COASTAL LAND USE PLANNING AND MANAGEMENT IN PRINCE WILLIAM COUNTY

A GUIDE BOOK

REGIONAL RESOURCES DIVISION

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COASTAL LAND USE PLANNING AND MANAGEMENT IN PRINCE WILLIAM COUNTY: A GUIDEBOOK

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PREFACE

Coastal areas such as the Potomac estuary, its tributaries, and adjacent lands, are in critical need of public attention. Coastal estuaries are the most biologically productive areas on earth, playing a vital role in the life cycle of a tremendous variety of fish, waterfowl, and wildlife. Coastal waters provide significant opportunities for recreational activities such as boating, water skiing, and swimming. However, these values are being increasingly threatened by man's activities. Pollution from urban development has degraded the quality of coastal waters, reducing their value for habitat and for outdoor recreation. Private shoreline development is rapidly reducing opportunities for public access to the shoreline.

The federal government and the State of Virginia have recognized the need for special management of coastal areas through the development of coastal resources management programs designed to balance man's activities in coastal areas with the protection of valuable coastal resources. A major objective of Virginia's program is the development of a State-local cooperative effort to minimize the adverse impacts of man's activities on coastal waters.

Prince William County has already affirmed the importance of coastal resources through the establishment of a local wetlands board under the Virginia Wetlands Law to protect the County's valuable coastal marshes. This guidebook is an attempt to provide information which would enable Prince William County to extend this philosophy to a more comprehensive protection of its coastal resources. Land use planning and management guidelines and standards are suggested for critical environmental areas such as beaches, bluffs, and wetlands, as well as for shorelands adjacent to these areas. The information contained in this report should be useful not only to local planners, but also to landowners in the County's coastal zone who wish to learn more about this unique environmental area.

The recommendations in this report have been developed by the staff of the Northern Virginia Planning District Commission (NVPDC) under contract with the Virginia Office of Commerce and Resources. Nothing in this report should be construed as representing the adopted policies of the NVPDC unless so stated in an adopted Resolution of said Commission.

TABLE OF CONTENTS

TABLE OF CONTENTS (continued)

LIST OF TABLES

LIST OF FIGURES

LIST OF MAPS

Coastal Land Use Planning and Management in Prince William County: A Guidebook

CHAPTER I

INTRODUCTION

The purpose of this guidebook is to provide information and technical assistance to land use planners and others involved in land development activities in Prince William County's coastal zone. The boundary of the coastal zone in Prince William County, shown on Map 1, roughly follows I-95 and is based on both the natural and man-made characteristics of the area. The coastal zone comprises a total of approcimately 18,180 acres.

Prince William County's shoreline is classified as a coastal area because it adjoins the Potomac Estuary, which forms part of the Chesapeake Bay estuarine system. An estuary is a semi-enclosed coastal water body with an open connection to the sea and a measurable quantity of salt in its waters. Estuaries are highly productive natural systems, functioning as a "trap" for life-sustaining nutrients and providing essential spawning and nursery grounds for a large number of commercial and sport fish and shellfish (A listing of fish and shellfish species common to the Prince William coastal area is provided in Appendix I).

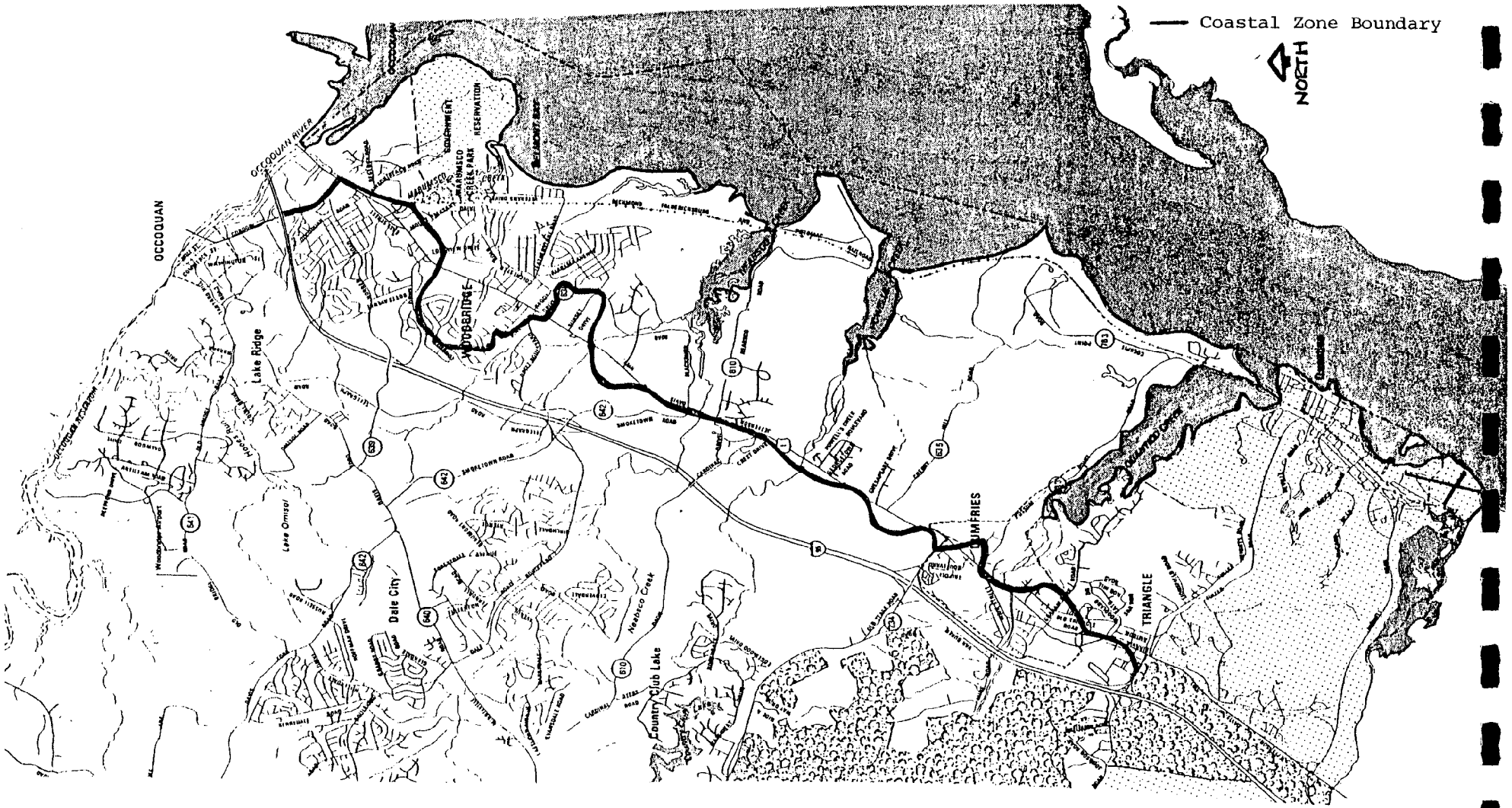
The confined characteristic of estuaries which makes them nutrient-rich also makes them especially vulnerable to pollution, since pollutants can be "trapped" in the estuary just as are nutrients. Therefore, development adjacent to estuarine waters requires special management. The State and Federal governments have recognized this need through the institution of coastal resources management programs designed to balance man's use of coastal areas with the unique needs of the fragile coastal ecosystem.

The Virginia Coastal Resources Management Program is designed to provide a cooperative State-local effort to manage coastal land and water resources. This management effort can be divided into two major approaches: 1) the protection of critical environmental areas; and 2) the control of development and uses of shorelands to minimize the adverse impacts of runoff on coastal waters.

Critical environmental areas in the Prince William County coastal zone include wetlands, tidal flats, nearshore shallows, bluffs, and beaches. Chapter III discusses the general location of these resources within the County's coastal zone. Wetlands and nearshore shallows are currently protected by permitting programs administered by local, State and Federal agencies. Tidal flats and beaches are protected only by Federal permitting programs. These programs are discussed further in Chapter IV.

Map 1

Prince William County Coastal Zone



Because of its direct drainage into coastal waters, land development adjoining the tidal streams and coastal waters in Prince William County has the potential to damage the marine environment unless carefully planned to minimize the polluting effects of runoff. Figures 1 and 2 illustrate the impacts of land development in coastal watersheds. The uncontrolled runoff of sediments, nutrients, bacteria and heavy metals can cause turbidity and depressed oxygen levels in the estuary, which in the past have resulted in periodic fish kills and the closure of shellfish grounds in the Upper Potomac. Typical pollutants and their impacts on water quality are summarized in Table 1. Such adverse impacts of land use on the estuarine environment can be reduced through proper land use planning and management techniques.

Chapter II of this guidebook outlines a series of land use planning and management guidelines and standards which, if implemented, can minimize the adverse impacts of man's activities on tidal waters. These guidelines and techniques are based on the most recent scientific, planning, and engineering information available. As our knowledge of coastal problems and solutions increases, this guidebook should be updated accordingly.

The greatest control over land use in the shorelands rests with local government, in cooperation with individual landowners. Many of the environmental guidelines and standards recommended herein are already in use in Prince William County, such as local erosion and sedimentation control. Others, such as the urban runoff controls, can be effectively incorporated into the existing structures of development planning and management in the County.

The most important goal of all those involved in the use of the County's coastal zone should be the consideration of coastal lands and waters as a single natural system. In order to understand the system and its important land/water interactions, existing natural and man-made resources of the coastal zone must be identified and analyzed. A generalized analysis for Prince William County's coastal zone is provided in Chapter III. Resources and development constraints of individual sites should be evaluated on a site-specific basis.

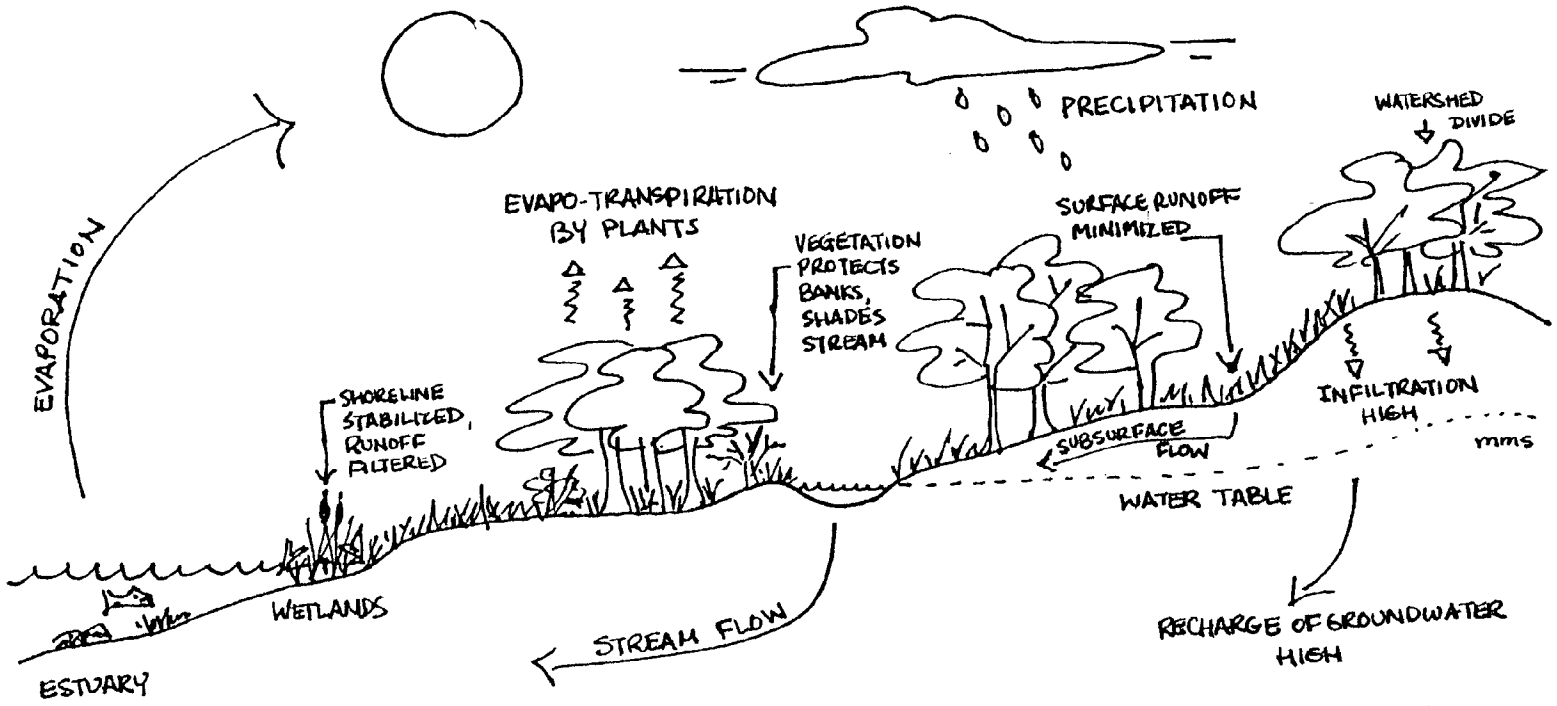


FIGURE 1. NATURAL COASTAL WATERSHED SYSTEM

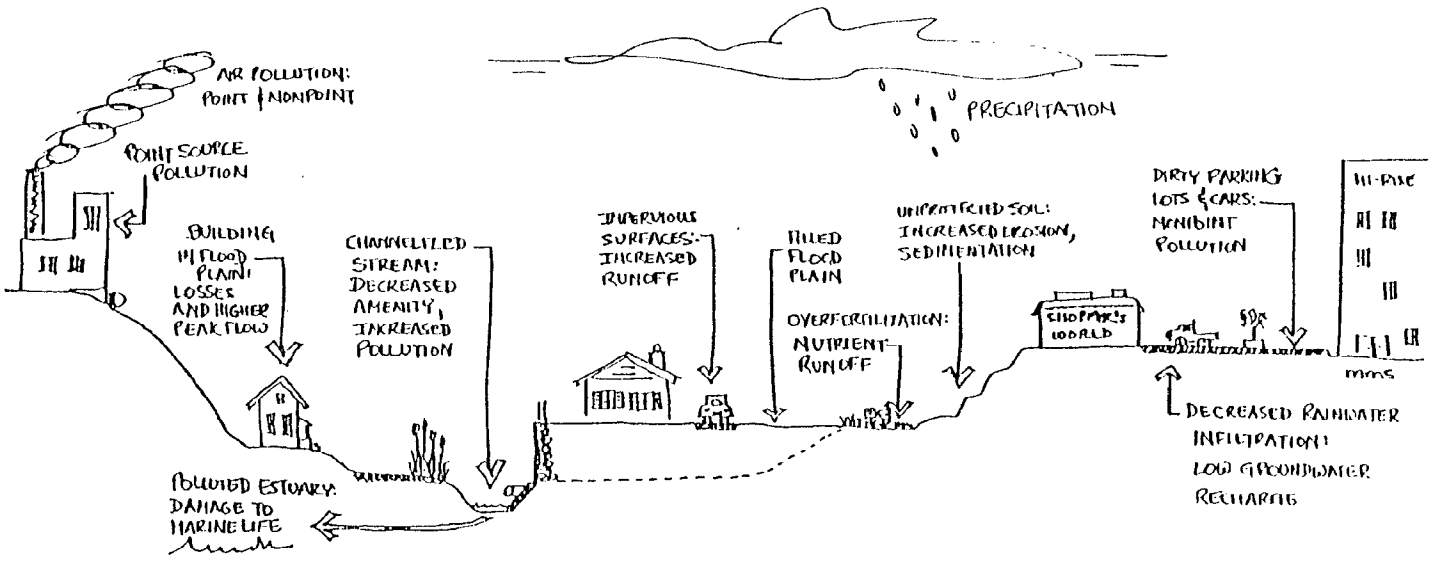


FIGURE 2. EFFECTS OF URBAN DEVELOPMENT ON COASTAL WATERSHEDS

Table 1.

SOME POLLUTANTS FOUND IN URBAN RUNOFF AND THEIR IMPACTS

SEDIMENT	In urban areas, excessive sediment comes primarily from construction activities and the erosion of stream channels after rainstorms. Soil erosion from construction sites can range from 5 to 100 tons/acre/year. This sediment can remain suspended in streams long after construction is completed. The sheer volume of sediment decreases flow capacity in drainageways, takes up storage volume in reservoirs, and covers aquatic plants and spawning areas essential for fish survival. Sediment particles may also have other pollutants attached to them, such as nutrients, pesticides or other oxygen demanding material.
NUTRIENTS	Nutrients found in urban runoff come from a variety of sources, and contaminate receiving waters in a number of ways. Nutrients in runoff originate from such varied sources as airborne pollutants, fertilizer wash-off from lawns, and decomposition of fallen leaves and other material. High concentrations of nitrogen and phosphorus can lead to excessive algae growth in receiving waters. As these organisms die off and decay, depletion of dissolved oxygen and subsequent fish kills can result.
BACTERIA	Significant bacteria levels as measured by fecal coliform are found in urban runoff. At the present time their origin is not completely understood. Major source are thought to be animal and bird droppings, sewer leakage and septic tank overflows. Contamination of this sort presents a potential health hazard for water contact recreation and water supply operations unless purification steps are taken.
TOXIC SUBSTANCES	A variety of toxic substances, including pesticides and heavy metals such as lead, zinc, manganese and cadmium, are often found in urban runoff. The origins of such materials are not well understood. However, there does seem to be some correlation with impervious areas subject to large amounts of vehicular traffic such as large shopping mall parking lots and heavily traveled highways. High concentrations of these toxic materials can result in fish kills.
OXYGEN-DEMANDING SUBSTANCES	Organic matter requires oxygen to decompose. Excessive amounts of decomposing matter results in oxygen depletion in receiving waters. In extreme cases discoloration, gas formation and odors may result. These conditions can be caused by excessive nutrients in runoff, septic tank discharges and sewer overflows carried to receiving streams.
PETROLEUM SUBSTANCES	Petroleum substances, particularly gasoline, oil and grease, are found in urban storm runoff. These substances wash off roads, highways and parking lots. They destroy aquatic organisms by adhering to them or by coating the habitat of the organisms and cutting off the supply of oxygen. Excessive amounts of these substances also detract from the aesthetic quality of receiving waters.
CHLORIDES	Chlorides are also assumed to be present in area storm runoff during seasonal periods. They originate in substances used to melt snow and ice on area roadways. Application of these materials in excessive amounts can kill aquatic organisms and increase oxygen demands on receiving waters.

SOURCE: Metropolitan Washington Council of Governments, Water Resources Planning Board, "The Water Monitor", Vol. III, No. 1, February 1979.

CHAPTER II

LAND USE PLANNING & MANAGEMENT GUIDELINES

Introduction

The planning and management of coastal resources can be aided by the classification of coastal areas into three broad use categories based on development suitability:

- Preservation areas: These include critical environmental areas, such as wetlands, beaches, and bluffs, which constitute highly productive unique, fragile or vulnerable natural habitats or areas of particular scenic or historical importance. It is recommended that these areas be preserved without development and protected from degradation due to direct use or to external sources.

- Conservation areas: These are defined as areas marginally suitable for development which possess important, but noncritical ecological significance. These areas, which include drainageways, floodplains, hillsides, and woodlands, usually serve as a buffer between preservation and development areas. Development in these areas, because of erosion, flooding and/or drainage problems, poses potential hazards to public health and safety and may require periodic outlays of public and private funds for erosion and/or flood prevention and reparation. For these reasons, development should be carefully controlled in these areas.

- Development areas: These are the remaining areas which are comparatively suitable for development and which possess less important ecological, recreational, and historical values than the previous two categories. A variety of land use activities may be appropriate in these areas, depending on site-specific conditions. Special precautions are suggested, however, to minimize the impacts of development on the sedimentation and pollution of the estuary.

This type of approach to coastal resources management has been taken by localities in the North Carolina (24) and Florida (12) coastal programs, among others, and is a widely recognized environmental planning tool.

The land use planning and management guidelines discussed below are designed to assist those involved in coastal land use decisions in effecting a balance between the many competing uses of this significant area of Prince William County. These guidelines are grouped by resource type into the three categories outlined above. A land use planning and management approach which draws on a combination of guidelines from all three categories will result in the most comprehensive, ecologically sound, and cost effective coastal resources management program for the County.

Preservation Areas

1. Wetlands and Bottomlands.

Background. Three interrelated wetland systems, are found along the Prince William County shoreline: nearshore shallows or bottomlands, tidal flats, and vegetated wetlands.

The shallow bottomlands, which are located below the low tide limit, are vegetated by aquatic perennials and bethic algae and are vital to fish and shellfish as spawning, nursery and feeding grounds. Uses of these bottomlands are controlled by the State through a permitting system administered by the Virginia Marine Resources Commission (Code of Virginia, 62.1-3).

From the low tide limits to near sea level are found tidal flats, also referred to as nonvegetated wetlands. While appearing to be lifeless, these flats are among the most valuable of coastal habitats. Nonvegetated wetlands or flats are important nursery and feeding grounds for fishes and shellfish, providing abundant food and shallow water refuge from predators for sensitive juvenile fishes, shedding blue crab, etc. Primary productivity is high due to the abundant supply of light and the year-round productivity of the nonvascular plants, i.e., bottom-dwelling algae and phytoplankton, found in these intertidal areas. In addition, relatively high levels of nutrient storage and cycling occur in the intertidal zone, since it is particularly conducive to direct exchanges among water, sediments, the atmosphere and aquatic life. Tidal flats constitute the primary feeding grounds of shorebirds and many waterfowl, making them prime areas of interest for birdwatchers. Finally, nonvegetated wetlands provide some degree of erosion protection to the shoreline and adjacent vegetated wetlands (29).

Above the tidal flats are found vegetated wetlands or marshlands which produce the organic matter basic to the important estuarine food web. Marshes provide food and/or habitat at some stage in the life cycle of 90-95% of Virginia's commercial and sport fishes, as well as waterfowl and various wildlife species such as raccoon, muskrat and otter (36). Wetlands also provide water quality protection to the estuary. Wetland vegetation changes inorganic nutrients in runoff into organic material, stored in their leaves and in their remains, which are trapped by the marsh root system to form peat. Wetlands also reduce the speed of runoff and streamflow, allowing sediment to settle out before reaching the estuary. In addition, wetlands provide flood and erosion protection to adjacent dry land areas, referred to as fastlands. One acre of marsh can absorb or hold 300,000 gallons of water (30). This water retention capability enhances the stability of the coastal water system by retaining water in dry periods and holding it

back during floods. Wetland vegetation also serves as a buffer that protects the shoreline from the eroding forces of tides and storms.

Because of these important public benefits and their sensitivity to alteration by man, tidal wetlands in Virginia are protected and managed through the 1972 Virginia Wetlands Law (Virginia Code, 62.1), administered by the Virginia Marine Resources Commission and local wetlands boards. The Virginia Code defines wetlands as "all land lying between and contiguous to mean low water and an elevation above mean low water equal to the factor 1.5 times the mean tide range. . ." and upon which grow specific kinds of vegetation (Virginia Code, 62.1-13.2(f)). For management purposes, the Virginia Institute of Marine Science (VIMS) has classified Virginia's wetlands by type and grouped them into five classifications according to the estimated total environmental value of an acre of each type.

Of the twelve types of wetlands in Virginia, only four are found in Prince William County: Types VI, VII, IX and XI. These comprise approximately 900 acres of wetlands. Three acres, or less than 1% of the County's wetlands are classified as Type VI. Type VII comprises 31 acres or 3%. The 54 acres of Type IX make up another 6%, leaving the remaining 812 acres, or 90%, as Type XI wetland. Further information about these wetland types is provided in the wetland summaries in Figure 3.

Types VII and XI which constitute 843 acres, or 93% of Prince William County wetlands, are in Group One, the highest of the five wetlands evaluation groups established by VIMS. According to VIMS, Group One marshes have the highest values in productivity and wildfowl/wildlife utility and are closely associated with fish spawning and nursery areas. They are also given high values as erosion inhibitors, are important to the shellfish industry, and are valued as natural shoreline stabilizers. VIMS recommends that Group One marshes be preserved.

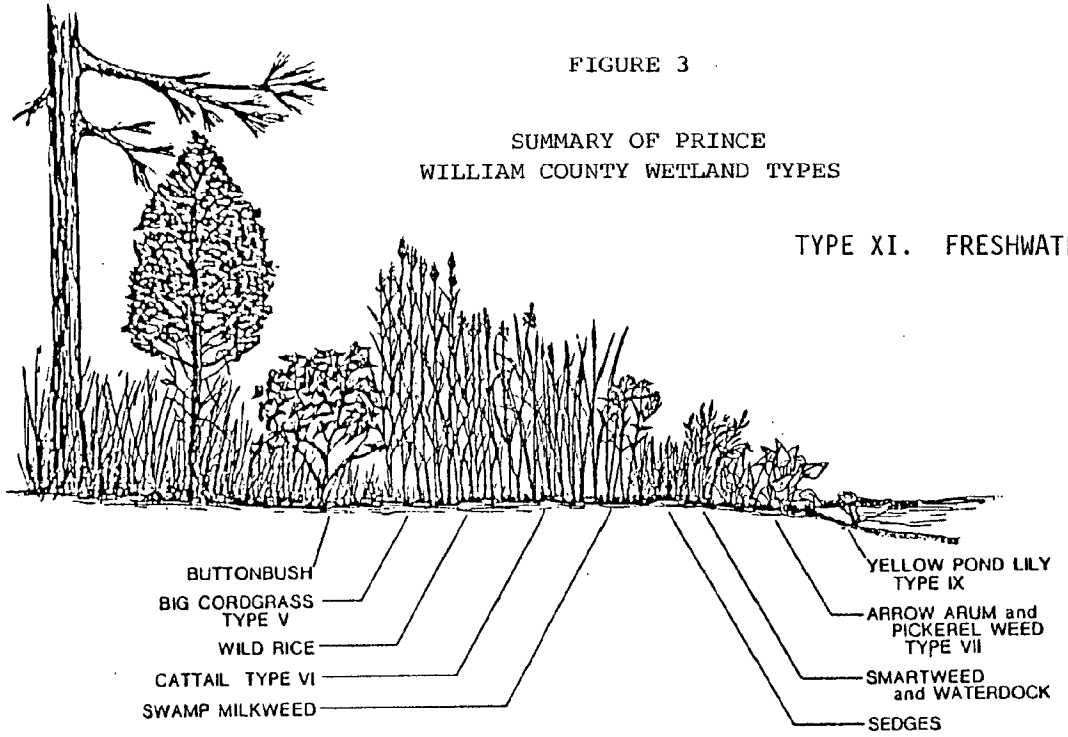
The Type VI marshland, which has been assigned a Group Two classification, is of only slightly lesser value than Group One marshes. VIMS cites the lower ranking of Group Two marshes as being due to a less readily available source of nutrients for the marine environment, since the higher elevations of these marshes result in less tidal action to flush nutrient-rich detritus into adjacent waterways. Group Two marshes are assigned very high values in water quality and coastal flood protection. VIMS recommends that these marshes also be preserved, although it would be better to alter Group Two marshes than Group One marshes.

The final marsh type found in the County, Type IX, which constitutes only 6% of the County's wetlands, is classified in the Group Three category. The yellow pond lily marsh is not considered to be a significant contribution to the food web, but it does have high

FIGURE 3

SUMMARY OF PRINCE
WILLIAM COUNTY WETLAND TYPES

TYPE XI. FRESHWATER MIXED COMMUNITY



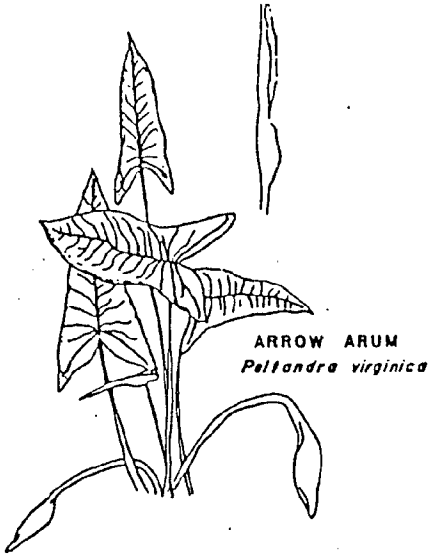
Dominant vegetation:	No single species covers more than 50% of the site.
Associated vegetation:	Bulrushes, sedges, waterdock, smartweeds, ferns, pickeral weed, arrow arum, wildrice, beggar's ticks, rice cutgrass.
Growth habit:	Heterogeneous mixutre of plants.
Physiographic position:	From submerged to the upper limits of the wetlands.
Average density:	Highly variable.
Annual production and detritus availability:	3 to 5 tons per acre. Ditritus of species such as arrow arum, pickerel weed and yellow pond lily would be available in the intertidal zone.
Waterfowl and wildlife utility:	A highly valuable marsh for a broad diversity in wildlife species. Plant species such as smartweeds, waterdock, wildrice and others are prime waterfowl and sora rail foods. Waters adjacent to these type marshes are also known as spawning & nursery grounds for striped bass, shad and river herring.
Potential erosion buffer:	Shoreline erosion protection provided by this type of marsh is equivalent to type VII, arrow arum - pickerel weed community.

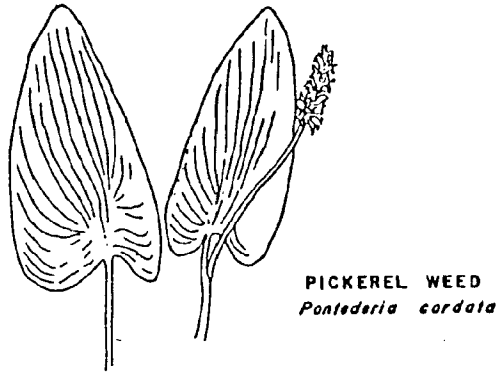
FIGURE 3 (continued)

Water quality control:	This ranks somewhat higher as a sediment trap and flood deterrent than an arrow arum - pickerel weed community. The presence of the stiffer, more resilient grasses, sedges and rushes and peaty substratum increases the ability of this type of community over a Type VII marsh as an assimilator of sediments and flood waters.
SUMMARY:	These are very valuable marshes and the aim should be to keep them in a natural state. This type of marsh would be ranked equivalent to a saltmarsh cordgrass marsh (Type I) and an arrow arum-pickerel weed (Type VII) marsh.

FIGURE 3 (continued)

TYPE VII. ARROW ARUM - PICKEREL WEED COMMUNITY

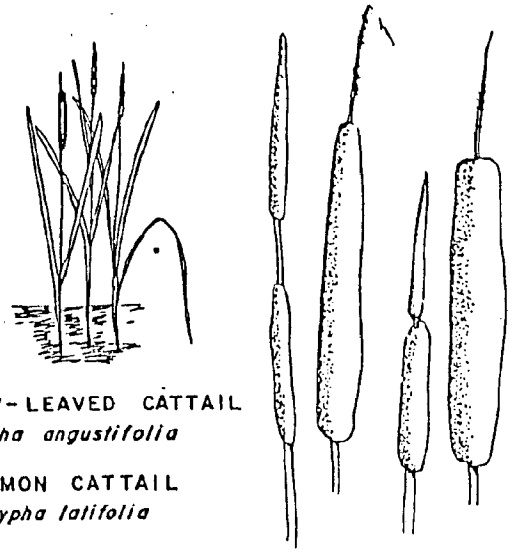




Dominant vegetation:	Arrow arum (Peltandra virginica (L.) Kunth.) Pickerel week (Pontederia cordata L.)
Associated vegetation:	Sedges, smartweeds, bulrushes, ferns, cattails, pond lily.
Growth habit:	Many broad leaved clumps growing from a thick, cylindrical rhizome; arrow or heart shaped leaves. Clumps 2 to 6 feet tall, average height 3 feet.
Physiographic position:	On tidal mud flats from mean sea level to about mean high tide in low salinity or freshwater marshes.
Average density:	1 or 2 clumps per 10 square feet.
Annual production and detritus availability:	2 to 4 tons per acre. Detritus readily available to the marine food web because of daily tide fluxes. In the fall of the year these species decompose quite rapidly and completely except for the root stock.
Waterfowl and wildlife	Seeds and shoots of both species are eaten by ducks. Arrow arum seeds float after the pod decays and are readily available for wood ducks. Often associated with confirmed spawning and nursery areas for herring and shad.
Potential erosion buffer:	Although this community type lacks the vast network of rhizomes, roots and peat substratum typical of a saltmarsh cordgrass community, this marsh/water interface vegetation is often the only vegetative buffer to shoreline erosion in freshwater areas. The substratum in a marsh such as this is typically soft, unstable mud. After the vegetation has decayed in the winter time, the mud flats are highly susceptible to erosion due to winter rains.

FIGURE 3 (continued)

Water quality control and flood buffer:	Slows the flow of flood waters, causing some suspended sediment to settle out.
SUMMARY:	Under natural conditions, the marsh of this type is relatively stable but it is highly sensitive to development and activities such as excessive boat traffic. Because of its many attributes, this marsh ranks similar to that of Type I.



NARROW-LEAVED CATTAIL
Typha angustifolia

COMMON CATTAIL
Typha latifolia

FIGURE 3 (continued)

TYPE VI. CATTAIL COMMUNITY

Dominant vegetation:	Narrowleaf cattail (Typha angustifolia L.)
Associated vegetation:	Broadleaf cattail (Typha latifolia L.), sedges, bulrushes, arrow arum, pickerel weed, smartweed, other fresh or brackish water plants.
Growth habit:	Characteristic "wiener on a stick" fruiting heads, long straplike leaves, somewhat blunted tips, 4 to 6 feet tall.
Phsiographic position:	Very wet sites, sometimes in standing water, often at the margin of marsh and uplands. Does well in seepage areas resulting from upland runoff.
Average density:	2 to 6 stalks per square foot.
Annual production and	2 to 4 tons per acre. Detritus usually not readily accessible to the marine environment.
Waterfowl and wildlife utility:	Provides habitat for certain birds; roots consumed by muskrats.
Potential erosion buffer:	Because of its preferred habitat and its characteristic shallow root system, Type VI is only a minor buffer to erosion.
Water quality control and flood buffer:	Its usual habitat along the upland margins in soft muddy areas ranks this marsh type high as a sediment trap despite its shallow rooted condition. Very few species will grow in these areas either because of the stagnant condition of the substratum or because they are inhibited by toxin release of the cattail roots or a combination of the two factors.
SUMMARY:	Because of its value as a wildlife food and habitat, its function as a sediment trap, its relatively high production and the usual soft substratum, this type of marsh community should not be indiscriminately used as a development site. As far as overall value is concerned it compares with a salt meadow marsh (Type II).

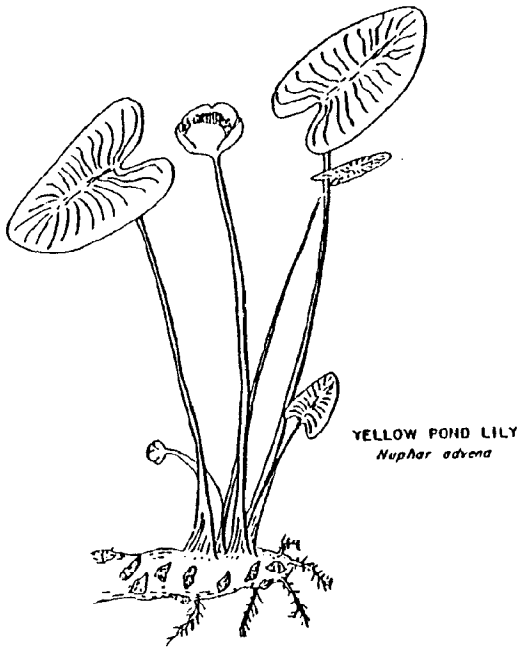


FIGURE 3 (continued)

TYPE IX. YELLOW POND LILY COMMUNITY

Dominant vegetation:	Yellow pond lily, spatter-dock (Nuphar luteum (L. Sibthrop and Smith
Associated vegetation:	Pickerel weed, arrow arum.
Growth habit:	Saucer shaped leaves with a narrow notch, floating on water; large, leathery yellow flower. 2 to 4 feet high from submerged root stalk.
Physiographic position:	Submerged except for floating leaves at high tide. Found in freshwater areas.
Average density:	One plant (cluster of leaves) for every 3 to 5 square feet.
Annual production and detritus availability:	½ to 1 ton per acre; detritus readily available but not a significant contributor to the food chain.
Waterfowl utility:	Excellent cover and attachment site for aquatic animals and algae. Feeding territory for aquatic birds and fish.
Potential erosion buffer:	While lacking the stiffness of grasses and sedges, these plants do reduce wave action from wind and boats. This has been noted in freshwater streams and boat channels.
Water quality control and flood buffer:	Although not a direct assimilator of sediments and flood waters, the flow of flood water is slowed somewhat and sediments can settle out. This function is minimal because the community is submerged completely in flood conditions.
SUMMARY:	Destruction of the community would result in a decrease in number and diversity of aquatic animal life in the immediate area. The greatest value the community has is its habitat for aquatic biota. This type should be ranked with or slightly higher than a Type III (black needlerush) marsh.

values for wildlife and waterfowl. The Group Three marsh is thus of less total value than Group One and Two marshes, and, if altered, would cause less total harm to the estuary than altering the wetlands assigned to the two preceding groups.

VIMS also suggests two general guidelines which can be used along with the wetlands evaluation system to make decisions on wetlands use:

1. Any marsh 2 feet or more in average width is considered to have significant values as an erosion deterrent and a sediment trap; and

2. Depending on marsh type and viability, any marsh greater than 0.1 acre may have significant values in terms of productivity, detritus availability, and wildlife habitat. Depending on its location, it may also have value as an erosion buffer (36).

In Prince William County, the local Wetlands Board is responsible for granting or denying permits for activities in wetlands (See Chapter IV for further information on the Board and its duties).

Man's activities in wetlands and bottomlands threaten the health and, in some cases, the continued existence of these areas. Dredging or filling activities may cause direct alteration of wetlands and bottomlands in the immediate vicinity, as well as indirect alterations to areas removed from the activity by changing current, sediment deposition, and erosion patterns. Dredging in these areas reduces primary productivity, eliminates fish and wildlife feeding grounds, and deposits sediments which may deplete the available oxygen supply. Filling of these areas effectively removes them from the aquatic system.

Construction of bulkheads, groins, breakwaters, docks and piers may cause particular harm to nonvegetated wetlands through scouring or sedimentation. Improperly designed bulkheads, for example, may result in erosion at the base of the bulkhead, altering the intertidal habitat (29).

Activities upstream from wetlands, which are outside the jurisdiction of the Wetlands Board, can also have an impact on the health of wetlands. Excess siltation or nutrient input from upland runoff can upset the wetlands system by altering water levels and dissolved oxygen concentrations. This problem is especially significant in embayed wetlands, such as those found at the mouths of the County's coastal streams, since flushing time is slower than in less confined wetlands. In addition, tidal wetlands can be harmed by either an increase or decrease in freshwater flow, which can be caused by increased runoff or the addition of upstream impoundments.

Guidelines. To assist local wetlands boards in executing their permitting responsibilities, the state has developed guidelines (17,36) for activities in and immediately adjacent to wetlands. Information on these guidelines can be obtained from the Prince William County Wetlands Board, which is discussed further in Chapter V. The following general guidelines may serve as a starting point for persons contemplating activities which may affect wetlands (6):

1. There should generally be no excavation in wetlands.
   Rationale: Excavation may disrupt the natural functions of wetlands by eliminating vegetation, disrupting natural water flows, destroying the marshy soil layers, and facilitating the drying out of wetlands. Excavation should be permitted only when required for essential public purposes (e.g., mosquito control, wildlife enhancement) and should be limited to a small percentage (10%) of the area.

2. There should generally be no land clearance, grading or removal of natural vegetation in wetlands.
   Rationale: Vegetation is the driving force of productivity in vegetated wetlands. Loss of vegetation will reduce productivity, resulting in a loss of nutrients to the estuarine system.

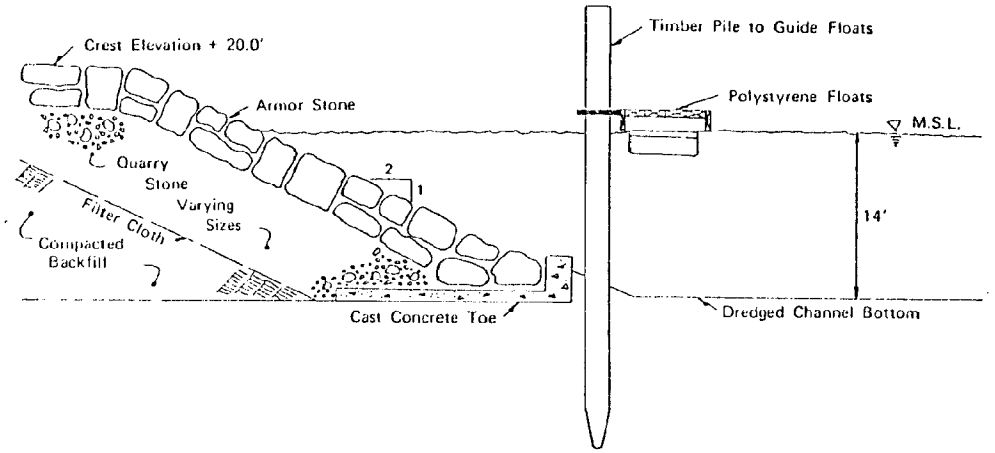
3. There should generally be no filling of wetlands.
   Rationale: The soil cover would eliminate the wetlands, change elevation, alter the water regime, and generally disrupt wetland functions.

4. There should generally be no solid-fill roads or other structures in wetlands.
   Rationale: Solid-fill obstructs water flow through wetlands, disrupting the delivery of freshwater and nutrients to the estuary and upsetting the salinity balance in the wetlands.

5. Shoreline defense structures (e.g., bulkheads), where necessary, should be built shoreward of wetlands, above the annual flood mark, and should be designed to be permeable to groundwater and runoff.
   Rationale: By definition, wetlands that should be undisturbed lie below this level. In addition, solid structures such as bulkheads that extend into water areas often adversely alter water circulation, increase scouring of the bottom, and preempt tidal marsh and tidal flat habitat areas. Permeable structures allow the free supply of fresh water and water-borne nutrients to wetlands and promote better drainage of the adjacent shorelands, so as to reduce erosion. Rock riprap (see Figure 4) is often the easiest and least costly shoreline protection measure and is both highly permeable and conducive to the

establishment of aquatic life. Another example is gabions, which are often used for lining stream channels. Gabions (5) are wire baskets, filled with rock and lined together to form a wall or channel lining.

FIGURE 4. TYPICAL ROCK RIPRAP STRUCTURE



6. As a rule, discharge or release of pollutants into wetlands should be minimized. Rationale: Although wetlands have a certain capacity to absorb and naturally treat nutrients and other pollutants from stormwater runoff (27), research has not established the capacity of each wetland type to assimilate these pollutants. Additions of nutrients to the tidal marshes of an estuary such as the Potomac, which is already rich in nutrients, may have a relatively minor impact, but this cannot be assured. Studies have shown that additions of organic nitrogen to estuaries and marshes significantly stimulates plant growth (34,35). Higher natural productivity means higher respiration rates in the water, decreasing oxygen concentration levels and possibly resulting in fish kills, particularly in summer months when oxygen concentration naturally drops very low at night (13). Research continues concerning the limits of acceptable estuarine nutrient pollution (27), but algal blooms and fish kills which have occurred in the Potomac make it apparent that such limits have already been exceeded on occasion in this region. In addition, the specific effects of excess nutrients may be obscured by toxic pollutants, which may diminish biological activity and reduce the diversity of life in the wetland and estuary systems(33). Therefore, it is advisable to minimize the introduction of pollutants into wetland systems, particularly sediment and toxic pollutants which may impair the natural nutrient treatment capacity of these areas.

Guidelines for activities upstream of wetlands are designed to regulate the two key natural processes that can threaten the health of wetlands: runoff and erosion. Adverse impacts on wetlands resulting from the acceleration of these processes due to man's activities can be controlled through both structural and nonstructural measures. An overall guideline to be followed for development in coastal watersheds is to maintain runoff and erosion levels at or near the natural level. Specific guidelines and standards which can be utilized to achieve this overall objective are discussed later in this report.

2. Bluffs

Background. Bluffs, which are areas of high elevation adjacent to the estuary, provide both environmental and aesthetic benefits to man. Similar to wetlands, bluffs protect inland areas from flooding. Bluffs also have high scenic potential because of the vistas afforded by their elevation. This often makes them desirable sites for residential development. However, bluffs are sensitive environmental areas because of their vulnerability to erosion.

The effects of erosion make bluffs dynamic natural features. Rainfall runoff, soil seepage, and tidal action all contribute to the erosion of bluffs and subsequent retreat of the shoreline. Man may contribute to this erosion through the action of boat wakes and by directing or augmenting runoff, although the impacts of the former are usually minor unless boat traffic is intense. Since bluff erosion is a natural process, guidelines pertaining to bluffs concern human safety more than they do the impact of man on the natural system.

Guidelines. The following guidelines are suggested for bluff preservation:

1. Control man's impact on bluff erosion by:

   a) Requiring slow or no wake zones in areas of high boat traffic adjacent to bluffs; and

   b) Encouraging the use of runoff controls on urban and agricultural land adjacent to bluffs (See Development Areas section below for recommended controls).

2. Minimize future losses of property due to highly eroding bluffs (i.e., rates of 1 foot per year or greater) by requiring a setback of structures beyond the thirty-year bluff recession line, or requiring movable structures or structural

protection for existing buildings within the 30-year setback zone; and

3. Minimize losses to existing property owners by encouraging a unified landowner approach to shoreline erosion control (See Chapter V for sources of technical assistance for shoreline stabilization).

Implementation. The first guideline, which deals with the control of boat traffic is not under local control. Implementation of this recommendation requires action by the State of Virginia and/or Maryland.

Implementation of guidelines 1(b) and 2, encouraging the use of runoff controls and regulating bluff development, can be accomplished at the local level through special local zoning and subdivision requirements. Such requirements for guideline 1(b) might take the form of runoff control techniques which are incorporated into a Public Facilities Manual. Fairfax County has taken this approach (11).

Implementation of the third guideline, which concerns shoreline erosion, can be accomplished through cooperative local, State, and federal efforts. Local agencies, such as the Planning Office and the Soil and Water Conservation District Office, can provide educational materials and technical assistance to landowners with shoreline erosion problems. These efforts should be accompanied by State or federal technical and financial assistance programs.

3. Beaches

Background. A beach is an unconsolidated, sloping area contiguous to the shore and composed of sand, gravel, or cobbles which results from wave and current action. Beaches in Prince William County occur next to bluffs or vegetated shorelines. Under normal conditions, the amount of sand or other material that makes up the beach is in careful balance with the current and tidal action of the Potomac River. Beaches act as dynamic shoreline protection structures, breaking the impact of waves and currents. Disruption of the natural balance of movement between beach and bottom materials through the construction of groins and jetties, etc., can accelerate shoreline erosion and result in the loss of beaches and subsequent erosion of fastlands. Beaches of good size and quality have long been valued for their recreation use.

Guidelines. The following guidelines are suggested for the identification and preservation of high quality beaches:

1. Beaches in Prince William County should be analyzed for their recreational potential, erosion control capabilities, and other values mentioned above.

Beach areas suitable for recreational access should be prioritized for possible public access acquisition.

2. Bulkheads, jetties, groins and other structural protection techniques should be avoided. Structures along the shoreline block the movement of sand and sediment materials necessary to replenish sand losses from storms. The beach may then become unstable and eventually disappear.

Implementation. In order to prevent the degradation or destruction of the high quality beaches, local acquisition of shoreland public access areas adjacent to such high quality beaches may be desirable at some point, particularly as Potomac River water quality improves to a level to allow public swimming. Coastal zone segment resource inventories that can help identify the location of County beach areas are presented in Chapter III.

State and federal shoreline permitting agencies should take the lead in promoting non-structural shoreline stabilization measures over structural measures to the greatest extent possible. Structural approaches, where necessary to protect private or public investments, should be coordinated with neighboring shoreline landowners. Local building inspectors can also work with shoreline landowners in developing the least ecologically damaging shoreline defense measures. A State-sponsored training program on shoreline protection would be very beneficial to building officials in coastal jurisdictions.

Conservation Areas

1. Hillsides

Background. Careful control of development on hillsides, defined here as areas with 8% slope or greater, is necessary to minimize the adverse impacts of ground disturbance, which include loss of slope and soil stability and accelerated erosion. Removal of vegetation from hillsides deprives the soil of the stabilizing effect of plant root systems and eliminates the water recycling benefits of plant transpiration. On slopes with no vegetation and exposed soils, new watercourses are readily formed, creating gullies which significantly increase the rate of erosion. Increasing the amount of paved surfaces on hillsides not only alters the natural drainage pattern, but also increases runoff and allows less precipitation to recharge groundwater resources. Such increased runoff and erosion contribute to sedimentation in downstream waterways, wetlands, embayments, and the Potomac estuary.

It has been demonstrated that erosion increases rapidly with the steepness of the slope. One study (9) indicates that the rate of erosion is proportional to the 1.35 power

of the slope. This means, for example, that the erosion from a 25% slope can be 12 times greater than from a 4% slope, and 5 times greater than from an 8% slope (9). Therefore, guidelines which have been developed for the wise use of hillsides are closely tied to variations in the steepness of the slope.

Guidelines. The regulation of hillside development is more sophisticated than in other critical environmental areas. Approaches to hillside regulations fall into three major categories (30): (1) slope-density provisions, which decrease allowable development densities as slope increases; (2) soil-overlay provisions, which assign use and density based on soil characteristics; and (3) the "guiding principles" approach, containing few specific standards, but rather specific policies to form the basis of individual project evaluations. Grading and erosion controls, discussed in the Development Areas Section below, are important supplements to any of these approaches.

Slope-density provisions are perhaps the most common form of hillside development regulation. Since most commercial and industrial land uses are not suited to hillsides due to the necessity for extensive grading and filling, these provisions focus on residential development. Such provisions generally take two forms: 1) requirements that certain percentages of a site remain in a natural state; or 2) limitations on the number of dwelling units allowed per acre. The severity of these restrictions varies among geographic areas, depending upon the range of slopes encountered.

Several examples of slope-density guidelines are provided in Reference (30). An example of the first approach to these guidelines, based on open space quotas, is summarized in Table 2.

An example of slope-density provisions based on lot size, developed by the Georgia Mountains Planning & Development Commission, are illustrated in Table 3. These provisions cover a very wide range of slopes, as might be expected in a mountainous region. Although the severe slopes at the upper range of Table 3 are unlikely to be encountered in the Prince William coastal zone, it indicates the full spectrum of considerations necessary in hillside regulation. The final column of Table 3 also gives maximum allowable land clearance. This thus represents a combination of the two types of slope-density guidelines. The full text of the Georgia Mountains PDC slope regulations is provided in Appendix II.

The second major approach to hillside regulation, the soil-overlay approach, is recommended for use in Prince William County. The availability of a complete soil survey for the County provides a rational basis for the development of regulations that reflect the varying sensitivities of sloped lands to erosion, runoff, and mass movement. This makes the regulations more easily understandable to developers and landowners, and

Table 2

Maximum Land Clearance Slope Guidelines

Slope	% of Land Left in Natural State
10 - 15%	25
25 - 20%	40
20 - 25%	55
25 - 30%	70
30%+	85

SOURCE: Reference (3).

Table 3

Minimum Lot Size Slope Guidelines

Topography, Slope Average	Minimum Area, (sq.ft.)	Minimum Average Width (ft.)	Minimum Average Depth (ft.)	Ground Surface to Remain in its Natural State (no cut or fill)
0-12%	15,000	60	90	50%
10-15%	18,000	80	100	60%
15-20%	22,000	80	110	65%
20-25%	28,000	100	120	70%
25-30%	35,000	100	150	75%
30-35%	44,000	120	175	80%
35-40%	54,000	150	200	85%
40-50%	65,000	175	250	95%
50-70%	85,000	200	300	95%
70-100%	Not less than five(5) acres.			95%
Over 100%	No lot development permitted.			100%

SOURCE: Reference (33).

therefore easier to administer by the local planning office. In addition, soil overlay provisions apply to the entire planning area, not just the hillsides, resulting in a more comprehensive approach to environmental management.

This approach relies on soil overlay maps, which represent soil groupings based on development suitability. For example, McHenry County, Illinois, has "Soil Overlay Regulations" which are added to the requirements of the existing zoning categories (30). A "Steep Soils Overlay District" has been established for areas with problem soil types and slopes greater than 12 percent. Other localities which have adopted a similar approach include Mine Hill, New Jersey, and Orange County, New York (30). An initial application of such an approach to the soils in Prince William County's coastal zone is provided on page 39 in the Development Areas section. This approach groups the County's coastal soils into four broad development suitability zones: unsuitable, low density/conservation, medium density, and high/low density. The low density/conservation zone roughly corresponds to the "Steep Soils Overlay District" of McHenry County, Illinois.

Implementation. Soil overlay zones are not meant to establish strict management boundaries, but to identify similar management areas which can provide guidance for individual land use decisions in the coastal zone. While the zoning ordinance provides a mechanism for local governments to implement such overlay districts, a more detailed analysis of soil and slope conditions would be necessary in order to establish accurate boundaries for each zone. Minimum lot size, grading and clearance restrictions, and other appropriate development requirements for each overlay zone could then be incorporated into the zoning ordinance.

2. Waterways

Background. Surface water drainageways, as integral parts of the hydrologic cycle, provide many public benefits in their natural state, including the transport of overland flow from upland areas for groundwater recharge and reservoir replenishment and the support of fish, waterfowl, and other wildlife. Development in upstream areas can result in increased runoff, accelerating the rate of stream flow, which may result in streambank erosion and a loss of shading vegetation. This not only increases the sediment load to the downstream receiving body, such as the estuary or wetlands, but increases water temperatures. Heated runoff from impervious surfaces further elevates water temperatures, which may have adverse effects on aquatic life sensitive to temperature changes.

Development also results in increased stormwater runoff, causing sedimentation and be minimized through urban stormwater and nonpoint pollution management programs, discussed in the Development Areas section of this report.

Guidelines. Several additional approaches to stream protection are outlined here. These approaches are designed not only to protect waterways from the adverse impacts of development mentioned above, but also to address the flooding impacts of streams on adjacent development areas. Typical stream protection regulations instituted by local governments provide for the establishment of a buffer zone along watercourses, usually extending 50 to 150 feet on either side of the stream, within which development and land disturbing activities are strictly limited. The buffer zone may be a fixed distance from mid-stream, or may "float" according to the character of adjacent areas. The former approach is easier to implement and administer, while the latter allows the inclusion of adjacent sensitive environmental areas, such as wetlands and steep slopes.

The following example of a fixed buffer, which would prohibit tree cutting, grading, filling, and construction in the following buffer areas, has been recommended by the Southeastern Wisconsin Regional Planning Commission (28):

Water Body	Buffer Width
lakes over 50 acres	300 feet
lakes 50 acres and less	200 feet
navigable streams	100 feet
all other streams	50 feet

Other criteria which have been suggested for stream buffers, based on open space considerations, include:

1. Preserve between 200 feet (18) and 300 feet (16) on either side of all watercourses. A 200 foot buffer provides about 24 acres of recreation area per mile of stream corridor (2).

2. Preserve a 150-foot buffer on each side of a stream and, for major streams, plan development of a 4000-foot wide corridor (1).

3. Require developers to preserve and/or donate 10% of their gross acreage to open space use, preferably in flood plain and shoreline areas (32).

A more scientific approach to stream buffer zones is based on sediment control considerations. From a sediment control standpoint, particularly during construction activities, a buffer zone acts as a backup measure to such traditional sediment control measures as detention basins and burlap fences. The State of Virginia and most of its localities have not yet taken this approach. For example, stream protection measures in

the Northern Virginia region concentrate instead on structural control measures such as stream bank stabilization with rock riprap or vegetation.

Buffer zone requirements, where they exist in other States (e.g., North Carolina), are usually based on limiting visible siltation to the first 25% of the buffer zone. This type of regulation has been shown to be difficult to implement, because of the difficulty in estimating ahead of time the width of buffer zone necessary to limit visible siltation to the performance standard (9). The City of Raleigh, North Carolina, therefore, has adopted the following formula for buffer zone width calculations (25):

$$W = 1.7K(LS)ML$$

where W = necessary width of buffer zone;
K = erodibility factor of the soils;
LS = soil loss factor based on the length and degree of the slopes;
M = an adjustment factor for the month of the year; and
L = length of the slope.

Experience with the formula has reportedly been satisfactory, with the normal range of the buffer zone width from 5 to 75 feet (9). The narrowest buffer zones occur in areas with gentle slopes and fairly stable soils. These narrow buffers, while perhaps accomplishing sediment control, do not contribute significantly to other stream valley protection objectives, such as the preservation of open space and wildlife habitat. A comprehensive stream protection policy would combine these approaches by establishing a minimum buffer width for open space concerns and applying the formula on an individual project basis to determine the desirability of expanding the buffer beyond this minimum.

The advantage of setting up a buffer zone, whether fixed, floating, or a combination thereof, is that it establishes a special management area, within which permitted uses and alterations may be identified by local government. Permitted uses typically include recreation, conservation, and non-tillage agricultural operations. Alterations that are restricted include dredging, filling and dumping in or adjacent to streams. An example of regulated uses for stream protection from Napa County, California include (30):

(1) Depositing or removing any material within a watercourse;
(2) Excavating within a watercourse;
(3) Planting or removing any vegetation within a watercourse;
(4) Constructing, altering or removing any structure within, upon, or across a watercourse; and
(5) Altering any embankment within a watercourse.

Implementation. Stream protection ordinances have been enacted in localities in several states which incorporate a buffer zone within which restrictions are applied to

most uses and alterations. Special use permits are required for uses and alterations in the buffer zone.

Private septic tank systems are currently prohibited by the State Health Department within 50 feet of waterways or water bodies. However, local health officials and scientific studies acknowledge, that although 50 feet is generally sufficient to achieve necessary reductions in coliform bacteria, it is probably not wide enough to remove nutrients, particularly nitrates. A 100-150 foot buffer is the suggested minimum for removal of nutrients, and a 300-foot zone is advisable (30).

3. Woodlands

Background. The many public benefits of woodlands makes them appropriate areas for conservation or careful development. These benefits include: wildlife habitat, soil stabilization, runoff moderation, noise buffer, absorption of certain air pollutants, and microclimate moderation. Mature forests in Virginia take 50 years to develop. Rapid, severe and widespread disturbance by man of woodlands can alter erosion rates, soil composition, and plant and animal diversity. Near heavily urbanized areas the unavailability of seed from scattered trees may impair the restoration of severely disturbed forests. Preserving stands of trees for natural reseeding is therefore an overall guideline to be followed in heavily developing areas.

The removal of forest vegetation has been shown to dramatically increase the runoff of nutrients to streams (5). Undisturbed forests efficiently retain and recycle nutrients from rainfall through transpiration and soil uptake. A 1967 study (4) by Bormann and Likens found that undisturbed forestlands lose only 7.2 lbs per acre per year of calcium (and equally small amounts of other nutrients), while devegetated watersheds experienced 3- to 15-fold increases in the loss of mineral nutrients.

Large tree species have traditionally been valued for their shading ability and the commercial value of their wood products, but ecological studies also show that understory trees, such as dogwood, play an important role in nutrient cycling, by acting as nutrient "pumps" which counter the downward movement of nutrients in soil to keep them in circulation between microorganisms and the active upper layers of litter and soil (22). In addition to the wildlife values of a diverse woodland, this factor is important in the selection of a woodland conservation strategy.

Guidelines. Guidelines for the use and management of woodlands should be based on

the ecological functions of woodlands. Guidelines for the removal or retention of trees with respect to tree function involve (30):

1. The condition of the woodlands: disease, decay.
2. The necessity to remove trees to construct public facilities and utilities.
3. Topography and susceptibility of soils to erosion.
4. Amount of existing woodland in the neighborhood.
5. The presence of "landmark" trees whose preservation is desirable and will not unreasonably interfere with the property's use.

The Fairfax County tree preservation ordinance provides a guide for the selection of trees to be retained by developers, which is shown in Table 4. This tree selection guide incorporates some ecological considerations. A comprehensive tree selection chart is included which indicates the characteristics of various species found in Northern Virginia.

Implementation. A tree preservation ordinance, such as the one enforced in Fairfax County, is the most common implementation mechanism for woodland protection. Many of these ordinances are based on a somewhat arbitrary preservation standard of saving a certain number of trees per acre. Similar to wetlands, woodland types vary in value and in sensitivity to disturbance by man. For this reason, the environmental performance approach discussed above, which is based on ecological functions, is recommended. Such an approach may take the form of an ordinance requiring a special permit, certain requirements in PUD ordinances, or a special provision of the subdivision ordinance.

4. Wildlife

Background. The extent and quality of habitat is the primary determinant of wildlife populations. The major habitat components are food, cover, and water, which must all be present within a species' daily cruising radius. Some species, such as the cottontail rabbit, may have a cruising radius of only one or two acres, while others, like quail, range over an area of 20-40 acres (3).

The quality of habitat depends largely on the nature and distribution of vegetation, which is controlled by land use practices. Thus, man's primary impact on wildlife is not through hunting, trapping and fishing, but through modification of vegetation. Man's land use activities can either improve or degrade the quality of wildlife habitat.

Urban sprawl reduces wildlife range. Continued highway construction results in increasing tolls of both large and small wildlife species. The contamination of water-courses by human and industrial wastes and nonpoint pollution adversely affects fish and

Table 4

Excerpt from: Fairfax County 1978 Public Facilities Manual, Vol. 3: Tree Preservation and Planting, Chapter 3-1

Preservation of trees in areas to be disturbed

Guide for selection of trees to be retained

1. Proposed development - Consider the mature height and spread of the trees to insure they will not interfere with proposed structures and overhead utilities. Consider the root development characteristics to insure they will not cause interference with walls, walks, drives, patios, and other paved surfaces or affect water and sewer lines, septic systems, or underground drainage systems.

2. High use areas - Consider the proposed use of the developed area. Select trees which exhibit a tolerance to air pollution if a large amount of air pollution will be present (see Tree Selection Chart). Select trees which are suitable for buffering or screening if noise or objectionable views are going to be a problem. (Evergreens provide better buffering and screening than deciduous trees.) Select trees which can tolerate de-icing salts if there is a chance these will be used. (See Tree Selection Chart).

3. Landfills - Consider the proximity to landfills. Gases generated can travel underground for a considerable distance to kill trees.

4. Life span - Preference should be given to trees with long life span.

5. Resistance to disease and insects - Trees that are known to be resistant to attacks by disease or insects should be given preference to those known to be susceptible.

6. Esthetic value - Consideration should be given to flowering habits, autumn foliage, bark and crown characteristics, and type of fruit.

7. Wildlife value - Leave trees which provide a good source of food, cover and nesting sites for wildlife. Example: Oaks, Hickories, and Dogwoods have a high food value.

8. Tolerance to sudden exposure - Consider the tolerance of the trees to the new environmental conditions such as increased direct sunlight, increased radiant heat from proposed buildings and pavement, and increased wind. Trees with a strong tap or fibruous root system should be given priority over those with a weak root system. (See Tree Selection Chart).

9. Appearance - Trees with a well-developed crown should generally be given preference over those with misshapen crowns or trunks, those with a small crown at the top of a tall trunk or those with narrow, V-shaped crotches. Those trees which are open grown usually possess better form than those which are grown in the woods.

Table 4 (continued)

10. Water table - Consideration should be given to the effect of grading on the water table and its accompanying effect on trees retained. Grades that are lowered will cause the water table to drop which will reduce the ground water available to the trees.

11. Grading - Consideration must be given to the proximity of proposed grading to the trees retained. Grading shall not take place within the drip line of these trees unless approved by the Director.

12. Outstanding specimens - Trees of impressive size or shape, of historical significance, or rare species should be preserved if possible.

13. Other trees - Consideration should be given to other trees growing in the immediate area. Example: Virginia Pine, which would not be of particular value if growing with hardwoods, would increase in value if this were the only tree species present on the site; trees standing alone are of higher value than those in a wooded situation.

14. Comfort - Consider the location of the trees to be retained in relation to the planned use of the site. Trees provide relief from summer heat and strong winds.

Table 4 (continued)

TREE SELECTION CHART

Botanical Name/Common Name	Moisture Requirements	Withstand Dry or Poor Sterile Soil	Type or Root System	Tolerance to De-Icing Salts	Sensitivity to Air Pollution: SO_2	O_3	Fl	NO_x	VDH & T Approved Street Trees
Abies concolor/White Fir	M	X	I		S	I			
Acer ginnala/Amur Maple	M	X	S		T	I			T
Acer platanoides/Norway Maple	M		S	T	T	T	I	S	T*,
Acer pseudoplatanus/Sycamore Maple	DM		I	T	T				
Acer rubrum/Red Maple	MW		S	S	S	T			C*,
Acer saccharinum/Silver Maple	MW		S	S	T	S	I		
Acer saccharum/Sugar Maple	M		S	I	T	T			
Aesculus hippocastanum/Horsechestnut	M		I	T		*			
Amelanchier canadensis/Serviceberry	M		S	T	S		I		T
Betula nigra/River Birch	W		S		S				
Betula pendula/European White Birch	MW	X	S	I	S	T	I		
Betula populifolia/Gray Birch	D	X	I	I	S				
Carpinus caroliniana/American Hornbeam	DM		S	S	T				
Carya species/Hickory sp.	DM		D	I	S				
Catalpa species/Catalpa sp.	M			I	S	S	I		
Celtis occidentalis/Hackberry	DW	X	D	T		*			
Cercis canadensis/Redbud	M		S	I	S	S			T
Cornus florida/Flowering Dogwood	M		S		T	T	T		T
Crataegus phaenopyrum/ Washington Hawthorne	DM		D	I		*			C*
Elaeagnus augustifolia/Russian olive		X		T	T		T		
Fagus grandifolia/American Beech	DM		S	S	S				
Fraxinus americana/White Ash	MW		I	I	S	S			
Fraxinus pennsylvanica/Green Ash	MW	X	I	I	S	S	I		
Gingko biloba/Gingko	DM	X	I		T	S	S	S	C*,
Gleditsia triacanthos inermis/ Thornless Honeylocust	DM	X	I	T		S			T
Ilex opaca/American Holly	M		I	I		T	T		P
Juglans nigra/Black Walnut	M		D	S		T	I		
Juniperus virginiana/Eastern Redcedar	DM	X	D	I	T		T		C*
Koelreuteria paniculata/Goldenraintree	DM	X	I			*			
Laris laricina/Larch	MW		S	T	S	S			

Table 4 (continued)

Botanical Name/Common Name	Moisture Requirements	Withstand Dry or Poor Sterile Soil	Type of Root System	Tolerance to De-Icing Salts	Sensitivity to Air Pollution SO_2	O_3	F	NO_x	VDH & T Approved Street Trees
Liquidambar styraciflua/Sweetgum	MW		S		S	S	T		
Liriodendron tulipfera/Tulippoplar	M		D	S	T	S			
Magnolia grandiflora/Southern Magnolia	DM		I			*			
Magnolia soulangeana/Saucer Magnolia	M		I			*			T
Magnolia stellata/Star Magnolia	M		S			*			
Malus species/Crabapple	M		S	I	S	S		S	T
Nyssa sylvatica/Black Gum	DW		S	I	T	T			
Oxydendron arboreum/Sourwood	M				T				
Paulownia tomentosa/Royal Paulownia	DM		S				S		
Phellodendron amurense/Amur Cork Tree	DM	X	S			*			
Picea abies/Norway Spruce	M	X	S	S		T			
Picea glauca/White Spruce	M		S	S	I	T	I	S	
Picea pungens glauca/ Colorado Blue Spruce	M		D	T	T	T	S	S	
Pinus echinata/Shortleaf Pine	DM	X	D				S		
Pinus nigra/Austrian Pine	M	X	D	T	S	S	I	S	
Pinus resinosa/Red Pine	D		D	S	S	T			
Pinus strobus/White Pine	M	X	S	S	S	S	S	S	
Pinus sylvestris/Scotch Pine	D	X	S	I	S	S	S		
Pinus thunbergii/Japanese Black Pine	M	X		T					
Pinus taeda/Loblolly Pine	DW				S		S		
Pinus virginiana/Virginia Pine	DW	X	I	I	S	S			
Populus grandidentata/Bigtooth Aspen	DM		I	T	S		I		
Populus deltoides/Eastern Cottonwood	MW		S	I	S	S	I		
Platanus occidentalis/Sycamore	MW		I	I	T	S	T		
Prunus serotina/Black Cherry	M	X	S	T	S				
Prunus serrulata Kwanzan/Kwanzan Cherry	M		S				T		T
Pseudotsuga menziesii/Douglas Fir	M		D	S	I	T	S		
Pyrus calleryana Bradford/Bradford Pear	M	X	I	I		*			T
Quercus alba/White Oak	DM		D	T	I	S	I		
Quercus coccinea/Scarlet Oak	DM		D	T		S	I		
Quercus falcata/Southern Red Oak	DM	X	D				I		
Quercus montana/Chestnut Oak	DM	X	D	T			I		
Quercus palustris/Pin Oak	DW		I	T	S	S	I		
Quercus phellos/Willow Oak	DW		I	T			I		
Quercus rubra (borealis)/Red Oak	DM		I	T	T	T	I		
Quercus stellata/Post Oak	DM	X	I				I		
Quercus velutina/Black Oak	DM		D			I			

Table 4 (continued)

Botanical Name/Common Name	Moisture Requirements	Withstand Dry or Poor Sterile Soil	Type of Root System	Tolerance to De-Icing Salts	Sensitivity to Air Pollution SO_2	O_3	Fl	NO_x	VDH & T Approved Street Trees
Robinia pseudoacacia/Black Locust	DM	X	S	I	T	S	I	S	
Salix babylonica/Weeping Willow	M		S	T	S	S	T		
Sassafras albidum/Sassafras	DM	X	D						
Sophora japonica/Japanese Pagodatree	DM	X	S			*			
Sorbus americana/Mountainash	M		S	I	S	S	T		C*
Taxodium distichum/Bald Cypress	MW		I						
Thuja occidentalis/Arborvitae	MW		I	T	T	T	I		
Tilia americana/American Linden	M		I	S	I	S	T		
Tilia cordata/Littleleaf Linden	M		I	S	I	S	T	S	P
Tsuga canadensis/Canadian Hemlock	M		S	S	S	S	T		
Ulmus americana/American Elm	M		I	S	S		T		
Ulmus fulva/Slippery Elm	W		I		I				
Zelkova serrata/Japanese Zelkova	M		S			*			

KEY

Moisture Requirements

MW - Moist to Wet Soil
M - Moist Soil
DM - Dry to Moist Soil
D - Dry Soil
DW - Dry to Wet Soil

Withstands Dry or Poor Sterile Soil

X - Does Withstand

Types of Root System

S - Shallow Lateral Root
I - Intermediate with Wide Spreading & Deep Lateral Roots
D - Deep Penetrating or Tap Root

Tolerance to De-icing Salts

T - Tolerant
I - Intermediate Tolerance
S - Sensitive

Sensitivity to Air Pollution

T - Tolerant
I - Intermediate
S - Sensitive
I/S - Intermediate or Tolerant depending upon reference source
S/I - Sensitive or Intermediate depending upon reference source
* - Generally Tolerant of parking lot conditions

VDH & T Approved Trees

T - Approved as Tailored Tree for Strips 6' and over
C - Approved as Columnar Tree for Strips 8' and over
P - Approved as Pyramidal Tree for Strips 12' and over
* - A Variety of the Species has been Approved

wildlife populations. Dredging and filling of marshes for residential, recreational, or other uses further reduces wildlife habitat areas. Among farming practices which have the most serious adverse effect upon wildlife are: 1) the use of chemical pesticides, which have taken a great toll on song and game birds and small animals; 2) channelization of streams for improved drainage, which reduces stream valley corridor habitats; and 3) clearing of woodland habitat and reduced field vegetation borders which has accompanied the trend toward increased large-scale farming operations. Land use practices which favor wildlife are suggested below.

Guidelines. Although the focus of this guidebook has primarily been toward urban development, there are certain farming practices especially favorable to wildlife which should be mentioned here, both for the professional and "backyard" farmer. Most farm crops, particularly corn, small grains and soybeans, are used for food and cover, to some extent, on a seasonal basis by wildlife. Late harvest and spring tillage, rather than tillage in the fall extend the period in which wildlife can utilize crops and crop residues. The addition of new crops and crop rotation provide diversification of food and cover. Fencing livestock out of woodlots conserves wildlife food and cover and also prevents excess soil erosion and stream sedimentation. Vegetated turning strips at field borders, shrubby fence rows, and windbreaks provide wildlife nesting cover.

Residential development can also contribute to the quality of wildlife habitat if properly designed. Cluster development, which allows the maintenance of natural vegetation areas, furnishes acceptable habitat for many songbirds, as well as quail, squirrels and rabbits. Dedication of stream valleys and floodplains to open space use not only provides recreational amenities, but promotes the establishment of open space corridors through which wildlife can travel to seek food, cover and water. In addition, the local game warden and the State Wildlife Commission can provide landowners with information and advice on planting materials which can improve wildlife habitat on individual properties.

Development Areas

Background. This section focuses on areas that are generally suitable for urban development and measures which can be taken to minimize the impact of development in these areas on coastal water resources. Urban development results in wastewater discharges, septic tank effluents, sedimentation from construction activities, and an increase in total rainfall runoff. These changes to the natural system can result in both water quality and flooding problems, which not only effect man's health, safety and welfare, but also threaten the health of the marine environment, which in Prince William County consists of the Potomac estuary, adjacent tidal marshes, and the aquatic and terrestial life they support.

Rainfall or stormwater runoff is referred to as a nonpoint source of water pollution, since it does not originate from a single source such as a wastewater treatment plant discharge and thus is more difficult to control. Typical urban development can cause the following changes in the factors affecting natural stormwater runoff (33):

a) an increase in impermeable surfaces, and consequent elimination of natural surface areas which retain precipitation;
b) a decrease in soil porosity due to compaction, which reduces infiltration of rainfall;
c) construction of improved channels and storm sewers to transport the excess surface water, which affects the rate and timing of rainfall runoff; and
d) a decrease in vegetation, and consequent reduction in transpiration and interception of precipitation by plant systems.

Usually one urban change affects several of these factors. For example, paving reduces the permeability of a natural surface, reduces vegetation and infiltration, thereby increasing peak rates and volumes of runoff while reducing the amount of water that seeps into the soil for groundwater recharge. Figure 1 in Chapter I illustrates this point.

While the impacts of excessive nutrient pollutants from point sources of water pollution, primarily wastewater treatment plants, on eutrophication in the Potomac estuary are well documented (39), the relative contribution of nonpoint sources to this problem has not been well researched. As higher levels of wastewater treatment are implemented within the region and urbanization continues, urban runoff will undoubtedly become an increasingly significant source of water pollution in the estuary and adjacent embayments.

Guidelines. The land use/water quality guidelines suggested below for development in coastal watersheds are divided into two sections: (A) general guidelines for the County's land use planning and management efforts in this area; and (B) site-specific guidelines for developers and individual landowners.

A. General guidelines. The following are general guidelines which can assist the County in developing and implementing land use plans and policies for the coastal zone:

1. Use the small watershed as a basic planning unit. The watershed is a basic topographic unit which includes distinct land/water relationships. The elements of these relationships - slopes, soils, drainage patterns, ground cover - should be inventoried as a basis for understanding the potential water quality impacts of land use changes.

2. Adapt the basic pattern and density of major urban development (100 acres

or more) to the geophysical characteristics of the watershed. Necessary information on the characteristics of proposed urban development includes:

a) Percent of impervious cover (pavement, rooftops). For example, the following figures have been developed by NVPDC for the Occoquan Basin (19):

Land Use	Effective % Impervious*
Estate Residential (0.1-0.2 Du/ac)	3-4%
Low Density Residential (0.5 Du/ac)	7%
Low Density Residential (1.0 Du/ac)	12%
Low Density Residential (2.0 Du/ac)	18%
Medium Density Residential (4.0 Du/ac)	28%
Medium Density/Townhouse (6.0 Du/ac)	34%
Townhouse (10 Du/ac)	40%
Townhouse (15 Du/ac)	46%
Garden Apartments (20-25 Du/ac)	50 - 60%
High-rise Residential (>25 Du/ac)	60 - 75%
Institutional	40%
Commercial/Office	90 - 95%
Industrial	65 - 90%

*Impervious cover directly connected to stormwater drainageway

b) Disturbed acreage. The following relationships between residential lot size and the maximum percentage of a site which should be disturbed have been suggested in Reference (31):

Residential lot size	% of Site Disturbed
5 acres	5
2 acres	10
1 acre	15
1/2 acre	25
1/4 acre	50
1/8 acre	75

3. Guide urban development into higher order watersheds. Higher order watersheds (i.e., downstream watersheds) generally have more stable streamflows than upstream areas. Urban development in these other areas may increase problems related to erosion, sedimentation, and flash floods (1). Urban development located near the mouth of a watershed, i.e., in higher order watersheds, often has less total impact

on downstream channel segments; e.g., channel enlargement, sedimentation, water quality degradation (7).

4. Guide urban development into the higher elevations of the watershed (ridges and plateaus) rather than stream valleys. Development away from waterways, particularly on moderate slopes, not only minimizes adverse water quality impacts on streams, but also protects development from flooding problems (9).

5. Encourage compact development in or adjacent to existing services. This not only lessens pressure to develop environmentally sensitive areas, but allows a more efficient and cost-effective provision of public services (26).

6. Control nonpoint source pollution through land use planning and management. Studies of nonpoint pollution in the Northern Virginia area (21) have resulted in the development of the following land use/nonpoint pollution relationships which can be used in the implementation of nonpoint pollution control measures for the Prince William County coastal zone:

a) For nitrogen, phosphorus, and organic matter (biochemical oxygen demand), annual nonpoint pollution loadings (lbs/acre/year) from almost all urban land uses were considerably higher than loadings from forestland, pasture land, and minimum tillage cropland; moreover, the urban land uses with the highest levels of impervious ground cover (e.g., pavement, rooftops) exhibited the highest annual loading rates, which in some cases, were equivalent to loading rates from conventional tillage cropland.

b) For heavy metals such as lead and zinc, annual nonpoint pollution loadings from urban land uses were considerably higher than loadings from rural-agricultural land uses, with the most highly impervious land uses exhibiting the highest loading rates, and vice versa.

c) A significant percentage of the plant nutrient loadings from all urban land uses was consistently unattached to sediment (i.e., found in a dissolved form), with the mean sediment-borne load in urban runoff ranging from 27%-42% of the total load for nitrogen and 45%-69% of the total load for phosphorus; the high quantities of dissolved loadings are significant from a nonpoint pollution management standpoint since this portion will generally not be removed by typical stormwater detention ponds.

d) A relatively small percentage of the lead loadings from all urban land uses was consistently unattached to sediment, with the mean sediment-borne load in urban runoff ranging from 85%-94% of the total load; the high quantities of suspended lead loadings suggest that stormwater detention ponds should be rather effective at reducing lead loadings in urban runoff.

e) Periodic analyses of pollutant loadings in rainfall revealed that air pollution is an important source of nonpoint pollution loadings and that atmospheric contributions of plant nutrients do not appear to be dependent on land use; however, since highly impervious urban land uses will convert larger amounts of rainfall to runoff than will urban land uses of lesser imperviousness, the significance of atmospheric loadings was found to vary from one land use to the next, ranging from 30%-90% for nitrogen, from 15%-50% for phosphorus, and from 5%-10% for lead.

f) A comparison of "population per acre" and nonpoint pollution "loading rates per acre" for high density and medium density residential land uses indicates that the high density land uses exhibit lower "per capita" loading rates for plant nutrients. However, since an acre of high density residential development exhibits higher plant nutrient loadings than an acre of medium density residential development, comparisons of the two densities are best made on a case-by-case basis that should consider: (a) whether or not the same control population is to be supported by the two land use patterns, and (b) the amount of open space preserved by the two conditions.

The NVPDC studies also identified the following relationships between surface runoff and soil types:

1. As the density of residential households increases from about one per acre (single family detached) to greater than 22 per acre (high-rise residential), the volume of surface runoff increases about four times for silt loam soils, five times for loam soils, and seven times for sandy loam soils. Thus, on a per capita basis, the impact of high density residential land use on runoff volume is less than for low density residential land use assuming a constant number of people are to be accommodated within a given watershed.

2. Similar findings were made in respect to total nitrogen, total phosphorus,

chemical oxygen demand (COD), and extractable lead runoff pollutant loads. For soils with a loam texture, about three times as much nitrogen, four times as much phosphorus, six times as much COD, and nine times the extractable lead annual runoff pollutants load per acre come from high-rise residential developments as from large lot single-family detached developments. On a per capita basis, loadings from the denser residential categories were lower than those associated with lower density residential developments.

3. Suburban shopping center and central business district types of development contribute the greatest per acre annual loads of nitrogen, phosphorus, COD and lead and the greatest per acre annual runoff volume of urban land uses.

4. For both runoff volumes and runoff pollutant loads, the soil texture is an important variable with looser, more porous soils releasing significantly less runoff and pollution loads than less porous soils for the land uses with moderate to low percentages of imperviousness.

Nonpoint pollution problems in the County's coastal zone can be addressed by both structural and nonstructural control strategies. The more traditional, structural control measures, including construction of stormwater detention and treatment facilities, land surface maintenance programs, etc., are also the more costly of the two general control strategies. While the need for structural controls may not be eliminated by the implementation of nonstructural strategies such as improved land use management, such a need can be reduced, along with its associated costs.

Nonstructural land use guidelines, which can minimize post-development runoff volumes and related pollutant loadings in stabilized urban watersheds, have been incorporated into a Soil Overlay Zone system mentioned above. This generalized soil classification system, which can be of assistance to local planners during master planning and site plan review, is described below.

Soil overlay zones. For the purposes of the soil overlay approach, the soils found in the County's coastal zone have been grouped into four broad suitability zones: unsuitable, low density/conservation, medium density, and high/low density. These groupings should be reviewed by local planners and soil experts and revised, if necessary.

1. Unsuitable. These areas include tidal marshes and floodplain soils. Flooding problems and poor drainage make these areas unsuitable for urban development. Recommended uses: conservation; low-density recreation such as bird watching, fishing, and hunting.

2. Low density/Conservation zone. These areas are characterized by steep soils and/or soils of high runoff potential that would maximize nonpoint pollution runoff loadings from urban development. This category generally corresponds to the "Steep Slope Overlay District" of McHenry County, Illinois, discussed above, with slopes generally excessive.
Recommended uses: Conservation, low-intensity recreation. If conservation uses are not possible, the placement of large-lot (2-10 acre lots) residential land uses in these areas is advisable to minimize the amount of impervious surface area, encourage the maintenance of tree cover, and minimize the amount of fertilized lawn area. Medium density residential development (1-5 dwelling units/acre) in these areas may require excessive expenditures for erosion and runoff pollution control facilities.

3. Medium density zone. These areas contain soils characterized by moderate permeability and moderate slopes (usually less than 8%), resulting in high soil moisture storage capacities.
Recommended uses: Medium density residential development (1-5 dwelling units/acre) in these areas would minimize the washoff of pollutants from residential lawn surfaces. Medium density residential development generally has a higher percentage of its total land area in lawn surfaces than other land uses. Significant dissolved nutrient loadings have been identified in runoff from residential lawns. Since these pollutant loadings are not associated with sediment, they cannot be effectively controlled by stormwater detention and storage measures, which are capable only of trapping sediment and suspended pollutant loadings. Very costly physical-chemical treatment facilities may be required to remove the significant percentages of nitrogen and phosphorus loadings that are dissolved in runoff from residential areas. By designating areas with the most permeable soils for urban land uses characterized by high percentages (60% - 85%) of landscaped lawn surfaces, washoff of dissolved plant nutrients from lawn surfaces during storm events can be minimized by the natural filtration and storage capacity of the permeable soils. On the other hand, the placement of medium density residential development on relatively impermeable land surfaces can be expected to maximize runoff pollution loadings from the fertilized lawn areas.

4. High Density/Low Density Zone. These areas contain soils characterized by poor permeability and slopes generally less than 8%.
Recommended uses: Highly impervious land uses (40% or more impervious) should be encouraged to locate in sewered areas of these zones to minimize post-development increases in runoff volumes associated with highly impervious

urban development and to preserve the more permeable soils with high moisture storage capabilities for medium density residential land uses. In unsewered areas within this zone, however, poor permeability conditions are likely to limit urban development to low density residential land uses (1 dwelling unit/acre or less).

Table 5 groups Prince William County coastal soils into these 4 zones. Their general location in the County's coastal zone is illustrated on maps for subsections of the coastal zone presented in Chapter III.

Implementation. Application of the Soil Overlay Zone technique to future updates in the comprehensive plan for the County's coastal areas will facilitate the implementation of these guidelines. Such nonstructural control strategies may not be able to reduce pollutant loads to pre-development conditions, and, therefore, they should be supplemented by the implementation of structural "best management practices" (BMP's).

Urban BMP's for controlling nonpoint pollution can be subdivided into three categories:

1. VOLUME CONTROLS: BMP's that channel a specified volume of runoff and dissolved as well as suspended pollutant loadings into the soil profile where pollutant removal can occur through physical, chemical and biological processes.

2. DISCHARGE OR DETENTION CONTROLS: BMP's that store stormwater and rely upon solids settling processes to remove sediment and sediment-related pollutant loadings.

3. SOURCE CONTROLS: Maintenance programs that minimize the accumulation and exposure of pollutants on the land surface and in the atmosphere during dry weather periods.

Examples of these types of control measures, along with recommended implementation guidelines, are provided in Table 6.

Many of these urban BMP's are quite similar to controls typically required for local stormwater management programs. For example, computer modelling studies (10) by the Northern Virginia Planning District Commission (NVPDC) have shown that, with minor design modifications, traditional stormwater detention ponds can achieve the following pollutant reduction rates for urban land uses:

a) Large-Lot Single Family Residential: 20%-30% reductions in annual phosphorus loadings; 50%-80% reductions in annual lead loadings.

Table 5

SOIL OVERLAY ZONES
Prince William County Soils

ZONE	FIELD NO.[1]	NAME
Unsuitable	1	Mixed aluvial land
	3	Congaree silt loam
	4	Congaree fine sandy loam
	5	Wehadkee silt loam
	6	Local colluvial land
	8	Worsham silt loam
	20	Meadowville silt loam
	89	Tidal marsh
Low Density Conservation	16C	Beltsville loams, permeable substratum
	35C,D,E	Watt shaly silt loam, sloping-steep
	38C	Beltsville fine sandy loam, sloping
	44C,D,E	Matapeake fine sandy loam, sloping-steep
	45D,E	Matapeake soils
	46B	Mattapes silt loam
	47	Dragston fine sandy loam
	49C.E	Lunt soils, sloping-moderately steep
	51A,B	Keyport silt loam
	61B,C,D,E	Loamy & gravelly sediments, steep-sloping
	63C,D,E	Louisburg sandy loam, sloping-steep
	65B	Colfax fine sandy loam
	84	Fallsington fine sanyd loam
	121D,E	Manor-Louisburg loams, sloping-steep
	144C,D,E	Ruston-Belgsville gravelly fine sandy loams
	161C,D,E	Silty and Clayey sediments
	197C	Altavista-like soils with fragipan, sloping
	460D,E	Appling-Glenelg soils, moderately steep - steep
Medium Density	44B,C	Metapeake fine sandy laom, gently sloping-sloping
	45B,C	Matapeake soils
	54B,C	Sassafras fine sandy loam, gently sloping-sloping
	60B,C	Appling fine sandy loam, gently sloping - sloping
	83B	Galestown loamy fine sand, gently sloping
	87B,C	Wickham loam, gently sloping - sloping
High/Low Density	16B, 37B	Beltsville loams, gently sloping
	38B	Beltsville fine sandy loam w/fragipan
	49B	Lunt soils, gently sloping
	53	Lenoir silt loam
	85	Elkton silt loam
	97	Altavista silt loam
	144B	Rusten-Beltsville gravelly fine sandy loams
	197B	Altavista-like soils with fragipan
	460B	Appling-Glenelg soils

[1] As shown in "Interim Soil Survey Report, Prince William County, Virginia," U.S. Department of Agriculture, Soil Conservation Service w/VPI-SU, July 1976 and discussed in "Soils of Prince William County," Report No. 8, Prince William County with VPI-SU Agronomy Department and Soil Conservation Service, n.d.

Table 6

URBAN "BEST MANAGEMENT PRACTICE" (BMP) GUIDELINES

BEST MANAGEMENT PRACTICE	PROPOSED GUIDELINES
I. VOLUME CONTROLS	
A. Control measures that artificially increase stormwater infiltration at the source 1. Dutch drain 2. Porous pavement 3. Turf grids	1. Encourage the utilization of volume controls wherever soil conditions are acceptable. 2. Volume controls should be designed to control post-development increases in runoff volumes from 10-year design storm. 3. Stormwater management ordinances or policies that cover the provision of volume controls should be adopted by participating jurisdictions.
B. Control measures that artificially increase stormwater infiltration after preliminary concentrations 1. Seepage pit 2. Swale storage with seepage pit 3. Rooftop storage with outlet to seepage pit 4. Stormwater detention pond with seepage pit	
II. DISCHARGE CONTROLS	
A. On-line storage ponds 1. Onsite Detention Ponds 2. Offsite Retention Ponds	1. To increase stormwater detention time and annual sediment capture rates, utilize one of the following design criterion for onsite detention storage facilities: a. Release rates should be based on pre-development peak runoff from 2-year design storm event; storage volume should be based on comparison of post-development runoff from 10-year design storm event and pre-development runoff from 2-year design storm event. b. Release rates should be based on pre-development peak runoff from 2-year design storm event and 10-year design storm event; storage volume should be based on comparison of pre- and post-development runoff from the 10-year design storm event. 2. Encourage the use of innovative outlet structure designs to increase trap efficiency of on-line detention storage facilities (e.g., perforated riser pipes).
B. Off-line storage plus stormwater treatment 1. Land application of stormwater during non-storm periods 2. Physical-chemical treatment	

Table 6
(con't)

BEST MANAGEMENT PRACTICES	PROPOSED GUIDELINES
II. DISCHARGE CONTROLS (continued)	3. Encourage the installation of prototype stormwater treatment facilities through: a. Federal demonstration projects o USEPA "Clean Lakes" Program (Section 314 of Federal Water Pollution Control Act Amendments) o USEPA Research Grants b. Site plan review negotiations 4. Stormwater management ordinances or policies that cover the provision of discharge controls should be adopted by participating jurisdictions.
III. SOURCE CONTROLS A. Nonstructural Control Measures 1. Land use controls to achieve reductions in runoff volumes and loading rates a. Soil permeability guidelines for site plan review and master planning b. Consideration of density tradeoffs (i.e., growth centers with relatively high net densities will generally produce lower nonpoint pollution loading rates per capita than sprawling land use pattern with relatively low net densities) during master plan preparation 2. Improved fertilizer and pesticide management practices to minimize the accumulation of potential pollutants on pervious surfaces a. Public education programs b. Improved management guidelines for plant chemical applications to public lands (e.g., require use of slow-release fertilizers) c. Incentives or disincentives for improved plant chemical management practices on private property (e.g., restrictions on use of high-nitrogen fertilizer; incentives for the use of slow-release fertilizers).	1. To reduce loadings from fertilized lawn surfaces, incorporate the following soil permeability guidelines into local site plan review and master planning programs: a. Encourage the placement of medium density residential land uses on the most permeable soils b. Encourage the placement of highly impervious land uses on the least permeable soils c. If areas with soils of low permeability are not suited to highly impervious land uses, encourage conservation or large-lot single family land uses 2. To reduce per capita loadings, consider the use of residential clustering techniques during the development of local master plans 3. Encourage the adoption of improved plant chemical management practices 4. Develop local urban cleanliness programs 5. Develop programs for improved cleaning and maintenance of paved areas and drainage facilities

Table 6
(con't)

BEST MANAGEMENT PRACTICES	PROPOSED GUIDELINES
III. SOURCE CONTROLS (continued)	
3. Urban Cleanliness Measures	
a. Public education programs	
o Anti-litter	
o Management of domestic pet wastes	
b. Economic incentive programs	
o Recycling of automobile waste materials (e.g., used oil)	
B. Structural Control Measures	
1. Improved cleaning and maintenance programs for:	
a. Streets	
b. Parking lots	
c. Urban drainageways and drainage structures	

b)	Medium Density Single Family Residential:	25%-45% reductions in annual phosphorus loadings; 50%-75% reductions in annual lead loadings.
c)	Townhouse/Garden Apt.:	30%-50% reductions in annual phosphorus loadings; 45%-70% reductions in annual lead loadings.
d)	Shopping Center:	30%-50% reductions in annual phosphorus loadings; 50%-75% reductions in annual lead loadings.

Detention ponds that capture the "first flush" of nonpoint pollution loadings and provide the maximum amount of offline detention can be expected to provide pollutant removal rates that are somewhat higher. Likewise, "volume" controls (e.g., seepage pits, Dutch drains) that reduce the amount of runoff from the urban land use can generally be expected to provide higher removal rates since these measures are capable of removing both dissolved and sediment-borne loadings. However, comparisons of estimated BMP efficiencies with runoff pollution loading rate increases resulting from urban development suggest that most BMP's will not be able to prevent urban loadings from exceeding predevelopment conditions (8). This affirms the recommendation that the implementation of the land use planning and management guidelines outlined herein are an important supplement to traditional structural control techniques.

More detailed information on the engineering aspects of urban BMP's can be obtained from the State "Urban Best Management Practices Handbook" (38). Further information on the relative efficiencies and cost effectiveness of these measures has been developed by the NVPDC as part of the Occoquan Basin Management Program (10).

B. Site-Specific Guidelines. Measures can be taken by developers and individual landowners to reduce adverse impacts on coastal waters at the site design, site preparation, and site occupancy stages of development. Table 7 indicates considerations of natural conditions during site selection and design to minimize post-development runoff pollution loadings. The most damaging impact of site preparation is erosion resulting from construction activities. Typical erosion rates from construction sites as compared to other land uses is given below (9):

Land Use	Sediment Produced (Tons/sq.mi./yr.)
Forest	9-50
Urban/Suburban	50-100
Farmland	1,000-5,000
Denuded construction sites	25,000-50,000

Table 7

SITE-SPECIFIC GUIDELINES FOR MINIMIZING RUNOFF POLLUTION

LOADINGS FROM URBAN DEVELOPMENT

Recommended Land Uses for Areas Exhibiting Specified Physical Features

	Soil Permeability		Land Slope		
Land Use Category	Slow(<2 in/hr)	Moderate(2-6 in/hr)	Severe(15%+)	Steep(7-15%)	Moderate(<7%
.1-.2 DUA	x		x	x	
.2-.5 DUA	x		x	x	
.5 DUA	x		x	x	
1 DUA		x		x	x
2 DUA		x			x
2-4 DUA		x			x
4-8 DUA		x			
8-12 DUA	x	x*			x
12-16 DUA	x	x*			x
High Rise Residential	x				x
Commercial	x				
Forest Conservation	x		x	x	

*Recommended for townhouse/garden apartment projects with impervious ground cover percentages less than 40%.

Developers and landowners contemplating any land-disturbing activities must comply with the County sediment and erosion control ordinance, which requires a permit for such activities and specifies acceptable erosion and sediment control measures.

Pollution resulting from stabilized urban areas can also be managed. Studies by the NVPDC and the Occoquan Watershed Monitoring Lab have shown that significant nutrient loadings can be attributed to fertilized lawn surfaces (21). Much of the problem is the result of improper timing and rates of fertilizer application. Contrary to popular belief and the advertising of fertilizer retailers, the best time to apply fertilizer is in the fall, before the first frost. This allows the fertilizer time to soak into the soil all winter. The high saturation of soils during most of the Spring when fertilizer use is highest will reduce the absorption of fertilizer applied at this time. A light application in the Spring--half the manufacturer's recommended amount--will promote moderate growth and reduce the incidence of disease. In addition, homeowners should be encouraged to choose fertilizers with high percentages of slow-release nitrogen. The slow-release nitrogen is preferable from a nonpoint pollution control standpoint because it is less susceptible to being washed away and thus contributing to the eutrophication of the estuary. Slow-release fertilizers also save labor, since fewer applications are required.

Recommended fertilizer applications vary according to grass type and soil composition, but a general rule of thumb for both the establishment and maintenance of lawns is two pounds of nitrogen per 1,000 square feet of lawn area. For example, that would be approximately 30 to 40 pounds of 5-10-5, 6-12-6, or 5-10-10 fertilizer per 1,000 square feet.

These measures will not only improve water quality, but will assure maximum effectiveness of the fertilizers while achieving cost-savings for the homeowner. Homeowners may obtain advice on lawns and gardens from the local extension agent of the Virginia Polytechnical Institute and State University (VPI&SU) Cooperative Extension Service. VPI&SU offers a free soil test which determines individual site lime and fertilizer needs. Appendix III provides a more detailed fertilizer guide for typical turfgrass of Prince William County, as recommended by the VPI&SU Extension Division.

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CHAPTER III

COASTAL RESOURCES OF PRINCE WILLIAM COUNTY

Introduction

An essential part of coastal resources planning and management is an inventory of existing resources in the coastal zone, both natural and man-made. This chapter presents such an inventory for Prince William County's coastal zone. While this inventory attempts to be comprehensive, available information is usually somewhat generalized, and should be supplemented by site-specific determinations when making individual land use decisions.

To simplify the presentation, the coastal zone has been divided into 5 segments, based on natural divisions of the shoreline such as creeks and points of land. For each segment, information is provided on the characteristics of both the shoreline and the fastlands, including both natural and man-made coastal resources. The approximate land area of each segment is shown in Table 8. For wetlands, the Virginia Institute of Marine Science (VIMS) Site and Type number from the State wetlands inventory program is indicated to assist in management decisions concerning these regulated areas. All resource information is illustrated on a series of maps for each segment, which include natural features, existing land use, future land use, and soil suitability zones. The soil suitability classifications have been defined previously in Chapter II.

The resource inventory must be supplemented by the land use planning and management guidelines provided in Chapter II. These guidelines are designed to assist in making land use decisions concerning the County's coastal resources. In order to facilitate cross-referencing, the resource types identified in this chapter correspond to the resource categories discussed in Chapter II.

SEGMENT 1: I-95 Bridge to Marumsco Creek

A. Characteristics of Shoreline. (See Map 2.)

1. Natural Resources

a) Wetlands. The total area of wetlands in Segment 1 is 87 acres. Individual wetland sites are as follows:

(1) Occoquan River at Woodbridge. Area: 5 acres; VIMS SITE #: 23; VIMS TYPE #: IX

This is a low, embayed marsh dominated by pickerel weed, arrow arum and yellow pond lily, which includes some areas of tidal flats.

(2) Occoquan River. Area: 26 acres; VIMS SITE #: 24; VIMS TYPE #: XI

This is a pocket marsh of high elevation, dominated by hibiscus and jewel weed with a fringe of pickerel weed.

(3) Conrad Island. Area: 2 acres; VIMS SITE #: 22; VIMS TYPE #: VII

Table 8

Land Area in Prince William County Coastal Zone By Segment

Segment	Shoreline Boundaries	Approximate Acreage
1	I-95 Bridge to Marumsco Creek	1945
2	Marumsco Creek to Freestone Point	3382
3	Freestone Point to Cockpit Point	4868
4	Cockpit Point to Shipping Point	4649
5	Shipping Point to Chopawamsic Creek	3334
TOTAL COASTAL ZONE		18,178

A small fringing marsh is found here, dominated by the pickerel weed-arrow arum community of the island.

(4) Marumsco Creek. Area: 55 acres; VIMS SITE #: 21; TYPE #: XI

A creek marsh with pickerel weed and pond lily is located along the creek channels. VIMS reports evidence of some channelization.

b) Beaches. (Total length: 2 miles)

Beaches in Segment 1 are of fair to poor quality for recreation use. These beaches are fairly wide and often vegetated. Of the 2 miles of beach within Segment 1, 0.1 mile is under the I-95 bridge and 1.4 miles are within the U.S. Military Reservation, thus restricting public access and usage.

c) Bluffs. (Total length: 0.2 miles)

The short distance of bluff in this segment is located adjacent to 26 acres of wetlands, making preservation especially important.

2. Man-made Resources. Approximately 45% of the shoreline in Segment 1 is in federal ownership. Man-made features of the shoreline include:

a) Shore Protection Structures. (Total length: 1.9 miles)

There are about 5,600 feet of effective rubble rip rap along the shoreline of the Military Reservation.

b) Shorefront Recreational Facilities.

There is a boat ramp at the Route 1 bridge and a 78-acre Veterans Memorial Park on the west side ot Marumsco Creek, owned and operated by the County.

B. Characteristics of Fastlands

1. Natural Resources

a) Soils and Slopes. (See Map 3.)

The major remaining undeveloped area, north of the Military Reservation and east of Woodbridge, contains moderate slopes with varying moisture storage capabilities which can support a mixture of medium density and high density land uses. While current zoning in this area (see Land Use below) proposes such a mixture, the zoning pattern does not appear to be entirely compatible with the soil suitabilities for nonpoint pollution management within this area. Nonpoint pollution control considerations seem to indicate that more of this land might be programmed for medium density residential uses and less for industrial and townhouse uses, within market limitations.

b) Vegetation and Wildlife. (See Map 2.)

Because of the built-up nature of this segment, the only significant vegetation and wildlife habitat area is found at the mouth of Marumsco Creek. It is recommended that the existing conservation use of this area be maintained.

c) Waterways. (See Map 2.)

Occoquan Creek, Belmont Bay, and Marumsco Creek are the most significant water bodies in this segment. While most areas of the shoreline have elevations of at least 10 feet msl, part of the Military reservation south of Taylors Point is susceptible to flooding during periods of abnormally high water. Further intense urban development above Marumsco Creek may threaten the embayed wetlands at its mouth. Nonpoint pollution control measures which might be instituted to minimize the addition of nutrients and other pollutants to this area from future development are discussed in Chapter II.

2. Man-made Resources . (See Maps 4 and 5.)

a) Land use

Most of the segment is programmed for urban or governmental use. Townhouse, apartment, and heavy industrial land uses are zoned for the major undeveloped area, north of the Military Reservation. Conservation-Park/Public Use dominates in the area adjacent to Marumsco Creek.

b) Developments of Regional Benefit/Key Facilities

The U.S. Military Reservation at Deephole Point is the primary non-local land use in this segment. If a State Coastal Resources Management Program is established, land use decisions at federal installations would be required to be consistent with coastal land use plans and policies.

SEGMENT 2: Marumsco Creek to Freestone Point

A. Characteristics of Shoreline (See Map 6.)

1. Natural Resources

a) Wetlands. The total area of wetlands in Segment 2 is approximately 333 acres. Individual wetland sites are as follows:

(1) Upper Farm Creek. Area: 36 acres; VIMS SITE #: 20; VIMS TYPE #: XI
This is a creek marsh, crossed by a dirt road, but a culvert allows some tidal flushing.

(2) Lower Farm Creek. Area: 7 acres; VIMS SITE #: 19; VIMS TYPE #: XI
This is a pocket marsh, containing a pickerel weed fringe with other species landward.

(3) Occoquan Bay. Area: 61 acres; VIMS SITE #: 18; VIMS TYPE #: XI

A large fringing marsh is found here; cattails dominate its interior.

(4) Neabsco Creek. Area: 229 acres; VIMS SITE #: 17; VIMS TYPE #: XI

Neabsco Creek contains a large creek marsh which consists of a mixed freshwater marsh community.

b) Beaches. (Total length: 1.6 miles)

Beach quality is poor to good for recreational use. Narrow, strip beaches, often vegetated, are found near Featherstone Shore and from the railroad bridge at Neabsco to Freestone Point. Small pocket beaches occur in several areas near Bayside Park and south of Featherstone. The beaches at Neabsco and Firestone Point, however, are fairly wide and clean.

c) Bluffs. (Total length: 0.3 miles)

Bluffs in this segment are found at Freestone Point. This area is experiencing some minor erosion due to rainfall runoff and undercutting of the cliff base by wave action from the Potomac, but the rocky composition of these bluffs apparently allows them to withstand major erosive forces.

2. Man-made Resources. Approximately 61% of Segment 2 shoreline is in private ownership, with 25% in federal ownership and 15% owned by the County. Man-made features of the shoreline include:

a) Shore Protection Structures. (Total length: 1.5 miles)

There are approximately 3,600 feet of effective rubble riprap from Deephole Point to the mouth of Marumsco Creek. Bayside Park and Featherstone Shores have about 3,400 feet of bulkhead, most of which VIMS has judged to be effective. This area also contains several groins. The marina just north of Featherstone Shores has approximately 300 feet of bulkhead, mainly for commercial purposes. Another 1200 feet of bulkheading, primarily serving a cosmetic rather than erosion control function, is found at the marina facilities on the south bank of Marumsco Creek. The railroad bridge is stabilized on the east side by an additional 50 feet of rubble riprap.

b) Shorefront Recreational Facilities.

Docking facilities, boat ramps and piers are found at Bayside Park, Featherstone shores, and Neabsco.

B. Characteristics of Fastlands

1. Natural Resources.

a) Soils and Slopes. (See Map 7)

Extreme slopes are associated with the minor stream valleys draining into the north side of Neabsco Creek. Additional severe slope conditions occur along the southern bank, near Neabsco and extending to Freestone Point. The portion of this segement which is most suitable for intensive urban development, to the west of Belmont Bay, is already almost entirely devoted to urban land uses. Conflicting land use zoning and suitability appears to occur, however, in the upper portion of the Farm Creek marsh system, which is programmed for heavy industrial use. While the remainder of the segment is primarily classified in the low density soil suitability zone, much of this land is committed or programmed for medium and high intensity urban land uses.

b) Vegetation and Wildlife. (See Map 6.)

Extensive woodlands are found in the hilly areas on either side of Neabsco Creek, to the south of existing urban development in the Marumsco Woods area. These forested areas are predominantly hardwood, with scattered pine and mixed pine-hardwood areas. Large expanses of wetlands occur in the Neabsco Creek system and to the east of the railroad tracks along Farm Creek. Both the forest lands and wetlands represent significant wildlife habitats, between them supporting such important hunting species as deer, wild turkey, quail, rabbit, squirrel, and fur-bearing mammals, such as the otter.

c) Waterways. (See Map 6.)

Belmont Bay and Neabsco Creek are the most significant water bodies in this segment. The only area susceptible to flooding, aside from the tidal marshes, is the Bayside Park area. According to the VIMS Shoreline survey (37), many structures here are below the 10-foot msl contour line, several of which might be inundated during periods of abnormally high water. The extensive Neabsco Creek wetlands system provides both flood protection and water quality benefits in its present state, including the filtering of effluent from a sewage treatment plant on its southern shore.

2. Man-made Resources

a) Land use. (See Maps 8 and 9)

Most of the upper portion of Segment 2 is presently in urban development, including commercial, medium density residential, and townhouse land uses. A section to the northwest of Neabsco Creek is zoned for a similar mixture of urban uses. Much of the southern bank of Neabsco Creek is committed to medium density residential development, with some commercial land uses existing at Neabsco. Plans for a large public park in the historical Freestone Point area are currently being developed.

b) Developments of Regional Benefit

There are no developments of greater than local significance in this segment.

SEGMENT 3: Freestone Point to Cockpit Point

A. Characteristics of Shoreline. (See Map 10.)

1. Natural Resources

a) Wetlands. The total area of wetlands in Segment 3 is approximately 212 acres. Individual wetlands locations are as follows:

(1) Powell's Creek. Area: 123 acres; VIMS SITE #: 16; VIMS TYPE #: XI

A large creek marsh is found at the mouth of Powell's Creek, the lowest downstream portions of which are dominated by pickerel weed and yellow pond lily. Wild rice and pickerel weed dominate the interior of the marsh, while the uplands and woody swamp are bordered by cattails, hibiscus and smartweeds. This marsh is a valuable fish nursery and spawning area as well as a wildlife habitat.

(2) Powell's Creek. Area: 89 acres

A fringe marsh extends along either side of the mouth of Powell's Creek.

b) Beaches. (Length: 2.2 miles)

There are beaches of fair to good quality for recreational use along the Potomac shore in this segment, with some long stretches of wide, clean beaches.

c) Bluffs. (Length: 0.34 mile)

The small bluff area in this segment is located adjacent to the fringe marsh on Powell's Creek.

2. Man-made Resources. Ownership of Segment 3 shoreline is completely private.

a) Shore Protection Structures. (Length: 0.2 mile)

There is one groin located along a beach area which VIMS has judged to be effective.

b) Shorefront Recreational Facilities.

There is one large fishing pier and a boathouse on the Potomac beach.

B. Characteristics of Fastlands

1. Natural Resources.

a) Soils and Slopes. (See Map 11.)

Much of the area bordering Powell's Creek is characterized by soil and

slope conditions which are unsuitable for urban development. The majority of the developed land in this segment is most suitable for low density residential development or conservation uses, with small scattered areas also suitable for medium or high density development. Access to much of this area is hindered by steep slope conditions which may reduce the feasibility of higher density urban development in this segment.

b) Vegetation and Wildlife (See Map 10.)

The majority of the segment (77%) is in unmanaged woodlands. There is some waterfowl hunting in the marshy areas of Powell's Creek. Bald eagles are found along the coast with small fur-bearing mammals such as muskrats, otters and beavers inhabiting the waterway areas. Turkey and deer are also commonly found in this segment. Existing wildlife habitats may be threatened by intensive urban development in this area.

c) Waterways (See Map 10.)

Powell's Creek is the major water body in this segment. The land rises rapidly from the coast and is not subject to flooding in most of this segment, except for the marshy areas around the mouth of Powell's Creek. Sport boating and fishing are common in this area.

2. Man-made Resources.

a) Land Use. (See Maps 12 and 13.)

Approximately one-half of the shoreline of this segment is zoned for industrial use while the northern shore is designated for parkland. Much of the land area in the interior of the segment is currently devoted to single family or townhouse developments. Large areas remain uncommitted, with most of the committed areas designated for single family homes and townhouses.

b) Developments of Regional Benefits/Key Facilities

A future public park at Freestone Point is planned for this segment.

SEGMENT 4: Cockpit Point to Shipping Point

A. Characteristics of Shorelands. (See Map 14.)

1. Natural Resources

a) Wetlands . Segment 4 contains a total of 242 acres of wetlands. Individual sites include:

(1) Lower Quantico Creek. Area: 4 acres; VIMS SITE #: 8; VIMS TYPE #: XI

This is a spit marsh with diverse, high marsh flora, such as hibiscus and water hemp, and a pickerel weed fringe.

(2) Middle Quantico Creek. Area: 17 acres; VIMS SITE #: 9; VIMS TYPE #: XI
This site contains a large pocket marsh of low elevation which is dominated by pickerel weed and yellow pond lily, with other species along the landward border.

(3) Middle Quantico Creek. Area: 3 acres; VIMS SITE #: 10; VIMS TYPE #: XI
A low elevation spit marsh which is dominated by pickerel weed and pond lily, is also found midway up Quantico Creek.

(4) Upper Quantico Creek. Area: 109 acres; VIMS SITE #: 11; VIMS TYPE #: XI
A large, fringing marsh with yellow pond lily extends onto tidal flats in Upper Quantico Creek while pickerel weed and wild rice dominate the interior of this wetlands site.

(5) Upper Quantico Creek. Area: 106 acres; VIMS SITE #: 12; VIMS TYPE #: XI
A large creek marsh with yellow pond lily is located along the channels and the entire lower section of Upper Quantico Creek. Pickerel weed and wild rice dominate the interior of this site.

(6) Middle Quantico Creek. Area: 1 acre; VIMS SITE #: 13; VIMS TYPE #: VI
This is a small pocket marsh dominated by cattails.

(7) Middle Quantico Creek. Area: 1 acre; VIMS SITE #: 14; VIMS TYPE #: XI
An additional small pocket marsh which is dominated by cattails and reed grass is found in the middle section of Quantico Creek. The reed grass indicates that the marsh has been disturbed, probably by fill.

(8) Middle Quantico Creek. Area: 1 acre; VIMS SITE #: 15; VIMS TYPE #: XI
This site contains a small fringing marsh with pickerel weed along the water channel and marsh hibiscus dominating the interior.

b) Beaches. (Length: 4.7 miles)
Beaches in Segment 4 are fair to poor quality for recreation use. There are several beach areas in the northern part of this segment that are fairly wide, but most of the beaches in the segment are narrow, strip beaches.

c) Bluffs. (Length: 0.9 miles)
Bluffs in this segment are located along the Potomac shore. The bluffs north of the VEPCO substation at Possum Point are experiencing slight to moderate erosion, due primarily to downhill rain and wave actions. Another small bluff area is found at Possum Nose, just south of Cockpit Point.

2. Man-made Resources. Segment 4 shoreline is seventy-seven percent in private ownership and twenty-three percent in Federal ownership. Man-made shoreline features are as follows:

a) Shore Protection Structures. (Length: 0.9 miles)

There are 3000 feet of stabilization structures near Possum Point for the VEPCO substation and 1800 feet of bulkheading in Quantico Creek, primarily for individual residential land uses.

b) Shorefront Recreation Facilities.

There are several private piers in this segment and a large pier at the substation site, but no developed public access sites.

B. Characteristics of Fastlands

1. Natural Resources.

a) Soils and Slopes (See Map 15.)

Much of the land in this segment is classified as most suitable for low density use. The presence of steep slopes in the segment, especially within the Cherry Hill area, may limit access to developable areas. There are also many marshy areas around Quantico Creek. Further urban development inland from the marsh system should include nonpoint pollution and stormwater management controls.

b) Vegetation and Wildlife (See Map 14.)

Approximately one-half of this segment is wooded and undeveloped. This segment is inhabited by small fur-bearing mammals, turkey, and deer, and is frequented by the bald eagle. The Cherry Hill area, flanked by marshlands and the estuarine system and representing the largest, privately-owned undeveloped area in the Prince William coastal zone, provides significant opportunity for public, low-intensity outdoor recreational uses.

c) Waterways (See Map 14.)

Quantico Creek is the major body of water in this segment. The majority of the shoreline in this segment is characterized by average elevations of 20 feet msl, minimizing flooding potential.

2. Man-made Resources. (See Maps 16 and 17.)

a) Land use.

The shoreline of the northern portion of this segment is currently either in industrial use or zoned for industrial use. A VEPCO power station is the major existing industrial site and is located along the southern shore of this segment. Some single family and townhouse developments exist in the segment interior. While there are some areas zoned for single family use, large areas of this segment remain uncommitted to development. Land use on the south side of Quantico Creek is dominated by the Quantico Marine Corps Base.

b) Developments of Regional Benefit/Key Facilities

A VEPCO power plant substation is located near Possum Point. The Richmond, Fredericksburg and Potomac Railroad line runs along the Potomac shoreline.

SEGMENT 5: Shipping Point to Chopawamsic Creek

A. Characteristics of Shorelands. (See Map 18.)

1. Natural Resources

a) Wetlands. The total area of wetlands in Segment 5 is 115 acres. Individual wetland sites include:

(1) Chopawamsic Creek. Area: 27 acres; VIMS SITE #: 1; VIMS TYPE #: VII

Numerous low elevation marsh islands which are primarily mudflats during the winter, lie in this area along the Prince William/Stafford County line.

(2) Upper Chopawamsic Creek. Area: 28 acres; VIMS SITE #: 3; VIMS TYPE #: IX

A creek marsh of low elevation is located along the southern boundary of the Marine Corps Base with cattails found along the landward border.

(3) Chopawamsic Creek. Area: 19 acres; VIMS SITE #: 3; VIMS TYPE #: XI

A pond lily and pickerel weed fringe is found near the mouth of the creek. with other marsh species found along the landward edge.

(4) Chopawamsic Creek. Area: 32 acres; VIMS SITE #: 4; VIMS TYPE #: XI

A fringing marsh extends just northwest of the Marine Corps Air Station, with a large number of cattails in the higher elevations.

(5) Chopawamsic Island. Area: 4 acres; VIMS SITE #: 5; VIMS TYPE #: XI

A freshwater high marsh is found on the northern end of the island, dominated by hibiscus.

(6) Quantico. Area: 2 acres; VIMS SITE #: 6; VIMS TYPE #: VI

This marsh, located across from Chopawamsic Island and north of the air strip, has been disturbed, with the lower portion largely filled.

(7) Lower Quantico Creek. Area: 3 acres; VIMS SITE #: 7; VIMS TYPE #: VII

A low elevation marsh, adjacent to the Quantico Creek railroad bridge, is dominated by pickerel weed and water hemp.

b) Beaches. (Length: 1.44 miles)

The beach areas in this segment, scattered along the Potomac shore, are of poor quality.

c) Bluffs. (Length: 0.1 mile)

The small bluff area in this segment is located adjacent to a fringe marsh area along Chopawamsic Creek.

2. Man-made Resources. Only eight percent of Segment 5 is in private ownership. The remainder is in federal ownership in the Quantico Marine Corps Base. Man-made shoreline features include:

a) Shore Protection Structures. (Length: 1.44 miles)

Stabilization structures are located along the Potomac shore at the town of Quantico. Stabilization on Chopawamsic Island has failed to halt the moderate erosion occurring at its southern end.

b) Shorefront Recreational Facilities

There are two large piers at the Headquarters Battalion Boat Dock with several boat slips.

B. Characteristics of Fastlands

1. Natural Resources.

a) Soils and Slopes (See Map 19.)

Soil and slope conditions are mixed in this segment, with the low density soil suitability zone predominating as it has in other segments. Principle unsuitable areas are found along the major creeks and stream valleys.

b) Vegetation and Wildlife (See Map 18.)

The majority of this segment is in mature hardwoods, comprising an extensive habitat area which is broken up only occasionally by Marine Corps Base facilities. Chopawamsic Creek's extensive marsh system also supports a variety of bird, waterfowl, and wildlife species.

c) Waterways (See Map 18.)

Chopawamsic Creek and the Potomac River constitute the principle waterways in this segment. Public access to these waterways is limited by federal government ownership of the entire shoreline.

2. Man-made Resources

a) Land use. (See Maps 20 and 21.)

With the exception of Chopawamsic Island and the Town of Quantico, the entire segment is in military use, precluding private development for the forseeable future.

b) Developments of Regional Benefit

The Quantico Marine Corps Base is a major military installation from a national perspective.

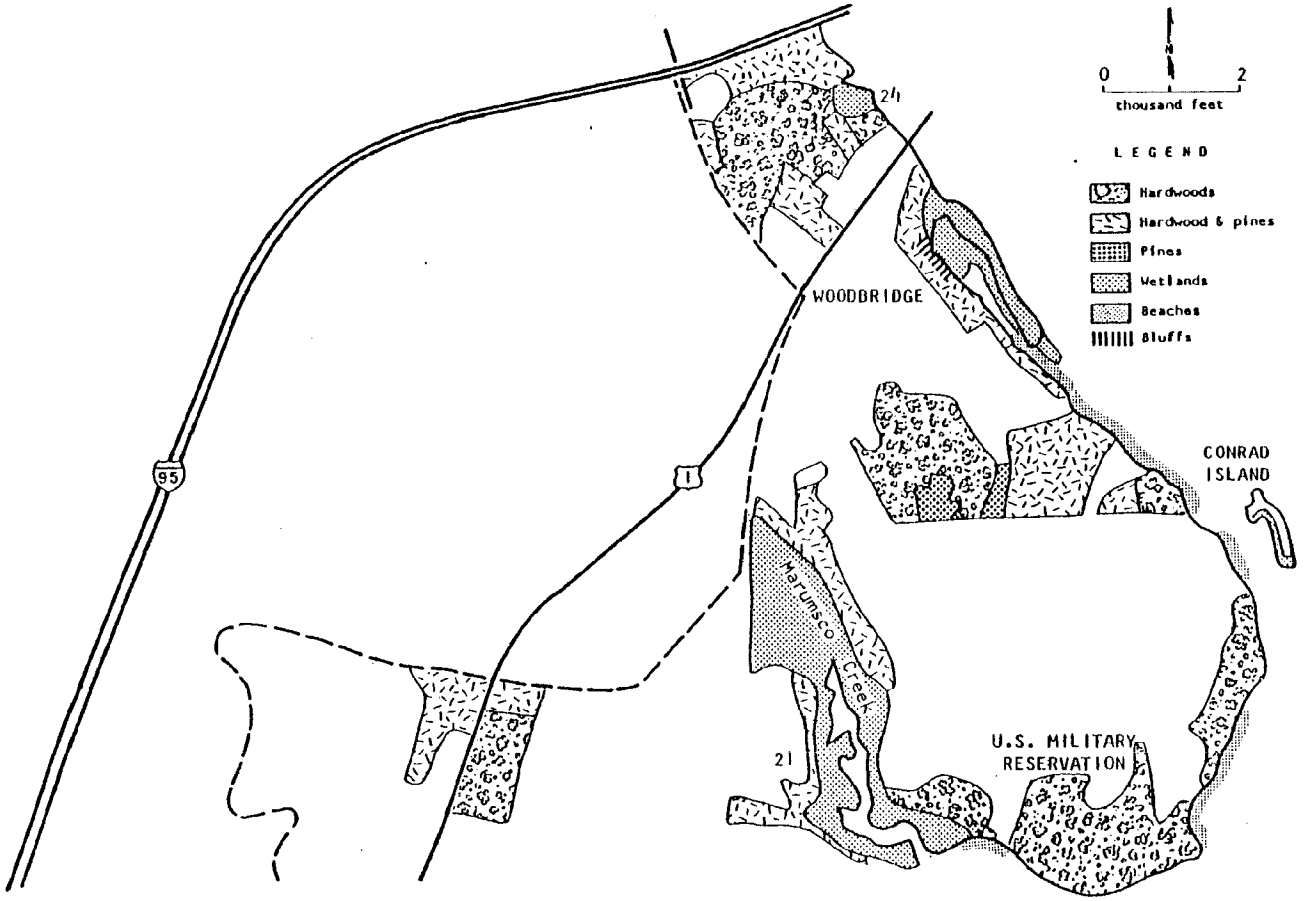
Summary of Chapters II and III.

The inventory of coastal resources in Prince William County indicates both problems and opportunities for those planning for and using the land and water resources of the County's coastal zone. Problems, such as increased nonpoint pollution and the degradation of wetlands, are likely to arise as development pressure continues to be experienced in proximity to the area's critical environmental resources. The soil suitability maps shown in Chapter III illustrate the natural constraints to land development in much of the County's undeveloped coastal zone. The extensive marshes and forest lands remaining in the coastal zone provide significant opportunities for the establishment of public open space and recreational areas to serve the growing number of residents of the County.

Chapter II provides suggestions for maximizing the using of the County's coastal resources while causing the least damage to natural coastal systems. A balanced land use planning and management program is offered which combines both structural and nonstructural measures to minimize land development impacts on the natural environment, while minimizing the costs associated with implementing such measures. The success of such a program requires the cooperation of government officials, land developers, and individual landowners in the coastal zone.

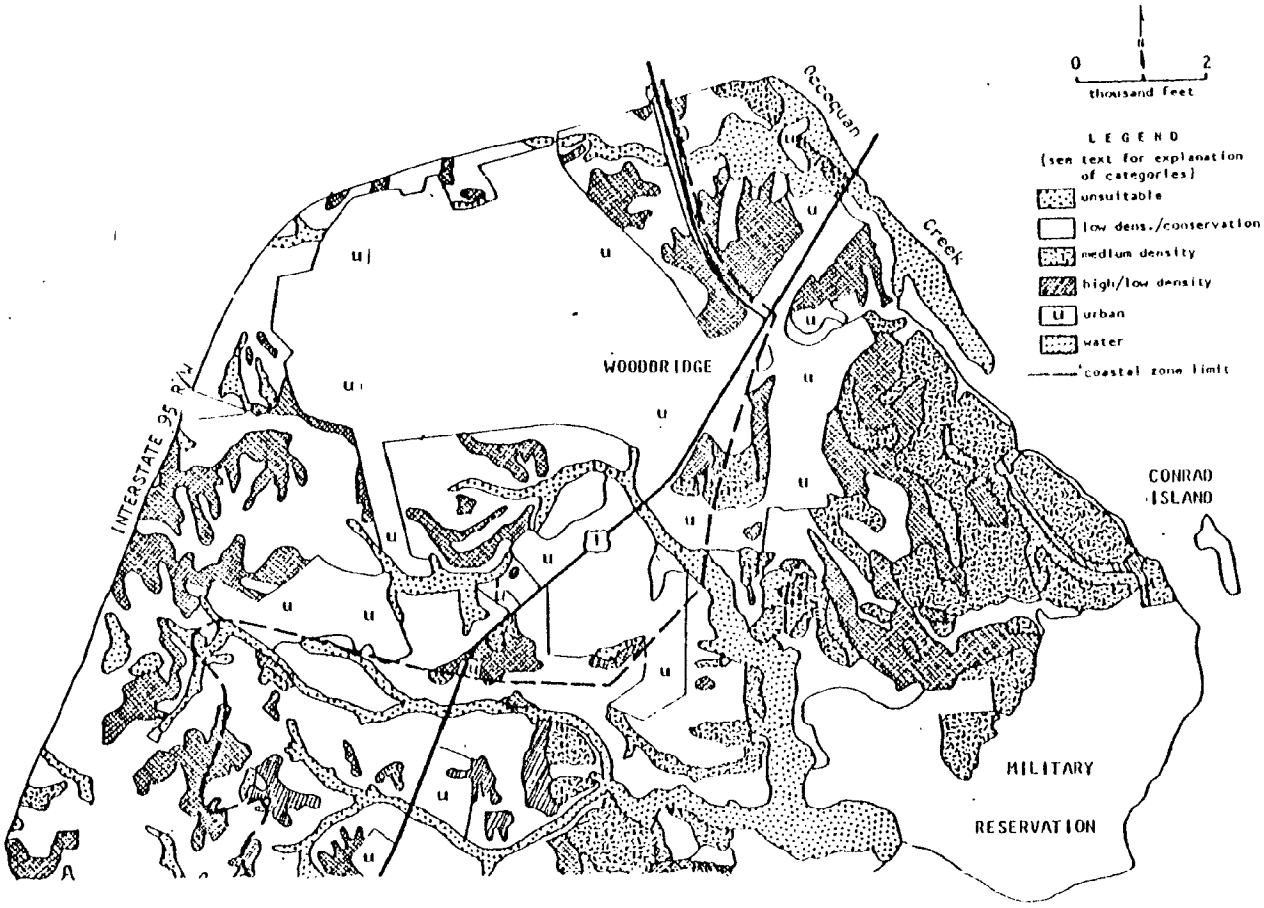
MAP 2

SEGMENT I: NATURAL RESOURCES



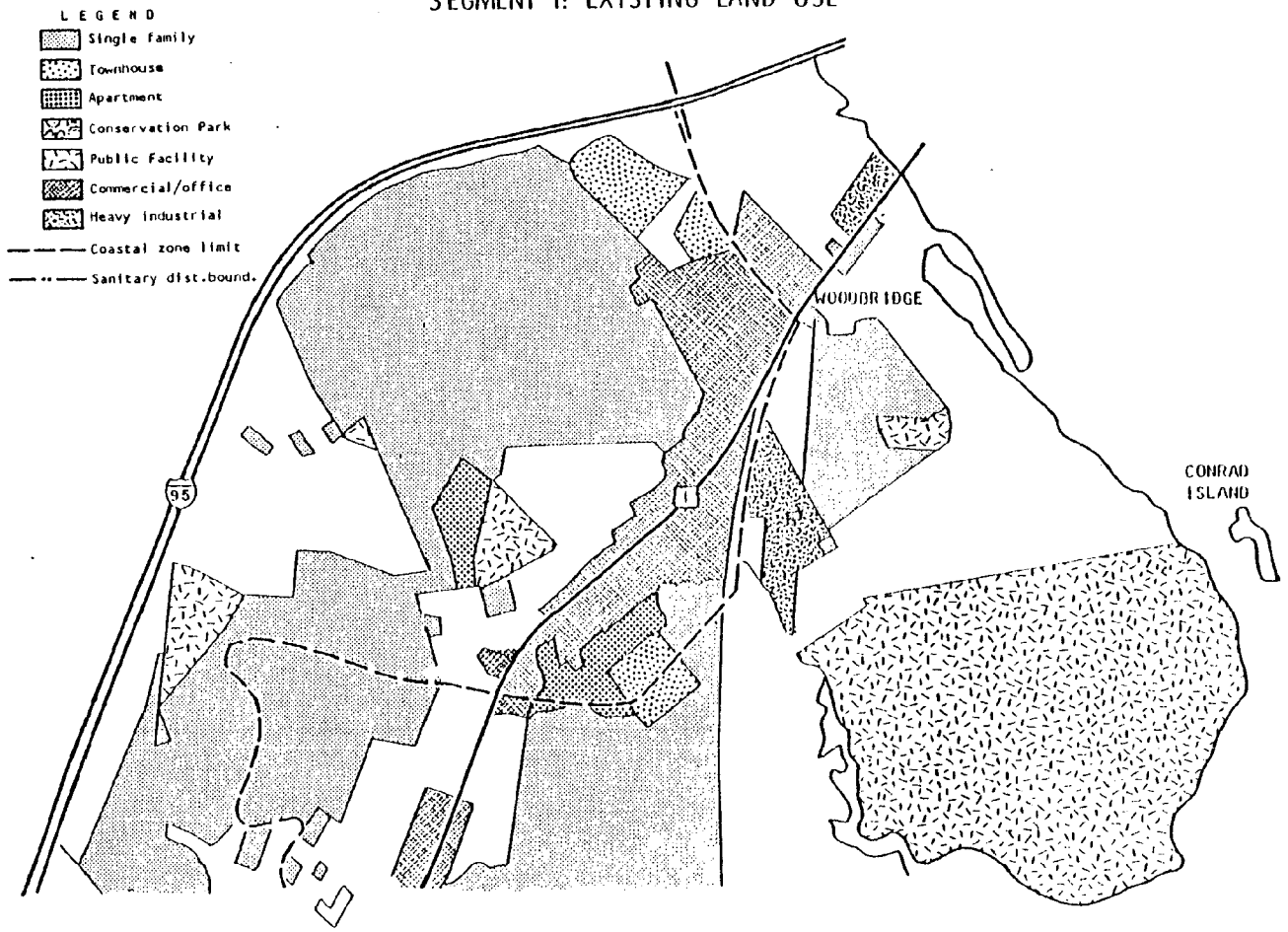
MAP 3

SEGMENT I; SOIL SUITABILITY ZONES



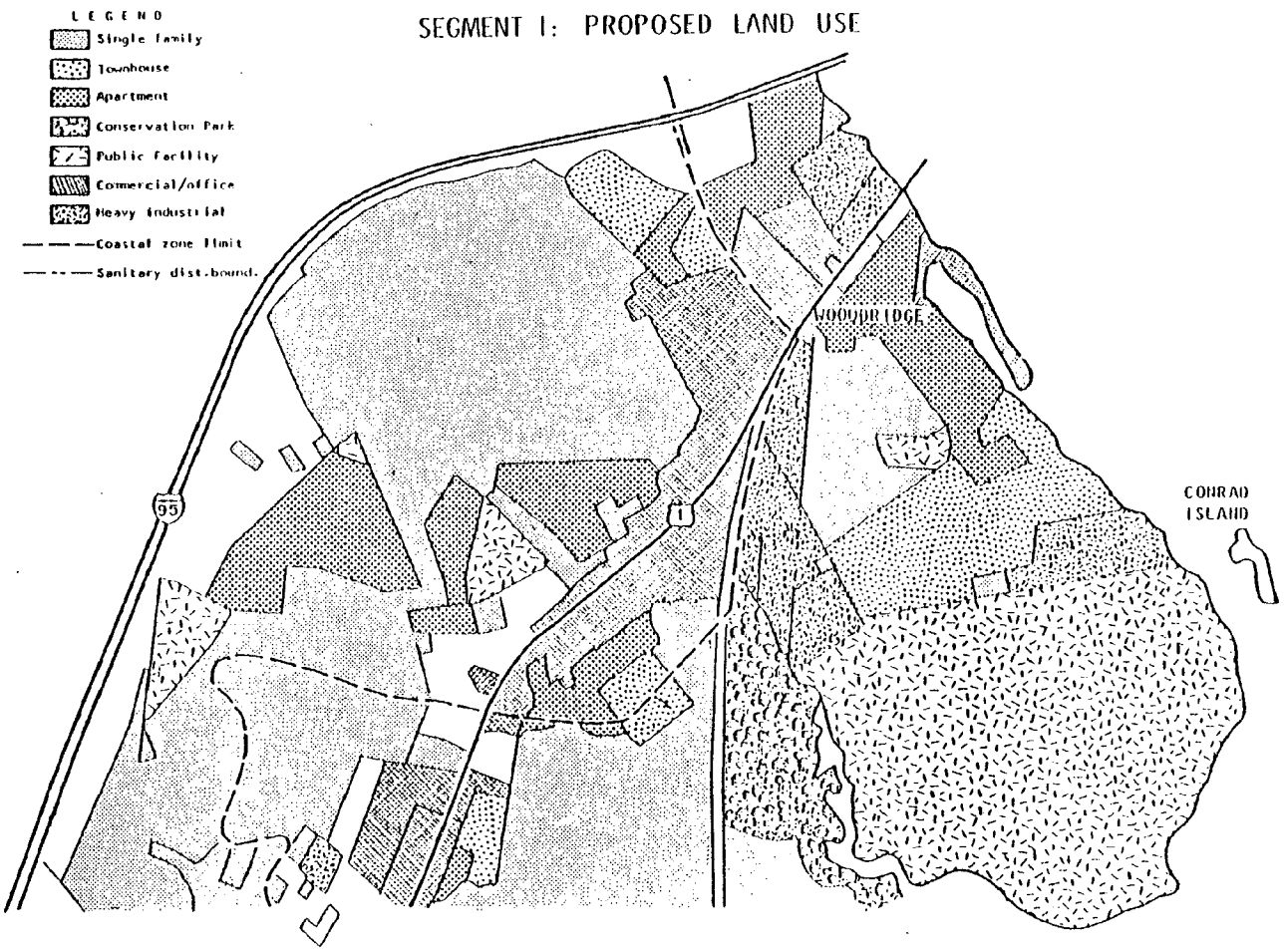
MAP 4

SEGMENT I: EXISTING LAND USE



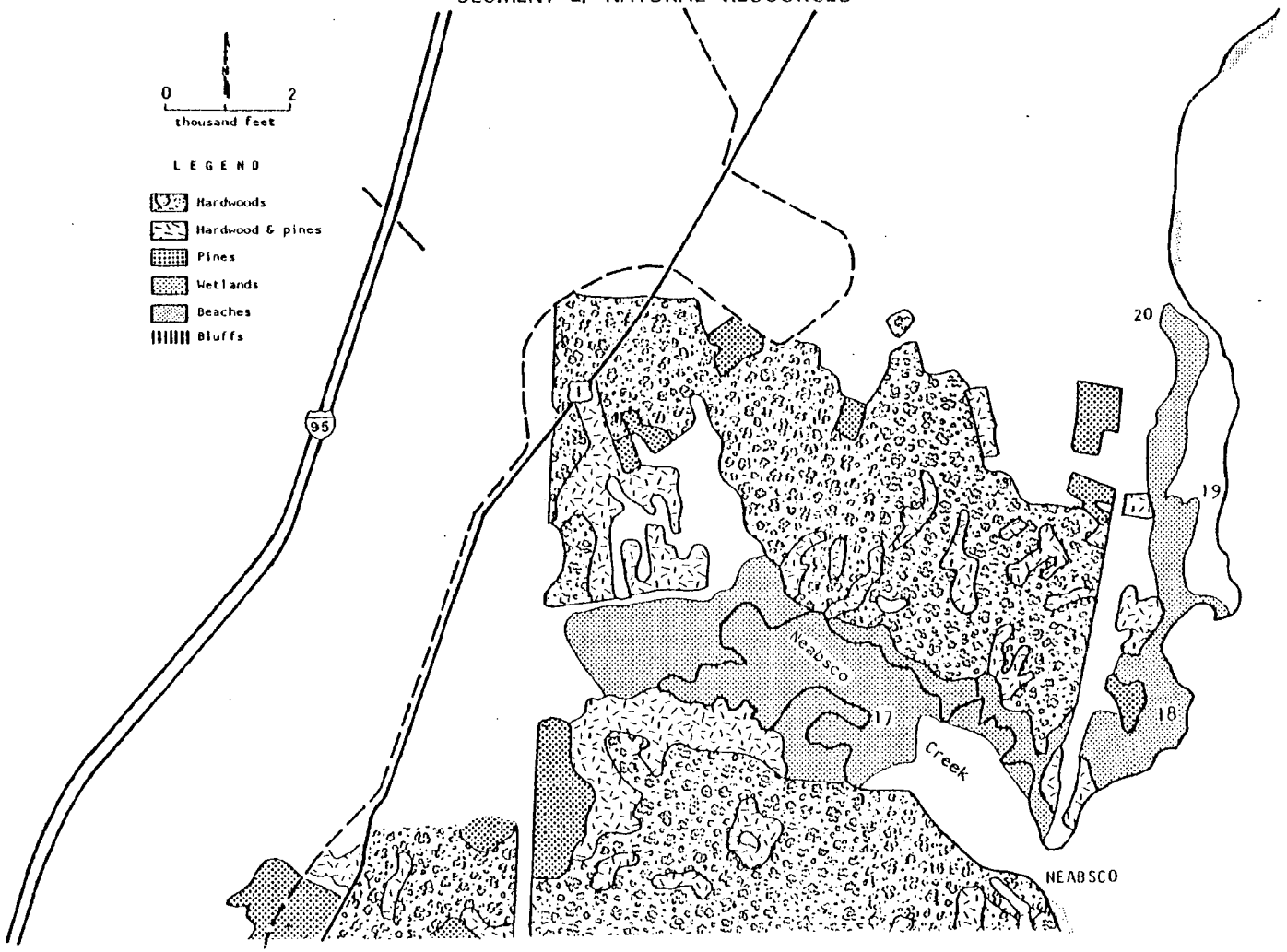
MAP 5

SEGMENT I: PROPOSED LAND USE



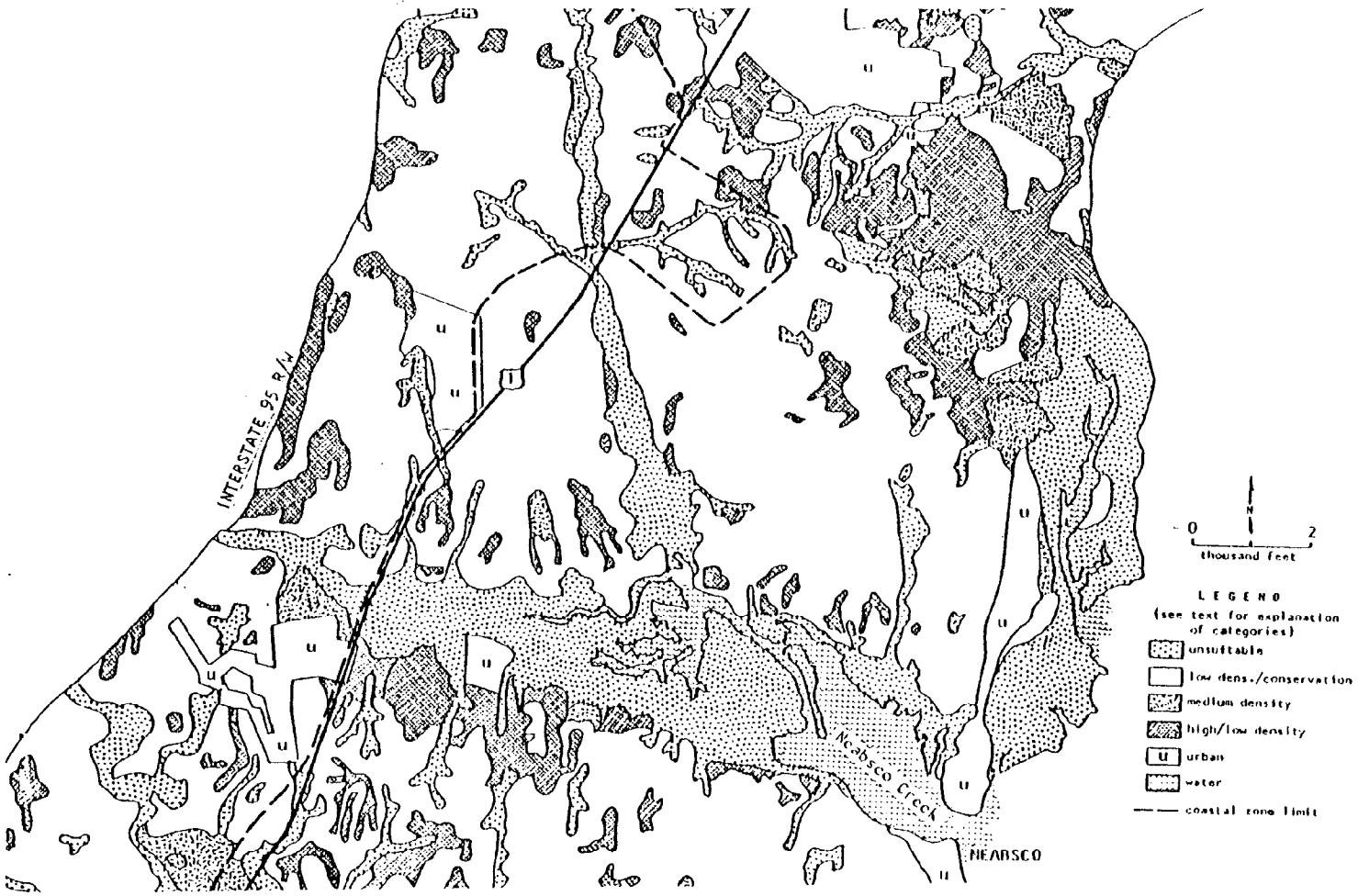
MAP 6

SEGMENT 2: NATURAL RESOURCES



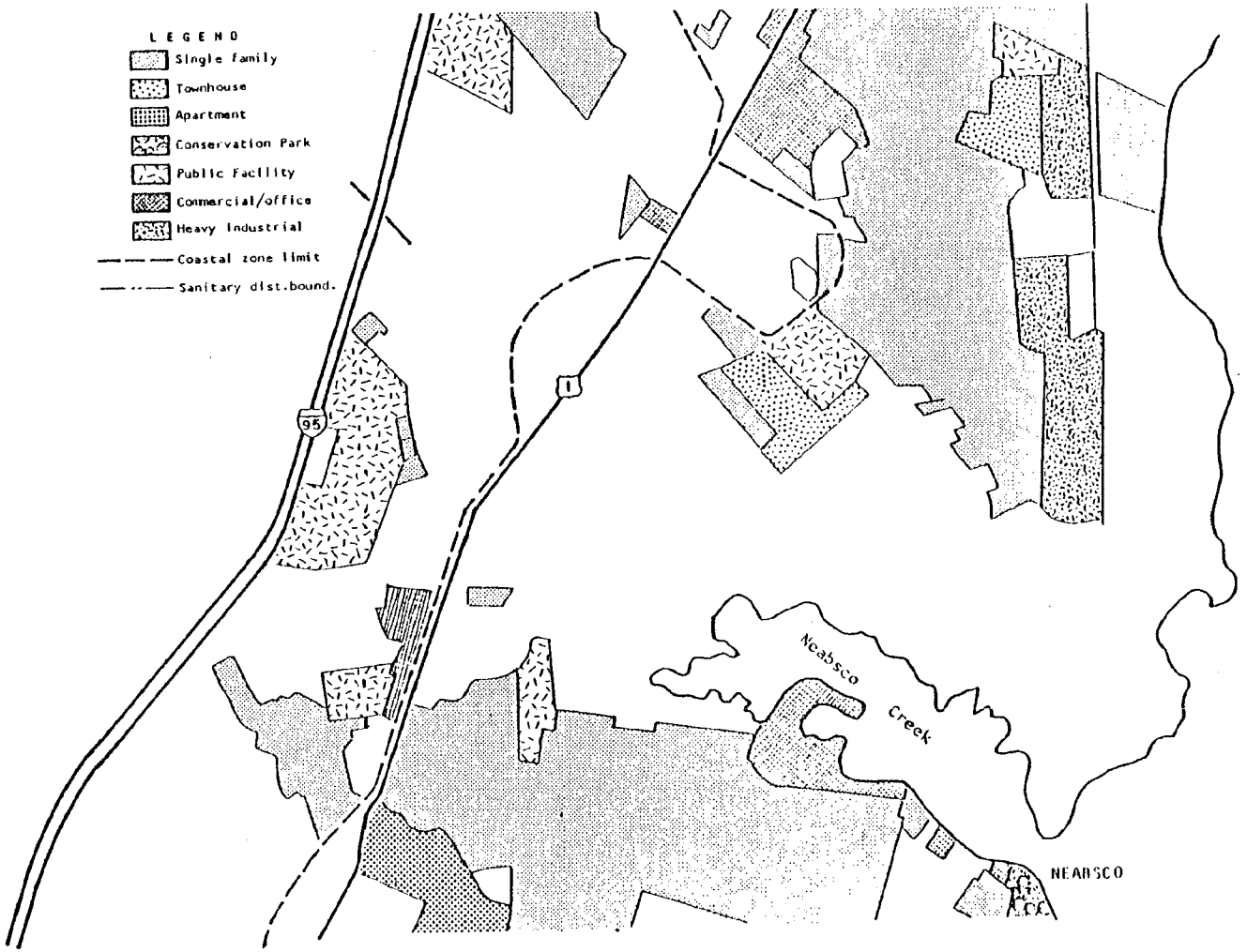
MAP 7

SEGMENT 2: SOIL SUITABILITY ZONES



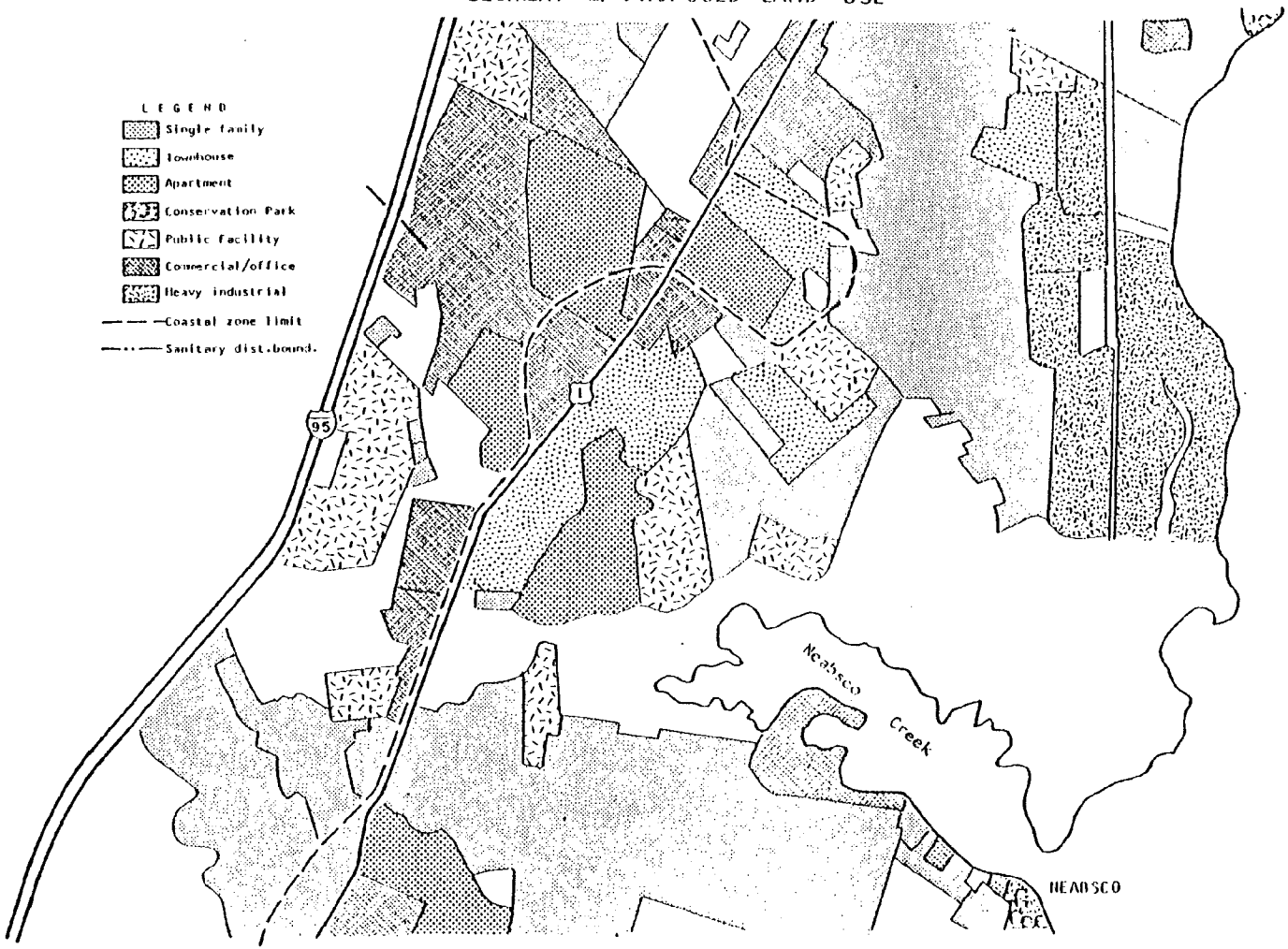
MAP 8

SEGMENT 2: EXISTING LAND USE



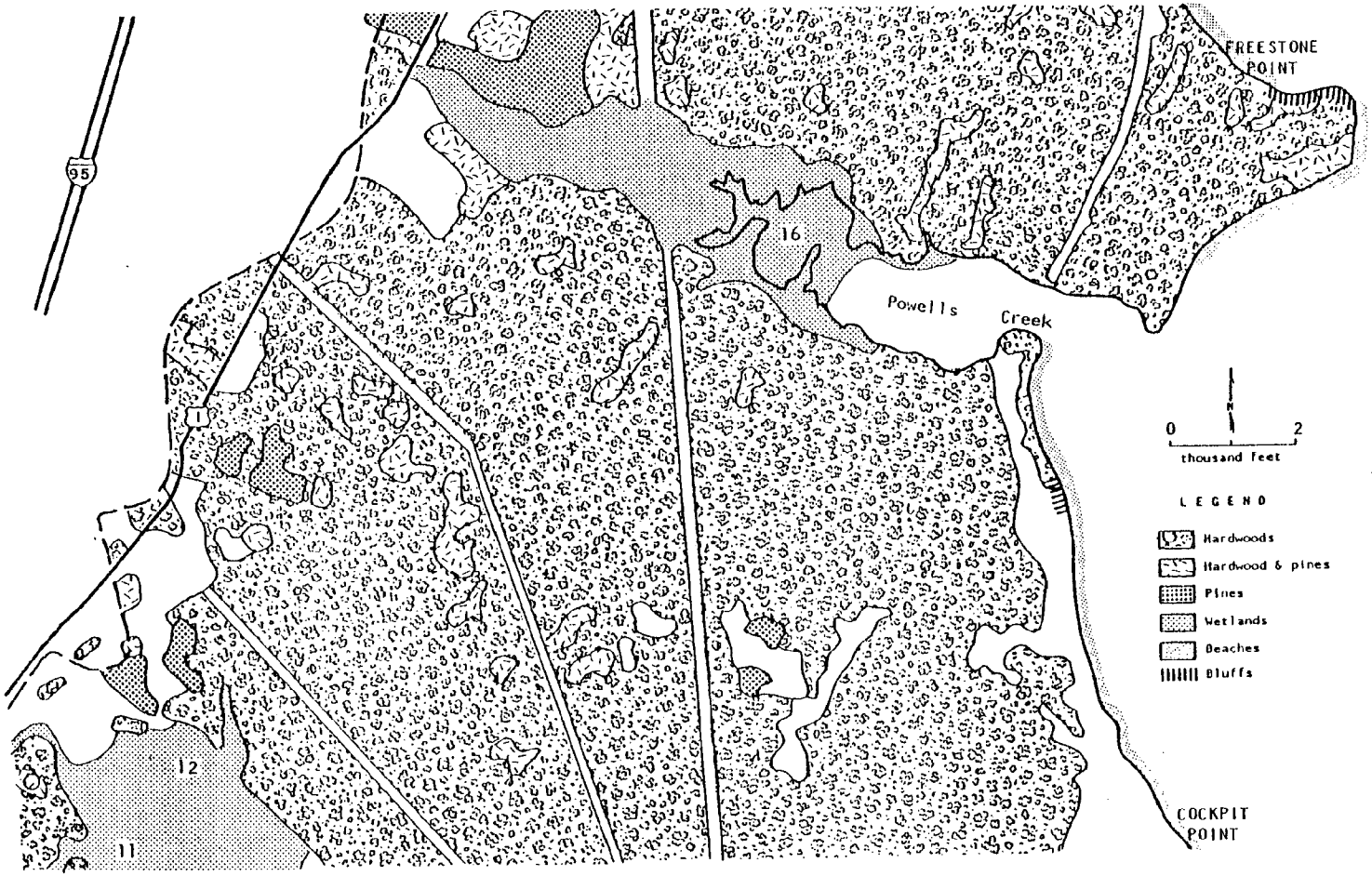
MAP 9

SEGMENT 2: PROPOSED LAND USE



MAP 10

SEGMENT 3: NATURAL RESOURCES

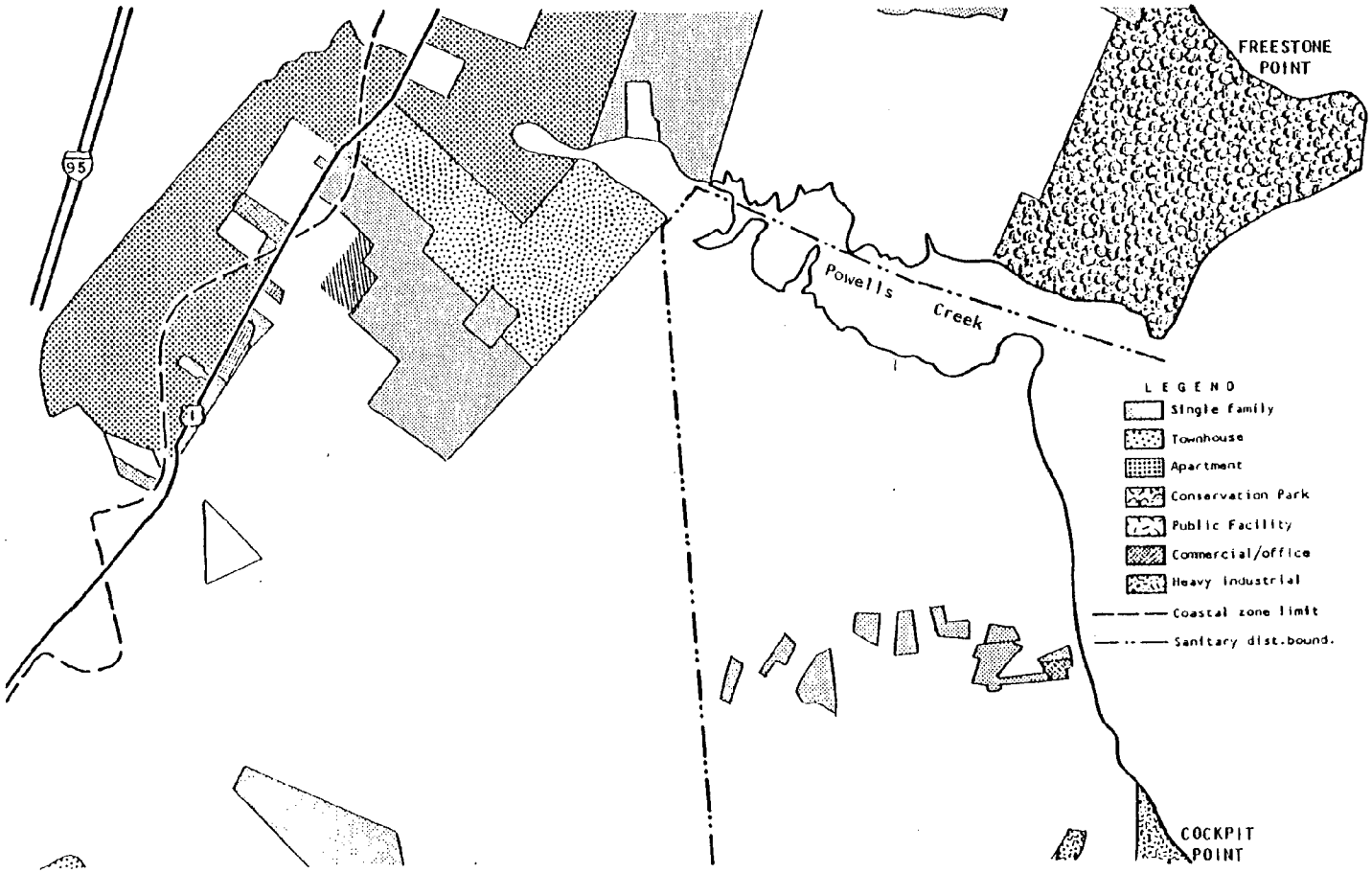


MAP 11

SEGMENT 3; SOIL SUITABILITY ZONES

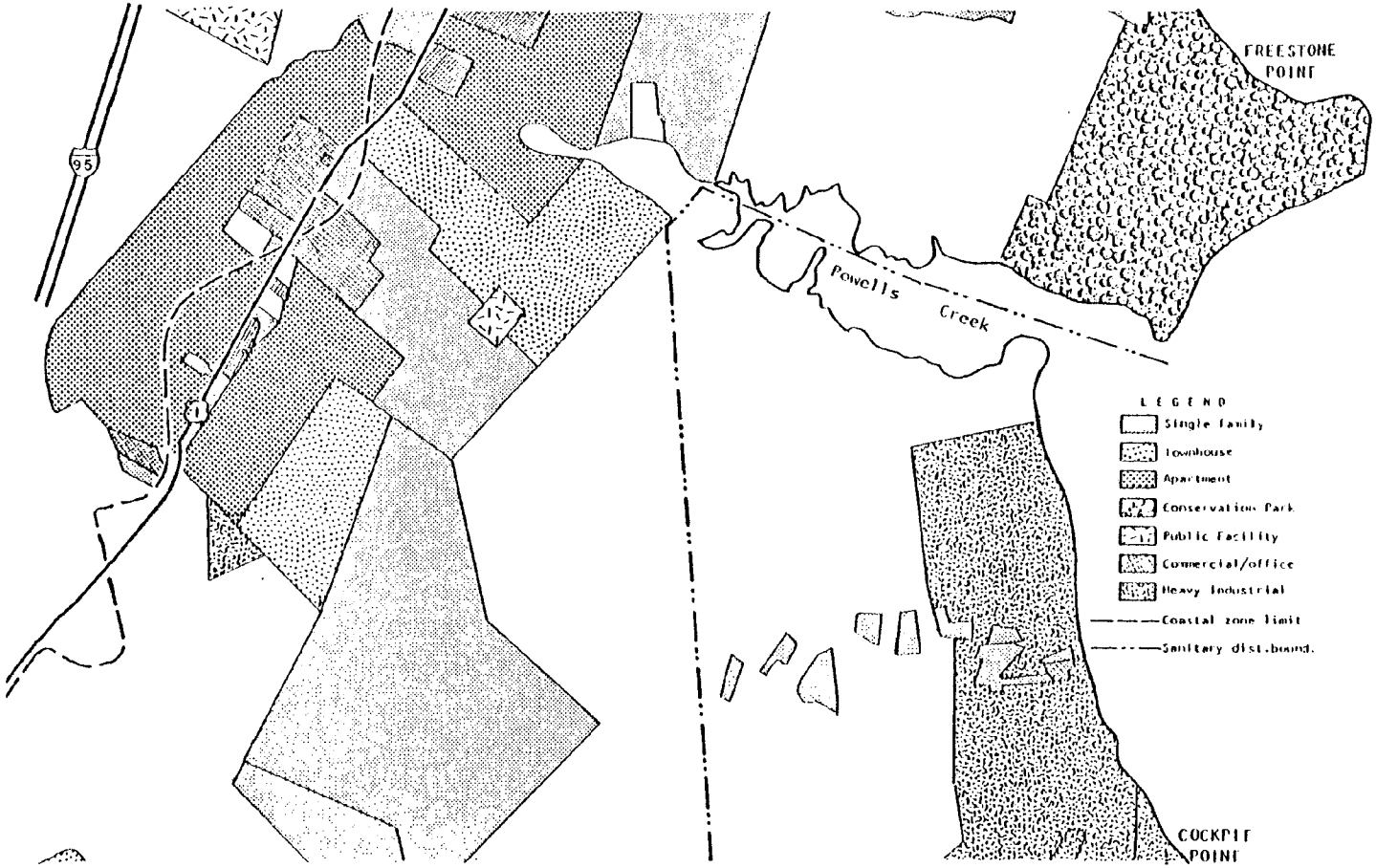
MAP 12

SEGMENT 3: EXISTING LAND USE



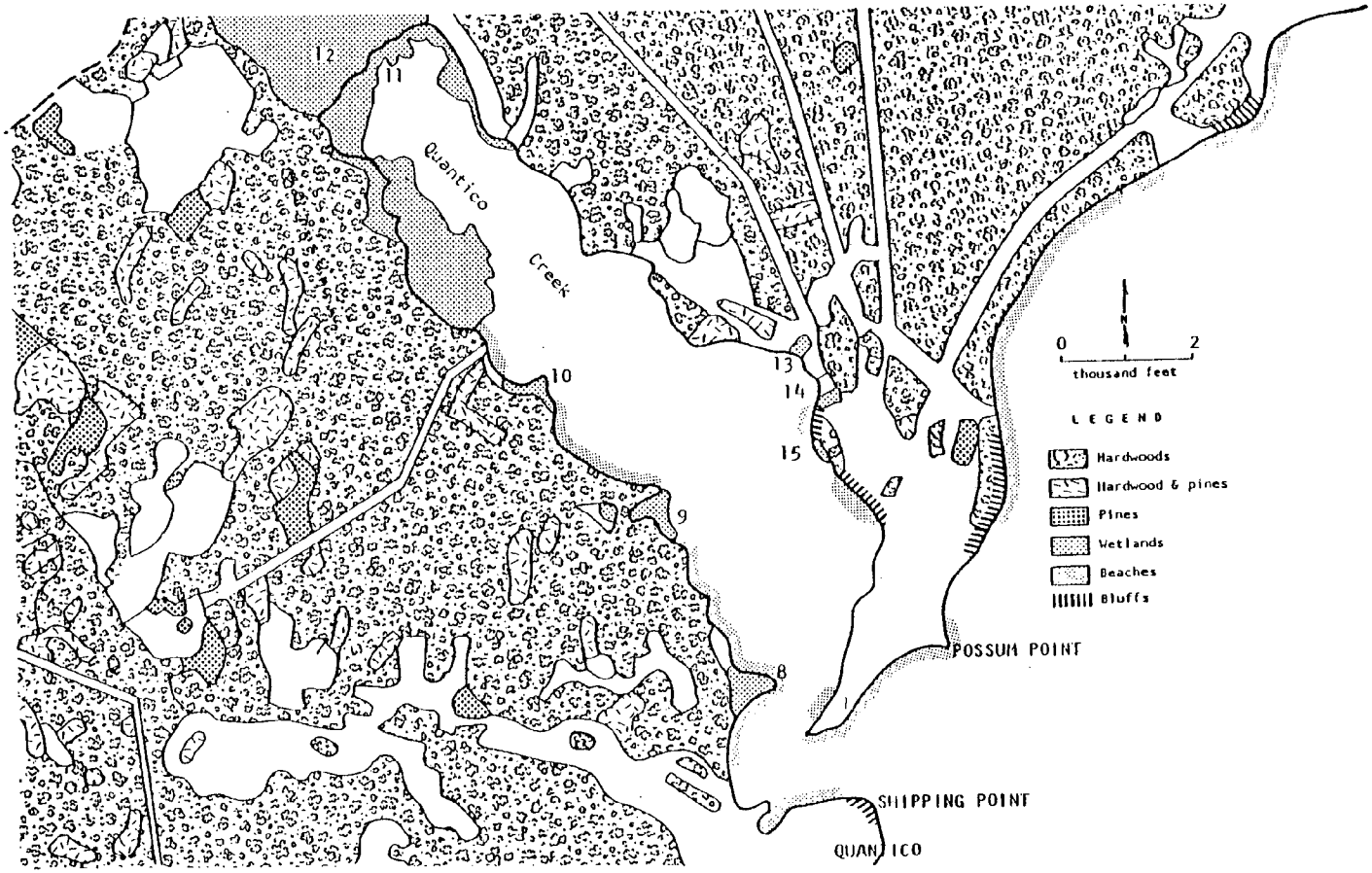
MAP 13

SEGMENT 3: PROPOSED LAND USE



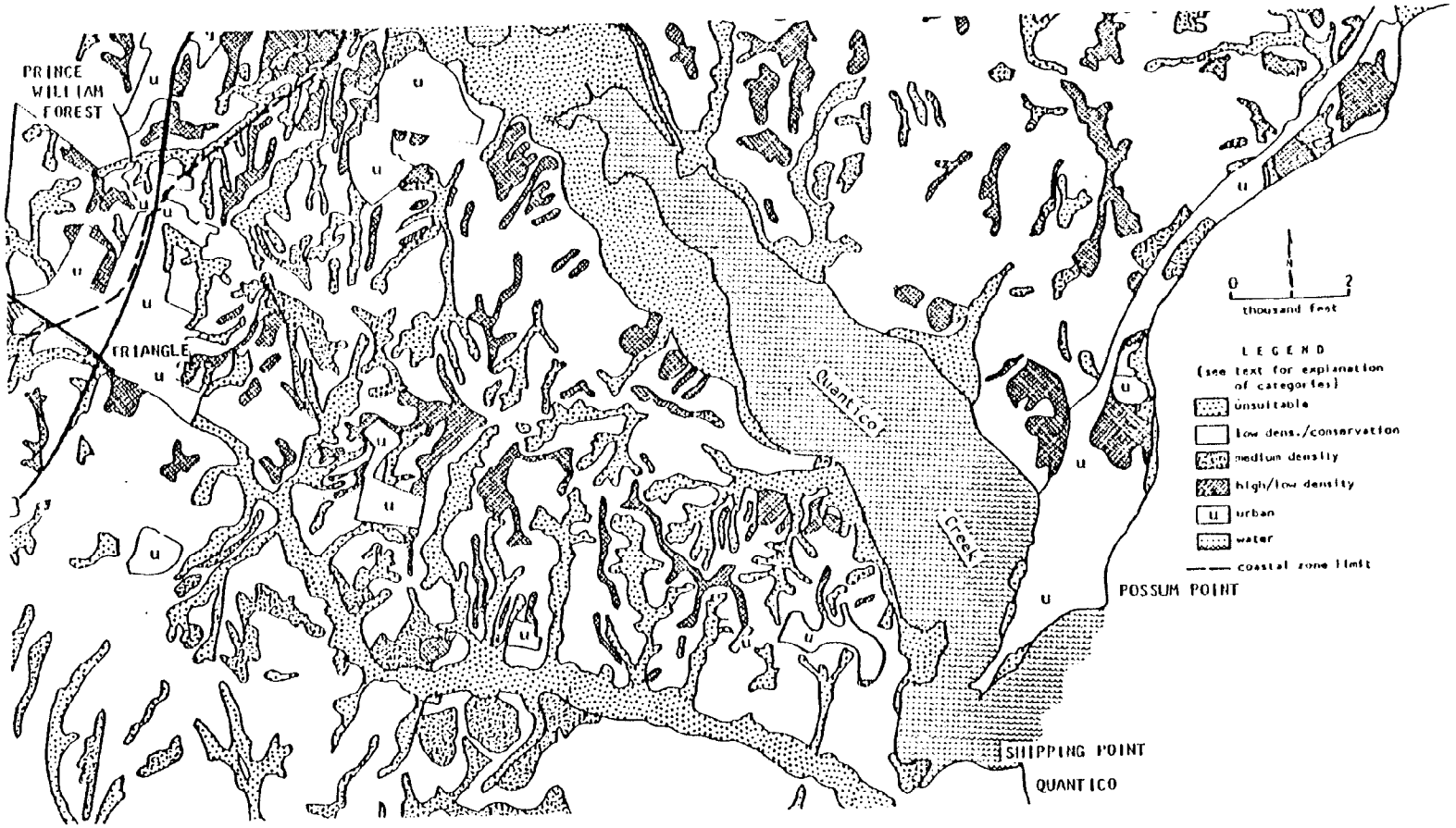
MAP 14

SEGMENT 4: NATURAL RESOURCES

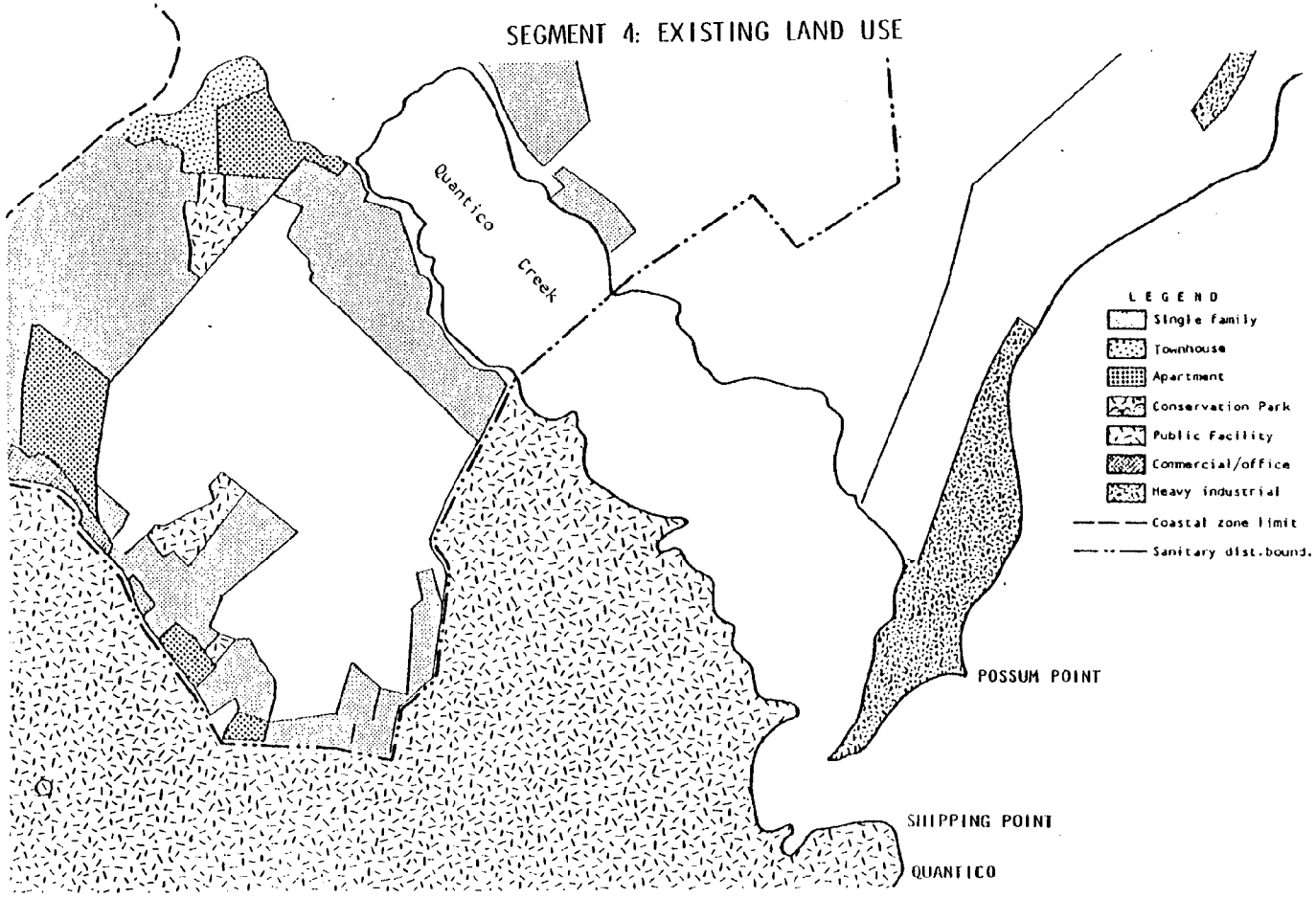


MAP 15

SEGMENT 4; SOIL SUITABILITY ZONES

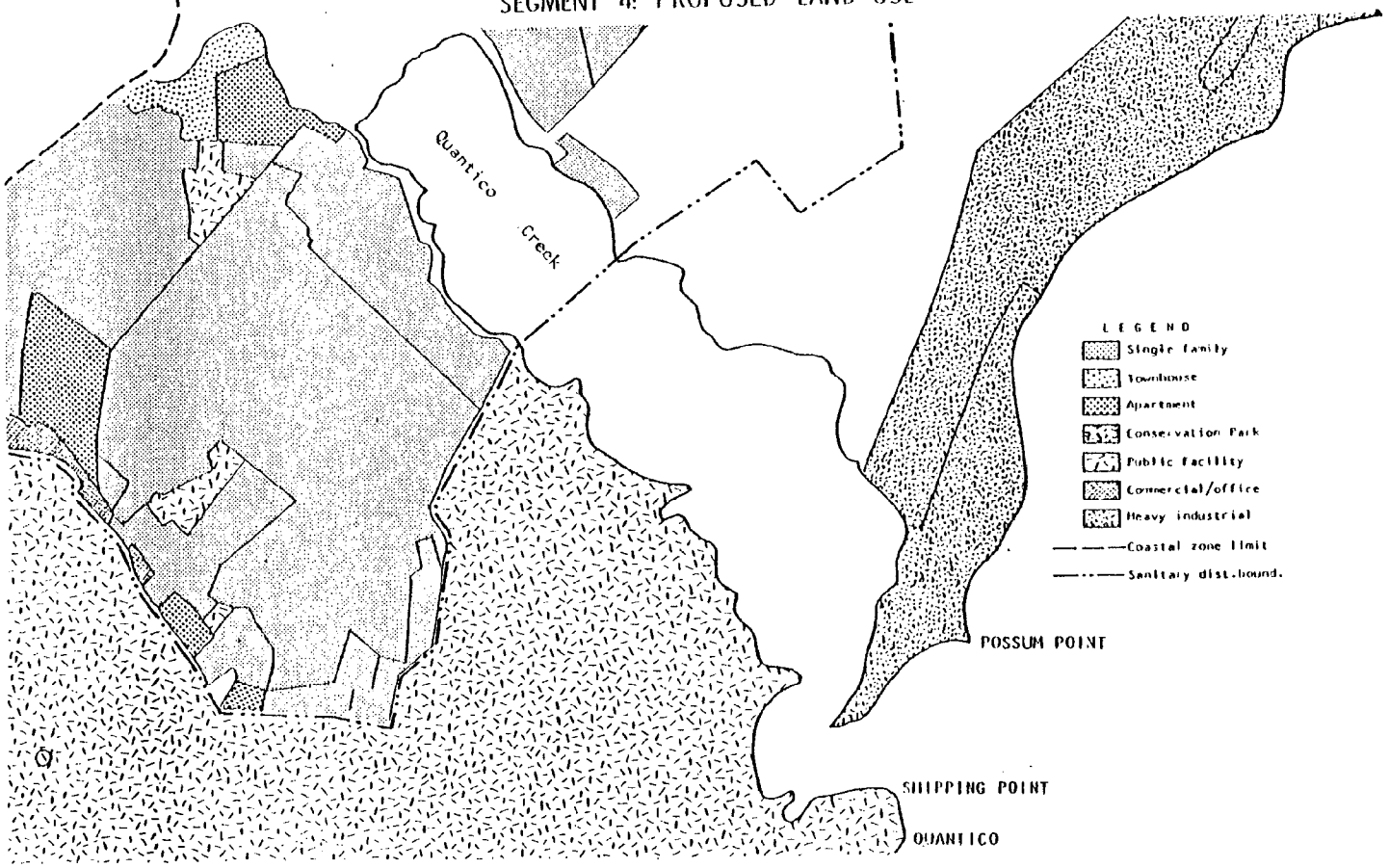


MAP 16


SEGMENT 4: EXISTING LAND USE
Quantico Creek
LEGEND
Single family
Townhouse
Apartment
Conservation Park
Public Facility
Commercial/office
Heavy industrial
Coastal zone limit
Sanitary dist.bound.
POSSUM POINT
SHIPPING POINT
QUANTICO

MAP 17

SEGMENT 4: PROPOSED LAND USE

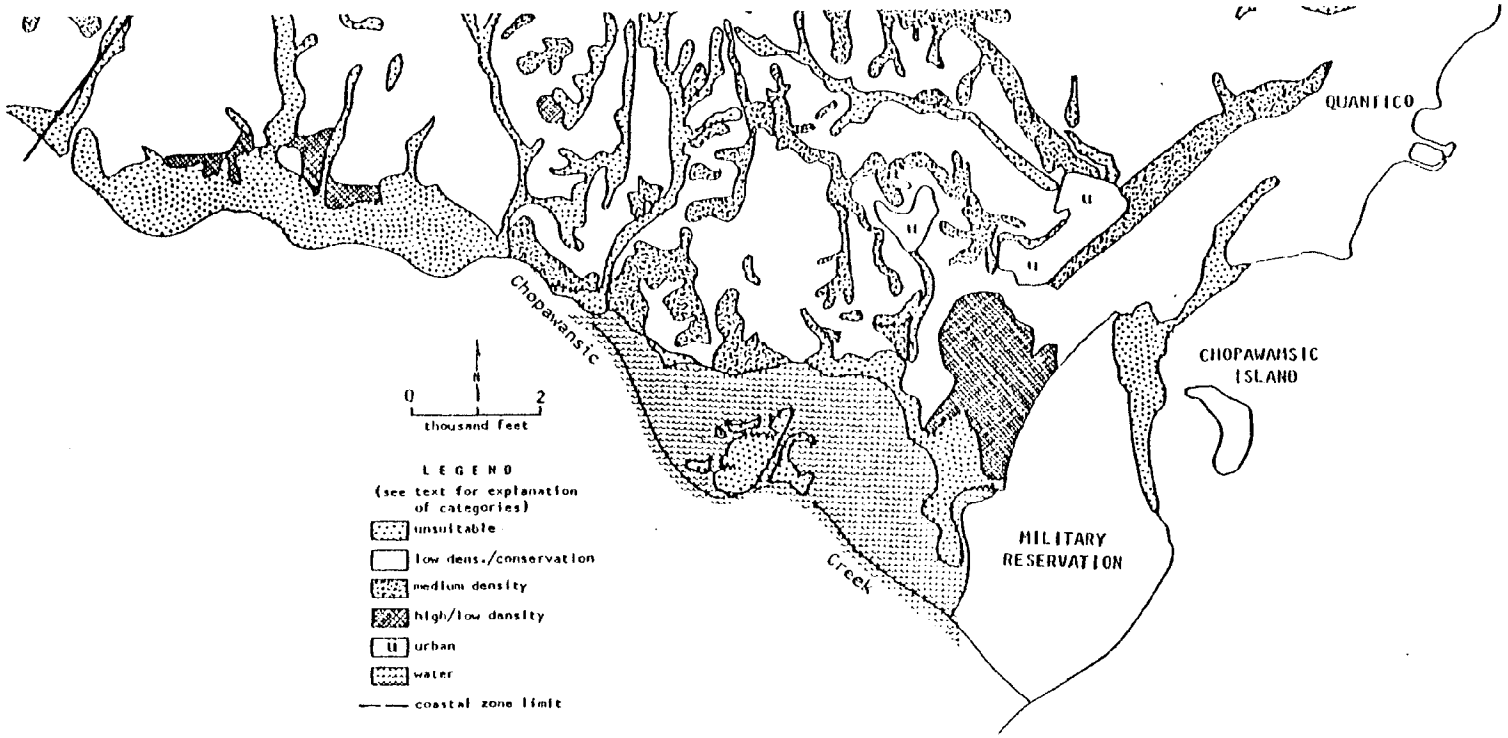


MAP 18

SEGMENT 5: NATURAL RESOURCES

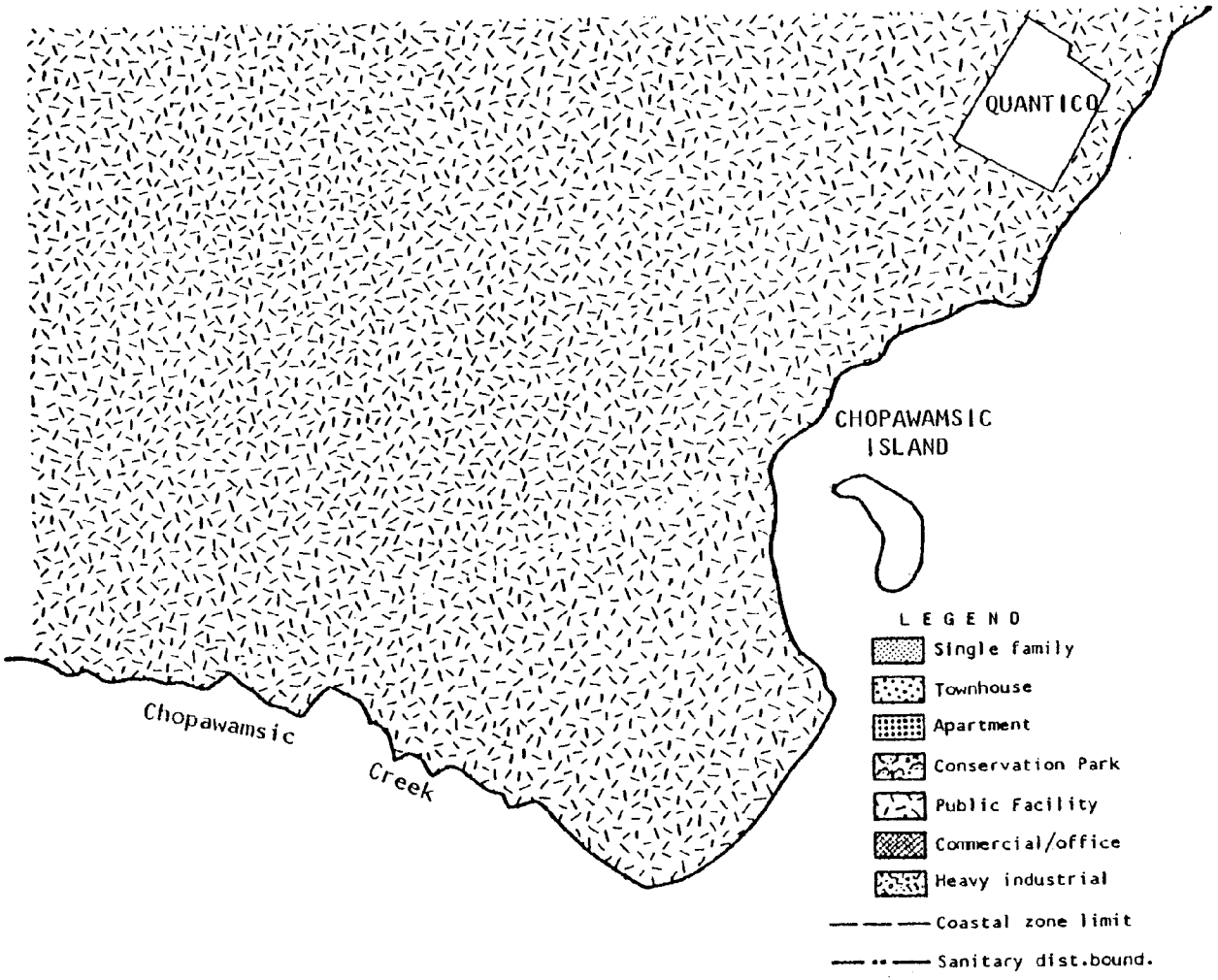
MAP 19

SEGMENT 5; SOIL SUITABILITY ZONES



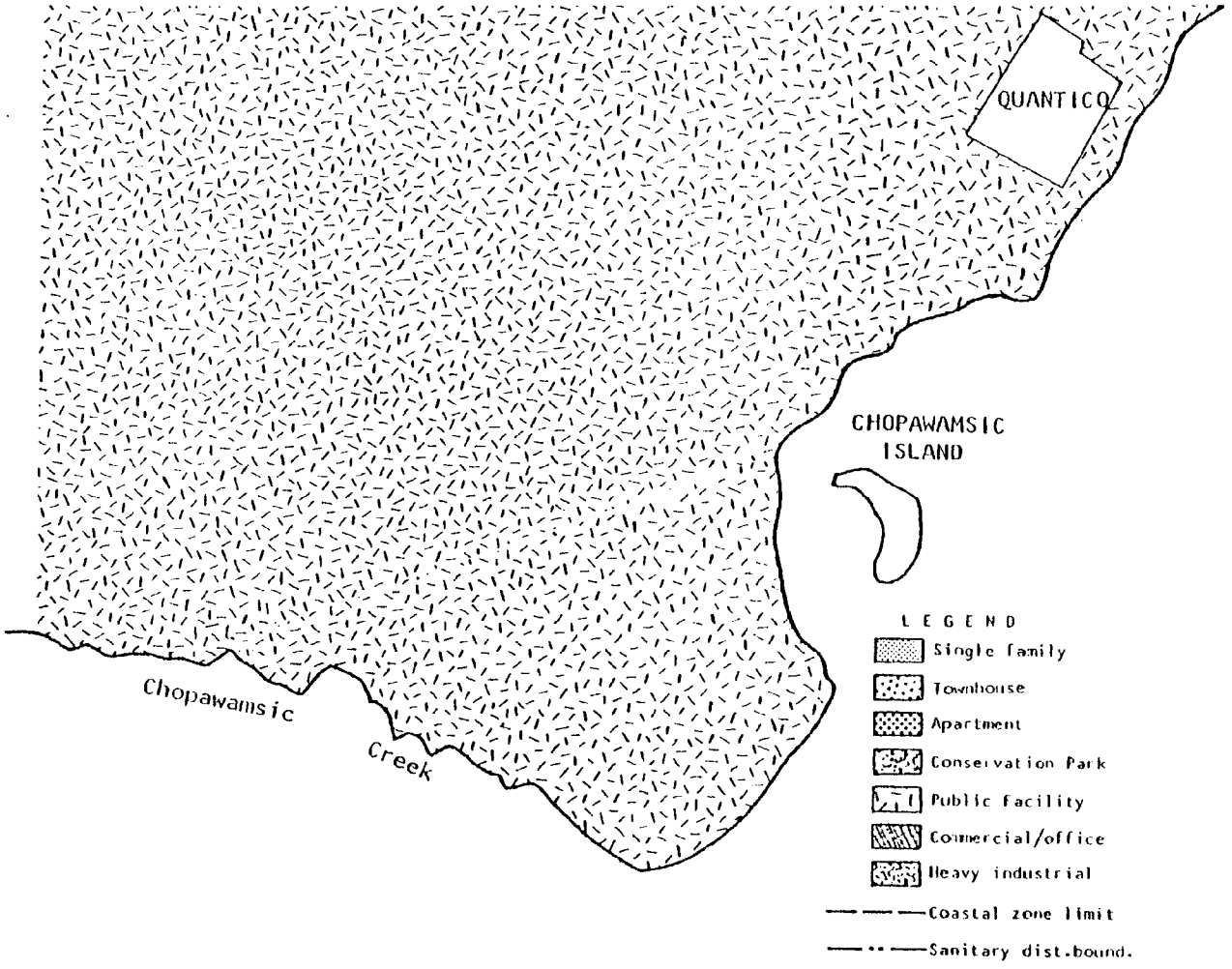
MAP 20

SEGMENT 5: EXISTING LAND USE



MAP 21

SEGMENT 5: PROPOSED LAND USE



CHAPTER IV.

STATE & FEDERAL POLICIES, PROGRAMS, AND REGULATIONS

A myriad of federal, state, and local governmental regulations apply to development in coastal Prince William County. Figure 5 summarizes existing regulations and provides an illustration of the interrelationships of the various levels of governmental jurisdictions in different portions of the coastal zone. These regulations are discussed in separate sections by subject area below.

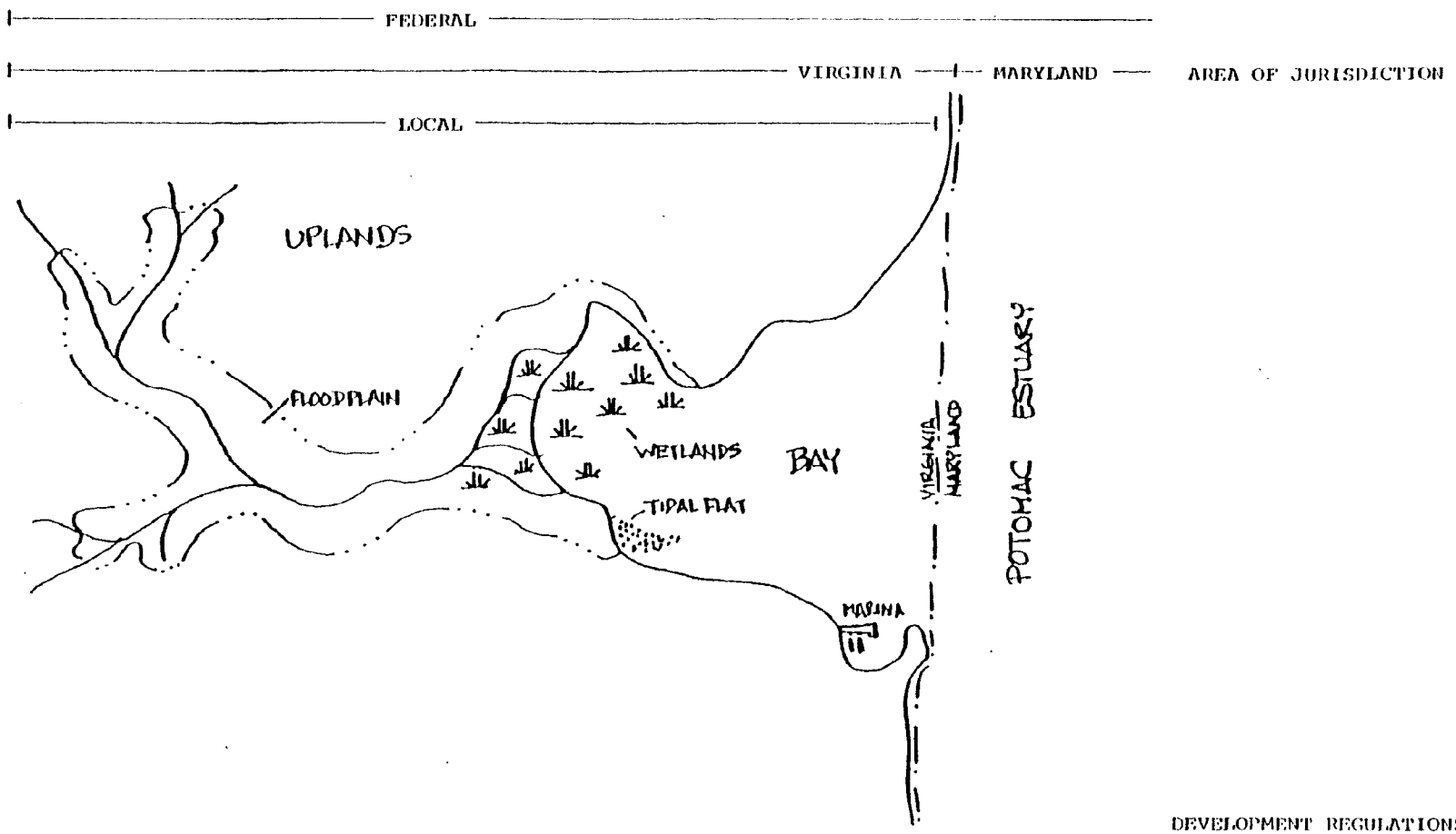
A. Permits for Activities in Navigable Waters, including Wetlands

1. USACE Permits for activities in navigable waters

A permit is required by the U.S. Army Corps of Engineers (USACE) for any structure or work in or affecting navigable waters of the U.S. As presently administered, permits are required at mean high tide level or lower, which includes wetlands. The permit decision is based upon an evaluation of the probable impact of the proposed activity on the public interest, according to Environmental Protection Agency (EPA) guidelines issued under Section 404(b) of the Federal Water Pollution Control Act Amendments of 1972. The benefits expected from the proposal must be balanced against its reasonably foreseeable detriments. For further information and technical assistance from the Corps concerning this program, see Chapter V.

FIGURE 5.

SUMMARY OF GOVERNMENTAL REGULATIONS FOR COASTAL PRINCE WILLIAM COUNTY



DEVELOPMENT REGULATIONS

Federal/State Water & Air Pollution Regulations
Federal Floodplain Insurance Regulations
Local Zoning & Subdivision Regulations
Local Building Permit
State Health Dept. Septic Tank Permit

Federal Permits for Activities in Navigable Waters
State Permit for Encroachment on State-owned Bottomlands
Local/State Wetlands Permit
Local Zoning & Subdivision Regulations
Local Building Permit
State Health Dept. Septic Tank Permit

2. Virginia Marine Resources Commission: Subaqueous Bottomlands Permits

Section 62.1-3 of the Code of Virginia directs the Marine Resources Commission to control all non-exempted uses of state-owned bottomlands through the issuance of permits. This section limits the extent of private property rights on Virginia's shorelines to mean low water and declares all other subaqueous land to be the property of the Commonwealth.

The Potomac River is an exception to State ownership below mean low water, because, under the Potomac River Compact of 1958, Virginia recognized Maryland as the owner of the Potomac River to the mean low water mark. The boundary adopted in the 1958 Compact was officially established by the Mathews-Nelson Survey of 1928. Although the boundary runs adjacent to the shoreline of the Potomac proper, the 1928 survey concluded that the line should not follow the indentations of creeks and bays, but should run from headland to headland. Any activities in the bays and creeks in Prince William's coastal zone are under the jurisdiction of Virginia, while activities beyond the mean low water mark of the Potomac shoreline fall under Maryland jurisdiction.

Uses which are regulated by the Virginia Marine Resources Commission under Section 62.1-3 include many activities for which federal permits are required, as discussed above, such as mixing the placement of wharves, bulkheads, dredging and fill by shoreline landowners. Among exempted activities are the placement of certain private piers for non-commercial use by landowners, uses of subaqueous beds for commercial fishing, and uses incident to the construction and maintenance of approved navigation and flood control projects.

In granting or denying a permit, the Commission considers factors similar to the public interest review conducted by the Army Corps of Engineers for federal permits. These factors include:

- consideration of the environmental quality goals contained in Article XI of the State Constitution
- the effects of the proposed project on reasonable and permissible uses of state waters and state-owned bottomlands
- the effects upon marine and fisheries resources of the Commonwealth
- the effects upon wetlands of the Commonwealth
- effects upon adjacent or nearby properties

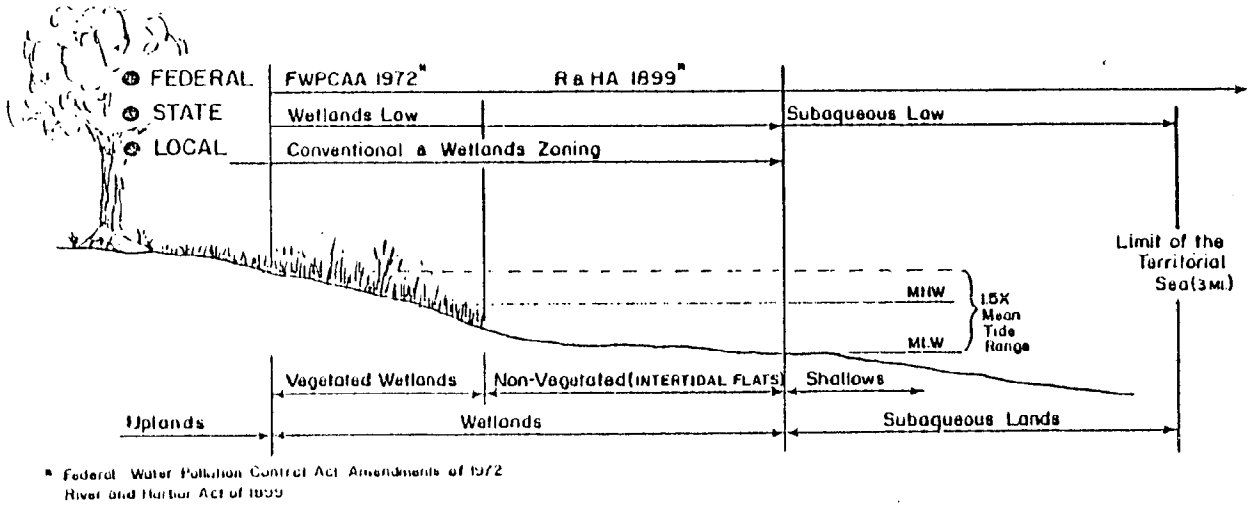
- water quality standards established by the State Water Control Board
- anticipated public and private benefits

Prior to granting or denying any permit for a boatyard or marina for commercial use, however, the owner or other applicant must present a plan for sewage treatment or disposal facilities which is approved by the State Department of Health.

3. Virginia Wetlands Act

Section 62.1-13 of the Code of Virginia, known as the Virginia wetlands law, was enacted by the General Assembly in 1972 in recognition of the valuable and irreplaceable nature of the State's wetlands. This law prohibits any regulated activity in tidal wetlands without a proper permit. Tidal wetlands are defined as those lands lying between and contiguous to mean low water and 1.5 times the mean tidal range, upon which certain specified vegetation grows.

Virginia's wetlands jurisdiction differs from federal jurisdiction over wetlands. The federal jurisdiction extends to all areas regularly inundated by water, which include tidal and freshwater marshlands, both vegetated and non-vegetated. Federal, State and local authority along vegetated shorelines is summarized in the illustration below.



Source: "Report of the Secretary of Commerce and Resources to the Governor and the General Assembly of Virginia Regarding Senate Joint Resolution No. 62," Senate Document No. 8, prepared by the Virginia Coastal Resources Management Program, October 1978.

The Virginia Wetlands Act allows localities to manage their wetlands through the adoption of a specified zoning ordinance which provides for the appointment of a local wetlands board to administer the permit program. All decisions by the local board are reviewed by the Commissioner of Marine Resources and are subject to modification or reversal by the Marine Resources Commission. Appeals can be made through the Commission and the Court.

Prince William County established a local wetlands board after the passage of the 1972 Act. This board was recently reconstituted by the County Board of Supervisors. Further information about the board is provided in Chapter V. The Virginia Institute of Marine Science (VIMS) has developed guidelines for use by wetlands boards in making permit decisions, entitled "Local Management of Wetlands: Environmental Considerations." An excerpt from this publication which outlines the typical contents of an application for a wetlands permit is reproduced in Appendix IV.

B. State Water Control Board Regulations and Programs

1. Water Quality Assurance

The State Water Control Board (SWCB) is responsible for the issuance of water quality assurance "401" certificates for pollution discharges into navigable waters, pursuant to the Federal Water Pollution Control Act Amendments of 1972. This certificate, which is tatamount to a permit, certifies that the proposed activity will comply with applicable state water quality control laws.

2. Industrial Discharge Permit Program

Under Section 62.1-44.16 of the Code, a permit is required from the SWCB for the discharge of industrial wastes to State waters. A permit will not be issued until approved treatment or control facilities are provided for a potential polluting activity.

3. Permits for Other Wastes

Section 62.1-44.17 provides a similar SWCB certification program for discharge or control facilities for "other wastes", defined as decayed wood, sawdust, shavings, bark, lime, garbage, refuse, ashes, offal, tar, oil, chemicals, and other substances, except industrial wastes and sewage.

4. Sewage Discharge Regulations

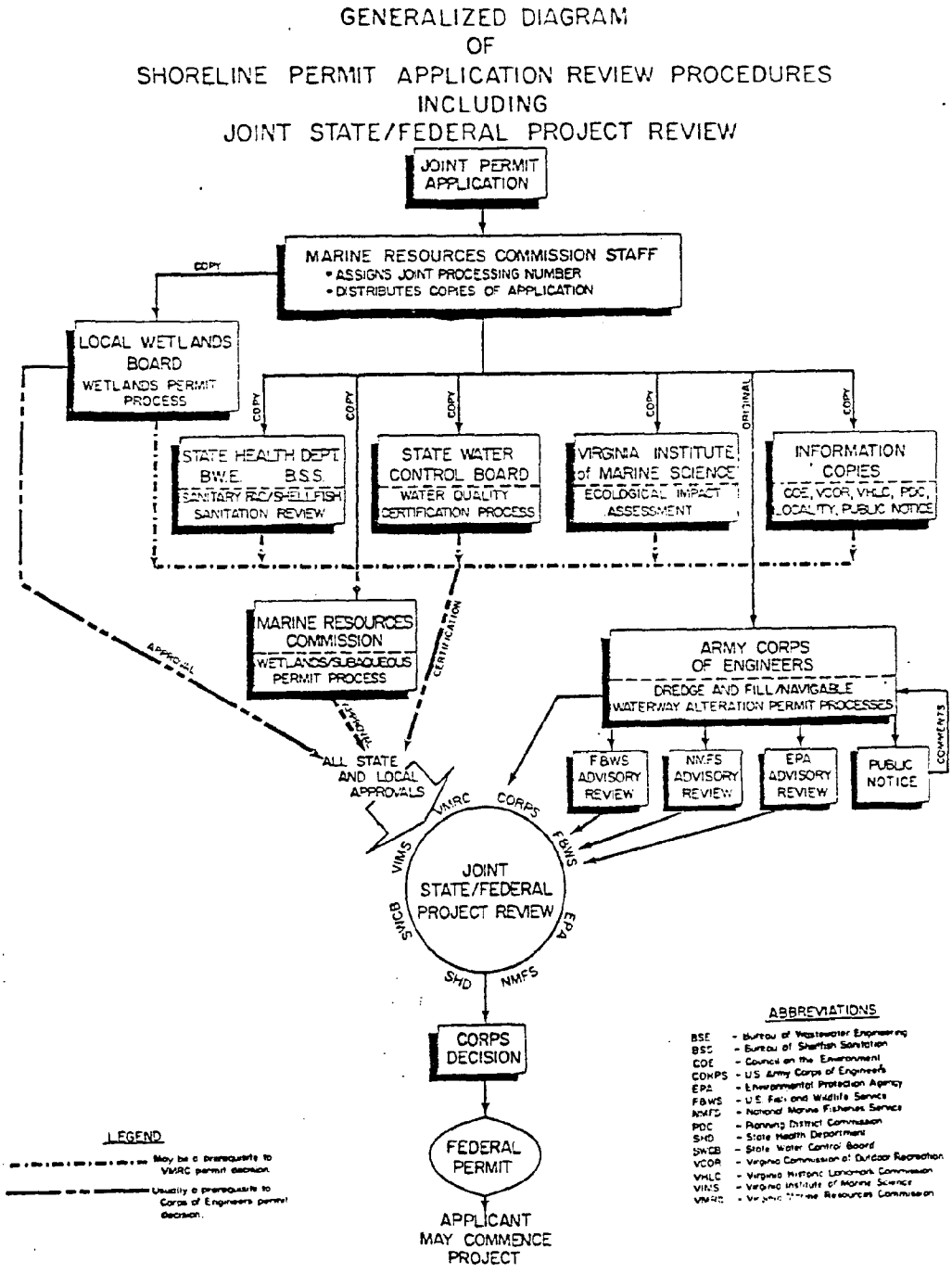
Article 4 of Title 62.1 of the Code places all sewage systems and sewage treatment facilities under the joint supervision of the SWCB and the State Health Department. The Health Department is responsible for the issuance of permits for septic tank systems, while the SWCB is given authority to issue permits prescribing the terms under which any pollution discharges may be made into sewerage systems and sewage treatment facilities.

C. Summary of State and Federal Shoreline Permits

As indicated in the sections above, there are many overlapping and sometimes duplicative permitting requirements operating in Virginia's coastal areas. Several steps have been taken to simplify and streamline the shoreline permitting process in Virginia. In 1977 the State Water Control Board and the Marine Resources Commission developed a consolidated permit application, which has recently evolved into a joint local-state-federal permit application. In addition, monthly meetings have been instituted between representatives

of State and federal permitting agencies to review pending applications, allowing a substantial reduction in processing time for many projects. This process is summarized in the accompanying diagram. State and federal permitting agencies continue to work on further measures to streamline shoreline permitting.

Figure 6.



SOURCE: Virginia Coastal Resources Management Program, "Report of the Secretary of Commerce and Resources to the Governor & the General Assembly Regarding Senate Joint Resolution No. 62," Senate Document No. 8, Richmond, October 1978.

D. Coastal Resources Management Programs

Both the State and federal governments have become involved in coastal resources planning and management in recognition of the unique and valuable resources of the coastal zone and the intensity of competition for use of these resources. The federal government, in enacting the Federal Coastal Zone Management Act of 1972, amended in 1976, established a framework and financial incentives for states to take primary responsibility for the planning and management of coastal land and water resources. Through its Wetlands Act and regulations over state fisheries and shellfish grounds, the Commonwealth was already involved in coastal resources management. Virginia has been able to increase its knowledge of the state's coastal management problems through participation in the Federal Coastal Zone Management Program.

1. Federal Coastal Zone Management Program

The federal program, instituted by the Coastal Zone Management Act of 1972, is administered by the Office of Coastal Zone Management (OCZM) in the Department of Commerce. OCZM provides funding assistance to participating states for planning and implementing a coastal zone management program, which must adhere to federal guidelines designed to encourage the states to exercise their full authority over the lands and waters in the coastal zone, which should include unified policies, criteria, standards, and processes for dealing with land and water use decisions of more than local significance.

Although OCZM allows State programs to be planned and implemented through its chosen agencies, including local governments, the Act requires some degree of State involvement in the control of coastal land and water uses. This is significant since many uses covered under the Act have traditionally been overseen exclusively by local government. The Act outlines three alternative techniques for achieving State involvement: 1) direct state land use and water use planning and regulation; 2) state standards and guidelines for local implementation; or 3) state review of all plans, projects, or regulations to ensure consistency with the management program. OCZM gives states wide latitude within these alternatives to establish specific management arrangements with local governments.

Since the program lacks federal regulatory powers, its success depends on the voluntary participation of states. Three types of federal grants are offered to

encourage coastal states to implement comprehensive management programs: program development grants; implementation grants for federally approved programs; and grants to establish estuarine sanctuaries. All 34 eligible states and territories have participated in the program development stage.

2. Virginia Coastal Resources Management Program

The Virginia Office of Commerce and Resources (OCR) has just completed the final year of its four year program development phase under funding from the federal Office of Coastal Zone Management (OCZM). In September 1977 the OCR published its recommendations for a comprehensive coastal resources management program, "Proposals for Coastal Resources Management in Virginia," which were designed both to address the specific needs of Virginia's coastal areas and to meet federal program approval requirements. During the 1978 General Assembly session coastal legislation was introduced which would be necessary to implement certain portions of the program. These bills were carried over to the 1979 legislative session, where greatly amended versions were defeated.

A lack of executive or legislative branch action to allow implementation of several key portions of the proposed management program has resulted in a termination by OCZM of Virginia's participation in the federal grant program for coastal planning and implementation as of March 31, 1979. This action does not preclude the State from continuing the coastal program on its own and seeking federal program approval at a later date, but it does eliminate the immediate financial incentive for the State to continue program development activities, which may hamper future attempts to gain legislative and executive branch support for the program.

The focus of the proposed program is on coastal "edges", where land and tidal waters meet. The State's coastal resources have been inventoried, and problems with their use and management have been identified. OCR has also enumerated the precepts of the program, as follows:

1. The historic, economic, cultural, environmental, and aesthetic heritage and values of Tidewater as we know it are worthy of our guardianship for future generations. Our decisions about these resources will be based upon these values as well as upon scientific fact.

2. The Commonwealth's coastal, estuarine, and marine environments are extremely valuable, productive, and fragile, and therefore require careful and protective stewardship by all Virginians.

3. Increasing and competing demands for the use of our coastal lands and waters have depleted and endangered some of our coastal resources.

4. A Coastal Resources Management Program must be prepared and implemented on the basis that it will benefit the citizens whom it will affect.

5. Public understanding of the use and value of our coastal resources and public participation in the management of these resources is essential to the proper implementation and success of Virginia's Coastal Resources Management Program.

6. Local involvement in decisions about coastal resources engenders a greater sense of public responsibility for the use of those resources.

7. All interests in Tidewater--agricultural, commercial, industrial, and environmental, as well as those of the individual citizen--deserve consideration when decisions are made about the use and allocation of coastal resources.

8. In addition to individual and local interests, some decisions about land and water uses in the coastal zone must be based upon national, interstate, state, and regional interests.

9. The state government must assert its authority and assume greater responsibility for protecting the public interest in coastal lands and waters, in an improved partnership with local governments.

10. The local, state, and federal governments share the responsibility for managing coastal resources; their exercise of authority must be complementary.

11. The state and local governments are accountable to the public for their policies and how they carry out those policies with respect to coastal land and water management.

12. Coastal Resources Management is a continuing planning and management effort; the methods, procedures, and techniques will continue to evolve and improve.

In addition, four major issues have been identified as in need of legislative consideration for implementation of the program: 1) mechanisms for regulation of land uses having effects on the marine environment ("primarily" non-point pollution impacts) and for protecting geographic areas of particular concern; 2) shoreline permitting of minor projects; 3) major projects permit review; and 4) State organization and authority to implement the program.

Further development of the Virginia Coastal Resources Management Program will undoubtedly involve these basic elements and a resolution of existing conflicts within the State concerning management approaches to these issues.

CHAPTER V.

SOURCES OF TECHNICAL ASSISTANCE

A. Shoreline Permitting

Shoreline permit programs have been developed by state and federal governments to protect the public interest in preserving wetlands, maintaining water quality, protecting fish and wildlife, maintaining navigable waterways, preventing health hazards, insuring adequate construction standards, and controlling private use of public property. Most permit programs also recognize social and economic impacts of shoreline projects on the community and the rights of neighboring property owners and provide a mechanism for public input to the permit process.

Waterfront property owners, developers and local officials often experience confusion, frustration and costly delays in obtaining permits for activities along and adjacent to the shoreline. As discussed in Chapter IV, permitting agencies are working to develop a more efficient shoreline permitting system. The list below indicates those agencies which should be contacted when shoreline alterations are contemplated. These agencies will not only provide the necessary permit application materials and instructions, but will assist the applicant in assessing any technical problems associated with the application.

FEDERAL AGENCY

U.S. Army Corps of Engineers (USACE) - Baltimore District

Title of Permits

(1) Individual Department of the Army permits for a) Activities in Navigable Waters ("Section 10 Permit"); and b) Discharges of Dredged or Fill Material into the Waters of the United States ("Section 404 Permit").

(2) General permits for certain categories of activities which have only minimal individual and cumulative impact on the environment. No individual permit must be obtained for activities within these categories. The Baltimore District, which serves Prince William County, has general permits in effect for periodic maintenance dredging and certain structures for small boats (i.e., private piers of less than 40 feet which do not extend beyond the 5' depth contour).

Address:

Regulatory Functions Branch
U.S. Army Corps of Engineers - Baltimore District
P.O. Box 1715
Baltimore, Maryland 21203

Phone Number: (301) 962-3477

STATE AGENCIES

1. Virginia Marine Resources Commission (VMRC)

Title of Permit: Subaqueous permit for activities affecting State-owned bottomlands

Address:

Virginia Marine Resources Commission
P.O. Box 756
2401 West Avenue
Newport News, Virginia 23607

Phone Number: (804) 245-2811

2. Virginia Institute of Marine Science (VIMS)

Advisory role only: Subaqueous laws direct VMRC to consult with interested state agencies, including VIMS, on permit applications. The primary concern of the Institute is the effect of the project on marine and estuarine environments. While VIMS does not issue permits, it encourages persons contemplating shoreline works to consult with it prior to submitting an application.

Address:

Virginia Institute of Marine Science
Glouchester Point, Virginia 23062

Phone Number: (804) 642-2111

LOCAL AGENCY

Prince William County Wetlands Board

Title of Permit: Wetlands permit for activities affecting tidal wetlands

Address:

Prince William County Wetlands Board
c/o Office of Comprehensive Planning
9300-B Peabody Street
Manassas, Virginia 22110

1979 Membership:

Jeffrey Tyrrell, Chairman
W. Shepard Elmore
Dr. George Garrigan
Alan Dent
H. Ewing Wall

Phone Number (Planning Office): (703) 368-9171, Ext. 430

B. Shoreline Erosion

Shoreline erosion, which is a naturally occurring process involving streamflow, tidal action, runoff and wind, is defined as a problem when it conflicts with man's use of shorefront property. The productions of shoreline erosion--sand, silt, and clay--contribute to sedimentation of the Potomac Estuary and the Chesapeake Bay system. The principal concern of shoreline property owners is the economic impacts of property losses due to shoreline erosion, and costly structural control measures are often constructed in an attempt to halt natural erosion processes.

The construction of shoreline erosion control structures and other human activities may accelerate shoreline erosion. All shoreline erosion control structures have either a short or long term impact on adjacent shorelines. Groins and jetties, for example, interrupt the flow of sand and sediments along the shoreline and may cause "starvation" of the banks downstream, increasing erosion rates downstream. The best coastal engineering designs attempt to achieve site specific erosion abatement while minimizing adverse erosion impacts on adjacent shorelines.

While the Prince William County coastal zone has no areas experiencing critical erosion, defined by the State as greater than 2 feet/year with endangered property improvements, certain areas of the shoreline are undergoing moderate erosion which may threaten human property. The following list provides sources of technical assistance for property owners

experiencing loss of property due to shoreline erosion.

FEDERAL AGENCIES

1. U.S. Army Corps of Engineers (USACE)- Baltimore District

The construction of any shoreline erosion control structures below mean high water fall under the permitting program of the USACE. Any persons contemplating a project within this area should contact the Baltimore District Office for the necessary permit application materials. In addition, the Corps is authorized by the 1974 Water Resources Development Act to provide technical assistance to any authorized agency of the State and its subdivisions.

Address:

U.S. Army Corps of Engineers - Baltimore District
P.O. Box 1715
Baltimore, Maryland 21203

Phone Number: (301) 962-3477

2. U.S. Army Corps of Engineers Coastal Engineering Research Center (CERC)

A more local federal source of information on shoreline erosion can be found at Fort Belvoir, Virginia. CERC is the Corps' national research center on coastal engineering, where studies are undertaken on the effectiveness of traditional and innovative shoreline stabilization techniques.

Address:

U.S. Army Corps of Engineers
Coastal Engineering Research Center
Kingman Building
Fort Belvoir, Virginia 22060

Phone Number: (703) 325-7518

STATE AGENCIES

1. Virginia Soil and Water Conservation Commission (VSWCC)

Article 2.2 of the Code of Virginia (Shore Erosion Control) recognizes shore erosion as a significant problem in the State and directs State resources to address the problem. Section 21-11.18 of this Article invests the Soil and Water Conservation Commission with the responsibility to coordinate shore erosion control programs of all State agencies and institutions and to secure the cooperation of federal agencies in protecting shorefront property from erosion. However, the Commission was authorized only one shore erosion engineer to carry out these responsibilities. Requests for shoreline erosion control assistance may be made through the local soil and water conservation district or through the State office.

Address:

Technical Services Office
Virginia Soil and Water Conservation Commission
830 East Main Street, Suite 800
Richmond, Virginia 23219

Phone Number: (804) 786-2064

2. Virginia Institute of Marine Science (VIMS)

VIMS offers technical advisory services to shorefront property owners on shoreline erosion as well as other coastal problems. A staff person who is experienced in structural control measures is available for consultation to any landowner or local government staff.

Address:

Virginia Institute of Marine Science
Glouchester Point, Virginia 23062

Phone Number: (804) 642-2111

LOCAL AGENCY

Prince William Soil and Water Conservation District

While the mandate of local soil and water conservation districts is primarily to address the problem of upland erosion, the local district can provide advice on shoreline erosion and assist the shorefront property owner in locating further technical assistance if necessary.

Address:

Prince William Soil & Water Conservation District
8088 Sudley Road
Manassas, Virginia 22110

Phone Number: (703) 361-1710

APPENDIX I

COMMON MARINE RESOURCES OF THE
POTOMAC RIVER ALONG PRINCE WILLIAM COUNTY

alewife
American eel
Atlantic silverside (from Cockpit Point downstream)
* bay anchovy
blue crabs (summer)
carp
catfish (brown bullhead, white and channel)
chad
* croaker
* herrings (in Occoquan Creek)
* hogchoker
juvenile bluefish (from just above Quantico Creek downstream)
largemouth bass
sea nettle
* spot
* striped bass (summer)
sunfish
* weakfish
* white perch (March-early June; in tidal embayments of Occoquan, Neabsco, Powell & Quantico Creeks)
winter jellyfish
yellow perch

* Fish species which rely on Potomac estuary areas along Prince William County for spawning grounds and/or nursery areas.

Source: Lippson, Alice Jane, ed., The Chesapeake Bay in Maryland: An Atlas of Natural Resources, Johns Hopkins University Press, Baltimore, 1973.

Metropolitan Washington Council of Governments, Water Resources Planning Board, The Water Monitor, Vol. II, No. 4, September, 1978.

APPENDIX II.

Section 808. Minimum Lot Size Based on Slope. The following table shall be used to determine the minimum lot size which shall be permitted. In using said table, interpolation shall be permitted.

Topography, Slope Average	Minimum Area, (Sq. Ft.)	Minimum Average Width (Ft.)	Minimum Average Depth (Ft.)	Ground Surface to Remain in its Natural State (No cut or fill)
0-10%	15,000	60	90	50%
10-15%	18,000	80	100	60%
15-20%	22,000	80	110	65%
20-25%	28,000	100	120	70%
25-30%	35,000	100	150	75%
30-35%	44,000	120	175	80%
35-40%	54,000	150	200	85%
40-50%	65,000	175	250	90%
50-70%	85,000	200	300	95%
70-100%	Not less than five (5) acres.			95%
Over 100%	No lot development permitted.			100%

808.1. The subdivider shall submit a "Slope Map" with the tentative map, showing by color or shading the areas of the tract lying within each slope category. No such map need be submitted if the average slope of the entire tract is ten percent (10%) or less.

Section 809. Lot Sizes Based on Type and Improvements Required.

809.1. Definitions. Hillside areas: A "Hillside Area" as referred to herein is defined as one with an average slope of 15% or more. The standards under Section 810 (General regulations and design) apply to all hillside areas with the added provision that areas with a cross slope of 40% or greater are considered to be extremely rugged and the development of this terrain is limited to lot size types IV as defined below:

... (a) Lots being served by community sewer systems may be granted variances, as is appropriate, for lot size on

each slope/lot size gradient.

...(b) Slope alterations shall not exceed five (5%) percent of the total lot size on any lot having an average slope greater than 15%. Such alterations should be only for grading site improvements.

...(c) Type III* - Lot area 20,000 feet to one acre: In this classification are subdivisions in which 80% of all lots have an area of 20,000 square feet or over and the average area of all lots is 20,000 square feet or over.

...(d) Type IV - Lot area one acre or over: Eighty percent of the lots in this classification shall be one acre or over, and the average area of all lots in the subdivision shall be one acre or over.

*20% of the lots in any hillside subdivision (not including lots at end of cul-de-sac) may have a reduced frontage provided that such reduction is not below the requirements of the next least restrictive type or classification of subdivision.

Source: "Georgia Mountains Areawide Land Development Standards", Georgia Mountains Areawide Land Development Policies and Procedures Manual, Georgia Mountains Planning and Development Commission, Gainesville, Georgia, March 1974.

GENERAL TURFGRASS FERTILIZATION GUIDE

Soil tests are a guide for liming and fertilization. The following general recommendations should be adjusted as indicated by a soil test.

Fertilizer rates are in pounds per 1,000 sq. ft. Equivalent amounts of similar analysis materials may be substituted for any fertilizer listed below.

Establishment: Before seeding, apply 50 pounds of a 5-10-5 fertilizer per 1,000 square feet and work this in with 4 to 6 inches of surface soil. When soils are very infertile it may be desirable to plow in or mix 25 pounds of 0-20-0 or 15 pounds of 0-30-15 fertilizer per 1,000 square feet with 6 inches of soil.

Maintenance: Maintenance fertilization should be adjusted depending upon the availability of nitrogen in the fertilizer used.

FERTILIZER PROGRAMS FOR MAINTAINING KENTUCKY BLUEGRASS AND FESCUE

Program 1. Readily Available Nitrogen

These programs include fertilizers in which 50% or less of the nitrogen is slowly available. The slowly available portion is listed on the fertilizer bag as water insoluble nitrogen (WIN). Nitrogen not specifically claimed as WIN can be assumed to be readily available.

These comments apply to Programs 1-a and 1-b:

1. Readily available sources of nitrogen may cause burning if applied at heavy rates or not watered in thoroughly immediately following application. Do not apply more than the suggested rate in a single application.
2. The December application can be omitted under some conditions, such as soils that are not subject to fast leaching and when grass is making satisfactory growth.
3. If inadequate fertilizer was applied in late fall, ½ to ¾ lb. of actual N may be applied in spring if turf color and growth indicate a need.

Program 1-a.

Time of Application	Nitrogen Needed per 1000 Sq. Ft.	Fertilizer Example—per 1000 Sq. Ft.		
Aug. 15 to Sept. 15	1 to 1½ lbs.	8 to 12 lbs.	12-4-8	OR
		5 to 7½ lbs.	20-10-10	OR
		4 to 6 lbs.	25-4-7*	
Oct. 1 to Nov. 15	1½ lbs.	12 lbs.	12-4-8	OR
		7½ lbs.	20-10-10	OR
		6 lbs.	25-4-7*	
December	1 to 1½ lbs.	8 to 12 lbs.	12-4-8	OR
		5 to 7½ lbs.	20-10-10	OR
		4 to 6 lbs.	25-4-7*	
May 20 to June 30	0 to ½ lb.	0 to 4 lbs.	12-4-8	OR
		0 to 2½ lbs.	20-10-10	OR
		0 to 2 lbs.	25-4-7*	

Program 1-b

Time of Application	Nitrogen Needed per 1000 Sq. Ft.	Fertilizer Example—per 1000 Sq. Ft.		
Aug. 15 to Sept. 15	1 to 1½ lbs.	3 to 4½ lbs.	ammonium nitrate	OR
		5 to 7 lbs.	ammonium nitrate lime	OR
		6 to 9 lbs.	nitrate of soda	OR
		2½ to 3 lbs.	urea	
Oct. 1 to Nov. 15	1 to 1½ lbs.	10 to 15 lbs.	10-10-10 or equivalent	
Dec. 1 to Dec. 15	1 to 1½ lbs.	3 to 4½ lbs.	ammonium nitrate	OR
		5 to 7½ lbs.	ammonium nitrate lime	OR
		6 to 9 lbs.	nitrate of soda	OR
		2½ to 3 lbs.	urea	
May 20 to June 30	0 to ½ lb.	0 to 1½ lbs.	ammonium nitrate	OR
		0 to 2½ lbs.	ammonium nitrate lime	OR
		0 to 3 lbs.	nitrate of soda	OR
		0 to 1½ lbs.	urea	

*This hypothetical fertilizer analysis is given as an illustration to group a great quantity of speciality turf fertilizers that contain high nitrogen, low phosphate, and medium potash levels.

Source: VPI&SU, "A Handbook of Agronomy", Publication #600, Blacksburg reprint June 1976.

Program 2. Slowly Available Nitrogen

Fertilizers in which 50% or more of the nitrogen is *water insoluble* (70% or more of the total nitrogen derived from urea formaldehyde).

Comments:

1. If needed to improve color, 1 lb. of actual nitrogen per 1000 sq. ft. from a quickly available source may be applied in late November or December.
2. If the soil is low in phosphate or potash it may be desirable to apply enough additional nutrient(s) to bring the total applied for the year to 3 lbs. Fall application is preferred.

Time of Application	Nitrogen Needed per 1000 Sq. Ft.	Fertilizer Example—per 1000 Sq. Ft.	
Aug. 15 to Oct. 1	3 to 4 lbs.	25 to 33 lbs. of 12-4-8	OR
		15 to 20 lbs. of 20-10-10	OR
		8 to 10 lbs. of urea-formaldehyde (38-0-0) PLUS 4 to 8 lbs. of 0-25-25 or equivalent.	
May 20 to June 30	0 to 1½ lbs.	0 to 4 lbs. of urea-formaldehyde	OR
		0 to 12 lbs. of 12-4-8	OR
		0 to 7½ lbs. of 20-10-10	

FERTILIZER PROGRAMS FOR MAINTAINING BERMUDAGRASS AND ZOYSIAGRASS

Program 3. Readily Available Nitrogen

These programs include fertilizers in which 50% or less of the nitrogen is slowly available. The slowly available portion is listed on the fertilizer bag as water insoluble nitrogen (WIN). Nitrogen not specifically claimed as WIN can be assumed to be readily available.

The following comments apply to Programs 3-a and 3-b.

1. Readily available sources of nitrogen may cause burning, especially in hot weather, if applied at heavy rates or not watered in thoroughly after application. Do not exceed suggested rate in a single application.
2. The July application should not be applied on zoysiagrass and may be omitted on bermudagrass turf if growth and color are satisfactory.
3. If the above amounts of phosphate and potash are in excess of needs, apply nitrogen alone for the March, May, and/or June applications.
4. Nitrogen should be omitted for the fall application on zoysiagrass and on bermudagrass if not overseeded. However, the phosphate and potash should be applied during the fall if these elements are not applied on a continuous basis or if a soil test indicates that either element is low.

Program 3-a.

Time of Application	Nitrogen Needed per 1000 Sq. Ft.	Fertilizer Example—per 1000 Sq. Ft.		
Sept. 1 to Oct. 15 or after overseeding	0 to 1½ lbs.	If overseeded:		
		8 to 12 lbs.	12-4-8	OR
		5 to 7½ lbs.	20-10-10	OR
		4 to 6 lbs.	25-4-7*	
		If not overseeded:		
		0 to 6 lbs.	0-25-25	
March 1 to April 1	1½ lbs.	12 lbs.	12-4-8	OR
		7½ lbs.	20-10-10	OR
		6 lbs.	25-4-7*	
May 1 to June 1	1½ lbs.	12 lbs.	12-4-8	OR
		7½ lbs.	20-10-10	OR
		6 lbs.	25-4-7*	
July 1 to Aug. 1	1 to 1½ lbs.	8 to 12 lbs.	12-4-8	OR
		5 to 7½ lbs.	20-10-10	OR
		4 to 6 lbs.	25-4-7*	

*This hypothetical fertilizer analysis is given as an illustration to group a great quantity of speciality turf fertilizers that contain high nitrogen, low phosphate, and medium potash levels.

Program 3-b.

Time of Application	Nitrogen Needed Per 1000 Sq. Ft.	Fertilizer Example—per 1000 Sq. Ft.
Oct. 1 to Oct. 15 or after overseeding	0 to 1½ lbs.	If overseeded: 10 to 15 lbs. 10-10-10 OR 10 to 15 lbs: 5-10-10 If not overseeded: 0 to 6 lbs. 0-25-25
March 1 to April 1	1½ lbs.	15 lbs. 10-10-10 OR 15 lbs. 10-5-5
May 1 to June 1	1½ lbs.	4½ lbs. ammonium nitrate OR 7½ lbs. ammonium nitrate lime OR 9 lbs. nitrate of soda OR 3½ lbs. urea
July 1 to Aug. 1	1 to 1½ lbs.	3 to 4½ lbs. ammonium nitrate OR 5 to 7½ lbs. ammonium nitrate lime OR 6 to 9 lbs. nitrate of soda OR 2½ to 3½ lbs. urea

Program 4. Slowly Available Nitrogen

Fertilizers in which 50% or more of the nitrogen is *water insoluble* (70% or more of the total nitrogen derived from urea-formaldehyde).

Comments:

1. If needed to improve color of overseeded grass, 1 lb. of actual nitrogen per 1000 sq. ft. from a quickly available source may be applied in winter between November and February.
2. Phosphate and potash applications should not exceed 1½ to 3 lbs. per year depending on the level in the soil. The fall application is most important and may be the only application of these nutrients needed.
3. When using a complete fertilizer make certain that the water insoluble nitrogen content is 50% or more of the total nitrogen. Otherwise, use Program 3-a.
4. Unless overseeded, nitrogen should not be applied during fall.

Time of Application	Nitrogen Needed per 1000 Sq. Ft.	Fertilizer Example—per 1000 Sq. Ft.
Sept. 1 to Oct. 15 or after overseeding	0 to 3 lbs.	If overseeded: 25 lbs. of 12-4-8 OR 15 lbs. of 20-10-10 OR 8 lbs. urea-formaldehyde PLUS 4 to 8 lbs. 0-25-25 If not overseeded: 4 to 8 lbs. 0-25-25 or equivalent
March 1 to April 15	4 lbs.	33 lbs.of 12-4-8 OR 20 lbs. of 20-10-10 OR 10 lbs. urea-formaldehyde PLUS 4 to 8 lbs. of 0-25-25 or equivalent

Lime: Apply enough to obtain and maintain a pH of between 6.0 and 6.5.

Recommended height of cut for turfgrass:

Grass	Mowing Height
Bluegrass	1½ to 2"
Tall fescue	2 to 2½"
Creeping red fescue	2 to 2½"
Bermudagrass	½ to 1"
Zoysia	¾ to 1"

Reference: VPI&SU Ext. Div. Pub. 311.

APPENDIX IV

CONTENTS OF A WETLANDS APPLICATION

Content	Wetlands Act Requirement	VIMS Recommended Amplification
Identification	Name and address of applicant.	Telephone numbers, home and business.
Location	Map showing wetlands affected and location of work thereon.	A general vicinity map showing the location of the project, state roads leading to the vicinity and county or local roads leading to the project. Where a project is difficult to locate on the ground, an additional enlarged sketch of the immediate vicinity, with directions, is helpful.
Detail	Map drawn to appropriate and uniform scale, showing the area of wetland affected, with the location of the work thereon, indicating the area of existing and proposed fill and excavation, especially the location, width, depth, and length of any proposed channel and the disposal area, all existing and proposed structures; sewage collection and treatment facilities, utility installations, roadways, and other related appurtenances or facilities, including those on adjacent uplands, and the type of equipment to be used and the means of equipment access to the activity site; the names and addresses of owners of record of adjacent land and known claimants of water rights in or adjacent to the wetland of whom the applicant has notice; an estimate of cost; the primary purpose of the project; any secondary purposes of the project, including further projects; the public	For new channels: Slope of bank. Depth of existing channel to which new channel is to be connected. Whether channel is dead-end or will have water flowing through. Bank erosion control measures. For spoil disposal: Height of berm. Width of berm at top and at bottom. Spillway detail or other de-watering technique. Distance of toe of berm from existing marsh. Erosion control during operation and revegetating detail. For bulkheads, groins, jetties, etc.: Precise dimensions - height, length, width, depth to be sunk, distances apart.

Wetlands Act Requirement	VIMS Recommended Amplification
benefit to be derived from the proposed project; a complete description of measures to be taken during and after the alteration to reduce detrimental off-site effects; the completion date of the proposed work, project or structure and such additional materials and documentation as the Wetlands Board may deem necessary.	Construction materials and details - deadmen, end-wall construction. For upland development: Drainage system and pollutant controls. Density of use-- number of houses, apartments, people involved in commercial operations, number of boats in marina. For everything: Land elevations and water depths.

SOURCE: Marcellus, Kenneth L., George M. Dawes and Gene M. Silberhorn, "Local Management of Wetlands: Environmental Considerations," Special Report No. 35, Virginia Institute of Marine Science, Gloucester Point, Virginia, June 1973.

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