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Volume I

SHORELINE MANAGEMENT OPTIONS

FOR

VIRGINIA COASTAL LOCALITIES

HC107.V8S46 1988 v.1

August, 1988

Institute for Environmental Negotiation
University of Virginia

for

The Virginia Council on the Environment

HC
107
.V8
S46
1988

ACKNOWLEDGEMENTS

This report has been prepared by the Institute for Environmental Negotiation under the direction of Richard C. Collins, Director. The report's principal author is Dr. Timothy Beatley, Assistant Professor of Environmental Planning. Other contributing staff include Bill O'Beirne, Graduate Assistant; Dr. Bruce Dotson, Assistant Director; and Elizabeth Waters, Senior Associate. Word processing and revisions were provided by Barbara Jones and Donna Rose.

Research and preparation of this report was commissioned by the Virginia Council on the Environment as part of a continuing effort to provide education and assistance to local governments in Virginia. The purpose of the effort is to promote effective and innovative land planning and management, in order to assure a quality environment for present and future generations of Virginians. This report was financed by a grant from the National Oceanic and Atmospheric Administration (Office of Ocean and Coastal Resources Management), under the provisions of the Coastal Zone Management Act of 1972, as amended.

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Executive Summary

Under the newly-adopted Chesapeake Bay Preservation Act, coastal localities in Virginia will soon be asked to adopt land use regulations and other management tools to reduce the negative impacts of growth and development on the water quality of the Bay. This report reviews the alternative management tools and approaches which could be used at the local level to protect water quality as well as to accomplish other important coastal goals and objectives. The report presents these alternatives by examining the shoreline management practices and experiences of states and localities around the country. In addition to the summary discussions presented in this report, a technical appendix has been assembled which provides actual ordinances and laws, or excerpts from them. These should be helpful to localities in drafting their own shoreline management provisions.

This report begins by suggesting that an initial step in developing a shoreline management program is to delineate or define those geographical areas of concern, where some level of regulation or management is desired. Once these areas are defined, localities can then consider which specific land use regulations, performance standards or other provisions would apply to activities within them. Several alternative strategies for delineating planning or management areas could be adopted. These alternatives, described and explained in detail in the report, are summarized as follows:

- Uniform Shoreline Zones: This approach involves delineating a management zone which is a uniform, non-variable distance landward from the Coastline or other important natural feature (e.g., a zone 1,000 feet landward of mean high water).
- Variable Shoreline Zones: This approach involves delineating similar shoreline management "bands," except that the boundaries of the zone are non-uniform and vary according to the specific characteristics and relevant features of the shoreline (e.g., 500 feet landward of mean high water, plus areas subject to significant flooding, and sensitive wildlife habitat).
- Watershed Approaches: Here the focus of management is not exclusively on delineating bay shorefront zones, but on controlling and managing activities in the watershed(s) that may have significance for protecting water quality.
- Overlay Zones and Special Natural Areas: Many localities around the country have taken the approach of delineating special environmental or natural areas of concern, often through the use of regulatory overlay zones. The boundaries of these areas reflect the

unique physical boundaries of individual natural features of concern (e.g., wetlands, dunes, areas of endangered species or plant life; areas of potential shellfish contamination).

- Uniform and Erosion-based Shoreline Setbacks: One approach to the problem of delineating a management area is simply to bypass this step and directly adopt specific performance standards. A locality could simply adopt a shoreline setback for development -- either a uniform setback (e.g., 100 feet landward of mean high water) or an erosion-based setback (e.g., a distance of 30 times the average annual rate of erosion) -- if the primary concern is the proximity of urban development to the shoreline.
- Tiered or Multi-level Approaches: For many localities the most appropriate strategy may be a combination of the above approaches. Localities may wish to create a tiered arrangement, where, for instance, a uniform shoreline zone is designated, but where other ecologically-based overlay zones are also designated. As well, the locality may wish to adopt some development restrictions which apply also at the watershed level.

Once a locality makes a determination concerning appropriate management areas, it must then consider the types of regulations and development restrictions that will apply in these areas. Choosing the appropriate management area(s) and considering the development restrictions to apply within them are not completely independent activities. For instance, a narrower and less inclusive uniform shoreline zone may be as effective or more effective at achieving water quality objectives than a wider management zone where less stringent development regulations apply. Localities will want to consider the trade-offs between the size of the management area(s) in which restrictions apply, and the scope and stringency of these restrictions. Depending upon local shoreline management goals and the level of local importance assigned to shoreline management, a locality may wish to both apply stringent restrictions, and to apply them over a large and inclusive management area.

Following consideration of the alternative approaches to delineating coastal management zones or areas, the bulk of the report focuses on the range of alternative management tools, techniques, and policies that could be applied in these management areas. Several broad categories of these tools are discussed, and briefly summarized here:

- Intensity and Use Restrictions: Localities can manage activities along the shoreline through specifying appropriate uses in different parts of the locality, as well as by managing the intensity of these activities. Under the category of use restrictions, the report examines a number of management practices including: shoreline land classification systems; urban growth boundaries; use restrictions in special environmental areas or overlay zones; water-dependent use restrictions; and movable and immovable structures. Under the discussion of controls on development density, the following are discussed: pre-established density limits; density limits established through individual site analysis; and clustering and density bonuses.
- Performance Approaches: Many localities and states impose certain minimum project design requirements aimed at reducing the "impacts" or "effects" of development. The report discusses both on-site and off-site performance approaches. Off-site performance approaches examined in this report include the use of water quality standards (in-stream standards) and wetlands mitigation. On-site performance controls examined include: urban development best management practices (e.g., stormwater discharge standards, buffers and setbacks; impervious surface standards, open space and vegetation standards, etc.), construction best management practices, agricultural best management practices, and silviculture best management practices.
- Environmental Impact Review and Information Requirements: Some localities may wish to obtain additional information about the likely effects of a proposed project or activity. This can be accomplished by requiring the preparation of environmental impact statements, special environmental studies and additional information during site plan review.
- Land Acquisition: While public acquisition of land, or certain interests in land, may be expensive it can represent a very effective and secure way of protecting certain sensitive resources. The report examines both fee simple and less-than-fee simple acquisition approaches, as well as alternative financing tools.
- Conservation Incentives and Public Investment Policies: The report examines the possible use of such incentive devices as the transfer of development rights (TDR) and concludes that such a techniques may hold promise for coastal localities in Virginia. It is suggested that capital facilities policy and public investment decisions often have a

substantial impact on the location and magnitude of local development and several tools under this category are examined. Specifically, the following are discussed in the report: Capital improvement programs (CIP), approaches to allocating scarce public service capacity, minimum facilities ordinances, and expenditure limitation approaches.

While the specific tools, techniques, and policies examined in this report are useful in protecting and enhancing water quality, they may also be useful in addressing other local management goals and objectives. Each coastal locality will have its own unique set of coastal values it wishes to protect and should consider those mixtures or combinations of programs that best suit these values.

I. Introduction

This report is intended to provide ideas on how growth and development along Virginia's shoreline can best be managed and controlled to promote water quality. The focus is on presenting options and alternatives, specifically by examining the range of tools and programs in use around the country. The report begins with the basic question of how the relevant shoreline management area or areas should be delimited (Section II). A number of alternative approaches are reviewed. The remainder and bulk of the report discusses a wide range of specific tools and techniques that could be employed within these designated management areas. Section III reviews more conventional use and density restrictions and Section IV examines a variety of "performance" controls and standards. Section V of the report discusses environmental impact review. Section VI reviews land acquisition strategies and Section VII examines the role of selected conservation incentives and public investment policies. Finally, Section VIII provides some concluding remarks. Appendix A, a list of contact agencies and their phone numbers, has been included for those interested in obtaining more detailed information on some of the techniques listed in the report. As a companion document to this report, a Technical Appendix has been prepared which includes relevant ordinances and laws, report excerpts, and so on. Where material is included in the Technical Appendix, it is mentioned in the text of this report.

While the primary objective of this report is to discuss options for managing land activities for the purposes of enhancing and protecting water quality, it is assumed that many other planning objectives from protection of visual resources to provision of efficient service delivery patterns will exist at the local level. Consequently, it should be remembered that the programs discussed below often do not simply have a water quality emphasis, but are also useful in achieving other important local and state objectives. While water quality is emphasized here other social and environmental objectives are also important and will be discussed and considered along the way.

II. Approaches to Defining the Management Area

A. Uniform Shoreline Zones

An initial important question is how precisely will localities define the areas of the coastline that warrant special management measures. A number of different approaches have been used around the country in delineating such areas. One approach is simply to adopt a uniform shoreline zone that follows the coastline or other relevant natural feature. Several states have utilized a standard which delineates the shoreline management zone as 1,000 feet from the shore, usually with the mean highwater (MHW) mark as the datum. Maryland's Critical Areas Program uses such an approach, as does California's coastal program. (See DeGrove, 1984.) The assumption is that such a zone is sufficiently large that it will permit the management of those land use activities and alterations which have the most serious impacts on water quality and other important shoreline values. In some cases such a "banded" approach has clearly proven inadequate. For instance, the Washington State Coastal Program has been severely criticized by the federal Office of Ocean and Coastal Resources (OCRM) which oversees the Federal Coastal Zone Management Program, because it mandates control over only a 200 foot shoreline zone.

Once such a management zone is delineated, certain activities and uses within the zone would then become subject to specific regulations and restrictions. The actual nature of these restrictions will vary depending upon local problems and management objectives, but will likely be a combination of the specific tools, techniques and programs identified and described below. For instance, the State of Florida has delineated Coastal Construction Control Lines (CCCL) along most of its coastline. These are generally oceanfront areas deemed to be especially hazardous locations for development. While development is permitted within these zones (i.e., seaward of the CCCL), it is subject to more rigorous building standards, intended to take into account the additional water, wave and wind forces present in these areas.

As another example, under North Carolina's Coastal Area Management Act (CAMA) Areas of Environmental Concern (AECs) are delineated. Estuarine Shorelines, for example, as one type of AEC, are defined in the CAMA regulations as "those non-ocean shorelines which are especially vulnerable to erosion, flooding or other adverse effects . . ." and extend "from the mean high water level or normal water level along the estuaries, sounds, bays, and brackish waters. . . for a distance of 75 feet landward" (N.C. Administrative Code, T15: 07H.0200). Again, development is not prohibited in these zones, but rather is subject to additional special development standards, including, among other things, restrictions to impervious surfaces (described later).

Maine's Mandatory Shoreland Zoning Act, adopted in 1973, offers an additional example. Under this legislation all municipalities containing shorelines are required to adopt minimum

shoreline zoning ordinances. The shoreline is specifically defined in the Act to include land 250 feet inland of the normal highwater mark of any pond, river or saltwater body. The state has stipulated, by way of a Minimum Shoreland Zoning Ordinance (contained in the Technical Appendix), the minimum development standards that must be implemented within this 250 foot management zone. These include, among other things, delineation of different use districts, specific density restrictions, shoreline setbacks, and so on.

B. Variable Shoreline Zones

Another strategy is to delineate management areas in a non-uniform manner, based on certain geological, ecological, or other criteria. While this approach would still result in a shoreline management "band," the band would be an irregular and variable one, depending upon the shape and physical attributes of relevant shoreland resources.

Oregon's coastal program offers an example of such an approach. Under the Shorelands Goal (Goal I7) all coastal cities and counties as part of their land use planning requirements must inventory and plan for the fastlands which surround its extensive system of estuaries. (See Oregon Department of Land Conservation and Development, I987.) The goal requires localities to inventory lands within I,000 feet of the estuary shoreline. Important resources found within this planning area must be included in the jurisdiction's "coastal shorelands boundary." More specifically, the coastal shoreland boundary must be a minimum of 50 feet upland from the estuary (as measured from the line of non-aquatic vegetation or mean high water whichever is greater) but must also extend upland to include at least the following:

- Areas subject to ocean flooding;
- Areas of geologic instability;
- Riparian vegetation;
- Significant shoreland and wetland biological habitats;
- Areas needed for water-dependent and water related uses, including dredged material disposal and mitigation sites; and
- Areas of exceptional aesthetic or scenic quality.

Uses and activities within this shoreland zone must be planned and regulated by localities so as to acknowledge this relationship to coastal estuaries, and to protect and enhance estuarian resources.

New York State's Coastal Erosion Hazard Areas Act offers an additional example of a variable, non-uniform management area. Under the Act the New York Department of Environmental Conservation (DEC) has the authority to designate two types of shoreline hazard

areas: natural protective feature areas and structural hazard areas. Natural protective feature areas are those areas which include beaches, dunes, bluffs, and wetlands. Structural hazard areas are defined as those portions of the shoreline receding at an average rate of one foot per year or more. The inland extent of this boundary is "calculated by starting at the landward limit of the fronting natural protective feature and measuring along a line which is perpendicular to the shoreline or horizonal distance landward which is 40 times the long term annual recession rate" (6 NYCRR, Part 505). Within each zone special development standards are applicable. Within structural hazard areas, only "movable" structures are permitted. Moreover, before the state can grant a coastal erosion management permit, the following additional requirements must also be met:

(1) No permanent foundation is attached to the movable structure and any temporary foundations are removed at the time the structure is moved. Below-grade footings will be allowed if satisfactory provision is made for their removal.

(2) No movable structure will be placed closer to the landward limit of a bluff than 25 feet.

(3) No movable structure may be placed or constructed so that, according to accepted engineering practice, its weight places an excessive ground loading on a bluff.

(4) A plan for the landward relocation of a movable structure, when threatened by shoreline recession, must be included with each coastal erosion management permit application.

(5) Movable structures, which have been located within an erosion hazard area pursuant to a coastal erosion management permit, must be removed before the receding edge recedes to within l0 feet of the most seaward point of the movable structure.

(6) Debris from structural damage which may occur as a result of sudden, unanticipated bluff edge failure or erosion must be removed within 60 days of the damaging event.

(7) The last owner of record, as shown on the latest assessment roll, of real property upon which a movable structure is placed, is responsible for removing that structure and its foundation, unless the last owner of record and the owner of the structure, if the structure is not owned by the last owner of record, have made an agreement providing otherwise . . . (6 NYCRR Part 505).

Special development restrictions are also placed on activities within natural protective feature areas. For instance, development, with the exception of elevated walkways, piers, breakwaters, and similar improvements is prohibited in these areas. Performance standards also control the design and installation of these improvements. As well, excavation and mining is

prohibited, as is vehicular traffic along bluffs, dunes, and vegetated beaches. The ability of existing structures within natural feature areas to expand is also curtailed. Existing structures can be enlarged horizontally 25% or 100 square feet, whichever is greater. (The full text of the New York Department of Environmental Conservation erosion regulations is included in the Technical Appendix.)

C. Watershed Approaches

One approach which is increasingly employed is to utilize the watershed as the appropriate management unit. This is particularly appropriate where the primary concern is water quality. The assumption is that it may often be much more effective to look at all the potentially polluting activities that may drain into streams, rivers and bays and to manage these activities, even when they occur at some distance from the actual shoreline. Increasingly, localities view the watershed as the most appropriate management unit when concerned about water quality. In later sections of this report a number of examples of watershed ordinances from around the country which take this approach are identified and described. The City of Austin, Texas, for example, has adopted a Comprehensive Watershed Protection Ordinance which combines its previous single-watershed regulations into a unified, jurisdiction-wide management framework. Under the ordinance critical water quality zones are established around all streams and water bodies, the sizes of which are determined by the types of waterway involved (minor waterways, intermediate waterways, and major waterways). For major waterways the critical water quality zone is defined by the 100-year floodplain, although the line may never extend further than 400 feet on either side of the centerline of the waterway, nor may this zone be narrower than 200 feet. Most, but not all, development activities are prohibited in this zone.

As well, special standards apply to water supply watersheds, and to watersheds classified as "suburban" under the Austin ordinance. (See the Technical Appendix for the text of the ordinance; more specific provisions of the ordinance are also described in subsequent sections of this report). For instance, development proposed within water supply watersheds must adhere to various standards concerning the design and location of wastewater disposal systems (.e.g., the location of sewer lines in certain quality control zones is generally prohibited, and on-site and package treatment plants must meet special design standards in these watersheds).

D. Overlay Zones and Special Natural Areas

A number of localities have resolved the issue of defining the management area by creating special regulatory overlay zones which apply to selected important, yet non-uniform, resources.

New Hanover County, North Carolina, for example, has been using a Conservation Overlay District as a special component of its zoning ordinance. The district creates special additional performance standards which apply to the following types of lands, delineated on County planning maps: swamp forest, pocosin, savannah, natural ponds, freshwater marsh, brackish marsh, primary nursery areas, barrier island beaches, maritime shrub thickets, salt marsh, animal and plant natural areas of special significance, and archeological and historical resources. For some types of resources to quality as a special resource area, they must be of a certain acreage size, for instance, 2.5 acres for swamp forests. For animal and plant natural areas, however, there is no minimum area required before the performance controls apply. The special provisions of the overlay apply when "either the resource is contained partially or wholly on the parcel or if the resource is located next to a parcel such that the resource setback . . . extends into the parcel." Among other things, development subject to the overlay zone must provide certain minimum conservation space (must preserve a certain portion of conservation resource) which is determined for each type of resource though a set of multipliers. (For a more detailed discussion of this provision see subsequent section dealing with "open space/conservation space requirements"; the entire text of the ordinance is included in the Technical Appendix). Proposed development must also meet minimum stormwater run-off standards, must incorporate buffer strips, and structures must be setback a minimum distance from conservation areas, among other requirements.

Harford County, Maryland implements several special environmental overlay districts. More specifically, the following types of Natural Resources Districts are employed:

1) Steep slopes. Any land area exceeding forty thousand (40,000) square feet with a slope in excess of twenty-five (25) percent

2) Marsh Areas. Any area of tidal and non-tidal wetlands exceeding forty thousand (40,000) square feet, including but not limited to, areas designated as Areas of Critical State Concern by the Maryland Department of State Planning . . .

3) Streams. The Natural Resources District Areas for stream protection shall be a minimum distance of one hundred fifty (I50) on both sides of the center line of the stream or fifty (50) feet beyond the one hundred (I00) year flood plain, whichever is greater, and along their tributaries for a minimum of seventy-five (75) feet on both sides of the center line of the tributary . . .

4) Shoreline. Any shoreline or water's edge along the Chesapeake Bay, Bush River, Susquehanna River, and the Gunpowder River, for a minimum distance of one thousand (I,000) feet landward from the mean high water line for tidal waters or the inland edge of tidal wetlands, if present.

Special Management Standards apply within each of these Natural Resource Districts. Within these areas restrictions are placed on the types of uses, on the extent of impervious surfaces permitted, and the extent of vegetative and forested cover that can be removed, among other requirements.

Several additional overlay zones, including the Myrtle Beach, South Carolina Coastal Protection Overlay Zone and the Patuxent River Buffer District, are described in subsequent sections of this report.

E. Uniform and Erosion Based Shoreline Setbacks

Some states and localities have adopted construction setback restrictions which avoid the delineation of specific management zones. Setbacks specifically prohibit development within a certain proximity of a relevant natural feature - - an ocean, bay, lake, river, sand dune, wetland, etc. Such setbacks are typically of two types -- a uniform setback (e.g., "x" number of feet from mean high water) or one based on variable elements of the natural environment, generally shoreline erosion rates. Florida and North Carolina, for example, have erosion-based setback restrictions. In the case of Florida, buildings are prohibited from being constructed seaward of the 30-year erosion line. In North Carolina, major developments (e.g., multi-family units) are prohibited seaward of the 60-year erosion line (as based on average annual erosion rates). Another related exmple of a variable setback is one which is tied to the presence and movement of sand dunes (e.g., structures must be located "x" number of feet behind the crest of the primary dune). Obviously the size, shape and long-term migration of dunes can vary greatly from place to place resulting in very different building setbacks. The setback approach is, of course, different from the uniform management area approach described earlier in that it prescribes a specific development performance, rather than a zone or area of concern in which any number of different tools, techniques, or management strategies might apply.

F. Tiered or Multi-level Approaches

In reality, of course, some of the more effective environmental management strategies will tend to be combinations of these different approaches. Localities may wish to create a tiered approach, which designates a uniform shoreline zone, but also delineates other ecologically-based overlay zones in environmental areas (e.g., for wetlands, wildlife areas). Each area may involve different management requirements - the uniform zone perhaps imposing the basic standards (e.g., use and density restrictions), but with additional standards applied within the overlay areas. Further, the same localities may also wish to adopt certain watershed-based regulations,

restrictions which might be applied over a larger geographical area than the uniform shoreline zone and which would probably not be as extensive or onerous. Shoreline setbacks (uniform or variable) could be adopted as the primary local strategy, but, more likely, they will be used in concert with other mangement techniques and strategies. An ocean or bay setback represents one of the specific regulatory tools that could be employed once shoreline management areas are identified and designated.

III. Intensity and Use Restrictions

A. Use Restrictions

The types of land uses or activities permitted in coastal management areas will certainly have implications for water quality and other local management objectives. It may be inappropriate, for instance, to permit certain potentially polluting industries in close proximity to sensitive shellfish areas. Agricultural and forestal land uses may be more appropriate neighbors to important wildlife habitat than would be multi-family residential development. Designation of permissible land use zones, then, may be an important and effective method of accomplishing many coastal management goals. Use designations can be assigned at both a rather broad and general level -- as in a land use plan diagram (e.g., allocating basic categories of residential, commercial, agriculture, open space) -- or in a much more detailed and specific manner, as in a typical zoning ordinance (e.g., with multiple residential zones). Ideally, these different levels of specificity will be consistent; that is, a general residential zone as defined in the land use or comprehensive plan is further subdivided into several more specific residential zones.

1. Development and Conservation Zones; Land Use Classification Systems

A number of examples of state and local use restrictions designed to protect water quality and other environmental values can be cited. The Maryland Critical Areas Program, for example, requires coastal localities in that state to divide their shoreline (the 1,000 ft. planning area) into three basic use categories, primarily reflecting the types and level of development activities already existing (Intensely Developed Areas, Limited Development Areas and Resource Conservation Areas). Under North Carolina's CAMA coastal localities must prepare land use plans which, among other things, include a land classification system and map. Not intended as a strict regulatory mechanism, the land classification system is intended to serve as a tool in describing where specific local implementation actions and policies will apply in the future. As the CAMA regulations state:

> The land classification system provides a framework to be used by local governments to identify the future use of all lands. The designation of land use classes allows the local government to illustrate their policy statements as to where and what density they want growth to occur, and where they want to conserve natural and cultural resources by guiding growth. (TI5: 07B.0200)

The CAMA regulations call for the use of five categories in local land classification systems: developed, transition, community, rural, and conservation. Each of these classes is specifically defined and described in the North Carolina CAMA regulations (included in the Technical Appendix). The following brief descriptions of the five categories are excerpted from these regulations:

- Developed: "Areas . . . currently urban in character where minimal undeveloped land remains and have in place, or are scheduled for the timely provision of, the usual municipal or public services . . . includes mixed land use such as residential, commercial, industrial, institutional, and other uses at high to moderate densities . . ."

- Transition: "Areas . . . presently being developed for urban purposes or will be developed in the next five to ten years to accommodate anticipated population and urban growth. These areas are in, or will be in a 'transition' state of development going from lower intensity uses to higher intensity uses and as such will eventually require urban services . . . "

- Community: "Areas . . . presently developed at low densities which are suitable for private septic tank use. These areas are clustered residential and/or commercial land uses which provide both low intensity shopping and housing opportunities and provide a local social sense of a 'community' . . . "

- Conservation: "Areas . . . include . . . AEC's including but not limited to public trust waters, estuarine waters, coastal wetlands, etc., other similar lands, environmentally significant because of their natural role in the integrity of the coastal region and include but are not limited to bottom land hardwoods, pocosins, swamp forests, areas that are or have a high probability of providing wildlife habitat, forest lands that are essentially undeveloped and lands which otherwise contain significant productive, natural, scenic, cultural or recreational resources . . ."

As an additional example of use designations, Oregon has developed and employs a system for classifying lands in and around its coastal estuaries. Coastal estuaries are divided into three basic use categories: natural, conservative and development. (There are two sub-categories within development: shallow draft and deep draft development.) While localities implement this system through local land use plans and development ordinances, the state establishes the more specific uses and activities which are permissible in the three different zones, as well as uses conditional upon additional resource capabilities tests. (See Oregon Department of Land Conservation and Development, 1987.) For instance, within natural management units few alterations are permitted. "Undeveloped low-intensity, water-dependent recreation" is permitted by right in these areas. As well, boat ramps for public use where no dredging or fill is required are contingent uses. On the other hand, more extensive

disturbances are permitted in development units. Here water-dependent commercial uses are permissible even where dredge and fills are required. Non-water-dependent uses not requiring dredge or fill" are also identified as conditional uses (see the Technical Appendix).

The Minmum Shoreland Zoning Ordinance required under Maine's Mandatory Shoreland Zoning Act, stipulates that the 250 foot shoreline zone (discussed earlier) should be divided into three use zones: a Resource Protection District, a General Development District and a Limited Residential-Recreational District. Criteria for defining and delineating these different use categories are provided in the ordinance. Resource Protection Districts, for example, are to include the following:

1. Inland or coastal wetlands . . . and specifically areas rated as moderate to high-volume waterfowl areas . . .
2. Floodplains as defined by the 100 year flood or the flood of record or, in the absence of these, by soil types identifiable as recent floodplain soils.
3. Areas having unstable soils subject to slumping, mass movement, or severe erosion, when these areas are two acres or more in size.

While municipalities have no choice but to include these areas in Resource Protection Districts, they have the option of also including the following: other significant wildlife habitat, natural sites of significant scenic or aesthetic value; areas designated by Federal, state or municipal governments as natural areas of significance to be protected from development; and other significant areas that should be included to achieve the purposes of the ordinance. The ordinance provides a detailed set of land use and activities permitted in each of these broad zones (see the Technical Appendix). Residential dwelling units are permitted in General Development Districts but are not permitted in Resource Protection Districts.

2. Urban Growth Boundaries

An important management strategy is to attempt to delineate between urban or development uses and resource areas. For instance, in Oregon all municipalities must designate urban growth boundaries (UGB's). Within these boundaries are urban and urbanizable areas -- areas where urban growth and development is permissible and desireable. The boundary must be drawn in such a way as to include enough land to accommodate approximately twenty years of growth (see Beatley and Brower, 1988). Land outside the UGB is reserved for resource uses (agriculture, forestry) and is generally not available for urban development. Such an arrangement serves to promote a more compact and contiguous pattern of development which in turn serves numerous social goals including

protection of productive resources, provision of more efficient urban services, and prevention of visual clutter.

3. Use Restrictions in Special Environmental Areas or Overlay Zones

The local overlay zones discussed earlier often impose special use restrictions on development. Orange County, North Carolina for example, has enacted a "Water Quality Critical Area" overlay zone adjacent to water supply impoundments. To prevent degradation of these drinking water supplies it places restrictions on the types of uses permissible in the zone. Specifically, while residential uses are permitted, all industrial and commercial uses are not. (A copy of the Orange County zoning ordinance is included in the Technical Appendix.) The Alamance County, North Carolina Watershed Protection Ordinance provides similar restrictions specifically prohibiting the following uses in its Water Quality Critical Areas:

1. Commercial use which sells, stores, or distributes motor fuel or other hazardous materials.
2. Airports
3. Industrial uses
4. Landfills, incinerators, and waste processors
5. Metal salvage facilities including junkyards
6. Manufacturing use or storage of any hazardous or toxic materials waste as listed on the EPA hazardous material list or determined by Alamance County Board of Commissioners.
7. Public or private sewage disposal systems except for sub-surface septic tanks.

Public community sewage treatment facilities may be allowed if the Health Department determines that a public health problem can be alleviated by constructing sewage facilities (Alamance County, N.C., 1987, p. I)

As well, the ordinance prohibits any new underground fuel or chemical storage tanks in the Water Quality Critical Area.

4. Water-dependent Uses

Some states and localities rely heavily on an approach which restricts shoreline uses to those considered "water-related" or "water-dependent." The objectives are typically to protect the sensitive and unique nature of shoreline areas from those types of development, often environmentally and aesthetically obtrusive, that do not need to be located there. Water dependency is a criteria, for example, used by the U.S. Army Corps of Engineers in its "public interest review" of proposals to build on wetlands (i.e., Section 404 permit requirements

under the federal Clean Water Act). If a use is not "water-dependent" there is a presumption that it could be accommodated elsewhere, i.e., in a location which would not require the destruction or damaging of a wetland. Recently, a proposed shopping center in Battleboro, Massachusetts was denied a Section 404 permit because it was deemed not to be water-dependent, and thus could be located on a site that would not require destruction of wetlands (see Baldwin, I987).

It is common for state wetlands management permitting programs to incorporate similar water dependency criteria. Under New Jersey's Coastal Area Facility Review Act coastal development is regulated according to a set of specific Coastal Resource and Development Policies. Under these policies development in coastal wetlands is prohibited unless certain conditions are met -- a key condition being that the proposed use or activity is water dependent. "Water-dependent" is specifically defined in the policies to mean "development that cannot physically function without direct access to the body of water along which it is proposed." The policies go on to provide both examples of what should and should not be considered water dependent:

1. Examples of water dependent uses include: marina activities requiring access to the water, such as commissioning and decommissioning new and used boats, boat regions and short term parking for boaters, storage of boats which are too large to be feasibly transported by car trailer (generally greater than 24 feet), rack systems for boat storage, industries such as fish processing plants and other industries which receive and quickly process raw materials by ships, commercial fishing operations, port activities requiring the loading and unloading of ships, and water-oriented recreation.

2. Water dependent uses exclude, for example: housing, hotels, motels, restaurants, warehouses, manufacturing facilities (except those which receive and quickly process raw materials by ship) dry boat storage for persons not participating in a water-dependent activity, automobile junkyards, and non-water oriented recreation such as roller rinks and racquet ball courts. (New Jersey Code, 7:7E-3.25)

Localities have adopted similar approaches on their own. A notable example is Portland, Maine which recently passed a citizen referendum requiring changes to its zoning code to restrict the city's waterfront areas to water-dependent forms of development. Specifically, the referendum prohibits hotels, motels, and residential uses which are not considered one of the following uses: I) fishing activities; 2) maritime activities; 3) functionally water dependent activities, and 4) authorized public uses. Each of these categories is specifically defined in the referendum (the text of which is included in the Technical Appendix). Maritime activities, for instance, are defined as "activities required for, supportive of or commonly

associated with the construction, repair, operation, storage, loading and unloading of boats, waterfront dock and port facilities, marinas and navigational aids, boat fuel and equipment supply, ground level parking, incidental to such uses and other activities the primary purposes of which is to facilitate maritime trade." Functionally Water Dependent activities are to include "activities that require, for their primary purpose, a location on the waterfront or that require direct access to the water and which cannot relocate away from the water."

5. Movable and Immovable Structures

In some coastal areas restrictions are placed on development based on its ability to respond to future environmental conditions -- and specifically the ability to pick up and move structures away from the shoreline, commensurate with future coastal erosion hazards. The New York Coastal Erosion Hazard Areas Act, discussed earlier, is a case in point. Under this Act in certain designated portions of the coastline (Structural Hazard Areas) only "movable" structures can be built. Some coastal localities have taken a similar approach by either encouraging or requiring lot dimensions and site designs which permit periodic landward relocation of buildings and other structures that may become vulnerable to shoreline erosion (e.g., see Brower, Collins, and Beatley, 1984).

B. Urban Density Restrictions

There is, of course, a close relationship between the intensity of activities which occur on land and their use. The difference between an agricultural use of land and a residential use is not simply a difference of the type of use, but also its intensity.

Conversely, the difference between single family residential uses and multi-family residential uses is not simply a matter of intensity or degree, but also one of land use. Intensity of use and type of use are clearly related. The density of development is typically used to describe the amount of urban growth and development permitted to occur on a parcel of land, usually expressed in terms of the number of permissible dwelling units per acre, or in terms of a minimum lot size.

1. Pre-established Development Density Limits

Both the Maryland Critical Areas program and North Carolina Coastal Area Management Act (CAMA) include density components in addition to the use provisions described above. Within Resource Conservation Areas under the Maryland program, the density of

permissible development is established in the state regulations. Specifically, the Maryland Critical Area regulations state that "Land . . . may be developed for residential uses at a density not to exceed one dwelling unit per 20 acres." While the state stipulates overall density, localities are given flexibility to choose the appropriate regulatory tools to accomplish this density. "Within this limit of overall density, minimum lot size may be determined by the local jurisdiction. Local jurisdictions are encouraged to consider such mechanisms as cluster development, transfer of development rights, maximum lot size provisions, and/or additional means to maintain the land area necessary to support the protective uses" (COMAR, 14.15.01). While under the CAMA's local land use planning requirements specific density caps are not stipulated, the state performance standards for Areas of Environmental Concerns (AEC's) do incorporate some specific density limitations. For example, development within Inlet Hazard Areas is permitted at a density of no greater than one residential or commercial unit per 15,000 square feet of land area, preventing the construction of high density uses in such especially dangerous areas. (N.C. Administrative Code, T15:07H.0300). As well, the regulations stipulate that "only residential structures of four units or less or non-residential structures of less than 5,000 square feet total floor area shall be allowed. . . " Managing the density of development, typically through zoning or subdivision ordinances, has been undertaken by numerous localities across the country to accomplish various environmental and social objectives. Development density is restricted in high slope areas, for instance, to minimize erosion and run-off impacts, to reduce the hazards associated with slope failure, and to reduce the public and private development and facility costs. Density has been regulated in groundwater recharge zones and wellhead areas to minimize the nonpoint effects on groundwater caused by such development, particularly from on-site waste disposal.

It has become common to regulate the density of development in and around water bodies such as lakes, ponds, and sounds, particularly where public sources of drinking water are involved. Reducing density in these critical water quality areas minimizes the extent of pollutants (from lawns, septic tanks, asphalt, etc.) that make their way into these water bodies. Numerous examples can be cited from around the country. In the State of North Carolina, for instance, a number of Piedmont communities have imposed density restrictions in critical water quality zones to protect drinking water sources. These local efforts are further buttressed by a new state surface water classification system that protects these waters at the state level (North Carolina Division of Enviromental Management, 1987). In the Orange County, North Carolina zoning ordinance, mentioned earlier, a minimum lot size of

80,000 square feet is required in Water Quality Critical Areas. In Protected Watershed Districts in the County (watersheds draining into drinking water sources) the minimum lot size for an industrial use is 200,000 square feet.

Under Maine's minimum shoreline zoning ordinance, residential lots in the shoreland zone must be at least 20,000 square feet if unsewered and l0,000 if sewered. Some Maine localities have gone beyond this requirement. Recently amended zoning and subdivision ordinances in the Town of Bridgton, Maine increase development density restrictions around its recreational lakes and ponds. In recent years extensive recreational development has led to substantial non-point pollution, particularly phospherous loadings. Under the new standards, residential lots must be at least 60,000 square feet in size. The Bridgton ordinances illustrate an additional approach to regulating density along a sensitive shoreline -- that is, regulating the dimensions of the shoreline lot to reduce the number of units immediately adjacent to and draining into a water body. For instance, under the Bridgton provisions, development lots abutting lakes, ponds, river, or streams must have a minimum shoreline frontage of l50 feet "measured in a straight line between the points of intersection of the side lot lines with the shoreline at normal high water elevation" (see the Technical Appendix for the full text of this ordinance). (The minimum shoreline zoning ordinance required by the State of Maine stipulates a minimum lot frontage of l00 feet.)

The Wisconsin Model Shoreland Zoning Ordinance, prepared by the Wisconsin Department of Natural Resources, is similar in its restrictions to those required in Maine (see the Technical Appendix). Development lots along shorelines must be a minimum of 20,000 square feet where not served by a sanitary sewer, and l0,000 square feet where served by a sanitary sewer. All buildings along the shoreline must be setback at least 75 feet from the ordinary highwater mark (see subsequent section on buffers and setbacks).

2. Density Limits Established Through Individual Site Analysis

In some localities permissible development density is not simply a function of one to two environmental factors but the cumulative presence of a number of factors. Santa Cruz County, California, for instance, has developed a system for determining permissible lot sizes in rural zoning districts on a site-by-site basis. The County's zoning ordinance includes a series of matrices which assign points to a development site based on the extent to which certain environmental conditions or factors are present. The factors considered include: type of access available, groundwater quality, proximity to important wildlife habitat, slope and erosion potential, seismic and landslide hazards, and fire hazards. Based on these point

matrices a development site is given a cumulative score which is then used to determine permissible lot size. As Table 1 indicates, for sites that are assigned twenty or fewer points (in rural residential zones) a minimum average parcel size of 20 acres is required. (The text of the rural residential density provisions is contained in the Technical Appendix.)

Table 1

Santa Cruz County Rural Density System

Total Number of Points Obtained	Minimum Average Parcel Size Allowed
0 - 20	20 acres
21-40	15 acres
41-60	10 acres
61-80	5 acres
81-100	2- 1/2 acres

Source: Santa Cruz County Planning Dept., 1987

It should be noted that similar density restrictions and similar environmental outcomes can result from local requirements for buffers and setbacks, as well as from caps on permissible impervious surfaces. These are also of concern in this report but are discussed in considerable detail in subsequent sections.

3. Clustering and Density Bonuses

The practice of clustering involves concentrating the bulk of a site's permissible density on only a portion of the parcel or site. This permits the undeveloped portion of the site to remain in an undeveloped, natural state. This approach permits retention of much of the natural value of the site and minimizes the impact of urban development. Houses may be clustered, for instance, to prevent destruction of important wetlands on the parcel, or to maximize distance from a sensitive stream or floodplain. A number of examples of local uses of a clustering concept can be described. Local clustering provisions can be mandatory, but are often optional or voluntary.

Clustering is often encouraged locally by providing density bonuses as an incentive. If developers cluster development on a certain portion of the parcel, for instance, away from an important natural resource, the developer may be given permission to increase the number of

dwelling units that may be built. Boulder County, Colorado offers an example. In much of the county, particularly in prime farming areas, permissible development density is one dwelling unit per thirty-five acres. However, under the County's "Non-urban Planned Unit Development" (NU-PUD) provisions, a developer can obtain an additional unit per thirty-five acres if he or she agrees to cluster the units. Specifically, all development must be clustered on 25% of the parcel, and the remaining 75% must be placed under an easement which prevents future development on this portion of the parcel. Such an arrangement leads to a more efficient pattern of development and retains the bulk of the land for agricultural and open space uses (for a more detailed explanation of the Boulder County program see Beatley and Brower, 1988).

The Austin Comprehensive Watersheds Ordinance has an interesting density bonus provision. In water supply watersheds, where there are three management zones delineated (a critical water quality zone, a water quality buffer zone and an uplands zone), incentives are provided for developers to donate land and leave undeveloped the most critical areas. These incentives are given in the form of relaxed impervious surface requirements. For instance, for each acre of land in the critical water quality zone (the zone directly adjacent to a waterway) donated to the city fee simple, the developer is given an additional 20,000 square feet of impervious cover in the uplands zone (the zone farthest away from the waterway). (See buffers and setbacks section for a more detailed discussion of the Austin Ordinance; the complete text of the ordinance is included in the Technical Appendix.)

The City of Myrtle Beach, South Carolina, has adopted a Coastal Protection Overlay Zone which results in a form of density transfer away from the shoreline and which lessens the economic hardship of a mandatory shoreline setback. Under the provisions of the zone substantial restrictions are placed on activities that can occur within an area marked by the 50-year erosion line. Specifically, uses in this zone are restricted to such low-intensity activities as elevated sundecks, patios, walkways, gazebos, stairs, etc. No other buildings or structures are permitted seaward of this 50-year erosion line (see the Technical Appendix). The ordinance includes a "setback impact allowance" intended to reduce the impacts of the provisions. Depending upon the percentage of a landowner's lot affected by the 50-year setback, the ordinance relaxes sideyard requirements (specifically, raising the height a building is permitted to be constructed before additional sideyard setbarks are required), in effect permitting higher densities on the remaining land (i.e., the area landward of the 50-year erosion line).

IV. Performance Approaches

The tools, techniques and policies discussed in the next few sections address what can be defined broadly as performance approaches. Instead of being subject simply to conventional use and density limitations, development activities are increasingly required to meet certain standards which relate directly to the "impacts" and "effects" of these activities. The impacts that must be considered range from stormwater run-off to destruction of wetlands; from effects on trees and vegetation to deterioration of groundwater quality, among others. Often performance standards stipulate that development activities satisfy certain end results, yet provide some flexibility for the developer in choosing the appropriate mixture or combination of design features.

A basic distinction is made here between on-site performance approaches and off-site performance standards. The two categories are clearly related though some distinction is useful. Off-site performance approaches take as their focus specific outcome standards that relate to the quality of resources off-site. A community may establish, for instance, a specific ambient air quality standard for a particular air pollutant and stipulate that each individual development must incorporate minimum design features so as not to exceed this standard. In contrast, on-site performance approaches refers to all on-site requirements where there is no direct and immediate external standard used to determine appropriate design features. While stream buffer requirements may be imposed on a developer to reduce impacts on water quality, under this approach there is no specific outcome standard (i.e., in-stream standard) to determine what level or extent of buffering the specific development should incorporate. Again, however, the two categories are closely related. Indeed, most of the on-site requirements would or could be used by developers in accomplishing off-site requirements.

A. Off-site Performance Standards

1. Water Quality Standards

The use of water quality standards (in-stream standards) in managing urban growth and development is certainly not new. Indeed, states have been involved in developing and using water quality standards for years as part of their responsibilities under the federal Clean Water Act. Each state water quality program contains a classification of water body uses (e.g., recreational, water supply, industrial) and a corresponding set of water quality criteria (e.g., maximum levels of BOD, suspended solids, etc.) consistent with these new classes. These standards are then used in implementing the permit requirements under the National Pollutant

Discharge Elimination System (NPDES) under the federal Clean Water Act. States and localities have used these types of water quality standards in regulating development activities. It is common for state and local wetland and shoreline development ordinances to stipulate that a proposed activity in a particular location is prohibited if it will result in a violation of state water quality standards. For example, the New Jersey Freshwater Wetlands Protection Act, discussed in a subsequent section, contains such a provision. As a further example, watershed ordinances, such as the Austin ordinance, often classify watersheds and vary the stringency of the required development performance standards according to the designed uses and/or quality of the streams and waterways involved (see the Austin ordinance in the Technical Appendix).

2. Wetlands Mitigation

The central idea behind wetlands mitigation standards is that it may be possible to compensate the loss of natural wetlands on a development site by restoring or creating new wetlands in other locations. Thus, the performance required by the development can be imposed off-site. Proponents of wetlands mitigation argue that this is an effective tool for maintaining, even expanding, the overall amount of wetlands in a community or state. Others, particularly wetlands ecologists, argue that the new wetlands created are not really as biologically productive, and do not completely replicate the functions of natural wetlands (this debate has yet to be fully resolved, e.g. see Race 1985). Many state and local wetlands laws contain provisions which explicitly require mitigation as a condition of development approval where the project results is in the destruction or degradation of on-site wetlands. Under New Jersey coastal law, when permits are issued for the disturbance or destruction of natural wetlands, "the disturbance or loss shall be compensated for by the creation or restoration of an area of wetlands at least the size of the surface area disturbed, unless the applicant can prove through the use of productivity models or other similar studies, that by restoring or creating a lesser area, there will be no net loss in the environmental value of wetlands in the aquatic system" (New Jersey Administrative Code, 7:7E-I.6). Under the New Jersey provisions wetlands restoration or creation may also be used to offset other effects of a proposed development. "Mitigation shall also be selectively considered on a case-by-case basis as compensation for other policies not able to be met by a particular project."

It is interesting to note that the newly-adopted New Jersey Freshwater Protection Act contains a provision which creates a Wetlands Mitigation Bank and a Wetlands Mitigation Council which will oversee it. The bank will permit developers with projects which destroy and damage freshwater wetlands and which consequently have mitigation responsibilities, to contribute funds to the bank in lieu of actual wetlands creation or restoration. The Wetland Mitigation Bank will then use the collected funds to finance the acquisition of wetlands and wetlands restoration projects (the text of act is included in the Technica Appendix).

B. On-Site Performance Standards

1. Urban Development Best Management Practices

a. Stormwater discharge standards

Urban stormwater runoff can have substantial negative impacts on surface water quality. It collects and carries into these waters oil, grease and numerous chemicals, and contributes to general flooding and erosion. Regulating the stormwater generation and retention capacities of new development has become a primary non-point pollution management strategy in a number of states and localities.

Three states -- Florida, Maryland, and North Carolina -- have been leaders in imposing state stormwater discharge standards. While Virginia does not currently have such a state level requirement, Virginia coastal localities can learn from the experiences of these states as well as other localities around the country, in developing their own stormwater management strategies. States and localities vary in the quantitative standards imposed on development. Most are directed at controlling the "first flush"; that is the early stages of rainfall and run-off which tend to collect the contaminants that have accumulated in the watersheds since the last rain. Studies in Florida have indicated that 90% of the pollution load of a storm is carried off during the first inch of rainfall (See Livingston, 1985).

Florida adopted Rule 17-25 in 1982 to address stormwater discharge. It establishes stormwater performance standards based on the size of the drainage area. For development sites of 100 acres or less, stormwater retention systems which will retain the first one-inch of rainfall must be put into place. For sites of over 100 acres, retention of the first one-half inch in required (due to the

diminishing effects of the first flush of larger drainage areas). The performance standard can be satisfied through a combination of methods, including detention and infiltration. (Specific methods are briefly described below.)

Under the Maryland Stormwater Management Act of 1984, each county and municipality in that state is required to adopt a stormwater management ordinance which must incorporate certain minimum state standards. Jurisdictions in eastern Maryland must adopt ordinances which "require that the post-development peak discharge for a 2-year frequency storm event be maintained at a level equal to or less than the 2-year pre-development peak discharge rate... " All other jurisdictions in the state must "require that the post-development peak discharges for a 2- and 10-year frequency storm event be maintained." (COMAR 08.05.05). For specially designated interjurisdictional flood hazard watersheds, development must not be permitted to increase the downstream peak discharge for the 100 year storm event.

Certain development activities are exempt from the Maryland state requirements. These include developments that do not disturb over 5,000 square feet of land, and single family residential projects with each unit on a lot of two acres or greater. The Maryland standards express a preference for certain types of stormwater control methods over others and require local ordinances to reflect this preference. Specifically, on-site infiltration of run-off is the most preferred approach, while stormwater detention structures are the least preferred.

North Carolina has recently adopted a similar state level approach, albeit one that is applicable just to the coastal zone. For development draining directly into sensitive coastal waters (Class SA waters) infiltration systems must "control the run-off from all impervious surfaces generated by one and one-half inches of rainfall . . . Run-off in excess of the design volume must flow overland through a vegetative filter with a minimum width of 50 feet measured from mean high water . . . " (N.C. Administrative Code T.5: 02H. 1000). For development draining to other waters, infiltration must control run-off from the first one inch of rainfall. Stormwater retention ponds are also permissible, and the state regulations provide additional detailed design standards for these as well as for infiltration systems. As with Maryland, certain types of development, including developments that do not require a "major" development permit under North Carolina's CAMA, are exempt. (The North Carolina standards have been included in the Technical Appendix to this report.)

Individual localities have for many years imposed stormwater management requirements on development projects and, as already mentioned, localities are often given responsibility for implementing state stormwater discharge standards. Local regulations typically require developers to prepare a drainage or stormwater management plan which is then usually reviewed in connection with local development approval. These plans must usually include basic information about the amount of stormwater run-off to be generated and proposed improvements to deal with it. The King County, Washington Surface Water Management Standards, for instance, require drainage plans to include the following:

1. Background computations for sizing drainage facilities.
   a) Depiction of the drainage area on a topographical map, with acreage indicated;
   b) Indication of the peak discharge and amount of run-off currently entering and leaving the subject property;
   c) Indication of the peak discharge and amount of run-off which will be generated within the subject property if development is allowed to proceed;
   d) Determination of the peak discharge that will be generated by the design storm frequencies as specified by the department at various points on the subject property;
2. Proposed improvements for handling the computed run-off;
3. Access and/or easements to all facilities for inspection, cleaning and repair. (King County, WA, Code, Title 9, Surface Water Management).

Local ordinances also typically include a requirement for the posting of a performance bond to ensure that stormwater improvements are completed. Ordinances also include provisions dealing with long term maintenance and upkeep of stormwater facilities. Special provisions often encourage or permit stormwater mangement facilities and improvements which address the run-off problems of multiple property owners in an area. It should be noted that review of drainage and stormwater management plans at the local level often occurs concurrently with review of plans for sedimentation and erosion control during construction (discussed in a subsequent section of this report).

Different localities impose different levels and types of retention standards. In Dekalb County, Georgia, for example, where soils do not permit reliance on infiltration, a combination of storage and controlled release is usually required. The release rate for stormwater from development requiring such retention must not "exceed the peak storm run-off rate from the area in its existing state for all

intensities up to and including the 100 year frequency for all durations" or must "not be greater than that calculated for a storm of two year frequency with a run-off coefficient of .20, .25, and .35 for land with an average slopes of up to two percent, two to seven percent, and over seven percent respectively" (chapter 4, Environmental and Land Development, Dekalb County Code; see the Technical Appendix). The retention storage of drainage facilities must be calculated on the basis of the 100 year storm event. The drainage system must have enough capacity to accommodate the flow from all upstream areas during the 100 year storm.

Leon County, Florida offers another example of stormwater discharge standards (included in the Technical Appendix). The county drainage standards state that applicants for stormwater permits must demonstrate that after the proposed development "surface water run-off from the site is equal to or less than the rate of flow of surface water run-off that would have occurred following a twenty-five year return frequency storm under existing conditions, unless run-off is discharged directly into an off-site drainage facility . . . or directly into a receiving water body" (chapter 7, Drainage, Leon County Code of Laws). The Leon performance standards also require that development minimize erosion during and after development, and that it protect the "beneficial functioning of wetlands as areas of natural storage and filtration of surface water run-off," among other requirements. More specific standards regulate the design and functioning of drainage improvements (see Technical Appendix).

b. Stormwater Retention/Detention Techniques

Once stormwater standards, such as those set at the state level in North Carolina, Maryland and Florida, have been established, it is typically up to the developer or project builder to establish the best combination of stormwater techniques and improvements to satisfy these standards. There are a number of possible approaches. Some, such as maintaining natural infiltration capacity by restricting the extent of impervious surfaces, are described in detail in subsequent sections of this report. The discussion here is primarily restricted to structural improvements which can be incorporated into development proposals to retain or detain stormwater to achieve desired performance standards. Two common categories of stormwater best management practices (BMP's) are infiltration and stormwater detention.

Infiltration systems are designed to collect stormwater run-off and permit it to seep back into the ground, in turn replenishing groundwater resources. Among the specific techniques included in this category are: downspouts that direct roof drainage to lawns, porous pavement, soak-away pits or dry wells, vegetated filter strips, infiltration trenches, and recharge percolation basins and swales. Detention techniques involve devices which hold stormwater for some period of time, from several minutes to a matter of days, before it is released into the natural drainage system. The most common detention device is a wet pond or basin. The use of natural or manmade wetlands is also usually characterized as a form of detention.

1)Infiltration

As noted above, infiltration strategies are in many places considered the preferred approach (e.g., the stated policy in Maryland). They have the advantage of both replenishing groundwater by providing a natural form of filtration and of cleansing pollutants contained in run-off. However, successful infiltration requires land with porous soils and groundwater that is well below the surface. In some parts of the country (for instance in Dekalb County Georgia described above) the soils do not permit adequate percolation, and detention is then the only available course of action. Of the infiltration devices available, infiltration trenches are perhaps the most commonly used. They typically consist of a shallow trench two to ten feet deep, filled with coarse stone aggregate permitting water storage, and gradual infiltration into surrounding soils (see Maryland Department of Natural Resources, 1984). Dry wells are similar in design, though usually with a smaller surface area. Vegetated or grass swales are also commonly used. These are depressions in the ground which slow and trap run-off permitting infiltration. Filter strips and roof drainage systems that runoff to grass areas are similar approaches, though they may require more space and hold less capacity than trenches. As one recent commentator suggests: "Nearly complete control of most urban run-off pollutants can occur using a Bermuda grass strip between 50 and 400 feet long." While the large expanse of grass required is usually not available in small developments, other areas such as hospitals, schools, office parks, and cluster residential developments are prime candidates for this kind of run-off treatment" (Pitt, 1986). (Also, see discussion of buffer strips below.) Grass filters are also relatively inexpensive when incorporated into a broader project

design. Porous pavement, concrete grids and lattice blocks represent alternatives to the conventional impervious materials used to build roads and parking lots. They have been proven to be as structurally sound as standard paving materials, yet maintain the natural drainage capacity of the land. Special concern is required to protect against groundwater contamination (some studies suggest porous pavement is most appropriate for low traffic areas). Recharge or percolation basins are another infiltration strategy and are usually built around stormwater collection outflows.

Where development space is particularly scarce infiltration systems have been placed under parking lots and other improvements. Stormwater is collected and stored in large perforated pipes, surrounded by gravel. Referred to as "exfiltration", such systems have been extensively used in Orlando, Florida (Zeno and Palmer, 1986).

Infiltration devices have generally proven to be effective at managing stormwater run-off. A survey of local experiences with infiltration in Maryland, for example, found that approximately 70% of the devices were functioning properly (Pensyl and Clement, 1987). Infiltration trenches received the highest rating of the infiltration techniques that were in use. Infiltration trenches were also the most commonly used device in that state, followed by infiltration basins, drywells, porous pavement and swales, in that order.

2)Stormwater Detention

Detention devices are usually in the form of a wet pond or basin. They are very effective at collecting stormwater run-off and removing pollutants through the settling of sediment. Concentrations of nutrients in run-off can also be reduced through biological processes which create algae (though for this to be effective the algae must be removed from the waste before discharge). Ideally, detention facilities are integrated into the landscape and can even provide aesthetic anemities to developers (e.g., creating "lake front" lots). Wetlands, both natural and manmade, have increasingly been used as forms of stormwater detention. Wetlands are quite effective at absorbing rainwaters and filtering out pollutants. It may not be desireable, however, to expose pristine natural wetlands to stormwater pollutants. To effectively use wetlands as filters or detention areas it may be

necessary to incorporate pre-treatment lakes to reduce sediment loads and remove certain types of pollutants (e.g., oils and grease).

c. Buffers and Setbacks

Shoreline buffers and setbacks often amount to the same thing, and they are generally discussed together here. They can differ, however, in several important ways. The provision of natural buffers usually implies an attempt to maintain a natural vegetative area -- an area of trees, grasses, and so on -- with the primary purpose of filtering pollutants and run-off before it reaches water bodies. Usually a requirement for a natural buffer implies the prohibition of buildings and structures, though this is not necessarily always the case. Moreover, a shoreline or coastal setback may often be intended (as we have already discussed in connection with oceanfront areas) as a strategy to reduce exposure of buildings to erosion and flood forces, and the zone which is left open and undeveloped as a result may not necessarily serve as a pollution buffer.

Requirements for creatively using undeveloped and natural zones around streams, rivers, lakes and other water bodies are increasingly common at both state and local levels. The Maryland Critical Areas program, for instance, requires local governments to establish a minimum 100 foot buffer "landward from the mean high water line of tidal waters, tributary streams and tidal wetlands." All new development activities are prohibited in these buffer zones (except certain water-dependent facilities) and the buffers are to be maintained in natural vegetation. Agricultural activities are permitted in the buffer strip but only where a 25 foot filter strip is created and where several other conditions are satisfied. Commercial harvesting of trees in the buffer zone is generally prohibited. (See Technical Appendix). Local governments are directed to extend the buffer inland,

> " . . . to include contiguous, sensitive areas, such as steep slopes, hydric soils, or highly erodible soils, whose development or disturbance may impact streams, wetlands, or other aquatic environments. In the case of continguous slopes of 15 percent or greater, the buffer shall be expanded 4 feet for every 1 percent of slope, or to the top of the slope, which ever is greater in extent" (COMAR 14.15.09).

It is common for local watershed protection ordinances to include a streambed buffer or setback requirement. Under the Durham County, North Carolina, Watershed

Protection Standards, for example, a 100 foot vegetated buffer is required on both sides of all perennial streams in Water Quality Critical Areas, and a 50 foot buffer for streams within Water Quality Basin Areas (see the Technical Appendix). The Bridgton, Maine Shoreland Zoning Ordinance, requires a 100 foot buffer zone around all its water bodies in which all new structures except for temporary docks meeting certain standards are prohibited (see the Technical Appendix). Local ordinances vary both in the extent of the buffer required and the methodologies used to calculate it. A natural stream buffer is required around all perennial streams within protected watershed districts in Orange County, North Carolina, and the extent of the buffer is to be estimated in the following way:

> The stream buffer area shall start at the outer edge of the floodplain and be measured a distance of fifty (50) feet away from the floodplain plus an additional distance depending on the slope near the stream. The slope shall be calculated by measuring a distance 250 feet from the center of the stream, determining the average rise in elevation and multiplying that value by four. This value shall be added to the minimum buffer of 50 feet to determine total width of the buffer area required. The maximum buffer in any case shall not exceed 150 feet.

In Residential Watershed Zoning Districts in Wake County, North Carolina, the size of the required buffer depends on the amount of land being drained. Twenty-five foot buffers (along each side) are required for streams draining 5 to 25 acres, and 50 foot buffers required for streams draining over 25 acres. Also, under the Wake Ordinance buildings must be setback an additional twenty-five feet from all buffer zones.

In the Austin, Texas Comprehensive Watersheds Ordinance discussed earlier, the size of the buffer depends on a heirarchy of waterways within the jurisdiction. For "minor" waterways, the Critical Water Quality Zone is defined by the 100 year floodplain, with the qualifier that the zone can never be less than 50 feet or greater than 100 feet on either side of the waterway. For "major" waterways, on the other hand, the minimum size of the Critical Water Quality Zone is 200 feet and the maximum is 400 feet. The Critical Water Quality Zone in Austin amounts to a buffer because urban development is prohibited within it. Some activities, such as parks and open space, are permitted. (See below.) (The full text of the ordinance is included in the Technical Appendix.) Furthermore, within the Critical Water Quality Zone, additional buffer restrictions are imposed. The ordinance prevents development of any type within one hundred and fifty feet of any "critical

environmental feature" such as bluffs, springs, canyon rimrocks, caves, sinkholes, and wetlands and requires maintenance of the natural vegetation to the maximum practical extent. As well, "no clearing, alteration or development of any kind shall be permitted within fifty (50) feet of a critical environmental feature, except hiking trails for educational purposes. . . "

For suburban watersheds the Austin ordinance establishes two additional management zones -- a "Water Quality Buffer Zone" and an "Uplands Zone." The Water Quality Buffer Zone extends parallel to the Critical Water Quality Zone for 150 feet inland along major waterways and 100 feet along intermediate waterways. While development within this "extra" buffer area is not prohibited, impervious surfaces are restricted to 30 percent of the land area of the parcel, exclusive of land in the floodplain. The upland zone imposes similar, though less stringent, restrictions. For water supply and suburban watersheds the development restrictions are even more stringent.

Local stream buffer standards tend to vary according to the precise uses permitted within them (e.g., farming, public utilities, bridges), whether buffers can be used in meeting minimum lot sizes standards and the extent to which existing vegetation must be protected or new vegetation established, among other differences. Within Austin's Critical Water Quality Zone, while buildings and structures are prohibited, certain activities are permitted. Specifically, the following are permissible activities in this buffer area:

1. arterial, collector, and residential street crossings (subject to additional restrictions);
2. fences that do not obstruct flood flows;
3. public and private parks, golf courses and open spaces, other than parking lots, when a program of fertilizer, pesticide and herbicide use is approved. . . provided, however, that in watersheds designated as water supply rural or where the Critical Water Quality Zone, park development is limited to trails and facilities (other than stables and corrals for animals), for hiking, jogging, non-motorized biking, and nature walks;
4. Boat docks, piers, wharves, or marinas, and necessary access and appurtences . . . All treated building materials that will be submerged in water must be approved . . .;
5. Detention basins, utilities, maintenances, and floodplain alterations . . .

The Maryland Department of State Planning has developed an interesting Model Buffer District Ordinance for localities with jurisdiction along the Patuxent River.

(The ordinance is included in the Technical Appendix.) The buffer district is to be defined in the following way:

a. For tidal water, a minimum distance of one hundred feet from the mean high water line or to the edge of the 100-year floodplain, whichever is greatest;
b. For non-tidal waters, a minimum distance of one hundred feet from the water's edge during average flows or to the edge of the 100-year floodplain, whichever is greatest.

This buffer area is intended to remain undeveloped, prohibiting most structures (except a structure having 200 square feet or less of impervious area for each parcel), as well as activities such as mining, excavation, and the storage of hazardous materials. Cutting of natural vegetation is permitted but must effect less than 20% of the total ground cover on the parcel (see Technical Appendix).

Buffers and setbacks are often required to protect wetlands and numerous state and local examples of such requirements can be cited. Under the New Jersey Coastal Area Facility Review Act (CAFRA), for example, a 300 foot wetlands buffer is delineated around all coastal wetlands. All development within this buffer zone is prohibited by the New Jersey regulations "unless it can be demonstrated that the proposed development will not have a significant adverse impact and will cause minimum feasible adverse impact, through the use of mitigation where appropriate on the wetlands, and on the natural ecotone between the wetlands and the surrounding upland."

The newly adopted New Jersey Freshwater Wetlands Protection Act requires that certain "transition areas" around freshwater wetlands be protected. The actual widths of the transition areas are to be determined by the State Department of Environmental Protection, according to the following:

1)No greater than 150 feet nor less than 75 feet for a freshwater wetland of exceptional resource value;
2)No greater than 50 feet nor less than 25 feet for a freshwater wetland of intermediate value. (N.J.S.A. 13: 9B-1 et.seq., see text included in the Technical Appendix).

Activities within these transition areas are severely curtailed. Among the activities prohibited here are the following: removal, excavation, or disturbance of soil; dumping or filling of any materials; erection of structures; except for temporary structures of 150 square feet or less; placement of pavements; and destruction of plant life which would alter the existing pattern of vegetation.

d. Impervious Surface Standards

Nonpoint run-off and erosion from rain and storms are normally minimal on natural sites. This is because water is able to infiltrate into the soil, in turn replenishing groundwater resources. As urban development occurs in an area, the amount of land covered with impervious or impenetrable surfaces (i.e., preventing infiltration) increases dramatically. Such surfaces include buildings, parking lots, streets, playgrounds, etc. One strategy which has been used extensively around the country is to place limits on the extent to which development can create impervious surfaces; that is, requiring development to maintain to some degree the natural pre-development infiltration capacity of the land.

The actual standards used, as well as the ways in which they are implemented, vary from place to place. Some example of standards will be helpful. Under North Carolina's CAMA, development within estuarine shoreline AEC's must not create impervious surfaces of greater than 30% of the AEC area of the lot "unless the applicant can effectively demonstrate, through innovative design, that the protection provided by the design would be equal to or exceed the protection by the 30 percent limitation" (N.C. Administrative Code, T 15:07H.0200). Development within Limited Development Areas under Maryland's Critical Areas Program is restricted to 15% impervious surfaces (COMAR, 14.15.02). In the Wake County, North Carolina Residential-80 Watershed Districts (designed to protect drinking water sources), impervious surfaces must not exceed six percent. Note that impervious surface restrictions are often complementary with density restrictions -- In this Wake County zone only single family structures on two-acre parcels are permitted, typically resulting in no more than six percent impervious surface. The Orange County, N.C., Watershed Protection Standards are similar. In water quality critical areas, impervious surfaces must not exceed six percent, although roof uses of residential structures can be excluded from the calculation where "roof run-off is kept from directly or indirectly entering street or parking/driveway drainage systems, but rather is directed to infiltrate the first one inch of stormwater across lawn or natural vegetation areas within the confines of the particular development in which the roof is located." For Water Quality Basin areas in the County (areas not immediately adjacent to a water body) the impervious restrictions are not as stringent, though they remain substantial. For development in those areas which

are not served by public sewer the impervious surfaces maximum is 15%, and for development served by public sewer the maximum is 30%. (See the Orange County "Regulations for Development Within Critical Watershed Areas," contained in the Technical Appendix to this report.)

e. Open Space and Natural Area Set-Asides

Some local ordinances impose performance standards on development requiring that certain minimum portions of a site or parcel be set aside or protected in open space or natural uses. The New Hanover County, North Carolina Conservation Overlay District, for example, stipulates that a certain amount of "conservation space" -- that is, a certain portion of the conservation resources such as swamp forest, pocosin, animal and plant natural areas present on the parcel -- must be set aside. The amount that must be set aside varies according to the type of conservation resource. Fifty percent of the swamp forest must be protected (a minimum of five acres), while 100% of brackish marsh and primary nursery areas must be preserved. The total minimum conservation space for a parcel is the addition of the required conservation space for each of these different natural resources. The ordinance does provide some flexibility by allowing the developers to trade off more conservation space for one resource for less of another (while the total minimum acreage that must be protected and set aside is not reduced).

It is common for local development ordinances to contain certain minimum open space standards. The Largo, Florida Comprehensive Development Code states, for instance, that "As a condition of approval, the developer may be required to set aside land for permanent open space." (Largo Development Code, 1985, subsection 5302.) The Code provides that required open space be preserved and maintained in one of several different ways:

1) Dedication of open space to the City of Largo or an appropriate public agency approved by the city . . . ;
2) Common ownership of the open space by a homeowner's association which assumes full responsibility for its maintenance;
3) Dedication of development rights of open space may be made to an appropriate public agency with ownership remaining with the developer or homeowner's association. Maintenance repsonsibility shall remain with the property owner;
4) Deed-restricted private ownership which shall prevent development and/or subsequent subdivision of open space land and provide the maintenance responsibility.

Open space requirements are often imposed or negotiated as a part of a planned unit development. Development may also be required to contribute to an open space acquisition fund where monies are used to acquire lands that become part of a community-wide or regional open space system.

f. Tree Protection and Vegetation Standards

A number of localities around the country have adopted tree protection ordinances. Protecting trees, particularly along waterways and the shoreline, has beneficial effects on water quality by serving as buffers and filters to pollutants. Trees maintain soil and streambank stability and thus reduce erosion. Moreover, protecting trees can be an important strategy in maintaining the visual resources of an area, as well as advancing local wildlife and recreational values. Trees can also enhance local air quality and reduce noise pollution.

Local tree protection ordinances typically require an individual to obtain a permit prior to removing or relocating a tree of a certain diameter. The applicant typically is required to submit a report along with the permit application which, among other things, states the reasons or justifications for removing the tree(s). Tree protection ordinances usually state certain criteria or conditions under which trees can be removed (e.g., to remove a safety hazard), and requirements for replacing the trees.

The Leon County, Florida tree protection ordinance offers an example. (See Technical Appendix for the full text of the ordinance.) Under this ordinance permits must be obtained where protected trees are threatened. Whether or not the county restriction applies to a particular tree or trees is a combination of the diameter of the tree and whether the tree is located in one of several tree protection zones. Where protected trees are involved, a permit for removal can be issued only where one or more of the following conditions is present:

1. Safety hazard. Necessity to remove trees which pose a safety hazard to pedestrians, property or vehicular traffic or threaten to cause disruption of public services; or which pose a safety hazard to persons or buildings.
2. Diseased or weakened trees. Necessity to remove diseased trees or trees weakened by age, storm, fire, or other injury.
3. Good forestry practices. Necessity to observe good forestry practices.

4. Construction of improvements. Necessity to remove trees in order to construct proposed improvements . . .
5. Compliance with other ordinances or codes.
6. Solar energy. Necessity to install solar energy equipment.

The ordinance requires the applicant to submit a plan for replacing trees, and the number of trees that must be replaced is explicitly stated in the ordinance as a function of the diameter of the tree removed. For instance, for each tree of 6l-72 inches in diameter removed, the applicant will be asked to plant l0 new trees (6'tall and l" in diameter). As the diameter of the tree to be removed decreases, so does the required number of replacement trees. Trees are also to be protected during the development construction process. All protected trees must be indicated by a location map approved by the County. The ordinance also states that:

> During development activity, the area within seventy-five percent of the dripline of any trees to remain on the site shall be protected from activities that may injure the tree. Such activities include but are not limited to cut-and-fill activities, building pad placements, road bed construction, and construction material storage. (Chapter l2, "Landscaping and Tree Protection," Code of Laws, Leon County, Florida)

As with many tree protection ordinances, tree nurseries and trees in active commercial operation are exempt from the permit requirements in Leon County.

Trees and forested areas can provide effective buffers for sensitive water bodies from urban and agricultural activities. Researchers at the Smithsonian Institution, for example, recently found that a forested buffer located between farm fields and a stream can remove as much as 80% of the nitrogen from farm run-off (Sullivan l986). Some states and localities have sought to manage the extent to which trees along stream banks and shorelines are removed. Under Maryland's Critical Areas Program localities must regulate tree removal in Limited Development Areas so that (among other restrictions) "no more than 20% of any forest or developed woodland may be removed from forest use . . . The remaining 80% shall be maintained through recorded, restricted convenants or similar instruments" (COMAR l4.l5.02). A greater percentage of trees can be removed (up to 50%), however, where trees are replaced at a rate of l.5 times the total surface area of the affected forest. Furthermore, harvesting of trees within the l00 foot shoreline buffer is generally prohibited (see discussion

of shoreline buffers). As an example of a similar approach, the Town of Bridgton, Maine allows the following in the 100 foot zones around its sensitive recreational lakes: "20% of the total mass of trees may be removed in any 10 year period providing that a well distributed forest canopy is maintained and that no alterations are made to the original topography and ground cover." The permitted tree removal percentage is raised to 30% of total mass for the adjacent management zone from 100 to 250 feet from water bodies.

The Wisconsin Model Shoreland Zoning ordinance (required of counties under Wisconsin Shoreland Mangement Program; see Technical Appendix) places restrictions on the extent of shore cover that can be removed. Specifically, within a zone thirty-five feet inland from the ordinary highwater mark, the following restrictions would apply:

- No more than 30 feet in any 100 feet, as measured along the ordinary highwater mark, may be clear cut to the depth of the 35 foot area.
- Natural shrubbery shall be preserved as far as practicable and where removed, it shall be replaced with other vegetation that is equally effective in retarding runoff, preventing erosion and preserving natural beauty.

Greater cutting can be permitted under the model ordinance if the applicant submits, and the locality approves, a cutting plan. Criteria for evaluating cutting plans are contained in the model ordinance.

g. Septic Tank Setbacks and Other Standards

Improperly located septic tanks and septic tanks which are not functioning properly, are a major source of water pollution and present in many areas a serious health threat. Consequently many states and localities regulate the placement, design and operation of on-site sewage disposal systems.

For example, under Florida's Areas of Critical Statewide Concern special land use regulations have been adopted which control development along the Franklin County Shoreline (intended to protect the water quality of the Apalachicola Bay; for an extensive discussion of the Florida ACSC program, see DeGrove, 1984). Among other restrictions, new controls have been placed on septic tanks use. Specifically, the new regulations state that:

> Within 75 feet of the Wetlands of Franklin County neither septic tanks nor alternative wastewater treatment systems shall be allowed. Within 75 to 150 feet of the Wetlands of Franklin County and in areas not served by a central wastewater system, alternative wastewater treatment systems shall be required. Standard septic tanks and their associated absorption beds, including sub-surface or mound systems, shall be prohibited.

Alternative treatment systems are in turn subject to additional standards (see the complete text of the ordinances in the Technical Appendix). The minimum Shoreland Zoning Ordinance required in Maine, as a further example, states that all subsurface sewage disposal systems shall be located in areas of suitable soil of at least 1,000 square feet in size and must be setback at least 100 feet from the normal high water mark of a water body (see the Technical Appendix).

h. Structural Elevation, Floodproofing, Wind Standards and Other Building Standards

A number of coastal states and localities have implemented special building standards for shorefront structures. Most coastal localities are currently participating in the National Flood Insurance Program (NFIP) and as a result must implement certain basic land use and construction standards for development in flood hazard areas, most notably requiring that new structures in the 100-year floodplain are elevated to the 100-year base flood elevation (BFE), and that development must be severely curtailed in the floodway (see the model floodplain management ordinance prepared by the North Carlina Division of Emergency Management, contained in the Technical Appendix). Some states and localities have gone substantially beyond the basic NFIP requirements, however. Some localities have prohibited all development activities in the 100-year floodplain, and others have imposed elevation standards beyond those required under NFIP (a practice often referred to as "free-boarding"). (See Brower, Beatley, and Blatt, 1988) States and localities also typically require that coastal structures be designed to withstand a certain sustained wind speed.

i. Wetland Protection and Enhancement

There has been substantial activity at both state and local levels in recent years aimed at preserving and protecting wetlands. Cities and Villages in Wisconsin, for instance, are required to adopt minimum provisions to protect

shoreland wetlands. The Wisconsin Department of Natural Resources has issued a model shoreland-wetland zoning ordinance which describes the minimum protective measures required (included in the Technical Appendix). The ordinance suggests that the shoreland-wetland zoning district be defined to include all wetlands in the local jurisdiction which are at least five acres in size and which are:

1)Within one thousand feet of the ordinary highwater mark of variable lakes, ponds or flowages . . .
2)Within three hundred feet of the ordinary highwater mask of navigable rivers or streams, or to the landward side of the floodplain, whichever distance is greater.

Residential development would not be permitted in the zone. Permitted uses would include: hiking, biking, trapping, hunting, swimming, harvesting of wild crops, and so on. Certain other uses which involve some alteration of the wetlands would be permitted subject to certain precautions. For instance, the construction and maintenance of non-residential building is permitted, provided that:

1) The building is used solely in conjunction with a use permitted in the shoreland-wetland district [e.g., silviculture, cultivation of cranberries] or for the raising of waterfowl, minnows or other wetland or aquatic animals;
2) The building cannot, as a practical matter, be located outside the wetland;
3) The building does not exceed 500 square feet in floor area; and
4) Only limited filling and excavating necessary to provide structural support for the building is allowed.

Limited construction of roads is also permitted, again if fairly detailed performance criteria are satisfied.

The zoning ordinance of the City of Sanibel Florida (Sanibel Island) contains a Special Interior Wetlands District intended to protect its unique interior wetlands areas. While development in the zone is not entirely prohibited, it is subject to an extensive set of development standards.

Development cannot occur closer than 200 feet to the Sanibel River (the primary location of the wetlands) and residential structures are not to be constructed below a certain elevation where possible. Specifically,

> No residential structure shall be developed on land at or below three feet in elevation, NGVD, unless the parcel to be developed does not contain at least five thousand square feet of buildable area or higher land on which to place a residential structure. If the parcel does not contain at least five thousand square feet of buildable area on higher land . . . only one structure may be permitted containing up to two dwelling units . . . and fill shall be limited to twenty percent of the gross area of the tract, lot or parcel, or seven thousand five hundred square feet, whichever is less (Sanibel Land Development Code, I986, p. 47).

Included also are restrictions on impervious surfaces, to excavation and filling, and to clearing of vegetation, and special requirements for the location and design of driveways and roadways (must be elevated on pilings when below a certain elevation).

The Town of Dennis, Massachusetts implements a wetlands protection program fairly typical of other New England communities. The present Dennis bylaws and guidelines, for example, prohibit a structure closer than 25 feet from wetlands, and no septic tanks are to be closer than I00 feet. The distance of a structure from the wetland is to be maximized and natural drainage and vegetation are to be maintained where possible (see Technical Appendix). New proposed wetlands bylaws (also contained in the Technical Appendix) would substantially expand the performance standards the town would implement.

As mentioned above, the State of New Jersey has recently enacted a Freshwater Wetlands Act which will extend protection beyond tidal wetlands. Among other things, it calls on the State Department of Environmental Protection to develop a classificaton system for freshwater wetlands, and stipulates certain specific protective actions which must be taken when considering permits for development in or around freshwater wetlands. The Department can issue a freshwater wetlands permit only if it makes the finding that the proposed development of activity:

1) Is water-dependent or requires access to the freshwater wetlands as a central element of its basic function, and has no practicable alternative which would involve a freshwater wetland or which would have a less adverse impact on the aquatic ecosystem, and which would not have other significant adverse environmental consequences . . or

2)Is nonwater-dependent and has no practicable alternative . . . which would not involve a freshwater wetland or which would have a less adverse impact on the aquatic ecosystem, and which would not have other significant adverse environmental consequences; and

3) Will result in minimum feasible alteration or impairment of the aquatic ecosystem, including existing contour, vegetation, fish and wildlife resources, and aquatic circulation of the freshwater wetland; and

4) Will not jeopardize the continued existence of species listed pursuant to "The Endangered and Nongame Species Conservation Act" . . . or while appearing on the Federal Endangered Species List, and will not result in the likelihood of the destruction of adverse modification of a habitat which is determined . . . as appropriate to be a critical habitat . . . ; and

5) Will not cause or contribute to a violation of any applicable state water quality standard; and

6) Will not cause or contribute to a violation of any applicable toxic effluent standard or prohibition; and

7) Will not violate any requirement imposed by the United States Government to protect any marine sanctuary. . . ; and

8) Will not cause or contribute to a significant degradation of ground or surface waters; and

9) Is in the public interest . . ., is necessary to realize the benefits derived from the activity, and is otherwise lawful. (N.J.S.A. I3:9 BI et. seq., see Technical Appendix for the full text).

The New Jersey Act contains what it calls the "Rebuttable Presumption": "It shall be a rebuttable presumption that there is a practicable alternative to any nonwater-dependent regulated activity that does not involve a freshwater wetland, and that such an alternative . . . would have less of an impact on the aquatic ecosystem." The Act sets forth standards that must be satisfied by the applicant in rebutting this presumption (further elaborated in the N.J. Department of Environmental Protection regulations). The new Act contains extensive mitigation requirements and creates a freshwater wetlands mitigation bank. (See previous section.)

2. Construction Best Management Practices

Site preparation and land disturbance associated with urban development can generate substantial erosion and non-point pollution. Some studies have indicated that erosion on construction sites may be as much as ten times greater than from land in cultivated row crops, 200 times greater than from pasture land and perhaps 2,000 times greater than from timberland (Bergquist, I986). States and localities have historically sought to

minimize construction impacts by requiring adherence to certain basic construction site standards and practices. Typically, these include such things as the use of erosion trapping devices such as siltation filters and traps, sediment ponds and diversions, restrictions to grading, use of mulch, and seeding and vegetation requirements, among other techniques.

A model construction site erosion control ordinance prepared by the Wisconsin Department of Natural Resources is included in the Technical Appendix. Under the ordinance landowners and developers must submit a control plan which identifies, among other things, the location and dimensions of all proposed land disturbing activities, the location of temporary soil and dirt stockpiles, the locations and dimensions of all control measures proposed to meet the requirements of the ordinance, a schedule indicating the timing of land disturbance and the installation of control measures, and provisions for the maintenance of control measures over the course of construction. The ordinance, as is typical, establishes the set of procedures for issuing erosion control permits, procedures for inspection and enforcement, and requirements for the posting of surety bonds.

Erosion and sedimentation control ordinances vary in the detail and stringency of the performance standards contained in them. At a minimum, ordinances require certain measures and actions to control run-off from disturbed areas. Under the Wisconsin model ordinance, disturbed ground left inactive for seven days or more must be stabilized through sodding, mulching, or an equivalent method. For disturbed sites of greater than ten acres, sedimentation basins must be constructed to trap run-off. Specifically,

> Each sedimentation basin shall have a surface area of at least l% of the area draining to the basin and at least 3 feet of depth and constructed in accordance with accepted design specifications. Sediment shall be removed to maintain a depth of 3 feet. The basin shall be designed to trap sediment greater than l5 microns in size, based on the set of l year design storms having durations from .05 to 24 hours. The basin discharge rate shall also be sufficiently low as to not cause erosion along the discharge channel or the receiving water.

Use of filter fences, straw bales or equivalent measures placed along sideslope and downslope portions of the site is deemed permissible for sites of less than ten acres. Restrictions are also placed on the location and placement of soil and dirt storage piles. Such piles of ten cubic yards or greater cannot be placed closer than 25 feet to any roadway or drainage channel, and must be stabilized (e.g., through tarps or vegetated

covers) when left for seven days or longer. Use of straw bales and filter fences to control erosion from soil storage areas is also required.

Restrictions to construction activities on high slopes areas will also reduce erosion potential, both long term and short term. The Austin Watersheds ordinance, for instance, prohibits the location of roadways and driveways on slopes in excess of 15% "except where necessary to provide primary access to areas of flatter slopes, constituting a minimum of two contiguous areas or building sites for at least five residential units." The ordinance also prohibits construction of buildings and parking areas or slopes of greater than 15%, except that construction can occur in areas where slope is 15-25% when the following criteria are satisfied:

1. Impervious cover on 15-25% slopes shall not exceed ten percent of the total area of 15-25% slope.

2. Structures located upslope of slope between 15-25% and not using terracing techniques shall be constructed utilizing pier and beam techniques. Fill shall be placed to blend with the natural contour. No vertical walls shall extend beyond the finished floor elevation, other than necessary to screen mechanical appurtenances, and shall be stepped, if appropriate. Terraced fill and walls shall be a maximum of 1 to 1 running grade limited to four feet in height for soil terrace. This section shall not apply to single family and duplex construction.

3. Structures located downslope between 15-25% shall be terraced and consolidated into the hillside. Structured elevation shall not exceed a maximum of eight feet in depth, except by terracing. Areas of cut not hidden from view shall be effectively screened by additional landscaping.

4. Hillside vegetation shall not be disturbed other than that necessary to locate the structure. All disturbed areas shall be restored with native vegetation.

5. If terraces are not provided, cuts and fills are to be retored to 3 to 1 slopes and revegetated. Restored slopes shall be limited to as short a length as possible.

Local construction control ordinances often restrict the extent of cutting and filling allowed. Under the Austin ordinance no fill can exceed a maximum of four feet of depth. As well, no cuts can be greater than four feet (except for structural excavation and within roadway right of ways). The extent of clearing for road construction is also restricted. Specifically, roadway clearing must not exceed twice the width of the roadway surface or the width of the dedicated roadway, whichever is less. As well, the "length of time between rough-cutting and final surfacing of roadways may not exceed eighteen months."

3. Agricultural Best Management Practices

Agricultural operations are a major source of nonpoint water pollution. The usual tillage of soil permits soil erosion, which in turn takes with it the pesticides, herbicides, and fertilizers that have been applied to the land. A wide variety of agricultural best management practices have been employed to reduce soil erosion, often encouraged through federal and state subsidies. Among the more common agricultural BMP's are the following: contouring; crop rotation; contour strips; conservation tillage; diversions, terraces and other structural practice; and containment of animal wastes (see Clark, HaverKamp and Chapman, 1985 for a comprehensive review).

Farmlands which are naturally subject to high levels of erosion represent a substantial problem. Considerable attention in recent years has been given to reducing the incentives for farmers to produce on such highly erodible soils. The federal Conservation Reserve Program (CRP), created under the 1985 Farm Act, is a major step in this direction. Under this program farmers are paid under ten year contracts with annual payments to take highly erodible lands out of production and to plant them in grass and trees. The federal CRP is also intended to complement the new "sodbuster" provisions which will penalize farmers who do not practice adequate erosion control (farming highly erodible soils without an erosion management plan) by withdrawing price supports.

States are also beginning to take some initiative in this area. The Reinvest in Minnesota (RIM) Reserve Program is perhaps the best example of recent state innovation in this area. Similar to the federal CRP, the RIM program pays farmers not to farm highly erodible soils, and subsidizes the planting of grass cover and trees. A landowner has the option of entering into an easement in perpetuity or for a shorter period, though for no less than twenty years. The level of payment is based on the fair market cash rent of the land (for limited duration easements, however, payments are to be based on 65% of the permanent easement payment). Payments can be in the form of a one-time lump sum, or can be distributed over four equal annual installments. Under the program no landowner can receive more than $50,000 annually. The state will cover up to 75% of the cost of establishing permanent cover on the land (not to exceed $75 per acre for limited duration easements and $100 for permanent easements) and up to 75% of the cost of planting trees (up to $200 per acre for limited duration easements and $300 for permanent easements). The RIM program has a relatively broad definition of eligible land. Land may be enrolled in the program if the land:

1. is marginal agricultural land;

2. is adjacent to marginal agricultural land that is being enrolled if enrollment of the adjacent land is beneficial to resource protection or necessary for efficient recording of the land description and if at least 50% of the total proposed acreage is marginal agricultural land;

3. consists of a converted wetland and cropland adjacent to the converted wetland to the extent of up to four acres of cropland for each acre of wetland restored; or

4. is land that with a living snowfence would be beneficial to resource protection.

In its brief period of existence the RIM program has been quite successful. In 1986, about 21,000 acres were enrolled in the program, encompassing some 900 easements (Minnesota Department of Agriculture, 1988).

4. Silviculture Best Management Practices

The commercial harvesting of woodlands can have severe impacts on the water quality of streams, rivers, and other surface waters. Clearcutting and other harvesting practices destablize soil, and open up areas to substantial erosion and run-off. Also, loss of forestlands can seriously modify wildlife habitat, as well as stream and other shoreline habitat by reducing shade and raising water temperatures and can jeopardize the aesthetic and recreational values forests serve.

Consequently, a number of states and some localities have enacted regulations which control forest harvesting practices, and which require the performance of certain forest management activities. Forest management practices typically address: required levels of timber restocking, fire protection rules, erosion control standards, and regulations to protect streams and watersheds, among others. The California Forest Practices Act (1973) and subsequent regulations, is often identified as one of the strongest state programs. Under the California program the state is divided into three forest districts (Coast, Northern and Southern), with the State Board of Forestry establishing forest practice rules and regulations for each district. Anyone wishing to conduct timber operations must submit a timber harvesting plan reviewed by the state for its consistency with management rules and regulations.

Of special interest are the regulations in the Coast District. Article 6 imposes special standards for Watercourse and Lake Protection Zones. A Watercourse and Lake Protection Zone is determined and included on the timber management plan, according to specific

criteria in the regulations. The greater the slope of the land, and the higher the class of water to be protected, the wider is the Watercourse and Lake Protection Zone, and the more stringent are the protective measures required. For class I water in the state (habitat for fish migration and spawning) in areas of 70% slope, the width of the watercourse and lake protection zone, is 200 feet. For logging operations within this zone the following performance standard (among others) must be achieved:

> "To protect water temperatures and act as a sediment filter strip, at least 50 percent of the overstory canopy shading the watercourse and 50 percent of the understory vegetation present before timber operations, shall be left standing and well-distributed, within the Watercourse and Lake Protection Zone."

Other standards address the manner in which different harvesting practices are conducted. For example, clearcut areas cannot exceed 80 acres (40 acres in high erosion zones). There are also minimum stocking requirements, erosion control standards (e.g., filling practices, restrictions on the use of tractors), fire protection standards (e.g., preparation of fire protection and control plans in certain circumstances), and forest insect and disease protection practices. The California provisions also require the establishment of buffer zones around nests of endangered bird species and other bird species of special concern. The size of the buffer is specifically established in the regultions for each particular species. For instance, for the bald eagle and peregrine falcon, the buffer must be a minimum of ten acres in size, but may be increased to as many as 40 acres. Within this zone no clearcutting is allowed, although thinning and other forms of harvesting are permitted. Critical periods of the year are also established when additional standards are imposed. For bald eagles, no timber operations are permitted in the buffer zone between January I5 and August I5 (or four weeks after fledging).

In addition to these standards which apply to entire Coast District, the California Coastal Commission has established several Special Treatment Areas where additional, more stringent requirements apply. These are areas of special ecological or aesthetic value. Clearcutting in these areas is not permitted by right, but must be justified by satisfying one or more criteria. Clearcutting areas in these zones can under no circumstances exceed I5 acres in size. In these special treatment areas, certain counties have secured other specific restrictions. In Marin County, for instance, additional restrictions are placed on the hours during which power equipment can be operated, and the use of clearcutting is prohibited entirely in the county. (See Technical Appendix for

the complete text.) As a further example, in Monterey County, special additional restrictions to logging are imposed in the scenic Big Sur area.

The State of Oregon has also been a leader in this area. Its Forest Practices Act imposes similar requirements, with the Oregon Board of Forestry adopting specific best management practices for commercial forestry. (Different though similar rules have been promulgated for three regions in the state -- the Northwest, Southwest, and East). The Oregon Program applies special management standards to what are called "Riparian Management Areas" (RMA). The widths of the areas vary. For streams, the width of the riparian area "shall average three (3) times the stream width, but it shall not average less than twenty-five (25) feet or average more than one hundred (I00) feet. Stream width is the average of the main channel width of the stream during its high water level flow." For estuaries the width of the riparian management area is set at I00 feet. For lakes and significant wetlands, the size of the riparian management area is a function of the size of the water body. For lakes and wetlands of less than one acre, the riparian management area is to average twenty-five feet, while, for lakes and wetlands of over ten acres the is to average I00 feet. In addition, several sub-zones, including aquatic areas (the wet zone), riparian areas (areas adjacent to the water) and the riparian area of influence (the remaining upland areas of the management area) are identified. Special harvesting and management rules apply in these different management zones. Specifically, for riparian management areas adjacent to class I waters (the most pristine waters in the state), the operator must retain an average of 75% of the pre-operation shade over the aquatic areas, must retain at least 50% of the pre-operation tree canopy in the riparian area, and must leave all snags and down timber in riparian management areas. The operator must retain live conifers in the management area according to certain standards and conditions. For example, as the stream and required riparian management area increases in size, so also does the size and number of conifers required. (The complete text of the forest practice rules is included in the Technical Appendix.)

5. Prohibitions to Shorehardening Structures

Several coastal states and localities have adopted regulations which prohibit or severely limit the use of permanent shorehardening structures such as seawalls, bulkheads, and riprap. The use of such structural devices can be very expensive and can often severely interrupt natural shoreline processes. Shoreline bulkheads and other

similar erosion control devices can impede the natural inland migration of wetlands in response to sea level rise (e.g., see Barth and Titus, I984). Under North Carolina's CAMA, permanent shorehardening structures have been banned in oceanfront areas. More specifically the CAMA regulations state that:

> Erosion control structures which cause significant adverse impacts on the value and enjoyment of adjacent properties or public access to and use of the ocean beach are prohibited. Such structures include, but are not limited to, wooden bulkheads, seawalls, rock or rubble revetments, wooden, metal, concrete, or rock jetties, groins and breakwaters; concrete-filled sandbags and tire structures.

The State of Oregon has imposed similar restrictions. Goal 18 -- Beaches and Dunes -- states that permits for beachfront protective structures will only be issued where development existed on or before January 1, 1977 (Oregon Land Conservation and Development Commission, 1985).

V. Environmental Impact Review and Information Requirements

Another broad category of strategies is to require the collection and presentation of information, on a project-by-project basis, on the likely environmental impacts of a proposed use or activity. Such an approach often takes one of several forms, including the preparation of environmental impact statements (EISs)requirements for the preparation of special studies and reports. As well, the common procedures for local site plan review also fall within this strategy.

A. Environmental Impact Statements

Federal agencies have been required to prepare Environmental Impact Statements (EISs) since the passage of the National Environmental Policy Act (NEPA) in 1969, and approximately half the states (including Virginia) have similar requirements. The use of EISs has been considerably less common at the local level, with the exception of a few states, such as California, that impose EIS requirements on local development projects (where local development permits are required).

As an example, the Tahoe Regional Planning Agency (Nevada/California) implements environmental review procedures which may require the preparation of environmental impact statements (for certain development projects). Initially, applicants for projects must complete an environmental checklist. Based on the checklist, the Regional Planning Agency will then determine whether significant impact on the environment is likely and if so it will require the preparation of an EIS. If insufficient information is provided in the checklist to make such a determination, the agency may require the preparation of an Environmental Assessment. Should a full environmental impact statement be required, the Tahoe Regional Planning Agency Code of Ordinances stipulates that it must include at a minimum the following information:

1) Description of the project;

2) The significant environmental impacts of the proposed project;

3) Any significant adverse environmental effects which cannot be avoided should the project be implemented;

4) Alternatives to the project;

5) Mitigation measures which must be implemented to assure meeting standards of the region;

6) The relationship between local short-term uses of man's environment and the maintenance and enhancement of long-term productivity;

7) Any significant irreversible and irretrievable commitments of resources which would be involved in the proposed project should it be implemented;

8) The growth-inducing impact of the proposed project (Chapter 5, "Environmental Documentation," text included in the Technical Appendix.)

B. Special Studies and Site Plan Review

More commonly, localities impose additional environment information and impact requirements in connection with a specific type of resource or activity or as a special condition to building in a particular geographical area or district. For example, under the Austin Comprehensive Watershed Ordinance, proposed developments within water supply watersheds are required to prepare "Environmental Assessments." These assessments must include a hydrogeologic element describing the topography, soils, and geology of the site, a vegetative element including tree survey, and the identification of significant plant material, a wastewater element describing alternative waste water disposal systems to be used over recharge areas, and an identification of critical environmental features, among other things.

As a further example, the City of Cannon Beach, Oregon requires a site investigation by a qualified expert where development is proposed on sites with slopes of 20% or greater and in other sensitive locations such as high hazard coastal zones, potential land-slide areas as designated on the City Master Hazards Map, and areas of weak foundation soils). Where serious threats appear to exist to a proposed use, the report must identify appropriate engineering and construction methods for minimizing these conditions, making development approval contingent upon their accomplishment (see Beatley and Brower, 1988).

Finally, most local governments are already involved in some form of environmental impact review by way of normal site plan review. This review process provides the opportunity for local officials to question the environmental and other impacts of a proposed project design, as well as to suggest or require design modifications to minimize or mitigate these impacts.

VI. Land Acquisition

Public land acquisition represents one of the most effective management strategies available. Through acquisition of sensitive shoreline areas or river and streambanks, the public can effectively exclude all activities, ensuring a level of protection that regulatory and other techniques may not permit. Acquisition also tends to provide a longer, more secure form of management, than land use regulations to be continually or periodically modified or circumvented. While acquisition provides greater public control over sensitive management areas, it has several disadvantages when compared with regulatory approaches. The most notable disadvantage is cost, particularly when considering shorefront areas which typically involve very high fair market land prices. Moreover, public acquisition takes private property off the local tax rolls, which can lead to substantial reductions in land tax revenues. Once land is acquired by the public, decisions must also be made concerning its use and management. Will the public have access to it? Which local or state government entity will have responsibility for its upkeep and management. Two broad categories of land acquisition are described below: fee-simple, and less-than-fee simple. Alternative approaches to financing acquisition are also discussed.

A. Fee Simple Acquisition

Fee simple acquisition simply involves purchasing the full rights of ownership. A number of examples of successful public fee simple acquisition programs can be cited. Boulder, Colorado has been operating an extensive (primarily) fee simple acquisition program since 1967 when voters there approved a one-cent sales tax, 40% of which is specifically contracted for open space land acquisition. This program has been tremendously successful and the city's urban greenbelt now includes more than 20,000 acres of land (including a mountain park). During this period the city has spent approximately $50 million for land acquisition. The city's open space system has successfully preserved much of the rural and scenic backdrop of the city, and has assisted in containing urban growth (for an extensive review of the Boulder program see Beatley and Brower, 1988).

B. Less-than-fee Simple Acquisition

Less-than-fee simple acquisition includes public programs intended to secure certain rights from landowners -- typically the right to develop. These approaches are often described as "PDR" or Purchase of Development Rights programs. Less-than-fee simple programs have several advantages over fee simple acquisition. The per acre acquisition costs

can be substantially lower, and the underlying ownership and management responsibilities remain in private hands. Such lands also continue to pay local property taxes, albeit at a level commensurate with their lowered market values.

King County, Washington is an example of a relatively successful PDR program. Here development rights have been acquired to over 12,000 acres of farm land at a cost of approximately $54 million. Guided by the recommendations of a Farmlands Study Commission, specific prime farmland areas were identified as eligible for development rights acquisition. A system was established giving priority to farmlands which were most threatened by urban development. The program has been completely voluntary and once the sale is made the landowner must sign a deed restriction legally limiting future use of the land to agriculture and open space. (The ordinance authorizing the sale of bonds for the acquisition, and which sets forth the procedures and priority system for guiding acquisition is included in the Technical Appendix; for a full discussion and analysis of the King County program, see Beatley and Brower, 1988).

C. Funding Alternatives

A number of options exist for financing state and local land acquisition programs. As mentioned above, some communities such as Boulder Colorado, have used a dedicated sales tax to fund acquisition. Other communities have funded acquisitions through a combination of general revenue funds and the floating of bonds. There is increasing interest around the country in the use of real estate transfer taxes, and there are several notable examples of the use of the funding source for land acquisition. The Nantucket Land Bank (Nantucket, Massachsuetts) is perhaps the best example to date. Created by a special act of the Massachusetts Legislature, the Land Bank was given authority to impose a tax on the value of land transfers. As a result of the booming land market there the tax has generated tremendous income, approximately $80,000 per week. Some $6 million had been raised from about 3,000 transfers as of July 1986 (Klein 1986). The Land Bank is also interesting organizationally. It is governed by a five person elected board, and has extensive authority, including the power of eminent domain. Other communities have obtained funds to purchase public lands through development exactions, and increasingly through the use of "impact fees." (See Snyder and Stegman, 1986, for an overview of the use of impact fees.) The City of San Francisco, for instance, requires all new downtown commercial development to pay a parks impact fee used to fund the acquisition of public parklands. Martin County, Florida has

imposed a beach impact fee, which is used to fund acquisition of public beach access areas. (See Beatley and Brower, 1988).

It is increasingly common for localities to seek dedication of streambeds and floodplains, either in fee-simple or less-than-fee simple, as condition of subdivision or site plan approval. The City of Raleigh, North Carolina has pursued such an approach since the mid-seventies as part of its Capitol Area Greenway Program (see City of Raleigh, 1985). This program has resulted in substantial recreational and flood reduction benefits. The greenbelt presently contains over 50 miles of public trails. Mecklenberg County, North Carolina (Charlotte) has been implementing a similar program, acquiring land as part of its linear greenway system through a combination of techniques, also including dedication during subdivision approvals and rezonings. To date more than 1,000 greenway acres have been secured there, again reducing flood damages, enhancing water quality and creating additional recreational amenities (see Brunnemer and Furuseth, 1986).

VII. Conservation Incentives and Public Investment Policies

A. Transfer of Development Rights (TDR)

The concept of Transfer of Development Rights or "TDR" is a direct extension of the clustering technique described earlier. While clustering involves shifting density from one portion of a parcel to another, TDR extends this idea to the broader community. Under a TDR program areas within the jurisdiction are designated as "sending zones" while other areas are designated "receiving zones." Property owners within sending zones can transfer extra or unused density there (i.e., by using them directly or selling them to developers to use) to receiving zone parcels where it can be used to increase permissible building densities. TDR programs can be either voluntary or mandatory. Under a voluntary program a landowner has either the option of developing at full density as permitted by right under the local zoning ordinance, or developing at a lower density (or not at all) and transferring unused density to other community sites.

Calvert County, Maryland has been implementing such a voluntary TDR program for about ten years with the primary objective of preserving prime farmland in the county (implementing ordinances adopted in 1979). Under this program a farm located in an agricultural preservation district can either develop at the base density or choose to sell these development rights for use in a "Transfer Zone District." Once the rights are sold, the farmer or landowner is severely restricted in his or her ability to develop in the future (e.g., future development density may not exceed one dwelling unit per 25 acres of land). Unlike many other TDR programs, the receiving zones are not designated in advance but rather represent a floating zone that could apply in various places in the County, subject to specific criteria. The Calvert program has been reasonably successful as a voluntary program. Since 1979 development rights have been transferred from approximately 2,500 acres of land in agricultural preservation districts (Bowan, undated).

Collier County, Florida offers another example of a voluntary TDR. The Collier zoning ordinance creates a "Special Treatment" Overlay District ("ST") which applies to sensitive environmental areas in the county including, but not limited to, mangrove and freshwater swamps, barrier islands, coastal beaches, and estuaries and aquifer recharge areas. The Collier zoning ordinance specifies potential receiving zones and establishes maximum increases in density that can occur through transfers. For instance, for the RMF-6 zoning district the maximum additional development density that can be accommodated is 1.20 units per acre. (See the text of the zoning provisions contained in the Technical Appendix.) For the county to approve the transfer the "ST" landowner must place a deed restriction on the land

which guarantees the land will forever remain in its natural condition and will never be developed. "For the purposes of this requirement, natural conditions shall include minor nature related improvements such as nature paths, boardwalks, outdoor educational learning areas, and removal of exotic vegetation" (Collier County Development Code).

Mandatory TDR programs, in contrast, are those which prohibit entirely or severely restrict the level of permissible development on a sending zone parcel and essentially allow the transfer as the only alternative. For example, the City of Austin Texas has imposed height limitations on buildings in its Capitol View Corridor Zones to protect vistas and views of the State Capitol building. Builders and developers have no choice but to adhere to the height restrictions but can transfer unused pre-overlay density to adjacent sites not obstructing views of the Capitol (see Beatley and Brower, 1988).

TDR generally is not considered the radical idea it once was. Indeed, it appears to be in wide use around the county, designed to achieve a variety of public goals (Beatley and Brower, 1988). The advantages of TDR are that it can reduce some of the economic sting of environmental regulations, while providing developers and landowners with greater flexibility. A major disadvantage is that it often requires a very strong development market, typically hinged to an expanding metropolitan area, to ensure that a significant market value attaches to development rights. This is especially a concern in states and localities where TDR is intended to provide full or partial compensation for public regulation.

B. Capital Facilities and Public Investment Policies

Local and state governments can have tremendous impacts on environmental quality and management of land and growth through decisions about the location, design and timing of capital facilities and other public investment policies. Capital facilities have been described as "growth shapers" because of their long-term influence on the patterns of private investment and growth. Through public investment decisions coastal localities have the opportunity to guide future development away from sensitive areas to minimize the water quality and other environment impacts of development. Several sub-categories of policies within this broad approach are described below.

1. Capital Improvements Programs (CIP)

Most localities are already involved in some level of public investment planning by way of a Capital Improvements Program or "CIP." While CIP's can vary, typically they include a listing and prioritizing of public projects and capital facilities over a period of

time (often seven years), as well as programs identifying how they will be funded. Typically updated yearly, the CIP can be a very useful tool to localities in managing development to reduce water quality problems and to address other environmental problems. The location and timing of capital facility investments can substantially influence patterns of growth, and in turn impact shoreline and local environmental resources. Some capital investments, such as the construction or expansion of a public sewage treatment system, will have direct and immediate effects on environmental quality. Others, such as the design and location of roads may tend to have more indirect though perhaps no less significant effects.

2. Allocating Scarce Public Service Capacity

For some localities the problem is how to allocate and dispense limited remaining public service capacity consistent with preferred local development goals. While this approach may not be relevant in every community, it becomes a tool where decisions must be made about how to distribute finite public services, such as sewer or water capacity, and where expansion of capacity in the short run is either impractical or undesirable. The Town of Nags Head, North Carolina, for example, receives a limited share of a regional water supply system and has adopted a unique water tap allocation ordinance to distribute this limited supply. Specifically, all proposed developments must apply for and secure water tap permits. Available annual permits are first allocated by land use class. For all proposed hotel, multifamily, commercial and office projects the permits are allocated according to a point system which ranks projects according to their representative design features. Points are awarded according to such factors as fire safety, location of development, water quality impacts, water conservation, traffic, and aesthetic appearance.

3. Minimum Facilities Ordinances

A number of localities around the country have adopted minimum facilities ordinances as a primary strategy in managing urban growth. Such ordinances stipulate that proposals for development will not be approved unless they will have access to a minimum level of public services. Typically such minimum services and facilities include public sewer and water, police and fire protection, and roads and schools, among others. Often developers have the choice of waiting until the public provides the facilities at some point in the future or making the investments themselves. Such a strategy has been used in

communities such as Montgomery County, Maryland and Boulder, Colorado (see Beatley and Brower, 1988). In Boulder, for instance, minimum service standards are quite precise. For instance, minimum police and fire service is defined in terms of response times. Under the Boulder program the minimum facilities standards are part of a broader growth phasing plan. Private developers are not permitted to make their own investments but must wait for the city to make them, or they must locate projects in those parts of the city where the full complement of urban services already exists. (An extensive case study of the Boulder system is contained in Beatley and Brower 1988.)

4. Expenditure Limitations Approaches

One effective management strategy which might be used at either state or local levels is to limit the level and type of public expenditures and subsidies in certain sensitive shoreline areas. The State of Florida pioneered this idea with its executive order 81-105 in 1981, which stated that state agencies were not to fund projects in hazardous barrier island locations. The Florida idea has been largely embodied in the 1982 Federal Coastal Barrier Resources Act ("COBRA") which withdraws most federal subsidies for development on designated undeveloped barrier island units (see Kuehn 1984). The Act withdraws federal flood insurance, development monies for such things as highways and sewer improvements, and post-disaster assistance. While it is unclear whether this approach will in the long run really retard barrier island development, signs do indicate that it is having some effect (Godschalk, 1986).

Under its 1985 Growth Management Act Florida has attempted to go even further in restricting state subsidies in hazardous shoreline areas. Specifically, the infrastructure policies prevent the state from funding the construction of bridges to barrier islands which are not already served by a bridge. As well, state agencies are prevented from funding improvements that would be located in high hazard zones as designated in the coastal protection elements of local comprehensive plans.

VIII. Some Conclusions

This report has attempted to provide an overview of the management options available to coastal localities in Virginia. It suggests that an initial step in developing a management program is to determine the appropriate dimensions of the planning and management zone or area. Several alternative strategies for doing this, including the adoption of a uniform distance shoreline zone, a variable zone based on certain shoreline features, a watershed approach, and the use of overlays and sensitive area designations have been discussed.

Once management areas or zones have been defined, localities have a range of specific tools and management devices that would be applied within the zones. Several primary categories have been identified: use and density restrictions; performance criteria and standards; environmental impact review; land acquisition; and incentives and public investment policies. While this has not been an exhaustive review of alternative tools and techniques, it has covered the primary strategies likely to be available to Virginia coastal localities.

While this report has emphasized tools and strategies that are useful in protecting and enhancing water quality, most of these same tools can be used to address other environmental management goals. Each coastal locality will have its own unique set of goals and values and should consider adopting those management tools and strategies, or combinations of tools and strategies, that maximize achievement of these local goals.

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APPENDIX A

Reference	Agency/Phone Number	Date Adopted
Maryland Critical Area Act	Maryland Critical Area Commission (301) 269-2418	1984
North Carolina Administrative Code: Esturaine Shorelines	North Carolina Coastal Resources Commission (919) 733-2293	1977
Maine: Minimum Shoreline Zoning Ordinance	Maine Department of Enviromental Protection (800) 452-1942	1973
Oregon Land Conservation And Development Act	Oregon Department of Land Conservation & Development (503) 373-0050	1976
New York: Coastal Erosion Hazard Areas Act	Commission of Enviromental Conservation (New York) (518) 474-2121	1984
Austin Texas: Comprehensive Watershed Ordinance	The City of Austin Planning Commission (512) 499-2640	1981
New Hanover: Conservation Overlay District	New Hanover County (N.C.) Planning Department (919) 341-7165	1982
Harford County: Natural Resource Overlay District	Harford County Maryland Planning Department (301) 838-6000	1985
Myrtle Beach: Overlay Zoning Ordinance	Myrtle Beach Planning Department (803) 626-1211	1984
Patuxent River Model Buffer District Ordinance	State of Maryland Department of State Planning (301) 263-7962	1980

Reference	Agency/PhoneNumber	Date Adopted
North Carolina Administrative Code: Land Classification	North Carolina Department of Natural Resources & Community Development (919) 733-2293	1974
Orange County: Regulations For Developing Within Critical Watersheds	Orange County Planning (N.C.) Department (919)732-8181	1985
Alamance County: Watershed Protection Ordinance	Alamance County North Carolina Planning (919) 228-1312 Ext. 258	1987
Portland Maine: Special Referendum Ballot	City of Portland Maine Planning Department (207) 775-5451	1988
Bridgton, Maine: Shoreland Zoning Ordinance	Bridgeton Maine Planning Department (207) 647-8786	1987
Wisconsin Shoreline Management Program	Wisconsin Department of Natural Resources (608) 266-2621	1967
Santa Cruz: Zoning Ordinance	Santa Cruz County California Planning Dept. (408) 425-2701	1982
Boulder County: Zoning Resolution	Boulder County Colorado Planning Department (303) 441-3930	1986
New Jersey: Freshwater Wetlands Protection Act	Division of Coastal Resources, New Jersey Department of Environmental Protection (609) 292-9762	1987
Maryland Stormwater Management Act	Maryland State Department of Planning, Stormwater Management Division (301) 269-2236	1984

Reference	Agency/Phone Number	Date Adopted
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King County: Surface Water Management Standards	King County, WA. Surface Water Management Program (206) 296-6519	1986
Dekalb County: Stormwater Ordinace	Dekalb County Georgia Planning Department (404) 371-2155	1974
Leon County: Stormwater Discharge Standards & Tree Ordinance	Leon County Florida Planning Department (904) 599-8600	1978
City of Durham: Watershed Protection Standards	Durham, North Carolina Planning Department (919) 683-4137	1974
North Carolina Coastal Area Management Act	North Carolina Department of Natural Resources & Community Development (919) 733-2293	1974
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Franklin County: Zoning Ordinance	Franklin County Florida Planning Department (904) 653-9783	1987
North Carolina: DEM Model Floodplain Management Ordinance	North Carolina Division of Emergency Management (919) 733-3867	1984
Wisconsin: City and Village Model Shoreline Zoning Ordinance	Wisconsin Department of Natural Resources (608) 266-2621	1983

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Reference	Agency/Phone Number	Date Adopted
Sanibel Island: Interior Wetland District Ordinance	Sanibel Florida Planning Department (813) 472-4136	1986
Town of Dennis: Wetlands Bylaws	Town of Dennis, Massachusetts Planning Department (617) 394-8300 Ext. 22	1975
Wisconsin: Construction Site Erosion Control	Nonpoint Source and Land Management Section, Wisconsin Department of Natural Resources (608) 266-9254	1987
Minnesota: Reinvest In Minnesota Program	Minnesota Soil & Water Conservation Board, RIM Reserve Program (612) 296-3767	1987
State of California: Forest Practices Act	State of California Department of Natural Resources (916) 445-5656	1985
Oregon: Forest Practice Rules	Oregon Department of Land Conservation & Development (503) 378-4926	1987
Lake Tahoe: Regional Planning Agency Code Ordinance	Tahoe Regional Planning Agency () -	
Nantucket Island: Land Bank Ordinance	The Nantucket Islands Land Bank Commission of the Commonwealth of Massachusetts (617) 228-7240	1984
King County: Aquisition Of Open Space Ordinance	King County Washington Planning Department (206) 296-4170	1979
Calvert County: Agricultural Zone Preservation Ordinance	Calvert County Planning Department (Maryland) (301) 535-2348	1978
Collier County: Agricultural Zone Preservation Ordinance	Board of County Commissioners Collier County, Florida (813) 774-8097	1978