800 ft.).

SHORELANDS USE
FASTLAND: Agricultural 17% (4,000 ft.), residential 24% (5,400 ft.), and unmanaged, wooded 59% (13,600 ft.).
SHORE: Waterfowl hunting in areas. Mostly unused.
NEARSHORE: Commercial shipping along the Appomattox River to Petersburg. There is also sport boating, fishing, and other water sports in the nearshore.

SHORELINE TRENDS: The shoreline trends basically E - W.

OWNERSHIP: Private.

ZONING: Agricultural except for some residential into the fastland.

FLOOD HAZARD: Moderate, noncritical. Flooding here is a result of heavy rains along the headwaters of the James River. Flood waters here are of low height than those at Richmond. Only the shore zone of extensive marsh would be inundated at such times, and no structures would be endangered.

BEACH QUALITY: There are no beaches in this segment.

PRESENT SHORE EROSION SITUATION
EROSION RATE: Slight or no change.
ENDANGERED STRUCTURES: None.
SHORE PROTECTIVE STRUCTURES: None.

Suggested Action: None. The area appears to be stable. The extensive marsh appears to be effective in combating any incident erosion.

OTHER SHORE STRUCTURES: One bridge, Route 10, going to Hopewell, and a railroad bridge west of there.

POTENTIAL USE ENHANCEMENT: Low. The fastlands behind the marshes on the Appomattox River are already residential areas. Further development here could take place, though it would tend to crowd the area and spoil the natural beauty of the land. Just south of Shand Creek, there is an area that is unpopulated. This area could be developed into a low intensity recreational park, with nature trails and picnicking facilities.

MAPS: USGS, 7.5 Min.Ser. (Topo.), HOPEWELL Quad., 1969.
        C&GS, #531, 1:20,000 scale, JAMES RIVER, Jordan Point to Richmond, 1971.
PHOTOS: No aerial VDIIS photos.

Suggested Action: None. The area appears to be stable. The extensive marsh appears to be effective in combating any incident erosion.

OTHER SHORE STRUCTURES: One bridge, Route 10, going to Hopewell, and a railroad bridge west of there.

POTENTIAL USE ENHANCEMENT: Low. The fastlands behind the marshes on the Appomattox River are already residential areas. Further development here could take place, though it would tend to crowd the area and spoil the natural beauty of the land. Just south of Shand Creek, there is an area that is unpopulated. This area could be developed into a low intensity recreational park, with nature trails and picnicking facilities.

MAPS: USGS, 7.5 Min.Ser. (Topo.), HOPEWELL Quad., 1969.
        C&GS, #531, 1:20,000 scale, JAMES RIVER, Jordan Point to Richmond, 1971.
PHOTOS: No aerial VDIIS photos.
MAP 2A
CITY OF RICHMOND
TOPOGRAPHY AND CULTURE
Segments H-1A, H-1B, C-1
// = Segment Boundary
/ = Subsegment Boundary
SHORELANDS TYPES
Segments H-1A, H-1B, C-1
FASTLAND
Low Shore
Moderately Low Shore
SHORE
Artificially Stabilized
Fringe Marsh
NEARSHORE
Narrow
MAP 4B
DUTCH GAP
SHORELANDS TYPES
Segments H-2A, H-2B, C-2A, C-2B, C-3A

FASTLAND
Low Shore
Moderately Low Shore
Moderately Low Shore with Bluff
Moderately High Shore
Moderately High Shore with Bluff
High Shore
High Shore with Bluff

SHORE
Artificially Stabilized
Fringe Marsh
Extensive Marsh
Embayed Marsh

NEARSHORE
Narrow
MAP 5A
JONES NECK
TOPOGRAPHY AND CULTURE
Segments C-3A, H-2B, H-3

- Segment Boundary
- Subsegment Boundary
MAP 5B
JONES NECK
SHORELANDS TYPES
Segments C-3A, H-2B, H-3

FASTLAND
Low Shore
Moderately Low Shore
Moderately Low Shore with Bluff
Moderately High Shore
Moderately High Shore with Bluff
High Shore
High Shore with Bluff

SHORE
Fringe Marsh
Extensive Marsh
Embayed Marsh

NEARSHORE
Narrow
MAP 6A
TURKEY ISLAND
TOPOGRAPHY AND CULTURE
Segments H-3, C-3A, C-3B, C-3C

\ = Segment Boundary
\ = Subsegment Boundary

H-3

C-3B

C-3A

C-3C

Bermuda Hundred

Shirley
MAP 6B
TURKEY ISLAND
SHORELANDS TYPES
Segments H-3, C-3A, C-3B, C-3C
FASTLAND
Low Shore
Moderately Low Shore
SHORE
Fringe Marsh
Extensive Marsh
Embayed Marsh
NEARSHORE
Narrow
MAP 7B
APPMATTOX RIVER
SHORELANDS TYPES
Segments C-3C and C4

FASTLAND
- Low Shore
- Moderately Low Shore
- Moderately High Shore
- Moderately High Shore with Bluff
- High Shore
- High Shore with Bluff

SHORE
- Fringe Marsh
- Extensive Marsh
- Embayed Marsh

NEARSHORE
- Narrow
- Intermediate

Legend:
- C-3C
- C-4
- Rivermont
- Total Flat
- Sump
- Sunken Island
- Highland Park
- Hopewell
- James River
- James River

Map Scale:
1 inch = 1.0 miles

North Arrow:
- Upward

Projection:
- Universal Transverse Mercator (UTM)