12-2000

Minimizing storm water runoff from residential development through land use measures

William R. Coleman

To the Graduate Council:

I am submitting herewith a thesis written by William R. Coleman entitled "Minimizing storm water runoff from residential development through land use measures." I have examined the final electronic copy of this thesis for form and content and recommend that it be accepted in partial fulfillment of the requirements for the degree of Master of Science, with a major in Planning.

John Penie, Major Professor

We have read this thesis and recommend its acceptance:

James A. Spencer, Bruce Tonn

Accepted for the Council:
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Vice Provost and Dean of the Graduate School

(Original signatures are on file with official student records.)

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John Peine, Major Professor

We have read this thesis
and recommend its acceptance

Accepted for the Council

Interim Vice Provost and
Dean of the Graduate School

Minimizing Storm Water Runoff from Residential Development through Land Use Measures

A Thesis Presented
for the
Master of Science in Planning Degree
The University of Tennessee

William R Coleman, III
December, 2000

DEDICATION

This thesis is dedicated to my father, William R. Coleman, Jr , whose continued love and support has truly made a difference in my life.

ACKNOWLEDGEMENTS

I would like to thank my major professor, Dr John Peine, for his patience, guidance and vision in the development of this thesis and my graduate school experience. I would also like to thank the other committee members Professor James Spencer and Dr. Bruce Tonn I am grateful to Professor James Spencer for his insights on the historical and practical application of land use planning. I am also grateful to Dr. Bruce Tonn for his helping enhance my analytical and research skills.

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INTRODUCTION

Since the beginnings of civilization, society has had an impact on water resources as a result of the location of increasingly dense areas of population on or near fresh water sources. As societies have grown and cities have emerged, larger amounts of regional natural resources have been needed in order to sustain development and quality of life regardless of regional capacities to support such growth Water resources are highly sensitive and do not fare well under encroachment by civilization Very often, development occurs within the boundaries of riparian areas, causing large amounts of sediment, organic matter and contaminants to be deposited into streams, creeks and rivers (altering and often eliminating the natural water cycle). The loading of streams, creeks and rivers with sediment and organic contaminants is detrimental to the natural purification processes inherent to aquatic ecosystems as well as damaging to aquatic life, which are threatened by both sedimentation and the lowered levels of dissolved oxygen which result from the presence of decomposing organic matter in the water

Human societies must have a fresh water supply in order to remain in a certain region or location Thus, civilizations have commonly developed spatially along rivers, deltas and lakes. However, as the population density of present-day civilization has increased at significantly higher levels than seen previously, the demands for both land and fresh water resources have increased and their quality has become a matter of increasing concern for policymakers Very often, the demand for land is satisfied by encroaching on sensitive areas needed to preserve water quality and maintain natural

water cycles With the size of cities and urbanized areas increasing, the need for land use measures to protect water quality becomes increasingly important in order to mitigate environmental impacts arising from the development and use of land Of particular concern is the growth of suburban areas as a primary housing source and the impact generated by increased use of impervious surfaces (streets, driveways and parking lots) and the stripping of diverse ground covers and trees in order to accommodate largely homogeneous grass plantings These trends have had significant impact on neighboring water bodies because much of the water now conveyed across residential development surface area enters without the benefit of having been filtered by adequate amounts of ground cover.

This thesis is prepared from the perspective that development will continue to occur and that the trend for suburban land development will continue to be a primary housing source The intent of this thesis is to suggest several land use ordinances that can help mitigate the impact of residential development if put into practice by a community

CHAPTER ONE

Introduction to Question and Methodology

The Problem

From the earliest stages of human development, civilizations have located around or near sources of fresh water As civilizations matured into intricate social networks, the formation of densely populated areas (cities) began to emerge and replace small, isolated village systems. The impact of civilization on water resources has increased over time In addition, the rate of population growth combined with the subsequent increases in consumption of terrestrial and aquatic resources make the issue of water quality particularly relevant for both the present and future Simply, we are entering a period of time when fresh water resources are becoming strained as a result of rapid increases both in population levels and in the demand for water from agriculture and industry (Kunstler 43 – 52)

Of particular concern is the trend of suburbanization that began developing after World War II in the United States. Suburbanization is often epitomized by the conversion of agricultural or forested areas located outside a city into residential developments Most of these previously undeveloped areas affected by suburbanization have stable soil systems and sufficient vegetation to disseminate rainwater in a manner that does not lead to heavy erosion However, the conversion of these areas to residential development very often results in the demolition of trees and ground cover in an effort to install the

development infrastructure, amenities and lawn areas required for the sale of residential housing projects. Very often, the result of residential development is increased soil erosion and pollution of water bodies due to the fundamental changes made to the soil and ecological systems

Because of the continuing (and increasing) trend toward suburbanization (or sprawl), the environmental impacts of residential development are becoming a growing concern Throughout the United States, both federal and state laws have been passed that require that the problems of urban runoff (or storm water) and soil erosion be contained and minimized in the development process However, much of the regulatory control of real estate development rests in city or county land use measures that address primarily the specifics of subdivision of land, erosion control methods and types of land uses as they relate to environmental issues. The issue addressed in this thesis is what types of land use ordinances already exist that can be adopted by county or city government in order to minimize the effects of residential development on water quality

Importance of this study

Federal and state legislation regarding water quality should apply at the county and city level. Given that counties and cities are "creatures of the state" it is then plausible that their policies should reflect those of the state and federal government Thus, county and city governments are bound to enforce in some form or fashion policies that are reflected in federal and consequent state legislation The importance of this study is to suggest land use measures that will help minimize the effects of urban runoff

brought about by residential development Because all development must have storm sewerage of some sort, the relation to provisions of the Clean Water Act passed by Congress in 1972 and in the Phase 1 and Phase 2 storm water rulings becomes clear

Most of the land use measures described in this study have already been adopted by various communities in an effort to control the impacts of development on water resources and practice preservation or stewardship of natural resources The measures to be introduced can be monitored and enforced in the same manner that other land use measures are implemented and thus are of a minimal cost to communities. The cost to the developer is likely to be minimal as most of the measures prohibit construction of residences in areas usually unsafe for development if delivering a quality product to a buyer is a priority

Statement of the problem

There is a great deal of literature available on "sustainable" or "green" development practices, which work to minimize urban runoff to a large degree through their design (Arendt Conservation 41) However, there are few studies that discuss how land use measures at the county or city level can serve the goals of the Clean Water Act of 1972 (Public Law 92-500) and the Water Quality Act of 1987 (Public Law 100-4), which call for the cleaning up and elimination of pollution in our nation's waterways In essence, there is no practical or "hand's on" guide that county or city agencies can employ in an attempt to satisfy the implied requirements of federal and state regulations using land use measures Apart from requirements contained in the Clean Water Act, the Phase 1 and

Phase 2 storm water rulings put forth by the Environmental Protection Agency (EPA) in the Water Quality Act of 1987 make the issue addressed in this paper particularly relevant The EPA's Phase 1 and Phase 2 storm water rulings require all cities to have a permitted storm water conveyance system (more commonly known as an "MS4 system" which conveys storm water only) (Dodson· 8 – 17) In the Phase 1 ruling, cities with populations of 100,000 or greater must have their MS4 systems permitted. In Phase 2, cities with populations below 100,000 must also have approved systems and attempt to minimize urban runoff with "Best Management Practices" (BMP), which could include land use measures The term BMP refers to water pollution prevention and is defined as "Methods that have been determined to be the most effective, practical means of preventing or reducing pollution from storm water runoff These include schedules of activities, prohibitions of practices, maintenance procedures, and other management practices " (Dodson· 474) Furthermore, the EPA emphasizes the use of BMP's that qualify as "source reduction measures" or practices that work to minimize contaminants from entering waterways to begin with (Dodson 155) Because of this, land use measures that work to control sediment loading of waterways or minimize such loading, are considered to be adequate BMP's

Phase 1 cities are also under obligation to pursue BMP's, however, most cities of Phase 1 size have operable MS4's compared to Phase 2 cities, which might not have the capital to upgrade or develop sizable storm water conveyance systems From a regulatory perspective, usage of non-engineered solutions to solve the problem of urban runoff are encouraged and are of great value to cities falling under the Phase 2 ruling However, the

benefits arising from adoption of land use measures are a slow process and not a short-term solution to the problem

The term "urban runoff" and "storm water discharges" are used frequently and both largely have the same definition Urban runoff refers to storm water that has traveled across parking lots or other impervious surfaces (streets, sidewalks, driveways and other parking areas) and vegetated areas (primarily lawns), and is then discharged into water bodies or storm water sewer systems (Pielou· 47) Environmental problems arise as storm water traveling across impervious surfaces or disturbed soil areas picks up both organic and inorganic contaminants and discharges them into water bodies. Either form of contamination can have detrimental effects on aquatic life/water quality. This problem is addressed, along with specific toxins and chemicals carried by urban runoff, and discussed at length in the thesis

Legal restrictions on how land can be used (developed) can have an impact if designed to allow organic and inorganic contaminants to be naturally deposited outside of riparian areas or to forbid development on soils that are unstable or with steep slopes (Pielou 36)

The intent of this thesis is to review the literature and other relevant resources in order to design a framework to describe a) regulations regarding water quality as it relates to urban runoff, b) land use measures that can be adopted by communities to minimize the effects of urban runoff, and, c) inventory of existing land use regulations that address the issue of urban runoff in the counties of Sevier and Blount, Tennessee and

the larger urban areas contained in these counties The outcomes of this study will include

1 An analysis of federal and state water quality policy and how it relates to local land use measures

2 A list of land use measures or concepts that strike a balance of responsibility between developer and governing agency.

3 A matrix of land use ordinances that can be used to ascertain a county's or a city's level of compliance with federal and state water quality regulation thru the presence of adequate measures to help mitigate the problem of urban runoff The three types of ordinances surveyed will be subdivision regulations, general land use plans and landscape ordinances. All three of these policy tools could be used by a community to address urban runoff in some way As will be seen, some are in place in the two sample communities, however, most are not

4 An inventory and analysis of the land use measures of both Sevier and Blount Counties and their contained communities in the State of Tennessee This inventory and analysis will utilize the prepared matrix and contrast land use measures found with those outlined in this thesis

As stated previously, no literature has been identified to date that suggests that land use policy can in itself solve the urban runoff problem However, the measures suggested in this thesis are all common in environmental design literature that stresses "sustainable" development with minimum impact to the environment This body of work is sometimes referred to as "conservation design " A leading representative of this work

is the author Randall Arendt who has written numerous books, most notably, *Growing Greener* (1999), *Rural by Design* (1994), *Conservation Design for Subdivisions* (1996) addressing the issue of making residential development more sustainable Karl Elfer's work, *Open Space and Urban Water Management* (1975), is unique in that he discusses elements that comprise what became popularized by Lane Kendig in his, *Performance Zoning* (1980) Most of the land use measures suggested in this paper fall into Kendig's definition of "performance zoning," in that they are clearly outlined and quantifiable zoning requirements Herein lies the crux of this thesis: in the context of growing federal and state policies, specific zoning measures can be adopted at the city and county level to address the issue urban runoff

Thesis Concept

This thesis attempts to define and explain both federal and state water quality policies, in particular, those policies addressing the issue of urban or storm water runoff as related to residential development This explanation is followed by a discussion about land use measures that help minimize urban runoff The final portion of the thesis is a prepared matrix that is used to inventory the subdivision regulations, land use ordinances and landscape ordinances of the communities of Sevier and Blount counties in regard to land use measures that mitigate urban runoff, as outlined in the previous section Subdivision regulations are included as they often contain set-back regulations which *could* be used to establish riparian buffers, gradient maximums and impervious surface area maximums The general land use plan is often where environmental-oriented

ordinances are located, and all the measures developed in this paper could, potentially, be contained in a general land use plan. Landscape ordinances are adopted land use measures that are specific to issues related to landscape such as plantings, buffer areas and restrictions If a landscape ordinance is developed with stipulations beyond planting and aesthetic requirements, it can often limit soil disturbance (example: tree ordinances) and require buffers around impervious surface areas (parking lots), which can help limit urban runoff The conclusions section evaluates whether or not sufficient land use measures are in place to mitigate urban runoff in the communities inventoried

Primary Research Question

What land use measures exist that can help mitigate urban runoff and thus facilitate compliance with federal and state regulations regarding water quality and are adoptable at the county or city level?

Secondary Research Questions

Are the policies adopted at the federal and state level regarding water quality mirrored in county or city land use ordinances?

Are ordinances that mitigate urban runoff in keeping with the principles of "smart development" or what is commonly known as "smart growth?"

Methodology

The research method utilized in this thesis was primarily that of reviewing literature and policy The initial investigation focused on understanding federal and state water quality policy and the questions subsequently raised and explored in this thesis Related journal articles, books, various federal, state and county/city documents and internet resources were reviewed in the fields of environmental policy, ecology, hydrology as they relate to storm water or urban runoff, land development, land use planning, policy and law

Once a wide array of material was researched and reviewed, considerable reflection and synthesis of materials ensued to identify recurring themes and fundamental needs Once recurring themes were identified, further research was conducted to develop possible alternative solutions to the needs identified in the context of the recurring themes Once identified, these alternatives or solutions were researched and developed into an abstract concept or matrix posed as the thrust of this thesis in an effort to address the fundamental needs discovered in the initial, and previously mentioned, phase of discovery

Relationship to planning

This topic presents an opportunity for land use planning to be used directly in solving an environmental problem More importantly, the environmental problem is directly related to land use That is, the issue of urban runoff is a land use issue and should be solved in part with land use measures This thesis attempts to demonstrate how

land use measures can be used to satisfy federal and state environmental regulations that are attempting to address what will be an even greater problem should urbanization trends continue

Limitations

There are certain limitations to this thesis given the level and depth of research afforded by a master's thesis This thesis does not represent an absolute or in-depth search of the literature available, but rather it provides a broad overview of the various related fields relevant to the subject addressed Certain areas of this thesis were investigated more thoroughly than other areas

This thesis is somewhat theoretical, and therefore in no way makes claims of absolute truths for any of the concepts proposed herein It is the inherent nature and consequent definition of concepts that they are not to be absolutes These concepts therefore attempt to make the most logical deductions possible with the information gathered in the research process Additional limitations of this thesis are as follows

- Infrastructure, design or engineered solutions to the problems associated with storm water are beyond the scope of this thesis The focus of this thesis is on policy solutions related to land use measures, which are generally non-technical in scope and description
- The area of study for the matrix will be Sevier and Blount counties of East Tennessee, and the larger communities contained within, which are a part of the West Prong and Middle Prong of the Little Pigeon River and the Little River

- A major focus of this thesis is residential development, however, there are applications to commercial development as well
- The land use measures presented here will not be compared or analyzed from a value-added approach The measures are suggested based on their established validity and no attempt is made to quantify the benefits or costs associated with these measures Furthermore, the mechanics of how the proposed measures work to mitigate urban runoff is beyond the scope of this thesis Most of the measures proposed require an understanding of underlying variables (such as types of soil, vegetation and geomorphology of riparian areas) in order to determine both the process by which contaminants are mitigated and what measures are appropriate to use Because most of these measures are then "site-specific" in their applicability, defining the process of the measures in mitigating contamination is beyond the scope of this thesis.
- In many ways, this thesis is a "work in progress" in that it initiates discussion of utilizing land use measures to help solve the problem of urban runoff In this regard, the concepts outlined in this thesis are more of a policy-review nature in hopes of helping stimulate advocacy in addressing the growing problem of urban runoff This advocacy approach is contrasted to that of a more investigative or scientific analysis of the benefits of the land use measures presented Also, the problem of urban runoff is, at the date of this writing, just beginning to be addressed from a regulatory perspective Unless a detailed analysis has been conducted of the contribution of point and nonpoint pollution sources to surface

water quality in a watershed, there is generally an absence of quantitative data that explains the problem as a whole in a numerical manner or specific plan of resolution Thus, the intent of this thesis is to capitalize on the fact that regulatory efforts have been made to curtail urban runoff and that this focus constitutes validity that there is indeed a problem In addition, it is hoped that this thesis will contribute to the dialogue that land use measures be advocated to address the problem of urban runoff.

CHAPTER TWO

Federal and State Water Quality Policy

Introduction

The following chapter develops the basic concepts of the Federal Water Pollution Control Act of 1972, more commonly known as the Clean Water Act, and its subsequent amendments, which combined represent the governing policy for maintaining water quality in our nation's waterways Particular attention will be paid to the state counterpart regulation as written by the Tennessee Legislature and its consequent implementation by the Tennessee Department of Environment and Conservation.

The interrelationship between Federal and State water quality regulation is a fundamental basis of both the Clean Water Act of 1972 and our nation's water quality policy As will be seen, the federal regulations largely govern the powers of the state in defining water quality standards and regulations However, implementation of the various federal programs are the duty of the state As a result, state environmental agencies are often at the forefront of environmental protection

Water quality policy in this country has evolved since 1972 to encompass more than the original intent of the Clean Water Act As the growth of urbanized areas has changed the landscape of the United States, so have the policies that protect the workings of our natural environment The notion of environmental policy, in particular relation to water quality policy, is not a static concept nor should it be construed as having

adequately addressed the impact of human beings on their environment In this regard, an analysis of water quality policy demonstrates how both federal and state entities can provide a national basis of regulation that protects both the condition and use of our natural environment.

Overview of the Clean Water Act of 1972

The degradation of our nation's waterways reached its peak in the latter part of the 1960's and early 1970's when events like the Cuyahoga River catching on fire, the level of pollution in Boston Harbor and a major oil spill in Southern California became regular headlines The health of our nation's waterways became an increasing concern and caught the attention of both legislators and the public.

The tasks of cleaning up the nation's waterways and establishing a framework of regulation to keep them clean was immense. Yet, in 1972 Congress passed the Federal Water Pollution Control Act, more commonly known as the Clean Water Act (CWA) and the arduous task of addressing the nation's water pollution problem was underway

In the midst of the sweeping environmental legislation of the early 1970's, a new agency was created to facilitate the agenda of cleaner water and air· the Environmental Protection Agency (EPA) From the beginning, it was clear that Congress wanted the regulations to be created and enforced from a federal level, however, implementation of the various programs was left to the discretion of the states Consequently, all states were required to adopt a form of the CWA and establish both the agencies and programs mandated from the federal level Michael Olexa (1999), in his paper entitled "Laws

Governing Use and Impact of Agricultural Chemicals," provides an elaboration of this point

"The object of the Act is to restore and maintain the chemical, physical, and biological integrity of the nation's water and to eventually eliminate the discharge of pollutants altogether The Clean Water Act establishes three categories of pollution sources point sources, non-point sources, and dredge and fill operations "

Appropriated under the CWA were numerous municipal grants, which helped somewhat to alleviate the burden for the states of complying with the mandates of the CWA However, many states viewed the CWA as an unfunded mandate and, as a result, most attempted only to comply with the CWA and not go beyond federal requirements. This fact should not be interpreted as a negative or negligent action by the states, but instead it demonstrates that the CWA has represented the bulk of water quality law/policy for most states for the past 25 years Some states, such as Tennessee, expanded somewhat the scope of CWA when they passed their state versions of the CWA. However, because of the vast resource requirements needed to implement the CWA, few states went beyond the call of duty required by the CWA and focused instead only on meeting federal requirements

National Pollution Discharge Elimination System (NPDES)

The major focus of the CWA was controlling "point source pollution" (PSP) which the Act defined in this way

"The term "point source" means any discernable, confined and discrete conveyance, including but not limited to any pipe, ditch, channel, tunnel, conduit, well, discrete fissure, container, rolling stock, concentrated animal feeding operation, or vessel or other floating craft, from which pollutants are or may be discharged This term does not include agricultural storm water discharges and return flows from irrigated agriculture " (Thompson· 17)

PSP represented what most thought at the time to be the greatest threat to our nation's waterways industrial polluters who discharged wastes into rivers, oceans and streams as part of the manufacturing processes Because it was the goal of the CWA to eliminate all PSP discharges by 1985, the National Pollution Discharge Elimination System or NPDES was developed, which called for all PSP discharges to be both permitted (and consequently monitored both by the polluter and state agency) and eventually eliminated It is now accepted that the goal of zero discharge is not going to happen anytime soon, however, much of the PSP problem that was common prior to passage of the CWA has been eliminated and/or controlled

The NPDES program also outlined basic permit principles, which laid the foundation for much of the success of the program.

- "Require whatever level of treatment or control necessary to comply with the most stringent of the Act's several types of discharge limitations
- Require any other actions or controls necessary to protect water quality (This relates to what are known as "Best Management Practices" or BMP)

- Require that permitted activities cease whenever necessary to comply with permit limits
- Require permittee to maintain and operate pollution control systems (including and necessary backup systems) in adequate condition to ensure compliance.
- Provide for the permit to be modified or revoked for cause
- Establish a duty to provide any information to the permitting agency necessary to determine if permit modification or revocation is in order
- Establish permission for entry for inspections
- Establish the type and frequency of monitoring and reporting required
- Spell out consequences of violations and require permittee to obtain a new permit or cease discharge before the permit expires " (The River Network 32 – 33)

How much of an effluent a permittee can discharge depends on both that particular permit application and the waters being discharged into. Understanding how much a waterway can handle in terms of effluent is discussed later in the concept of Total Maximum Daily Load (TMDL) However, there are two types of standards or requirements that determine effluent limitations·

Technology-Based Standards (TBS)· Simply, all permittees fall into a category of industrial discharge and that category has a maximum allowable amount of discharge set by EPA The term "technology-based" is used as it represents the level of technology a permittee must possess in order to be permitted and comply with CWA regardless of the receiving water Simply, an entity that could not control the amounts of pollutants discharged into a water would not qualify for a permit as they would exceed TBS TBS

discharges are usually described in terms of "maximum daily" or "monthly average" limitations In addition, most permits require submission of monthly Discharge Monitoring Reports (DMR) (The River Network. 33 – 35)

Water Quality-Based Requirements (WQBR). Granted, TBS regulates how much and what is discharged into waters, but one unknown variable remains how much a certain waterway can handle, given its volume, gradient, etc The notion of WQBR accommodates the fact that TBS-compliant discharges could still foul or damage a waterway beyond its natural ability to recover Individual states may vary the WQBR and the amount of pollutants allowed depending on what the water classification is for a particular body of water Water classifications –as they relate to the state of Tennessee- are contained elsewhere in this thesis. In establishing WQBR for a waterway, a state must attempt to do the following

1 Designate the use of the waterway by or for the public
2 Establish the appropriate Water Quality Criteria or WQBR
3 Develop and implement antidegradation policies and procedures Antidegradation policies imply that the water classification or designation can/will be maintained under the proposed level of discharges. (The River Network 34)

Total Maximum Daily Loads

The notion that there is sufficient technology and understanding of water bodies to develop measurements such as WQBR is the fundamental basis for establishing the formula known as Total Maximum Daily Load (TMDL) In the simplest of terms, TMDL

suggests that there is a maximum amount of pollutants a stream or river can handle and still function properly given its classification. Given that the original goal of the CWA was to eliminate *all* discharges by 1985, the suggestion could be made that TMDL has provided a "back door" exemption from the policy of discharge elimination Simply, TMDL's allow discharges to continue under the questionable assumption that science has developed sufficient understanding of what and how much effluent a waterway can handle. Many environmental groups have legally challenged the concept of TMDL's for this very reason as much of the evidence behind the concept does not conclusively support continued discharges and maintaining water quality levels. (The River Network· 19) Assuming the EPA is correct in its application of TMDL's, the formula has provided the philosophical basis for continuing to pollute waterways and subverting the goal of zero discharges (Jarrell: 28) Conceivably, the goal of attaining zero discharges seems almost extreme or burdensome (given the costs) if contrasted with the notion that waterways can receive pollutants and still function within man-made classifications that determine their role in the hydrological cycle Thus, given the license TMDL provides, the concept deserves study and understanding by both environmental groups and concerned communities

In its simplest terms, TMDL has been defined as "A watershed restoration plan for impaired water bodies. Many experts believe these plans (TMDL), provide the best hope for the clean-up and restoration of our most troubled waters " (The River Network· 81) "The maximum quantity of a pollutant that can enter a water body without adversely affecting the beneficial uses of the water body " (Jarrell. v) Thus, the TMDL is

a guideline for what level of contaminants are allowable, as well as a tool for getting a water body back on track for being used as a resource in the category to which it is assigned The 1998 305(b) report for Tennessee defines TMDL as follows "A Total Maximum Daily Load (TMDL) is a study that 1) quantifies the amount of a pollutant in a stream, 2) identifies the sources of the pollutant, 3) and recommends regulatory or other actions that may need to be taken in order to clean up the stream " (Tennessee 305(b) 60)

There is a direct link between TMDL's and the clean-up of a water body. Again, the Tennessee 305(b) suggests the following actions once a TMDL has been implemented.

- "Re-allocate limits on the sources of pollutants documented as impacting streams It might be necessary to lower the amount of pollutants being discharged under NPDES permits or to require the installation of other control measures, if necessary, to insure that standards will be met
- Cooperate with other state and federal agencies that work directly with other sources on plans to achieve water quality standards, through techniques such as installation of appropriate Best Management Practices (BMP) " (Tennessee 305(b)· 60)

An interesting point is also made regarding TMDL's in the 1998 305(b) report "TMDL development is not considered appropriate for all bodies of water on the 303(d) list (the list for impaired waters in a state) If enforcement has already been taken and a compliance schedule has been developed, or if best management practices have already been installed for non-regulated activities, the TMDL is considered not applicable. In

cases involving pollution sources in other states that flows into Tennessee, the recommendation may be that another state or EPA develop the TMDL " (Tennessee· 305(b)· 60)

Clearly, all impaired waters do not receive a TMDL if the problem is of a nature that can be solved without the formal regime of a TMDL This unusual element in the TMDL process is noted, as it is a factor in understanding water quality policy as it relates to the state level Simply, not all listed waterways get a TMDL, however, this can often mean that the underlying causes of contamination are not addressed in a manner that water quality improvement is likely to occur. Also, from the previous citation, it is clear that establishing a TMDL is not the first approach in cleaning up a contaminated water body TMDL's are expensive to prepare, given their level of detail, and quite time-consuming, given their broad scope As mentioned previously, many environmental groups challenge the notion of TMDL's as an effective way of mitigating water quality problems (The River Network: 23) Another factor is that once a TMDL is approved by the EPA, the state is obligated to fulfill the objective of cleaning up a water body in the context outlined Many states resist such levels of effort and often do not prepare a TMDL on a water body unless it is so impaired that it makes the state's list of impaired waters and there are little signs of improvement

Assuming that a waterway is functioning within its assigned water-use classification, then the permitted discharges continue to be allowed with the oversight of testing For those waterways that have been tested and are deemed "impaired" or polluted beyond the level allowed under their water-use classification, a TMDL is prepared in an

attempt to establish a strategy to bring the waterway back into performance, with the exception of those waterways falling into the previously cited category of being impaired but not in need of a TMDL The concept of TMDL is established in section 303 of the CWA, which addresses impaired waters Contained also in section 303 is the requirement that all impaired waterways be "listed" on what is commonly known as the "303-d list," which means they have been deemed polluted beyond their classification and must be restored through the TMDL system.

The EPA lists seven components for their TMDL program:

1) Target identification what is the problem and how can it be quantified?
2) Identification of current deviation from the target or the level of pollution reduction necessary to meet the target how different are current conditions from desired conditions?
3) Source identification where is the pollution coming from?
4) Allocation of pollutant loads (or an alternative providing an equivalent demonstration of attainability of standards)
5) Implementation plan how will TMDL standards be achieved?
6) Process for monitoring/assessment of effectiveness. is the implementation plan working?
7) Process for TMDL revision after data come in from BMP (Best Management Practices) implementation and monitoring, are revisions in the TMDL justified? (Jarrell 2)

The formula for TMDL is as follows

Sum of Waste Load Allocations (WLA)

+ Sum of Load Allocations (LA)

+ Background Loads (BL)

+ Margin of Safety (MOS)

= Total Maximum Daily Load (Jarrell 2)

Definitions

Waste Load Allocations (WLA) WLA are those permitted point source pollution (PSP) discharges entering a water body daily

Load Allocations (LA) LA are those nonpoint (to be discussed later in this paper) sources of pollution entering a water body daily

Background Loads (BL): "Loads of naturally occurring materials that would have entered the water body prior to disturbance of the watershed by human activities For example, phosphorus derived from the natural rocks in a watershed provides the native vegetation with their nutrient P requirement " (Jarrell iv)

Margin of Safety (MOS) MOS represents an "error" factor of sorts or allows for uncertainty in the calculations of both WLA and LA

Typical parameters for a TMDL might include establishing limitations on the following contaminants

- Total phosphorus (TP)
- Ammonia/ammonium
- Total suspended solids (TSS – total particles suspended in the water)
- Total dissolved solids (TDS – salts dissolved in water)

- Temperature
- Pathogens (fecal coliform and bacteria)
- Pesticides
- Nitrate
- Habitat Alteration/Modification turbidity and TSS pollution due to dams, dredging, channelization, ditching, housing developments, highway construction and maintenance, and count operations
- Biochemical Oxygen Demand (BOD)
- Low Dissolved Oxygen (DO)
- Metals
- pH
- Sulfates
- Legacy Pollutants chlordane, mercury, and dieldrin Legacy pollutants hopefully are no longer being generated or discharged directly into water bodies although some legacy pollutants are being deposited via the atmosphere

(Jarrell iv, v)

Tennessee Water Quality Standards and Classifications

As mentioned previously, each state choosing to undertake the mandates of the CWA adopted their own water quality legislation The term "choose" is used as some states refused to take responsibility for adopting CWA programs (which was allowed under the legislation) and as a result the EPA has implemented programs on those states

behalf (The River Network 8) Because the states were given a federal mandate to comply with, state legislation often repeats federal regulations and in some cases adds individual programs that enhance or expand the federal demands. The Tennessee Water Quality Control Act of 1977 states

"Recognizing that the waters of Tennessee are the property of the state and are held in public trust for the use of the people of the state, it is declared to be the public policy of Tennessee that the people of Tennessee have a right to unpolluted waters

In the exercise of its public trust of the waters of the state, the government of Tennessee has an obligation to take all prudent steps to secure, protect, and preserve this right " (Tennessee TWQCA 69-3-102)

An example of program expansion is found in the Tennessee Water Quality Control Act of 1977, which establishes the ARAP (Aquatic Resource Alteration Permit) program which requires permits for any "physical disturbance" to bodies of water (dams, channel alteration, ect) Tennessee is one of the few states to adopt such a measure addressing the effects of physical disturbance This example demonstrates the importance of understanding both state and federal law when analyzing water quality policy of a state

Every two years, states must submit a report to Congress regarding the condition of its waters the 305(b) report Included within this report are those waters that are listed as impaired and on the previously mentioned 303-d list The most recent 305(b) report for the state of Tennessee states the following goals

- Assess the general water quality conditions of rivers, streams, lakes, and wetlands
- Identify the causes of water pollution and the sources of pollutants
- Specify waters which have been found to pose human-health risks due to elevated bacteria levels or contamination of fish
- Highlight areas of improved water quality

The Tennessee Water Quality Control Board is responsible for declaring designations in compliance with the CWA Presently in Tennessee there are seven basic water classifications per the 305 (b) report

Fish and Aquatic Life (FAL)· FAL criteria prevent toxicity to aquatic life. These criteria come in two forms acute criteria, the level of a contaminant that causes death in organisms in a relatively short time and; chronic criteria, a lower level that may cause death over a longer period of time, or might have other effects such as reproductive failure. Some of these criteria are specific to trout waters, due to the sensitivity of trout species

Recreation The use of streams for swimming and fishing is protected by these criteria, which are established to prevent excessive bacteria in the water and buildup of toxic materials in fish Fecal coliform has historically been chosen as the indicator of contamination in streams The fecal coliform criteria is 200 colonies per 100 ml of water, as a geometric mean of ten or more samples Other recreational criteria prevent metals or organic compounds from accumulating in fish flesh to the point that an advisory might be necessary

Drinking Water Supply Drinking water criteria insure that the waters are free of substances that might cause a public health threat if a treatment facility is unable to remove them Additionally, contaminants are often difficult to remove during the water treatment process, so keeping them out of the water reduces the cost of treatment

Irrigation Irrigation criteria protect the quality of water so it may be used for agriculture

Industrial Water Supply: These criteria protect the quality of water used for industrial purposes

Livestock Watering and Wildlife Ecological effects to wildlife and farm animals are prevented by implementation of these criteria

Navigation Stream alterations that might impact commercial navigation within streams and lakes is prevented through these criteria.

Water bodies that are assessed fall into one of three categories as outlined in the cited 1998 Tennessee 305(b) report:

Fully Supporting Fully supporting water bodies have water quality as good or better than that needed to support the designated uses assigned to it by the Water Quality Control Board Most streams in Tennessee fall into this category

Partially Supporting Partially supporting water bodies are somewhat impacted by pollution and water quality criteria are exceeded on a regular basis Water quality is considered moderately impacted Significant differences may be noted when biological communities at partially supporting streams are compared with those at unimpacted sites

Not Supporting Not supporting water bodies are highly impacted by pollution and water quality criteria are exceeded frequently Water quality is considered severely impacted

and substantial differences in biological communities are noted when compared to unimpacted sites

Per the most recent (1998) 305(b) report, a summary of those waterways complying with their designation is seen in the previous table. Table 2-1 begins with those designations having the most restrictions on pollutants and ends with those categories with limited water quality requirements, which might explain the higher rate of supporting use in the categories that have fewer restrictions This conclusion is drawn from analysis of the requirements for each of the classifications found in Table 2-2,

TABLE 2-1 Water body classifications and compliance

Classification:	% of River Miles Fully Supporting Uses
Fish and Aquatic Life	76 9%
Recreation	95 3%
Domestic Water Supply	99 2%
Irrigation	100%
Livestock Watering & Wildlife	100%
Navigation	100%

Source Tennessee 305(b) 55

which details the Ph, dissolved oxygen, maximum temperature and fecal coliform standards

In general terms, the most stringent standard is FAL as it has a slightly narrower pH band, however, the Recreational classification allows less fecal coliform All categories (with the exception of Navigation, which has no restrictions) limit Ph in range and require that dissolved oxygen levels not drop to levels that odors become apparent. Those waters having largely human contact also restrict fecal coliform levels

TABLE 2-2 Tennessee Water Quality Standards per Classification

Classification	PH	Dissolved O2	Max Temp	Fecal Coliform
Domestic Water	6 0 – 9 0	Prevent Odors	30.5 C	1000/100 – mean 5000/100 – max
Industrial	6 0 – 9 0	Prevent Odors	30 5 C	N/A
FAL	6.0 – 8 5	Prevent Odors	30.5 C	1000/100 – mean 5000/100 – max
Recreational	6 0 – 9 0	Prevent Odors	30.5 C	200/100 – mean 1000/100 – max
Irrigation	6.0 – 9 0	Prevent Odors	N/A	N/A
Livestock	6.0 – 9 0	Prevent Odors	N/A	N/A
Navigation	N/A	N/A	N/A	N/A

Source Tennessee. 305(b) 53

Per the Tennessee 305(b) report, 6.8% of river miles fall into the "Not Supporting" category and would be addressed in the 303(d) list 16 9% of Lakes in Tennessee fall into the "Not Supporting" category and would be addressed in the 303(d) list as well Although not attached to the 305(b) report, a TMDL has been prepared for each of these impaired waters and is in turn monitored by the Tennessee Department of Environment and Conservation or TDEC. It should be noted that according to the 1998 Tennessee 305(b) report, 17% of rivers and streams are "evaluated" which implies they are "assessed using data more than five years old or those assessments based on special data, such as land use, watershed information, and predictive models " (Tennessee· 305(b) 4) While the remaining 83% are "monitored" which entails using "current data less than five years old, including fixed-station ambient, intensive surveys, NPDES compliance sampling, or biological monitoring " (Tennessee 305(b) 4) It is interesting to note the level or percent of monitored assessments for rivers for the past 10 years

according to the 305(b) report has increased from 37 percent in 1990 to 83 percent in 1998 TDEC attributes the substantial increase to other agencies, mainly the Tennessee Valley Authority (TVA), for their increased monitoring efforts In regard to lakes, 0.7% are evaluated and 99 3% are monitored according to the 305(b) report

Contained in the 1998 305(b) report is a lengthy discussion regarding both the nature and source of pollutants in the waters of Tennessee This data is summarized in the following tables, however, what is interesting is the impact of sediments on the conditions of Tennessee water bodies Because of the strong association between urban runoff and siltation or sediment loading, it is clear that the problem of runoff is a major source of contamination for the state's rivers and lakes Also, the impact of soil disturbance is dependent on soil type and its propensity for erosion or instability Table 2 – 3 shows the major relative causes of river water quality impairment. In the 305 (b) report, the following is stated in reference to causes of pollution in rivers

"While no single cause of river impairment is dominant, conventional pollutants such as siltation, suspended solids, nutrient enrichment and organic enrichment/low dissolved oxygen affect the most river miles Major sources of these pollutants are agricultural activities, hydromodification, as well as municipal point sources Other sources of impairment include urban runoff/storm sewers, construction activities, and industrial point sources " (Tennessee.305(b)· 39)

TABLE 2-3 Major Relative Causes of River Impairment:

Siltation/Suspended Solids	38%
Hydraulic Modifications	15%
Toxic Pollutants	11%
Pathogens	11%
Org Enrichment/Low DO	11%

Source Tennessee 305(b) 40

Table 2-3 shows that siltation and suspended solids combined represent 38 percent or well over a third of the problems with rivers not meeting water quality standards The 305(b) report provides some insight into how these contaminants affect water quality "Silt and suspended solids impact streams by blocking light penetration and smothering aquatic life " (Tennessee 305(b) 39) Thus, the issue of siltation/suspended solids, which is a major component of urban runoff, has an effect on aquatic life and, in turn, water quality and is a leading cause of river impairment This statistic bolsters the argument that taking steps to limit sediment loading of waterways is an appropriate goal for improving the water quality of Tennessee waterways

In terms of the causes of lake impairments, a major source of contaminants are PCB's other inorganic pollutants (mostly mercury) which comprise roughly 48 percent of major relative causes of lake impairment per table 2-4 Siltation and suspended solids are 15 percent of major relative causes

TABLE 2-4 Major Relative Causes of Lake Impairment:

PCB's	29%
Inorganic Pollutants	18%
Siltation/Suspended Solids	15%
Nutrients	11%

Source Tennessee 305(b) 25

Nonpoint Source Pollution

The primary focus of the CWA was to put control measures into place that addressed the growing problem of PSP By the early 1980's, it was widely believed that NPDES had managed PSP to a level that appeared to be heading towards the goal of zero discharge by 1985 However, as 1985 approached, it became clear that a zero discharge condition in the nation's waterways was not attainable for the time being Congress revisited the CWA and amended it somewhat with the 1987 Water Quality Act (WQA). However, given the successes of managing PSP, a new emphasis was placed on nonpoint source pollution

The CWA in section 102(a) required "comprehensive" programs that dealt with all types of pollution that entered into the nations waterways. In section 201(c) of the CWA, mention is made of the nonpoint problem; however, PSP was the primary focus of the CWA

"To the extent practicable, waste treatment management shall be on an area wide basis and provide control or treatment of all point and nonpoint sources of pollution, including in place or accumulated pollution sources " (Thompson· 14 – 17)

The term "nonpoint" is somewhat curious in that it means any pollutant that is not from a particular or "point" source. This category would include: agriculture, silviculture, mining, construction, salt-water intrusion, land and subsurface disposal of pollutants (Thompson 19) However, the greatest threat comes from what is classified as "urban runoff " The categories of principal urban runoff contaminates are provided in Table 2-5

TABLE 2-5 Principal Urban Runoff Contaminates

Category	Examples
Metals	Zinc, cadmium, copper, chromium, arsenic, lead
Organic chemicals	Pesticides, oil, gasoline, grease
Pathogens	Viruses, bacteria, protozoa
Nutrients	Nitrogen, phosphorous
Biochemical Oxygen Demand (BOD)	Grass clippings, fallen leaves, hydrocarbons, human/animal waste
Sediment	Sand, soil and silt
Salts	Sodium chloride, calcium chloride

(NRDC Storm water . 2 8)

and give several examples of pollutants that could enter waterways from runoff of a residential area

A comparison between principal urban runoff contaminants and major relative causes of river and lake impairment shows strong similarity In particular, urban runoff poses a real threat due to the amount of sediment and nutrients (particularly phosphorous) that can be delivered into a waterway after a storm event (Jarrell 3)

Nutrient Standards

It should be noted that in a federal act known as the Clean Water Action Plan of 1998, the EPA is given until December 31, 2003 to develop a list of nutrient loads (particularly nitrogen, phosphorus, chlorophyll-a) that will be added to existing water quality standards and consequently enforced Turbidity, although not a nutrient, is also a part of the proposed nutrient standard listing and is included as it is often an indicator of high levels of nutrients The addition of nutrient standards will more than likely lead to new additions to state 303(d) lists (Jarrell vi) These likely additions (particularly that of

turbidity, which arises from soil erosion and nitrogen/phosphorous that can come from yard wastes) are critical to the issue addressed in this paper of what needs to be done on the county level, possibly through land use measures to meet state and federal standards With the inclusion of nutrients, a tightening of water standards as they relate to urban runoff appears to be on the horizon The question then becomes whether county/city governments will be forced to employ "Best Management Practices" or BMP's via land use ordinances in order to contain urban runoff contaminants. Another important issue, assuming that nutrient standards are passed, is what measures, other than land use measures can be used to limit urban runoff? Given the nature of the problem of urban runoff and given the fact that the funds available to address it are limited, it is important to find cost-effective ways to deal with urban runoff. This point is made to suggest the validity of using land use measures to minimize nonpoint contamination if standards are tightened with the inclusion of nutrient standards

Nonpoint Source-Specific Legislation

A major focus of the 1987 amendment was section 319, which instructed states to address the issue of toxic runoffs that discharged into waterways. In some ways, this was good news, in that a consensus existed that PSP was being dealt with in an efficient manner and that other problems could now receive attention. The problem of "nonpoint source pollution" (NPSP) had been known and acknowledged in the CWA, however, it was felt to be the lesser of evils at that time. With the 1987 Water Quality Act, states

were also ordered to address the problem of municipal and industrial storm water runoff commonly referred to as Phase 1 and Phase 2 Rulings

Phase 1 and Phase 2 Storm water Regulations

The urban runoff threat exists not only in the pollutants that could flush directly from a construction site, neighborhood or industrial site into a stream, creek or river, but from municipal storm sewer systems Storm sewer systems that convey storm water only are known as "MS4" systems and are regulated under the 1987 WQA amendment Given that many communities utilize creeks and streams as means of storm water conveyance, these waterways now come under greater scrutiny in terms of water quality. In addition, the new regulations in essence call for minimizing runoff from developed sites into waterways Given the possibility of adoption of nutrient standards, areas of residential development could quickly become major sources of contamination. The intent of the Phase 1 and Phase 2 rulings are to clean up MS4 systems which in turn means minimizing urban runoff

Under WQA, MS4 systems in cities with populations over 100,000 were included under the first phase of the NPDES storm water program (commonly known as "Phase 1") which were adopted in the mid-90's Cities with populations below 100,000 fall into the Phase 2 category. Congress had mandated that the second phase of the program (which addressed the remaining MS4 systems) be in place by 1992, but several extensions were allowed (despite lawsuits by environmental groups attempting to prevent the extensions) In 1997, an interim draft of the phase 2 standards was released (NRDC Storm water . 2 3)

In reviewing the measures implemented under the Phase 2 Proposed rulings, one sees a greater emphasis on eliminating urban runoff than in the Phase 1 ruling In the Phase 2 rulings, for example, the size of construction sites requiring discharge permits is decreased from five acres to one acres Indeed, much of the resistance to the Phase 2 ruling was the requirement that sites of soil disturbance between the acreage of 5 and 1 acres be included under NPDES regulations Prior to the Phase 2 ruling, only sites in excess of 5 acres required permits In addition, most of the improvements made under Phase 2 focus on greater community participation as well as addressing the notion that storm water issues are watershed related issues and should viewed in that context An EPA document outlining the Phase 2 ruling describes its goal· "to preserve, protect, and improve the Nation's water resources from polluted storm water runoff" (EPA 1) Indeed when the reduction in acreage is considered along with greater community participation, it is evident that Phase 2 should bring about needed change in addressing the issue of urban runoff

The Phase 1 and Phase 2 rulings by the EPA are quite complex and particularly germane to the issues addressed in this paper where they call for storm water discharge permits on construction sites and MS4 systems Because of the obvious impact associated with these increased regulations -which will require more permits and oversight of construction sites- it is hoped by both environmental groups and the EPA that progress will be made in limiting urban runoff by city and counties as well as by land developers

City and County Government Urban Runoff Issues

The larger picture of the Phase 1 and Phase 2 rulings concerns the permitting of MS4 storm water systems and the regulation of contaminant loads being discharged from these systems Because most municipalities (with the adoption of the Phase 2 ruling) now must have permits for their storm water discharges, the issue of urban runoff becomes a priority for city and county governments The need to minimize construction site discharges is particularly relevant to the regulation of city or county storm water systems as such sites are a major source of soil disturbance In addition, because of the area required in residential developments compared with commercial developments, and, the fact that most residential developments exceed 5 acres or at least 1 acre, it is likely that communities will need to place constraints on the subdivision and development of land for residential purposes in order to minimize soil erosion and resulting urban runoff to be carried by city or county storm sewerage systems

In a research project conducted by the Tennessee Water Resources Research Center and the University of Tennessee's Civil and Environmental Engineering Department, technical and non-technical storm water decision-makers were polled in an attempt to better understand the problem of urban runoff in Tennessee (Gangaware, et al 2) Seventy-eight cities in Tennessee with populations in excess of 5,000 were polled with an 80 percent response rate for non-technical (largely elected officials or county executives) and a 56 percent response rate for technical storm water decision makers On water quality issues, the survey found that non-technical respondents ranked illegal dumping as the most important problem followed by impervious surface areas, and

eroding streambanks as the second and third ranked contributors respectively. Technical respondents ranked construction runoff as the greatest problem with impervious areas and illegal dumping second and third

However, an interesting disparity emerges when the respondents were asked about regulatory tools that should be used to mitigate the problem of urban runoff. Non-technical respondents tended to see federal and state regulations as the primary tool. Responses to complaints or litigation and land use controls ranked second Technical respondents cited subdivision regulations as the most important tool with floodplain zones, zoning ordinances and building codes all nearly tied as a second-place responses. What is interesting in the disparity of responses is that the non-technical respondents, largely elected officials, cited federal and state regulations as a primary tool for combating the problem of urban runoff with complaints and land use measures a far second. Yet, the technical respondents saw land use measures as the primary way to control the problem. Taking things a step further, the technical respondents saw subdivision regulations or local city/county measures as primary tools for addressing storm water issues. This raises an interesting point regarding the question of why there aren't more land use ordinances passed, or utilized for that matter, to address the topic of urban runoff. Perhaps the mind-set of the elected city officials or county executives is that self-governance isn't a politically viable solution Or, perhaps there is not a real understanding by non-technical decision makers regarding the issue of urban runoff The previous are mere speculations, they are based on the fact that there is a discrepancy between responses of the two groups On a note of solidarity, both respondents agreed

that funding was the biggest barrier to addressing the problem of urban runoff (Gangaware, et al· 2 – 7)

The most important implication of the Phase 1 and Phase 2 regulations is that they directly address the topic of urban runoff above and beyond the context of conveyance systems. Simply, both phases give city and county governments a great deal of responsibility for minimizing the problem of urban runoff at the source. How does a county or city do this? As will be developed, there are numerous policy instruments in place that, if employed in the direction of mitigating urban runoff, could be quite effective Given the passage of the Phase 1 and 2 amendments, it appears that communities need to better address the problem of urban runoff It is possible perhaps that communities need to review existing regulations related to urban runoff (primarily soil erosion control regulations and in some cases a general storm water ordinances) as such existing regulations may not be working to the extent necessary to fulfill tighter regulation (for example, by including nutrients, particularly turbidity, as monitored substances) should they be passed at either the federal or state level and enforced.

Wetlands As Protected Under the Clean Water Act

Wetlands are covered under the CWA in section 404, which allows for the discharge of dredge or fill material into the nation's waters only if permitted by the U S Army Corp of Engineers. Areas known as "Special Aquatic Sites" are afforded special protection under section 404 and are largely defined as areas where terrestrial and aquatic environments interface Examples of Special Aquatic Sites as outlined in section 404 are as follows

- Sanctuaries and refuges
- Wetlands
- Mud flats
- Vegetated shallows
- Coral reefs
- Riffle and pool complexes

(The River Network· 96)

If an activity permitted by the U.S Army Corp of Engineers falls into a section 404 category, then certification must be made that clarifies that the activity is not in violation of section 404 Because section 401 of the CWA requires states to certify that federal permits do not violate standards, the certification is often called "401 certification " In areas where wetlands are threatened by development, citizen review of 401 certifications, expiring related discharge applications, and activities that should have 401 certification (and may or may not have 401 certification) is critical Citizen review of areas covered under section 404 can often lead to the possibility of legal action being taken by citizen-plaintiffs to enforce the various aspects of section 401/404 compliance (The River Network 94 – 99)

In more rural settings, the Food Security Act of 1985, which provides for what is more commonly known as the "Swamp Buster Provision" may apply. Under the Swamp Buster Provision, which is implemented by the USDA through the Natural Resources Conservation Service and the Agricultural Stabilization and Conservation Service, wetland degradation is protected by denial of agricultural subsidies to qualified producers

who have engaged in the conversion of wetlands (draining, dredging or filling) for agricultural production. (Olexa 6 – 8)

The inclusion of wetlands is made as many creeks, rivers and lakes have adjacent wetlands and their protection is clear from the regulations discussed As an aside, this reference is made as an example of when policy wants to clearly protect or minimize damage to a natural resource it can be done Critics of wetlands policy argue that the measures imposed are too rigid; however, such measures were implemented after years of self-policing or restraint by those developing wetlands and there being limited controls either available to or enforced by city or county planning agencies to minimize impact It is merely an observation that if measures are not taken to correct the problems contributing to urban runoff, then perhaps some form of federal legislation that protects riparian areas (beyond that of existing wetlands regulation) could be seen A further observation could be made that the Phase 1 and Phase 2 storm water rulings resemble a federal mandate to put into place policies that will minimize contributions to urban runoff

Citizen Suits Under the Clean Water Act

Under section 505 of the CWA, citizens are allowed to sue either the EPA, state agencies or alleged violators This was initially a highly contested aspect of the CWA because industry was afraid that a barrage of lawsuits would result However, the caveat that a suit can only be brought if the EPA has failed to take action against the alleged violator has kept litigation in this regard to a reasonable level In addition, the citizen-

plaintiff must document the alleged violation and give the EPA 60 days notice of intent to sue In the event of judgment, penalties are awarded but paid to the U.S Treasury instead of the plaintiff (The River Network 37)

This element of the CWA has been a source of contention for various industries who have been sued for alleged violations and is mentioned as there could be an opportunity under the Phase 2 Rulings for citizen groups to possibly file suit against those communities that are slow to fulfill the requirements outlined in Phase 2 (or for those Phase 1 communities not upholding the requirements of the ruling). More importantly, it could be argued that, in an attempt to fulfill BMP requirements, the absence of land use measures protecting the public from the nuisance of urban runoff could be a basis for legal action However, this is only an observation based on the amount of opposition to the rulings, as seen in the extensions, and it is too early in the implementation of the Phase 2 rulings for their to be an argument of non-compliance.

Summary

The following chapter has outlined the major legislation regarding water quality (particularly that of nonpoint source pollution) in the United States and certain key provisions adopted by the state of Tennessee regarding this matter Also, the issue of how city/county decision-makers think of the problem of urban runoff has been addressed

As discussed, under the Phase 1 and Phase 2 storm water rulings city and county governments will have to address the adequacy of their MS4 systems Perhaps a benefit of this introspection will be that land use measures will become more agreeable to city

and county decision-makers in addressing nonpoint source pollution as such measures are of little cost to implement versus the capital expenditures necessary to treat MS4 discharges By requiring city and county decision-makers to address this problem, it could be construed that the Phase 1 and Phase 2 storm water rulings could open the door for consideration of land use measures that minimize the loading of storm sewerage system and in turn address the problem of urban runoff

CHAPTER THREE

Land Use Measures That Help Mitigate Urban Runoff

Introduction

Federal and state mandates for cleaner waterways have grown to include discharges from MS4 storm sewer systems under the Phase 1 and Phase 2 rulings The Phase 1 and Phase 2 rulings in turn require city/counties to work to minimize the amount of urban runoff being deposited into streams, rivers and lakes as these waterways are often a major part of an area's storm sewer system. Residential developments are heavy users of storm sewer systems as well as often being a major contributor of urban runoff. The following section will develop understanding of land use ordinances or other related regulations that can help reduce levels of urban runoff in relation to residential development.

Section 208 of the CWA includes a land use planning provision that directs states to help clean up our nation's waters by utilizing land use planning processes The section calls for something akin to a watershed plan in that areas with significant water quality issues are to be addressed in a contextual, somewhat regional, manner According to a report prepared by the National Resource Defense Council, the section 208 planning process should result in

"a. Management programs which are capable of handling the long-term (twenty-year) sewage treatment needs of an area,. . .including sewage treatment plant construction, sludge management, and land treatment,

b. Regulatory programs (including land use requirements) to control runoff and other pollution associated with agriculture, mining, forestry, construction, and urban storm water;

c Regulatory programs to control the location, modification, and construction of any facilities that can result in water pollution,

d. Regulatory programs to protect groundwaters and prevent saltwater intrusion, and

e Other programs needed to achieve and maintain high-quality waters " (NRDC: Land Use 72 – 75)

The problem with the Section 208 provision is that many states resisted designating 208 areas and embracing the notion of the land use ordinance revision based on a federal dictum Several suits were brought to spur the EPA to get section 208 planning objectives off the ground, but Section 319 –which serves as the primary regulatory basis for nonpoint source pollution- became the primary emphasis for states in their attempts to minimize nonpoint source pollution because it was much easier to interpret and did not involve city/county involvement (NRDC Land Use· 70)

Consequently, there is little regulation regarding land use measures to mitigate urban runoff other than standard soil erosion control measures and requirements. As has been typical in environmental policy implementation, states are given a great deal of autonomy in developing measures to comply with federal environmental regulations

However, the EPA's requirement that soil disturbance sites of 1 acre or more (under the more recent Phase 2 ruling) and impending nutrient standards (which will put even more pressure on municipalities to clean up urban runoff into waterways) suggest that a more proactive stance is being taken by the federal government in addressing this matter Another view might be that the EPA is giving more support to state environmental agencies that have typically seen federal mandates somewhat weakened when adopted by state legislatures. Regardless of the motivation, the fact remains that there is an atmosphere of regulatory tightening in regard to the problem of urban runoff, and it is likely that some form of regulation utilizing land use practices could someday be made to address this growing environmental problem

A source utilized in this thesis is the Center for Watershed Protection or CWP, an organization which was founded in 1992 and works with "local, state, and federal government agencies (particularly the EPA) to provide objective and scientifically sound information on effective techniques to protect and restore urban watersheds " (www cwp org 9/30/00) A primary focus of the CWP is to find solutions to the urban runoff problem that are zoning or land use measure-based. The land use tools recommended by CWP are summarized as follows

- Develop minimum aquatic or riparian buffer zones/strips with a minimum of 100 feet in width
- Include floodplain, steep slopes, delineated wetlands and critical habitat areas in riparian buffer areas In essence, limit development in these areas in order to help minimize the problem of urban runoff

- Utilize "Open Space Development," which concentrates dwelling units in a compact area and allows undeveloped or "open" space elsewhere on the site The benefits and goals of Open Space Development are less impervious surface area and soil erosion potential meaning less loading of sediments into waterways. (www.cwp org 9/30/00)

Most of the land use measures discussed in this thesis reflect those outlined by the CWP, those outside of the CWP recommendation are submitted based on literature review

The term land use measures are used in this paper in a broad sense It is best defined in the capacity of any regulation or ordinance affecting the rights of a property owner in developing land primarily for residential use This definition is given because the term land use measures is applicable to those regulations commonly found in a general land use plan, a subdivision regulation, and landscape ordinances or provisions. The reason for this is that much of the current literature utilized in thesis did not distinguish between measures in relation to their source or whether their being located in a general plan or zoning ordinance Instead, measures were discussed without distinguishing their location of reference, as this is a point of questionable relevance per the literature consulted Case in point was the City of Maryville, which will be inventoried in chapter four of this thesis Maryville has combined subdivision regulations, zoning ordinances and land use plans all into one document pertinent to residential development in an effort to streamline the application process Furthermore, a general land use plan, as used in the context of this thesis, can also be used to imply the

zoning ordinances of a community as sometimes there is a distinction between general land use plans and the accompanying zoning ordinances Also, the term "landscape ordinance" is used to mean both a mandated ordinance or provision within the general land use plan that relate to landscape-related issues. This generality is made in an effort to establish that landscape-related regulations can be of benefit in addressing the problem of urban runoff regardless of where they are located Often, landscape regulations can be found in a ordinance that was passed to address specifically landscape concerns; or, landscape provisions contained within a general land use plan Either source (ordinance or provision) is applicable in addressing the problem of urban runoff

General land use plans, subdivision regulations and landscape ordinances limit in some fashion the rights of a landowner in the use of their land, but all three could also be used to implement federal and state mandates regarding improved water quality The author believes there should be a connection between environmental agendas set by the federal and state governments and how they are executed at the county/city level Such permeation to the local level are common when it comes to certain health codes and social agendas (anti-discrimination laws for example), however, there does not seem to be a significant connection between the local level and the federal and state governments regarding the policies relating to environmental problems.

As has been discussed, the CWA clearly intends to have some sort of planning element in containing the nonpoint or urban runoff problem, however, there is little evidence to suggest a connection between the CWA agenda and city/county planning

A part of this lack of connection is that land use ordinances are often a product of the community decision-making process. As a result, city/counties may resist having too much regulation and strive for the basics required to mitigate sanitary and health requirements On the other hand, some communities have embraced strong land use provisions that state with great detail what a developer can or cannot do regarding soil disturbance and building/site clearing practices This disparity reflects the somewhat localized nature of land use ordinances resulting from the community planning process.

To take this discussion a step further, an argument could be made that communities wanting to grow at a high rate might find it practical to abandon restrictive land use ordinances, because doing so would make development an easier task On the other hand, communities who want to preserve certain aspects of their area (environmental, heritage or historical) might embrace tighter land use restrictions in the spirit of conservation Regardless of which paradigm is embraced by a community, the fact remains that selection of the level of land use ordinances (beyond the minimums required for sanitary and health reasons) is largely a community decision.

The issue of urban runoff is interesting in that there have been federal and state laws passed that articulate a policy position There have not, however, been any state-wide laws that mandate to counties that they apply certain land use ordinances in an effort to help compliance with regulations regarding the effects of urban runoff Granted storm water and soil erosion requirements are often required, but many of these are technical and left largely up to the applicant (developer) to employ by following "Best Management Practices" or BMP

The following section looks at various land use ordinances that could be employed and would minimize the effects of urban/storm water runoff if adopted at the county level It could be argued that communities embracing such measures are not "anti-development" but instead complying with federal and state laws and preserving the quality of water for all and not forsaking the water quality of a community for the desires of a few who wish to improve their land at the expense of those downstream The ordinances that will be discussed are not "anti-development" nor are they intended to represent such an agenda Instead, the ordinances discussed are regarded as largely conservation-oriented, allowing development to continue to occur, but within certain parameters that protect all.

Measures that receive the most attention here are those that could be adopted in a general land use plan. However, all the measures discussed could largely be used in either the subdivision regulations or landscape ordinances

It should be noted that often such regulations are in keeping with sensible building/development practices since site problems often increase development costs and raise future maintenance and builder warranty issues Also, many sensitive areas do not make for good development sites as the underlying soils are unstable and, over the course of the asset life, problems arise from water seepage or weakened foundation stability, often requiring further investment. However, many of the areas needing protection offer marketable vistas or surroundings that make such measures seem stifling or overly restrictive by prohibiting/limiting development Thus market pressures create demand for land in sensitive areas and, in the pursuit of profit maximization, all lands located in a

parcel are put to use regardless of their suitability for development The need for restrictions protecting sensitive areas is justifiable both in order to protect unsuspecting buyers as well as to limit nuisances caused by development in unstable or sensitive areas

Because the driving force in a project is rate of return and concessions made to regulations impair profit maximization and go uncompensated, developers often resist any sort of terms or restriction of use regarding property being developed However, those living "downstream" are the recipients of the excess wastes carried by storm water off of a neighboring site Except in rare cases of litigation, most of those "downstream" go uncompensated for the damages incurred by upstream neighbors who have not done all that is required to mitigate runoff. Thus, who speaks for or protects those downstream from the negligent or minimal efforts of those disturbing land upstream? More importantly, are such restrictions justified based on the logic that such regulations are protecting the rights of downstream property owners to enjoy their property without the nuisance of excessive sediment from those upstream?

The regulatory measures to be discussed here are basically rules regarding sensitive areas The measures put forth do not go into selection of building materials or design, instead, they simply say "hands off" or "treat with care" areas that usually comprise small amounts of the land to be developed or ask that land not be disrupted with impervious surface, in order to address the fact that the carrying capacity of a site is significantly impaired by such surfaces from disseminating surface water

Many of these measures are beneficial for all involved They are obviously considerate to the environment, as heavy sediment and nutrient loads in streams (arising

from runoff) will lead to loss of life for aquatic creatures and those dependent on a vibrant riparian habitat. They are beneficial for those living downstream, as they will not suffer the additional burden of another's wasteful neglect They are beneficial for the purchaser or end user of a developed land, as the site selected will have avoided areas that often lead to further maintenance (and consequent property value) problems And finally, they are beneficial for those developing a site, as all are required to adhere to the same set of standards (thus making a level playing field) Future liability is lessened by adherence to regulations that protect all parties involved. Therefore, regulations of this nature are beneficial to all affected and, if the area to be developed is of adequate size, they allow the developer of land to potentially achieve profit maximization If a parcel in question is of such a size that regulation limits development, perhaps the point to be made is not that there are too many regulations, but instead that the site is not sufficient in size or buildable land to support the proposed development.

Ian McHarg, considered by many to be the founder of environmental planning as well as an inspiration to the development of Geographic Information Systems (GIS), has written extensively about selecting suitable building sites according to underlying environmental values Simply, McHarg felt that certain areas have higher environmental value than others based on the underlying environmental processes that occur on or within the site Furthermore, the sum area of land with high environmental value for most communities is not large enough that it cannot be protected through sensible planning Also, many of these areas are unsuitable for building or development and can be protected by land use measures if a community chooses to do so This is best

demonstrated in Table 3-1 produced by McHarg, which relates to the areas to be described in this paper and how land uses should be constructed either to protect or utilize them while maintaining the ecological processes that make them environmentally valuable.

Criticism is then warranted regarding land use practices by communities that do not minimize environmental impact as many of these areas are either unbuildable or should be preserved in order to sustain environmental processes. Randall Arendt, who has written several books on the topic of environmentally-friendly or "green" development practices and zoning, states in his book, Growing Greener, several reasons why subdivision regulations need to be reviewed

- "Existing conventional approaches to subdivision development ultimately produce nothing more than house lots and streets.
- Alternative methods of designing for the same overall density while also preserving 50 percent or more of the site are not difficult to master, and they create more attractive and pleasing living environments that sell more easily and appreciate faster than conventional "house lot and street" developments
- The significant land protection achievable through "conservation subdivision design" should help smooth the local review and approval process
- Conservation subdivisions are simply better places in which to live "

(Arendt Growing 5)

From the above it is clear that there is "market distinction" for products built with a conservation bias Simply, a niche is developing where the market rewards developers

TABLE 3-1 Recommended Land Uses

Limited Development Areas	Recommended Land Uses
Surface Water and Riparian Lands	Ports, harbors, marinas, water treatment plants open space for institutional and housing use, agriculture, forestry and recreation
Marshes	Recreation
50 Year Flood Plains	Same as Surface Water and Riparian Lands
Aquifers	Agriculture, forestry, recreation, industries which do not produce toxic or offensive effluents All land uses within limits set by percolation
Aquifer Recharge Areas	As aquifers
Prime Agricultural Lands	Agriculture, forestry, recreation, open space for institutions, housing at 1 house per 25 acres
Steep Lands	Forestry, recreation, housing at maximum density of 1 house per 3 acres, where wooded
Forests and Woodlands	Forestry, recreation, housing at densities not higher than 1 house per acre

(McHarg 43)

financially by faster inventory turn and possibly higher prices The underlying notion is that the real estate community, like most industries, is one of constant change, where rewards are given to those who anticipate or work with changes in consumer preference Thus, perhaps asking that subdivisions be built with a conservation ethic or bias is not an unfair burden if consumer preference is heading in that direction to begin with

Defining land use measures that limit the impact of urban runoff

The following section discusses various zoning or regulatory tools and standards often found in land use ordinances that can be implemented by county/city governing bodies relating to the issue of storm water runoff All of the tools to be discussed can be categorically defined as.

- Forbidding disturbance (or development) of sensitive lands or areas.
- Limiting the amount of impervious surface or areas
- Defining allowable limits of encroachment by development or into sensitive areas

The first category of land use measures are those forbidding disturbance or development on sensitive lands or areas As will be discussed further in other parts of this paper, most of the areas denoted as "off-limits" are areas not usually suitable for residential or most commercial applications. Thus, although regulations take away rights of development, restricted areas are not ones that most would want to develop anyway, as the cost of mitigating conditions would be excessive and not likely to be borne by the market The measures that fall into this first category are as follows.

Natural Resource Protection Standards Most of the areas falling into this category are highly sensitive to development and are commonly understood to be natural resources of importance and value to more than just the landowner. An example might be an aquifer recharge area, as those living within several hundred miles of such a site might be affected by limiting recharge and consequently lowered water tables

Restrictions Related to Soil Types Similar logic is found within this restriction to that of the previous in that certain soil types should not be built on as they are either a) a natural resource (e g prime farm land), or b) not suitable for development (e g hydric soils)

Special reserve areas or districts Often entire areas or districts can be made either off-limits to development entirely, or carrying certain restrictions on development

The second category of land use measures limit the amount of impervious surface, which cannot process surface water adequately Limiting such surfaces is critical to minimizing the problem of runoff Not only do impervious surfaces increase/intensify water flow, but many toxic elements can be picked up as water flows over these surfaces and into streams, creeks or rivers There are also other considerations such as increased temperature for areas with a large area of impervious surfaces as these areas are often heat absorbing concrete or asphalt The term "heat island" refers to the effect of large areas of impervious surfaces where temperature tends to be higher than those surrounding it. (Pielou 62) The following are land use measures associated with limiting impervious surface area

Maximum Impervious Surface This measure is perhaps the most salient as it states specifically how much impervious surface area is allowed However, taken alone, it does not adequately address the various site issues that can arise making the amount of impervious surface area only one of many concerns

Minimum Open Space or Open Space Ratio Stating a percentage of area that must remain open space is a common way of sorting out land use in a proposed development. However, often the required percentage may be too low to mitigate other factors contributing to urban runoff (such as gradient) or even the placement of the open space. Another consideration is that the amount of open space changes with the particular land use intended although it is common for communities to have a standard open space designation requirement.

The third category defines limits of encroachment on sensitive areas, primarily on what is known as riparian areas or areas bordering on waterways The term "buffer" is often employed when discussing the amount of encroachment as development must be kept at an adequate distance from sensitive areas so that the habitat will not be largely destroyed in terms of sustainability of life (aquatic or terrestrial) Also of consideration are riparian areas with steep slopes, which pose a particular risk of runoff problems

Slope Maximums. As mentioned previously, areas with steep slopes (either hilly areas or ridge lines) pose particular risk to runoff problems including sediment loading of waterways as well as flash flooding and the complications associated with it

Flood Plain Restrictions Development in floodplains is risky and environmentally detrimental unless significant flood control measures are in place However, because of

the likelihood of hydric soils and other related conditions, flood plains are often unsuitable for building and given to particular uses such as baseball fields or parks and greenways Despite the natural barriers to development, regulatory restrictions are still necessary, because proximity to water is an amenity in high demand while posing significant environmental risk.

Riparian Buffers The encroachment of development on riparian areas is extremely detrimental to both aquatic and terrestrial habitat, shoreline stability (and consequent sediment loading of waterways) and adequate vegetation. Of all the measures presented in this paper, perhaps this measure is the most important in the preservation of water quality, and, of little more than an inconvenience to most developments However, soil disturbance and development right up to river/stream banks is a common occurrence, as such activities appear to developers to be benign and of little consequence

Tree Protection Zone Encroachment by development (ranging from soil disturbance or impervious surface) into the drip-line of trees is very common and yet a major contributor of soil instability and damage to tree health, which inevitably leads to loss of vegetation Trees are a means of mitigating runoff, thus, protecting the areas within the drip-line is a sound method for both preserving the health of the trees and reducing soil erosion.

Land use ordinances that work to minimize nonpoint source pollution.

Land use ordinances, more commonly known as zoning, determine where various uses will be permitted In prior sections, the legal framework that allows land use ordinances has been explained as well as the general categories of land use measures that

can have an impact on mitigating urban runoff or nonpoint source pollution What follows is in-depth explanations of specific land use ordinances adoptable by cities and counties desiring to minimize nonpoint source pollution

Natural resource protection standards

The kinds of protections needed to preserve natural resources can vary in interpretation, depending on the characteristics of the protected resource For example, the recharge areas of an aquifer or related drainage basins might qualify for protection in areas with water supply problems as keeping these lands from being developed would be important in protecting the natural water cycle and replenishment of the aquifer. However, the more common types of natural resource protection standards are for wetlands or sensitive habitats that might deteriorate ecologically if adjacent lands were developed for residential or commercial use. Elfers outlines several points related to protecting natural resource areas in his Open Space and Urban Water Management

- "Preserve natural hydrologic processes in critical areas preserve a 100 – 300 foot buffer along streams and lakes, preserve 80–100 percent of steep sloes (over 25 percent gradient) in a natural state, preserve 60–80 percent of moderate slopes (15–25 percent) in a natural state
- Preserve natural groundwater recharge processes preserved 85-100 percent of a groundwater recharge area in a natural state; prohibit on-site waste disposal in recharge areas

- Preserve wetland areas and processes particularly preserve wetlands of 50 acres or more Wetlands as small as 10-15 acres can be ecologically significant Maintain a border of natural vegetation of at least 50 feet when disturbed by urban activities
- Preserve significant wildlife habitats Preserve areas of several hundreds acres if near urban development; connect the habitats via stream valleys or other linkages.
- Preserve unique and particularly scenic areas preserve wild or free-flowing streams in segments of at least 25 miles; preserve wilderness areas of at least 25 square miles and keep them relatively inaccessible " (Elfers 25-32)

The above list demonstrates that natural resources should be protected in varying ways that conserve the ecological processes unique to those particular land areas. Arendt makes the point that often sensitive areas are not the best to build on to begin with, thus there is a practical rationale for allowing some areas to be undeveloped, in particular aquifer recharge areas, "Although many aquifer recharge areas consists of soils that are not inherently unbuildable (such as excessively drained sands and gravels, and certain of the less severe hydric soils), they should be avoided for construction when other parts of the property are available and are less constrained by environmental factors " (Arendt. Conservation 38)

Another type of natural resource protection standard relates to "Aquifer Protection Overlay Districts" (or APOD) The APOD simply serves as a "floating" zoning district that carries specific restrictions that in essence limit the amount of development activity which would negatively impact groundwater quality as well as adjacent water bodies

(Jeer, et al 68) Under the APOD, the area being protected is critical for maintaining ground water quality as aquifers naturally recharge in areas with permeable soils and rock Thus, this restriction seeks to protect the natural processes inherent to an aquifer by limiting the amounts of soil disturbance, impervious surfaces and density of housing Sanjay Jeer, et al in their work Nonpoint Source Pollution· A Handbook For Local Governments describe at length a model water resource protection ordinance which incorporates the APOD and also outline a succinct argument for natural resource protection.

"a) protect the public health, safety, and welfare of the residents through the preservation of groundwater resources,

b) identify uses that are prohibited or allowed only by special use permit within designated aquifer protection overlay districts;

c) protect groundwater and surface water resources from nitrogen contamination and pollution from storm water runoff . " (Jeer, et al 67)

The basis for restrictions protecting natural resource areas lines in the premise of "protecting public health" along with "protecting groundwater/surface water resources " Sensitive natural resource areas are different and carry a greater environmental value, and thus, should be afforded different rules and regulations in how they are utilized by the public Such areas are highly sensitive and once damaged, cannot be repaired. Thus, given the orientation to serve the public good, these lands should be protected

Restrictions related to soil types

For special soils, such as floodplains or hydric or saturated soils, parameters can be set that specify types of development and particular site development requirements. Elfers suggests the following "Restrict development on certain soil types: poorly drained soils, i.e , flat and impermeable, shallow soils, i.e., less than 5 feet to bedrock, high water tables, i e., less than 7 feet to surface; soils with high "shrink-swell" properties." (Elfers. 72) It should be noted that not only does the above parameter suggest what would be environmentally the most prudent of measures, it is also accepted construction methodology Residential/commercial development should not occur on soils that will not adequately support the proposed use as it is likely problems will develop

The Calvert County, Maryland development ordinance carries restrictions on development on farmable soils in its "Farm Community Overlay District " The restriction limits the buildable area to 20 percent of areas of workable cropland (Calvert County· 2-3 b) Granted, this restriction takes place in an overlay district, but it is an example of how restrictions can be made regarding soil type in order to restrict development. As will be seen in the inventory of communities in Blount and Sevier counties, there are restrictions on building on hydric soils, which very often are found in wetlands or floodplains

Special reserve areas or districts

Special districts can be enacted that have particular requirements attached in order to preserve one or more aspects (Example· Resource Protection, Rural Agriculture). Very often these are cultural features, such as historical or ethnic value; however, the same

basis of protection could be used for environmental resources An example of this might be the preservation of a man-made canal via the establishment of a special district that limits development within a certain range Also, the preservation of a historical area (Example Native American burial sites or shell mounds) can often have the dual purpose of protecting sensitive lands if the area protected is large enough to have environmental impact Given that many historical areas are adjacent to or near water resources, this measure could be very beneficial for preserving riparian areas in a historical preservation context

Calvert County, Maryland has what is called a "Conservation District" which carries limited development restrictions and comprises areas that are "wetlands, floodplain, steep slopes, streams and their buffers." (Calvert, MD: 5-1 03) Another example of using a special district for conservation purposes, among them promoting water quality, is found in Montgomery County, Pennsylvania The Land Preservation District or LPD is designed to protect open land and sensitive areas with a purpose of "reducing erosion and sedimentation by the retention of existing vegetation, and the minimization of development on steep slopes. preserve open land, including those areas containing unique and sensitive natural features such as woodlands, steep slopes, streams, floodplains and wetlands, by setting them aside from development " (Montgomery 1 A – C) Both of these examples show how overlay or special districts can be put in place to help minimize the environmental effects of development on sensitive areas

Maximum impervious surface

The most critical component of the urban landscape that should be managed in order to limit urban runoff is the building of more impervious surfaces. Impervious surfaces allow contaminants to build up to dangerous levels which are susceptible to sheet flow from rainfall and consequently flush into water bodies. Also, impervious surfaces offer little resistance to rainfall and act as an accelerator of flow velocity, which leads to high levels of soil erosion as the water carried across impervious surfaces enters drain fields. Kendig notes, "(The) impervious surface ratio . is the proportion of a site occupied by impervious surfaces. These are surfaces which do not absorb rain and include all buildings, roads, sidewalks, patios, parking areas, and any areas paved in concrete or asphalt Impervious surfaces critically alter the natural environment. Besides the obvious increase in storm water runoff, there are many other related adverse environmental impacts To calculate, divide areas of impervious surface by gross site area " (Kendig 27) Limiting the amount of impervious surface area is perhaps the best way to mitigate the problem which Kendig accomplishes by suggesting maximum amounts of impervious surface area as seen in Table 3-2. Much of the damage brought about by impervious surfaces could be mitigated if the areas were "semi-impervious," however, the question of consumer demand for such a product is too uncertain for the construction industry to embrace such technologies despite their popularity overseas (Spirin. 138) Table 3-2 provides standards for impervious surface areas in residential housing lots It should be noted that according to Kendig in the following table that a "Village House" is a single-family detached house with very small front and side yards

TABLE 3-2 Impervious Surface Ratios

Housing Type	Minimum Lot Area: 2BR/3BR in square feet	Maximum On-lot Impervious: 2BR/3BR
Single-family	6,600 / 7,400	16% / 22%
Lot-line	5,500 / 6,200	22% / 28%
Village House	4,200 / 4,600	23% / 23%
Twin House	3,200 / 3,400	33% / 32%

(Kendig 224 – 226)

Table 3-3 suggests maximum impervious surface ratios by zoning district type. This ratio was previously defined by Kendig as dividing the impervious surface areas by the gross site area It should be noted also that "Development" district is one of mixed use with some commercial and light industrial use. As can be seen, the more intensely developed a district is the greater the impervious surface area Given the link between impervious surface area and the environmental problem of urban runoff, land use planning that took into effect this correlation and sited areas with high levels of impervious surface areas an adequate distance from riparian areas could help alleviate the problem of urban runoff

TABLE 3-3 Impervious Surface Rations per District Type

District type:	Impervious Surface Ratio:
Wilderness	01
Agricultural	06 - 09
Conservation	06
Rural	08 - 11
Estate	08 - 14
Development	18 - 40
Urban Core	36 - 52

(Kendig 76 – 91)

Minimum open space or Open Space Ratio

Perhaps the best mitigants to urban runoff are vegetated areas that capture sediment and contaminants before they enter riparian areas or water bodies. Open space requirements to protect such vegetated areas are quite common as it is generally understood that open space promotes public health, being conducive to proper ventilation and recreation The issue for land use planners is how much open space is needed: often the least possible amount is protected since open space is equivalent to undeveloped land and thus has limited market value Open space can often be used for other functions such as recreation and flood prevention Areas in floodplains/wetlands often have a 100 percent open space requirement. Another example of open spaces that could be protected would be areas with a slope of 25 percent or greater, where a minimum open space requirement (for example, 80 percent), could be required. The amount open space protected determines the effectiveness " looking at all the buildable land on a site, at least one-quarter must remain as relatively undisturbed open space " (Arendt. Conservation 7) As will be seen, a 25 percent open space requirement is quite minimal in the scope of various land uses Elfers suggests something similar to a 25 percent requirement "Preserve at least 30 percent of the development as open space or common grounds Require that the open spaces be at least 6,000 square feet in size Require that at least half of the open space not have a slope of over 10 percent " (Elfers 7) It should be noted that the requirement that the slope of protected land not exceed a gradient of 10 percent belies that the land be usable for recreation as well as possible storm water retention Concerning the value of open space for recreation, Elfers also reflects that

communities need "about 10 acres of park land per 1,000 people and need about 10 acres of *other* open space per 1,000 people " (Elfers. 7) Most of the discussion of this topic focuses on the amount of area given to open space, however, the approach offered by Elfers is to proportion the amount of open space to the number of people Open space can have the dual functions of protecting habitat or mitigating runoff and providing recreational space. The potential risk associated with giving open space primarily a recreational function is that the placement of such areas might be of little environmental value as the need for accessibility and convenience might be of greater concern to a community

Kendig defines the open space ratio as measuring the "proportion of a site, excluding land occupied by private lots or road rights-of-way, which remains undeveloped and is specifically designated as open space . To calculate, divide acres of open space by gross site area " (Kendig: 26) Based on Kendig's formula, Table 3-4 suggests open space ratios for the various types of areas.

TABLE 3-4 Open Space Ratios

Natural Resource Area	Open Space Ratio
Floodplain	1.00
Wetlands	1 00
Natural retention area	90
Steep slope (25% or more)	85
Forest	80
Pond shore	80
Lake shore	70
Steep slope (15 – 25%).	70
Steep slope (8 – 15%).	60

(Kendig 30)

In terms of different district types, the following recommendations by Kendig suggest open space ratios for the majority of district types that would contain residential areas Included also are the previously cited impervious surface ratios, which suggest the inverse relationship between open space and impervious surface. As can be seen in Table 3-5, the greater the impervious surface, the less the open space This of course is logical, given that there is only so much area and increased amounts of impervious surface area can only translate to less open space However, the point is that society has made a decision to limit natural processes by lowering the amount of open space (which allows for a natural solution for urban runoff) for the accommodation of vehicles Thus, there is something of a conflict regarding open space versus the accommodation of vehicles

TABLE 3-5 Open Space versus Impervious Surface Ratios

District type:	Open Space Ratio:	Impervious Surface Ratio:
Wilderness	98	01
Agricultural	90	06 - 09
Conservation	85	06
Rural	80	08 - 11
Estate	50	08 - 14
Development	50	18 - 40
Urban Core	25	36 - 52

(Kendig: 76 – 91)

In the Hamburg Township in Livingston County Michigan, there is a "Open Space Community" zoning ordinance This ordinance is unique in that an "Open Space Community" is established as an overlay district and open space an intended goal of the community. The Open Space Community as defined by this ordinance is "a predominantly single family residential development in which dwelling units are placed together into one or more groupings within a defined project area The dwelling units are

separated from adjacent properties or other groupings of dwellings by substantial open space that is perpetually protected from development " (Hamburg Township· 14 2) This type of development is similar to that called for by the Center for Watershed Protection (CWP) which recommends "Open Space Development," with concentrated housing areas in order to make room for open space. (www cwp org) However, the intent of the community to require this style of development is stated as "An open space community shall result in a recognizable and substantial benefit, both to the residents of the property and to the overall quality of life in the Township This benefit should accrue, in spite of any foreseeable detriments of the proposed development " (Hamburg Township: 14.3 1)

In terms of "how much" open space, the Hamburg ordinance states, "An open space community shall maintain a minimum of forty percent of the gross area of the site as dedicated open space held in common ownership." (Hamburg Township: 14.4.4) The requirement of forty percent open space is short of Kendig's suggested fifty percent of open space for residential development.

In Montgomery County, Pennsylvania, the previously mentioned Land Preservation District requires 75 percent open space A requirement is also made that a neighborhood with 10 or more residential lots must have at least 1,000 square feet per lot of open space. Uses allowed as open space include agricultural areas, passive recreational areas and open land in its natural state (Montgomery 4-M) This requirement of 75 percent open space fits closer to the ideal set by Kendig and would almost qualify as a rural designation, which Kendig says should have at least 80 percent open space In the Montgomery Land Preservation District program, most of the land utilized in this

capacity is rural and often being converted to residential Thus, the Montgomery requirements, though rural, do not completely meet with Kendig's requirements.

Slope maximums

Land with an average slope of 15 percent or greater pose significant flooding/erosion risks as the gradient causes surface water to wash away large amounts of soil in a short period of time, thereby destabilizing the slope. (Pielou 21) Thus, any land-clearing event further destabilizes the soil and often removes groundcover which is a natural mitigant to the effects of heavy rain or snowmelt Elfers makes the point that some thought and care must be dedicated to working with areas having a steep grade and minimal ground cover "Prohibit development if there is no forest cover or good ground cover Require 1-4 acres per dwelling unit depending on the slope and the ground cover." (Elfers. 6) It is also advised that as the gradient increases so should the care used in development "Slopes over 25 percent should be avoided for clearing, regarding, or construction Slopes of between 15 and 25 percent require special site planning and should also be avoided whenever practicable " (Elfers 7) However, it is a common development practice to disturb areas with steep gradient with the assumption that erosion control methods will mitigate the problem There is some fault in this logic because once groundcover or topsoil is removed, the underlying soils have very little (if any) organic matter to absorb or slow the rate of surface water speed. With few or no barriers to contain surface water, sub-soils (in the Southeast often clay) are easily swept away and end up in streams or creeks It could be argued that addressing the problem through conservative construction techniques, or simply not disturbing steep-sloped

areas, is better for all (developer and the natural environment) rather than assuming man-made erosion prevention measures will alleviate the problem (Pielou: 85)

In Travis County, Texas, a nonpoint source pollution control ordinance exists that contains, among other things, specific thresholds based on slope of onsite retention for several types of pollutants: total suspended solids, total phosphorous, oil and grease. For total suspended solids, slopes between zero and ten percent, seventy percent of the annual pollutant load, must be retained The requirements increase until slopes that exceed twenty percent must retain ninety percent of the annual pollutant load Similar requirements are found for phosphorous which states a slope between zero and ten percent must retain seventy percent of annual pollutant load, continuing up to slopes greater than twenty percent containing eighty-five percent of annual pollutant load. The requirements on oil and grease are similar to those on phosphorous (Travis: 5-b) Travis County's ordinance is unique in that it acknowledges the impact of slope and states specific requirements for certain contaminants. While there is not a reference to soil or contaminants coming off of impervious surface areas, there is a relation to the problem of urban runoff as all three of the previously mentioned contaminants are listed as a part of the urban runoff problem and can have dire impact on the quality of a waterway if allowed to enter it

Flood Plain restrictions

A community with floodplains that are known or potential risks might consider the following options in mitigating risk according to Marya Morris in her Subdivision Design in Flood Hazard Areas:

- "Keep (floodplain areas) undeveloped
- Use public monies to acquire and convert the lands to recreational uses such as parks or a greenway
- Permit some low-density development; or
- Allow some combination of the latter two options " (Morris· 16)

It is also common for a zoning ordinance to contain specific zoning areas designated "flood plain" or "flood hazard zone" in which certain uses are allowed (Morris· 17) Subdivision within floodplains very often carries with it specific requirements to lessen the potential for flood damage or risk A typical example might be to require buildings to be located on higher ground or to require drainage ways. (Morris: 18) Very often such areas that carry additional requirements are called "overlay districts" or "overlay zones," which helps in the development review process. (Morris 24) The obvious advantage to restricting development in floodplains in relation to urban runoff is that it forms something of a riparian buffer – a concept to be developed in the next section Again, not only is this practice a mitigant to urban runoff, but also sound building practice as the chance of flood is real for areas within the 100 year floodplain – a term denoting the likelihood or statistic probability of flooding, "one speaks of a flood which can be expected to occur on the average of once in two, five, ten, fifty, 100 or 500

years (This corresponds to a probability of occurrence of fifty, twenty, ten, two, and one and 0.2 percent for any one year) Obviously, as the frequency decreases, the magnitude of potential flood damage increases (Keyes· 59) As one moves away from a "no-development" position in regard to floodplains, it is critical that development occurring within a floodplain be restricted Elfers suggests, "Restrict development within the 100-year flood plain – permit some uses, e g., recreation, parking storage (and) maintain at least 80 percent of the area in natural ground cover " (Elfers 52) Also, "Require at least 70 percent of each residential lot to be above the 100-year flood level Require houses to be at least two feet above the 100-year flood level and 40 feet from it " (Elfers· 8) However, there are impacts associated with developing in or around a floodplain that should be mitigated if a concern for the effects of urban runoff are to be considered. A possible restriction might be something akin to a buffer area around a floodplain or at least a requirement that "new buildings be set back 50 to 100 feet from the edge of floodplains." (Arendt Conservation 34) The notion that sensitive lands be protected or "buffered" from human development is in keeping with protecting public safety, since such buffers can work –in the case of floodplains- to protect property and lives in the event that natural processes (floods) should occur

In the previously mentioned Montgomery County, Pennsylvania's Land Preservation District or LPD, a requirement is made that calls for neighborhoods to be "located on areas which are relatively free of sensitive environmental features. .(such as) floodplain or wetlands " (Montgomery· 4-F) Montgomery's LPD has several other

requirements that are addressed in this chapter, however, the relevance of the LDP to this section is its restriction that development cannot occur in a LPD adjacent to a floodplain

Riparian or waterway setback or buffer zone ordinances

The use of buffers to mitigate noise and light is a common feature of the urban landscape. Elfers makes reference to this, "Use open space buffers to the extent that it is feasible to reduce noise levels forested buffers of 200-300 feet along highways and railroads can reduce noise level by as much as 20 db Use open space buffers to the extent that it is feasible to reduce levels of air pollutants: forested buffers in the range of 1,000 feet can make significant reductions in the local levels of certain air pollutants, e g , dust particles." (Elfers 9) A natural, vegetated strip can protect the health and welfare of neighboring properties from nuisance elements such as noise, light and dust

Similarly, a riparian buffer which can preserve riparian habitat, as well as mitigating the effects of urban runoff, becomes a critical element in protecting water bodies from contamination The buffer acts as something of a "last defense" in protecting the water bodies from the invasion of contaminated water Much of the sediment/contaminant load arriving from developed lands can be absorbed by ground cover if enough exists to act as a buffer protecting the actual water body, certainly the presence (whether adequate or not) of ground cover slows the sheet flow to a point where the sediment may settle somewhat. (Pielou 91) The benefits of a buffer are numerous as aptly pointed out by Elfers, "Natural buffers are particularly important in relation to controlling erosion on shore land, controlling water quality related to urban or shore land

runoff; providing wildlife habitat; stabilizing stream banks; controlling water temperature for fish " (Elfers· 123) Again, the benefits of allowing a strip or buffer of vegetation between disturbed or developed areas and a riparian area are numerous

The question regarding buffers then becomes that of the appropriate dimensions: Arendt recommends "..a buffer of natural native species vegetation of at least 100 feet in depth adjacent to wetlands and surface waters, including creeks, streams, springs, lakes and ponds " (Arendt· Conservation· 169) While Arendt takes the position that a 100 foot buffer is sufficient, there are other views on this subject Elfers recommends, "The natural buffer is often recommended to be 300 feet on each side of the stream." (Elfers: 123) However, other variables to consider when determining the amount of buffer include slope and amount of area developed "The banks along streams and watercourses should be maintained at slopes to assure vegetative stability. A 50 percent slope is generally considered to be the maximum slope on which vegetation can be established and maintained However, for maximum vegetative stability the slope should be 33 percent or less " (Elfers 124) Simply, if the slope in a riparian area is so steep that a question of soil stability exists, then a larger buffer is needed to mitigate the rate of water descending into such a destabilized area

The City of Napa, California has an ordinance on Riparian Habitat Areas which states that buffers will be at least 50 feet wide, measured from the top of a stream, creek or riverbank. This width may be increased if not large enough given natural constraints (City of Napa 17 60 80) In Baltimore County, Maryland, a forested buffer of seventy-five feet is required around an active stream (Baltimore b-2)

Dr. Jack Ranney, is a Senior Research Scientist at the University of Tennessee's Energy, Environment and Resources Center, conducted a study of sediment control methods and application in East Tennessee (Ranney: 1) Ranney sampled 56 sites where soil disturbance was occurring from construction and where riparian habitats, mostly streams, existed nearby Ranney also found that the majority of the sites sampled did not have adequate sediment barriers and posed a significant threat to neighboring riparian areas Of those sites that had some form of sediment control measures (roughly 70 percent of the sample set), only 23 percent of controls were properly installed and maintained Taking into account the fact that most sediment control methods are either poorly installed or not adequately maintained or monitored, Ranney suggests that development within a 1,000 feet of a riparian area poses significant threats and that adequate retention must exist in order to preserve riparian habitat. Ranney's study demonstrates an adequate buffer system is necessary in most developed areas as soil erosion methods are deployed at varying levels of effectiveness Thus, if a community has a buffer requirement, the effects of a failed soil erosion control system are minimized. A buffer ordinance also serves as an adequate way to control damage to riparian areas and is easily understood Ranney implies that development within 1,000 feet of a riparian area increases the likelihood of soil erosion and conveyance into a water body, however, others suggest buffer zones ranging from 100 to 300 feet. The fact remains, however, that the presence of some form of required buffer is what matters, and the greater the size of the buffer the greater the benefit in conserving riparian areas

Tree Protection Zone ordinance

As has been established, soil disturbance leads to a unstable surface area and consequent vulnerability to storm events which are a major cause of urban runoff Also established has been the fact that vegetation or ground cover can slow or mitigate soil erosion and often acts as a barrier, thereby mitigating soil erosion and the loading of sediments into water bodies Yet, as has been noted, a typical pre-construction ritual of developers is to remove all topsoil, vegetation and most trees in preparing a site for construction Apart from the obvious loss of vegetation and habitat, such measures destabilize the soil system and limit the ability of a site to absorb water. Thus, a measure that prevents unnecessary soil disturbance and removal of vegetation can limit possible soil erosion and consequent runoff The previously discussed open space requirements can accomplish this to some degree, however, on smaller sites, where open space requirements are not applicable, the same benefits can be achieved by ordinances that limit the removal of trees of a certain size The intent with this type of ordinance is that it will reduce soil disturbance and consequently reduce the problem of urban runoff, but it can also serve the public as well as the owner of residential property by providing aesthetic value and health benefits

Kendig suggests a zoning ordinance where, "No more than fifteen percent of any mature woodland may be cleared or developed The remaining eighty-five percent shall be maintained as permanent open space. No more than thirty percent of any woodlands may be cleared or developed The remaining seventy percent shall be maintained as permanent open space No more than sixty percent of any young woodland shall be

cleared The remaining forty percent shall be maintained as permanently open space " (Kendig 133) The distinctive feature of this suggestion is the combination of both open space and preservation of trees or wooded areas This is unique to an ordinance that might call for protection of trees of certain size whereby development is kept at a specified distance (Example. no soil disturbance within 15 feet of a tree) However, Kendig includes tree protection in his definition of woodland·

"Woodland an area of planted material covering one (1) acre or more and consisting of thirty percent or more canopy trees having an eight inch or greater caliper, or any grove consisting of eight or more trees having a ten inch or greater caliper.

Woodland, mature. An area of plant material covering one acre or more and consisting of thirty percent or more canopy trees having a sixteen inch or greater caliper, or any grove consisting of eight or more trees having an eighteen inch or greater caliper

Woodland, young· an area of plant material covering one acre or more consisting of seventy percent or more canopy trees having a two and one-half inch caliper or greater ". (Kendig 109)

Another method of protecting trees and the areas contained within their drip zones might be requiring a special permit to remove a tree of a certain size Christopher Duerksen, in his book, Tree Conservation Ordinances, describes such a measure, "Some ordinances allow issuance of a removal permit if the applicant demonstrates there will be "no significant adverse impact" on the environment Others require the permitting

authority to "determine what effect the removal will have upon the drainage, topography, natural resources, and ecology of the area and shall consider these factors in granting or denying said application " (Duerksen· 22) Often such ordinances might be found in conjunction with a landscape ordinance that requires tree demolition to be articulated as part of an overall plan, rather than just as wanton removal Again, Duerksen cites an example of this, "Another community's tree conservation ordinance requires a landscape plan as a condition of tree removal, but nowhere specifies what should be in that plan " (Duerksen· 22) Thus, Duerksen points to the problems inherent in such ordinances which require plans in order to license the removal of trees how detailed should the plan be, what should the scope of detail be, and are sufficient resources available to adequately review such plans

The City of Napa, California, in their ordinance on Riparian Habitat Areas, states the following

1 "Site development shall be fitted to the topography and soil so as to create the least potential for vegetation loss and site disturbance,

2 Vegetation removal shall be limited to that amount necessary for the development of the site. Protection of tree crowns and root zones shall be required for all trees planned for retention," (City of Napa 17 60 80)

As can be seen, minimizing soil disturbance is important to minimizing waterway contamination, which includes limiting the amount of vegetation removed as well as the

retention of trees For those trees to be retained, the Napa ordinance directly calls for not disturbing the root zone area (or drip line), which helps minimize soil disturbance

Subdivision regulations and their relation to minimizing nonpoint source pollution

Subdivision of land, or the dividing of land into two or more lots, is a common occurrence that offers an opportunity to encourage or require practices that will minimize environmental impact. While many aspects of subdivision regulations are beyond the scope of relevance for this paper, there is an opportunity for communities to place restrictions during the subdivision of land that can mitigate urban runoff This point was highlighted in the previously discussed study where technical decision makers in city/county public works departments saw subdivision regulations as the best regulatory tool in dealing with urban runoff. Subdivision regulations can often contain language that limits development in floodplain or wetland areas Often these requirements follow the notion that development in certain areas can lead to problems for a homeowner, in that the soils built-upon or the area built-in are limited in their capacity to accommodate residential housing

Soil erosion containment requirements are often found within subdivision regulations The complexities of soil erosion methods are beyond the scope of this paper, being more related to engineering than to land use policy. Most subdivision regulations contain requirements related to soil erosion However, as investigated in the paper by Dr. Jack Ranney, soil erosion control methods are not always properly deployed or monitored beyond their initial implementation by either the developer or governing agencies

(Ranney 5) Thus, the notion that simply requiring soil erosion control measures adequately addresses the problem of urban runoff is not a completely effective policy There is then a need for land use measures that place systemic controls on erosion in addition to existing soil erosion control methods as the combination of the two should be effective in helping solve the problems associated with urban runoff.

The purpose of including subdivision regulations in the scope of this paper is that they can, and often do, include some of the measures already identified in this paper in some form or fashion. Again, many of the previously discussed measures are included within subdivision regulations with the intent of protecting against the creation of substandard residential lots, however, such regulations can also afford a community the opportunity to limit urban runoff

The typical subdivision regulation contains many different elements related to the subdivision of land for resale In a report prepared by the American Society of Planning Officials (a predecessor organization to the American Planning Association), a typical subdivision regulation ordinance might contain the following sections

"I Purpose

II Definitions

III Procedure of Submission of Plats

IV Specifications for Plans and Plats

V Design Standards

VI Improvements

VII Dedication and Reservations

XIII Variances and Appeals

IX. Violations and Penalties

X Amendments

XI Miscellaneous" (American Society of Planning Officials 23 – 25)

Sections similar to V, VI and VII are typically where measures that might help mitigate runoff can be found Section V, or Design Standards "usually begins with provisions dealing with general mandates, provisions requiring coordination of design standards with the zoning map and ordinances, with the land use plan " (American Society of Planning Officials· 14) Thus, it is arguable that measures such as those previously discussed which are found within the land use plan to prevent urban run-off could be required in the subdivision of land.

The Improvements section is perhaps the section that causes the most contention among developers as it represents the outlay of capital as mandated by a county or city to fulfill regulations regarding the subdivision of land This section typically contains requirements for engineering drawings as well as plans for the sequence of construction Often in the "required improvements" section, or sections comparatively named, there are mandates for storm sewerage along with a host of other improvements necessary to provide basic services to residential subdivision tenants (example curb and gutter, street signage and layout, fire hydrants) It is possible that this policy instrument could be used to regulate the area of impervious surface (streets and parking area dimensions) in the context of limiting urban runoff In relation to storm sewerage, the specific requirements and engineering aspects are far beyond the scope of this paper Most storm sewerage

requirements focus on the collection and conveyance of storm water and not what happens to it beyond that However, requirements for storm sewerage, as a common and necessary practice, in most subdivisions, present an opportunity for a community to limit urban runoff Very often, these requirements focus strictly on the conveyance aspect of storm sewers and overlook contributing factors such as the amount of impervious surface or soil disturbance However, it is possible that requirements could be made regarding the placement of sewer outfalls or culverts in proximity to water bodies or the location of drain fields (retention ponds) a certain distance away from water bodies or riparian areas. These, of course, are just a few examples of how communities could use storm sewer requirements to minimize the effects of runoff

Section VII, Dedications and Reservations, is another area where land use measures to limit urban runoff could be found Very often there are subsections within this subsection that lay out requirements for easements regarding such items as open space, watercourses and planting strips This would also be a logical place for requiring easements for riparian buffers as well.

Landscape ordinances and their relation to minimizing nonpoint source pollution

Landscape ordinances have the potential to mitigate environmental impact, particularly impact related to urban runoff, by limiting or defining allowable amounts of soil disturbance and demolition of vegetation, two major contributors to urban runoff As discussed in the section on various land use measures, very often tree protection zone ordinances can be found in landscape ordinances In addition, various requirements that

can help mitigate the effects of development on the natural environment can be contained within an landscape ordinance, should a community choose to adopt one. The following comes from Wendelyn Martz and Marya Morris's, Preparing a Landscape Ordinance, and lists the typical components of a landscape ordinance:

"1. Purpose

2. Definitions

3. Applicability (for whom does the ordinance apply: new developments, ect.)

4. Conflict

5. Landscape Design Standards

6. Site Design Standards

7. Irrigation Design Standards

8. Plant Material and Installation Standards

9. Maintenance Standards for Cultivated Landscape Areas

10. Maintenance of Natural Plant Communities

11. Landscape Plan Required" (Martz and Morris: 20 – 26)

As is the case with subdivision regulations, the main provisions of landscape ordinances that might contain urban runoff-related measures are found in the design standard sections Section 5, Landscape Design Standards, often can contain minimum tree and shrub planting or preservation requirements (Martz and Morris: 25) Section 6, Site Design Standards, is another section where runoff-related measures might be found. This section can sometimes contain requirements for a minimum area of open space or for the preservation of plant communities. The preservation of plant communities (trees,

shrubs or vegetation) is of particular relevance, as the prohibition on the demolition of certain species or sizes of plants, can translate into less soil disturbance. Another way to control soil disturbance might be to require grading or site clearing activities to be permitted via a landscape ordinance

Many only associate a landscape ordinance with the aesthetic qualities associated with higher amounts of plantings, trees and preserved areas. However, a landscape ordinance goes far beyond just bringing natural beauty to a community and can actually be a policy mechanism that limits the impact of urban runoff As discussed at length previously, a tree ordinance that limits the removal of trees or wooded areas can both bring aesthetic value to a project or development and help to reduce soil disturbance in a developed area

Correlation between proposed land use controls and "Smart Development"

As the problem of sprawl has increased over the past several decades, the public conscience has been raised regarding the reasonable use of land to accommodate growth. A growing consensus in the public forum is that communities should adopt some measures or ordinances to curb sprawl At the heart of this trend is what appears to be an increased public desire to better use or maximize land as a natural resource As will be seen, many of the proposed measures in this paper fit into the "Smart Growth or Development" agenda

Defining either "Smart Growth" or "Smart Development" is difficult, however, both terms embody the term "sustainable" which can be defined as, " development that

meets the needs of the present generation without compromising the ability of future generations to meet their own needs." (Morris· 24) A summation of this approach comes in this quote from the Native American tribe, the Iroquois. "In our every deliberation, we must consider the impact of our decisions on the next seven generations " (Krizek and Power· 8) Thus preservation of resource quality or use of a natural resource that can be sustained for more than several decades (or ideally longer) is the primary tenet of sustainability and consequently "Smart Development "

In a report published by the American Planning Association entitled, "The Principles of Smart Development," the principles of smart development are as follows:

"1) Efficient use of land resources.

2) Full use of urban services

3) Mixed use.

4) Transportation options.

5) Detailed, human-scale design.

6) Implementation" (American Planning Association 3)

Relevant to the topic of this paper is the first principle, which is defined in greater detail in the APA report as follows "Smart development supports the preservation of land and natural resources These benefits result from compact building forms, infill development, and decreased street and parking standards which leads to less impervious surface. At a regional scale, cooperative growth management can encourage more compact development patterns, protecting farmland and open space from urban sprawl At the local scale, compact building patterns preserve land for city and neighborhood

parks as well as local woods and wetlands " (American Planning Association: 7) The priority of smart development to preserve land and natural resources combined with a commitment to open space makes it a salient point of discussion for this paper Of course, one of the tenets of smart growth is compact or higher densities in residential development and this, if not handled correctly, could result in greater nonpoint sources of pollution compared to lower density developments because of increased impervious surface areas However, much of the impact of higher density development can be mitigated with larger amounts of open space which is a common feature used in smart development to offset the higher densities

In the report by APA, several case studies are presented that look at smart development methods These case studies involve the implementation of several of the previously mentioned land use measures which help mitigate the effects of nonpoint source pollution The following are relevant highlights from the case studies of a subdivision in Oregon that contained enough information to compare with the land use mechanisms previously discussed in this report

Fairview Village, Fairview, Oregon

- 4 5 acres of natural open space and 3.5 acres of formal parks contained within a 137 acre parcel or an open space ratio of (8 acres/ 137 acres) 5 8% While this is a bit lower than the 25% open space ratio that Kendig expressed as needed in an "Urban Core" district, the development contains a high degree of retail/office/public buildings or mixed use development which is common to smart development projects

- A 50-foot riparian buffer zone protecting Fairview Creek
- A Provision that all storm water be captured on site

Fairview Village is an example that shows that there is a correlation between smart growth or development methodologies and the minimization of nonpoint source pollution As stated previously, a fundamental principle in smart growth or development is a land ethic that places an emphasis on minimizing contamination associated with residential development This comparison is not to suggest a "hand in glove" relationship, but instead that a correlation does exist and it is likely that continued interest in smart growth or development methodologies will lead to more communities that employ techniques known to minimize nonpoint source pollution or urban runoff.

CHAPTER FOUR

Land Use Measures Matrix

Introduction

The purpose of this chapter is to take the land use measures previously discussed and put them into a matrix format which a community (city or county) or environmental organization could use to make an inventory of potential water quality or urban runoff measures This matrix could be helpful both to communities as well as environmental groups seeking to understand how adequately the land use measures of a community address the problem of urban runoff. The matrix will be applied to two counties and their larger communities Sevier and Blount, which are located in East Tennessee, in order to evaluate how well their ordinances provide mitigating measures for nonpoint sources pollution

The term land use measures are used in this paper and matrix in a broad sense. It is best defined in this capacity as, "any regulation or ordinance affecting the rights of a property owner in developing land " This definition is given because from the perspective of the author the term "land use measures" is applicable to those regulations commonly found in a general land use plan as well as those found in subdivision regulations and landscape ordinances. It should be further noted that in the context of this thesis, the term "landscape ordinance" is used to mean both a mandated ordinance or provisions within the general land use plan that relate to landscape-related issues The intent here is to point

out to the reader that landscape-related regulations can be of benefit in addressing the problem of urban runoff Often, these regulations can be found in a ordinance that was passed to address specifically landscape concerns, or, landscape provisions contained within a general land use plan Either source (ordinance or provision) is applicable in addressing the problem of urban runoff

Construction of Matrix

The matrix prepared attempts to incorporate the range of existing land use measures that might be applied at the community level The first category in the matrix is subdivision regulations In Tennessee, subdivision regulations are required by law, and comprise the minimum land use controls for most communities. Thus, it is hoped that even if a community has only subdivision regulations, this matrix can be helpful in evaluating to some degree whether there is a bias in those regulations toward preserving water resources.

The second category refers to land use ordinances commonly found in general land use plans However, the existence of a general plan (complete with land use ordinances or zoning) is not a common occurrence unless mandated by state law Even if a general plan exists, there may be few land use measures employed that have any environmental significance. However, the presence of a land use plan is a significant improvement in terms of land usage over a sole reliance on subdivision regulations A general plan can address other types of land uses (commercial, industrial, multifamily), which have environmental and societal impact As has been stated before, the focus of

this paper is primarily on residential areas or the conversion of undeveloped land, which represents an enormous amount of dedicated land resources for a community Thus, the focus of both this thesis and the matrix are residential and undeveloped land.

The third category of this matrix is the landscape ordinance. Landscape ordinances are unusual in that they might be adopted by a community without having a general plan, although that is unlikely. Thus, the assumption made in the construction of this matrix is that the land use control areas are progressive, starting with subdivision regulations (the more basic of land use control measures) and progressing to landscape ordinances (perhaps one of the more sophisticated land use measures) As was discussed previously, a landscape ordinance can go far beyond making a community aesthetically pleasing. A landscape ordinance can often serve as a control or regulator of major soil disturbances for a community and thus its inclusion is warranted.

Utilizing the Matrix

In no way does this matrix contain all of the possible land use measures adoptable by a community wanting to curtail the problem of urban runoff However, the measures represented in this matrix, if taken in a broad sense, do encapsulate what needs to be done both community-wide as well as site specifically. It is in the underlying reasoning of these measures that are important, and deviations should be noted if present in a community As has been stated before, the measures presented in this paper are mainstream land use measures that have already been employed by a number of communities in some form or fashion

The following matrix is constructed to facilitate an inventory of a community in regard to land use measures addressing urban runoff, however, another application could be to provide a list of adoptable land use measures that could insure a community's water bodies are adequately protected. In communities where there is a high level of rural to urban land conversion, this might be especially helpful

The first step in utilizing this matrix is gathering the necessary documents. Often, local planning agencies can provide the relevant documents as all of the documents required are public information

The second step is to read the documents and look for measures that are either identical to the ones listed in this matrix or similar in concept In other words, whether a measure is called a "lot set-back from streams" or a "riparian buffer," the same goal is accomplished in preserving a natural resource. In the case of general land use plans, for example, natural resource protection areas might possibly be found in land use classifications Often conversations with planning officials can help in the information gathering process as most planners that work on a regular basis either in subdivision review or general planning are familiar with the particulars of their community

The last step is to compile the information found and assess the general level of protection afforded natural resources by existing land use measures Again, the intent of this matrix is to give interested individuals or organizations an outline of sorts on acceptable land use measures relating to urban runoff This matrix is not intended to be a comprehensive or static tool, but instead one that offers guidance in how to conduct an inventory analysis

Input of Matrix Data

The data compiled in this matrix were found by contacting related planning agencies in the various communities. All of these documents were read and land use measures were identified that fit within the scheme of the matrix It should be noted that many of the measures found did not fit into the exact terms outlined previously in this thesis If the measure was related to those discussed previously, then it was noted in the compilation of matrix information. The logic being that the intent of the matrix was to inventory what measures existed and if an ordinance partly addressed that of a previously discussed land measure then it was worth noting.

In addition, the purpose of performing an inventory on two counties (and the larger communities contained within) is to give an example of how analysis of a watershed or drainage basin for a river might be conducted. Although outside the realm of this paper, communities or environmental groups wanting to conduct a policy analysis in regards to water quality as it relates to a watershed could do so in a similar fashion to that seen in the following inventory. Also, a further step in doing a watershed study would be to compile all of the measures identified into a master list that could be used as a starting point in drafting a regional watershed land use plan

The following matrixes will cover two counties and their respective planning departments

Sevier County		**Blount County**	
Sevier County Govt	*Table 4-1*	Blount County Govt	*Table 4-6*
City of Sevierville	*Table 4-2*	City of Maryville	*Table 4-7*
City of Gatlinburg	*Table 4-3*		
City of Pigeon Forge	*Table 4-4*		
City of Pittman Center	*Table 4-5*		

The format for these matrixes will be to present the completed matrix with subsequent comments to follow. Because the comments are directly relevant to the matrix presented, the comments will be presented immediately afterwards in order to avoid confusion and to make reference easier

The matrixes are also placed in their related county heading with the county government being the first one in each respective section There is specific reasoning behind the order of the matrixes as presented in this thesis In addition, comments were only made as either a point of clarification or in application to the matters discussed in this thesis

Table 4-1 Sevier County Water Quality-Oriented Land Use Control Matrix

County Name: Sevier **State:** Tennessee **Date of Input:** August 9, 2000			
	Subdivision Regulations	**Land Use Ordinances**	**Landscape Ordinances**
Does this Land Use Measure exist in the community?	YES	NO	NO
Natural resource protection standards Are there any provisions that make attempt to protect resources such as groundwater recharge areas, wetland areas, significant wildlife habitats, particularly scenic areas, and free-flowing streams?			
Restrictions related to soil type Is development restricted in areas with certain soil types?			
Special reserve areas or districts Do provisions exist that allow for special areas or districts such as resource protection or rural agriculture?			
Maximum impervious surface Do any restrictions exist on the maximum amount of impervious surface being allowed in a development or area?			
Minimum open space or open space ratio Is there a minimum amount or required amount for open space in developments?	YES		
Slope maximums for development Do restrictions exist that prohibit or restrict development in areas with steep slopes?			
Flood Plain restrictions Do restrictions exist that limit types of development within flood plains?	YES		
Riparian or waterway setback or buffers Are there requirements that state minimum setbacks or buffers around riparian areas?			
Tree Protection Zone Are there provisions that protect soil or tree disturbance/removal?			
Other measures or comments Are there requirements contained that are not listed or are similar to those described above Please list and describe under the appropriate column			

Table 4–1 (Continued)

Summary of Sevier County Use Control Matrix Input

Subdivision Regulations

- **Minimum Open Space:** A possible dedication of 10 percent of gross area could be required if the area being developed is planned to be (per the official map) designated either a school, park or public access (usually waterfront) While this is not "open space" in the context intended, it was the only open space provision found
- **Flood Plain Restrictions:** Land subject to flooding or deemed topographically unsuitable cannot be developed for residential purposes.

Land Use Ordinances Although a county-wide land use ordinance does not exist, the Sevier County Commissioners have asked for and received permission to place the question of whether or not the citizens want a county-wide zoning amendment on the next ballot

Comments

Sevier County presents an example of a situation where there are no other land use ordinances other than subdivision regulations However, the existing subdivision regulations contain some ordinances of benefit to solving the problem of urban runoff

TABLE 4-2 Sevierville Water Quality-Oriented Land Use Control Matrix

Community, City or County Name: Sevierville **State:** Tennessee **Date of Input:** August 9, 2000			
	Subdivision Regulations	**Land Use Ordinances**	**Landscape Ordinances**
Does this Land Use Measure exist in the community?	YES	YES	YES
Natural resource protection standards Are there any provisions that make attempt to protect resources such as groundwater recharge areas, wetland areas, significant wildlife habitats, particularly scenic areas, and free-flowing streams?			
Restrictions related to soil type Is development restricted in areas with certain soil types?			
Special reserve areas or districts Do provisions exist that allow for special areas or districts such as resource protection or rural agriculture?			
Maximum impervious surface Do any restrictions exist on the maximum amount of impervious surface being allowed in a development or area?			
Minimum open space or open space ratio Is there a minimum amount or required amount for open space in developments?	YES		
Slope maximums for development Do restrictions exist that prohibit or restrict development in areas with steep slopes?			
Flood Plain restrictions Do restrictions exist that limit types of development within flood plains?	YES	YES	
Riparian or waterway setback or buffers Are there requirements that state minimum setbacks or buffers around riparian areas?		YES SEE FLOODPLAIN	
Tree Protection Zone Are there provisions that protect soil or tree disturbance/removal?			
Other measures or comments Are there requirements contained that are not listed or are similar to those described above Please list and describe under the appropriate column			PLANTING MINIMUMS, PARKING LOT BUFFERS

Table 4–2 (Continued)

Summary of Sevierville Land Use Control Matrix Input

Subdivision Regulations

- **Minimum Open Space:** A possible dedication of 10 percent of gross area could be required if the area being developed is planned to be (per the official map) designated either a school, park or public access (usually waterfront) While this is not "open space" in the context intended, it was the only open space provision found
- **Flood Plain Restrictions:** Land "subject to flooding," as referred to in the ordinance, cannot be developed for residential purposes.

Land Use Ordinances

- **Flood Plain Restrictions:** Finished floor elevations should be one foot above the 100-year flood elevation No buildings or permanent structures are allowed within 10 feet of an established floodway. On any stream without an established floodway, no building or permanent structure is allowed within 10 feet of the top of the bank of the stream. The prior in some ways fits the criteria of a riparian buffer, however, the requirement that the waterway not have an established floodway mitigates the benefit of such a buffer for water quality purposes but does serve to protect property Also contained within the Land Use Ordinances is the establishment of a Flood Plain District (FP-1)

- **Other Measures or Comments:** In the Landscape Ordinance are two provisions that relate to impervious surfaces in that although intended to beautify parking lots, these measures could also be deemed of benefit in mitigating runoff The first requirement is that there be plantings along the edge of parking lots bordering on natural areas The second requirement is that for the interior areas of parking lots (particularly "islands"), a minimum of one tree per 300 square feet of interior area is required. Granted, neither of these fit firmly within the intent of the matrix, however, they are related to impervious surfaces.

Comments·

An interesting component of the Sevierville study was that within the landscape ordinance there is a requirement of a buffer strip around parking lots. The requirement for such a strip seems to be largely for aesthetic reasons, as there is no reference otherwise, however, the requirement is an example of how concern for aesthetics can help to minimize urban runoff as such strips help contain runoff wastes to some degree. It illustrates that such requirements could be adopted by communities to promote both aesthetic and environmental values, if adopted with both values in mind

As mentioned previously, many feel landscape ordinances are largely focused on aesthetics; however, there are greater applications and benefits that can be derived from such ordinances if the measures are adopted with environmental benefits as well as aesthetic ones in mind

TABLE 4-3 Gatlinburg Water Quality-Oriented Land Use Control Matrix

Community, City or County Name: Gatlinburg **State.** Tennessee **Date of Input:** August 9, 2000			
	Subdivision Regulations	**Land Use Ordinances**	**Landscape Ordinances**
Does this Land Use Measure exist in the community?	YES	YES	NO
Natural resource protection standards Are there any provisions that make attempt to protect resources such as groundwater recharge areas, wetland areas, significant wildlife habitats, particularly scenic areas, and free-flowing streams?		YES	
Restrictions related to soil type Is development restricted in areas with certain soil types?			
Special reserve areas or districts Do provisions exist that allow for special areas or districts such as resource protection or rural agriculture?		YES	
Maximum impervious surface Do any restrictions exist on the maximum amount of impervious surface being allowed in a development or area?			
Minimum open space or open space ratio Is there a minimum amount or required amount for open space in developments?	YES	YES	
Slope maximums for development Do restrictions exist that prohibit or restrict development in areas with steep slopes?		YES	
Flood Plain restrictions Do restrictions exist that limit types of development within flood plains?	YES	YES	
Riparian or waterway setback or buffers Are there requirements that state minimum setbacks or buffers around riparian areas?			
Tree Protection Zone Are there provisions that protect soil or tree disturbance/removal?		YES	
Other measures or comments Are there requirements contained that are not listed or are similar to those described above Please list and describe under the appropriate column			

Table 4–3 (Continued)

Summary of Gatlinburg Land Use Control Matrix Input:

Subdivision Regulations

- **Minimum Open Space:** A possible dedication of 10 percent of gross area could be required if the area being developed is planned to be (per the official map) designated either a school, park or public access (usually waterfront) While this is not "open space" in the context intended, it was the only open space provision found
- **Flood Plain Restrictions:** Land subject to flooding or deemed topographically unsuitable cannot be developed for residential purposes.

Land Use Ordinances

- **Flood Plain Restrictions:** FP-1 is a designated "floodplain district." Within a 500-year floodway no permanent structures are allowed. There also exists a "Small Stream Flooding District" where a flood hazard is present and encroachment by either fill material or permanent structure is not allowed within a distance of the stream bank equal to two times the width of the stream (measured from bank to bank) at the top of the bank or 10 feet each side form the top of the bank, whichever is greater
- **Slope Maximum:** Residential areas are allowed varying densities, however, "hillside" or "slope" developments are required to have lower densities to minimize "storm water runoff" according to the ordinance Multifamily

developments on steep slopes are required to be clustered to decrease public infrastructure requirements Planned Unit Developments (PUD) are encouraged for all developments, however, if the slope is greater than 15 percent, then a PUD is required

- **Natural Resource Protection Standards:** In environmental and/or geologically sensitive areas, allowable densities will be "lowered " Natural drainage areas are protected from development Local streams which do not meet state standards for recreational and other uses shall be cleaned up and protected from further degradation according to the ordinance
- **Minimum Open Space:** Larger commercial developments are required to develop small, personal open spaces as part of their landscaping plans.
- **Tree Protection:** The number of large mature trees removed due to development shall be kept to a minimum
- **Special Reserve Areas:** Density of commercial development within Glades area is restricted so that existing open space can be maintained and general characteristics can be preserved

Comments

It should be noted that much of the City of Gatlinburg operates in apparent violation of their own ordinances in regards to floodway development and ridge top development as it relates to density

TABLE 4-4 Pigeon Forge Water Quality-Oriented Land Use Control Matrix

Community, City or County Name: Pigeon Forge **State:** Tennessee **Date of Input:** August 9, 2000			
	Subdivision Regulations	**Land Use Ordinances**	**Landscape Ordinances**
Does this Land Use Measure exist in the community?	YES	YES	NO
Natural resource protection standards Are there any provisions that make attempt to protect resources such as groundwater recharge areas, wetland areas, significant wildlife habitats, particularly scenic areas, and free-flowing streams?			
Restrictions related to soil type Is development restricted in areas with certain soil types?			
Special reserve areas or districts Do provisions exist that allow for special areas or districts such as resource protection or rural agriculture?			
Maximum impervious surface Do any restrictions exist on the maximum amount of impervious surface being allowed in a development or area?			
Minimum open space or open space ratio Is there a minimum amount or required amount for open space in developments?	YES		
Slope maximums for development Do restrictions exist that prohibit or restrict development in areas with steep slopes?			
Flood Plain restrictions Do restrictions exist that limit types of development within flood plains?	YES	YES	
Riparian or waterway setback or buffers Are there requirements that state minimum setbacks or buffers around riparian areas?		YES	
Tree Protection Zone Are there provisions that protect soil or tree disturbance/removal?			
Other measures or comments Are there requirements contained that are not listed or are similar to those described above Please list and describe under the appropriate column			

Table 4–4 (Continued)

Summary of Pigeon Forge Land Use Control Matrix Input

Subdivision Regulations

- **Minimum Open Space:** A possible dedication of 10 percent of gross area could be required if the area being developed is planned to be (per the official map) designated either a school, park or public access (usually waterfront). While this is not "open space" in the context intended, it was the only open space provision found
- **Flood Plain Restrictions:** Land subject to flooding or deemed topographically unsuitable cannot be developed for residential purposes

Land Use Ordinances

- **Flood Plain Restrictions:** FP-1 is a designated "floodplain district " Any structure proposed within 50 feet of any main drainage channel or stream must be approved by Planning Commission.
- **Riparian Buffer:** No building is permitted within 15 feet of the top of the bank of any stream

Comments

A riparian buffer of 15 feet is perhaps of little or any benefit However, if a community or environmental group were interested in improving water quality, requests could be made to increase the buffer area to one that is of a beneficial size

TABLE 4-5 Pittman Center Water Quality-Oriented Land Use Control Matrix

Community Name: Pittman Center **State:** Tennessee **Date of Input:** August 9, 2000			
	Subdivision Regulations	**Land Use Ordinances**	**Landscape Ordinances**
Does this Land Use Measure exist in the community?	YES	YES	NO
Natural resource protection standards Are there any provisions that make attempt to protect resources such as groundwater recharge areas, wetland areas, significant wildlife habitats, particularly scenic areas, and free-flowing streams?			
Restrictions related to soil type Is development restricted in areas with certain soil types?			
Special reserve areas or districts Do provisions exist that allow for special areas or districts such as resource protection or rural agriculture?		YES	
Maximum impervious surface Do any restrictions exist on the maximum amount of impervious surface being allowed in a development or area?			
Minimum open space or open space ratio Is there a minimum amount or required amount for open space in developments?	YES		
Slope maximums for development Do restrictions exist that prohibit or restrict development in areas with steep slopes?			
Flood Plain restrictions Do restrictions exist that limit types of development within flood plains?	YES	YES	
Riparian or waterway setback or buffers Are there requirements that state minimum setbacks or buffers around riparian areas?		YES	
Tree Protection Zone Are there provisions that protect soil or tree disturbance/removal?			
Other measures or comments Are there requirements contained that are not listed or are similar to those described above Please list and describe under the appropriate column			

Table 4–5 (Continued)

Summary of Pittman Center Land Use Control Matrix Input·

Subdivision Regulations

- **Minimum Open Space:** A possible dedication of 10 percent of gross area could be required if the area being developed is planned to be (per the official map) designated either a school, park or public access (usually waterfront) While this is not "open space" in the context intended, it was the only open space provision found.
- **Flood Plain Restrictions:** Land subject to flooding or deemed topographically unsuitable cannot be developed for residential purposes

Land Use Ordinances

- **Special Reserve Areas:** Within the ordinance is a provision for an Open Space/Recreational District which allows for protection of excessive slopes, poor soils and other environmental concerns.
- **Flood Plain Restrictions:** F-1 is a designated "floodplain district " Any permanent structure proposed within this area must be approved by the Planning Commission
- **Riparian Buffers:** There must be a 10-foot vegetation and ground-cover buffer around streams or "water courses " A minimum building setback of 25-feet for buildings adjacent to watercourses and the 10-foot vegetation buffer can be included in the 25-foot calculation

TABLE 4-6 Blount County Water Quality-Oriented Land Use Control Matrix

County Name: Blount **State:** Tennessee **Date of Input:** August 9, 2000			
	Subdivision Regulations	**Land Use Ordinances**	**Landscape Ordinances**
Does this Land Use Measure exist in the community?	YES	YES in effect as of 9/1	NO
Natural resource protection standards Are there any provisions that make attempt to protect resources such as groundwater recharge areas, wetland areas, significant wildlife habitats, particularly scenic areas, and free-flowing streams?			
Restrictions related to soil type Is development restricted in areas with certain soil types?			
Special reserve areas or districts Do provisions exist that allow for special areas or districts such as resource protection or rural agriculture?			
Maximum impervious surface Do any restrictions exist on the maximum amount of impervious surface being allowed in a development or area?			
Minimum open space or open space ratio Is there a minimum amount or required amount for open space in developments?			
Slope maximums for development Do restrictions exist that prohibit or restrict development in areas with steep slopes?	YES		
Flood Plain restrictions Do restrictions exist that limit types of development within flood plains?	YES	YES	
Riparian or waterway setback or buffers Are there requirements that state minimum setbacks or buffers around riparian areas?	YES		
Tree Protection Zone Are there provisions that protect soil or tree disturbance/removal?			
Other measures or comments Are there requirements contained that are not listed or are similar to those described above Please list and describe under the appropriate column			

Table 4–6 (Continued)

Summary of Blount County Land Use Control Matrix Input

Subdivision Regulations

- **Flood Plain Restrictions:** Land subject to flooding or deemed topographically unsuitable cannot be developed for residential purposes unless hazards are mitigated to a point of satisfaction to the county
- **Riparian buffers:** In order to "lessen the constant potential of water pollution from septic fields," a water hazard area exists to serve as a buffer Originally these buffers were larger than they presently are, however, because of continued approval of variances, the buffers have been lessened to their present sizes. For areas along Fort Loudon reservoir, the water hazard area extends 25-feet from the 820' contour Originally this buffer was 100-feet Along the Little River, as well as any major other creeks and continuously flowing streams, the water hazard area or buffer is 25-feet from the edge of bank (originally 100-feet)
- **Slope Maximums:** Land with a slope greater than 40 percent is deemed undevelopable unless the developer can show proposed plans are feasible If a subdivision has an average slope of 15 percent or greater with an area greater than 15 acres, then a special development standard applies under the designation of "hillside subdivisions " Because of the possibility that such gradient may not be suitable for development, a geologic study must be performed to make sure percolation exists and that the soils are adequate for construction

Land Use Ordinances

In June of this year (2000), the county commissioners passed a land use ordinance that goes into effect September 1 The focus of the land use ordinance is safety and public health, thus, there are few provisions that relate to environmental or conservation concerns However, the existing subdivision regulations address these issues quite well. It is anticipated that once the zoning ordinance is in place, amendments will be made similar to those found in the subdivision regulations.

- **Flood Plain Restrictions:** A flood hazard overlay district exists for areas within the 100-year floodplain which requires a development permit for such developments. Apart from numerous building safety requirements, there is a rule requiring that "new and replacement sanitary sewers be designed to minimize or eliminate infiltration of flood waters The lowest floor of a structure (residential or non-residential) must be 1 foot above base flood elevation.

Comments

This study provides an example of how an ordinance such as a riparian buffer might be contained in a subdivision regulation In addition, this study also shows how adopted measures with environmental benefits, such as the riparian buffer in this case can be reduced in effectiveness, over time, by zoning commissions through variances

TABLE 4-7 Maryville, Tennessee Water Quality-Oriented Land Use Control Matrix

City Name: Maryville **State:** Tennessee **Date of Input:** August 9, 2000			
	Subdivision Regulations	**Land Use Ordinances**	**Landscape Ordinances**
Does this Land Use Measure exist in the community?	Yes, but contained in Land Use Ord	YES	YES
Natural resource protection standards Are there any provisions that make attempt to protect resources such as groundwater recharge areas, wetland areas, significant wildlife habitats, particularly scenic areas, and free-flowing streams?			
Restrictions related to soil type Is development restricted in areas with certain soil types?			
Special reserve areas or districts Do provisions exist that allow for special areas or districts such as resource protection or rural agriculture?		YES	
Maximum impervious surface Do any restrictions exist on the maximum amount of impervious surface being allowed in a development or area?			
Minimum open space or open space ratio Is there a minimum amount or required amount for open space in developments?		YES	
Slope maximums for development Do restrictions exist that prohibit or restrict development in areas with steep slopes?			
Flood Plain restrictions Do restrictions exist that limit types of development within flood plains?		YES	
Riparian or waterway setback or buffers Are there requirements that state minimum setbacks or buffers around riparian areas?			
Tree Protection Zone Are there provisions that protect soil or tree disturbance/removal?			YES
Other measures or comments Are there requirements contained that are not listed or are similar to those described above Please list and describe under the appropriate column			

Table 4–7 (Continued)

Summary of Maryville Land Use Control Matrix Input

Subdivision Regulations. In 1988, Maryville streamlined their permitting process and combined subdivision regulations within Land Use Ordinances in what are called "Land Development Regulations " Thus, a separate document or subdivision regulations, does not exist

Land Use Ordinances or Land Development Regulations

- **Special Reserve Areas:** A unique designation exists called an "Environmental Conservation District," or District III, that is largely used as a buffer zone between the city of Maryville and a quarry located nearby. By placing this restrictive zoning designation on the land bordering the quarry the community hopes to insure that should the land change hands development will be done in a way that both preserves the area's aesthetics quality and mitigate public safety issues The designation requires that these areas be developed at a low to moderate densities with the following uses low density estate residential, recreation/open space, public/semi-public
- **Minimum Open Space:** In residential developments, there is a requirement that 0025 acres or 108 9 square feet per expected resident be dedicated to open space. However, if this formula does not generate 2,000 square feet of open space, then the requirement can be waived as it has been deemed by the Planning Commission that parks less than 2,000 square feet are not beneficial

- **Floodplain Restrictions:** Inhabited structures are not permissible within floodways Permissible uses range from golf courses to parking lots Residential development can occur, though restricted, with the threat of flood addressed by requiring that elevations of buildings be above base flood level and that there be an anchoring of accessory buildings

Comments:

The Maryville study provides an example of a community that has chosen to combine subdivision regulations with its general land use plan. According to the Maryville Planning Department, the reason for adopting one inclusive document was to help streamline applications and to avoid any complications that arise from having multiple policy documents. As might be imagined, the combined document is quite lengthy and finding ordinances related to the subdivision of land is something of a challenge as the traditional components of subdivision regulations are spread throughout the document However, according to the Maryville Planning Department, questions regarding applications and zoning variances have decreased somewhat since the subdivision regulation and land use plan were combined

CHAPTER FIVE

Summary and Conclusions

Summary

In both federal and state environmental policies that relate to water-quality issues, the problem of urban runoff is a growing priority As was seen previously, the original goal of the Clean Water Act was to address point source polluters and stop our nation's waterways from being primarily a dumpsite for industrial and municipal wastes At the time of the adoption of the Clean Water Act, many of our nation's waterways were polluted to the point of being toxic to human (and certainly aquatic) life For the most part, the nation's waterways are cleaner today than thirty years ago, which is a testament to both the validity and strategies of the Clean Water Act. Although addressed in the original Clean Water Act, the issue of nonpoint source pollution has become more prevalent in consequent revisions of the Act as the issue of point source pollution has been controlled to a large degree

The issue of urban runoff is complex because there are many contributors of nonpoint source pollution, however, regardless of the source, the effects are the same. This thesis focuses on residential development, which is a major source of 2 major contributors to urban runoff land disturbance and increased impervious surface areas arising from roadways and driveways. This area of focus is particularly important for communities, because of the stance of the EPA regarding the permitting of MS4 storm water systems, of which residential developers are major users

The phase 1 and phase 2 storm water rulings call for communities to put into place storm water strategies that minimize pollutants entering water bodies A logical starting point for most community storm water strategies is to examine present erosion control programs and development regulations in general. However, many local governments rely on existing waterways to convey storm water This makes these streams (and often rivers) a priority for local governments to clean up and put into place measures that will curtail activities that lead to further contamination Because of the inexpensive nature of land use measures to local governing authorities, it is believed that communities coming under the Phase 2 ruling will look for cheaper ways to minimize urban runoff and gearing zoning or land use to that goal is one way to accomplish best management practices. In addition, the possible adoption of nutrient standards as a water quality criteria makes containment of runoff from residential development even more critical as such developments are a major source of nutrient loading in waterways Presently, there are a variety of strategies that are employed to reduce runoff from residential development For the most part, many of these strategies are largely engineered and design-focused. Developers are encouraged to go beyond the stated minimum engineering standards, but there is little benefit to developers in exceeding requirements since such efforts translate into greater costs (and possibly lower investment returns) Thus, communities need to raise the standards in order to encourage developers to attempt to develop methods of on-site water containment that can achieve the goal of minimizing runoff

Engineered solutions are beyond the scope of this paper, and it is the opinion of the author that if such solutions are adequately employed or performed as designed that many residential storm water discharge problems can be mitigated. However, many engineered systems require maintenance and occasional improvements in order to be effective, thus, their effectiveness diminishes over time

The justification for employing land use measures as a means of minimizing the problem of urban runoff lies in these two facts: urban runoff is a growing problem which is increasingly becoming a focus of state and federal policy, and engineered water control systems alone have not proven sufficient to solve the problem Land use measures employed to define allowable development terms that minimize urban runoff will help take the next step of necessary restrictions on development that are adjacent to riparian areas or areas with high environmental value

In reviewing the existing land use measures in communities in Sevier and Blount counties, it becomes apparent that there are various interpretations of how to deal with the problem of urban or storm water runoff from a land use perspective However, for the most part, this issue is not a priority for the communities inventoried and few measures exist that adequately address the issue. Assuming these communities desired to address the issue of urban runoff (or were forced to do so by regulatory means), all would have to adopt additional measures in order to address the issue or attempt compliance However, there doesn't seem to be a connection between federal/state water quality policies and land use measures Federal/state environmental policies are passed and then carried out by the appropriately designated agencies However, if communities are going to create

their own storm water programs, they must look within their own regulatory powers to determine the best course of action rather than waiting for direct orders from an environmental agency.

In summary, it would appear that land use measures are not used effectively to mitigate environmental issues. Instead, in their present state, land use measures or zoning are still largely being used to mitigate nuisance, aesthetic, and public health issues rather than to conserve and protect natural resources There are, of course, numerous exceptions to the prior statement and enormous efforts have been made in some communities to use land use measures more effectively to protect natural resources; however, the fact remains that the public (notably developers) resist the notion of protecting natural resources at the expense of development More importantly, particularly as seen in the Sevier and Blount county surveys, some environmental protection land use measures may exist, but not with enough restrictions to produce a notable impact or be considered protective

Conclusions

This thesis draws several conclusions regarding the topic of urban runoff and how communities can deal with the issue through land use measures.

The first conclusion is that this area is of growing regulatory focus and will become a major environmental challenge for communities Although the Clean Water Act focused on point source polluters, a growing priority in addressing nonpoint source pollution is evident, particularly after the 1987 revision of the Clean Water Act As

discussed previously, this revision calls for the permitting of municipal storm sewerage systems (notably MS4) systems and challenges communities to minimize loading of these systems at major sources such as. residential development Consequent revisions to the storm water ruling have made minimizing soil disturbance a priority as seen in lowering the size of developments requiring permits from 5 to 1 acre In addition, the possibility of adding nutrients to water quality standards (particularly turbidity) indicates that regulatory efforts are being directed at minimizing the effects of soil disturbance arising from development Communities will soon be forced to deal with the issue of storm water or urban runoff Trying to tackle the problem without looking at existing residential development practices will make the problem harder to solve, in particular if standards for permits become more stringent (as in the case of incorporating nutrient restrictions into water quality standards) The continued trend in urbanization of rural areas and increased housing demand puts residential development at the forefront of activities contributing to soil disturbance

The second conclusion of this thesis is that adoptable land use measures exist and can be used to address the issue of urban runoff More importantly, most of these measures are "common sense" and are in keeping with providing quality housing. The land use measures discussed in this paper are, in the opinion of the author, "developer friendly," as none of them places an undue burden on the developer in reaching compliance. Instead, the land use measures suggested in this paper insure that housing is not built on areas prone to flooding and that extensive efforts be made to mitigate such things as steep gradient or soils that are poorly suited for development The measures

contained also stress something akin to a "land ethic," where some areas are protected from development as their value environmentally is either irreplaceable or necessary to preserve ecological functions in a community As explained in detail previously, the benefit for a few individuals arising from developing such areas, pales in comparison with the loss of benefits to the masses who need the ecological benefits arising from such areas

In addition, the content of subdivision regulations, land use plans and landscape ordinances are open to broad interpretations. Thus, ideally, any of these policy instruments could be adopted to contain measures addressing the issue of urban runoff

The third conclusion is that most communities do not have adequate zoning measures in place to mitigate the issue of urban runoff effectively. A major reason for this is that there has not been a federal or state priority in relation to this, and for most communities the problem of urban runoff is not seen as a high priority. It is the belief of the author that this will change over the next decade as regulations regarding this matter tighten. Even so, there are few land use measures already existing that developers must contend with that address the issue of urban runoff, which means an inordinate amount of importance is placed on engineered solutions In an effort to better balance the solutions associated with urban runoff, a strategy that involves engineered solutions *and* land use measures is ideal.

The fourth conclusion is that land use measures are an appropriate way to help protect natural resources and should be used more often to do so. The original justification for zoning was to protect the public from health risks and nuisances This

justification was grounded in the belief that individuals have the right to a certain standard or quality of life. Citizens have a right to swimmable, fishable and perhaps drinkable community water resources. Allowing a river or stream to be so contaminated that it is unusable to humans (much less wildlife) means that the rights of the public have been infringed on by a very limited number of entities that received economic benefit from being allowed to discharge pollutants into a waterway instead of handling the wastes in a more environmentally-friendly manner In many ways this is akin to allowing an industrial operation to locate in the midst of a neighborhood and proceed to belch smoke and particulate matter upon the surrounding residents. Following this analogy, if zoning can be used to mitigate that sort of nuisance, then the same manner of regulation should be available to protect community water resources Rivers, streams and lakes belong to all citizens and protection should be in place that allows their use by many rather than a few.

It is the intent of this thesis to provide a set of measures that could be used either by planning agencies wishing to address the issue of urban runoff in their ordinances or by concerned citizens or environmental groups wishing to ascertain their communities' level of preparedness in addressing the issue of urban runoff With the impending implications arising from the phase 1 and phase 2 storm water rulings, communities can look at development standards and put into place requirements that minimize soil erosion and more importantly the contamination of water bodies. Another application of this thesis might be in helping environmental groups better understand what opportunities land use measures provide for protecting water resources

The fifth and final conclusion is that the problem of nonpoint source pollution is at an early stage of understanding as to the nature of the environmental problem created and the most effective way of addressing it. The problem itself is very complex with numerous variables contributing to an already complex situation. Thus, much of what is known or can be quantified about the problem as a whole is limited as attention is just now being directed in understanding this growing environmental problem. Consequently, the measures presented in this thesis are done so without supporting scientific analysis in relation to how they minimize nonpoint source pollution

It should be noted that there are several other values to communities adopting the measures presented in this thesis Communities could embrace these measures primarily to enhance aesthetic and biodiversity values while realizing as a secondary benefit the mitigation of nonpoint source pollution.

In many ways, this thesis is a work in progress in that it initiates discussion of utilizing land use measures to help solve the problem of urban runoff. The concepts outlined in this thesis are of a policy-review nature in hopes of helping stimulate advocacy in addressing the growing problem of urban runoff. This advocacy approach is contrasted to that of a more investigative or scientific analysis of the benefits of the land use measures presented Thus, the intent of this thesis is to capitalize on the regulatory efforts that have been initiated to curtail urban runoff In addition, it is hoped that this thesis will contribute to the dialogue that land use measures be applied to address the problem of urban runoff Also, as more scientific data emerges, it is hoped that this dialogue will help communities be more open to embracing land use measures that reflect

an orientation to proper stewardship of the environment as a solution to urban runoff versus engineered solutions which can sometimes have negative environmental impacts

As has been mentioned previously, the issue of urban runoff is critical to maintaining the health of our nation's waterways Most would not consider residential development to be a contributor to one of our nation's growing water quality problem; however, the fact remains that inordinate amounts of urban or storm water runoff contaminate waterways and should be kept on-site Because urban runoff is a land-based problem, the crux of this thesis is that it should be addressed with land-based solutions such as land use measures

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River Network· Grassroots organization that helps communities mobilize and protect their watersheds or rivers: *rivernetwork.org*

Tennessee Department of Environment and Conservation: *state tn us/environment/*

National Water Summary· also referred to as U S Geological Survey's (USGS) "Encyclopedia of Water " *http.//water usgs gov/newsum/index.html*

EPA websites:

Surf your watershed: *www epa.gov/surf/*

STORET database· an enormous database of water quality information gathered by agencies and other reliable sources over many decades. *epa gov/OWOW/STORET*

Toxic Release Inventory: a summary of reported releases of toxic substances to the environment. *epa.gov/surf2/locate/map2 html*

Index of Watershed Indicators. a synthesis of information from various sources for 15 different water resource indicators by watershed Indicators of water quality condition and vulnerability are combined to characterize each watershed in terms of its water quality problems and its vulnerability to threats. *epa.gov/surf/iwi/*

Enviromapper for Watersheds interactive mapping tool allowing users to look at many geographical levels of environmental data. *epa.gov/surf2/iwimapper/enviromapper/*

Information on phase II implementation of storm water discharges program *epa gov/owmitnet/sw/phase2*

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VITA

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He also holds the Certified Commercial Investment Member or CCIM professional designation, which is a common designation for commercial real estate developers and brokers Attainment of the CCIM designation requires extensive coursework, adequate work experience, presentation of a major project or paper and passage of a comprehensive exam