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Planning • Engineering • Landscape Architecture

DEPARTMENT OF PLANNING
AND COMMUNITY DEVELOPMENT
CAROLINE COUNTY, VIRGINIA

STORMWATER MANAGEMENT PLAN AND ORDINANCE

DECEMBER 29, 1989

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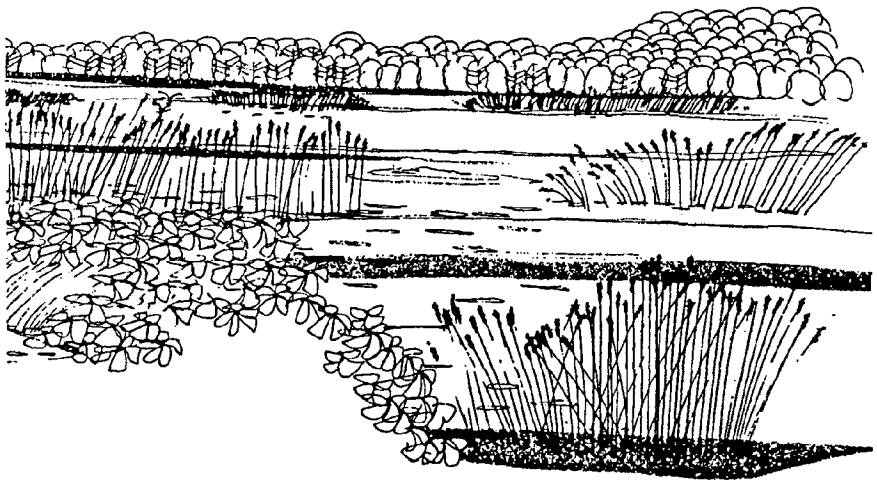

DECEMBER 29, 1989

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CAROLINE COUNTY

STORMWATER MANAGEMENT PLAN

I. INTRODUCTION

OBJECTIVES

The objective of this report is to provide a technical analysis of stormwater runoff and to use the results to develop a stormwater management component to the Caroline County Comprehensive Plan. There currently is neither an existing stormwater management component in the comprehensive plan nor any such planning or basis for planning to allow the county to respond to water quality degradation from land disturbing activities within the county. It is in the best interests of the citizenry of Caroline County to preserve and protect the quality of the waters originating from and passing through the County. Financial support for the development of this report has been received, in part, by the Council on the Environment pursuant to Coastal Resources Program Grant Number NA 89 AA-D-CZ-134 from the National Oceanic and Atmospheric Administration (NOAA).

This project parallels state and federal programs and policies in an effort to respond to the National Clean Water Act, The Chesapeake Bay Act and The Virginia Stormwater Management Law (HB 1848). At a local level, sensing the inevitable pressures from land development and the recent stormwater management problems that exist within the proximity of Caroline County, the County Board of Supervisors have taken a proactive position to plan for development within the County in-order to protect the quality of the water, land and natural resources and to preserve and protect an environment that is beneficial to the residents of the County and the citizens of the Commonwealth.

APPROACH

This project has sought to develop an adaptable constitution to the stormwater management plan. The "shifting target" nature of stormwater management requires a flexible plan. Rather than becoming obsolete as land use changes or the character of proposed improvements alter, this plan can be updated to reflect these changes.

This plan also uses regional planning concepts rather than site specific solutions. Neighboring communities to the north have experienced a profusion of problems when a piecemeal approach was taken and has rendered a long term liability to the municipality. A regional approach yields consideration to the upstream, immediate vicinity and down stream impacts and develops a basin-wide strategy for the implementation of best management practices. This approach will serve to reduce the overall impact of development, non-point source pollution and to mitigate the detrimental effects of localized flooding.

Finally, this project has focused on the County's primary growth areas. A regional stormwater management plan has been created for the Polecat Creek drainage basin as a first step in the initiation of a county wide Drainage Master Plan. This will serve as a planning tool for existing and future development within the Polecat basin. This will also serve as a bench mark for the

completion of the remaining county drainage basins, eventually incorporating the Rappahannock, Pamunkey, Mattaponi, Maracossic, South River and Reedy Creek drainage basins within the County boundaries.

GOALS

Stormwater management and drainage master plans are generally developed to provide both a solution to existing drainage problems and to provide for adequate drainage for future development within a watershed. The evolution and selection of drainage improvements are based upon the ultimate land use conditions. These conditions are derived from the County's land use map and the planning departments currently envisioned ultimate land use. Any changes to the ultimate land use condition within a drainage basin can make a revision of the management plan necessary. This can be facilitated by updating the data base for that drainage basin.

The conventional philosophy of solving drainage problems has changed recently. Formerly the solution was to remove the water as quickly as possible. This implied increasing channel capacity through structural modifications. Current trends in solving drainage problems include the following: detention or retention storage to both reduce peak discharges from smaller sub-basins and to keep sub-basin peaks from adding to the amount of water down stream; maintaining existing flood areas (within existing flood zones) to act as natural storage basins; examining the environmental impacts of proposed drainage improvements; and assessing the water quality impacts of site developments on the receiving waters.

Computers have made a fundamental change in the ability of municipalities to perform complex hydrological computations with a relatively small capital investment in hardware. Until a few years ago, the most practical computational method for this type of study was the use of the Rational Formula, first utilized in the early 1900's and limited to a small area of application (non regional). Today most hydrological data can be developed using very advanced computer software such as HEC-1, HEC-2 and WSPRO for water surface profiling (used for the Caroline F.E.M.A. study) and the Soil Conservation Service's TR-20 and TR-55 for water shed basin modeling.

This computational ability was utilized in preparation of the initial data base for the Polecat Creek drainage basin. Computerized data bases allow for the maintenance of the data base by incorporation of changes in land use patterns. This will also allow for the precise analysis of specific locations proposed for development, the ability to evaluate downstream effects of these changes and the projection of required channel modifications to maintain post-development runoff characteristics equal to or better than the pre-development runoff characteristics. All these benefits are to be realized in the development of the stormwater management plan for Caroline County.

The following main goals were accomplished in the development of the stormwater management plan:

1. Use of the simplest computer model that is consistent with the stated objectives of the planning function, using sound engineering procedures.

2. Use of up-to-date existing and future development land planning data which incorporates input from the County Planning Department.

3. Use of a flexible data base that allows for changing land use patterns to be input and what-if scenarios to be tried.

4. Ability to quickly evaluate proposed changes without the time and expense of extensive revisions and lengthy computations.

DEVELOPMENT STRATEGY

The stormwater management study has five basic tasks that encompass the entire project. Those tasks and the progression of the subtasks are shown in algorithmic format (flow chart) in Figure 1. This defines the individual component tasks and sequencing of the tasks undertaken during this study.

The study also required the identification of existing resources to use in this as well as future studies. Financial resources needed to be conserved, thus identifying existing relevant data became a significant subtask. The selection of a computational method for the study was also a primal task which shaped the entire study.

The available methods for performing the hydraulic and hydrological computations had to be collected and examined for applicability, ease of use, engineering properties, results generated and consistency with the objective of the project. Hand computational methods were considered but ruled out due to the loss of efficiency in data base maintenance once the project was completed. A spread sheet - formulized rational method was considered but not used due to the inability of this method to accurately predict results in areas greater than 200 acres. It was determined that a computerized method that had broad acceptance and familiarity in the engineering field, had time tested results and could be applied in a regional method would be the most optimal choice for a computation method.

After review of available software the United States Department of Agriculture's Soil Conservation Service Technical Release No. 55 (TR-55), "Urban Hydrology for Small Watersheds" was selected. TR-55 presents simplified procedures to calculate storm runoff volumes, peak rates of discharge, hydrographs, and storage volumes required for detention structures. These procedures are applicable in small water sheds throughout the United States. First issued in 1975, this method has been utilized for almost 15 years and is recognized throughout the U.S. The program generates pre-developed and post-developed condition hydrographs for small watersheds between one and 2000 acres in size. TR-55 also includes a detention storage estimate procedure.

TR-55 uses the area, curve number, time of concentration, travel time, and precipitation value for each subarea within a watershed to find the corresponding tabular hydrograph. The program automatically computes and displays the runoff values. It then multiplies each subarea's runoff and area by the respective tabular hydrographs, and sums these subarea hydrographs to obtain a composite hyrdrogrpah for the watershed.

STORMWATER MANAGEMENT PLAN FOR CAROLINE COUNTY

PROJECT TASKS

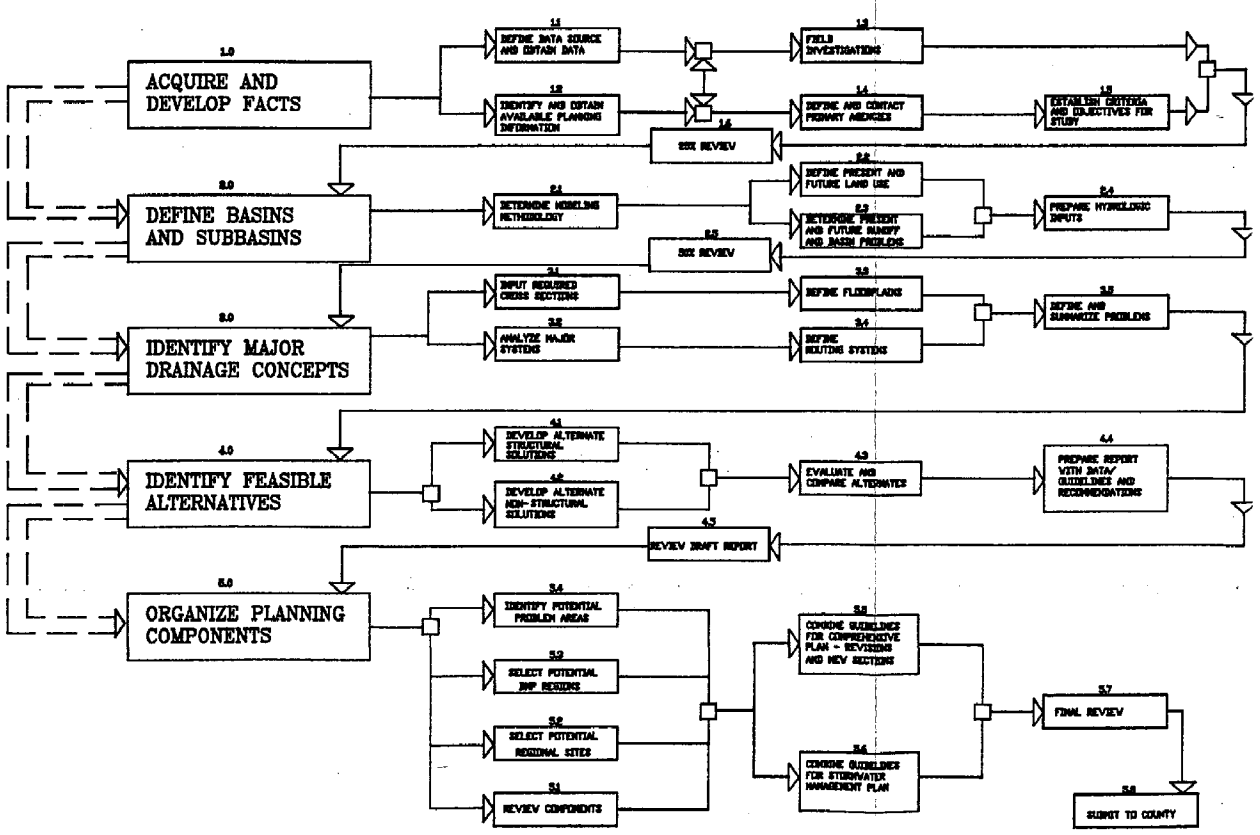
TASK 1 – DATA COLLECTION

TASK 2 – HYDROLOGIC ANALYSIS

TASK 3 – HYDRAULIC ANALYSIS

TASK 4 – STORMWATER MANAGEMENT

TASK 5 – REQUIRED REPORTS



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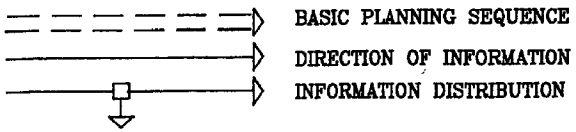


FIGURE 1

The SCS TR-55 methods are often used for preparing drainage reports that will be reviewed by county and city agencies. It is also ideal for use with detention pond sizing and routing. TR-55 is completely compatible with the SCS Tabular Hydrographs (latest edition June 1986), and has the internal procedures in place to allow use of updated tabular hydrographs issued by the SCS in the future.

Output form TR-55 for the Tabular Hydrograph Method includes a printout of the input data and intermediate calculations. Tables summarize the hydrograph, peak discharge, and time to peak for each subarea, and for the composite watershed. There is also a function for formatted printing of the SCS tabular hydrographs, so you can confirm the accuracy of the tables included.

II. STORMWATER MANAGEMENT

INTRODUCTION

Several components comprise the institutional framework within which stormwater management programs are developed and implemented. Of prime interest are government programs with potential to impose constraints on activities that modify natural drainage patterns. In the absence of a separate stormwater management program, the relevant constraints in Virginia consist primarily of water quality controls over the development and use of land. Administrative responsibilities for these programs are exercised at the federal, state, and local levels of government.

FEDERAL ROLE

The federal role in water quality protection traditionally has focused on control of point source waste discharge. After a relatively long period of evolution, federal controls have developed into a comprehensive regulatory system. Prior to 1987, however, federal control of Nonpoint Source (NPS) pollution, including urban stormwater discharges, had consisted mainly of indirect measures. Attention to the general NPS pollution problem was contained in section 208 of the Clean Water Act (CWA {adopted as the Federal Water Pollution Control Act Amendment of 1972}). This section leaves the actual control to the states, and EPA views the control of NPS pollution as primarily a state problem.

STATE ROLE

The state role in stormwater management comprises three areas of activities:

(1) the water quality management program administered under the State Water Law (SWCL) consistent with federal requirements,
(2) the financial assistance program for NPS management, and
(3) state involvement in the administration of land use controls, which are primarily implemented by the state's localities.

SWCL provides broad authority for the Virginia Water Control Board (VWCB) to conduct a water quality management program. The purpose of SWCL is stated:

> "It is the policy of the Commonwealth of Virginia and the purpose of this law to: (1) protect existing high quality that any such waters will permit all reasonable public uses and will support the propagation and growth of all aquatic life, including game fish, which might reasonably be expected to inhabit them, (2) safeguard the clean waters of the State from pollution, (3) prevent any increase in pollution, (4) reduce existing pollution..."

The scope of coverage is indicated by SWCL's definition of "state waters", which includes" all water, on the surface and under the ground, wholly or partially within or bordering the State or within its jurisdiction..."

In 1989 the General Assembly affected legislation to further protect the states waters by enactment of HB 1848. Introduced by delegate William T. Wilson HB 1848 (Senate 722) adds Article 1.1 to

Chapter 6 of Title 10.1 to permit local governments to adopt local option stormwater management programs. As of this writing the stormwater management regulations are in draft format and are awaiting public hearing in mid 1990. Perhaps most significant is the regulation's section on nonpoint source pollution reduction which adopts a method well known to the State of Florida by implementation of "first flush" runoff controls for "keystone" pollutants. In anticipation of this regulation the Caroline County project parallels this methodology.

THE LOCAL ROLE

With the coming of the stormwater management regulation in 1990, Virginia's localities have six basic tools for administration and enforcement of stormwater management. These six tools are as follows:

A) Stormwater Management Regulations
B) Soil Erosion and Sediment Control Law
C) The Comprehensive Plan
D) Zoning
E) Subdivision Regulation
F) Tax Laws

It is essential to use each of the six enforcement tools to regulate development in the proper manner with adequate regard to due process, unnecessary duplicity and equality. This plan and subsequent ordinance attempt to augment the existing regulations without requiring duplication of effort or undue constraints to development.

The Stormwater Management Ordinance (SMO) created as part of this study utilizes existing regulations to effect the implementation of "first flush" water runoff control and "keystone" pollutants control.

STORMWATER MANAGEMENT "PHILOSOPHY"

The 1989 Virginia General Assembly enacted, effective July 1, 1989, a comprehensive Stormwater Management Law (HB 1848). Virginia already has a Erosion and Sediment Control Law which addresses the stormwater management concerns of increased volumes, velocities, and peak rates. HB 1848; however, goes further to encourage the use of comprehensive basin-wide drainage planning and points to the need for nonpoint source (NPS) pollution control.

Several studies done in the State of Florida have demonstrated that stormwater was the primary source of pollutant loading into its receiving waters. Florida has concluded that an effective stormwater management program must involve "the implementation of actions to control water in its hydrologic cycle with the objective of providing : 1) surface drainage, 2) flood control, 3) erosion and sediment control and 4) reduction of pollutants in runoff". The most common stormwater pollutants and deterioration mechanisms are sediment, oxygen demanding substances, heavy metals, and nutrients. Of primary importance to water quality is the "first flush phenomena". This term describes the washing action that stormwater has on accumulated pollutants in the watershed. This flushing creates a shock loading of pollutants. It has been demonstrated that the first one inch of rain to fall as runoff carries 90% of the pollution load from a storm event.

Another result that should be achieved is the use of comprehensive watershed or basin-wide planning to get away from the present day "piecemeal" approach to stormwater management. While this approach is adequate for a parcel-to-parcel compliance, the aggregate effect upon the drainage basin, which may contain a large number of parcels, is usually drastic. The problem of contending with the downstream effects of these upstream developments has historically been passed to the administrating municipal entity in both monetary and liability concerns.

These are but a few of the items that need to be understood and looked at in the development of an adequate stormwater management regulation that will meet the needs of Caroline County, HB 1848 and to protect the environmental quality of our precious water resources.

PRINCIPLES OF STORMWATER MANAGEMENT

1. It is much more efficient and cost-effective to prevent problems than to attempt to correct problems after the fact.

2. Every piece of land is part of a larger watershed.

3. Optimum design of the stormwater management system should mimic (and use) the features and functions of the natural drainage system which is largely capital, energy and maintenance cost free.

4. The volume, rate, timing and pollutant load of stormwater after development should closely approximate the conditions which occurred before development.

5. Encourage on-site storage of stormwater through vegetative and structural infiltration. Capture the "first flush" whenever construction constraints allow.

6. Stormwater management systems, emphasizing vegetative practices, should be planned, constructed and stabilized in advance of the facilities that will discharge into them.

7. The stormwater management system must be designed beginning with the outlet or point of outfall from the project.

8. Whenever possible, construct the components of the stormwater management system on the contour following the topography.

9. Stormwater is a component of the total water resources which should not be casually discarded but be used to replenish those resources.

10. Whenever practical, multiple use temporary storage basins should be an integral component of the stormwater system.

11. Storage areas should be designed with sinuous shorelines.

12. Vegetated buffer strips should be retained in their natural state or created along the banks of all water bodies.

13. The stormwater management system must receive regular maintenance.

14. On-site conveyance and storage systems should be given equal consideration as that of downstream or off-site systems.

15. Stormwater management as a utility: some parcels are better suited to economical solution than others.

STORMWATER MANAGEMENT PRACTICES

The regional stormwater management plan for the Polecat Creek drainage basin will identify candidate areas for regional stormwater management facilities. It will also indicate areas within the basin that can utilize best management practices for stormwater runoff reduction thus minimizing the need for structural solutions. Structural solutions such as retention, detention and in-line pipe storage are capital intensive answers to the stormwater problem. The characteristics of some developing areas can be controlled by planning methods to reduce the need for expensive structural solutions in the future. It must be realized, however, that the more land converted from open space and woodlands to residential and commercial areas, the more likely the probability of stormwater problems.

It is essential to understand how Best Management Practices work and what they consist of. The following two sections will concentrate on presenting BMP's for pollution source controls and secondly, BMP's to be utilized in conjunction with development inspections in the form of construction guidelines to reduce stormwater impacts.

III. BEST MANAGEMENT PRACTICES

ALTERNATIVES FOR POLLUTION SOURCE CONTROL

This section presents a number of possible management practices which can be used to improve the quality and/or control the rate of stormwater runoff. The selection of any practice or combination of practices for implementation must be based upon careful judgement, taking into account a wide variety of considerations.

Of course, the effectiveness of a practice in achieving its stated purpose is a primary consideration along with the cost of implementation. These two factors will in most cases determine whether or not the use of a practice is feasible or worthwhile. There are, however, many other considerations which must also be taken into account. These considerations may or may not relate to the stated purpose of the practice.

For example, construction of an impoundment may be an effective way to capture runoff and reduce the downstream impacts of a new development project. However, additional considerations concerning land requirements and maintenance responsibilities may make an alternative solution more attractive. A planner or engineer must take into account all aspects of implementation before selecting a practice for use.

The purpose of this section is to provide the County Planning Department broad overall comparison of practices with regard to a number of common considerations to aid in the evaluation of alternatives. Figure 2 presented here is intended to alert the planner to the major applicabilities of the practices and to their comparative advantages and disadvantages. Before actually selecting a practice for use, however, the planner or engineer should become thoroughly familiar with the practice standards and specifications which provide additional and more detailed information needed to make a final decision.

Explanation of Figure 2

In Figure 2 each practice is rated with respect to fifteen separate considerations. These considerations are divided into three categories: types of control, applicability, and other considerations. Following are definitions of each consideration:

Type of Control

Control of Soil Erosion indicates the potential of a practice to reduce the particulate or settleable pollutant load in stormwater runoff.

Control of Pollutants indicates the potential of a practice to remove soluble pollutants from stormwater runoff.

Control of Runoff Rate and Volume indicates the potential of a practice to reduce runoff volume or to control discharge rates through stormwater detention and/or infiltration.

FIGURE 2

Applicability

New Development indicates the applicability of a practice in areas which are in the process of being developed to urban-type uses for the first time. Examples would include new residential subdivisions or shopping malls in previously rural areas.

Existing Development indicates the applicability of a practice in established urban areas where additional new development is unlikely.

High Density Development indicates the applicability of a practice in densely developed urban areas which consist of greater than 50 percent impervious surfaces (i.e. rooftops, pavement, etc.). Examples include city business districts, heavy commercial or industrial areas, high rise residential areas, etc.

Low-Medium Density Development indicates the applicability of a practice in urban areas with less than 50 percent impervious cover. Examples include suburban residential subdivisions, parks, some light commercial or industrial areas, etc.

Site-Specific Applications indicates the applicability of a practice to control runoff or pollution problems on a single site or small drainage area basis.

Areawide Applications indicates the applicability of a practice to control runoff or pollution from large drainage areas of multisite developments.

Other Considerations

Municipal Responsibility indicates the portion of installation, operation and/or maintenance responsibilities borne by the local government or its designated management agency.

Property Owner Responsibility indicates the portion of installation, operation and/or maintenance responsibilities borne by an individual property owner.

Environmental Improvement indicates the level of improvement in the physical and psychological attractiveness of an area resulting from the implementation of the practice.

Groundwater Pollution Potential indicates the potential for groundwater pollution as a result of practice implementation.

Maintenance Requirement indicates the relative amount of maintenance required to keep the practice functioning efficiently and effectively.

Land Requirement indicates the relative amount of surface area necessary for the installation and operation of the practice.

Each practice is generally rated with respect to each consideration by symbols which are defined as follows:

H - Denotes a high applicability or major area of consideration.
M - Denotes a moderate applicability or a consideration of some significance.
L - Denotes a low applicability or a consideration of little significance.
V - Denotes a variable applicability or level of consideration which is dependent upon specific local conditions.
NA - Not applicable.

It should be understood that these BMP ratings are tentative, somewhat subjective and difficult to define. They are intended only to represent general ranges which aide the user in evaluating alternative practices with respect to each consideration.

Following is the overview of practices by category:

Pollution Source Controls

1 - Street Cleaning: This practice involves sweeping, vacuuming, flushing, or otherwise cleaning streets, parking lots and other paved vehicular traffic areas. The objective is to remove dry-weather accumulations of pollutants, especially fine particulate matter, before washoff can occur, thus reducing the potential for pollutional impacts on receiving waters. In the past, street cleaning operations were conducted primarily for aesthetic purposes; however, they are now known to be effective methods of improving the quality of stormwater runoff if carried out properly.

2 - Vegetative Control: This practice involves retaining as much natural vegetation as possible in developing areas and establishing new vegetation wherever possible in the urban environment. The goal is to utilize the natural capacity of plant materials to intercept and absorb airborne and runoff-related pollutants, and to reduce by interception and infiltration the increased volumes and peak flow rates to runoff caused by urban development. Recommended vegetative materials include trees, shrubs, vines, ground covers, turf, and wetland plants.

3 - Fertilizer Application Control: This practice involves managing the use of fertilizer so as to keep it on the land and out of our waterways. Implementation will result in maximum effectiveness of the nutrients on vegetation and reduced nutrient loads in our waterways. The practice covers concepts such as public education, the need for soil testing, and the proper timing of fertilizer applications.

4 - Pesticide Use Control: This practice involves eliminating excessive pesticide use by proper application procedures and the use of alternatives to chemical pest control. The goal is to reduce the load of pesticide-related contaminants in stormwater runoff. The practice covers legal requirements for pesticide application, methods of application, equipment cleaning, disposal of unused chemicals and empty containers, pesticide storage, alternative pest control methodologies, and public education. Both commercial-scale application and private home use are involved.

5 - Reduction of Traffic-Generated Pollutants: This practice encourages the use of preventative measures to lower the amounts of nonpoint source pollutants originating from motor vehicle traffic in urban areas. Measures covered include greater care in the preventative maintenance of vehicles and the reduction of vehicle miles travelled (VMT) by greater use of public transportation and car pools.

6 - Nonpoint Source Pollution Control on Construction Sites: This practice encourages the use of good management and "house-keeping" techniques on construction sites to reduce the availability of construction-related pollutants which can contaminate runoff water and, where runoff contamination cannot be avoided, to retain the pollutants and polluted water on the site. Concepts covered include erosion and sediment control, equipment maintenance and repair, storm sewer inlet protection, trash collection and disposal, the use of designated washing areas for cleaning equipment, proper material storage, dust control at demolition sites, use of proper sanitary equipment and pesticide use control.

Runoff Controls

7 - Retention/Detention This practice involves the construction or modification of surface water impoundments in a manner which will protect downstream areas from potential water quality degradation, flooding, and stream channel degradation due to upstream development. The objective is to detain stormwater and release it at a controlled rate. Downstream water quality is improved through sediment removal, plant uptake of nutrients, chemical transformations, spread-out pollutant loadings and other processes. This practice is limited to structures less than 25 feet in height and which impound less than 100 acre-feet of water.

8 - Parking lot Storage: This practice involves the use of impervious parking areas as temporary impoundments during rainstorms. Parking lot drainage systems can be designed to temporarily detain stormwater in special designated areas, and release it at a controlled rate. The objective is to protect downstream areas from increased flooding, stream channel degradation and/or combined sewer overflows caused by urban development. It is important that these facilities be designed to minimize potential safety hazards and inconvenience to motorists and pedestrians.

9 - Rooftop Runoff Control: This practice encourages the disposal of rooftop runoff by systems and techniques that avoid or replace direct connections of roof drainage systems to sewer systems. The objective is to reduce the frequency of sewer overflows. Proposed alternatives to sewer connection include surface drainage, subsurface infiltrations, and runoff collection and storage.

10 - Rooftop Detention: This practice describes how stormwater falling directly onto flat roof surfaces can be temporarily ponded and gradually released by incorporating controlled-flow roof drains into building designs. The purpose is to reduce adverse impacts of rooftop runoff on sewer systems and receiving streams. Rooftop detention can be incorporated into the design of most new buildings, and many existing structures also can be modified for this function.

11 - Infiltration Trenches: This practice involves the excavation of trenches which are backfilled with sand and/or graded aggregates. Stormwater runoff from impervious surfaces can be directed to these facilities for detention and infiltration. Permeable soils are a pre-requisite. The potential for groundwater pollution must also be carefully evaluated.

12 - Concrete Grid and Modular Pavement: This practice involves the use of a special pervious material in low traffic areas. The pavement consists of concrete grids or other structural units alternated with pervious fillers such as sod, gravel or sand. The resultant pavement provides an adequate bearing surface and yet allows a significant amount of infiltration thereby reducing runoff volume and discharge rate and improving the water quality.

13 - Porous Asphalt Pavement: This practice involves the use of a special asphaltic paving material which allows stormwater to infiltrate at a high rate. Infiltration water is stored below the pavement in a high-void aggregate base. This practice provides for stormwater detention and in some cases increases infiltration into the ground. Use of the practice can contribute to reduced sewer overflows, decreased flooding and stream channel degradation, and improved water quality. This type of pavement offers many other benefits not related to water quality, including enhanced visibility, increased safety and reduced drainage system costs.

14 - Grassed Waterways, Buffer Strips, and Seepage Areas: This practice involves utilizing grassed surfaces to reduce runoff velocities, enhance infiltration and remove runoff contaminants, thus improving runoff quality and reducing the potential for downstream channel degradation and sediment pollution due to development. Concepts covered include using grass-lined roadside swales instead of curb and gutter installations; using grass-lined open drainage channels instead of paved channels; using grass-covered surfaces to intercept runoff and filter out some of the contaminants; and using small shallow basins over permeable soils to capture and infiltrate runoff.

Collection and Treatment

15 - Sewer System Control: This practice involves planning, designing and managing alternative methods for the collection and transport of sanitary wastewater in order to maximize the efficiency of existing and newly planned sewer systems, thereby increasing waste treatment efficiency and reducing the amount of stormwater infiltration into sanitary sewers. Alternatives covered include sewer separation, inflow/infiltration control, polymer injection, design and construction considerations, and sewer and catch basin maintenance operations.

16 - Stormwater Conveyance System Storage: This practice involves providing storage capability within stormwater conveyance systems for temporary detention and controlled release of stormwater during wet weather flows. Where combined sewers are utilized for stormwater conveyance, the purpose is to reduce the frequency and magnitude of sewer overflows and to increase the quantity of stormwater receiving treatment before entering receiving waters. Where separate conveyance systems exist, the purposes are to reduce downstream flow peaks and to provide some particulate removal through stormwater detention. Both in-line and off-line storage facilities are involved.

17 - Conventional Flow Regulators: This practice involves the installation of traditionally used mechanical devices in stormwater conveyance and storage facilities to provide control of the volumes, velocities, and directions of fluid flows in order to maximize the operating efficiencies of these systems. Three general categories of conventional flow regulators involve static regulators, semi-automatic dynamic regulators, and automatic dynamic regulators.

CONSTRUCTION GUIDELINES

This section is a summary overview of the methods and practice of stormwater management recommended to be used to control runoff during development of the County. The complete list of standards and specifications can be found in Chapter 3 of the 1980 Virginia Erosion and Sediment Control Handbook. These practices shown in Figure 3 are the thirty most optimal BMP's and represent many of the practices to be implemented for all land development as it occurs within Caroline County.

Explanation of Figure 3

1 - STORMWATER CONVEYANCE CHANNEL: A permanent channel designed to carry concentrated flows without erosion. Applicable to man-made channels, including roadside ditches, and natural channels that are modified to accommodate increased flows generated by land development; not generally applicable to major, continuous-flowing natural streams.

2 - RIPRAP: A permanent, erosion-resistent ground cover of large, loose, angular stone installed wherever soil conditions, water turbulence and velocity, expected vegetative cover, etc., are such that soil may erode under design flow conditions.

3 - EXFILTRATION TRENCH: A permanent pipe or trench which conveys stormwater to an area and percolates into the ground for conversion of stormwater into groundwater.

4 - INFILTRATION TRENCH: A permanent pipe or trench which collects stormwater and transports it to an outlet channel or basin.

5 - CHECK DAMS: Small, temporary dams constructed across a drainage ditch to reduce the velocity of concentrated flows, reducing erosion of the swale or ditch. Limited to use in small open channels which drains 10 acres or less; should not be used in live streams.

6 - WATERWAY DROP STRUCTURE: A permanent structure or series of structures designed to step water flow down a slope without causing channel erosion; applicable in natural or man-made channels with long, relatively steep reaches.

7 - PAVED FLUME: A permanent concrete-line channel constructed to conduct concentrated runoff from the top to the bottom of a slope without causing erosion on or below the slope.

8 - OUTLET PROTECTION: The installation of paved and/or riprap channel sections and/or stilling basins below storm drain outlets to reduce erosion from scouring at outlets and to reduce flow velocities before stormwater enters receiving channels below these outlets.

FIGURE 3

9 &
10 - RETENTION/DETENTION: This practice involves the construction or modification of surface water impoundments in a manner which will protect downstream areas from potential water quality degradation, flooding, and stream channel degradation due to upstream development. The objective is to detain stormwater and release it at a controlled rate. Downstream water quality is improved through sediment removal, plant uptake of nutrients, chemical transformations, spread-out pollutant loadings and other processes. This practice is limited to structures less than 25 feet in height and which impound less than 100 acre-feet of water.

11 - POROUS ASPHALT PAVEMENT: This practice involves the use of a special asphaltic paving material which allows stormwater to infiltrate at a high rate. Infiltration water is stored below the pavement in a high-void aggregate base. This practice provides for stormwater detention and in some cases increases infiltration into the ground. Use of the practice can contribute to reduced sewer overflows, decreased flooding and stream channel degradation, and improved water quality. This type of pavement offers many other benefits not related to water quality, including enhanced visibility, increased safety and reduced drainage system costs.

12 - CONCRETE GRID AND MODULAR PAVEMENT: This practice involves the use of a special pervious material in low traffic areas. The pavement consists of concrete grids or other structural units alternated with pervious fillers such as sod, gravel or sand. The resultant pavement provides an adequate bearing surface and yet allows a significant amount of infiltration thereby reducing runoff volume and discharge rate and improving the water quality.

13 - PARKING LOT STORAGE: This practice involves the use of impervious parking areas as temporary impoundments during rainstorms. Parking lot drainage systems can be designed to temporarily detain stormwater in special designated areas, and release it at a controlled rate. The objective is to protect downstream areas from increased flooding, stream channel degradation and/or combined sewer overflows caused by urban development. It is important that these facilities be designed to minimize potential safety hazards and inconvenience to motorists and pedestrians.

14 - INLINE PIPE STORAGE: This practice involves providing storage capability within stormwater conveyance systems for temporary detention and controlled release of stormwater during wet weather flows. Where combined sewers are utilized for stormwater conveyance, the purpose is to reduce the frequency and magnitude of sewer overflows and to increase the quantity of stormwater receiving treatment before entering receiving waters. Where separate conveyance systems exist, the purposes are to reduce downstream flow peaks and to provide some particulate removal through stormwater detention. Both in-line and off-line storage facilities are involved.

15 - I/I CONTROL: This practice involves planning, designing and managing alternative methods for the collection and transport of sanitary wastewater in order to maximize and efficiency

of existing and newly planned sewer systems, thereby increasing waste treatment efficiency and reducing the amount of stormwater infiltration into sanitary sewers. Alternatives covered include sewer separation, inflow/infiltration control, polymer injection, design and construction considerations, and sewer and catch basin maintenance operations.

16 - SILT FENCE: A temporary sediment barrier constructed of posts, filter fabric and, in some cases, a wire support fence, placed across or at the toe of a slope or in a minor drainageway to intercept and detain sediment and decrease flow velocities from drainage areas of limited size; applicable where sheet and rill erosion or small concentrated flows may be a problem. Maximum effective life is 6 months.

17 - STORM DRAIN INLET PROTECTION: The installation of various kinds of sediment trapping measures around drop inlet or curb inlet structures prior to permanent stabilization of the disturbed area; limited to drainage areas not exceeding one acre, and not intended to control large, concentrated stormwater flows.

18 - TEMPORARY SEDIMENT BASIN: A basin with a controlled stormwater release structure, formed by constructing an embankment of compacted soil across a drainageway, to detain sediment-laden runoff from disturbed areas greater than 5 acres for enough time to allow most of the sediment to settle out. Can be constructed only where there is sufficient space and appropriate topography. Maximum effective life is 18 months unless designed as a permanent pond by a qualified professional engineer.

19 - TEMPORARY SLOPE DRAIN: A flexible tubing or conduit, used before permanent drainage structures are installed, intended to conduct concentrated runoff safely from the top to the bottom of a disturbed slope without causing erosion on or below the slope.

20 - TEMPORARY DIVERSION DIKE: A ridge of compacted soil located at the top or base of a sloping disturbed area to divert off-site runoff away from unprotected slopes and to a stabilized outlet, or to divert sediment-laden runoff to a sediment trapping structure. Maximum effective life is 18 months.

21 - VEGETATIVE BUFFER ZONE: Establishment of vegetative cover or retention of existing vegetative cover to reduce runoff velocities, enhance infiltration and remove runoff contaminants, thus improving runoff quality and reducing potential for downstream degradation and sediment pollution.

22 - ESTABLISH MARSHLANDS: Marsh lands constitute an important resource as a necessary interface between land and water. Marshlands store water and accommodate fluctuations in stream volumes during heavy rains while vegetation helps stabilize streambanks, minimize erosion and filters pollutants from stormwater runoff. The establishment of Marshlands are important considerations with respect to water quality, aquatic life and vegetative stability.

24 - LEVEL SPREADER: An outlet for dikes and diversions consisting of an excavated depression constructed at zero grade across a slope to convert concentrated, sediment-free runoff to sheet flow and release it onto areas of undistributed soil stabilized by existing vegetation.

25 - TOPSOILING: Preserving and using topsoil to provide a suitable growth medium for vegetation use to stabilize disturbed areas. Applicable where preservation or importation of topsoil is most cost-effective method of providing a suitable growth medium; not recommended for slopes steeper than 2:1.

26 - TEMPORARY SEEDING: Establishment of temporary vegetative cover on disturbing areas by seeding with appropriate rapidly-growing plants on sites that will not be brought to final grade for periods of 30 days to one year.

27 - PERMANENT SEEDING: Establishment of perennial vegetative cover by planting seed on rough-graded areas that will not be brought to final grade for a year or more or where permanent, long-lived vegetative cover is needed on fine-graded areas.

28 - SODDING: Stabilizing fine-graded areas by establishing permanent grass stands with sod. Provides immediate protection against erosion, and is especially effective in grassed swales and waterways or in areas where an immediate aesthetic effect is desirable.

29 - TREES, SHRUBS, VINES AND GROUND COVERS: Stabilizing disturbing areas by planting trees, shrubs, vines and ground covers where turf is not preferred. These plant materials also provide food and shelter for wildlife as well as many environmental benefits. Especially effective where ornamental plants are desirable and turf maintenance if difficult.

30 - TREE PRESERVATION AND PROTECTION: Protecting existing trees from mechanical and other injury during land disturbing and construction activity to insure the survival of desirable trees where they will be effective for erosion and sediment control and provide other environmental and aesthetic benefits.

IV. STORMWATER MANAGEMENT ORDINANCE

PREFACE

This document is the product of work initiated by the Caroline County Planning Department, Engineering Department and the County Planning Commission in April of 1989. It represents the combination of two new state regulations and an existing regulation. The two new regulations, The Chesapeake Bay Act (VR 173-02-01) and the Virginia Stormwater Management Law (mandated by HB 1848) put forth new water quality measures to help safeguard aquatic ecosystems and protect our environment. The existing regulation, the State Erosion and Sediment Control Law worked to control the detrimental effects of increased water quantity. By combination of these three regulations into a single document it is felt that the objectives of all three can be met pertaining to future land development within the County.

This document is intended to serve as an introduction to the Caroline County Planning Commission of the required stormwater management regulations. The Commission will then begin the process of review and subsequent adoption. This document shall be labeled as a draft until that time which it is officially adopted.

DRAFT

CAROLINE COUNTY STORMWATER MANAGEMENT ORDINANCE

BE IT ORDAINED BY THE BOARD OF SUPERVISORS OF CAROLINE COUNTY, VIRGINIA, that:

A. Pursuant to Chapter 6 of Title 10.1, article 1.1, Section 10, Code of Virginia, as amended, this ordinance, to be known as the "Stormwater Management Ordinance" of Caroline County, Virginia, is hereby enacted as follows:

Section 1. Title

This Ordinance shall be known as the "Stormwater Management Ordinance" (SMO) of Caroline County, Virginia.

Section 2. Purpose

It is the policy of Caroline County to protect and promote the public health, safety and general welfare of its citizens through the management of stormwater, to protect public and private property from damage, to reduce the effects of development and other land conversions on land and stream channel degradation that frequently occurs in the form of water pollution, stream channel erosion, depletion of groundwater resources, and more frequent localized flooding. It is recognized that these effects adversely impact fish, aquatic life, recreation, shipping, property values and other uses of lands and waters. In general, to insure the attainment and maintenance of water quality standards and to preserve and enhance the environmental quality of water courses originating in and flowing through Caroline County.

In order to attain these goals this ordinance shall, as nearly as possible, endeavor to maintain after - development runoff rates of flow to match the pre-development runoff characteristics; require minimum design criteria to control nonpoint source pollution, localized flooding and stream channel erosion.

These regulations for stormwater management apply to the development of land and other land conversions for residential, commercial, industrial or institutional use. These regulations specify the minimum content of plan applications as well as individual responsibilities.

Section 3. Authorization

The Stormwater Management Ordinance is authorized by the Code of Virginia (1950), as amended by adding in Chapter 6 of title 10.1 an article numbered 1.1, consisting of sections numbered 10.1-603.1 through 10.1-603.15.

Section 4. Definitions

As used in this ordinance, unless the context clearly indicates otherwise, the following words shall have the indicated definitions:

4.01 "Adequate Channel" means a natural or manmade watercourse which is capable of conveying runoff from a chosen frequency storm event without overtopping its banks or eroding the channel lining.

4.02 "Applicant" means any person submitting a stormwater management plan for approval.

4.03 "Approving agency" means the County of Caroline, which is responsible for review and approval of stormwater management plans.

4.04 "Aquifer" means a porous water bearing geologic formation generally restricted to materials capable of yielding an appreciable supply of water.

4.05 "Department" means the Department of Conservation and Recreation.

4.06 "Detention structure" means a permanent structure for the temporary storage of runoff which is designed so as not to create a permanent pool of water.

4.07 "Develop land" means to change the runoff characteristics of a parcel of land in conjunction with residential, commercial, industrial, or institutional construction or alteration.

4.08 "Development" means the construction, redevelopment or substantial alteration of residential, commercial, industrial, institutional, recreation, transportation or utility facilities or structures.

4.09 "Direct runoff" means the flow of rainwater, snowmelt or spring flow over the land surface toward stream channels.

4.10 "Division" means the Division of Soil and Water Conservation, Department of Conservation and Recreation, Commonwealth of Virginia.

4.11 "Drainage area" means that area contributing runoff to a single point measured in a horizontal plane, which is enclosed by a ridge line.

4.12 "Extended detention" - the controlled release of stormwater over a prescribed period of time.

4.13 "First Flush" means the delivery of a disproportionately large load of pollutants in surface runoff during the early parts of storms due to the rapid runoff of accumulated pollutants.

4.14 "Flooding" means a volume of water which is too great to be confined within the banks or walls of the stream, water body or conveyance system and which overflows onto adjacent lands, causing or threatening damage.

4.15 "Flow attenuation" means prolonging the flow time of runoff to reduce the peak discharge.

4.16 "Impervious" - the condition of being impenetrable by water.

4.17 "Infiltration" means the passage or movement of water into the soil surface.

4.18 "Land development" or "land development project" means a man-made change to the land surface that potentially changes its runoff characteristics.

4.19 "Land-disturbing activity" means any use of the land by any person in residential, commercial, industrial, institutional, educational, or governmental development, that results in a change in the natural cover or topography and that may cause or contribute to degradation of the quality of stormwater runoff.

4.20 "Local stormwater management program" or "local program" means a statement of the various methods employed by a locality to manage the runoff from land development projects and may include such items as local ordinances, policies and guidelines, technical materials, inspection, enforcement and evaluation.

4.21 "Maintenance" - any action necessary to preserve stormwater management facilities in proper working condition, in order to serve their intended purposes and to prevent structural failure of such facilities.

4.22 "Nonpoint source pollution" means pollution whose sources cannot be pinpointed but rather is washed from the land surface in a diffuse manner by stormwater runoff.

4.23 "Off-site stormwater management" means the design and construction of a facility necessary to control stormwater from more than one development.

4.24 "On-site stormwater management" means the design and construction of systems necessary to control stormwater within an immediate development.

4.25 "Person" any individual, partnership, firm, association, joint venture, public or private corporation, trust, estate, commission, board, public or private institution, utility, cooperative, County, city, town or other political subdivision of the Commonwealth, any interstate body or any other legal entity.

4.26 "Porous paving" means an open graded asphaltic or reticular concrete or other material which allows water to pass through it.

4.27 "Post-development" means conditions that may be reasonably expected or anticipated to exist after completion of the land development activity on a specific site or tract of land.

4.28 "Pre-development" means conditions that exist at the time that plans for the development of a tract of land are approved by the plan approval authority, Where staged development or plan approval is segmental (preliminary, grading, roads and utilities, etc), the first item approved or permitted shall establish pre-land development conditions. In the case of land development by governmental agencies, the initiation of land acquisition shall establish the time at which pre-land development conditions are fixed.

4.29 "Redevelopment" means the process of developing land that is or has been developed.

4.30 "Retention structure" means a permanent structure that provides for the storage of runoff by means of a permanent pool of water.

4.31 "Regional (Basin-wide) Stormwater Management Facility" means a facility or series of facilities that are designed to function in concert and control stormwater runoff from a large contributing area, only portions or which may experience land development.

4.32 "Regional Stormwater Management Plan" or "regional plan" means a document containing material describing how runoff from predeveloped land, subdivision, and future planned development areas will be controlled by coordinated design and implementation of a regional stormwater management facility.

4.33 "Runoff" means that portion of precipitation that is discharged across the land surface or through conveyances to one or more waterways.

4.34 "Sediment" means soils or other surficial materials transported or deposited by the action of wind, water, ice or gravity as a product or erosion.

4.35 "Stormwater management" means, for:

a) Quantitative control, a system of vegetative and structural measures that control the increased volume and rate of surface runoff caused by man-made changes to the land, and;

b) Qualitative control, a system of vegetative, structural and other measures that reduce or eliminate pollutants that might otherwise be carried by surface runoff.

4.36 "Stormwater Management Plan" means a set of drawings or other documents submitted by a person as a prerequisite to obtaining a stormwater management approval, which contain all of the information and specifications required by an approving agency.

4.37 "Subdivision" means the division of a parcel of land into three or more lots or parcels of less than five acres each for the purpose of transfer of ownership or building development, or, if a new street is involved in such division, any division of a parcel of land. The term includes resubdivision.

4.38 "Tributary stream" means any perennial stream that is so depicted on the most recent U.S. Geological Survey 7-½ minute topographic quadrangle map (scale 1:24,000).

4.39 "Use" means an activity on the land other than development, including, but not limited to agriculture, horticulture, silviculture and recreation.

4.40 "Watershed" means the total drainage area contributing runoff to a single point.

Section 5. General Provisions

5-1 This ordinance has been promulgated by the County of Caroline to:

a. Inhibit the deterioration of existing waters and waterways within Caroline County by requiring development to maintain post-development runoff characteristics (water quantity, quality and general direction of flow), or as nearly as practicable, equal to or better than the pre-development runoff characteristics.

b. Control nonpoint source pollution, localized flooding, and stream channel erosion, by establishing minimum acceptable technical criteria that must be met by all stormwater management plans required by this ordinance.

c. Establish minimum acceptable administrative procedures for application, approval, implementation and amendments for stormwater management plans.

d. Require the provision of long-term responsibility for and maintenance of stormwater management control devices and other techniques specified to manage the quality and quantity of runoff.

e. Provide for the integration of this ordinance with the Stormwater Management Regulations enacted by the Commonwealth of Virginia, Department of Conservation and Recreation, Division of Soil and Water Conservation (The Department) and to establish procedures for the periodic reporting to the Department.

5-2 Variances. The County reserves the right to waive or modify any of the regulations which are deemed inappropriate or too restrictive for site conditions, by granting a variance. Such variance may be granted under the following conditions:

a. At the time of plan submission, an applicant may request a variance to become part of the approved stormwater management plan. The applicant must explain the reasons for requesting the variance in writing. Specific variances which are allowed by the County of Caroline must be documented on the final approved stormwater management plan.

b. During construction, the person responsible for implementing the approved plan may request variances in writing to the County. The County will review the request and respond in writing approving or disapproving such request. Without a written approval, no variance shall be considered valid. The County will respond to A variance request during construction within fourteen calendar days, not inclusive of any holiday or nationally recognized period of time in which County administration is not active. If the County has not responded with the aforementioned time limit, the request will be regarded as disapproved. Following disapproval, the applicant may resubmit a variance request with additional documentation.

Section 6. Procedures for Application, Approval, Amendment and Fees

6-1 Applicants for approval of a stormwater management plan shall submit four copies of the proposed plan to the County or agents of the County, together with a certificate of responsibility and guarantees of performance.

6-2 Every applicant for approval of a stormwater management plan shall submit with the application a fee in the amount of $ _____ payable to the Treasurer of Caroline County, to cover the costs of administration of the plan.

6-3 Stormwater management plans may be referred to the Department and/or other agents acting on behalf of Caroline County for technical review and recommendation. The Department and/or agents acting on behalf of the County shall return such plans with written review and recommendations within 30 days.

6-4 Notwithstanding the comments and recommendations of the Department, the County shall have full authority to approve or disapprove any stormwater management plan. Such approval or disapproval shall be promptly communicated to the applicant, together with, in the event a plan is disapproved, a written description of any defects in the plan and corrective measures which must be taken to obtain approval.

6-5 If the County shall fail either to notify the applicant of a plan's approval or disapproval, or to call for additions or revisions thereto, within 45 days after the same have been submitted to the County by an applicant, such plan shall be deemed to be approved and the applicant may lawfully proceed with the proposed activity in accord with the submitted plans.

6-6 Any stormwater management plan which has been previously approved may be amended if:

a. On site inspection has revealed the "inadequacy" of the plan to accomplish the control objectives of the plan.

b. The person responsible for carrying out the approved plan finds that because of changed circumstances or for other reasons, the approved plan cannot be effectively carried out, and proposed amendments to the plan, consistent with the requirements of this act, are agreed to by the County and the person responsible for carrying out the plan.

6-7 The applicant shall not have more than six (6) months after receiving official approval concerning the Stormwater Management Plan to implement such approved plan. Failure to do so shall make the approval null and void. The

County may, on written request by the applicant, grant an extension of this time limit.

6-8 For the purpose of the provision of this ordinance when land disturbing activity will be required of a contractor performing construction work pursuant to a construction contract, the preparation, submission, and approval of a stormwater management plan shall be the responsibility of the owner.

Section 7. Minimum Criteria

7-1 No application for preliminary plan of subdivision shall be approved unless it includes a statement, and/or drawing, describing, in concept, the manner in which water quality impacts and stormwater, resulting from the development, will be controlled or managed. This concept plan, which must be approved by the County, shall indicate whether stormwater will be managed on-site or off-site, and, if on-site, the general location and type of management. Those stormwater management plans shall be referred for comment to the County and other public agencies. No building or sediment control permit shall be issued by the County for any parcel or lot created prior to, or subsequent to, the effective date of this article, unless a stormwater management plan, or waiver thereof, for the plat or parcel, shall have been approved by the County that is consistent with the requirements of this ordinance. The provisions of this ordinance do not apply to construction of single-family residences, or their accessory buildings, on lots of two acres, or more, as set forth in state law. This single family residence exemption shall be valid based upon the condition that the construction of said residence is not part of a larger development contiguous or non-contiguous to the lot in question.

7-2 Stormwater management and control measures, structures, and devices shall be so planned, designed, and constructed as to provide protection from the calculated two-year pre-development maximum outflow velocities and the ten-year pre-development minimum flow rates. Runoff rates and channel adequacy shall be calculated using the procedures in the current edition of the Virginia Erosion and Sediment Control Handbook.

7-3 No land-disturbing activity subject to the control of this ordinance shall be undertaken except in accordance with the following standards:

a. Buffer Zone. No land-disturbing activity shall be permitted in proximity to a lake or natural watercourse unless a buffer zone is provided along the margin of the watercourse of sufficient width to confine visible siltation within the twenty-five percent (25%) of the buffer zone nearer the land-disturbing activity, provided, that this subsection (a) shall not apply to a land-disturbing activity in connection with the construction of facilities to be located on, over, or under a lake or natural watercourse.

b. Stream banks and channels downstream from any land-disturbing activity shall be protected from increased degradation by accelerated erosion caused by increased velocity and/or quantity of runoff from the land-disturbing activity.

c. The land-disturbing activity shall be planned and conducted such that the velocity of stormwater runoff in the receiving watercourse at the point of discharge complies with those rates indicated in Section 7-2 of this ordinance.

d. No person shall initiate any land-disturbing activity if one (1) contiguous acre or more is to be uncovered unless, thirty or more days prior to initiating the activity, a soil erosion and sedimentation control plan and a stormwater management plan for such activity is filed with and approved by Caroline County. Compliance with this ordinance does not exempt the applicant from other ordinances which may also require compliance.

If conditions (b) or (c) of this paragraph cannot be met, the channel below the discharge point shall be designed and constructed to withstand the expected velocity and required adequate channel to a point where the existing channel is deemed, by the County as adequate.

e. Measures applied alone or in combination to satisfy the intent of this section are acceptable if there are no objectionable secondary consequences. The County recognizes that the management of stormwater runoff to minimize or control downstream channel and bank erosion is a developing technology. Innovative techniques and ideas will be considered and may be used when shown to have the potential to produce successful results. Some alternatives are to:

(1) avoid increases in surface runoff volume and velocity by including measures to promote infiltration to compensate for increased runoff from areas rendered impervious,

(2) avoid increases in stormwater discharge velocities by using vegetated or roughened swales and waterways in lieu of closed drains and high velocity paved sections,

(3) provide energy dissipators at outlets of storm drainage facilities to reduce flow velocities at the point of discharge. These may range from simple rip-rapped sections to complex structures,

(4) protect watercourses subject to accelerated erosion by improving cross sections and/or providing erosion-resistant lining.

f. Exceptions - This rule shall not apply where it can be demonstrated that stormwater discharge velocities will not create an erosion problem in the receiving watercourse and the quantity of water complies with the rates indicated in Section 7-2.

7-4 Computer watershed modeling, if required, shall be performed in accordance with the procedures outlined in Technical Release No. 55, United States Department of Agriculture, Soil Conservation Service. All calculations shall be submitted along with all computer inputs and outputs on paper and on suitable electronic media for verification. A registered professional engineer currently valid in the Commonwealth of Virginia shall affix his/her seal on each submittal of the calculations.

7-5 When the person conducting a land-disturbing activity is also the person conducting a borrow or waste disposal activity, areas from which borrow is obtained which are not regulated by the provisions of the State Mining Act, and any waste areas for surplus materials other than landfills regulated by the State, shall be considered as part of the land-disturbing activity where the borrow material is being used or from which the waste material originated. When the person conducting land-disturbing activity is not the person obtaining the borrow and/or disposing of the waste, these areas shall be considered a separate land-disturbing activity.

7-6 Temporary access and haul roads, other than public roads, constructed or used in connection with any land-disturbing activity shall be considered a part of such activity.

7-7 Land-disturbing activity in connection with construction in, on, over, or under a lake or natural watercourse shall be planned and conducted in such a manner as to minimize the extent and duration of disturbance of the stream channel. The relocation of a stream, where relocation is an essential part of the proposed activity, shall be planned and executed so as to minimize changes in the stream flow characteristics, except when justification for significant alternation to flow characteristic is provided. Advisory Note: The U.S. Army Corps of Engineers shall be notified of any planned operation in lakes or natural watercourses for possible issuance of Section 404 or other permits as well as other appropriate state agencies.

7-8 During the development of a site, the person conducting the land-disturbing activity shall install and maintain all temporary and permanent control measures as required by the approved plan or any provision of this Ordinance, or any order adopted pursuant to this Ordinance. After site development, the land owner or person in possession or control of the land

shall install and/or maintain all necessary permanent control measures, except those measures installed within a road or street right-of-way or easement accepted for maintenance by a governmental agency.

7-9 Whenever Caroline County determines that significant excessive runoff is occurring as a result of land-disturbing activity, despite application and maintenance of protective practices, the person conducting the land-disturbing activity will be required to and shall take additional protective action.

7-10 The plan required by this section shall contain architectural and engineering drawings, maps, assumptions, calculations, and narrative statements as needed to adequately describe the proposed development of the tract and the measures planned to comply with the requirements of this ordinance. Plan content may vary to meet the needs of specific site requirements. As a minimum, the submitted stormwater management plan shall consist of the following:

a. Location and design of the planned stormwater control device(s).

b. Drainage calculations.

c. Discharge hydrograph for the 2-year and 10-year storm event.

d. Projected specific water quality control features.

e. Recommended inspection and maintenance schedule.

f. Developer/contractor liability time period.

g. Professional Engineer Certification from valid Virginia registered P.E.

h. Mean flow of receiving water, pre-development and post-development.

i. Standard minimum design flow.

Any facility construction, channel improvements or modifications must comply with all applicable laws and regulations. Any facility that involves a dam 25 feet or greater in height or that impounds 100 acre feet or more shall conform to the Virginia Dam Safety Regulations. Impounding structures that are smaller than those covered by the Dam Safety Regulations shall be checked for structural integrity and floodplain impacts for the 100 year storm event.

A schedule for maintenance of the stormwater management facility shall be developed that sets forth the maintenance requirements and the person responsible to perform the maintenance. This schedule shall be part of the stormwater maintenance plan. If the designated maintenance responsibility is with a person other than a local government, a maintenance agreement

shall be executed between the responsible person and the local government.

7-11 Keystone Pollutant Provision. (Water Quality Provisions)

Stormwater Management facilities shall be designed and constructed to achieve the required nonpoint source pollutant reduction treatment for the first 0.5 inch (first flush) of runoff.

1. The Department of Conservation and Recreation will develop and provide to the applicant a list of the major pollutant(s) requiring nonpoint source reduction which must be achieved for the specific land disturbing activity. The identified pollutants will be termed "keystone" pollutants for that particular development and required measures shall be taken by the applicant to ensure that, at a minimum, required reductions of the keystone pollutant(s) are achieved to meet the stormwater quality requirements. Factors such as existing pollutant loading, land use changes and anticipated sources of pollutants are considered in the development of the list of keystone pollutants.

2. The keystone pollutant list and the reduction methods proposed shall be part of the minimum plan content required of each stormwater management plan submitted for approval as indicated in Section 7-10, condition d., Project specific water quality control features, of this ordinance.

Section 8. Inspections and Investigations

Agents and officials of Caroline County will periodically inspect the sites of land-disturbing activity for which permits have been issued to determine whether the activity is being conducted in accordance with the plan and to determine whether the activity is being conducted in accordance with the plan and to determine whether the measures required in the plan are affective in controlling stormwater runoff resulting from land-disturbing activity.

If, through inspection, it is determined that a person engaged in land-disturbing activity has failed to comply with the approved plan, a notice of violation shall be served upon that person by registered or certified mail or other means. The notice shall set forth the measures necessary to achieve compliance with the plan, specify a reasonable time period within which such measures must be completed, and warn that failure to correct the violation within the time period will result in the assessment of civil penalty or other enforcement action, including revoking the granted permit. Revocation of a permit may cause invalidation of all other permits for the site.

Caroline County shall have the power to conduct such investigation as it may reasonably deem necessary to carry out its duties as prescribed in this ordinance, and for this purpose to enter at reasonable times upon property, public or private, for the purpose of investigating and inspecting the sites of any land-disturbing activity.

No person shall refuse entry or access to any authorized representative or agent of Caroline County who requests entry for purposes of inspection, and who presents appropriate credentials, nor shall any person obstruct, hamper, or interfere with any such representatives while in the process or carrying out his official duties.

Caroline County shall also have the power to require written statements, or the filing of reports under oath, with respect to pertinent questions relating to land-disturbing activity.

Section 9. Certification and Guarantees of Performance

9-1 Prior to the issuance of any building permit for construction of a development requiring a stormwater management facility, the County shall require from the applicant or owner a performance or cash bond, irrevocable letter of credit, certificate or guarantee, or other instrument from a financial institution or issuing organization or entity, in a form satisfactory to him and approved by the County, for the construction of the approved stormwater management facility in an amount equal to the estimated cost of such construction. For the purposes of this article, a certification of guarantee is an instrument issued by an organization or entity which is approved by the County and meets such capitalization and other reasonable criteria, including, but not limited to the demonstrated expertise of the issuing organization or its members in stormwater management; and the incidence of violation of, or otherwise failing to comply with, the provisions of this chapter by all members of the issuing organization or entity. The certification of guarantee shall only be issued by the approved organization or entity. Any questions as to the eligibility of an applicant to post a certificate or guarantee shall be resolved by the County. The bond, letter of credit, certificate or guarantee, or other instrument shall be conditioned upon the faithful performance of the terms and conditions of the approved stormwater management plan and the construction of the facility as set forth in such plan and the provisions of this article. The bond, letter of credit, certificate of guarantee, or other instrument shall inure to the benefit of the County, and to any person aggrieved by the applicant's or owner's failure to comply with the conditions thereof. The bond, letter of credit, certificate of guarantee, or other instrument shall not be fully released by the County until a final inspection has been made by the County as being in compliance with the approved plan and the provisions of this ordinance. In addition, the County may establish a procedure whereby the applicant may enter into an agreement with the County and provide a bond, letter of credit, certificate of guarantee or other instrument equal to the cost of the stormwater management facility with the County. The agreement shall set forth the various stages of the work to be done on the facility. Upon completion of each stage, the applicant shall notify the County that he is ready for an inspection

and, upon certification by the County and/or agents of the County that such stage has been completed in accordance with the approved plan and requirements of this ordinance, the County may reduce the bond, letter of credit, certificate of guarantee or other instrument pro-rata, or direct the director of finance to refund to the applicant a pro rated share of the amount deposited by the applicant with the County.

9-2 The County shall immediately revoke the permit upon failure of the permittee to maintain such bond or certificate of guarantee. Whenever the County shall find a violation of an applicable law or regulation by an organization or entity issuing certificates of guarantee, the County may immediately revoke all permits of members of that organization or entity for which a certificate or guarantee has been posted, and may issue stop work orders wherever applicable until an appropriate bond or other instrument acceptable to the County is substituted for the certificates of a guarantee.

Section 10. Administrative Appeal, Judicial Review

10-1 Final decisions of the County or its agents (Agent) under this ordinance shall be subject to review by the Planning Commission provided that an appeal is filed within 30 days from the date of such decision and such decision adversely affects the rights, duties, or privileges of the person engaging or proposing to engage in land disturbing activities. An appeal hearing shall be held at, or prior to, the next regularly scheduled meeting of the Planning Commission after the appeal is made, provided that the Planning Commission and other involved parties have had at least seven days notice.

10-2 At an appeals review hearing, the Planning Commission shall consider the evidence of the Agent and applicant and such other evidence and opinion germane to the issue. After such consideration, the Commission may reverse, modify, or affirm the Agent's action in writing. The decision of the Planning Commission shall be final subject only to review by the Court of Record of Caroline County, provided an appeal is filed within 30 days from the date of the final written decision which adversely affects the rights, duties, or privileges of the applicant engaging or proposing to engage in land disturbing activities.

Section 11. Penalties, Injunction, and Other Legal Actions

11-1 Any person who violates any of the provisions of this ordinance, or rules or orders adopted or issued pursuant to this ordinance, or who initiates or continues a land-disturbing activity for which an Stormwater Management plan is required except in accordance with the terms, conditions, and provisions of an approved plan, shall be subject to a civil penalty of not more than $100, except that the penalty for failure to submit an Stormwater Management plan shall be as provided by subdivision (4) of this subsection. No penalty shall be assessed until the person alleged to be in violation has been notified of the violation by registered or certified mail, return receipt requested, or other means. The notice shall describe the violation with

reasonable particularity, specify a reasonable time period within which the violation must be corrected, and warn that failure to correct the violation within the time period will result in the assessment of a civil penalty or other enforcement action. Each day of continuing violation shall constitute a separate violation.

11-2 The amount of the civil penalty shall be assessed pursuant to the following:

a) $100 per day for failure to secure from Caroline County an approved stormwater management plan prior to conducting a land-disturbing activity on a tract comprising one (1) acre or more, when one (1) contiguous acre or more is to be uncovered.

b) $100 per day for failure to take all reasonable measures to protect public property, private property, a lake or natural watercourse, from damage caused by land-disturbing activities.

c) $75 per day for failure to conduct a land-disturbing activity in accordance with the provisions of the stormwater management plan which was approved.

d) $75 per day for failure on a tract of one (1) acre or more, when one (1) contiguous acre or more is uncovered, to install sedimentation and erosion control devices sufficient to retain the sediment generated by the land-disturbing activity within the boundaries of the tract during construction upon and development of the tract.

e) $75 per day for failure to maintain satisfactory stormwater control measures, structures and devices on the site that are designed to provide protection from the calculated 2-year pre-development maximum outflow velocities and/or the 10-year pre-development minimum flow rates.

f) $75 per day for failure to maintain temporary and permanent stormwater control measures and facilities during the development of the site.

g) $50 per day for failure on graded slopes and fills to maintain an angle sufficient to retain vegetative cover or other adequate erosion control devices or structures.

h) $50 per day for failure within 30 days of completion of any phase of grading to plant or otherwise provide exposed, graded slopes or fills with ground cover, devices, or structures sufficient to restrain erosion.

i) $50 per day for failure on a tract of one (1) acre, when one (1) contiguous acre or more is uncovered, to plant or otherwise provide ground cover sufficient to restrain erosion within 30 working days or 120 calendar days, whichever is the shorter, following completion of construction or development.

j) $25 per day for failure to file an acceptable, revised stormwater management plan after being notified by Caroline County of the need to do so.

k) $25 per day for failure to retain along a lake or natural watercourse a buffer zone of sufficient width to confine visible siltation within 25 percent of the buffer zone nearest the land-disturbing activity.

11-3 Caroline County shall make written demand for payment upon the person in violation, and shall set forth in detail a description of the violation for which the penalty has been imposed. Caroline County shall consider the degree and extent of harm caused by the violation and the cost of rectifying the damage. If payment is not received or equitable settlement reached within 30 days after demand for payment is made the matter shall be referred to The Commonwealth's Attorney for institution of a civil action in the name of Caroline County, in the appropriate division of the Courts for recovery of the penalty.

11-4 Any person who fails to submit a stormwater management plan for approval as required by this ordinance shall be subject to a single, noncontinuing civil penalty of not more than One Thousand Dollars ($1,000.00). Any person who is subject to a civil penalty under this subdivision may be subject to additional civil penalties for violation of any other provision of this ordinance, or rules or orders adopted or issued pursuant to this ordinance.

11-5 Any person who knowingly or willfully violates any provision of this ordinance, or rule or order adopted or issued pursuant to this ordinance, or who knowingly or willfully initiates or continues a land-disturbing activity for which a stormwater management plan is required except in accordance with the terms, conditions, and provisions of an approved plan, shall be guilty of a misdemeanor punishable by imprisonment not to exceed 30 days, or by a fine not to exceed $1,000, or both, in the discretion of the court.

Section 12. Liability

12-1 Nothing contained in this ordinance shall be construed as in any way imposing liability upon the County of Caroline for damages to persons or property based on compliance with or failure to comply with the provisions hereof and such liability is expressly disclaimed.

Section 13. Agent, Duties, and Appointment

13-1 This ordinance shall be enforced and administered by the Agent.

13-2 The Agent shall be appointed by the Board of Supervisors of Caroline County and shall serve at the pleasure of the Board.

Section 14. Severability

If any provision of this ordinance is held to be unconstitutional or invalid such unconstitutionality or invalidity shall not affect the remaining provisions of this ordinance.

Section 15. Incorporated Towns

This ordinance shall not apply to any land-disturbing activity in any of the Incorporated Towns within the boundaries of Caroline County unless and until the governing body of any such town shall by appropriate action indicate their intention to have the land-disturbing activities within its boundaries covered by the terms and provisions of this Ordinance. Upon the taking of such action by the governing body of any of said Incorporated Towns the terms and provisions of this Ordinance shall apply fully to any land disturbing activity in said Incorporated Town.

B. This ordinance shall be effective immediately upon its passage by the Board of Supervisors of Caroline County.

SAMPLE

DECLARATION OF COVENANTS

AND

DEED OF EASEMENT

FOR MAINTENANCE OF

STORMWATER IMPOUNDMENT FACILITIES

DECLARATION OF COVENANTS

INSPECTION/MAINTENANCE OF STORMWATER IMPOUNDMENT FACILITY

THIS DECLARATION, made this _____ day of _____, 19_____, between _____, hereinafter referred to as the "COVENANTOR(S)", owner(s) of the following property: _____

_____

_____, and Caroline County, Virginia, hereinafter referred to as the "COUNTY".

WITNESSETH:

We, the COVENANTOR(S), with full authority to execute deeds, mortgages, other covenants, and all rights, titles and interests in the property described above, do hereby covenant with the COUNTY as follows:

1. The COVENANTOR(S), shall provide maintenance for the stormwater impoundment facility, hereinafter referred to as the "FACILITY", located on and serving the above described property to ensure that the facility is and remains in proper working condition in accordance with approved design standards, and with the law and applicable executive regulations.
2. If necessary, the COVENANTOR(S) shall levy regular or special assessments against all present or subsequent owners of property served by the FACILITY to ensure that the FACILITY is properly maintained.
3. The COVENANTOR(S) shall provide and maintain perpetual access from public rights-of-way to the FACILITY for the COUNTY, its agent and its contractor.

4. The COVENANTOR(S) shall grant the COUNTY, its agent and its contractor a right of entry to the FACILITY for the purpose of inspecting, operating, installing, constructing, reconstructing, maintaining or repairing the FACILITY.
5. If, after reasonable notice by the COUNTY, the COVENANTOR(S) shall fail to maintain the FACILITY in accordance with the approved design standards with the law and applicable executive regulations, the COUNTY may perform all necessary repair or maintenance work, and the

COUNTY may assess the COVENANTOR(S) and/or all owners of property served by the FACILITY for the cost of the work and any applicable penalties.

6. The COVENANTOR(S) shall indemnify and save the COUNTY harmless from any and all claims for damages to persons or property arising from the installation, construction, maintenance, repair, operation or use of the FACILITY.

7. The COVENANTOR(S) shall promptly notify the COUNTY when the COVENANTOR(S) legally transfers any of the COVENANTOR(S)' responsibilities for the FACILITY. The COVENANTOR(S) shall supply the COUNTY with a copy of any document of transfer, executed by both parties.

8. The covenants contained herein shall run with the land and shall bind the COVENANTOR(S) and the COVENANTOR(S)' heirs, executors, administrators, successors and assignees, and shall bind all present and subsequent owners of property served by the FACILITY.

9. This COVENANT shall be recorded in the County Land Records.

IN WITNESS WHEREOF, the COVENANTOR(S) have executed this DECLARATION OF COVENANTS as of this _____ day of _____ 19 _____.

ATTEST: FOR THE COVENANTOR(S)

_____ _____

_____ Date: _____

STATE OF VIRGINIA

COUNTY OF CAROLINE

I hereby certify that on this _____ day of _____, 19 ____, before the subscribed, a Notary Public of the State of Virginia, and for the County of Caroline, aforesaid personally appeared _____ and did acknowledge the aforegoing instrument to be their Act.

In Testimony whereof,
I have affixed my
official seal

_____ My Commission Expires: _____

NOTARY PUBLIC

THIS DEED OF EASEMENT made this _____ day of _____, 19 ___, by and between _____, Grantor(s) and Caroline County, VIRGINIA, hereinafter referred to as the COUNTY.

WITNESSETH: That in consideration of the sum of One Dollar ($1.00) paid by the County, the receipt of which is hereby acknowledged, and other good and valuable consideration, the Grantor(s) do hereby grant the convey with General Warranty unto the County, its successors and assigns a stormwater impoundment easement and right of way described as follows:

TO HAVE AND TO HOLD said easement and right of way together with the rights and privileges pertinent to their proper use and benefit forever by the County, its successors and assigns.

AND the Grantor(s), for themselves, their heirs and assigns, covenant and agree with the County, it successors and assigns, as follows:

FIRST: That the Grantor(s) will never erect nor permit to be erected any building or structure of any nature whatsoever, nor fill or excavate within said easement and right of way without the County's written consent;

SECOND: That the County, its successors and assigns, shall at all time have a right to enter said easement and right of way for the purpose of installing, constructing, reconstructing, maintaining, repairing, operating, and inspecting the stormwater impoundment facility within said easement and right of way, the right of entry to be along the line herein designated or along such other lines as the Grantor(s) may designate; and

WITNESS:- (his) (their) hand(s) and seal(s) the day and first herinabove written.

_____ _____(Seal)
Witness

_____ _____(Seal)
Witness

_____ _____(Seal)
Witness

_____ _____(Seal)
Witness

STATE OF SS:
COUNTY OF

I hereby certify that on this _____ day of _____, 19 ____, before the subscriber, a Notary Public of the State of _____, and for the County of Caroline, aforesaid personally appeared _____ and did acknowledge the aforegoing instrument to be (his) (their) act.

IN TESTIMONY WHEREOF, I have affixed my official seal

_____
NOTARY PUBLIC

V. STORMWATER MASTER PLAN

INTRODUCTION

A regional stormwater management plan has been developed for the Polecat Creek drainage basin. This has established a first step in a stormwater master plan for a County wide planning tool. The Stormwater Master Plan for Caroline County will eventually incorporate the Rappahannock, Pamunkey, Mattaponi, Maracossic, South River and Reedy Creek drainage basins as well.

HYDROLOGY

Caroline County is located in the northeastern section of Virginia. The County has one primary drainage divide running approximately east to west which separates two major drainage basins within the County's landmass. The two basins are the Rappahannock and York River Basins.

The Rappahannock River Basin is bordered on the north by the Potomac-Shenandoah River Basin and on the south by the York River Basin in Virginia. The headwaters of the Rappahannock River lie in Fauquier and Rappahannock Counties and the basin drains in a southeasterly direction entering the Chesapeake Bay between Lancaster and Middlesex Counties. There are 2,715 square miles of drainage area in the Basin, which is about six and four fifths percent of Virginia's total area. The Rappahannock River is 184 miles in length, and the Basin varies from 10 to 50 miles in width.

The York River Basin lies in the central and eastern section of Virginia. The Basin extends along a southeast to northwest line on either side of the Fredericksburg to Richmond corridor and is bounded by the Rappahannock Basin to the north and James River Basin to the south. The York River Basin drains 2,661 square miles of area, representing six and two-thirds percent of Virginia's total area. From the headwaters of the York Basin in Orange County to the mouth of Chesapeake Bay is a distance of approximately 120 miles. The Basin varies uniformly in width from five miles at the mouth of the York River to 40 miles in the headwaters. A major tributary to the York River is the Mattaponi River.

The Polecat Creek Basin collects runoff and flows into the Mattaponi River. It comprises nearly fifty square files of drainage area and drains from west to east along a length of approximately eight miles falling from elevation 115 at the source to elevation 67 at the Mattaponi River. The basin is contained entirely within the County's Corporate boundaries. It is comprised of twenty four separate subbasins which individually collect the entire amount of water that flows into the Polecat Creek. The largest tributary to the Polecat is Stevens Mill Run. Stevens Mill Run, comprised of 6 subbasins is characterized by several large impoundments, the two largest being Lake Caroline (287 acres) and Lake Hermitage (50 acres).

The names and approximate size of each subbasin studied are indicated in Table 1. Each subbasin was named after a prominent geographic feature within the immediate vicinity of the subbasin. Place names were often used to impart geographic location to those familiar with the County.

TABLE 1

SUBBASINS OF POLECAT CREEK

Subbasin Number	Subbasin Name	Subbasin Size (acres)
1	Stevens Mill Run: Chilesburg Branch	1,680
2	Stevens Mill Run: Lake Hermitage Branch	960
3	Stevens Mill Run: Ladysmith Branch	1,520
4	Stevens Mill Run: Lake Caroline Branch	2,220
5	Stevens Mill Run: Interstate-95 Branch	1,130
6	Stevens Mill Run: I-95 Rest Stop Branch	872
7A	Cedar Fork Branch	890
7B	Coffey Corner Branch	890
7C	Houstons Corner Branch	1,150
7D	Golansville Branch	1,450
8	Reedy Creek Branch	2,260
9	DeJarnette Mill Run	1,800
10	Hackett Creek Branch	1,790
11	Route 207 Branch	780
12	Route 601 Branch	660
13	Route 601 East Branch	545
14	Penola Branch	620
15	Millpond Swamp Branch	900
16	Saddle Swamp Branch	2,240
17	Middle Powerline Branch	695
18	Powerline Branch	405
19	Colemans Mill Branch	1,110
20	McDuff Branch	1,600
21	Carmel Church Branch	2,555

PHYSIOGRAPHY

Hydrologic Soil Groups

No Soil Conservation Service (S.C.S.) report has been completed for Caroline County. As of this study the field work is about forty percent complete. Based upon preliminary field reports from the Caroline County S.C.S. field supervisors a predominant soil type for the Polecat Basin was selected as a default soil type. Where S.C.S. could not supply soils data the default soil type, Emporia was selected based upon the predominance of this soil within the basin. Emporia-fsl-2 to 6 % is classified as a typic hapludults. The other candidate soils were Rumfords or Slagles. The selection of emporia will slightly over estimate the amount of water runoff to yield a worst case condition. The selection of a class of soil from the other groups would under estimate the utlimate development runoff amounts. As the S.C.S. soils study is completed the original study data can be modified for a more accurate predictive model.

The emporia series consists of very deep, well drained soils of the upper coastal plain. They formed in loamy and clayey sediments. Typically, these soils have a pale brown loamy fine sand and fine sandy loam surface layer 15 inches thick. The subsoil from 15 to 17 inches is mottled yellowish-brown sandy clay loam and clay loam. The substrata from 57 to 70 inches is a mottled sandy clay-loam. The slopes typically range from 2 to 6 percent. These characteristics can be considered average for the Polecat Basin.

The hydrologic soil group classification for Emporia is C. Group C soils have low infiltration rates when thoroughly wetted and consists chiefly of soils with a layer that impedes downward movement of water and soils with moderately fine to fine texture. The permeability of this soil it typically 2.0 to 6.0 inches per hour. This soil's suitability for reservoir impoundment is dependent upon the slope steepness. 0-3 percent slope will have moderate seepage as well as 3 to 8 percent slopes. Slopes greater than 8 percent usually experience severe seepage. Use in grassed water ways this soil yields slow percolation rates. This is not conducive for use of exfiltration trench systems.

GEOLOGY

The headwaters to the Polecat Creek begin as either a granitic gneiss of uncertain age in the seven series place names (Cedar Fork, Coffey Corner, Houstons Corner and Golansville Branches) or a Mioceneic Calvert formation consisting of diatomaceous sand or a gravely mix interlaced with upland gravel and sand. The Calvert formations exist primarily within Stevens Mill Run Subbasins. These types of soil combined with steep slopes greater than six percent can cause highly erodible soil conditions. The Calvert formations are not considered good candidates for impoundments and require geotechnical engineering techniques to render them suitable as impoundment sites. These highly erodible areas are indicated on Figure 7 and shown as a crossed box.

From the middle basin to the confluence of the Mattaponi River the soil consists mainly of a Pamunky Group soil called the Nanjamoy formation. This consists of sands of low grade which is locally gypsiferous. This is also a tertiary aged soil formation formed in the eocenic era. These soils are moderately erodible. Existing in the lower reaches of the Polecat they exist in combination with slight slopes from zero to four percent and are inherently stable. A marked increase in stream velocity would have severe effects on this soil type without adequate engineering modifications.

HYDRAULICS

The existing conditions of the Polecat Creek Basin were modeled based upon the following assumptions:

(1) S.C.S. TR-55 modeling;
(2) default soils group C;
(3) two typical stream sections; and
(4) A 10 year storm = 5.04 inches per hour for a 24 hour duration

The S.C.S. TR-55 computer model was used to generate the basin model hydrographs. All conditions stated within the user manual apply. The use of hydrologic soil group C may over estimate the actual amount of water but provides a slightly exaggerated condition for the study of

potential basins that would benefit by regional impoundments. For consistency only two typical stream sections were selected for modeling purposes. A detailed survey and cross sections were not feasible for the time and monetary resources allocated. Both existing and ultimate development conditions were modeled under the same assumptions. Figure 4 indicates those typical stream sections used to determine time of concentration and total time variables.

The existing conditions were assessed from U.S.G.S. quadrangle mapping and 1987 S.C.S. aerial mapping. This established existing land use data such as, slope and condition of, the land. The ultimate developed condition was derived from the County Planning Departments land use plan. Figure 5 indicates the corresponding S.C.S. land use assignments made to each of the areas within the Polecat Basin. These assignments correspond to the S.C.S. curve number tables and the County zoning maps. Where variable residential densities are allowed by zoning an S.C.S. curve number that approximates the average of these densities was applied.

Of the 30,722 acres considered in the study 22,845 acres are currently classified as Forestry/Undeveloped (seventy four percent). The ultimate land use indicates slightly over 5,000 (sixteen percent) acres are to remain in this classification. This is a significant change in the gross amount of land available to attenuate the effects of any size storm. Table 2 indicates the acres of land use changes in each subbasin. From this basic data a ranking of each subbasin was derived to assess which ones may have a high potential for regional stormwater facilities. The ranking system used a weighing value to emphasize areas that have the greatest land use changes planned. For example an area that is undeveloped under existing conditions and is changed to a commercial and/or business land use classification would receive a greater weighing factor than a residential area converting to the same. The weighing factors are derived form the magnitude of change between S.C.S. numbers assigned to land use categories. The base factor for the lowest S.C.S. curve number is assigned to undeveloped land. Table 3 entitled "Potential for Stormwater Management Cases" shows the various factors, ranking equations and potential stormwater management numbers derived. The rankings shown on the right side of the table indicate the most probable problem subbasins. The lower the number the higher the potential (a 1 indicates the most potential for a problem subbasin) for a problem to occur. All though this ranking is based solely upon raw land conversions, this is the single most contributing cause to stormwater problems. As an area becomes more impervious it collects more stormwater runoff and flows at a faster rate. This increased quantity and velocity is the central theme of stormwater management.

Many of these subbasins, while achieving a low ranking (high problem potential) may not be immediately considered candidates for regional stormwater management facilities. Judgement must be used along with other data derived form the computer model to make this determination. Early use of Best Management Practices while a subbasin is developing can reduce the need of a structural solution or at least retard the need.

The computer model was run for both the existing and ultimate land use conditions using a ten year storm event. Unit hydrographs were developed for each storm (existing ten year and ultimate ten year) and plotted on the same graph. The resultant graph, which depicts a time versus quantity of water plot, indicates typically a bell shaped curve with the highest point coinciding with the peak flow. In all cases the ultimate development plotted above the existing for the twenty four hour period considered. The ultimate development hydrograph plotting above the existing hydrograph

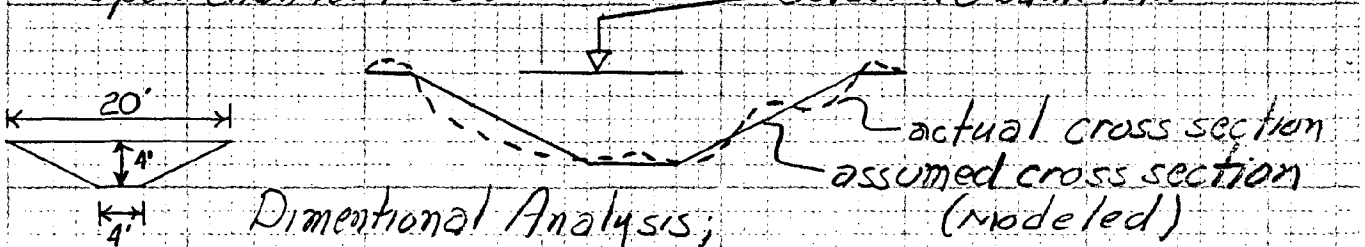
Harland Bartholomew & Associates, Inc.

SUBJECT Polecat Creek Basin JOB NO. PH577501
Channel Flow Sections SHEET NO. 1 OF 1
MADE BY RSL DATE 10/30/89 CHECKED BY JC DATE 11-7-89

Typical Stream Sections

FIGURE 4

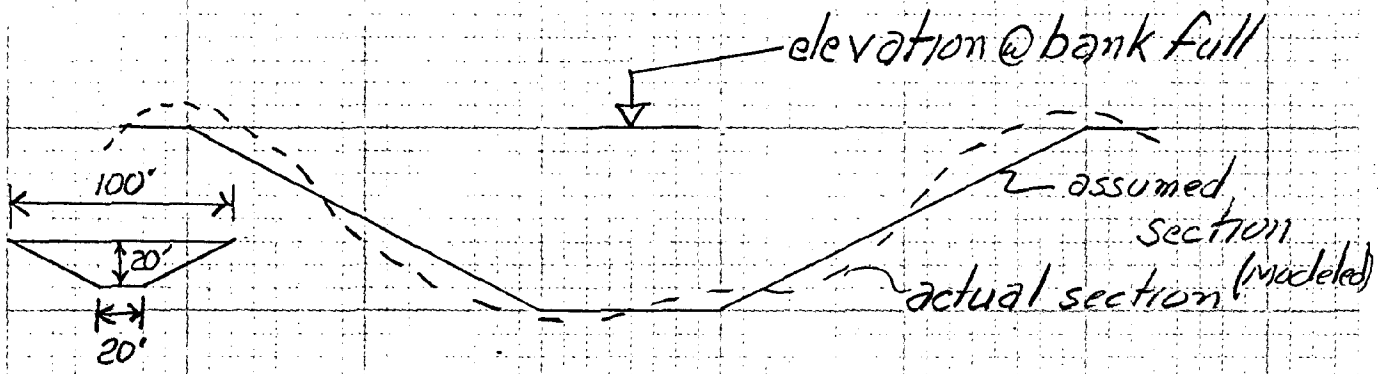
Open channel flow:



Dimentional Analysis; (Modeled)

Cross sectional area = 48 ft.²
Wetted perimeter = 41.89 ft.
Hydraulic radius = 1.15 ft.

Intermediate channel flow:



Dimentional Analysis;

Cross sectional area = 1200 ft.²
Wetted perimeter = 209.44 ft.
Hydraulic radius = 5.73 ft.

Manning Roughness Coefficients, "n"
(Tbl. 1 - Appendix A - page 100 - FHWA charts)
Natural stream channels

Med. brush on banks & weeds = 0.050
MAJ. stream channels = 0.035
dense brush on banks & hvy. weeds = 0.070

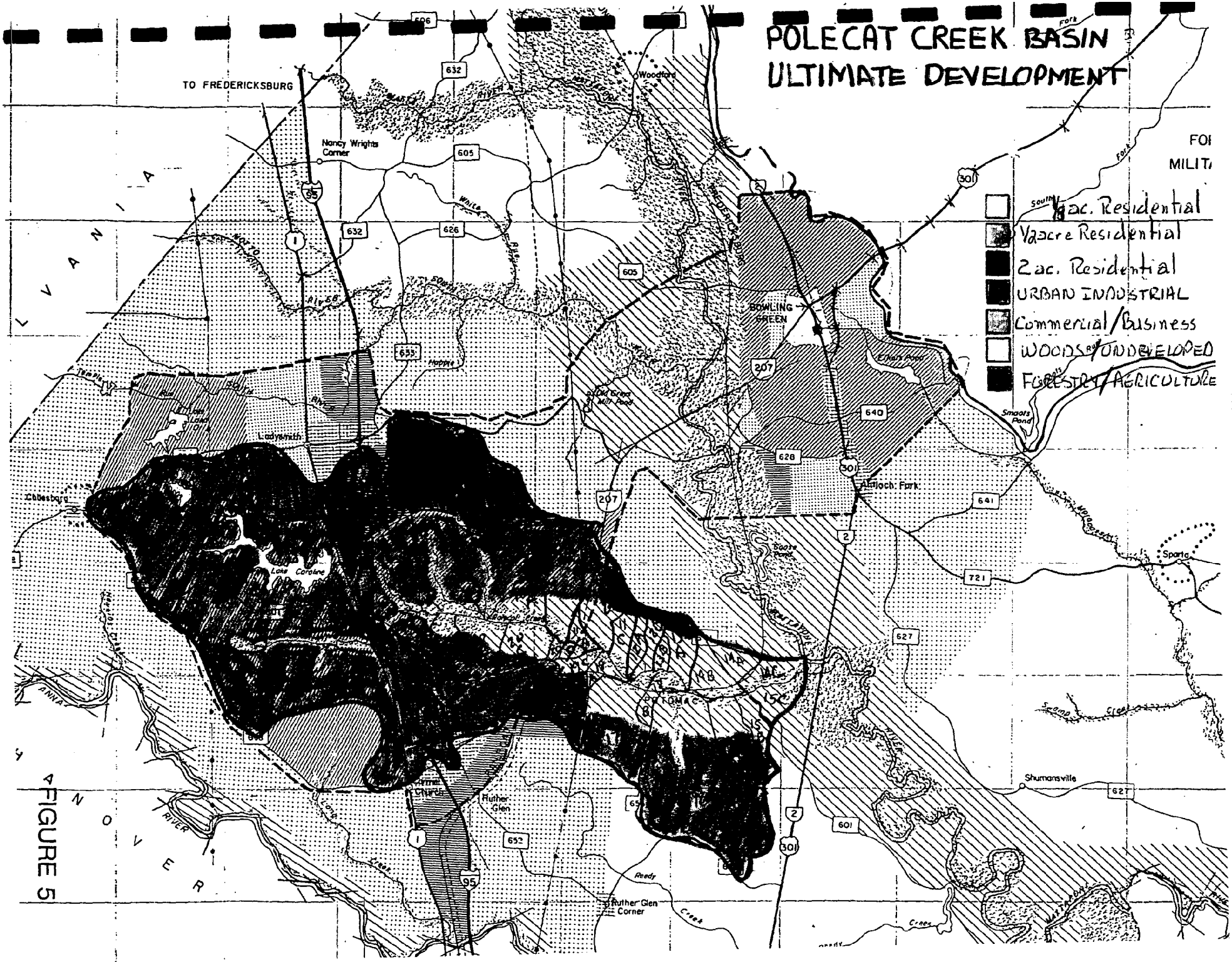

POLECAT CREEK BASIN
ULTIMATE DEVELOPMENT
1/8 ac. Residential
1/2 acre Residential
2 ac. Residential
URBAN INDUSTRIAL
Commercial/Business
WOODS/UNDEVELOPED
FORESTRY/AGRICULTURE
TO FREDERICKSBURG
Nancy Wrights Corner
Woodford
BOWLING GREEN
Ladysmith
Chilesburg
Lake Caroline
Antioch Fork
Smoots Pond
Sparta
Shumansville
Ruther Glen
Ruther Glen Corner
Reedy Creek
Swamp Creek
Old Grays Mill Pond
Elkers Pond
Goose Pond
Happy
POTOMAC
RIVER
FREDERICKSBURG
LVANIA
HANOVER

FIGURE 5

TABLE 2

POLECAT CREEK DRAINAGE BASIN
LAND USE CATEGORIES

SUB-BASIN NO.	EXISTING LAND USE (IN ACRES)							ULTIMATE LAND USE (IN ACRES)							
	A	B	C	D	E	F	G	A	B	C	D	E	F	G	TOTALS
1	1425	225		30							1680				1680
2	390	220		350							960				960
3	860	80		300	260		20				750	750		20	1520
4	830	170		1220							2080			140	2220
5	1060	70								115	90	30		895	1130
6	780	80				12		80			620	160	12		872
7A	800	90									890				890
7B	550	340						10			880				890
7C	270	880						25			1125				1150
7D	1160	240				50		170			1070	160	50		1450
8	1900	360						140		1240	880				2260
9	1620	180						90		850	860				1800
10	1280	510						550		105	1135				1790
11	685	95						380		200	200				780
12	600	60						600	40	20					660
13	470	75						470	45	30					545
14	250	370						250	370						620
15	800	100						610	290						900
16	1990	250						275	1965						2240
17	685	10						280	310					105	695
18	360	45						395						10	405
19	870	240						150				385		575	1110
20	1225	375						820			780				1600
21	1985	455	55				60	30			1125	630	770		2555
TOTAL	22845	5520	55	1900	260	62	80	5325	3020	2560	15125	2115	832	1745	30722

LAND USE CATEGORIES		% change @ Ultimate
A	Forestry/Undeveloped	-77%
B	Agricultural	-45%
C	Residential 2 acre lots	+455%
D	Residential 1/2 acre lots	+654%
E	Residential 1/8 acre lots	+713%
F	Commerical/Business	+124%
G	Urban Industrial	+208%

TABLE 3

POLECAT CREEK DRAINAGE BASIN
POTENTIAL FOR STORMWATER MANAGEMENT CASES

SUB-BASIN NO.	FACTORED ULTIMATE LAND USE	FACTORED EXISTING LAND USE	POTENTIAL STRM. MGT. NUMBER	POTENTIAL STRM. MGT. RANK
1	2,234	1,784	450	5
2	1,277	1,168	109	16
3	2,153	1,793	360	8
4	2,979	2,694	285	10
5	1,672	1,159	513	3
6	1,163	912	251	12
7A	1,184	928	256	11
7B	1,180	1,033	148	15
7C	1,521	1,520	2	20
7D	1,912	1,579	332	9
8	2,898	2,411	486	4
9	2,322	1,876	446	6
10	2,194	2,004	190	13
11	902	820	82	18
12	682	685	(3)	22
13	572	577	(4)	23
14	775	775	0	21
15	1,022	942	80	19
16	3,065	2,345	720	2
17	880	699	181	14
18	410	424	(14)	24
19	1,602	1,211	391	7
20	1,857	1,758	100	17
21	3,680	2,793	887	1

TOTAL = 24

	LAND USE CATEGORIES	S.C.S. CURVE #	LAND USE FACTOR (LUF)
A	Forestry/Undeveloped	60	1.00
B	Agricultural	85	1.42
C	Residential 2 acre lots	77	1.28
D	Residential 1/2 acre lots	80	1.33
E	Residential 1/8 acre lots	90	1.50
F	Commercial/Business	94	1.57
G	Urban Industrial	91	1.52

Factored Ultimate Land Use Number = LUF X LU category for A + same for B + ...
Factored Existing Land Use Number = LUF X LU category for A + same for B + ...
Potential Stormwater Mgt. Number = Factored Ultimate LU - Factored Existing LU Number
Land Use Factor is S.C.S. curve number - 60\60 (i.e. {(CN - 60) \ 60}) except LU A, which = 1.

is indicative (see Figure 6) of larger amounts of stormwater being induced into the basin due to smaller areas of land available to absorb the runoff. The difference between the two hydrographs is the amount of water that needs to be impounded to maintain existing conditions and runoff characteristics in the future (at ultimate development). The dual hydrograph plots and existing and ultimate development hydrologic/hydraulic calculations are not contained within the body of this report. These ancillary documents are contained in the 849 page technical supplement.

REGIONAL SITE POTENTIAL

After calculation of the amount of storage required in each subbasin an assessment of the potential of each subbasin has been made to determine the feasibility and location of potential impoundment sites. Each of the 21 subbasins and additional catchments within the subbasins were analyzed for regional site potential yielding a total of forty-two drainage areas studied. Based upon the amount of storage required, the potential ranking in Table 3 and topographic characteristics of the individual catchments, three generalized categories were established for each catchment.

Of these forty-two catchment areas twenty-one had storage requirements less than twenty-two acre-feet for the ultimate developed condition. These areas are not candidates for regional sites as these storage requirements can be reduced by implementation of best management practices and conventional on-site treatment or current development practices. These sites are included in the "low" category for regional site potential. Six of the forty two catchments were chacterized by a "medium" potential for a regional site. These areas had between twenty-two to forty-nine acre-feet of storage required. Large scale developments may have the required land area for impoundments and regional sittings may or may not be required. These catchments will need to be coordinated on a regional bases so if no regional site is selected, the discharge times and rates can be planned. In this scenario the coordination of consecutive development is extremely critical. Each development must be studied on a case-by-case bases. In the end, a regional facility may be the optimal solution for these areas.

Approximately one third of the areas studied are candidates for regional stormwater management sites. The total amount is fifteen out of forty two. These sites as well as all aggregate sites and the generalized categories are shown in Table 4. These fifteen sites contain six areas with storage requirements of over one hundred acre-feet. We can now examine each of the fifteen subbasin or catchment candidates to determine which and how many of the potential sites should be planned for.

SELECTED SITES

Subbasins 1, 3 and 4 have been ruled out due to the existence of the 287 acre impoundment, Lake Caroline. These contributory subbasins will deliver an estimated 341.5 acre-feet additional storage requirement on Lake Caroline. This would raise the average water elevation in the Lake less than two feet during the 10 year storm. Subbasin 2 would also contribute to Lake Caroline, but is first attenuated by Lake Hermitage. These impoundments act as existing regional facilities and are therefore not new selected sites.

FIGURE 6

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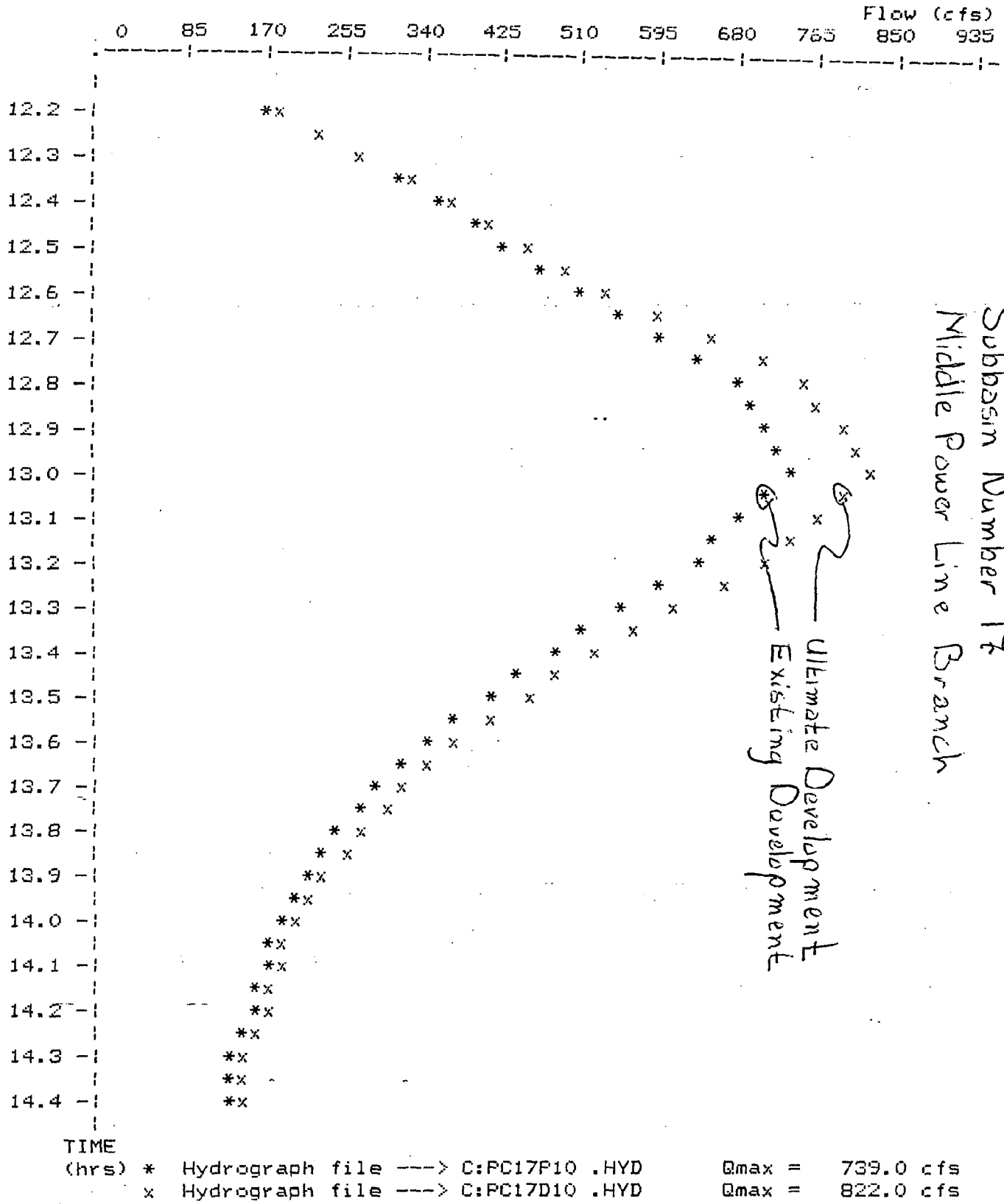

Combined Ten Year Hydrographs
Subbasin Number 17
Middle Power Line Branch

Ultimate Development
Existing Development

TABLE 4

POLECAT CREEK DRAINAGE BASIN
REGIONAL STORMWATER MANAGEMENT

PROJECTED STORAGE VOLUME REQUIREMENT		REGIONAL SITE POTENTIAL		
SUB-BASIN NUMBER	STORAGE (arce-feet)	HIGH	MEDIUM	LOW
1	131.6	*		
2	48.3		*	
3	85.5	*		
4	124.4	*		
5	121.5	*		
6	78.2	*		
7A	71.6	*		
7B	55.1	*		
7C	46.2	*		
7D	112.9		*	
8A	16.2			*
8B	80.6	*		
8C	78.4	*		
9	149.0	*		
10A	30.3		*	
10B	82.5	*		
11A	0.0			*
11B	37.2		*	
11C	6.2			*
12A	12.6			*
12B	17.1			*
13A	20.1			*
13B	4.9			*
14A	0.0			*
14B	0.0			*
14C	0.0			*

TABLE 4 (Cont'd)

POLECAT CREEK DRAINAGE BASIN
REGIONAL STORMWATER MANAGEMENT

PROJECTED STORAGE VOLUME REQUIREMENT		REGIONAL SITE POTENTIAL		
SUB-BASIN NUMBER	STORAGE (arce-feet)	HIGH	MEDIUM	LOW
15A	0.0			*
15B	0.0			*
16	0.0			*
17	40.1		*	
18A	0.0			*
18B	0.0			*
19A	80.1	*		
19B	20.6			*
19C	0.0			*
20A	29.9		*	
20B	20.5			*
20C	21.7			*
20D	0.0			*
21A	161.2	*		
21B	12.4			*
21C	81.5	*		
TOTALS (42)	1,878.4	15	6	21

Subbasins 12, 13, 14, 15, 16, 17, 18 and 20 are also ruled out due to the minimal amounts of storage requirements. The selected subbasins for regional sites are as follows:

Subbasin Number	Subbasin Name
5	Stevens Mill Run: Interstate-95 Branch
6	Stevens Mill Run: I-95 Rest Stop Branch
7D	Golansville Branch
8	Reedy Creek Branch
9	DeJarnette Mill Run
10	Hackett Creek Branch
11	Route 207 Branch
19	Colemans Mill Branch
21	Carmel Church Branch

Of these nine selected sites two sites have existing impoundments that could be increased in size to handle additional storage volumes. These are Hackett Creek and Colemans Mill Pond in subbasins ten and nineteen respectively. The potential locations and sizes are indicated on Figure 7 following this section. The sizes and locations are approximate. The actual ownership of the property has not been investigated. These sites should be incorporated into the ultimate land use plan to be consistent with the ultimate planned development.

FIGURE 7

VI. CONCLUSIONS & RECOMMENDATION

INTRODUCTION

The goals and objectives of this type of study are ineffective unless measures to implement them are adopted. Attention must be given throughout the development of the County's land mass to the increasing need of stormwater management. The implementation of the strategies brought forth by this study can be achieved best by the conscientious administration of The Land Use Plan, the Zoning Ordinance and the Comprehensive Plan of Caroline County. Rezoning requests should be reviewed against the potential stormwater management problems it may cause. Drastic changes from the current land use plan will require major changes in the results of this study and should be avoided if possible to avoid restudy and/or invalidation of existing hydrological data bases. Finally the Comprehensive Plan needs to address the completion of a County wide Master Drainage Plan for the remaining drainage basins within the County.

CHANGES TO THE ZONING ORDINANCE

In general, two topics are in need of inclusion into the Zoning Ordinance. The first is the incorporation of the Stormwater Management Ordinance into the site plan submittal procedure and secondly the treatment of development within the 100 year floodplain. The Floodplain section should be amended to require more development guidelines for any type of development occurring within the boundaries of the 100 year floodplain. Existing lots in which the entire lot is within the 100 year floodplain as of the Plan's adoption date, can be developed according to existing regulations. The subdivision of new residential lots in which no building site is outside the 100 year floodplain should be prohibited. The subdivision of commercial and industrial land in which all of the new lot would be within the boundary of the 100 year floodplain should also be prohibited.

Commercial and industrial projects which purpose any filing, rechanneling and/or imposition of structures within the 100 year floodplain should be required to submit a thorough floodplain study which addresses specific engineering guidelines to show the effect of such development upon upstream projects and the existing boundaries of the floodplain. Projects which change the boundary of the existing floodplain should be prohibited.

To assist in the implementation of the Best Management Practices consideration should be given to the creation of a Land Management Overlay for the Land Use Plan. This is an overlay category which works in conjunction with the primary land use category for a property. This overlay identifies land which can be developed through the use of specific development standards which assure the protection of the County's drinking water supplies and the aesthetic quality of the riverfronts and major waterways, or which have development limitations due to a predominance of poor soils and/or steep slopes. Development density is mandated by the primary land use classification of the property and its maximum development density. The Land Use Plan can designate in this land use overlay category environmnetally sensitive areas which should be protected from the potentially detrimental effects of development through the enactment of Best Management Practices (BMP's). The following natural resources are to be protected under this Land Use Overlay category: watersheds; groundwater recharge areas; severe slopes and areas with poor soils; floodplains, drainage basins runs, and perennial streams (as indicated on maps produced by the

United States Geological Survey and the National Ocean Survey at a scale of 1:24000); and waterfront and lakefronts.

The Land Use Plan needs to recognize the necessity of giving development rights to environmentally sensitive land by designating a primary land use category to each property in the County. However, the Plan needs to acknowledge the importance of protecting these areas by placing a Land Management Overlay designation on them. This overlay identifies areas which need a more intensive review process of development proposals to assure protection against non-point source pollution in drinking water supplies, to protect against groundwater pollution in recharge areas, and to prevent the erosion and sedimentation of land.

The primary land use recommendation for Land Management areas outside the boundary of the Growth Area is Rural Residential; however, Agricultural uses are shown in those areas with suitable soils and/or existing farms. Residential development in both areas is assumed to be on two (2) acre lots with private utilities. Within the Growth Area, Land Management Areas would be developed according to the primary land use designation. For example, along Route 207 in the Polecat Basin there is a large amount of acreage designated urban industrial, with portions indicating floodplain undeveloped. The Plan could recommend the use of Best Mangement Practices when developing the environmentally sensitive sections of the industrial land. For example, in residential areas, innovative subdivision techniques would be recommended so development could be shifted away from the environmentally sensitive sections of a parcel.

Agricultural uses in these areas may have the effect of contributing non-point source pollution into water sources. Commerical forestal uses have the potential for creating sedimentation and erosion problems caused by harvesting trees on steep slopes. As such, agricultural and forestal uses are encouraged to use Agricultural and Forestal Best Management Practices (BMP's), respectively.

Most of the land that would be overlayed by this category area found in the rural areas of the County and are not served by public utilities.

Other minor changes are listed herein to assist with the incorporation of the 1989 F.E.M.A. Study and the inclusion of Resource Protection and Resource Management areas which will be required by the Chesapeake Bay Act.

Article II - Definitions - Page 3

* Floodplain or "Flood Prone Areas" "Maps delineating 100-year floodplain...Federal insurance Administration, **Federal Emergency Management Administration (F.E.M.A.) Flood Insurance Studies."**

* Page 4. Need to add definition of Buffer Zone as it pertains to Chesapeake Bay Act.

* Page 9. Need to add definitions of Resource Management and Resource Protection Areas.

Article V-A - Agricultural Residential District (AR-1)

Section 8 - Buffer Zone Requirements - Page 22

* Add language that states additional buffer required if it is within designated Resource Management or Resource Protection Areas.

Article XI - Planned Unit Developments

Section 2 - part a), Item 7, floodplain limits - Page 33

* floodplain is one word (F.E.M.A. defined)
* should read "100 yr. floodplain limit as established by the 1989 F.E.M.A. Flood Insurance Study."
* Should indicate F.I.R.M. (Flood Insurance Risk Map) panel numbers on submittal.

Section 2 - part b), Item 8, Utility Information -.Page 34

* "...drainage facilities, **Stormwater Management Facilities**, electric,..."
* Add item (11) to read as follows:
  (11) Location of any identified Resource Protection and/or Resource Management Areas with measures to assure compliance with the Chesapeake Bay Area Performance Criteria.
* Add item (12) to read as follows:
  Downstream hydrologic analysis for all tributary streams (an perennial stream depicted on the most recent U.S. Geological Survey 7 1/2 minute topographic quadrangle mapping) within the proposed development. The analysis must indicate the pre-development runoff as well as the postdevelopment runoff conditions.

Article XV - Supplemental Regulations

Section 6 Page 67

* Paragraph 1; Floodplain is one word.

* Item 2; Floodplain is one word; third sentence "Any structure permitted..." Please note that in most cases there should be NO permitted construction within the 100 year floodplain; Fourth sentence"...(3) feet above the **established 100 year floodplain elevation...**", also please note that the maximum recorded flood may not be applicable wording in the Route 17 area which has tidal influence and has flood record data tot the 500 year event. This would include any major storm (i.e. hurricanes) event and may preclude any development in these areas.

* Item 3; Using the ground floor elevation may not protect from underground storage tanks which could potentially hold industrial paints or solvents or petroleum based products that may be harmful in the event of a leak. Suggest this wording; "...Unless ground floor levels and underground storage tank foundation elevations of such.....(3) feet above the established 100 year..."

Section 7 - Item 6 - Paragraph (f) Buffer Zones - Page 72

* Item f - Buffer Zones; Add language for Resource Protection and Resource Management Areas.

Section 12 - Special Provisions Applicable to (R-3)

* Paragraph 4. 50 foot buffer requirement for mobile home parks needs to include provision for 100 foot buffer if it is in a Resource Management or Resource Protection Area.

Section 14 - Site Plan Requirements - Page 76

* The site plan contents, item 16 paragraph (h) needs to be reworded to incorporate the Stormwater Maintenance Ordinance compliance, downstream impact analysis, channel velocity measures, etc.

Section 17 - Resource Protection/Resource Management Areas

* This section should contain appropriate wording to incorporate the performance criteria for part IV of the Chesapeake Bay Act as well as part III Section 3.4 the Intensely Developed Area Criteria.

Section 18 -

* This is where the current Section 17 should live, renamed as Section 18.

Article XVII - Administration and Enforcement - Page 88

* Need to include wording to incorporate the Stormwater Management Ordinance requirements into the site plan submittal, permit application and fee process.

REZONING APPLICATIONS

The following changes should be made to the rezoning application process;

The application should require that the applicant address the land's development potential and submit a generalized development plan which depicts existing and proposed development. Applications for projects should also indicate environmentally sensitive areas, and historical and archeological sites, and the treatment of such areas.

Private developers need to appreciate the fundamental relationship between the Comprehensive Plan and zoning. Zoning amendments should require that the developer's application reflect the environmental mapping being prepared for the County in conjunction with the Chesapeake Bay Act.

The development plans should also list all Best Management Practices implemented as part of the site design. In subbasins where regional stormwater management facilities are anticipated, the developers participation must be specifically identified prior to approval of any development.

CAPITAL IMPROVEMENTS PROGRAM

The Capital Improvements Program (CIP) represents a planned schedule of expenditures for physical improvements in the County over a six (6) year period. The CIP is also a budgeting tool which allows the County to anticipate expenditure levels several years in advance and plan financing strategies. It is in this regard that the following recommendations are made for the inclusion of items in the CIP to generate the necessary funding to complete what this study has begun.

The County should take steps to study the following drainage basins in order to complete the county wide drainage study:

- Rappahannock River Basin,
- North Anna/Pamunkey River Basin;
- Mattaponi River Basin;
- Maracossic River Basin; and
- Reedy Creek Basin.

This will complete the Master Drainage Plan for the County and create a tool for the management of growth as it occurs. The studies could begin in the primary growth areas first with the remainder to follow over as short a period of time as possible. The next logical basin to study is the South River Basin as this encompasses a rapidly developing area. This should be followed by the Rappahannock flowage and the Maracossic Basin. The order in which basins are studied is where development is most rapidly occurring. Ideally the entire County should be studied at one time.

It is also recommended that the County's Engineering Department be capable of utilizing the available hydrological data created by this study. The Departments need for an AT class microcomputer will grow each year. Without this ability the Engineering Department will not be able to utilize all of the engineering tools available today.

CONCLUSION

A stormwater management plan and ordinance are static documents unless steps to implement the plan are identified, developed, and ultimately adopted as County ordinances. This study has identified measures required to implement the Plan. Over time, as the Plan becomes operational, additional measures may become apparent and need to be adopted. Only by working with a document over time can additional implementation measures be identified.

The implementation strategies included in the Plan are designed to allow growth while maintaining the existing hydrologic character of the County. The strategies can easily be implemented through amendments to the County's Zoning and Subdivision Ordinances, and through the adoption of the stormwater management ordinance.

In general, the implementation measures recommend that County regulations be enhanced in some measure, whether through the adoption of new zoning categories, performance zoning amendments, adoption of best management practices, or by requiring more detailed information on zoning or rezoning applications to show the total effect of a development proposal on the natural and manmade environments. The basic intent of the implementation strategies is to upgrade and/or adopt new measures which place more accountability on developers to provide good plans and ultimately develop good projects.

The financing phasing of the remaining studies is a major tool for implementing the strategies suggested. The CIP is the financial tool which helps the Land Use Plan reach fruition by annually identifying projects needed prior to or in conjunction with private development. The Land Use Plan needs to identify the planned regional stormwater management sites so protective zoning measures can be exercised by the County.

With the timely implementation of these measures Caroline County can achieve the objectives of this study; to protect the quality of the water, land and natural resources and to preserve and protect an environment that is beneficial to the residents of the County and the citizens of the Commonwealth.

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