

A Greenways Approach to Resource Management:

The Process of Environmental Corridor Design

by

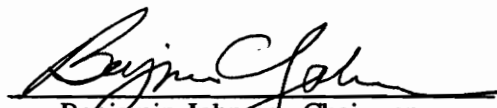
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THE PROCESS OF RIPARIAN CORRIDOR DESIGN

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(ABSTRACT)

The many miles of our river and stream corridors are some of our country's most valuable resources. The lands adjacent to rivers possess important agricultural soils, wetlands, fish and wildlife habitats, floodplains, historic communities and places for recreation. In the United States, early uses of rivers include; thoroughfares for crop exportation and exploration, and important source of water for many uses, and places to dispose of unwanted wastes. Recently, efforts to improve water quality have resulted in a new awareness of the nation's rivers and streams. This growing public recognition that rivers have many other values besides simply traditional economic uses has resulted in the multi-objective river corridor management activities which are occurring in numerous cities and countryside's across the country. Often termed greenways, these projects are generally grassroots efforts to preserve ecologically sensitive resources and at the same time provide for a growing recreational demand.

A key feature, essential to the success of these projects, is the development of cooperative public and private partnerships, incorporating multiple objectives into the planning process. This thesis is an attempt to analyze that process and break it down into general terms in an effort to provide a framework for communities to follow when entering into greenway planning projects.

The methodology used to get at this process is a combination of; reviewing the existing literature available on corridor design and grassroots movements, as well as an in depth look at successful river greenways in an effort to extract the critical elements involved in environmental and recreational corridor planning. With an understanding of these elements, a process is constructed which highlights the essential steps in the planning process and their order of implementation.

Once the process model is constructed, it is then applied to a site in order to illustrate the process and how it can be fine tuned to meet the needs of a specific region and community.

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CHAPTER 1

Introduction

Greenways are defined by many planners as corridors of protected open space managed for conservation and recreation purposes. They generally follow natural land or water features, and link cultural features, historic sites, parks and nature reserves with each other and with populated areas. In rural areas, greenways are planned natural corridors linking large natural areas such as; state parks, national forests or wildlife refuges. Rural greenways preserve native habitats and wildlife migration routes, and can be an impetus to restore ecologically valuable landscapes. In conjunction with existing and proposed recreational trail systems, rural greenways have the ability to form a green infrastructure for America's countryside's, and ultimately a nationwide network of trails and conservation corridors.

The Virginia Department of Conservation and various planners believe that few other conservation and recreation efforts produce as many varied benefits and provide for such multiple uses as greenways. They function in many ways, serving to:

- connect people, communities, and countryside
- link important cultural and historic sites - fostering greater awareness and appreciation for them
- improve water quality by buffering streams and trapping pollutants
- help protect the quantity of water, a natural resource vital to people, plants and wildlife
- reduce flood damages
- direct development and growth away for environmentally sensitive areas
- provide important open space resources
- enhance economic development
- increase property values of homes and lands
- help preserve the biological diversity of plant and animal species by maintaining the connections between natural communities
- improve the quality of life by providing areas for hiking, biking, picnicking, fishing, strolling, and other recreational activities, passive and active
- build community pride
- foster a land ethic within the community through conservation and environmental education

With the successful planning and implementation of greenway projects, we as a nation will come closer to building a green infrastructure which would connect our country's cultural and recreational resources, while at the same time ensure the preservation of many of our valued natural resources.

Land Ethic

The implications of the rising demand for recreational amenities in the countryside are many - conflicts with traditional rural land uses, congested country roads, sensitive flora & fauna at risk and pollution of air, soil & water are a common concern as well as an occurrence. Not only are there environmental barriers to greenway planning, but logistical and physical ones as well. Communities often want to protect and enhance their precious natural and cultural resources, however the task often appears overwhelming. Because each greenway project is so different, there is really no prescription for communities to follow. It is possible, however, to derive a framework for greenway planning, design, implementation and management.

The following thesis is an attempt at understanding the complex whole of environmental greenway planning and implementation. Riparian corridors offer excellent locales for active and passive recreation, however, this recreation cannot go unchecked. It is this designer/researchers belief that all riparian greenways can be designed to meet the needs of the environment first and the recreational needs of a country's growing population second. Due to the vulnerability of riparian corridors and thier minimal protection, greenways are a satisfactory approach to regional environmental planning. Creating a multi-use, multi-functional greenway is desirable and appropriate to riparian corridor design, however, the design should be well thought out, eliminating recreational facilities in environmentally critical areas. This is a design thesis, it is an exploration into design approaches for environmental design of riparian corridors. The hypothesis of this project is "How does a designer plan for multi-use greenways, which has environmental protection as a primary goal, and at the same time plan for recreational use without this use severely impacting the ecology of a given area?"

The thesis begins with a review of the existing literature which is helpful in understanding the modern day phenomenon of greenways. It starts with the identification of our current environmental problems and why greenways are an appropriate solution to these problems. It goes on to define certain landscape elements which are common to all riparian corridors and

investigates their interrelatedness with each other. A brief overview of the history of greenways is discussed, followed by a look at a variety of planning strategies which are commonly used to protect and acquire lands.

Secondly, a collection of greenway case studies are reviewed in an effort to determine the greenway process carried out in successful projects and gain an understanding of how these projects have dealt with the issues that arise in multi-use, multi-functional greenway design. With this understanding a process model is constructed, which lays out a framework for the process of deriving planning strategies, delineating corridors, trail design & environmental mitigation, and the management of environmental riparian corridors.

With a general knowledge of how the overall process works, it is then applied to a site in an effort to illustrate the process and provide an understanding of how this general process model can be fine tuned to meet the conditions of a specific project. For the purposes of this project, one key issue of the process model is extracted and explored in depth. This key issue is the corridor delineation process, which this designer sees as the most important issue to explore in the beginning stages of planning for an environmental riparian corridor as well as providing a vision document which can later be integrated into other aspects of the greenway process.

The overall product of this thesis is a general process model for the planning and the resulting design of a network of riparian corridors in central Virginia. It is hoped that this work will be instrumental in the actualization of not only central Virginia's environmental corridors, but for the design of other riparian corridors as well.

Problem Statement

Due to the multiple uses and benefits of greenways, communities large and small, urban and rural, are turning to the greenway concept as a viable solution to environmental protection, regional recreation planning, economic development and historic preservation. Simultaneously, ISTEA (Intermodal Surface Transportation Act) moneys have recently become available for a variety of transportation alternative projects. Consequently, greenways fall into this category and ISTEA funding is a first choice for many greenway planners. Because of this increased interest in greenway planning as well as the availability of funding moneys, this researcher saw the need to outline the general greenway planning process in an

effort to aid grassroots planners with their own projects, thus, possibly increasing their chances for getting highly sought after funding.

Equally important is the need to point out to greenway key players the fact that riparian greenways are excellent opportunities for environmental designs which can function to preserve, restore, and protect our nation's vulnerable river corridors. While many riparian corridors across the country are being developed as recreational greenways, there needs to be an understanding that it does not take any more time, money or planning to make these corridors function environmentally as well as recreationally. And, in the long run, offer many more benefits to society than simply places to swim, hike, and canoe.

With the onslaught of greenway popularity, the idea of a green infrastructure for America emerges. The linkage of these corridors from coast to coast begins to realize the actualization of this new type of infrastructure. Charles Little says that, "Many of the individual parks and nature sanctuaries acquired during the 1960's and early 1970's are intersected by linear commons of some sort - usually a stream valley, less often an open-space ridgeline, or an abandoned transportation route. What greenways can do is to multiply the utility of existing parks - ecologically, recreationally, and aesthetically - by linking them together like pearls on a strand" (Little, 1990). It is this linkage that forms the green infrastructure that can be so valuable to the environment, wildlife, and people.

The problem with many greenway designs is that they fail to address the larger ecological problems of our modern times. While ecological benefits are inherent in the greenway philosophy, a conscious effort at environmental preservation through greenway design and implementation could be a primary goal in every new and emerging greenway project. After all, an ecological design is ultimately more sustainable for humans.

CHAPTER 2

Introduction

The current phenomenon of greenways and their environmental & social implications is the subject of the following inquiry. The recent wave of greenway building in the United States is not surprising given the fragmentation of our landscapes due to little comprehensive regional planning of growth and development. As a result of this fragmentation, greenways are being built along continuous, natural corridors such as rivers and ridgelines. Recreation and conservation are the primary goals in many of these projects, however, this practice is causing concern with conservationists. While most conservationists prefer greenways over other types of land uses, unchecked recreational uses can have significant impacts on landscape ecology. Traditional methods used in the designing of recreation areas are known to impact natural systems by; jeopardizing wildlife habitats, degrading water quality by soil erosion, and destroying native vegetation. The underlying principle of conservation is that utilizing natural resources does not, in itself, pose a threat to the environment. It is the manner in which we do it that dictates whether our activities are detrimental or benign (Labaree, 1992).

Historically, landscape architects and designers have planned for greenbelts around cities and parkways linking scenic and cultural resources (Little, 1990). In an effort to achieve these project goals of linkage, ideas for planning strategies & tools began to emerge which could be used to acquire the needed lands and protect the lands from future development. These people were visionaries in their fields as well as the originators of today's greenway movement. Presently, there are many more sophisticated regulatory and non-regulatory planning tools which can be implemented in greenway projects, and others are being developed all the time in an effort to preserve and protect our country's remaining natural, cultural, and scenic resources.

The methods used in the delineation of these corridors have begun to change as well, giving environmental concerns priority as opposed to recreation, but, there are still many measures which could be taken to ensure a higher level ecological integrity. Innovative projects are going on around the country, although, based on the existing literature, they are the exception and not the norm. With the onslaught of greenway building in the twentieth century, along with our increasing needs to have environmentally responsible designs for the land, it seems likely that environmental preservation is an appropriate primary goal in all greenway projects.

With a general understanding of what greenways are, a look at how they can function to preserve natural resources is the next subject of inquiry. The following literature review is intended to give the reader an overview of the catalysts, key elements, and issues in landscape ecology involved in riparian greenway planning in this country. It will begin by addressing the environmental problems of our modern landscapes. It will then give a brief history of greenways, touching on their origins and the key players responsible for their beginnings. Then, a look at important corridor designers and their methods will be discussed, and built upon later in the thesis inquiry. It will follow with a broad look at some of the regulatory and non-regulatory planning tools which are available for use to greenway planners. It will conclude with a review of a recent grassroots movement, specifically the river conservation movement, in an effort to gain an understanding of the process of this movement and illustrate it.

The Environmental Problem

For years, experts in the fields of land planning, landscape ecology and landscape architecture have determined the reasons for our unhealthy landscapes; the development of land without regard for the natural processes and ecosystems of that land. Because of this disregard, many of our modern landscapes are fragmented and open spaces are lost. As a result, wildlife habitats have become broken apart, thus endangering the diversity of habitat of a wide variety of animal & plant life. Habitat loss clearly contributed to the fact that, as of 1990, 597 species of animals & plants in the United States were listed as threatened or endangered by the U.S. Fish & Wildlife Service (U.S. Department of Interior 1990, as cited in Smith & Hellmund, 1993, pg. 2).

Developments impact on the landscape becomes even more apparent when looking at how the natural systems within that landscape are functioning. When large areas of land are broken up, or fragmented by development, so are the habitats that support all species of non-human life within that regions landscape. These smaller, more isolated habitats that result support fewer native species. Developed areas that separate habitat fragments tend to discourage dispersal of individuals between populations, making them more vulnerable to genetic inbreeding and localized extinction's. This phenomenon is referred to as the biogeographic island theory. This theory predicts that small isolated islands, or patches, will experience higher extinction rates and lower immigration rates of species than large islands closer to a

species source (Smith & Hellmund, 1993, pg. 2). Also, fragmentation encourages the spread of “weedy” plants and animals that often displace or prey upon native species (Wilcove et al. 1986; Wilcox and Murphy 1985; Noss, chapter 3, Smith & Hellmund, 1993, pg. 2).

This isolation of patches, as well as the edge habitat, are two major reasons why fragmentation is so environmentally destructive. An edge habitat is an area of transition between two types of land cover. Edges exist throughout nature in many forms and are often areas of high biological diversity because two or more natural communities come together and influence each other. Plants and animals which live in each community utilize the edge as does a distinct set of species specifically adapted to ecological edges. While an edge environment which is the result of human activity can be disruptive to some species because of the resulting fragmentation, there are other species which will adapt and thrive there. There are many species which require interior spaces, shielded from the influence of surrounding lands. These are the species which are most threatened by development. Fragmentation changes the natural balance between edge and interior. Heavily fragmented landscapes may not have any interior at all (Labaree, 1992).

It is now clear that the environmental impact of human development tends to decrease the environments ability to respond to changes in two fundamental ways; reducing genetic diversity and hindering wildlife movement. As populations of plant & animal species decline, their genetic diversity also declines, diminishing their ability to adapt to long term change. In addition to genetic alterations, plants & animals respond to their changing environment through movements. Animals move in response to wildfires, hurricanes and other environmentally altering occurrences. As climate changes, both plants & animals move to stay in environments which they are adapted, fragmentation hinders this movement thus endangering the species chance for survival (Labaree, 1992, pg. 6).

As to be expected, development and the resulting fragmentation of lands has specific impacts on water quality as well. Wetlands and other lands along rivers, called riparian zones, are crucial to maintaining water quality in our streams and rivers. These lands perform important functions in regard to water quality, such as; trapping sediments, filtering out urban and agricultural pollutants, controlling floods & their impacts, and supporting an abundance of important plant & animal species. Ironically, these sensitive riparian lands are often the first to be altered due to their favorable conditions for many types of land use. However, any type of environmentally altering activity within the watershed will usually adversely affect water quality when done with traditional methods. Clear cutting, heavy grading, and the installation

of impervious surfaces are examples of these traditional land management & development methods. There are strategies which should be employed when altering the landscape in an effort to maintain water quality. Those strategies are intended to mitigate stormwater runoff, the first being to slow the overall rate of response of the stormwater flow system. This slowing will induce infiltration and settling of contaminants and reduce rates of surface flushing and erosion. One measure of system response is concentration time. If the concentration times of stormflow, especially those that flush surfaces frequently such as flows from storms in the range of 0.5 to 1.0 inch rainfall, can be extended rather than decreased with development, an important step can be taken toward water quality control (Marsh, 1991). Other mitigation strategies are discussed in more detail later in this paper.

Also helpful in understanding landscape ecology is a concept which is known as the landscape matrix. This refers to the dominant land cover of a given landscape and how that land cover is responsible for that landscapes processes, changes, and functions. Within the matrix patches are linear and non-linear elements. The linear elements of the landscape are streams, roads, and other such linear features. These elements are what make up corridors. The linkage of patches and corridors within the landscape matrix is a critical factor in ecological greenway design. With these elements in mind, along with more site-specific considerations, this arrangement can be used to provide for habitat and human need simultaneously (Smith & Hellmund, 1993).

Another important concept in environmental corridor design is that of the landscape modification gradient. This is the idea that the landscape is divided into 5 categories. These categories are dependent on the intensity of human influence on that landscape, which encompasses relatively untouched lands to the highly modified landscapes of our urban environments. The following diagram shows the five categories of the landscape modification gradient (Smith & Hellmund, 1993, pg. 27). A sixth category could be included between the last two which would be successional landscapes. These are areas which were once managed or altered in some way, but are in the process of reverting back to a quasi-natural state.

Urban --- Suburban --- Cultivated --- Managed --- Natural
Highly modified-----Untouched

In all environments and at all scales, landscape structure is a fundamental characteristic that helps determine the nature of ecological relationships. A recognition and understanding of developments impacts on these relationships is crucial to conserving and/or restoring our landscapes. By looking at the problems of the past we can begin to derive guidelines for future development, as well as for greenway building, which is compatible with the environments needs as well as human needs.

Greenways Types

In Charles Little's research he found that although greenway projects resist categorization, there are five major project types:

- 1) Urban riverside greenways, usually created as part of a redevelopment program along neglected, often run-down city waterfronts.
- 2) Recreational greenways, featuring paths and trails of various kinds, often of relatively long distance, based on natural corridors as well as public rights-of-way.
- 3) Ecologically significant natural corridors, usually along rivers and streams and ridgelines, to provide for wildlife migration and species interchange.
- 4) Scenic and historic routes, usually along a road or highway.
- 5) Comprehensive greenway systems or networks, usually based on natural landforms such as valleys and ridges but sometimes simply an opportunistic assemblage of greenways and open spaces of various kinds to create an alternative municipal or regional green infrastructure (Little, 1990, pgs. 4-5).

One of the most important traits of a greenway is that of linkage and the edge effect. Greenways provide opportunities to bring together many important resources. Whether these resources are human, ecological, historical or cultural, greenways are a unique and environmentally responsible way to unite them. Greenway diversity as well as geographic differences indicates that, ecologically and socially, greenways function differently (Little, 1990). Ecologically, greenways can protect natural areas and diminish the isolating,

disruptive effects of habitat fragmentation on wildlife and water resources. Their effectiveness on both of these counts, however, will vary according to their width, shape, location, context, and other factors (Smith & Hellmund, 1993, pg. 26). Socially, greenways provide can provide a sense of community, economic development, recreational areas, and the conservation of a regions natural & cultural resources.

History

An understanding of today's greenways movement is facilitated by a basic knowledge of its origins. The modern day greenway is the product of an evolution of ideas and actions by a variety of conservationists, planners, landscape architects, and other visionaries. In the limited literature available on greenways, the credit for being the originator of the concept is given to "the first landscape architect", Frederick Law Olmsted. Olmsted designed several parkways in the late 1800's which linked existing parks. The most notable of these were his Emerald Necklace in Boston, the Ocean Parkway in New York, and his plan for Berkeley, California, which called for linking park lands near the campus to drives and walks along the Strawberry Creek Valley. Building on this concept of linkage was Robert Moses. Moses created more parks and parkways than any other single person in history. He built parkways in the Bronx, Manhattan, Queens and Long Island. He planned his Long Island parkway to link existing parks, although he often created new parks to build parkways to (Little, 1990, pgs. 13-15).

In 1902, Ebenezer Howard introduced his idea of the "garden city". Among other things, this concept called for a country belt around these cities to maintain its urban integrity by maintaining the rural integrity. Sir Patrick Abercrombie was instrumental in making these belts possible in and around the city of London. In 1944, he proposed a plan that called for a belt which was to be five miles deep, consisting of public open spaces, as well as private holdings which would be regulated to preclude suburban development. Thus the tool of land acquisition was implemented in greenbelt projects (Little, 1990, pg. 15).

The most instrumental person in adopting the European greenbelt theory and applying it in the United States was Benton McKaye. McKaye was an important figure in regional planning during the 1920's, an active member of the Regional Planning Association of America and co-founder of the Wilderness Society in 1936 (Little, 1990 pg. 18).

McKaye's chief concerns with our traditional planning strategies was the it would eventually lead to what is now commonly known as urban sprawl. His solution to threat was to create "a

common public ground" around cities which would act a barrier to unchecked urban growth. He describes the effect of this common public ground as; "The outstanding topographic features consist of the range of hills and mountains encircling the locality together with the four ridges reaching toward the central city.....It would form a linear area, or belt around and through the locality, well adapted for camping and primitive land. These open ways along the crestlines mark the lines for developing the primitive environment, while the motor ways mark the lines for extending the metropolitan environment. The motor ways form the channels of the metropolitan flood, while the open ways (crossing and flanking the motor ways) form dams and levees for controlling the flood". McKaye not only wanted to surround cities with green "open ways", but also to bisect it with them (Little, 1990, pg. 19).

McKaye can be credited with combining the early ideas of parkways and open space networks with the European concept of the greenbelt. Regardless of these substantial achievements, he is best known for his role as the originator of the Appalachian Trail (AT), which he first proposed in 1921 in a magazines publication. This project was to be an extension of his open way concept only on a much larger scale - containing the spread of development along the eastern seaboard and at the same time providing for a primitive trail system which would cover 2,000 miles, from Maine to Georgia.

It may now be apparent that the Appalachian Trail, as it exists today, is not what McKaye had intended. He saw it as "a way to form the base throughout eastern populous America for controlling the metropolitan invasion", not as simply a hiking trail. Although, in Benton McKaye's view the AT may be a failure, it is easy to surmise how he intended the design of corridors to fill the role of a multitude of functions, such is the intent for many of our modern greenways.

In the 1960's, environmental issues were becoming more and more important in the minds of landscape architects and planners. With a recognized need for protecting natural corridors, particularly along waterways, designers looked to greenways as a vehicle to implement ecological designs. Designers such as Ian McHarg devised methods to inventory natural resources, and create designs which work for the land, causing the least negative impacts on landscape ecology.

McHarg's approach to land planning is basically that "it is necessary to understand nature as an interacting process that represents a relative value system, and that can be interpreted as proffering opportunities for human uses - but also revealing constraints, and even prohibitions to certain of these" (McHarg, 1969, pg. 127).

Based on this concept, McHarg has developed his method for ecological planning. His method has been termed "physiographic determinism", and is a method which is intended to establish priorities for development and conservation based on natural processes (Little, 1990, pg. 21). With an understanding of what greenways are, it becomes evident that these concepts produce persuasive evidence of the ecological value of greenways. For example, riparian vegetation serve many functions within the realm of landscape ecology, as well as for recreational and aesthetic purposes. They act as filters for stormwater runoff, provide food and habitat for wildlife, and have the capacity to provide for a wide range of aesthetic and recreational opportunities. Thus, a greenway along a rivers edge has the potential to protect and preserve the riparian vegetation and in turn the ecological processes occurring within that vegetation.

McHarg has devised a method for determining the appropriate land uses for a given region. The method is "a simple sequential examination of a place in order to understand it". This understanding reveals the place as an interacting system, a storehouse and a value system. From this information it is possible to prescribe potential land uses - not as single activities, but as associations of these" (McHarg, 1969, pg. 151). The method involves taking a comprehensive look at specific natural features and processes. These features and processes include; climate, geology, physiography, hydrology, groundwater, soils, plants, wildlife, slopes, water resources, and mineral resources. Once these determinants of landscape ecology are inventoried, they are then mapped individually on a clear sheet of mylar. When all of the maps are complete, they are layered upon a white base map of the region of study. It is then very easy to see where critical features are present and where they are not. There is a range of values which are given to areas where; several features are present, only a few are present, and none exist. It becomes obvious that the areas where none or only a few determinants are present, are areas which are appropriate for development. Conversely, the areas where these determinants are abundant are lands which are prime candidates for conservation. It should be noted that in more recent year, McHarg has incorporated cultural and historical determinants into this process as well as the natural ones (Little, 1990, pg. 21).

Ian McHarg was not the first to use transparent map overlays in an effort to guide land use planning according to the relative ecological value and sensitivity of each element of the landscape. Professor Phillip Lewis, director of the University of Wisconsin's Environmental Awareness Center in Madison, developed a landscape inventorying process which also stressed the importance of ecological features in guiding land conservation, placing emphasis on ecology in planning and design techniques.

Through the use of inventory map overlays, Lewis found that the majority of important ecological features were found in areas of steep topography and stream corridors. He describes these findings as, "The flat, rolling farmlands and the expansive forest have their share of beauty. But it is the stream valleys, the bluffs and ridges, the roaring and quiet waters, mellow wetlands, and sandy soils that combine in elongated designs, tying the land together in regional and statewide corridors of outstanding landscape qualities". Lewis termed these sensitive corridors, "environmental corridors" and proceeded to devise a method for determining the locations and the relative values of an environmental corridor (Little, 1990, pg. 23).

Lewis' landscape analysis involves approximately 220 environmental values, each with a corresponding symbol which is placed on a base map of the region of study. These symbols vary for specific projects, however the symbols often represent features such as; natural and man-made water resources, wetlands, vegetation, cultural, topography, wildlife, visual qualities and viewsheds. When these symbols which represent the 220 values are applied to a regional map, Lewis has found that they tend to position themselves in a linear pattern along natural corridors such as streams and ridgelines. Lewis writes; "Most of the features are found within the combined patterns of water, wetland, and steep topography of 12.5% or greater." (Little, 1990).

These findings, along with the methods used to get at the findings are all important concepts to understand when entering into greenway planning and design.

Planning

The International City Management Association has defined planning as follows; “The broad object of planning is to further the welfare of the people in the community by helping to create an increasingly better, more healthful, convenient, efficient, and attractive community environment. The physical as well as the social and economic community is a single organism, all features and activities of which are related and interdependent. These facts must be supplemented by the application of intelligent foresight and planned administrative and legal coordination if balance, harmony and order are to be insured. It is the task of planning to supply this foresight and this overall coordination” (Stokes, 1989, Smith, 1979, p.27). While the initial steps of conservation involve; identifying the issues, organizing, and inventorying resources, the actual attempts at protection is what constitutes planning.

The Comprehensive Plan is the locally adopted document that directs the future growth of most localities in Virginia. This is the community's predetermined path for the future, specifying what actions would make the community a good place in which to live, work, and visit. In other words, the plan outlines what needs to be done, and how and when to do it in an organized fashion. “Most comprehensive plans are updated every five years, with amendments occurring whenever growth rates or special circumstances dictate. Few of these plans envision a finished state, that point in the development process where the design capacity of the community will have been achieved” (Dept. of Conservation and Recreation, 1990). The Virginia Department of Conservation and Recreation are suggesting a greenways approach to comprehensive planning in the state. They believe, “One of the constraints of the comprehensive planning paradigm is that it neglects the idea of the lands carrying capacity and sustainability. There is no lines drawn between the amount of development and the quality of life of all living things. By incorporating the greenways philosophy into these plans, communities will have the assurance that the final design can be envisioned and that policies will be embraced that will ensure protection of the quality of life from the time the plan has been adopted until it has been developed to its finished state” (Dept. of Conservation and Recreation, 1990). They also contend that inclusion of environmental preservation goals in the comprehensive plan is necessary to ensure that the proper goals are being pursued. “The comprehensive plan should expound policies which can be put into action through a greenways plan. The greenway plan should be an actual part of the document so that the vision is laid out and implementation can be begin.”

An important aspect of the greenway concept, according to Va. DCR planners, is that it actually facilitates development. However, it is development with the least negative impacts on natural resources. After the appropriate environmental inventories have been made, future growth can be phased with the development of utilities and government services at a pace that the locality can manage (Dept. of Conservation and Recreation, 1990). Growth management is a major concern of all localities across the country and at all levels of government. The important thing for these localities to remember when planning for the future is that development can occur without destroying a communities cultural and natural resources.

The Virginia Department of Conservation and Recreation offers a list of policies to be adopted when building a greenways plan into the comprehensive plan. These policies focus on the environment and preserving/maintaining environmental quality as well as the formation of recreational programs in ecologically sensitive areas. Some of the implementation tools that they recommend are; the designation of agricultural and forestal districts, zoning ordinances (Planned Unit Development and Overlay Districts), inclusion of a greenways plan in the comprehensive plan, Chesapeake Bay Preservation Act regulations, proffers, donated conservation or preservation easements, and land trusts. This state office also suggests a process for greenway implementation which involves five steps. Firstly, form a planning committee that represents local interests. Then, define the quality of life factors in the community and develop criteria to determine the standards by which these features will be assessed. Thirdly, inventory historic, cultural, recreational, scenic and natural resources. Fourth, develop a plan for the best utilization of the remaining county land assuring protection of environmental values and in keeping with the rate of development of infrastructure to accommodate this growth (Dept. of Conservation and Recreation, 1990). A goal of the design phase of this thesis project is to define a design and implementation process in a more detailed, site specific manner, building upon these five steps as well as the case study research findings.

Given the inherent problems with development and the recognized need for environmental planning, greenways appear to be an appropriate method for protecting and managing river corridors and at the same time, water resources. Because greenways are a grassroots effort, the planning process tends to bring a community closer together, whether all are in favor of the plan or not, people are interacting on either side of the issue. Because of this grassroots tendency of greenways there are definite roles which need to be filled in regards to planning

issues when moving through the process. Specifically, these roles are public and private. In other words, there are specific duties which need to be carried out by state and local government officials, while simultaneously, there are duties which can be taken on by private citizens to ensure successful greenway development.

Public Roles

Zoning and Ordinances

The most important tool in land use planning is zoning. Zoning divides the land under a local government's jurisdiction into districts or zones, each of which may have different requirements, in order to regulate the use of land and the placement, size, and use of buildings. Zoning is used to segregate different and incompatible uses, such as preventing industrial uses in residential subdivisions or nonfarm residences in agricultural areas (Rails to Trails, 1993).

One of the problems with traditional zoning is that there is an assumption that all lands should be developed and the methods used for development is based on rigid, geometrical requirements such as lot size, road frontage and setbacks. Zoning treats all land as essentially the same, regardless of topography, natural features, vegetation, wildlife habitats or scenic quality. These drawbacks to traditional zoning methods were one of the catalysts for Lewis' and McHarg's work. Zoning problems often occur because while localities will devise their own master plans, they will adopt zoning ordinances from other localities which have completely different natural resources and circumstances. Zoning can be much more effective if local governments inventory their areas resources, then zone the land according to ecologically sensitive and suitable development areas. Zoning is not necessarily retroactive, thus, usually cannot protect people or their property from existing uses.

Other land protection techniques that local governments can use include; the zoning ordinance, large-lot zoning, agricultural zoning, subdivision ordinances, and the combining of zoning and ordinances.

A basic zoning ordinance defines residential, commercial, industrial and agricultural uses and designates specific areas for each uses. Uses in each zone can be exclusive or cumulative. Exclusive-use zones allow only those uses specified by the ordinance. Unrestricted zones allowing multiple uses are possible but do not allow for more specific regulation of uses as is

possible under exclusive use. Large-lot zoning may be adopted with the intent of slowing development. Under such ordinances, a house may be built only if it is located on a lot that is much larger than the 1 to 3 acre minimum lot sizes typically permitted in many rural ordinances. Critics feel that often large-lot zoning can do more harm than good because while the intent is to protect land, large-lot residential may actually waste land and may increase environmental problems rather than alleviate them. Low density residential development may cause development to spread further into the country, causing pressures for more and better roads, water, sewer, and other services. Agricultural zoning, which limits nonfarm uses and often mandates very large, farm-sized lots, has as its aim the protection and maintenance of farm operations. Many agricultural zones permit nonfarm activities to the extent that they are virtually holding categories for "vacant" farmland until some kind of development comes along.

Subdivision ordinances set standards for the division of larger parcels of land into smaller ones, including specifying the location of streets, open space, utilities, and other improvements. Used in combination with zoning ordinances, the subdivision ordinance can be an important rural conservation technique. Subdivision and the subsequent development affect a community's character, its natural resources, and its public services. Good design and engineering standards mandated by subdivision ordinance can go a long way to lessen the negative impacts of development., .

Flexible Land-Use Regulations

Currently, many communities prefer to use ordinances that offer more flexibility and more land protection. Many local governments have used overlay zoning (sometimes called "critical area zoning") to protect certain resources found throughout communities regardless of zoning. These overlay zones do not change the underlying zoning, but they add additional protections for the resources that have been identified. They are superimposed over a community's various zones that are already in place, creating an additional set of requirements to be met when the special resources protected by the overlay would be affected by proposed changes. These special resources could include; stream corridors, prime agricultural land, ridgelines, wetlands, wildlife habitats, large areas of mature forests, historically significant areas, scenic road corridors, trail corridors, buffers to parkland, or whatever else the community, planners, and designers have determined worthy of preservation (Russell, 1990).

Performance systems attempt to address many of the criticisms of zoning and subdivision ordinances by establishing ways to examine the actual effects of any proposed development. Under performance systems the burden is placed on the developer to mitigate objectionable impacts before a building permit can be issued. Performance systems may be classified either as performance standards or a performance zoning and are generally applied through the use of a point system. Performance standards are applied to permitted uses in regular zoning categories in order to govern the intensity, siting, or design of a proposed development. This type of zoning takes performance standards one step further by reducing or eliminating the number of zones, so that any use might occur anywhere in the community.

Using transfer of development rights (TDR), sometimes called transfer of development credits, a local government allows development rights that are assigned through zoning to one parcel to be transferred to another parcel at a different location. In this way, the right to develop a parcel of land can be separated from the land itself; both the property and the development rights remain private property and can be sold separately. For the community, TDR's have the potential to protect large areas of the community, at little or no cost to the public, and development can be concentrated where appropriate.

Environmental Protection

Under the Virginia Wetlands Act, local governments can choose to manage wetlands within their jurisdictions through a wetlands zoning ordinance created by the state legislators. Or, in the absence of a desire for local control offered by the wetlands zoning ordinance, localities can allow such jurisdiction to be exercised by a state agency, the Virginia Marine Resources Commission. The great majority of localities exercise local control under a wetlands zoning ordinance. If local jurisdiction is chosen, local governing bodies may appoint wetlands boards to administer wetlands policy and apply criteria stated in the Act by granting or denying permits for activities affecting wetlands. Local wetlands boards are authorized to operate only under the wetlands zoning ordinance. The management policy expressed in the Wetlands Act is to "accommodate necessary economic development in a manner consistent with wetlands preservation". Although the Act requires a balance between development and preservation, it offers no definitions for "necessary economic development, or wetlands preservation". The interpretation of "necessary" may ultimately prove to be related to the costs and benefits associated with a particular wetlands disturbing activity and what may

legally constitute a taking of private property without just compensation under a given set of circumstances.

Adjustments in real estate taxes can influence conservation as well. Differential taxation lowers the tax burden on those lands a community wishes to protect from development. Rather than assessing these lands at their full market value, the local government assesses them at "use value". Another measure of using taxing authority to achieve conservation is a high capital gains tax on real estate held for the short term. This is believed to protect rural lands from short-term speculation.

To help protect rural agricultural land uses, often communities will designate agricultural districts. These districts are special areas where state and local governments may be limited in their ability to restrict farm practices, take farmland by eminent domain or annexation, or allow the construction of utilities. To participate, farmers sign voluntary agreements to keep their land in agriculture for a specific period of years, with the option of renewing. In some states, farmers must be part of an agricultural district to qualify for differential tax assessment or purchase of development rights.

Private Roles

Voluntary Techniques for Private Land Protection

Looking to the private sector for ways to protect and conserve lands offers innovative solutions to these types of problems. Creative trial and error, often born of desperation to save threatened resources, have resulted in a birth of new ideas for conservation approaches.

Conservation or preservation easements are widely used tools in open space preservation. This type of easement is an agreement between a property owner and the holder of the easement, usually a governmental entity dictating management of the property by current and future owners. This type of agreement allows a property owner to continue owning and using a property while securing its protection. Easements are an alternative to owning property outright or to such governmental regulation as zoning. Owning property outright may not be necessary if the owner can give it proper protection and public use is not the goal.

Somewhat similar to this idea is proffers. This is when developers are encouraged to proffer open space that would tie into a conservation system that links subdivisions with other preservation efforts within a given community.

Land Acquisition

Acquiring properties, whether by purchase or through donation, is usually an expensive way to protect it. However, sometimes it is the only option, particularly when planning for parks and other public uses. Some things to consider when purchasing properties are; rights of first refusal, financing property purchases, bargain sales, and donations.

To guarantee the opportunity to purchase important properties, an organization can use either a right of first refusal or an option to purchase a property. By granting a right of first refusal, a property owner agrees to notify a prospective purchaser that the property is to be offered for sale and give the purchaser the opportunity to match a reasonable offer, typically within ten to ninety days. An option to purchase a property generally involves paying a landowner for the guarantee that the landowner will reserve the property at a pre-determined price for a set period of time, typically ninety days to a year. This is helpful if an organization needs time to raise the needed funds to purchase the land.

An organization has a number of options that may make acquisition more affordable for them and more attractive to the property owner. For example, an installment sale enables the organization to spread its outlay of funds over time, and may in some cases enable the seller to spread any capital gains tax liability over several years. Another approach to acquiring property outright is a lease-purchase agreement, whereby the rent under the terms of the lease is applied toward a pre-determined purchase price. If for some reason the buyer cannot secure the future funding, it can terminate the lease-purchase agreement.

A bargain sale allows an organization to acquire a property partly as a purchase and partly as a gift by buying property at less than its fair market. The seller sets a price below the appraised value of the property and considers the difference to be a gift, for which he or she can claim a charitable income tax deduction. The seller's compensation, therefore, is a combination of cash and lowered taxes.

Donations of lands are sometimes made to nonprofit organizations and local governments. Organizations offered such gifts should make sure that they can afford the responsibility of management before accepting the property, or make sure they can sell it under the terms of the gift.

Voluntary Property Protection Planning

Land trusts are an important non-regulatory tool which can be used when attempting to preserve open space. Generally they are established to protect areas of significant natural diversity, important recreational opportunities, or both. These trusts are non-profit organizations which acquire land at bargain prices or donations. They then receive tax deductions on that land because of the reduced purchase price. Next, they evaluate the potential of that land based on its ecological constraints, and sell off the developable land with deed restrictions attached. The remaining land is then managed in such a way as to preserve and protect its resources. Land trusts are becoming a frequently used method of obtaining lands for all types of conservation. In Virginia there are only a few existing trusts, however, they are very much encouraged when attempting to preserve open space. Other non-regulatory tools include; transferable development rights, purchased development rights, mandatory dedication, and impact fees.

The planning tools mentioned here are appropriate for use in greenway implementation and are generally important steps in successful projects. Every greenway process will need to employ a combination of these planning tools in order to obtain & protect the necessary lands, whether they are owned by the government, private citizens, or organizations. It is difficult to stress just how important these planning tools are to an infant project. In terms of acquiring and protecting the needed lands, the successful implementation of regulatory and non-regulatory planning tools, is a critical step in a greenway strategy. A thorough review of the planning tools available in a given area should be an early step in greenway planning.

Citizen Movements - River Conservation

When trying to understand private roles in planning for conservation, a look at the Wild & Scenic River movement is helpful and informative. This movement to protect rivers is a multiple objective combination of local efforts to conserve and protect rivers across the country. River conservation is local politics, requiring organized public involvement to work with local governments.

From the turn of the century until the mid 1950's river protection was focused on a few, select rivers, often motivated by dam building within parklands. By 1955, a new vigor was given to river protection, when coalition groups formed and fought plans to dam the Green and Yampa Rivers in Dinosaur National Monument. It is at this point that river conservation took on a broader scope of concerns (Palmer, 1993).

Public interest and citizen action over dams, streambed destruction, water pollution and shoreline development paved the way for new and different attitudes about the use and management of rivers. A national movement now exists as well. This is in the form of an organization called American Rivers, which has advocated the nationwide protection of rivers since 1973. This organization was a result of the passing of the Wild and Scenic rivers Act in 1968. Designation of a wild and scenic river prohibits dams and other federal projects destructive to waterways. Federal agencies may not permit hydroelectric diversions or other damaging activities requiring a federal license. The program recognizes the importance of riverfront land protection, but instead of expensive and unpopular land acquisitions, the act encourages the use of easements, partial ownership including development rights - that allow residents to stay and keep their property but not develop the land.

Within this act there are other possible classifications of rivers depending on the amount of access and shoreline development present along the river corridor. These classifications are; wild, scenic and recreational. Wild rivers are "vestiges of primitive America", and are generally inaccessible by roads. Scenic rivers are mostly "primitive" with shorelines "largely undeveloped". Recreational rivers are "readily accessible by roads" and may have more development. To be eligible for designation, a river segment (which can include streams), must be free flowing and have one or more "outstandingly remarkable" features - scenic, recreational, geologic, fish and wildlife, historic, cultural, or other similar values (Palmer, 1993, pg. 8).

In addition to federal protection, many states have implemented river protection programs which enhance the federal designation by protecting additional waterways (Palmer 1986, Stokes et al 1989, Smith & Hellmund, 1993, pg. 8). The passing of these federal and state legislation's along with the increased demand for outdoor recreation has made riparian corridors a prime location for greenway development.

Greenway Building

Greenways are being created in a variety of ways at the local level. They are being realized either by the initiative of concerned citizens who's designs are based on local resources and the preservation of unique features, while others are the result of local governments attempt at economic development, resource management, or recreational amenities. Another approach to greenway creation are land trusts and private, nonprofit, land conservation groups of varying sizes and complexities. These citizens organizations are among the fastest-growing open space groups in the nation - consisting of some 800 active trusts with a collective membership of over 700,000. The Land Trust Alliance in Washington D.C. is the trusts national organization, and plays an important role in the greenway movement (Hudson, 1991).

This movement has consisted of many individuals coming together and taking their communities ecological fate into their own hands. Individuals who are committed to protecting and preserving their regions unique character and natural resources.

Conclusion

These are elements involved in the modern day greenway movement. The fragmentation of our landscapes due to little regional planning of growth and development is the main catalyst for these linear greenway designs. However, while greenways are much preferred over many types of land uses, recreational resource planning should be guided by ecological constraints. By combining local conditions with various planning tools, community activists are supplied with the basics for implementing a greenways plan.

Innovative designers such as Ian McHarg and Phillip Lewis recognized this fact and developed methods for ecological planning which are the basis for the following inquiry and resulting design application.

CHAPTER 3

The modern greenways movement in this country has offered a satisfactory solution to many of our communities recreation & conservation problems. However, there is a drawback. This drawback is that while greenways are an appropriate approach to these dilemmas, the actualization of a greenway project is often a difficult, sometimes insurmountable task. Because these types of projects are generally grassroots, each greenway is different, custom made to suit specific circumstances, so there is no one prescription to follow. However, while each project is unique there are key issues which are common to all. It is these commonalities which can be identified and used as a guide in greenway planning that are the focus of this inquiry.

The following thesis is intended to be a design thesis, with the product being a greenway design for a river corridor and its second-order tributaries in central Virginia. However, in order to have an informed design, traditional research methods are employed. The method this researchers feels is the most appropriate in guiding the design work is case study evaluation. The intent is to look at a collection of successful greenway projects and extract their approaches to key issues which facilitated the projects success. Then, with an understanding of the key issues involved, a process model for greenway planning will be constructed. One key issue of the model, corridor delineation, will be illustrated in the resulting greenway design and the other issues included in the model can be used as a guide by community planners in the actual implementation of the project. The model will be structured in such a way as to be a useful tool for the planning, design and management of any riparian greenway.

The specific type of greenway projects which will be of interest in the case study inquiry are riparian greenways. Because of a riparian corridors capacity to allow for a multiple of environmental management practices, recreational resources, along with their natural linearity, they are often popular sites for greenway projects. It is this multiple use which makes the model even more helpful in guiding the planning, design and management of any riparian greenway.

Before selecting the case studies, it is important to have an established set of criteria to ensure that there is a consistency of issues being addressed. The criteria used in selecting the case studies for this project were:

- A river corridor

- Encompasses an urban to rural area
- Crosses jurisdictional boundaries ex: County, state or city boundaries
- Planning for in excess 10 miles in length
- Encompasses multiple land uses ex: agricultural, residential, commercial etc.
- Used innovative design, management, or regulatory techniques for land acquisitions and corridor protection
- Environmental protection is a primary or secondary goal

Once the case studies were selected, greenway officials in each region were contacted and an explanation of the thesis intents were explained to each. Based on these phone interviews, and the review of the information that each official provided, key issues in the greenway process became apparent. It is these key issues and each individual projects innovative ways of handling them which is of special interest to this researcher. The projects profiled in this study are: Capital Area Greenway Raleigh, Southeast Tennessee River Valley, Boulder Creek Tributaries Greenway, and Southeastern Wisconsin Environmental Corridors. All of these projects meet the aforementioned criteria, however, there are varying degrees of information available regarding the many issues of each unique implementation process. Therefore, some case studies are more detailed than others. The diagram on the following page illustrates the primary and secondary goals of the projects.

Each of the case studies were broken down into four main categories which were determined to be the key issues of greenway planning and implementation. These are; corridor delineation, planning and policy, implementation, and management. Once the key issues were identified, they became the focus for evaluation. When describing these case studies, most portions were taken verbatim from the greenway Master Plan documents in an effort to eliminate any error of interpretation, and the remaining portions were put into the researchers own words. At the end of each case study, the researcher comments on elements that are unique to that specific project, as well as instrumental in constructing an informed process model. Once all of the case studies have been explained and evaluated, the researcher draws collective conclusions in order to derive a greenway process model. It became apparent that a fifth issues, community support, was pervasive in every aspect of the four issues, thus, a fifth category is derived in the process model. The important elements involved in each of the key

issues will be discussed, then pulled together in a flow diagram in an effort to illustrate the proper sequence of events. Then, the five key issues will be discussed simultaneously in order to illustrate how these key issues are interrelated and should be orchestrated to create a process. This model is intended to be used as a guide for greenway planning, implementation and management, and it is hoped that it will eliminate as many unnecessary, and costly steps as possible in an infant project.

The last portion of the theses will be a greenway design for a riparian corridor in central Virginia. The derived model is intended to give guidance to community planners and key players in the region as they move through the greenway process. The key issue which will be investigated in the design phase is corridor delineation. This researcher feels that this is the most important issue to explore in the design process of this thesis not only because it is the means to establishing a vision document for a environmental/recreational greenway, but the illustration of this particular issue is the most feasible and helpful within the constraints of this thesis project. Other duties involved in the planning of this greenway will be carried out by community planners and government officials who know the best way to go about applying the model within their own jurisdictions.

	Raleigh, N.C.	Chattanooga, TN.	Boulder, CO.	Southeastern, WI.
Water Quality			*	*
Flood Control	o		*	
Habitat Preservation			*	*
Open Space Preservation	*	o		*
Recreation	*	*	o	o
Ecotourism				*

Case Study Project Goal Matrix

- * Represents primary project goal
- o Resrepresents secondary project goal

THE CAPITAL AREA GREENWAY - Raleigh, North Carolina

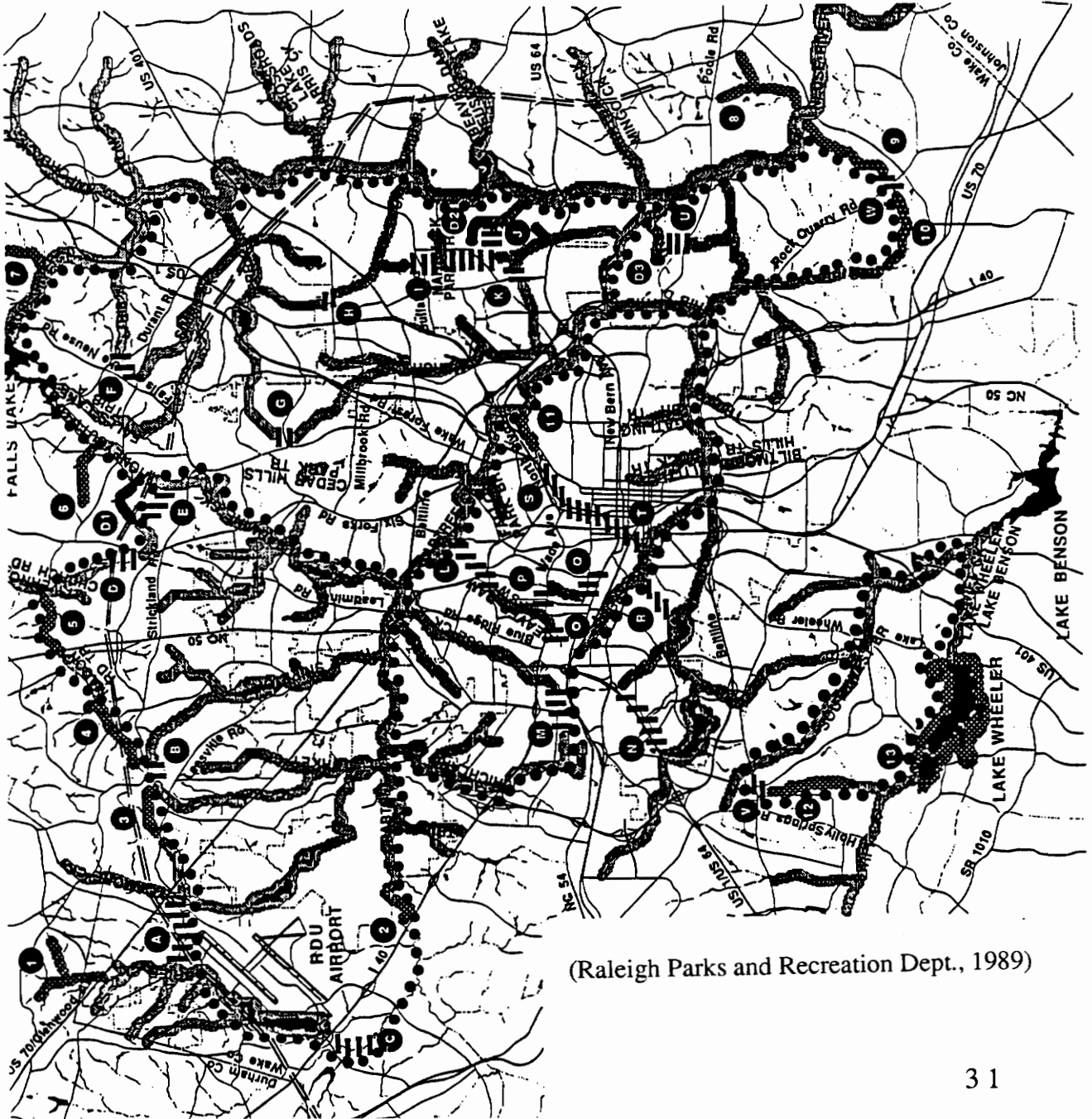
CONTEXT

North Carolina is located in the southeastern United States on the Atlantic Ocean. It is bounded by Virginia to the north, South Carolina and Georgia to the south and Tennessee to the west (Colliers Encyclopedia, Vol. 19).




North Carolina consists of three physiographic regions. The coastal plain is a gently rolling plain and swampy tidewater close to the Atlantic coast. The Coastal Plain makes up 45% of the states land mass. Another 45% of the state consists of the Piedmont Plateau. This is the area west of the Coastal Plain and is characterized by forested, rolling hills. The far west portion of the state, and the remaining 10%, is the High Intermontane Plateau. This area includes the parallel, northeast-to-southwest-trending Blue Ridge and Great Smoky mountain ranges.

Raleigh is the capital of North Carolina and the seat of Wake County. The city was named for Sir Walter Raleigh, who was a famed English adventurer and writer. The original site of this capital city was selected in 1788, and in 1792, the city was sited on a sloping ridgeline between Crabtree and Walnut Creeks. This was at a time, shortly after the American Revolution when many of the original states were moving their capital cities inland, away from the seaboard. As growth and development occurred in Raleigh, the tributaries of these two creeks became usurped by the city. However, because of the nature of these floodplain bottomlands, many of the areas adjacent to these tributaries were left as open space. In the 1950's, innovative engineering techniques made development in these bottomlands possible. This development not only experienced the ecological problems of flooding, water pollution and loss of open space, but a sense of place for the city's residents was lost as well. These types of problems are not unique to Raleigh, however, their response to the problems was. In 1970, a graduate student in Landscape Architecture, Bill Flourmoy, did a master plan of a greenway system for Raleigh in an effort to meet the requirements for his master's thesis. In late 1973, the Raleigh city council adopted this plan and created the Raleigh Greenway Commission.

Raleigh's rich and diverse history, is in part responsible for the greenway system that they now have. This greenway has been so successful that it has been the model for many similar projects across the country.



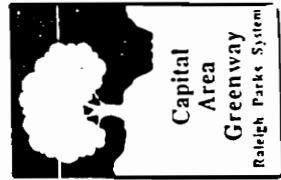
Key:

-  Existing greenway corridors, 1986 CAG Master Plan
-  Corridor additions and extensions
-  Corridor deletions
-  Corridor connectors
-  Major Greenway Loops

NOTE: LETTERS AND NUMBERS REFER TO PROPOSED CHANGES IN MASTER PLAN. SEE CHART, SYSTEM-WIDE RECOMMENDATIONS. FOR A COMPLETE DESCRIPTION OF THE GREENWAY SYSTEM, SEE 3000 SCALE GREENWAY PLAN.

Capital Area Greenway

Master Plan - Update 1989



(Raleigh Parks and Recreation Dept., 1989)

PROJECT GOALS AND OBJECTIVES

Providing for recreational amenities was a primary goal in the Raleigh Greenway project. Devastating floods along the major creeks and their tributaries was the catalyst that persuaded the city's officials to enact a floodplain protection ordinance that restricted development within these floodplains. With the lands adjacent to the city's creeks protected, the recreational opportunities that the lands could provide became a primary focus for the greenway. Another greenway goal was to achieve an acreage to population ratio of 5.7 acres for every 1,000 citizens. As the system grows, this role of recreation will become increasingly important as trail segments are connected to form long routes and the user base increases with general population growth and development in outlying areas of the city (Capital Area Greenway Master Plan, 1989). Environmental preservation was a secondary goal of this project. Raleigh officials realized that retaining environmentally important areas and conditions are needed to maintain a high standard of livability for the city. Planners feel that continued success of the greenway depends on accessibility, continuity and linkage of greenway trails. Based on these concepts, planners have made modifications to the 1986 master plan focusing on; 1) Necessary extensions, additions and/or deletions of greenway corridors, 2) Designation of greenway connectors between existing or proposed corridors isolated corridor segments or as a replacement for deleted corridors, 3) Identification of major and minor loops within the system, 4) Identification of node types/search areas to supplement neighborhood park service, 5) Expanded nomenclature to better identify and locate minor and penetrator corridors not previously named, 6) Revision of standard minimum corridor widths (minor corridors and penetrators) to more accurately reflect natural stream order and easement acquisition potential. These modifications reflect a commitment to quality in greenway design as well as a commitment to the experience of the user in terms of recreational uses and quality of life issues.

COMMUNITY SUPPORT

The participation of civic groups, environmental organizations, and other such groups cannot be overemphasized when talking about greenways management. In Raleigh, the interest and support of its citizens is what has turned the initial greenway plan into an unfolding reality. The Parks, Recreation and Greenway Advisory Board is composed entirely of citizens appointed by City Council to provide direction and guidance to the program. Some other ways the citizens are helping are; participating in the Adopt-a-Trail Program, using the greenways and reporting conditions that need attention, organizing and leading trail hikes,

providing planning and design suggestions for new project proposals, organizing the clean-up of neighborhood creeks, organizing the building of foot trails and financially supporting and promoting neighborhood greenway projects.

Businesses can also play an important role in making a greenway happen. Much of the land for the greenway in Raleigh has been donated by real estate developers. Many dedications are considered charitable contributions and those property owners who dedicate land are able to receive income tax credits. Property owners who wish to retain the actual ownership of the land while it is being used for greenway purposes can give partial property rights of easements to the city (Raleigh Parks and Recreation Dept., 1989, pg. 5).

Government Support is generally the most typical kind, if the citizens want it, then government will be involved. Government agencies ranging in duties from conservation, utilities, land use planning, transportation to recreation, all affect the feasibility of the greenway project. In Raleigh, funds for acquisition and development have come primarily from the Capital Improvement Program. Some funding has also been obtained through Wake County Parks and Recreation Grant-in-Aid Program. Generally other sources of funding are needed in order to meet all of the financial needs that will arise as the project advances.

The Capital Area Greenway now includes more than 900 acres of land and nearly 27 miles of completed trails along the areas creeks and streams. It has truly become a sort of infrastructure for the city, a green infrastructure which serves both people and the environment.

CORRIDOR DELINEATION

The Raleigh greenway system is based on the natural order of streams in the region and is comprised of three primary components. These are: corridors, connectors and nodes. Loops are a fourth element which is the result of the three.

Corridors

Raleigh greenway planners define corridors as linear park areas located within the stream corridors that provide linkage to major nodes such as parks, schools, shopping centers, and residential areas. Corridors vary in width depending on the natural stream order and their relative importance in the system. Along the area's largest watercourse, the greenway corridor has a minimum standard width of one hundred and fifty feet measured from the bank on both sides of the river. Along the other two major spines of the greenway system, the minimum width is one hundred feet measured from the bank on both sides of these major watercourses. Other creeks, streams, and tributaries are assigned minimum standard greenway widths of either seventy-five feet or fifty feet (Raleigh Parks and Recreation Dept., 1989).

Greenway corridors are classified as Major Corridors, Minor Corridors or Penetrator Corridors. The three major corridors provide the backbone of this linear park system by dividing the City into three relatively equal subareas. Minor corridors further divide these subareas to provide additional recreational opportunities and linkage to the three major corridors. Minor corridors also make possible loop trails within the system. Penetrators are tributary corridors that provide access from residential areas to minor and major corridors.

Major, minor and penetrator corridors together create a finely meshed linear park net over the City. It is this fabric that will unify Raleigh's open space and recreational opportunities as well as provide for ecological health in an urban & suburban setting.

Connectors

Greenway connectors play an increasingly important role in highly urbanized areas of the City where creeks and streams have been piped or where existing development may preclude acquisition. Connectors provide needed east/west routes, especially in the northern districts of the City where stream corridors run north to south. They also provide opportunities for loops within the system, increase accessibility to the overall system, and strengthen the fabric of the open space network.

Nodes

Major nodes within the greenway system include existing and proposed parks, school sites, major shopping centers and commercial areas, employment centers, university and college campuses, and recreational areas. Major nodes are both destination points within the system

and points of access to greenway corridors. Minor nodes are smaller open space areas adjacent to greenway corridors that allow for expanded recreational opportunities, access and/or parking.

Minor nodes can be classified as one of the following types, depending on their location;

- 1) Terminal Nodes - these areas occur at the ends of penetrator corridors.
- 2) Lateral Nodes - these expanded areas occur directly adjacent to a greenway corridor
- 3) Axillary Nodes - these areas occur at the confluence of two greenway corridors

Loops

Greenway loops have occurred primarily around lakes within existing parks. These small, internal loops within park nodes provide important trail circuits for many recreational users, especially joggers and bicyclists.

As the overall system grows and corridors are connected, larger loops become more possible. These large loops provide both increased recreational opportunities and a transportation alternative in that they not only provide larger trail circuits, but often shorten the distance to important nodes within the system. Loops can be classified as follows:

- 1) Regional Loop - Raleigh's greenway system along with those of adjacent municipalities have the potential to form a regional loop.
- 2) Quadrant Loops - Five large loops are possible, an Inner City loop and one in each of the four major quadrants of the City.
- 3) District Loops - smaller loops are possible within each planning district.
- 4) Internal Loops - loops around lakes and ponds or loop trail systems within larger acreage's will continue as a possibility.

Raleigh's multicreek greenway, along with a rigorous floodplain protection ordinance has no doubt contributed to the environmental integrity of the region. This linear open space allows for a vegetated buffer along streams to protect water quality and fragile natural ecosystems such as wetlands. Further, the urban environment is enhanced through air quality, temperature, and noise moderation resulting from the conservation of vegetation. Finally,

these areas function as wildlife corridors, allowing a greater diversity of animals to travel through and survive within Raleigh's urban areas (Little, 1991).

POLICY

The Raleigh greenway is a recreational-conservation system which has grown through an incubation period to emerge as a shaping force in both city recreation policy and zoning administration policy and law (Raleigh Parks and Recreation Dept. 1989, pg.1). Issues regarding land acquisition and land use restrictions are crucial elements in greenway planning. As previously mentioned, Raleigh city officials implemented a rigorous floodplain protection ordinance that put severe limitations on development around the regions streams. This ordinance was the catalyst for the implementation of the greenway and its stream corridor protection. Other planning & acquisition tools have been necessary in the protection of the greenway system as well.

In order for Raleigh to meet its future goals, substantial stretches of easements and fee simple properties need to be acquired along the greenway corridors. Recently, the city passed a Facility Fees Ordinance, which has facilitated the land acquisition process. This ordinance calls for the dedication of greenway easements in new residential developments. Owners or developers are reimbursed for the dedicated greenway easement according to a payment schedule established by the ordinance. Acquisition is limited to floodplain areas within designated corridors of the approved greenway master plan.

The City of Raleigh's current greenway acquisition program is four-fold:

- 1) Systemwide Greenway Acquisition - includes previously designated parcels and on-going dedication of greenway easements in new residential development through the subdivision and plan review process.

- 2) Greenway Reservations - involves negotiating for greenway easement through non-residential properties as part of the subdivision and plan review process. Typically, the specified greenway area is reserved by the developer or owner for a period of twelve months from the date of submittal, during which time the City can negotiate for the greenway easement or property.

3) Targeted Acquisition - involves the acquisition of specified properties or easements along corridors for the purpose of trail construction over the next several years. Major emphasis for this kind of acquisition will be along the primary corridors in an attempt to complete acquisition and link existing trails to form longer trail routes.

4) Coordinated Acquisition - involves obtaining joint-use easements by acquiring greenway easements over, or in addition to; required sewer easement, road rights-of-way, wetlands required for mitigation or other possible joint-effort situations. This type of acquisition was very successful along one of the primary corridors, where greenway easements were "piggy-backed" over required sewer easements as part of the Neuse/Perry Interceptor Project.

The acquisition of land around waterbodies that are part of a private development is a hurdle for Raleigh greenway planners. In these cases, the lakes perimeter is retained as "community" open space under the control of the developer or a homeowner's association. Often the developers will agree to a greenway corridor around the waterbody, however, they wish to exclude public access around the lake making it available only for the developments residents. This privatization has been responsible for the loss of many portions of the greenway system (Raleigh Parks and Recreation Dept.,1989).

Greenway planners have developed a strategy in an effort to ensure corridor continuity and accessibility. This strategy consists of the following:

- Both sides of the lake or pond are studied in terms of ease of acquisition, potential impact to adjacent property owners, trail construction possibilities, and linkage to existing or proposed trails outside of the development.
- The floodplain area is reviewed to determine the extent of floodway and fringe as it relates to greenway acquisition under the Facility Fee Ordinance.
- One side of the lake or pond is selected for greenway easement acquisition and future trail construction.
- The acquisition and trail development plan is reviewed with the developer, homeowner's association, or individual property owners. Negotiations may involve joint-use or joint-development efforts.

The acquisition of land for this greenway system is an intricate process that requires the bringing together of several interested parties. These parties include; developers, City Council members and the County Registrar of Deeds, The City Manager's office, several City boards and commissions, several City of Raleigh departments and private landowners (Raleigh Parks and Recreation Dept., 1989, pgs. 31-32). Continued success of this greenway project relies on many circumstances, however, the ability to acquire the needed lands is the ultimate factor in the accomplishment of greenway goals.

IMPLEMENTATION

When designing for environmental preservation, implementation techniques are crucial. This is the point in the greenway process where debilitating damage can be done to ecological resources if care is not taken in the implementation of the design.

In Raleigh's case, as well as many other greenway projects, their goals are to design the greenway to meet the needs of multiple users. The problem with this is that to meet this goal, trail surfaces need to be paved with asphalt to service bicyclists and the handicapped. Watershed Restrictions is a major issue hindering the continuity of a paved greenway. According to city code, primary and secondary watercourse buffers are required adjacent to existing ponds and proposed ponds used for stormwater impoundment, as well as adjacent to existing creeks and streams (50 feet for Primary Watercourse Buffer and 25 feet for Secondary Watercourse Buffer). These buffer areas prohibit any clearing of vegetation or development of impervious surface area. Current regulations severely restrict greenway development within primary watercourse buffers along one of the greenways major corridors. This becomes a problem because watershed restrictions allow only for the establishment of "ungravelled natural footpaths" within Primary Watercourse Buffer Areas. The issue here is that of additional impervious surface that must be accounted for within the maximum established percentages (Raleigh Parks and Recreation Dept., 1989, pg. 36 & 37).

Through the interpretation of the text, greenway planners feel that it suggests that the width of the primary and secondary buffers be increased by adding 4 times the average percent of slope adjacent to the watercourse. (A primary watercourse buffer of 50 feet would be increased to 90 feet if the adjacent slope was 10%). This additional vegetative buffer, along with the construction of simple impoundment, diversion and velocity reducing structures for controlling runoff from upslope development and paved trail surfaces might provide

adequate control to permit the additional, minimal impervious surface generated by paved greenway trails (Raleigh Parks and Recreation Dept., 1989, pgs. 36-37).

In addition to the paved trails, other design features are required for greenway implementation. The Raleigh City Code has established guidelines for floodplain development and, of course, greenways & bikeways fall into the category of permitted uses. However, any structures employing vertical elements are prohibited by this code because of the adverse impact on the capacity of channels, floodways, or drainage facilities. These elements also have the potential to redirect velocities of water onto adjacent properties.

The conflict between greenway as a permitted use and restrictions of construction facilities such as fences, picnic shelters, bollards, etc. which employ vertical elements is a problem for greenway planners. The time spent on the review and approval of trail plans has slowed down the greenway process considerably. Planners feel that there should be revisions to the code in an effort to establish criteria that will allow the construction of minor greenway facilities within the floodway (Raleigh Parks and Recreation Dept., 1989, pg. 40).

Other design features used in the Capital Area Greenway are:

- Bollards - as control & separation devices and as a signage device
- Signs - location, directional, mileage, and other information
- Boardwalks - utilized through marshes and swamplands
- Decks/Observation Areas
- Picnic Areas - picnic tables, picnic shelters, trash receptacles and associated facilities.
- Open Field Areas (Greenway Nodes) - field games, informal picnic area, etc.
- Fences - for separation and security control
- Parking Lots - public access points with off-street vehicular parking.
- Drainage Structures - catch basins, piping, drainage swales, etc. to control runoff
- Retaining Walls - necessary in steep topographic conditions
- Docks - future canoe launch facilities
- Bridges - trail continuity over creeks and streams; footbridges to major structures.

MANAGEMENT

Raleigh's Capital Area Greenway management strategies have been laid out with the long-term vision in mind. When planning for new major & minor corridors, connectors, and nodes, the city's resources and manpower are utilized to the greatest extent possible. For example, the updated master plan states that; planning for greenway connectors should also coincide with design efforts for new road or road improvement projects. An assessment of all locations, present and future, where major greenway structures and greenway connectors will be necessary in order to connect or expand greenway corridors should be a primary consideration (Raleigh Parks and Recreation Dept., 1989).

As previously mentioned, linkage is an important consideration for Raleigh greenway planners. Staff is in contact with greenway planners from surrounding counties regarding the feasibility of future connections. The Open Space Action Plan has been adopted by at least one of the neighboring counties, and has established that agency as a greenway coordinator for the area. The agreement of common goals and objectives is the next step in opening up the channels of communication between all of these municipalities.

Two organizations were developed, by private parties, to facilitate land acquisition and plan for state-wide linkages of greenway. These groups are; Triangle Land Conservancy and the Triangle Greenway Council.

OBSERVATIONS

In Raleigh's approach to greenway design, one can find many elements needed for a comprehensive planning approach. Their goal of acreage to population ratio of 5.7 acres for every 1,000 citizens is an interesting approach to ensuring recreational amenities and open space. This concept could also be applied to wildlife and plants, allowing for needed habitats for rare or endangered species by establishing guidelines based on their needs.

The idea that corridors are based on the natural order of streams in the region is a logical way to protect water quality as well as provide for a pleasant experience for the greenway user. Also critical to environmental concerns is the fact that the acquired corridor encompasses both sides of the stream. In terms of water quality and wildlife habitat, this is crucial in maintaining ecological health in the region. However, the method used to determine these

corridor widths is questionable. The widths vary depending on actual stream order and the relative importance within the system. This researcher questions this because, without environmental inventories to pinpoint critical areas, it is hard to say which is most important within the system. Also questionable, in environmental terms, is the lack of consideration for upland regions of the watershed. To be truly comprehensive in approaches to water quality, all areas of the watershed should be addressed.

The focus on continuity, accessibility and linkage is critical in any greenway project as well as conducive to the proper management of environmental & recreational resources. Raleigh's approach is notable because of this focus as well as the resulting structure. The designation of major, minor and penetrator nodes illustrate these concepts and at the same time, divides the system into manageable sections. The further breakdown into connectors, loops and nodes is appropriate for greenway design. Often, greenway designs consist simply of pinpointing resources and linking them, however, Raleigh uses a larger framework in distinguishing corridor delineation which not only aids in management practices, but in future expansion of the system as well.

A look at land use restrictions and acquisition techniques used here is helpful in understanding how lands can be obtained. The floodplain protection ordinance opened the door for future preservation approaches around the regions streams and ultimately, led to the present greenway system. The Facility Fees Ordinance which facilitated the acquisition process is an interesting way to preserve needed lands, however, this is limited only to floodplain lands, and cannot not be employed when obtaining lands in the upland reaches of the watershed. Coordinated acquisition is a creative way to maximize resources and minimize the acquisition of privately owned lands in areas where existing infrastructure and proposed greenway corridors meet.

Mitigation issues in greenway implementation are most important in terms of actual environmental health. A greenway with the best of intentions for the environment is useless if the actual construction is not done properly. The biggest problem with the Capital Area Greenway, and many other greenways as well, is the intent on paving most trail surfaces. This researcher feels that there is a contradiction in greenway planning when environmental preservation is a goal and at the same time an eight foot wide swath of asphalt is laid adjacent to the stream corridor. While the desire to make trails accessible for a variety of users is

understood, another approach to trail surfacing could be more compatible with environmental goals. This becomes even more of a problem when planners advocate rewriting city codes regarding floodplain restrictions in order to allow for the implementation paved trail surfaces. While they do plan to make design adjustments to control increased runoff caused by paved surfaces, a filtering surface approach to trail design would eliminate the costs of additional impoundment and diversion features.

Management issues in Raleigh have become quite innovative due to the mere length of the greenway. The crossing of jurisdictional boundaries has created a need for multi-regional planning and management teams. The Open Space Action Plan which has been put in place is an important step in successful greenway design. A regional coordinator has been established to determine common goals and objectives. This helps to create a system which reads as one entity and is coherent to the users.

Raleigh, like many other communities across the country, has employed many citizen organizations in the greenway process. A community group, The Greenway Advisory Board, is an innovative way to get community input into the planning process. However, the fact that the City Council appoints the members could be a problem if the community's wants and needs conflict with the city's.

All in all, Raleigh offers an excellent case study for those interested in multi-jurisdictional greenway design. While their focus is mainly on recreation, the regions wildlife and water resources benefit as well.

THE SOUTHEAST TENNESSEE RIVER VALLEY - Chattanooga, TN.

CONTEXT

Tennessee is located in the east south-central United States. It is bounded on the north by Kentucky and Virginia, on the east by North Carolina, and on the South by Georgia, Alabama, and Mississippi; on the west it is separated from Arkansas and Missouri by the Mississippi River. The state is divided into six physiographic regions: the Great Smoky Mountains along the North Carolina state line, the relatively flat Cumberland Plateau, the Interior Low Plateau in Middle Tennessee, the Eastern Gulf Coastal Plateau, and the Mississippi Alluvial Plain. The Tennessee River valley dominates the landscape of much of the state, as the river flows south in the eastern part of the state and subsequently flows north in the states' western part. The Mississippi River and several small tributaries drain the extreme western portion of Tennessee (Colliers Encyclopedia, Vol. 6, pg. 633).

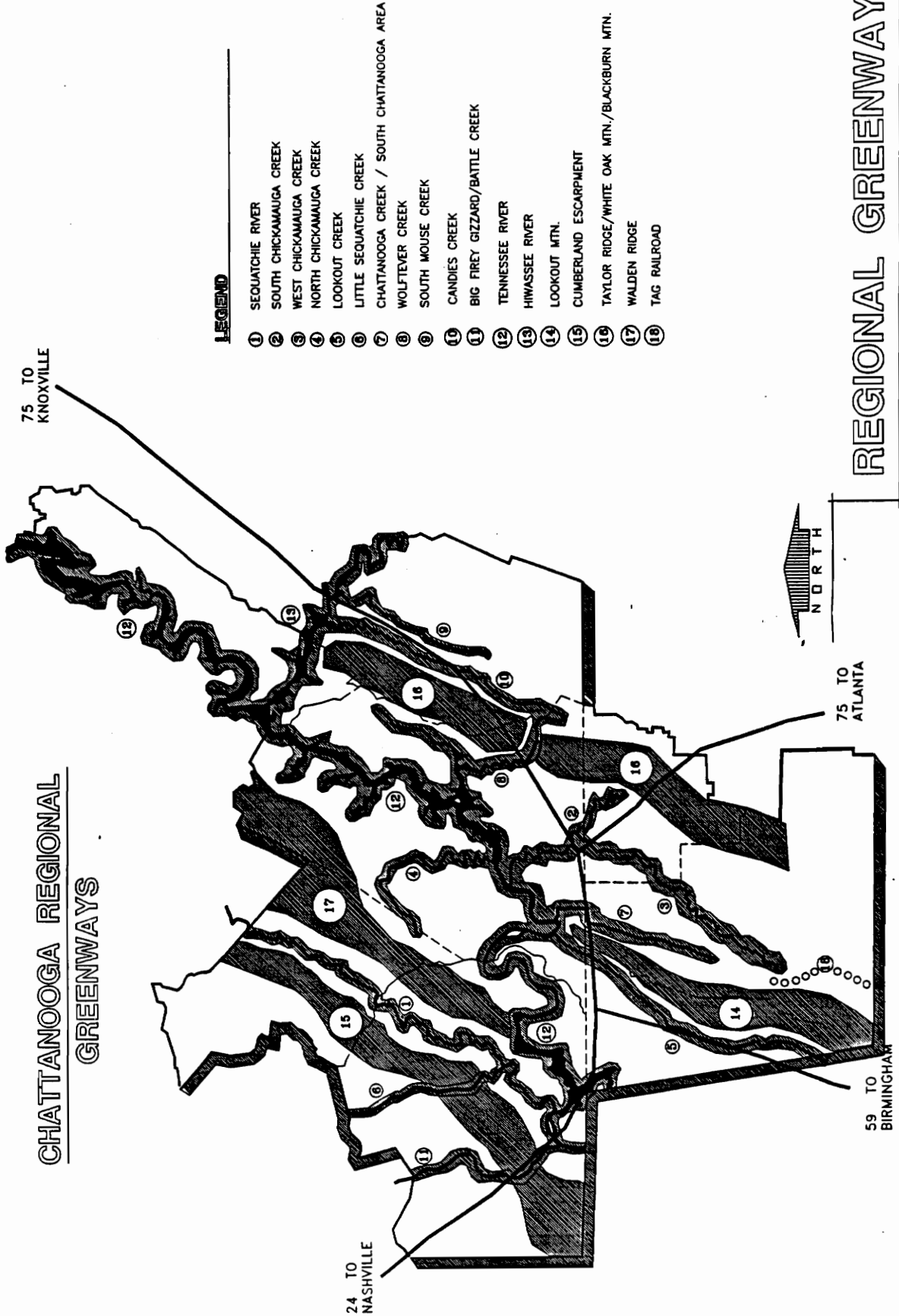
The Tennessee River is the central component of one of the world's greatest irrigation and hydropower systems and a major waterway of the southeastern United States. It is formed by the confluence of the Holston and French Broad rivers, just east of Knoxville, and flows south-southwest to Chattanooga. It then turns west, crossing through the Cumberland Plateau into Alabama. It ultimately joins the Ohio River at Paducah, Kentucky after running the course of 652 miles. The rivers drainage basin consists of approximately 40,910 square miles.

The City of Chattanooga is the seat of Hamilton County, in southeastern Tennessee, on the Moccasin Bend of the Tennessee River, near the Georgia state line. It is the headquarters for the Tennessee Valley Authority (TVA) power system. The city's site was settled around 1815 when John Ross who was later made a Cherokee Indian chief, established a trading post on the river. It was renamed Chattanooga in 1838, most likely referring to the Indian expression for the nearby Lookout Mountain, which meant "rock rising to a point." (Colliers Encyclopedia, Vol. 6, pg. 139).

A steep-incline railway ascends Lookout Mountain, and at the top one can find gardens and odd stone formations known as Rock City. Chickamauga Lake is a nearby reservoir which is 59 miles long. Impounded by a TVA dam on the Tennessee River for power and flood control, this lake also provides many recreational resources.

CHATTANOOGA REGIONAL GREENWAYS

REGIONAL GREENWAY MAP



LEGEND

- ① SEQUATCHIE RIVER
- ② SOUTH CHICKAMAUGA CREEK
- ③ WEST CHICKAMAUGA CREEK
- ④ NORTH CHICKAMAUGA CREEK
- ⑤ LOOKOUT CREEK
- ⑥ LITTLE SEQUATCHIE CREEK
- ⑦ CHATTANOOGA CREEK / SOUTH CHATTANOOGA AREA
- ⑧ WOLFEVER CREEK
- ⑨ SOUTH MOUSE CREEK
- ⑩ CANDIES CREEK
- ⑪ BIG FIRE GIZZARD/BATTLE CREEK
- ⑫ TENNESSEE RIVER
- ⑬ HIWASSEE RIVER
- ⑭ LOOKOUT MTN.
- ⑮ CUMBERLAND ESCARPMENT
- ⑯ TAYLOR RIDGE/WHITE OAK MTN./BLACKBURN MTN.
- ⑰ WALDEN RIDGE
- ⑱ TAG RAILROAD

The Southeast Tennessee River Valley has derived a long term greenways plan which has been a great success in the eyes of its community. It is expanding at a steady pace because of this popularity. The Tennessee River is responsible for giving Chattanooga its unique character and rich cultural history. It is this river and its tributaries that provide for the greenway, and citizens of the area are pleased to find a way to link the many cultural resources of their region.

Moccasin Bend, the largest remaining parcel of open space close to downtown Chattanooga, as well as the site of some of the areas most significant archaeological and cultural resources, needed a plan for its protection. In 1982, a task force was appointed in an effort to devise a long-term land use and management plan. Moccasin Bend is an area on the Tennessee River, and it is this river corridor that has provided the opportunity for what has become a greenway master plan which spans eight counties and two states.

This Chattanooga Regional Greenways project is intended to link the existing greenways of Chattanooga, specifically, the Tennessee Riverpark and the North Chickamauga Creek. Tennessee Riverpark is an area of downtown whose plan called for new housing, offices, industries, hotel and commercial opportunities, rehabilitated warehouse facilities, public parks and an aquarium along the Tennessee River all linked by a series of trails for walking, cycling and horseback riding. The RiverCity Company, a non-profit development corporation, was formed in 1986 to help implement this plan and to develop a long-range strategy for managing and maintaining the parks and trails along this corridor. Public/private partnerships were developed with local business, foundations and government agencies to fund the development of Tennessee Riverpark, the area's first greenway (Hixson Chamber of Commerce, 1989, pg. 8).

The North Chickamauga Creek Greenway was the regions first "grassroots" greenway, and is located in Hixson, a suburb of Chattanooga. In 1988, the Hixson Chamber of Commerce formed a Parks Committee to evaluate park and open space needs and opportunities in the community. This committee identified the North Chickamauga Creek corridor as the community's largest remaining expanse of open space and as the best location for a passive community recreational facility. The committee recommended that the City develop a greenway along eight miles of the creek that would link numerous neighborhoods, schools and parks with a multi-purpose paved trail (Hixson Chamber of Commerce, 1989, pg. 8).

The study process and plan for the Regional Greenways is helpful in understanding the Chattanooga philosophy and approach to greenway planning and implementation. The following will be an overview of this process and plan.

To begin the process, a planning team was organized in an effort to help identify what the community wanted to address in a greenways plan. This team organized many citizen workshops and meetings as a means to gather public ideas as well as initiate citizen involvement from the ideas conception. The project goals of this team were identified as:

- To identify a conceptual network of greenways throughout the Chattanooga area
- To develop implementation strategies for this conceptual network of greenways
- To undertake pilot greenway projects that place pieces of this conceptual greenways network "on the ground".
- To conduct a planning process that encourages and integrates public participation and support at every phase of the process.
- To increase the regional level of awareness and interest in corridor protection.

In spring 1992, workshops were conducted in each of the eight counties in an effort to facilitate community involvement, as well as to gather ideas from interested citizens. The ideas that emerged included; what the citizens wanted to see linked with a greenway system, what areas the citizens saw as contributing to the regional identity of the Southeast Tennessee River Valley, and significant sites that could aid in the interpretation of the regions rich Native American and Civil War histories of the valley.

Through the planning teams efforts, as well as more series of community workshops, these recommendations were established for implementing the Regional Greenways Network:

- 1.) Focus on the Tennessee River as the Spine of the Regional Greenways System

Ecotourism is a primary goal for this greenway system. It is recommended that Chambers of Commerce and Tourism Boards throughout both states, each county and all communities should market the Tennessee River as a major destination for outdoor recreation, ecology-based tourism and environmental business development or relocation.

2.) Establish Regional Greenways Coordination and Offer Technical Assistance

The Trust for Public Land has been hired by the City of Chattanooga to oversee the City's efforts. This organization will help the City develop strategies for planning, funding, developing, managing and maintaining both individual greenways and the City's network of trails and open space. This also calls for the development of a position for a regional greenways coordinator to serve a number of functions, including; provide technical assistance and staff support to new and proposed greenways, prepare grant proposals for greenway funding, identify sources of resource information and host meetings.

3.) Establish a Regional Greenways Advocacy Organization

In addition to professionally-staffed agencies, there needs to be a citizen-led, "grassroots" organization to help in accomplishing project goals. This group could also become a non-profit advocacy organization and a land trust with a board of directors. This would give the group the ability to hold title to and interest in land which would be helpful in the development of a greenway system. Many landowners are more likely to sell or donate land to a non-profit organization than a governmental entity.

4.) Establish a Mechanism for Inter-county and Inter-state Development and Management of Greenways

If greenways are to be developed on a regional basis, there must be some mechanism to allow for cooperation across these jurisdictional boundaries.

Two scenarios are options for accomplishing cooperation:

- Concurrent development and management by individual jurisdictions
- Development and management by one regional entity

While this process and plan is valuable for looking at how a project can get off the ground, for the purposes of this research, it is necessary to look at elements involved in a implemented project. The following is taken from the North Chickamauga Creek Master Plan in order to take a closer look at how issues such as corridor delineation and implementation are handled in Chattanooga.

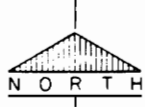
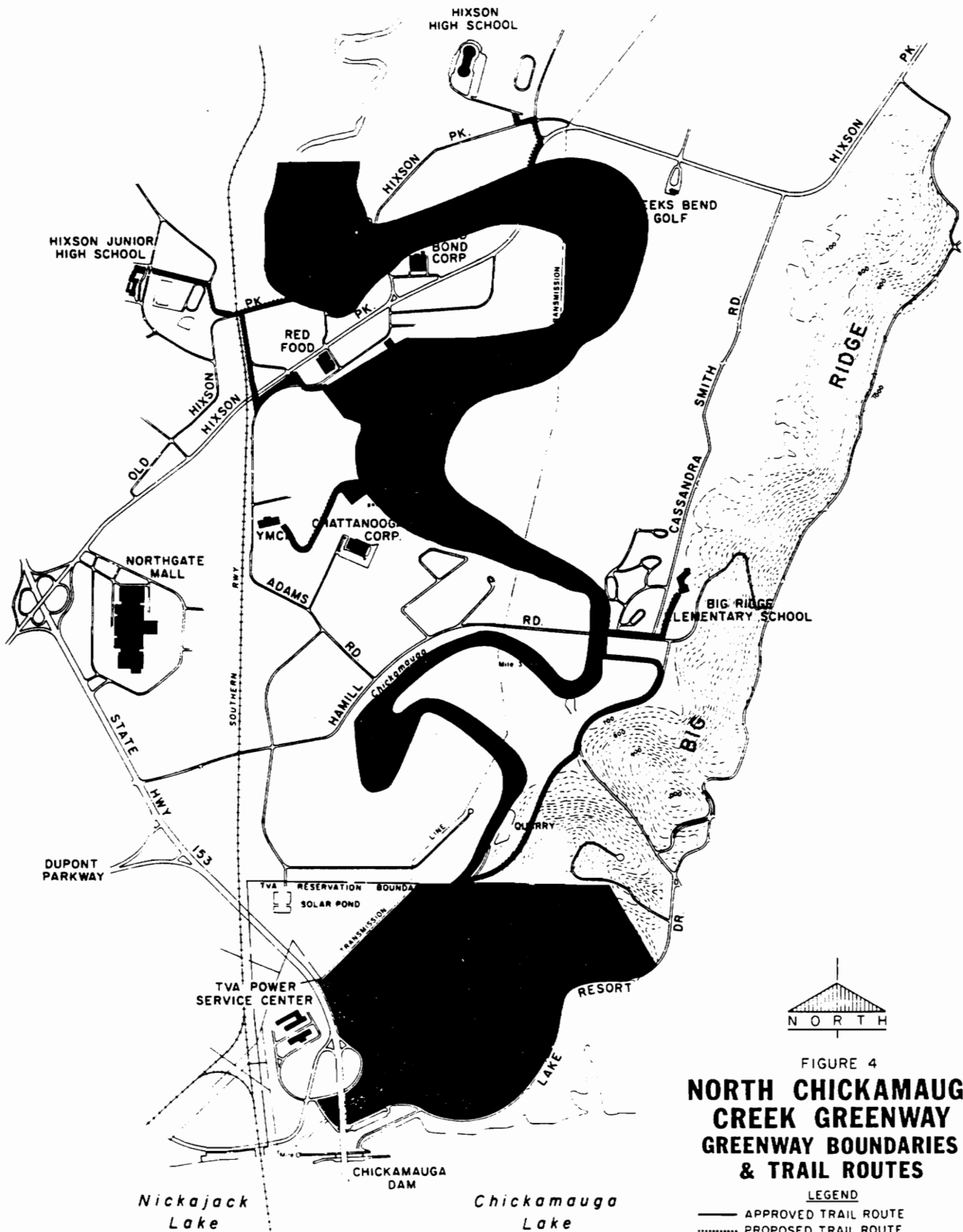


FIGURE 4
**NORTH CHICKAMAUGA
 CREEK GREENWAY
 GREENWAY BOUNDARIES
 & TRAIL ROUTES**

- LEGEND**
- APPROVED TRAIL ROUTE
 - PROPOSED TRAIL ROUTE
 - - - - APPROVED FOOT TRAIL
 - █ PROPOSED GREENWAY BOUNDARY

NORTH CHICKAMAUGA CREEK - Chattanooga, TN.

CORRIDOR DELINEATION

This greenway plan is the result of recreational and conservation needs that the community feels have to be addressed in order to maintain environmental health, and quality of life in the region. They also see the project as a way to give positive public value to land that has little or no development value and can bring increased value to adjacent lands. The North Chickamauga Creek Greenway will enable the attainment of two community goals: a much needed and accessible recreational area for residents for activities such as bicycling, jogging and walking, and preservation of a tranquil natural environment in the midst of urban development for wildlife and the maintenance of a high water quality.

The greenway corridor along the creek was determined by the floodplain boundaries. At present, the proposed protected area is synonymous with the floodway, however, the planners realize that future expansion outside of the floodway may be desirable. The greenway corridor encompasses both sides of the creek and the planners are intent on maintaining, and in some places restoring, the vegetative buffer that runs the entire course of the waterway from ridge to lakeshore (Chickamauga Lake is formed by a dam at the creek's confluence with Nickajack Lake). This restoration would include limited clearing and replanting that would offer opportunities to landscape with plants that are not only aesthetic, but attractive to certain animals as food or cover.

The trails run along the protected floodway, generally on one side of the creek, however, there are spur trails which run along the upland ridges as well as connect schools and existing recreation areas.

POLICY

The plan for this greenway project calls for the consideration of several issues. Land acquisitions and funding are important elements in determining the ultimate success of any greenway project, and the master plan takes the following positions when considering land acquisitions and funding.

In acquiring the property rights needed for the greenway, emphasis should be placed on using land acquisition methods that will encourage the cooperation of property owners and promote support for the development of the greenway. The use of eminent domain should be avoided. Special importance will be placed on informing riparian landowners and

developers of the environmental, recreational, economic and tax benefits associated with greenways, and their active support of development of the greenway should be encouraged. Donation, dedication during the zoning or subdivision approval process, agreement with a controlling public authority, and negotiated purchase are all methods that should be employed.

Interests in property that may be acquired to establish the greenway include the following:

- Fee Title
- Conservation Easement (if public access to land areas covered by the easement is anticipated, a public use clause should be included in the easement instrument)
- Common Law Easement
- Lease

The appropriate type of interest to be acquired in a particular situation will depend upon several factors, including the desires of the property owner, the size of the real estate parcel, the conservation values to be preserved, and the particular purpose of the acquisition.

A variety of sources at the Federal, State, and local levels offer potential funding for the greenway's land acquisitions and construction. Some of these sources are:

- Hotel/Motel Tax - \$50,000 of Hamilton County's Hotel/Motel tax was earmarked for the greenway project during the 1988 session of the Tennessee legislature
- Hixson Chamber of Commerce requested that Hamilton County and the city of Chattanooga each include \$50,000 in their budgets for the 1988-89 fiscal year for the development of the greenway. The city approved an appropriation of \$25,000 for the project
- A local artist painted a scene of North Chickamauga Creek and donated the painting to the Chattanooga Chamber Foundation. Limited edition prints of the painting are being sold by the Hixson Chamber of Commerce to benefit the project

- Private funding in the form of grants to form foundations and facilitate donations of property, services, and money from individuals, corporations, and community organizations are also being pursued

IMPLEMENTATION

The greenway trail is constructed to accommodate all age groups and a wide variety of users, including bicyclists, joggers, and walkers. The needs of the handicapped is also considered in the trail planning. Planners want the trail to be accessible by vehicles up to the size of a light pickup truck to allow for more efficient maintenance and security. They have let this mix of use dictate the type of trail to be implemented, which is a hard surfaced, smooth, and fairly wide trail, with gentle curves and grades. The trail route and development is done by sections within the entire, proposed corridor. The corridor was broken down into five section and cost analyses were done separately for each section. However, when completed, the sections will read as one, continuous greenway.

The trail is eight feet wide with other design standards chosen for the most demanding use anticipated, in this case bicycling. Undesirable vegetation will be cleared to a minimum height of 10 feet and minimum width of 14 feet. Turn radii will be 8 to 10 feet or wider, and grades will be held to less than 10 percent where possible.

The surface will be at least two inches of hot-mix asphalt over four to six inches of compacted crushed gravel. In some cases and engineering fabric underlayment and a deeper stone base will be needed because of the wet, shifting substrate found in the floodplain. Three inches of hot-mix asphalt is used in areas subject to frequent flooding. Design features, such as slight outsloping of the trail surface, water dips, culvert, diversions, and other devices, are used to control drainage and minimize trail damage from flooding.

Fences will be erected where necessary; in selecting the type of fencing and its placement, the habits and needs of any wildlife frequenting the area will be given consideration. Screens of vegetation are planted to block undesirable views and noise. Landscaping will also be used to enhance visual features, retard erosion, attract wildlife, or prevent entry to the trail. Landscape planting will not be extensive and in general will avoid introduced species in favor of native plants.

The trail route is chosen to blend into the topography with as little environmental disruption as possible. Removed topsoil will be backfilled to the edge of the asphalt and seeded. Gentle curves and scenic viewpoints will be planned to lend interest and variety to the trail experience.

MANAGEMENT

The city of Chattanooga will acquire and hold the necessary property interests and the city's Department of Public Utilities, Grounds, and Buildings will have management responsibilities for the greenway. This same city agency will establish policies and guidelines for the administration, security, and maintenance of the greenway. A Greenway Advisory Board has been established by the city to assist in formulating day-to-day operational policies and guidelines. Additional technical assistance may be necessary, and the Chattanooga-Hamilton County Regional Planning Commission staff, TVA, TDOC, TWRA, The University of Tennessee at Chattanooga, and others may be consulted to help determine appropriate policies for the operation of the greenway.

Security along the greenway is a concern of both trail users and adjacent property owners. Regulations and standards have been established to insure safety and security along this greenway system. These regulations and standards are:

- The trail will be patrolled regularly by park police. A program of volunteers similar to that which utilizes the retirees who patrol national forests and parks may also be added for additional security.
- The greenway will be open only during daylight hours. Gates to the trails will be closed at night.
- Motorized bikes and all four-wheeled vehicles, with the exception of maintenance vehicles, will be prohibited from the trail.
- All items such as signs, lighting, benches, and trash receptacles will be permanently placed to prevent their removal.
- Signs at main entrances to the trails will specify trail regulations.
- Parking lots, lights, and access points to the greenway will be positioned with the security of trail users, nearby businesses and residents in mind.

Maintenance for the greenway and trail system includes the following:

- Upkeep of the trail surface
- Repair of buildings, bridges, signs, benches, etc.
- Soil erosion control
- Vegetation control
- Trash removal
- Security Vehicles
- Clearance of navigation obstructions

Participating agencies will also cooperate in conducting programs and publishing literature to educate users about proper trail use to try to reduce maintenance and security needs.

Volunteer maintenance and patrol can cut costs and supplement trail operations. Various groups, such as schools, civic groups, or Boy Scouts, may adopt segments of the greenway for maintenance projects, much like the adopt-a-highway program. The maintenance program calls for the grass to be mowed one yard on each side of the path to control poison ivy and weeds and to accommodate maintenance equipment. Planners call for the clearance of navigation obstructions to be done in an environmentally sound manner.

Greenway planners feel that a greenway along the North Chickamauga Creek corridor will serve both conservational and recreational objectives. It would help protect the creek and its surrounding bottomlands, provide recreational opportunities for persons of all ages, and preserve open space in the center of the community. The low level of development required would have minimum impact on the creek. Extension of the greenway from the center of the community to the mouth of the creek would provide access to approximately 270 acres of wooded upland on the Chickamauga Dam Reservation, open the community to the lakeshore and riverfront, and preserve the opportunity for a future connection to the extensive Tennessee Riverpark planned for the banks of the Tennessee River.

OBSERVATIONS

Chattanooga has made a grand effort to attract tourists to their region by using their natural and cultural resources for ecotourism. This calls for a collaborative effort of several jurisdictions, and this is where one can learn much from Chattanooga in regards to greenway planning. Their focus on forming groups, teams and committees to accomplish their

ambitious greenway goals offers a fascinating look at the human resource aspect of greenway planning. The initial planning teams goals are important goals for any community planning this type of project. The most notable are; 1) to undertake a pilot greenway project that place pieces of conceptual greenways "on the ground" 2) conduct a planning process that encourages and integrates public participation and support at every phase of the process, and 3) to increase the regional level of awareness and interest in corridor protection. The first is probably the most important of the goals. The ability to get just a small portion of the master plan built is a critical move in the implementation process. If there is something built which people can use and see how it works, they will be much more likely to encourage future greenway extensions. The second, the encouragement of public participation is also very important to the process. There needs to be a feeling of public ownership to every project, that this linear park is for the community and its natural resources, will ultimately mean a more heavily used and better maintained greenway. The need to increase regional awareness of corridor protection is a necessary step in any environmental greenways project. Most people are aware of the problems related to floodplain development, but often they don't realize the environmental and recreational benefits that these floodplains can provide.

Chattanooga has realized that to accomplish their ambitious goals, they need to use outside expertise. This is apparent by the many organizations which have been brought in to oversee the city's efforts, the Trust for Public Land and the Nature Conservancy are two examples. In addition, the formation of their own organizations is a top priority. Appropriate for what they want to accomplish is a Regional Greenways Advocacy Organization. This citizen-led, non-profit organization and land trust is involved in many aspects of planning and acquisition. This is an excellent approach to land acquisition because the greenway really does become the community's and the government is not directly involved in land ownership. This idea is compatible with their goal of using acquisition methods which encourage the cooperation of property owners and promote the support for the development of the greenway. They feel the use of eminent domain should be avoided in the acquisitions because it could create negative feelings towards the greenway project within the community. An important goal of this greenway project is to give positive public value to land that has little or no development value, this is an admirable effort.

The North Chickamauga Creek Greenway offers innovative ideas in terms of project funding. The Hotel/Motel Tax that was passed by the Tennessee legislature in 1988, is notable not only

because it is a solid source of funding for the project, but it illustrates the region's commitment to ecotourism and greenway development. Another solid funding source is the appropriation of \$25,000 in the County and City budgets for the development of the greenway. Again, this shows a strong commitment to the project.

The actual design of the trails of the North Chickamauga Creek Greenway is where this project falls short. While they specify that the trail route is chosen to blend into the topography with as little environmental disruption as possible, their design guidelines indicate a very engineered trail. The trail design calls for paved surfaces throughout the eight miles of trail corridor, with design features such as diversions and culverts in an effort to minimize trail damage. The whole of the trail is to be accessible by a light pick-up truck for maintenance purposes.

While the trail seems to be very engineered, the planners often make reference to the trail experience. Designers have included gentle curves and scenic viewpoints in an effort to add interest and variety to the trail experience. This idea of the trail experience is critical to the success of a project and it's encouraging to see planners considering it, however, it should encompass the entire length of the trail and not occasional features.

Another concern is the lack of attention paid to upland regions of the watershed. Except for specific linkages of nodes, such as schools, the upland areas are generally disregarded. If this project is truly going to address water quality issues, there must be management practices applied to the ridgelines and upland areas of the watershed.

Security on the trail is a concern of property owners on all greenway projects, and Chattanooga has established regulations and standards to help ensure the safety of all parties. One notable idea is the establishment of a program of volunteers to patrol the trails. This is an excellent way to insure security while at the same time creating an atmosphere of community on the trails. Volunteers are also used for the maintenance of the trails and parks.

BOULDER CREEK TRIBUTARY GREENWAY, Boulder, Colorado

CONTEXT

The state of Colorado is located in the west-central United States, straddling the Rocky Mountains. It is bounded on the north by Wyoming and Nebraska, on the east by Nebraska and Kansas, on the south by Oklahoma and New Mexico, and on the west by Utah. Its capital city is Denver.

Colorado can be divided into three physiographic regions: the semiarid portion of eastern Colorado where water supplies are limited, topography is flat, and vegetation consists mostly of grasses is called the Plains. Central Colorado, which is the most densely populated area of the state, is classified as the Colorado Piedmont. In western Colorado, the southern Rocky Mountains and Colorado Plateau are characterized by mountain ranges and mesas alternating with broad valleys and deep canyons (Colliers Encyclopedia, Vol. 4, pg. 466).

The City of Boulder is the seat of the county which bears the same name and is located 30 miles northwest of Denver. Boulder sits at the base of the Rocky Mountains and the ridgelines of these mountains form the backdrop to the community, with the Great Plains to the east. Boulder Creek originates from the adjacent mountains, coursing through foothill canyons before emptying into the city and surrounding low-lying plains. The extreme topography within the Boulder Creek drainage basin subjects the urban area to severe flash floods when storms occur. Peak 200-year flows range from 12,00 cubic feet per second (cfs) on the main stem of the creek to several hundred cfs on the smaller tributaries (National Park Service, 1991, pg. 40)

In the past, settlement in Boulder has centered around access to the mountain canyon and the creek as a perennial water source. In these modern times, a high quality of life and amenable climate have been the catalyst for the cities growth and development. Due to the university, government, and other professional activities, Boulder has an estimated population of 85,000 residents (National Park Service, 1991, pg. 40).

Boulder Creek has a history of flooding, which has continually cost the city and its residents millions in damages. A 10-to-25 year flood hit in 1969, and its destruction spurred the enactment of a new floodplain ordinance and proposals for dredging and concrete channels for Boulder Creek. The city and its residents took an innovative approach to floodplain

management by considering multiple objectives and flood conveyance for the creek corridor. An agreement between city and county officials in the 1960's called for the preservation of natural stream corridors as community amenities. Thus, in 1978, the Boulder Valley Comprehensive Plan stated that the "functional and aesthetic qualities of drainage courses and waterways shall be preserved and enhanced in a manner compatible with a basically non-structural approach to flood control; and in particular, a non-containment approach to flood management on Boulder Creek" (National Park Service, 1991, pg. 40).

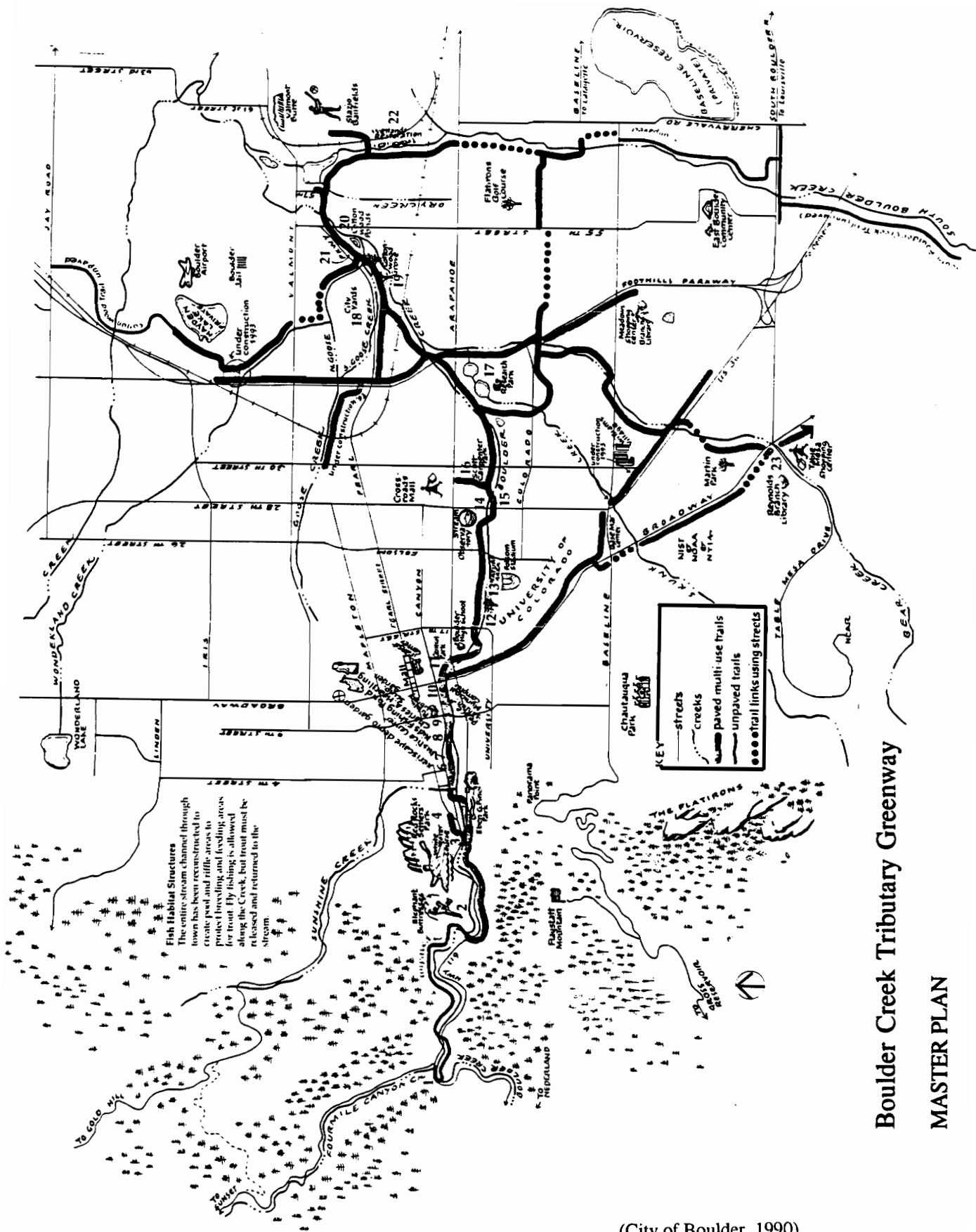
In its infancy, the Boulder Creek greenway project was intended to restore environmental features and establish a non-motorized transportation corridor along the creek. The plan then grew into the development of a five-mile continuous path and linear park running throughout the city of Boulder. The identified objectives which were to guide the design and management of the creek corridor are as follows;

- Create an offstreet non-motorized transportation system
- Preserve and enhance fish and wildlife habitat
- Protect ecologically sensitive areas
- Preserve and enhance riparian wetlands
- Protect water rights of multiple irrigation companies
- Maintain and improve flood carrying capacity of the waterway
- Protect water quality
- Provide opportunities for active and passive recreation

Eventually, the design of the corridor called for fish, wildlife and recreation, including the engineering of whitewater boating features, enhancing fisheries habitat, and developing paved and gravel pathways that serve bicyclists, walkers, joggers and the handicapped.

Boulder Greenbelt

In 1967, an open-space acquisition program was started by the city, and since this time the program has protected 20,000 acres of land in an around the city. This effort was funded by a dedicated 0.4% sales tax, and in 1989, the sales tax was raised to 0.77%. The cost for these accomplishments has been \$67 million, and presently the program's funds are being used to complete acquisition of a greenbelt just outside the city limits in an attempt to control urban sprawl, protect natural areas, and provide recreational access.



Boulder Creek Tributary Greenway MASTER PLAN

(City of Boulder, 1990)

GOALS AND OBJECTIVES

Presently, the goals and objectives for the Boulder Creek Greenway are even more focused on the environment. Some of the creek's tributaries are considered "relatively pristine", and residents & city officials intend to either respect or sensitively design improvements to promote this level of environmental health.

COMMUNITY SUPPORT

As a result of the 1969 flood, City Council began pursuing alternatives for the Boulder Creek Corridor. Council appointed a committee to make recommendations, and sponsored numerous public hearings, neighborhood meetings, and other opportunities for public input. With this feedback, the Planning Department developed the Boulder Creek Corridor Plan, which received widespread public support, and City Council approved the plan in 1984. This multi-objective planning solution generated from the public planning process resulted in the community and political support needed to obtain financial and other backing to implement the project.

CORRIDOR DELINEATION

The plan recommended developing a five-mile continuous path and linear park along the entire length of Boulder Creek through the city. The final design for the project included strategies to revitalize the creek for fish, wildlife and recreation. The City of Boulder carried out a number of creative activities along Boulder Creek that meet these multiple objectives. Connectivity along the greenway is specifically addressed as an important feature for wildlife movement. Guidelines derived for the implementation of the project also recommend making the greenway as wide as possible to increase suitability for wildlife. Width is limited by existing development in most places, and heavy recreational use causes at least partial breaks in connectivity at some locations. The corridor delineation process was facilitated by a comprehensive understanding of the creek corridor and its tributaries. Channel configurations, stream flows, tributary context and wetlands were all evaluated thoroughly to give direction in the actualization of a successful greenway functioning for conservation and recreation purposes.

The width of natural vegetation within the greenway is relatively narrow where it traverses the urban center, ranging from about 10 to 50 feet beyond the stream's banks. The floodplain of Boulder Creek is the site of the greenway, however, currently only one side of the creek corridors floodplain is included.

POLICY

Selective acquisitions of property interests along the greenway are pursued by greenway officials. Acquisitions are based on specific considerations and are considered as opportunities occur and as resources become available. Additional property may be purchased in the interest of developing expanded greenways along both banks of the creek.

Critical portions of property and improvements is sought by donation or dedication when property with creek frontage is developed, redeveloped, or annexed. An easement of adequate size to protect the riparian edge will be sought when property with creek frontage is developed or redeveloped. Every effort will be made to respect the rights of adjacent property owners as greenway projects are designed and implemented. Specific trails may be redesigned, rerouted, or excluded from occurring on private property to protect the individuals privacy. Adjacent property owners will be involved in each phase of the greenway process. Overall city objectives will be balanced with individual property owners' concerns.

The City is pursuing and developing water quality improvement strategies. Every opportunity will be taken to improve water quality in the tributaries prior to their confluence with Boulder Creek. Wetland areas will be created wherever possible. Base flows will be maintained in stream channels as opposed to being entirely intercepted by irrigation ditches.

The city, with funds generated by its open space sales tax, is able to maintain an aggressive acquisition program in addition to its work in stream restoration. The county, with a smaller acquisition budget but planning authority over a large area, stresses land-use regulation and growth management. The Boulder County Nature Association was formed to work with private landowners, municipal and county governments, and federal agencies to implement a broader ecosystem plan for the county. The plan includes critical areas identified by the county but also delineates a more extensive, connected network of open space composed of core habitat areas and connecting corridors. The association helps provide direction and acts as a facilitator for the owners that manage these lands. Their work is limited to cooperative

efforts, such as ecological management planning for private lands, transfer of development rights, creative development plans, fee acquisition, and encouragement of land trades to consolidate disjunct federal lands into larger units with a high degree of connectivity. Recent association efforts have focused on negotiation donated conservation easements along key portions of two elk migration routes and a 2-mile segment of riparian habitat.

ENVIRONMENTAL MITIGATION AND TRAIL CONSTRUCTION

Before restoration began, Boulder Creek had been channellized and shortened by 30% to speed drainage of floodwaters. as a result of this channelization, streambeds had been flattened, increasing sediment deposition and minimizing the benefits of pool-and-riffle sequences and channel meanders.

Restoration efforts began in the 1980's, and since this time improvements which have been made include; deepening of streams low-flow channels, stair steps and drop structures were built to produce pool-and-riffle sequences, and riparian vegetation restored.

Environmental Preservation/Restoration

In order to identify and preserve ecologically important areas, officials will do biological assessments during project design prior to construction. In other words, assessments of habitat areas will be done to determine the overall biological impacts of design implementation. In undisturbed or restored areas, a buffer of riparian vegetation will be maintained and may vary in width. Trails and bridges will be designed to direct people away from other sensitive areas where no physical changes are proposed. In relatively intact areas of stream corridor, slightly disturbed ecosystems will be identified with the goal of restoring & preserving them. Undeveloped but disturbed areas of stream corridor will be considered for restoration and improvement of wildlife habitat. The restoration of elements of natural stream corridors will be a priority at these sites, although a transition from natural to developed areas will be planned.

Fish and aquatic habitat and wetland improvement opportunities will be considered as the corridors are developed. Fish habitat improvements through pool and riffle development, talweg improvements, stream bank protection and revegetation have been made in several locations along Boulder Creek and could be made in appropriate locations along parts of

South Boulder Creek and other tributaries as adequate in-stream flow becomes available. Opportunities to improve aquatic and wetland habitat exist along all the tributaries.

Trails and Recreation

Existing and proposed trails and bikeways are important planning considerations and may be accommodated in or near the creek corridors. Safe & convenient entry points will be designed where trails and bikeways cross stream corridors, as well as the parking at important entry points to the trails. Additionally, the trails will be key links to the larger trail systems within the mountains, foothills, and plains. These trails are not envisioned to be only along the tributaries. Connecting trails to parks, schools, and other existing trails are also included.

To preserve the stream corridor environment and provide guidance for the design of trails, design guidelines have been developed. These guidelines provide information on designing stream corridors, vegetation, and the design of trails and related facilities.

The flood carrying capacity of the creeks will not be reduced and, as part of existing drainageway master plans, may be increased. Flood control efforts will be implemented as multi-purpose projects where feasible in conformance with the criteria included in the plan. Care will be taken in the design, siting and construction of signs, park furniture, and fences to mitigate potential flood hazards. In areas where channel improvements are planned for flood utilization, every effort will be made to retain all mature trees. Any trees and vegetation removed will be replaced with similar vegetation where practical. All tributary greenway improvements will be designed to be accessible to handicapped people where such access is reasonable.

Boulder's Tributary Greenway is an excellent case study not only in terms of environmental goals but in design guidelines for riparian corridors as well. The Tributary Greenway Master Plan includes fairly extensive guidelines for the design of; two stage channels, energy dissipators & drop structures, stream bank stabilization through the use of crib walls & brush layering, restoration of artificial channels, vegetating grouted rip rap, vegetation management practices, paved & graveled trail construction, and many of the design features necessary in greenway implementation.

Design Guidelines

Altering Stream Corridors

The first priority in planning for stream corridors is to maintain stable channels with riparian wetlands and vegetation and natural configurations.

Stable Stream Corridor Design

When stream corridors must be modified or restored, design a two stage channel with a separate low flow within the flood channel. Do not design the 100 year flood channel and low flow channel to have the same or similar bottom width because such channels are frequently unstable and contribute to the decline of water quality.

Stabilizing Stream Banks

Stream banks are naturally established by the interaction of flowing water, rock, soil, and vegetative roots. A designer can choose from and combine several methods which follow nature's example to stabilize slopes and create an aesthetically pleasing design.

Restoring Altered Stream Channels

In restoring altered stream channels, use techniques which can increase channel stability and contribute to water quality. These techniques include; terracing to create a two stage channel with areas for water to spread over during periods of high flow and which are vegetated, create a defined talweg (the area which would be occupied by a trace of water flowing in a channel) which follows natural meander patterns as closely as possible, and install rock or log deflectors to control bank erosion

Drop Structures

Drop structures are one way to dissipate energy and control velocity. Drop structures required for flood control can also be important aesthetic elements in the landscape with the sights and sounds of falling water and pools.

Riparian Vegetation and Wetland Functions

Riparian vegetation and wetlands are organized in a complex mosaic based on available moisture and the size and age of the vegetation.

Existing Vegetation

The first priority in vegetation management is to preserve existing or native vegetation such as wooded areas, wetland areas, individual trees over 2" in trunk diameter or groups of trees and shrubs

New Vegetation

The establishment of new riparian areas is encouraged. Local, native species are to be used when establishing new riparian areas.

Habitat Enhancement

Because 60% of local wildlife is dependent on stream corridors, plant species and groupings should be designed to provide food and cover for wildlife. Corridors connecting larger areas of wildlife habitat are particularly important.

Creating New Wetlands

The establishment of new wetland areas for their own merit or as areas to replace other wetlands impacted during construction is encouraged in the greenways. Such communities can be established on sites with permanent shallow standing water, high water tables, or adjacent to running water. These communities should be designed to meet ecological functions which are appropriate to the site. Specific vegetation and functions should be based on topography, soil chemistry, water chemistry, and flood characteristics.

Replacement of Existing Wetlands

Wetlands created to replace those destroyed by construction must be designed to replace the functions of the destroyed wetland in accordance with the appropriate permit.

Vegetation Management Plan

Greenway designs will often involve the creation of complex arrangement of plant communities which require different management techniques over time such as mowing seasonally, mowing every few years, selective thinning, and pruning. Often this work will be performed by crews who do not understand the intent of the design. Therefore, a plan providing directions for maintenance would be highly beneficial whether that maintenance be by public agency or private property owner.

Trails and Related Facilities

All Trails

Trails should not appear carved through a hillside. An alignment which has long curves and short tangents will flow gracefully through the landscape. Residential areas of the greenway require a design that is sensitive to the character, forms, materials, and colors. Nearby residents should be closely involved in the design process. Sensitivity in locating and designing trails to address privacy concerns is a priority. Environmentally sensitive areas require a careful balance between the desire for recreation and the protection of natural resources. Determine the appropriate location and intensity of use of any path system

carefully. Trails and wildlife habitat potentially conflict because of the environmental impact of construction. In addition, some wildlife species are intolerant of the presence of trail users. Where high quality habitat is present, trail links which provide low transportation value should be eliminated. Where high value habitat is present, trail links which provide high transportation benefits should be routed around the habitat.

Paved Trails

Paved trails provide an easily maintained surface to direct trail users, provide for easy maintenance, and minimize resource damage. When designing paved trails; provide adequate sight distance for curves and underpasses, and design path to safely reduce bike and roller skate speed.

Unpaved Trails

When designing for unpaved trails, surface materials should provide stability and remain relatively firm when wet. The color of the surface should blend with the natural environment to minimize visual impact. Provide structures necessary to prevent erosion of surface material such as concrete pans at cross drainage locations and water bars or short paved sections on slopes to limit erosion.

Parallel Paved and Unpaved Trails

Where paved and unpaved paths are separate, the unpaved path should be nearer the water to allow closer contact of pedestrians to water where appropriate. The standard minimum width of the paved path is eight feet where a separate unpaved path is provided; it can be ten feet where high volume is anticipated. The minimum width of the unpaved path is 36 inches.

MANAGEMENT

A coordinated management plan for maintenance of City land and improvements along the creeks will be developed. Maintenance responsibilities will include sweeping trails, removing debris and trash, pruning branches, mowing along trail edges, reporting any dumping or damage to improvements along the creeks, monitoring the stream quality, assisting trail users and enforcing traffic and other regulations. This maintenance should have the same status and priority as streets and alleys. These costs will need to be included in the capital budgets of the affected departments.

Based on a careful analysis of need, a vegetation and planting program for each stream corridor will be implemented. The plan recognizes the need for a sustained vegetation management and planting program to maintain and enhance the ecology of each stream.

Trees lost to age and storms will need to be replaced. Vegetation along the banks and in sensitive areas will need increased maintenance as the use of these areas increases. Thinning may be necessary to preserve diversity. Adjacent property may require significant planting to heal the scars of structural removal.

Boulder is recognized nationally both as a city that has retained a high-quality environmental and aesthetic character, and as a community that had remarkable success in planning and managing its growth and development to serve broad public interests. The multi-objective Boulder Creek planning solution generated from the public planning process resulted in the community and political support needed to obtain financial backing. Beyond mitigating flood hazards, the Boulder Creek corridor is a key amenity contributing to the attractiveness of the city. It bisects some of the city's most heavily developed areas, yet retains its integrity as a natural, tranquil, greenway corridor.

OBSERVATIONS

It is apparent when reading this case study that the primary objective of this greenway project is ecological preservation and restoration. While recreational aspects are quite important in Boulder, they take a backseat to the environmental integrity of the creek and its tributary corridors. The commitment of city officials to a non-structural approach to flood control is evidence of their environmentally minded intentions. Thus, Boulder's greenway is an excellent example for planners and designers interested in promoting environmental preservation in their own greenway projects.

Many greenway plans begin by inventorying natural resources such as plant & wildlife habitats, however, Boulders approach goes a step further, they actually assess the effects of an implemented design on a given area. Once the assessments are done, design of the trail is carried out with the previously identified critical areas avoided. Other important habitat areas which have been degraded have been given priority for restoration through the use of design features which will simulate the natural conditions as much as possible. Also, the location of the habitat area and the intensity of use for recreational uses is a concern in trail design.

An important element in the design of the Boulder greenway is the aesthetics of the built trail. Designers have gone to great lengths in developing their design guidelines to insure the trail has a natural, flowing effect. By the use of long curves and short tangents, as well as a

sensitivity to materials, forms and colors, this natural effect is attempted. One concern of this researcher is their need to make as many trails as possible handicapped accessible. While it is recognized that these types of accessible trails are desirable, the question must be asked, "At what point do you give up aesthetics and environmentally sound design for accessibility?"

The focus on citizen involvement throughout the entire greenway process is an admirable goal of greenway planners. After reading the Master Plan, and speaking to the greenway coordinator, Gary Lacy, it is apparent that planners embrace the concept of a community "owned" greenway. In Boulder it is recognized that rarely can officials employ eminent domain on a large scale and have a successful project.

For this researcher, one of the most useful elements of the Boulder plan is their extensive design guidelines. These guidelines provide a comprehensive view of environmentally sound implementation techniques. While there are many steps to take before the building of recreational amenities actually begins, these are useful to have on hand and give direction to the proper manipulation of site specific features.

SOUTHEASTERN WISCONSIN ENVIRONMENTAL CORRIDORS

CONTEXT

One of the northern states of the midwest, Wisconsin is bounded on the north by Lake Superior and the Upper Peninsula of Michigan, on the east by Lake Michigan, on the south by Illinois, and on the west by Minnesota and Iowa. The capital of the state is Madison (Colliers Encyclopedia, Vol. 23).

Wisconsin comprises five physical regions; the Northern Highland, the Lake Superior Lowland, the Central Plain, the Western Upland, and the Southeastern Ridges and Lowlands. Northern Wisconsin has one of the greatest concentrations of lakes in the world. This is one of the few states in which essentially all drainage is outflowing (Colliers Encyclopedia, Vol. 23, pg. 711).

Approximately 45% of the state is covered with second-growth forests that consist of hardwoods and evergreens. Wildlife in the state is abundant. Common species include; fox, deer, squirrel, chipmunk, gopher and black bear. Dense populations of waterfowl can be found, including migratory geese twice a year. Fish species number more than 170, including major freshwater game fish and salmon (Colliers Encyclopedia, Vol. 23, pg. 711).

Wisconsin's rich natural resources coupled with their industrial economy has been the catalyst for the state innovative environmental protection practices. Corridor protection in southeastern Wisconsin dates from the 1920's, when a system of parkways, designed by Charles B. Whitnall, was initiated in Milwaukee County. In the 1960's, the concept was further promoted by Professor Phillip Lewis, Jr., of the University of Wisconsin at Madison. Lewis recognized the concentration of important natural resources along waterways and ridgelines and recommended their protection by the state for both recreation and conservation. Lewis' recommendations were adopted by the Southeastern Wisconsin Regional Planning Commission (SEWRPC) as part of its regional land-use plan in 1966. Since then, corridor protection has been one of the commission's primary goals (Smith & Hellmund, 1993).

The seven-county southeastern Wisconsin region covers roughly 2,700 square miles (1.7 million acres) of rolling, glacially sculpted terrain to the west of Lake Michigan. The region is largely agricultural but also includes the cities of Milwaukee, Waukesha, Kenosha, and Racine in its eastern reaches. Near the region's western boundaries, there are a number on

substantial tracts of remnant hardwood forest. This east-to-west transition from urban to agricultural to more forested landscapes, although not uniform throughout the area, illustrates the concept of the landscape modification gradient and has a marked impact on the types of greenways that have been protected in the region (Smith & Hellmund, 1993). These greenways have been termed environmental corridors, more specifically primary and secondary environmental corridors.

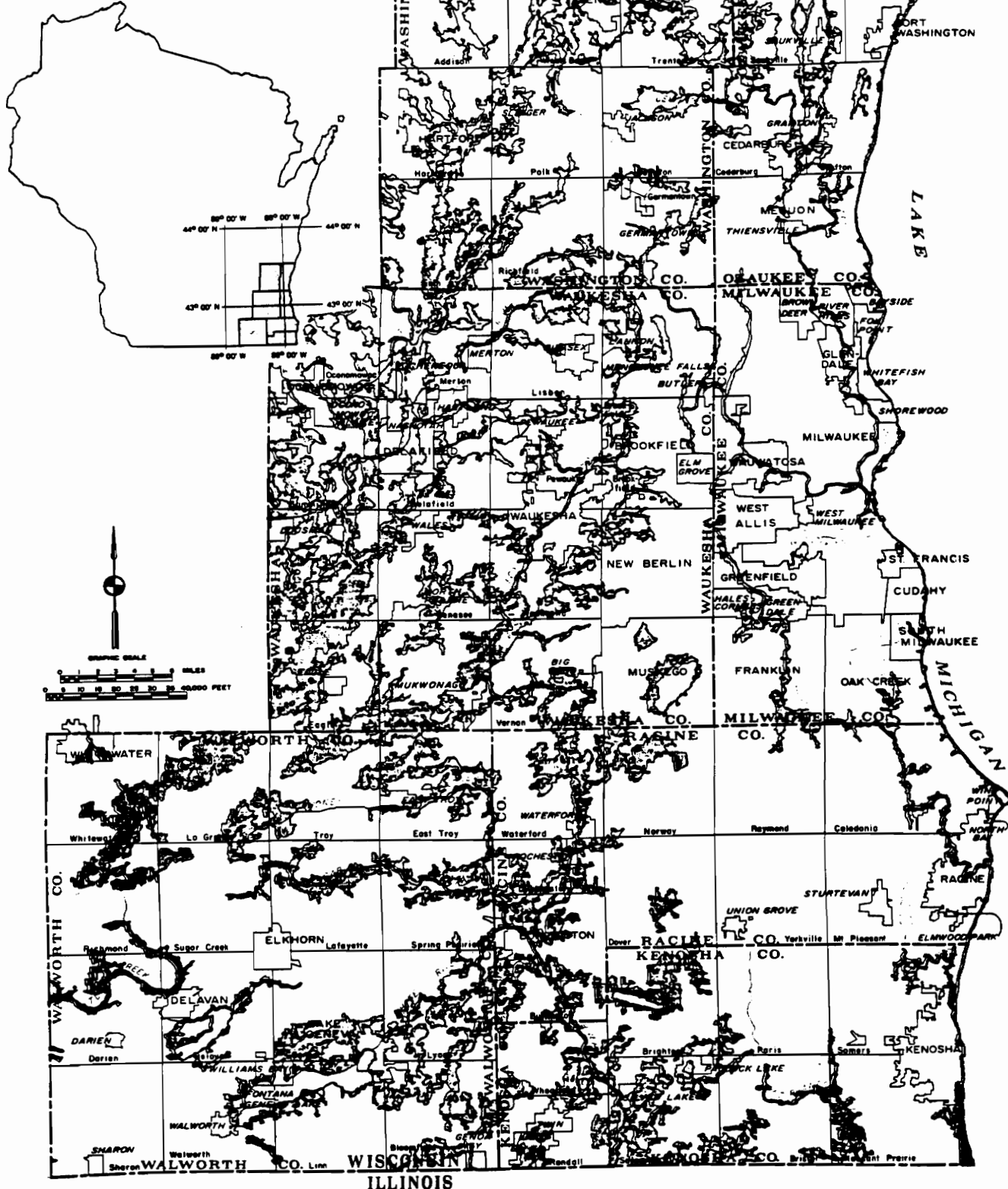
Primary environmental corridors are linear areas in the landscape which not only encompass the most important natural resource base elements - woodlands, wetlands, wildlife habitat areas, shorelines, floodlands, organic soils, areas of groundwater recharge and discharge, and rough topography - but also consist generally of those lands which are poorly suited for urban development. Over the last 25 years, the Commission through its planning efforts has successfully applied the environmental corridor concept on a regional scale, with the corridors now finding their way into county and local land use plans and into state regulations. Preservation in natural open uses of these corridor lands will do much not only to ensure the maintenance of the overall environmental quality of the region, but to help prevent the creation of new environmental and developmental problems (SE Wisconsin Regional Planning Commission, 1993, pg. 8).

PRIMARY ENVIRONMENTAL CORRIDORS PROTECTED

LEGEND

PRIMARY ENVIRONMENTAL CORRIDORS

-  PROTECTED THROUGH PUBLIC OWNERSHIP OR PUBLIC REGULATION
-  UNPROTECTED



Southeastern Wisconsin Environmental Corridors

MASTER PLAN (SE Wisconsin Regional Planning Comm., 1992)

CORRIDOR DELINEATION

One of the most important tasks completed under the regional planning program for southeastern Wisconsin has been the identification and delineation of those areas in the region in which concentrations of natural resource elements occur. It was recognized that preservation of the natural resources, especially where these resources are concentrated in identifiable geographic areas, was essential both to the maintenance of the overall environmental quality of the region and to the continued level of the quality of life for the resident population.

Under the regional planning program, seven elements of the natural resource base have been considered essential to the maintenance of both the ecological balance as well as the overall quality of life in the region:

- 1) lakes, rivers, and streams and the associated shorelands and floodlands
- 2) Wetlands
- 3) woodlands
- 4) prairies
- 5) wildlife habitat areas
- 6) wet, poorly drained, and organic soils
- 7) rugged terrain and high relief topography

In addition, there are certain other features which, although not a part of the natural resource base per se, are closely related to or centered on that base and are a determining factor in identifying and delineating areas with recreational, aesthetic, ecological, and cultural value. These features include:

- 1) existing park and open space sites
- 2) potential park and open space sites
- 3) historic sites
- 4) scenic areas and vistas
- 5) natural and scientific sites

The delineation of these 12 natural resource and natural resource-related elements on maps results in a concentration of such elements in an essentially linear pattern of relatively narrow, elongated areas which have been termed "environmental corridors" by the Regional Planning Commission. Primary environmental corridors include a wide variety of the most important

natural resource and resource-related elements and are at least 400 acres in size, two miles long, and 200 feet wide. Secondary environmental corridors generally connect with the primary environmental corridors and are at least 100 acres in size and one mile long. In addition, smaller concentrations of natural resource features that have been separated physically from the environmental corridors by intensive urban or agricultural land uses have also been identified. These areas, which are at least five acres in size, are referred to as isolated natural areas.

The preservation of these environmental corridors in essentially natural, open uses can assist in flood-flow attenuation, water pollution abatement, noise pollution abatement, glare reduction, and favorable climate modification. Such preservation is also essential to facilitate the movement of wildlife, especially in times of stress, and for the movement and dispersal of seeds for a variety of plant species. In addition, because of the many interacting relationships which exist between living organisms and their environment, the destruction or deterioration of one important element of the total environment may lead to a chain reaction of deterioration and destruction of other elements.

The design process begins with a comprehensive resource inventory of each county, mapped on aerial photographs at a scale of 1" = 400'. The resulting data base resides in a geographic information system (GIS), covers all pertinent classes of natural resources including vegetation, soils, wildlife habitat, hydrology, scenic vistas, and land use, and is updated every five years. These data form the basis for corridor design and other planning activities undertaken by the commission (Smith & Hellmund, 1993).

Each resource type is assigned an importance value between 5 and 20, based on its relative importance as determined by consensus of SEWRPC staff and technical advisory committees. For a given portion of the region, the GIS is used to combine maps showing all of the resource types, and any area covered by at least one of the resources is marked off. The cumulative point value for all resources coinciding in a particular area is calculated. Any area with a point total of 10 or more is considered to have significant natural resource value. Although some isolated areas have a value of 10 or more, high-value areas usually line up along waterways and ridgelines.(Smith & Hellmund, 1993).

An important element of corridor function, connectivity, has been successfully addressed in this project. This goal of connectivity is built into the process in order to connect natural areas separated by short stretches of land the fall shy of the 10 point cutoff. In these instances, the distance over which these connections are made is determined by a set of specific guidelines relating to the smaller of the two areas to be connected (Smith & Hellmund, 1993).

POLICY

Primary corridors encompass 467 square miles, or roughly 17% of the region. Of this area, 147 square miles, or 31% of the total corridor area, have been purchased by local, county and state governments. An additional 44% of primary corridors (20 square miles) that occur on private lands have been protected through local, county, and state regulation or the federal Wetlands Protection Act.

Areas which have been designated as primary environmental corridors are placed in one of several zoning districts, depending upon the type and character of the natural resource features to be preserved and protected. All lakes, rivers, streams, wetlands, and associated undeveloped floodlands and shorelands, including lowland wildlife habitat, generally should be placed in lowland conservancy or floodland protection districts. Upland wooded areas and areas of steep slope, that is, 12% or more, including scenic overlooks and upland wildlife habitat, generally should be placed in appropriate upland conservancy, rural-density residential, or park and recreational district. Placement of the environmental corridors in these zoning districts are intended to generally promote the preservation of such corridors in essentially natural, open uses (SE Wisconsin Regional Planning Commission, 1993, pg. 388).

It is noted that adherence to the environmental corridor development guidelines may require that certain large land-consuming facilities, such as golf courses and certain transportation and utility facilities, may have to be located wholly or partially on adjacent agricultural lands, including prime agricultural lands. Proposals for such development must be evaluated on a case-by-case basis, carefully weighing farmland preservation objectives and environmental corridor preservation objectives for the affected area (SE Wisconsin Regional Planning Commission, 1992, pg. 399).

Residential development is thoroughly addressed in the Regional Plan document. Among other guidelines, the plan calls for residential development to be directed to areas of the corridor which may have been previously disturbed and to the edges of the corridor. Where clustered residential development is utilized, the surrounding lands needed to maintain the recommended net residential density should be placed under restrictive covenants or dedicated to an appropriate public agency, a private conservancy organization, or a duly constituted neighborhood homeowners association, with dedication specifying maintenance in natural, open use.

One of the more effective regulatory tools used to protect the corridors lies in the permitting process for sanitary sewer extensions. Like all planning commissions in the state, SEWRPC is charged with maintaining an areawide water-quality management plan that designates sewer service areas and environmentally sensitive land within those districts (in this case, sensitive lands are defined as primary environmental corridors). Before the state's Department of Natural Resources can approve a proposed sewer extension, it must determine that the extension and associated development will not intrude upon any primary corridors. However, exceptions can be made in specific cases. Parks, outdoor recreation facilities, and low-density residential developments (with 5-acre minimum lot sizes) are sometimes considered to be compatible with corridor protection, in which case they are allowed to intrude upon corridor lands (Smith & Hellmund, 1993 pg. 166).

IMPLEMENTATION

In this region greenways provide multiple uses, not only in terms of environmental functions but for human uses as well. Many of the corridors act as roads and parkways for at least part of their length, and most contain walking or bike trails for recreation and commuting. Outside of the metropolis of Milwaukee, the landscape changes quickly from urban to agricultural, and these environmental corridors serve the purposes of filtering out fertilizers from runoff and maintaining upland wooded habitats that are rare in this intensively farmed landscape (Smith & Hellmund, 1993).

The City of Waukesha is traversed by the corridor, and within the city there is a traditional urban park with mowed grass and a few shade trees. This park provides little protection for water or wildlife compared to areas outside of the urban environment. The corridor extends to encompass a large State Forest. The Kettle Moraine State Forest covers 19,000 acres and

travels the ridgeline for some 20 miles. The forest is connected to other, smaller natural areas nearby and thus has the potential to serve not only as a preserve but also as a reservoir of native species, helping to maintain diversity beyond its immediate boundaries (Smith & Hellmund, 1993). This State Forest is not only crucial to habitat preservation but a regional recreation center as well. The Ice Age National Scenic Trail traverses 36 miles of ridgeline and bisects numerous local trails and campgrounds.

All told, the SEWRPC has recommended a system of seventy county and state parks and 500 miles of recreational trails with environmental corridors as part of park and open-space plans for each of the seven counties. At present, sixty of these parks and 170 miles of trails are available for public use.

OBSERVATIONS

Southeastern Wisconsin provides an excellent example of a regional commitment to maintaining environmental quality. The focus on the environment rather than the recreational opportunities that these corridors provide is proof of this commitment.

The most important aspect of this case study is the comprehensive, regional approach to environmental land planning. This type of approach minimizes the chances of one jurisdiction's attempts at environmental preservation being negated by the traditional land management practices of adjacent jurisdictions. Not to mention the fact that much more can be done to insure environmental integrity as well as provide more enticing recreational facilities when these separate entities come together to act as a whole. Planners and designers have recognized the fact that nature's course does not usually coincide with human boundaries.

Another, notable aspect of this plan is the derivation of a consistent method used in environmental resource inventorying. These inventories form the basis for corridor design and other planning activities within the region. The use of overlays along with the rating system, appears to be an appropriate approach to identifying natural resources and sensitive areas. While recognizing the benefits of this system, some critics feel that ecological processes are not addressed by this method. They argue that location and arrangement of particular types and combinations of resources are unduly favored over the functional interactions between elements of the landscape (Smith & Hellmund, 1993).

Connectivity has been addressed in all the previous case studies, however, here the focus is on connecting natural resources as opposed to recreational resources. Connectivity is built into the inventorying process to insure habitat and seed dispersal.

Within this planning region, zoning is often used as an ecological preservation tool as opposed to simply an acquisition method. The type of land cover generally determines the type of zoning which is best suited to its protection, insuring that these lands will be preserved in essentially natural, open uses. Extremely sensitive areas are protected with more permanent tools such as floodland protection districts and lowland conservancy's. Conservancy's are also recommended for cluster and other residential developments that are within or near the environmental corridors whose adjacent lands need protection. An important aspect of the zoning process for corridor development is that each proposal is evaluated on a case-by-case basis, carefully analyzing the developments potential impacts. The apparent downfall of this project is the giving up of prime agricultural lands for other uses. However, the case-by-case analysis of development projects is an added check and balance for proper land use decisions.

CHAPTER 4

Introduction

The purpose of reviewing the existing literature and the case studies is to build upon the current methods for ecological planning as well as learn from the successes & failures of implemented projects. With this knowledge, one can begin to pull out key points in order to construct a process model for greenway. Because of the inherent uniqueness of individual projects, the model needs to be very general in nature, addressing the large issues which are common to all projects. These general commonalities are the focus of the model.

Methodology

The model is based on observations from the case studies, the literature, and the researchers knowledge of linear conservation planning. It is not intended to be the only steps in a long process, however, it highlights the most important ones which should not be overlooked in the planning process. Applications will find that specific elements of the model may have to change to meet local conditions and site constraints. The methodology for constructing the model is as follows; the text is comprised of what was learned from the case studies, along with information obtained from the literature, and this researchers ideas on ways of dealing with specific greenway issues, all combined to present a general process overview of the five key issues of riparian greenway planning. Each key issue is dealt with separately, then to conclude, the researcher has constructed flow charts which graphically illustrate the general elements and sequence of events of that key issue. The last portion of the model illustrates how these issues are dealt with simultaneously, and a comprehensive process model is illustrated by a flow chart.

The case studies prove that no two greenways are alike. Each greenway process is unique and is primarily defined by the people involved, their objectives and the resources the project is intended to protect, connect, and enhance (Little, 1990). Greenways are limited only by one's imagination, however, some basic principles are common to all. They are linear corridors of protected open space, they usually protect important or sensitive resources, they connect important community resources, such as parks and schools, and the usually provide for human access to these resources, although some areas are too ecologically sensitive for recreational use and must be preserved as natural refuges. The following model gives insights into how to enhance and preserve these types of landscapes. The thesis will then go on to illustrate how to apply and fine tune this model in order to meet the needs of a specific greenway locale.

Establishing Goals and Objectives

As was seen in all of the case studies, it is vital that a long term vision is defined when entering into a greenways project. This involves being honest about what the intentions of the project are, and following through with them. If the project is intended to stimulate economic development, such as in Chattanooga, then planners should approach the project in that manner. This is not to say that a greenway project cannot serve multiple objectives, however, planners should determine their primary goals first. Once this done, secondary goals can start to be defined and the project strategies can be custom made to meet those goals and objectives.

It was evident in each of the case studies that the long range success of a greenways project is contingent upon community involvement. The very linearity of a greenway means that its existence, or lack of it, will affect many lives(Little, 1990). According to Charles Little, most successful greenway projects make a serious effort early on to communicate their concept to a broad audience. Then goes on to note that this process is not the same as the physical greenway planning, which comes later and is based on environmental and physical needs. Determining project goals is an appropriate stage of planning to begin soliciting public opinion and support.

The project goals should reflect the communities want and needs and incorporate them into the master plan. In order to do this, working committees or project planning teams, need to be organized. In Chattanooga this committee consisted of staff from they Rivers, Trails, and Conservation Assistance Program; the Chattanooga Area Regional Council of Governments/Southeast Tennessee Development District, The Coosa Valley Regional Development Center, the Tennessee Valley Authority; the U.S. Forest Service, the Soil Conservation Service, the Chattanooga/Hamilton County Regional Planning Commission, the City of Cleveland Planning Department, Inc., and a local environmental consultant and member of the South Chickamauga Creek Greenway Alliance. The responsibilities of the planning team were to help identify what natural, cultural and recreational resources should be included within the greenways system, gather and map resource information, analyze resource data and identify a regional network of greenways, and to develop recommendations for implementing, funding managing and maintaining this network. The planning team used frequent citizen workshops, meetings and other input to guide them through the process.

They then were able to develop their project goals, one of the goals being educating the general public on corridor protection.

As we saw in the case studies, primary and secondary goals vary based on what the community and local officials desire of the greenway. In Raleigh, primary goals were determined to be recreational, while environmental preservation was secondary. In Chattanooga economic development through ecotourism was the primary goal, thus environmental preservation followed as secondary. In Boulder, environmental preservation and ecological restoration was the primary goal with recreational amenities being secondary. And in Southeastern Wisconsin, priorities were natural resource protection while recreation was permitted as a secondary goal. It is apparent from all the case studies that establishing these types of goals and staying faithful to these goals was a guiding force in the success of these projects.

Once these goals are defined, planners can begin to assign key uses to the greenway. Having a good grasp on what the key uses are to be will facilitate the corridor delineation process, as well as give direction to future steps regarding policy, planning, implementation and management.

COMMUNITY SUPPORT

Building support throughout the community for a greenways project is critical in getting the project underway, as each of the case studies have proven. For obvious reasons, community involvement cannot stop once the project goals are defined, there are many more aspects of planning and implementation which need the communities participation.

In order to stimulate early achievement, a document that is descriptive and suggestive rather than anything prescriptive and authoritative is helpful. In other words, a vision document which lays out the overall goals and objectives of a potential project (Little, 1990). In Raleigh this document was in the form of a masters thesis, in Chattanooga the vision document was derived by a series of public hearings and meetings, Boulder planners relied heavily on public input as well as recognized environmental needs, and in Wisconsin environmental quality and preservation was the guiding force for the vision. In all these cases, a vision document was derived in the early stages of the project, thus supplying a working document for future planning efforts.

The issues discussed in the vision documents were descriptive of the projects goals and key uses. For example, in Raleigh the document described how floodplain zoning could be employed, how easements could be acquired, how paths should be built, and where. It also provided politicians and the public alike with persuasive rationales for taking action - the social, economic, environmental, and aesthetic benefits of the greenway.

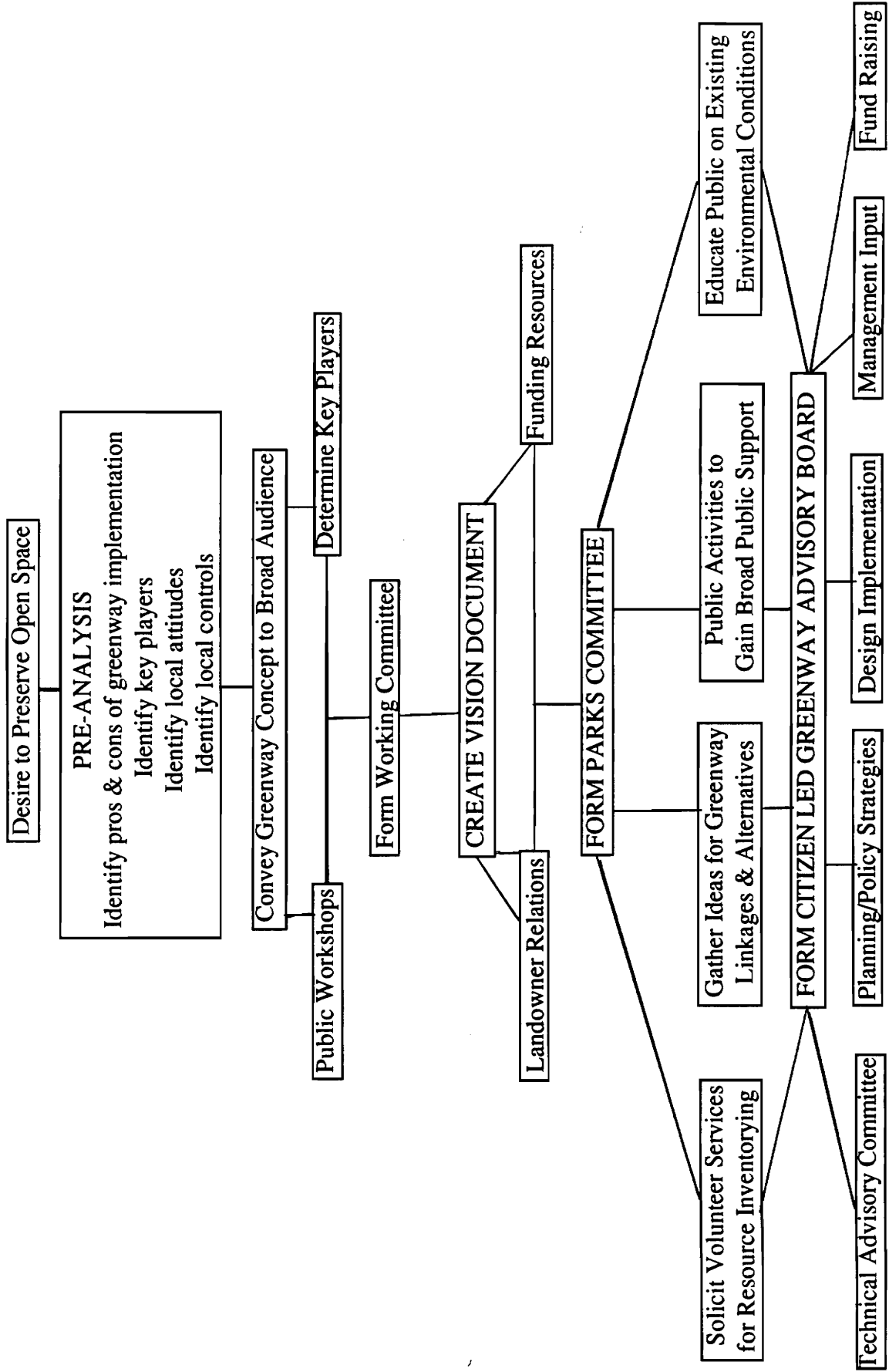
The basic consensus-seeking source of information about the greenway idea should be the words and drawings of the vision document, presenting the proposed greenway in a context that is inherently interesting and compelling to the general reader. Other communication efforts are necessary as well - activities such as; magazine and newspaper articles, slide shows, and special publicity-generating events (Little, 1990). These events could include; promotional walks, Christmas tree and garden mulching centers for trail surfacing, and educational seminars on an areas natural resources. These activities are all similar to what was done in Chattanooga.

The design process can help to educate the public about what it takes to sustain a greenway over the long term and how they will benefit from it. Also important is to educate citizens on local environmental and social problems. This education process was evident in each one of the case studies. The extensive public hearing and community meetings which were held were all attempts to not only gauge the community wants but also to educate them on pertinent regional issues. For example, in Chattanooga, the Park Committee held a meeting with representatives of various agencies and organizations to brief them on the greenway concept and gather information for further development of the preliminary plan. These agencies and organizations included; US Soil Conservation Service, Department of Health and Environment, a biology teacher from the high school, TEA and several city and county officials. These participants briefed the officers and directors of the Chattanooga Area Chamber of Commerce on the effects the greenway could have on the region. Other efforts were greenway presentations to a wide variety of community groups by local organizations such as; Chattanooga Audubon Society, Cherokee Chapter of the Sierra Club, National Park Service, Tennessee Conservation League, and the Tennessee River Gorge Natural Areas Trust. Similar efforts were carried out in Boulder and Raleigh as well.

The next step in the process, if not already accomplished, is to recruit interested organization members, as well as a variety of citizens to establish a greenway advisory committee.

Advisory committees were formed in three of the four case studies and proved to be a critical step in each of the processes. In Chattanooga the greenway advisory board consisted of members of the general public, governmental officials, technical experts, and representatives of interested organizations. Chattanooga is a good example in that it stressed the need for the advisory committee from the projects inception and its importance to the long term success of the project. In Raleigh, the advisory board is composed entirely of citizens appointed by City Council and is used to provide direction and guidance's to the Capital Area Greenway Program. The board members have participated in all aspects of the program, duties include; providing planning and design suggestions for new project proposals, organizing the clean-up of neighborhood creeks, and supporting/promoting neighborhood greenway projects to name a few.

COMMUNITY SUPPORT PROCESS



CORRIDOR DELINEATION

Once the community has shown its support for the project and the projects goals and key uses have been defined, the next step is to delineate the corridor/s of which the greenway will consist of. As was evident in the case studies, community involvement was instrumental in determining the corridor routes, as was the involvement of regional environmental groups and government agencies. In the data, the beginning stages of the design process involved several interested parties physically experiencing much of the riparian corridor. This proved to be helpful for delineation of the corridor swath as well as the beginning stages of an important stage in greenway development, resource inventorying.

A variety of methods were used for the inventory process in the data. An understanding of the region and its resources was an important consideration for choosing which method to use. In all of the case studies, planners referred back to the project goals when engaging in the resource inventory process. For example, in Boulder environmental preservation/restoration was a primary goal of the project and with this in mind, planners pinpointed areas along the creek corridor which possessed the following characteristics; floodplains, wetlands, irrigation diversions, minimum stream flow, tributary confluence's, vegetation degradation, and areas of bank erosion. Based on the location of these sensitive areas, the greenway corridor could begin to be defined in a fashion which would best restore and protect these sensitive ecological features.

Once the region has been inventoried it is important to store the data in a reliable and accessible manner. Geographical Information Systems (GIS) is a widely used method for this purpose. The Wisconsin case study illustrates how one region is using GIS for not only storing data, but for the environmental design itself. There the design process began with a comprehensive resource inventory of each county mapped on aerial photographs at a scale of 1"=400'. The resulting data base is kept in a geographic information system, and covers all pertinent classes of natural resources including vegetation, soils, wildlife habitat, hydrology, scenic vistas, and land use. The SEWRPC updates this data every five years and uses it to form the basis for the corridor design and other planning activities undertaken by the planning commission (Smith & Hellmund, 1993).

In Wisconsin they also employ the overlay method for ecological design which is a variation on Ian McHarg's methodology. There, each resource type is assigned an importance value between 5 and 20, based on its relative importance as determined by a consensus of the

SEWRPC staff and technical advisory committees. For a given portion of the region, the GIS is used to combine maps showing all of the resource types, and any area covered by at least one of these resources is marked off. Then the cumulative point value for all resources coinciding in a particular area is calculated. Any area with a point total of 10 or more are considered high value areas and are usually found lined up along waterways and ridgelines.

If GIS is not an option, then there are many other methods which can be used, however, they are generally more time consuming. These methods include; using existing USGS maps, contacting the appropriate governmental department and obtaining their maps, and overlaying these maps to get an overview of the conditions of the site.

When determining corridor delineation, the goals and key uses for the greenway project need to be the primary consideration. If environmental quality is a primary objective, then specific elements need to be addressed, as was illustrated in each of the case studies. These elements include corridor context, corridor width, the natural order of streams, and the upland regions of the watershed.

Context

Understanding the context of the riparian corridor within the entire network of rivers and streams is important. For example, removing riparian vegetation alters headwater streams more than high-order streams, and a corridor's width, length, and extension upstream from a site are important for maintenance of water temperature. Riparian greenways often include areas where two or more streams converge. These sites are sometimes referred to as nodes within the larger network and connect numerous environmentally critical areas. Planners in the field recommend that the width of the greenway at these nodes be increased in order to eliminate any chance of ecological degradation. Boulder is an excellent example of tributary consideration. Because most of the tributaries of Boulder Creek are channelized, the greenway plan is geared to restoring these tributaries to a quasi-natural state, specifically addressing the design of two-stage channels that can accommodate both low flows and periodic floods, as well as the restoration of alternating sequences of pools and riffles which are crucial to a diversity of stream habitats.

Other contextual questions that are important for greenway planners to ask are; What are the adjacent land uses? Is the corridor important for wildlife movement? How is the corridor

affected by, or how does it affect other segments upstream and downstream? (Smith & Hellmund, 1993). Southeastern Wisconsin illustrates this idea of corridor context by their attention to all the riparian corridors within the region. All of these corridors have been given a designation of either primary or secondary corridor status, thus providing some level of protection for all important riparian landscapes.

Corridor Alignment

As the case studies demonstrated alignment, or the determination of the lands needed to be acquired for an environmental corridor should include the following features; the corridor encompasses both sides of the waterway, the protected corridor is as continuous along the waterway as possible, the protected lands includes all tributaries of the watershed, the corridor identifies and protects areas of high erosion potential, and identifies and protects confluence areas of two or more streams. In each of the case studies one, if not all, of these features were addressed in the corridor plan. Boulder is a good example of how to identify these types of areas and the problems which may be occurring in these areas and how to address those problems. They have established extensive guidelines which are adapted to riparian conditions typical of Boulder's stream and vegetation types and its urban environment. With the exception of areas devoted mostly to recreation, trails conform to the relative sensitivity of natural features by avoiding large or fragile habitat patches and by approaching stream banks only at selected locations.

Width

An approach to determining corridor widths which is often used is arbitrary buffers such as what is used in Raleigh, North Carolina. Widths are assigned to stream corridors based on the natural order of the stream. For example, a first order stream would have a buffer of 100' while a second order stream has a buffer of 75' and a third order stream would have a buffer of 50'. The problem with this arbitrary method is by now apparent; while these widths may be appropriate at most areas of the corridor, other areas may need more of a buffer because of intensive adjacent land uses such as agriculture, and abundance of impervious surfaces or any number of other circumstances. Boulder's guidelines recommend making greenways as wide as possible to increase suitability for wildlife. However, greenway widths in Boulder are severely limited by existing development in most places. In Chattanooga widths are synonymous with the 100-year floodplain, however, planners realize that future expansion outside of the floodway may be desirable.

Budd has derived methods for determining corridors widths as well. He and his colleagues use simple field survey methods on selected reaches of a stream. A riparian corridors potential for sediment filtration and temperature control is assessed qualitatively, as well as terrestrial and aquatic habitat and vegetation's contribution to stream structure. Stream characteristics which are surveyed include stream type, slope of the streambed, soil class, runoff and erosion potential, water capacity of the soil, vegetation cover, temperature control, stream structure, sedimentation control, and wildlife habitat. The designer uses all these factors to estimate the appropriate width of the corridor. It is important to keep in mind when determining widths that a greenway with an arbitrary width may be too narrow to filter sediment from an agricultural field, or other land uses, and may fail to fully protect significant natural features. On the other hand, a greenway in the same location that has a flexible width can be widened at appropriate locations (Smith & Hellmund, 1993, pg. 92).

Critical Areas

Critical areas are areas which could be significantly impacted by a greenways project and need to be identified and planned for during corridor delineation. There are many types of critical areas which are within, adjacent to, and beyond the riparian corridor. As was done in each of the case studies, these areas should be included as part of the greenway and given special management practices. These areas include; intermittent tributaries, gullies, drainage swales, natural vegetation, steep slopes, unstable soil area, lateral wetlands, undercut banks, bridge crossings, path or boat ramp accesses, development sites, areas of intensive forest cutting, pastures, cultivated fields, aquifer recharge or discharge zones, and wetlands.

Other critical areas to consider in environmental corridor planning are; aquifer recharge or discharge zones and floodplains. Aquifer recharge areas help maintain year-round stream flows and should be protected if a high level of environmental quality is desired. These areas are not often easily identifiable, however, a rule of thumb is; if a wetland or seasonally wet soils occur uphill from a stream, then they are probably groundwater recharge areas. Outcrops of bedrock known to be aquifers are also important recharge areas. Springs laterally uphill from streams are discharge areas for the aquifer and may be recharge areas for the stream. Nearly all of the geomorphic floodplain is either a recharge or discharge area for stream water (Smith & Hellmund, 1993, pg. 94).

Corridor Structure

Greenway corridors generally have an underlying hierarchy and structure and should be classified based on this hierarchy. Corridors within a larger system have varying degrees of importance within that system both in terms of the environment and recreational opportunities. This concept was illustrated effectively in the Raleigh Greenway Project. Close attention is paid to corridor structure in an effort to ensure continuity. Generally, the concept of connectivity is what determines a corridors importance, however, as was seen in Raleigh, other elements are important as well. These elements are; connectors, linkage, accessibility, nodes and loops.

According to Daniel S. Smith, connectivity is the degree of linkage of points along a greenway, and is very important for the success of any project. In terms of wildlife, the functional connectivity varies based on the needs of each species. Roads are usually the most common and prominent barriers that compromise greenway connectivity, although degraded habitat areas can have similar effects. Connectivity is also important in providing continuous protection for streams. Unprotected portions of a waterway can reduce water quality downstream and inhibit the movement of aquatic organisms. Smith feels that designers can ensure connectivity by locating greenways in roadless areas, by maintaining continuous stream side vegetation, and by making use of crossing structures for wildlife such as; underpasses and tunnels (Smith & Hellmund, 1993).

Thorne adds to the connectivity concept by stating that when one is designing greenways intended for wildlife movement, the spatial and temporal dynamics of the shifting-mosaic steady state, as well as the possibility of large-scale disturbances, point to the need for relatively wide corridors to maintain connectivity among mature habitats. An understanding of succession also leads to the recognition that greenways should include not only a diversity of mature habitats but also all stages of ecological succession (Harris, 1984 as cited in Smith & Hellmund, 1993, pg. 36).

There are several approaches a designer can take in an effort to ensure corridor connectivity. One is to design a network of multiple corridors linking habitat patches to provide redundancy and multiple movement pathways. This will not only provide alternative routes for wildlife movement, but will also allow for a wide range of recreational opportunities. This approach was taken in Boulder, where connectivity is specifically addressed as an important

feature for wildlife movement. In Southeastern Wisconsin the corridor delineation process favors the maintenance of connectivity among natural areas by focusing on linear aggregation of natural features. Further considerations of connectivity is built into the method in order to connect natural areas separated by short stretches of land that fall shy of the 10-point cutoff. The distance over which these connections are made is determined by a set of specific guidelines relating to the smaller of the two areas to be connected. An example of this is; if the smaller of the two areas is more than 640 acres (1 sq. mile), a connecting zone 1/2 mile long can be included in the corridor, if the area is only 100 acres in extent, the connecting zone can be no more than 880' (1/6 mile) long (Smith & Hellmund, 1993. S E Wisconsin Regional Planning Commission, 1981).

Continuity of corridors can be established or maintained with the use of connectors. Often greenway corridors are severed by man-made facilities such as roads, or by development that precludes acquisition of public greenway easements, natural topography can cause breaks in corridors as well. Raleigh planners found that greenway connectors are necessary in order to provide continuity along a particular corridor or link two corridors together. These connectors can be sidewalks, bridges, pedestrian tunnels and underpasses or designated bicycle routes. They can also be trails located within the easement areas of major utilities such as cross-county transmission lines or abandoned railroad rights-of-way. Connectors also provide opportunities for loops within the system, increase accessibility to the overall system and strengthening the fabric of the open space system (Raleigh Parks and Recreation Dept., 1989, Pg. 4).

Corridor Linkages

The case studies emphasize the importance of linkages with other greenway networks, and the desirability of accomplishing links. These linkages not only create more recreational opportunities, but provide immeasurable benefits for wildlife. One of the most important issues to keep in mind when designing for multi-jurisdictional linkages is the idea of corridor consistency. It is important for the experience of the user that the corridors read as one entity to the greatest extent possible. This means that consistency in design features is a must. A regional greenways coordinator can be very instrumental in ensuring this consistency. The idea of a regional coordinator is common to all of the case studies. During data collection for this research, it was learned that while Boulder and Raleigh already employ a regional

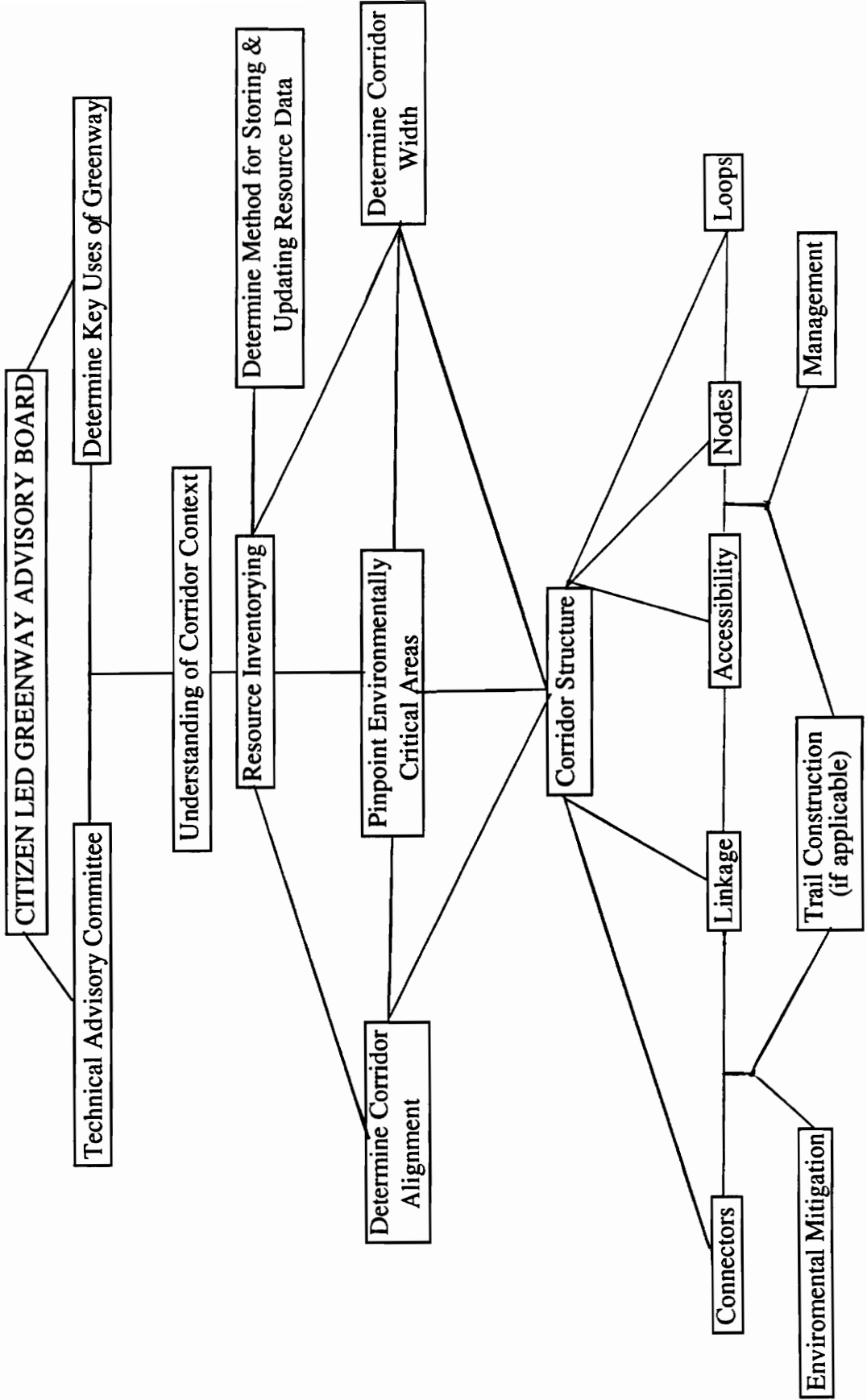
coordinator, Chattanooga was beginning the process of hiring one. In Wisconsin, the regional planning commission served that role.

Making the greenway accessible to the public is an important consideration when delineating the corridor. Two main reasons why accessibility is important are; (1) people need to have entrance and exit points in order to utilize the trail system, (2) ecologically sensitive areas need to be avoided, thus defined entrance and exit points can control what areas people impact. Each project is different, and local designers know best what their areas resources are, so determining access points is really a design decision. However, it is important to remember the immense ecological impacts that can occur in and around these areas and the proper tactics should be taken to minimize these impacts.

Nodes are important elements within a greenway system because they are either destination points for the recreational user, or points of stream confluence within the overall stream network which link numerous environmentally critical elements. In either case, special design attention and management practices need to be given to these areas. Buffering, revegetating, and stabilizing these critical areas should be a top priority for planners.

Loops are necessary elements within a greenway design because they facilitate linkages and provide for a variety of experiences for the recreational user as well as accommodate the needs of wildlife for multiple movement corridors.

CORRIDOR DELINEATION PROCESS



POLICY AND PLANNING

Greenway planning entails many duties, so it is important to be as organized as possible from the start. There should be a group or agency who will be responsible for orchestrating the project, and it is very beneficial to determine what type of organizational approach will be taken early on. Charles Little breaks down the organizational approaches into three categories based on his extensive case study research. The first is a governmental agency which does all corridor acquisitions and development of the trail system. Boulder is an example of this approach, and is having great success with their municipal system. This system is a combination of city, county, and the Boulder County Nature Association working in harmony to carry out the variety of duties involved in greenway making. The different approaches to land protection taken by the city, the county and the BCNA are appropriate to their organizational strengths and financial resources. The city, with funding available from an implemented open space sales tax, is able to actively pursue the acquisitions of needed lands, while the county has the power to exert planning authority over a large area. This planning authority stresses land use regulation, growth management, and environmental preservation. In addition, the association enjoys strong landowner relations, thus enabling it to act as a catalyst and facilitator for public and private sectors alike. These three entities have similar goals, thus maintain a high level of cooperation.

Raleigh also uses this approach, however, they also rely heavily on nongovernmental groups to do local planning and implementation. The greenway system is overseen by the Raleigh Parks and Recreation Department Design/Development Division. The acquisition of land for the Capital Area Greenway System is a multi-faceted process involving the coordination and cooperation of private landowners, developers, several City of Raleigh departments, several City boards and commissions, the City Managers office, City Council and the County Registrar of Deeds.

However, while Raleigh's organizational approach apparently works well, a key finding in Little's research is the need for the government agency to be independent of other typical governmental, functional departments such as transportation, parks and recreation, public works, or the like. Ideally, the work should be assigned to a greenway commission that has no other duties and therefore no potential conflicts of interest (Little, 1991, pgs. 180-181).

The second approach is to develop a private, nonprofit association. This is a road less traveled in greenway planning but is a legitimate and feasible approach depending on the specific circumstances of the project in question. While none of the case studies illustrated this, one way of pursuing this type of organizational entity is to develop a land trust in the region which is responsible for carrying out the initial steps in greenway planning and design as well as acquiring needed lands.

The third organizational approach is to combine public and private efforts and resources. Often called a greenway foundation, this type of organization seems to be the most successful for a wide range of projects. By successful, this means these types of greenways are enjoying multiple users and continued growth, this does not necessarily mean environmental success. This organizational approach is ideally in the form of a single-purpose, publicly authorized greenway foundation, with a board of directors that represents citizen organizations, business corporations, professional and academic associations, and government departments (Little, 1991). Chattanooga Riverpark is an example of a public-private organization which was legislatively chartered. There, the City of Chattanooga hired the Trust for Public Land (TPL), a national non-profit conservation organization, to oversee its greenway efforts. Developing permanent funding mechanisms and organizing a local greenways support organization is the primary emphasis. Other ways to form this type of organization are; an outgrowth of a governmental committee or, it can simply arise on its own (Little, 1991).

Little points out that this type of organization, or greenway foundations, have the benefits of a private nonprofit organization in that it can cut deals with landowners, moving quickly and decisively. At the same time, it can avoid the chief disadvantage of the private group, which is a lack of authority, either actual or implied by official status. A strictly private greenway organization has no more clout than any group of citizens, but a public-private foundation can often borrow the governmental powers it needs by working closely with public agencies - for the regulation land, or the use of public funds and authorities for acquisition, construction, and maintenance (Little, 1990).

Regional Greenways Advisor

An appropriate consideration at this time is whether or not to employ a greenway advisor. The planners in Chattanooga state that if a regional system of greenways is the ultimate goal, for it to become a reality, the involvement of a regional organization or agency is necessary

to provide cooperation across political boundaries. They believe that a regional coordinator could serve a number of functions such as:

- 1) Provide technical assistance and staff support to existing greenway efforts and new groups and communities interested in developing greenways and trails. Technical assistance could include helping coordinate greenway activities in separate jurisdictions, prepare grant proposals for greenway funding, identify sources of resource information and hosting meetings.
- 2) Provide coordination of greenway efforts throughout the region and between various political jurisdictions.
- 3) Provide assistance with education and marketing of regional greenway efforts through newsletters, other publications, workshops, special events and news releases.

They go on to state that one possible scenario for regional coordination would be to establish a regional greenways coordination council consisting of entities that are presently planning for greenways in the region. This council could convene periodically to discuss what each is doing in relation to greenways. Each entity would be responsible for managing the greenway activities that occur within their jurisdiction, and this council would provide the opportunity for the key greenway players in the region to discuss ways to provide consistency and coordination beyond each entity's sphere of influence (Hixson Chamber of Commerce, 1994).

Planning Tools

Developing planning strategies was the first step in taking action to address greenway feasibility in each of the case studies. There are unlimited tools available for corridor protection and land acquisition, the trick is knowing which tool to implement to achieve the desired results. Creative approaches to using available acquisition and protection tools was a key element to greenway success in all of the case studies.

Land Acquisition

Land trusts are functional entities for facilitating open space conservation and ecological preservation, and are particularly useful if the organizational structure is either private, or public/private combination. We saw in the case studies that land trusts can play a crucial role in the success of a greenways project, as is the case in Chattanooga where the Trust for Public

Land(TPL), is an active participant in greenway planning. Rather than actually acquiring land, the TPL plays a consulting role, helping the City of Chattanooga develop strategies for planning, funding, developing, managing and maintaining both individual greenways and the City's network of trails and open space.

Land trusts acting in conjunction with governmental agencies, can do much to meet greenway goals. The philosophy of many land trusts is 'Save what needs to be saved, and build what needs to be. As private organizations, land trusts are very flexible in the way they can acquire properties, particularly in their ability to take risks and move quickly. Knowing what should be protected is an important aspect of developing a property-protection program. Stokes contends that the environmental inventories should form the basis of the decision making process. Developing a set of criteria in advance of such decision making can aid the organization in accepting or denying a gift and in focusing its efforts on encouraging particular owners to donate, sell, or consider some other kind of protection (Stokes, 1989).

Land trusts have been instrumental in numerous greenway projects across the country and the formation of a trust is highly recommended for any greenways project by experts in the field .

Other non-regulatory tools which were used in the case studies that can aid in land acquisition are; transfer of development rights, purchased development rights, mandatory dedication, developer impact fees, bargain sale, and donations.

Land Protection

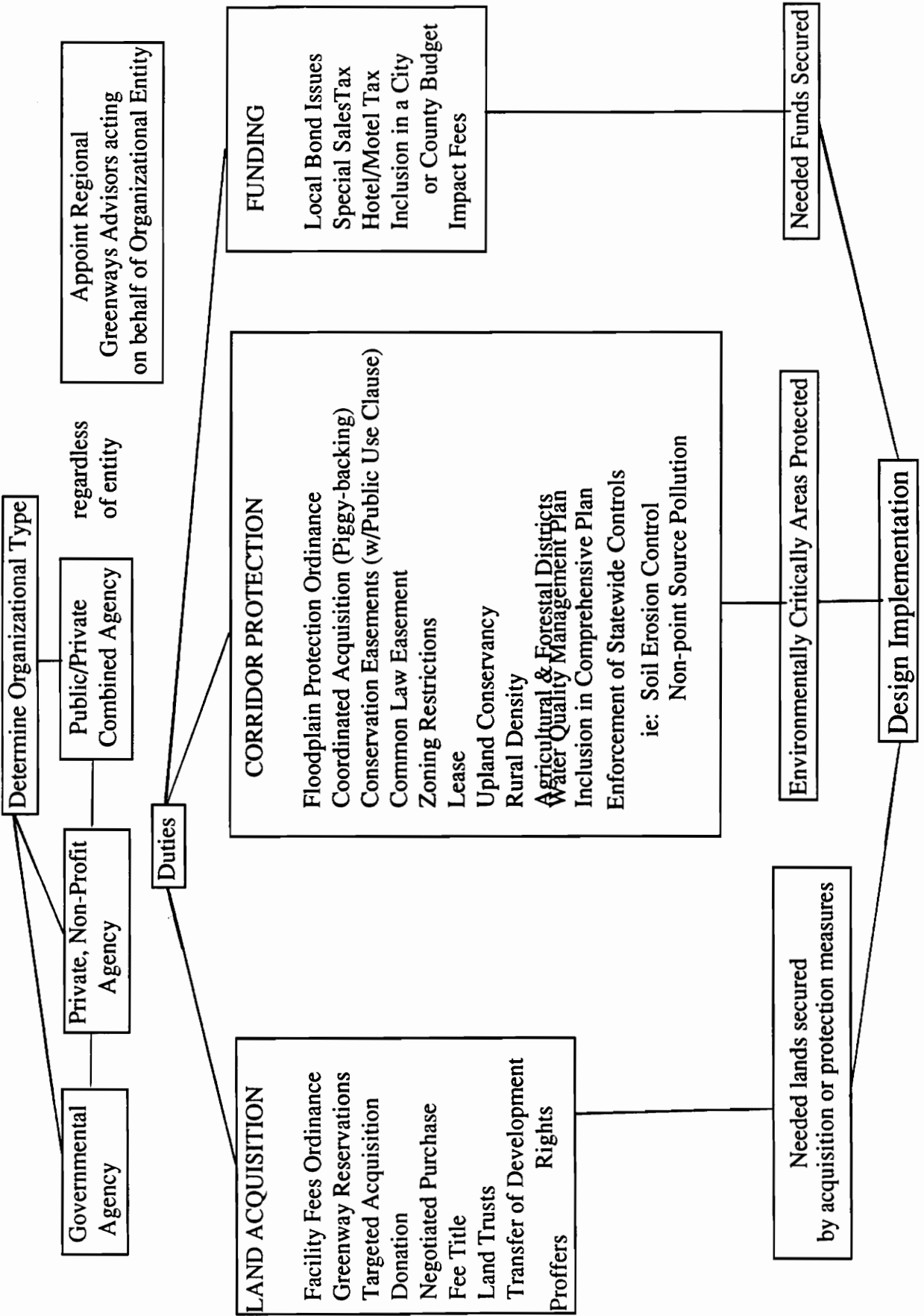
Often land acquisition is not feasible or necessary, however, when planning for environmental corridors, land protection is always desirable. The case studies illustrated that there are many regulatory tools which can be implemented as a means to protect necessary lands. These options included floodplain ordinances & protection districts, wetlands protection act, vegetative buffer incentives for farmers, restrictive covenants, inclusion in the Comprehensive Plans, water quality management plans, zoning ordinances, facility fee ordinances, overlay zones, conservation easements, Chesapeake Bay Preservation Act, agricultural and forestal districts, and proffers from developers.

Each of the case studies established floodplain ordinances and protection districts in an effort to protect the greenway corridor. These tools insure that development cannot occur within the designated floodplain, restricting land uses to recreation and conservation.

It is important to remember that, depending on the area and the circumstances, a variety of tools may be employed. In Boulder planners found that there are some important rules of thumb to remember when engaging in the land protection process. Firstly, a careful analysis of needed lands should be done prior to the start of the acquisition/protection process, then selective identifications of lands can be made. Secondly, respect for property owners and their rights should be a top priority. Thirdly, to avoid negative confrontations, pinpoint property owners who are behind the project and are willing to donate lands. Then let them help deal with the hesitant property owners by setting the example and selling the idea.

It can be surmised from the case studies that protection ordinances, conservation easements and public use easements should be attempted before any outright acquisitions are made for the corridor spine. In some instances, property owners were given the option of foregoing the paying of property taxes in return for permanent easements. Park and access areas were acquired by the organizational entity to ensure permanent use and avoid liability issues.

PLANNING/POLICY PROCESS



IMPLEMENTATION

If the greenway is going to function as a recreational resource for the community, then there are special considerations to be made when designing and implementing the amenities and restoration efforts. It is helpful if designers have a trail concept which can be referred to during the trail design and construction process. An example of this can be seen in Boulder where the trails within the urban center are intended to function as a sort of promenade, while moving out of the urban areas trails become narrower and more primitive. This was their design concept and they were consistent in its application.

Another important consideration when designing the trail corridor is the feasibility of continuity. While trail continuity is often desirable, it is not always possible. It became apparent after speaking with greenway planners in each of the case study projects that alternative trail routes were necessary because of uncooperative landowners along the initial design route. This flexibility is an important aspect to project success, and alternatives should be built into any greenway plan.

Because of the in progress nature of the case studies it is difficult to derive many of the other trail design consideration from the case studies. In an effort this stage of the process more informative to the reader, much of the following process was taken from the book, *Trails for the Twenty-first Century*, the case studies are referred to when sufficient information is available.

According to the authors, resource inventorying should be the first priority for trail design. Similar to the assessments made prior to corridor delineation, but on a smaller, more aesthetically focused, scale. Inventories include; existing vegetation, intersecting streams, surrounding topography, significant natural features, existing built features, community activity centers, infrastructure, wildlife habitats, viewsheds, spatial values of the landscape, and cultural resources. Apparent in each of the case studies was the trail design in keeping with the regions unique identity and reflecting those surroundings where possible. The following is an in depth look at the elements to be inventoried based on the text.

Climate can be an important element in trail design as well as a dictator of appropriate design features. Climate will generally come into play the most when designing facilities for trailheads, however, there may be a need for design features along the trail such as; vegetation,

lean-to's or trellis structures with vines for shade in areas where plantings are undesirable. Shelters act to make a trail more usable in times of extreme weather conditions. They also act as resting areas, wind blocks, and rain & sun canopies. To increase the usability of the trail, it is necessary to consider the climatic conditions of the region and respond to those conditions by including the appropriate design features.

When determining the alignment of the trail, topographical features can provide for a multiple of experiences for the trail users. Grades and slopes will affect trail development, particularly in respect to drainage patterns. Assessment of these patterns is necessary in order to determine which types of drainage controls are needed and where. It is also important to identify where off-site water collects and drains through the corridor. Ponds, rock outcroppings, wetlands and other natural features in the region are important attractions in a trail design. Using the topography to ones advantage means to identify these areas which can offer loop trails extending up or downhill which will provide; scenic views and vistas, sunrises or sunsets, pass interesting rock formations, and exhibit the regions unique landscape structure in general. In Raleigh, the loop concept is used extensively for recreational purposes. The greenway loops have occurred primarily around Lakes within existing parks. To help guide the trail design process it is suggested that important questions for designers to ask are; Will providing access to these areas cause serious erosion problems? and, Will public use of these natural features result in their destruction? If the answers are yes, then designers may have to eliminate certain outstanding natural features from inclusion in the trail design in an effort to preserve them.

All landscapes have dominant plant species which truly reflect the character of the place. Native vegetation is easily identified by local people and is often a source of pride within the community. This can be a functional and aesthetic element, forming a foundation in any trail design. As mentioned several times in this document, vegetation is critical to water quality because of its buffering and filtering capabilities. The case studies have shown that a continuous strip of vegetation of an appropriate width should line all riparian corridors. However, vegetation can also be used to enhance the experience of the trail. Trees and other plant materials can be used to; create physical barriers, provide protection for climatic elements, attract wildlife, and provide focal points along the trail. Fruit-bearing plants along the trail can provide food for wildlife, as well as trail users. In Chattanooga local garden clubs were recruited to help maintain the trail and to develop interpretive signs.

Another source of community pride is a regions native wildlife populations. A users trail experience can be greatly enhanced by the presence of local fauna. Design techniques can be employed which will attract wildlife to the trail area without jeopardizing their safety. For example, in Chattanooga wildflower meadows attract butterflies to the trail. Also, certain areas attract wildlife because of their proximity to water or forest cover. A local bird-watching organization may wish to help create an environment along the trail that fosters the presence of birds. In Boulder, planners found that when clearing for the trail, workers should keep in mind that often large, dead trees serve as perches for raptors and sources of food for woodpeckers. Consideration for plantings that provide food, shelter, and nesting areas for wildlife were made to help enhance the trails experience.

Incorporating historic sites and structures into the trail such as; canal locks, railroad depots, and historic buildings, will also help to enhance a user's experiences. The interpretation of this history can be an added attraction, highlighting the history of the regions culture and landscape. As was done in Chattanooga, local artists and designers could be asked to create artworks based on the local history. This also served as a source of funding for trail implementation and/or maintenance. City and state arts councils and the National Endowment for the Arts offer funds encouraging the use of local talent for innovative projects. Moneys may also be sought for well-known national talent when local artists are unavailable.

The use of local or regional materials in constructing the built features of a trail can be the uniting element which creates a sense uniqueness to the trail. Features such as; surfacing materials, fences, bridges and signs can all be constructed using these local resources. The use of local materials also keeps moneys within the community, becoming a possible source of support for the trail because areas businesses will benefit from it. Factory and quarry owners may want to supply the project with materials as their contribution. Incorporating local materials into the built trail gives local businesses another opportunity to get involved in the project.

There are a multiple of other design features which are needed for trail projects. These features are important contributors to the trail experience and so demand special considerations. This aspect of trail design is very involved, and what is used and how really depends of the trail concept. However, important universal design decision include; surfacing widths & materials, minimizing ecological impacts and trail support facilities.

Trail Widths & Surfaces

When accommodating a range of users within a single trail, considerations of design should be focused on width, surface, and the travel speed of the user groups. Often, it is not feasible, or environmentally appropriate, to acquire lands for separate trails, therefore, the trail needs to be designed to accommodate the user groups which it is intended for. Although national standards do not exist, the case studies showed a consideration to the user groups and the numbers of people who are likely to use the trail and what the experience of the trail is intended to be. Designers should try to pinpoint areas of significant traffic loads and design for those demands where necessary. According to Flink, loop trails which may carry lighter loads, strictly for recreational purposes, may be designed for lesser use demands. In areas of high traffic, a two-way, single tread path should be built to a standard width of 10' with a 5' shoulder on either side of the trail. This includes pedestrian and bicycle traffic. In areas of lesser traffic, on loop and rural trails, the experience of the trail may be intended to be more primitive, therefore, narrower widths with no shoulders would be appropriate (Rails to Trails, 1993).

Trail surface is a result of the subgrade, subbase and surfacing materials. The subgrade is the native soil mass of the landscape; the subbase is the man-made layer of stone and rock constructed on top of the subgrade; and the trail surface is the material installed on top of the subbase. As a unit, the structural qualities of these three individual components determine the strength and quality of a trail. Each region is unique with regard to the subgrade and careful analysis of this, as well as drainage patterns along the trail, will lead to a properly designed trail surface which, with routine maintenance, will last a long time (Rails to Trails, 1993). It is proven that asphalt trail surfaces are impermeable, therefore contribute to increased stormwater runoff. In Raleigh, watershed restriction state that asphalt trails are not permitted within the buffer zone along the riparian corridor. However, while planners are taking advantage of those restrictions for many planning aspects of the greenway, they want to rewrite the code to allow for asphalt trails.

Not only will ungravelled footpaths allow for greater filtering capabilities of the soil, but will enhance the trail experience as well. Some pervious surfacing material which are available are; granular stone, natural surface of native soil and vegetation, and wood chips or mulch. A granular stone surface could be supplied by a local quarry and would be in keeping with the natural characteristics of the regions, while a mulch surface could be supplied by the clearing

of vegetation for trail construction and even local functions such as; Christmas tree mulch drives at the first of every year, or garden clean-ups during the spring and summer months. Chattanooga planners scheduled many activities of this sort.

Minimizing Impacts

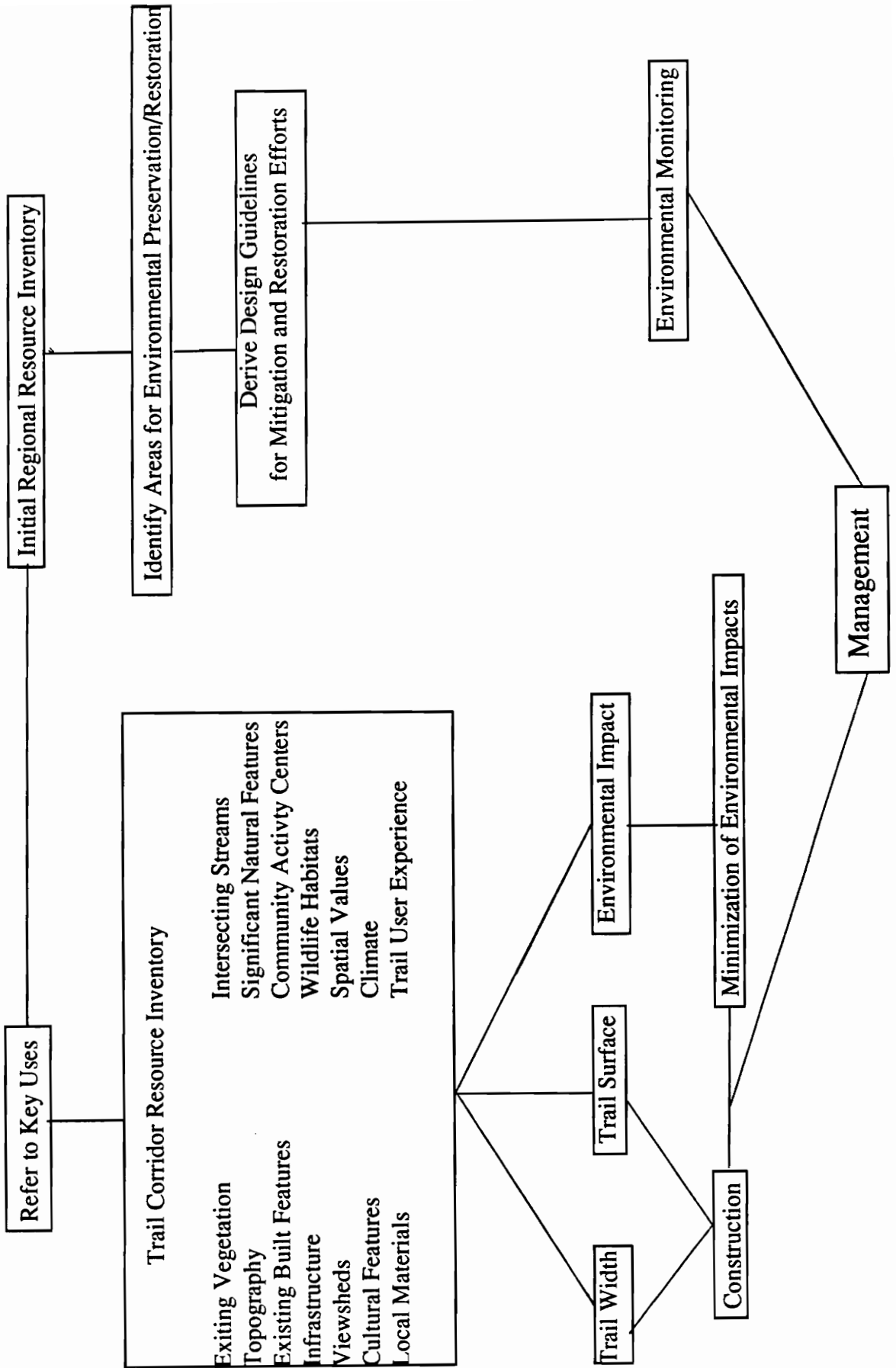
When designing a trail within an environmental corridor, designers must take care not to negate the good intentions of the corridor by unchecked recreational activities. There are some guidelines to follow when building the trail which will help minimize these recreational impacts. Designers should consider not only the trail width, but the adjacent 100' on either side of the trail's alignment. Trails should be designed to discourage users from wandering off the trail, degrading vegetation and threatening wildlife habitats. This can be achieved by hedge plantings along trails which borders sensitive areas. Important at this stage is to go back to the corridor delineation inventories and again pinpoint areas of sensitive resources and route the trail and other areas which will have high-activity levels away from these areas. Trail designers and planners should make a point of training workers on the best construction practices, stressing the minimization of vegetation removal and the resulting soil erosion in the construction process (Rails to Trails, 1993).

Design Features

Design features are necessary in an greenway plan. They can function to do many things such as; provide for passive and active recreation, stabilize steep banks, direct user patterns, provide information, preserve sensitive wetlands, and provide for stormwater drainage. These features include elements such as;

- Picnic Areas - tables, shelters, and trash facilities
- Open field Areas - game areas
- Docks - canoe launches
- Retaining Walls - stabilize steep banks, and provide for landscaped areas
- Fences - security, separation, and direct use
- Bollards - security, separation, direct use and provide information
- Signs - provide information
- Boardwalks - traverse sensitive wetlands and marshes
- Bridges - enhance connectivity
- Culverts - drainage

TRAIL CONSTRUCTION & ENVIRONMENTAL MITIGATION PROCESS



MANAGEMENT

Management issues in each of the case studies were very straightforward, consisting of duties that fall into the categories of; maintenance, security, environmental monitoring, funding and landowner relations. However, before these issues can be addressed the managing entity needs to be identified. As the case studies illustrated, determining what agency should manage the greenway system is a critical step in developing a successful project strategy. Possible agencies include; local, county, state, federal, and private agencies. Generally speaking, it is preferable to have one agency, rather than a group of small agencies, manage the greenway. The managing entity will generally be determined in the beginning phases of the project when the type of organizational agencies desired for the project is chosen. Which ever the agency, it is advisable to formulate a day-to-day schedule of operational policies and guidelines.

The management of a greenway system requires the attention to many details, specifically the administration, maintenance, and security of the corridor/s. Comprehensive planning will minimize the maintenance and security problems which may eventually arise, therefore, it is advisable to develop definite maintenance and security practices which are consistent with project goals and the key uses of the corridor. This was evident in Boulder where vegetation management addresses both issues. Vegetation is used for environmental restoration as well as living fences, providing barriers between the trail corridor and adjacent commercial and residential properties.

A successful maintenance program requires continuity and a high level of citizen involvement (Rails to Trails, 1993). There are many civic organizations which can be employed for volunteer maintenance purposes, thus reducing needed funds, improving trail safety, and building goodwill with people living adjacent to the trail. In Chattanooga these types of groups are used extensively to carry out many of the necessary duties. Some of the civic groups employed in the case studies are; senior citizen safety patrol groups, Boy Scouts, Girl Scouts, garden clubs, conservationist, historical societies, and city beautification groups.

Maintenance

Maintenance duties are many, and a detailed maintenance schedule generally includes several tasks. The following list of tasks are a culmination of the tasks which were identified in the case study data.

Surface Repair - Trail surfaces should be patched or graded on a regular basis to eliminate pot holes and ruts. Care should be taken to ensure that finished patches are as flush with the trails surface as possible to avoid unnecessary accidents.

Drainage Repair - Repair any trail damage from seasonal washouts and silt of gravel washes. Identify the source of the drainage problem and take steps to remedy it. Clean all culverts, catch basins, and other drainage structures on an appropriate occasions, or at least annually.

Trash Removal - Pick up litter from trail and access points and empty all trashcans and recycling bins.

Erosion Controls - Monitor all erosion controls used in the design of the trail and make adjustments where needed. Identify areas of erosion that may have been overlooked during the design phase and make the appropriate adjustments.

Vegetation Control - While this researcher does not feel that mowing along the trail shoulders should be part of the maintenance plan, mowing will be necessary in parks and trailheads. Sight distance and overhead clearance should not be impaired by vegetation when feasible. Trim trees, shrubs, and tall grass to meet sight-distance requirements based on a specific design speed. Spot prune and remove encroaching vegetation and allow room for seasonal growth. Fallen trees should also be removed.

Structural Deterioration Maintenance - Inspect structures annually to ensure they are in good condition. Pay special attention to wood foundations and posts to determine whether rot or termites are present.

Lighting - Make necessary lighting improvements in appropriate areas, particularly, at road crossings, tunnels, and trailheads. Keep lights clean and replace fixtures as required to maintain desired luminescence.

Signs and Traffic Marking - Inspect signs for both motorists and trail users and keep them in good condition. Make sure any pavement marking are clear and prominent.

Sweeping and Cleaning - Keep the trail free of debris, including broken glass and other sharp objects.

It is helpful to have a method for the users to communicate improvements and/or additions that they feel should be done to the trail system. Perhaps comment cards at trailheads could provide the means necessary for this communication.

Security

The security of trail users and adjacent property owners is a big issue in most greenway projects. Good design can prevent many security problems and make the user more comfortable in a given space. Ways to make a trail and its related facilities safer which was seen in the case study data are;

- The greenway should be patrolled regularly by park police, or volunteer patrol groups. A trail patrol's primary function is to provide assistance and information, not to apprehend criminals. Patrol personnel should perform positive trail functions such as; distributing maps and brochures, providing information, offering bicycle safety checks, and other service-oriented activities. Security personnel should not use a motorized vehicle to patrol because users tend to respond favorably to someone who appears more like a trail user than a law- enforcement officer (Rails to Trails, 1993).
- The trail system is open only during daylight hours.
- All items such as signs, lighting, benches, and trash receptacles are permanently placed to prevent their removal.
- Signs at main entrances to trails specify trail regulations.
- Signs at main entrances to trails specify trail etiquette.
- Parking lots, lights and access points to the trails are positioned with the security of trail users, nearby businesses and residents in mind.
- Motorized bikes and ATV's are prohibited from the trail.
- Fences and/or vegetative barriers are constructed in areas adjacent to residential and commercial buildings.
- Gates are constructed at all trail entry points and locked after operational hours.

Environmental Monitoring

Once the project has been implemented, there is a need for monitoring environmental impacts to ensure that the corridor is doing what it was intended to, such as; improving water quality, preserving wetlands, enhancing wildlife habitats and buffering non-point source pollution. Boulder is an excellent example of the importance of environmental monitoring. Greenway officials routinely monitor the restored areas as well as other ecologically important areas to

be sure that they are functioning as they are intended to. If not, then alterations are scheduled to correct the problems.

Funding

Of course moneys are needed to manage any greenway system and, if there are trails, keep them in the desired state of repair. There are several ways to go about raising funds for the management of the trail system, and the case studies are the source for the following suggestions. Funding options include;

Grants - There are numerous grants available at the federal, state, and private levels. See appendices for more details on grants sources.

Local bond issues - Even if communities or counties in the region are able to receive some funding from grants, in most cases they will still need some local funding. ISTEA funding is a prime example; local partners must provide at least 20% of the project funding to receive the other 80%. A local bond can be used as the sole source for greenway acquisition and development, but it is preferable to leverage these local dollars with funding from other sources also.

Special Sales Tax - The local option sales tax could be increased a small amount - less than 1 cent - to provide capital for the greenway system.

Hotel/Motel Tax - Using a portion of the existing Hotel/Motel Tax may be preferable to new tax measures for greenways; this is money primarily collected from tourists and other visitors to the region.

Inclusion in a city or county budget - There needs to be some long-term support in local budgets if greenway efforts are to ever become a reality. Cities and counties from throughout a given region could find it advantageous to all provide funds to a regional entity, such as a regional park authority or planning entity, to develop the greenways network.

Leasing subsurface utility rights beneath greenway corridors - Several trail efforts have been successful in funding their entire trail development efforts through the leasing of subsurface rights to telecommunications firms. Other utilities such as water, sewer and natural gas may also be interested in discussing opportunities for shared use of corridors.

User Fees - Greenways users can be required to pay a minimal fee for using existing facilities and this money can be used to maintain existing trails and develop new ones.

Developer Impact Fees - These fees could be charged by local government based on the size and density of new developments and its impact on the resource.

Developers can be required to pay these fees, which could be used to purchase land and develop new greenways and trails, or to dedicate open space and construct trails along designated greenway corridors.

Landowner Relations

Adjacent landowners, whether they are simply next to greenway lands or key land donors, need to be well informed about the greenway process. Often, in the beginning stages of planning it is these people who can be the biggest hindrances to the projects progress. However, in most projects, once a trail is open, many ardent opponents realize that their fears are unfounded and begin to recognize that the trail is a good neighbor, and a nice amenity for the community (Rails to Trails, 1993). Regardless, landowners should be treated with respect and included in the communication process.

The case study data offer some tactics which were helpful when dealing with adjacent landowners. These tactics include;

Newsletters - Written correspondence informing landowners of the next steps in the greenway process, lets them know when specific issues are being addressed so they can comment on these issues if so desired.

Presentations - Special presentations of the design work can be scheduled exclusively for landowners. Presentations can be made compelling by tailoring them for the audience.

Public Hearings - Hearings regarding trail policies would be held and viewed as opportunities for a two-way exchange. Encourage individuals to voice concerns about user conflicts in a constructive way and take the opportunity to explain conflict-prevention techniques.

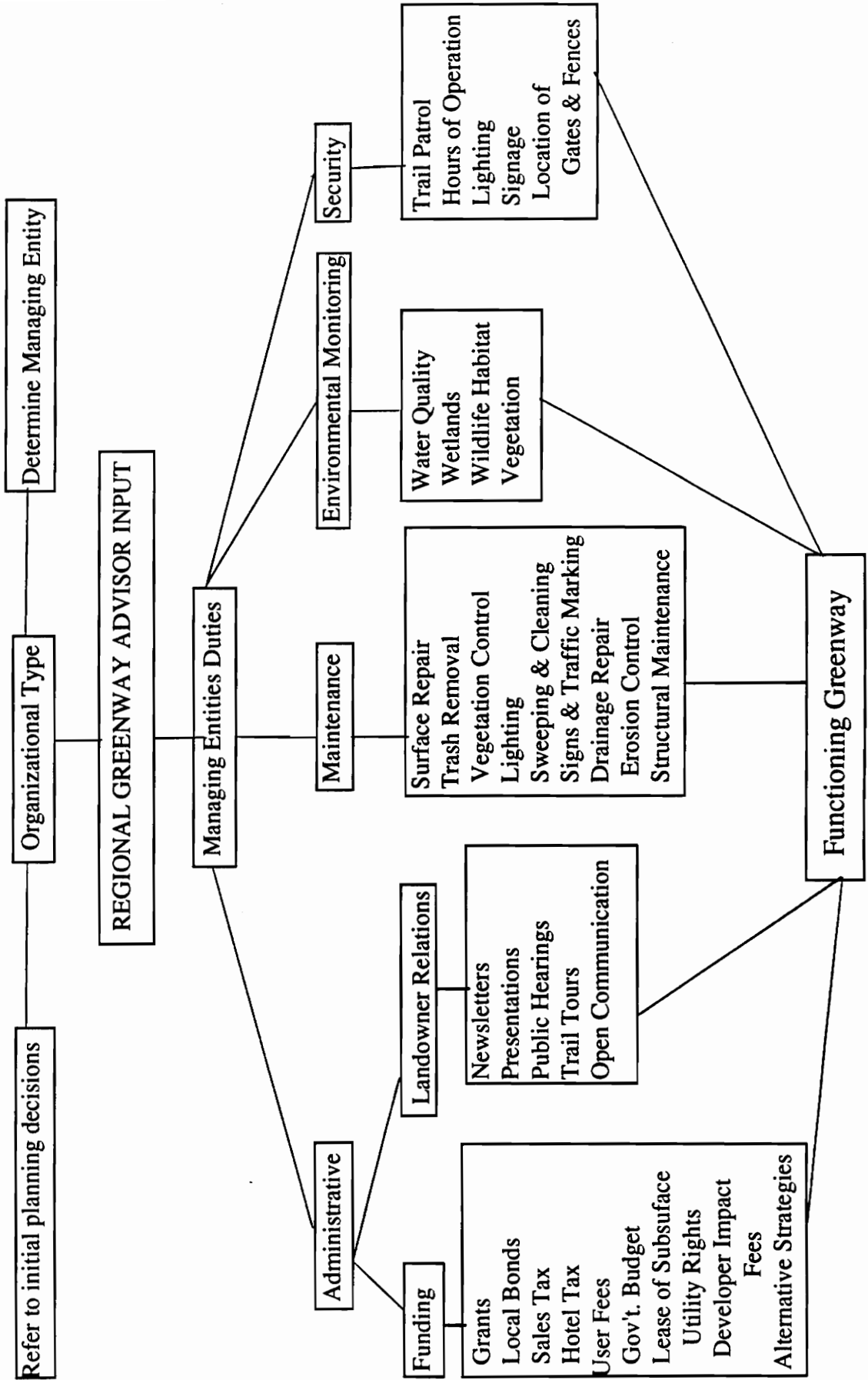
Trail Tours - Trail tours led by a greenway official gives the adjacent residents a firsthand opportunity to point out any continuing problem areas. If landowners have not previously been on the trail, the tour may give them a better understanding of it.

Open Communication - Be sure that landowners know who to contact if problems arise. Preferably, this contact is someone they've dealt with in the past

and feel comfortable with. Establish a mechanism for regular input from landowners.

In Chattanooga, the Hixson Chamber of Commerce Park Committee first focused on the landowners along the creek whose land the proposed greenway route would cross. Many of the landowners had been personally contacted by committee members and informed of the proposal prior the greenway receiving the attention of the local media when a Senator visited the creek. Practically all such landowners were contacted and informed prior to any design implementation.

MANAGEMENT PROCESS



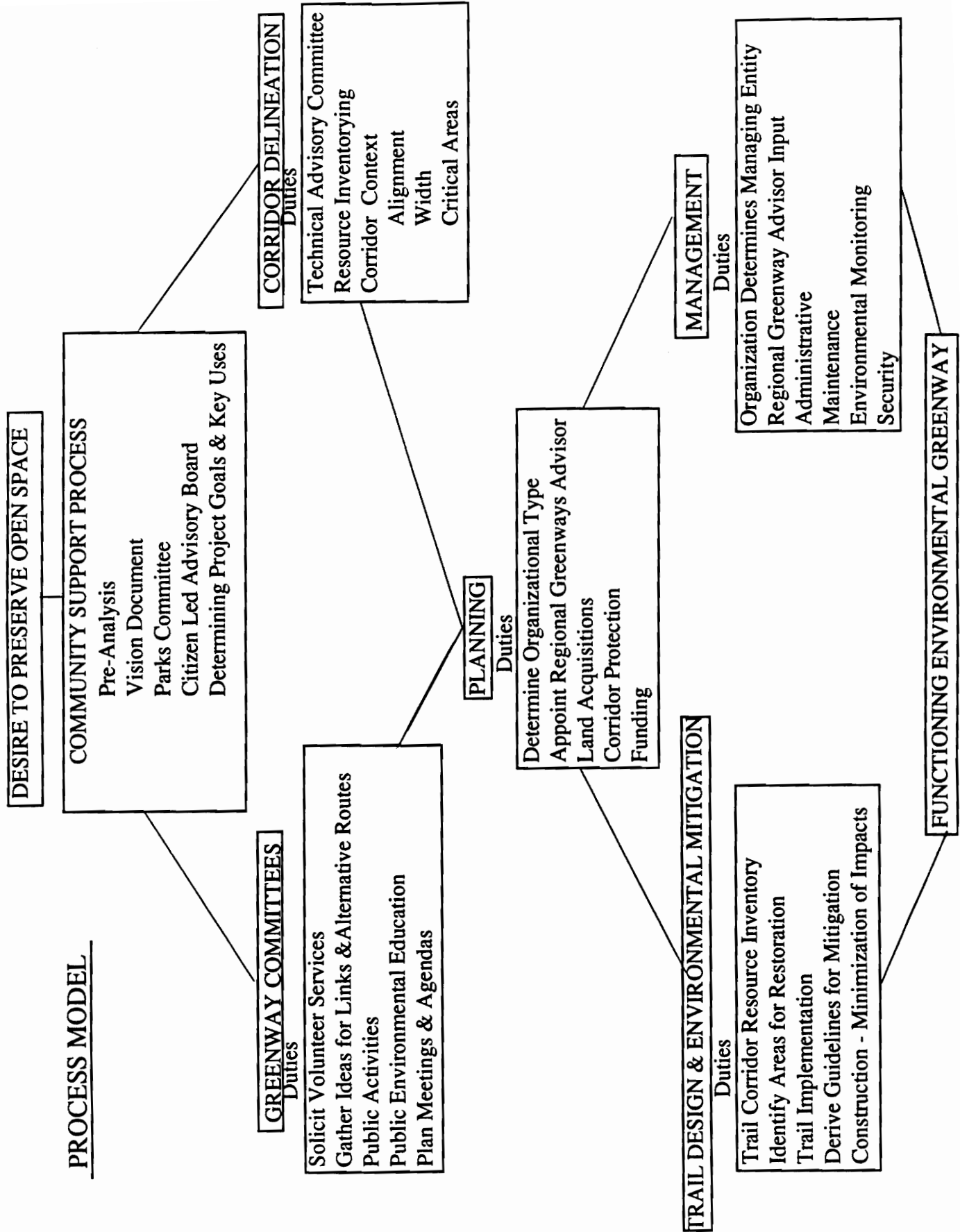
PROCESS OVERVIEW

A factor that is not included in the process model is that of time. It is difficult to assess just how much time the process takes. Each of the case studies evolved over time, and this idea of an evolution seems to be the norm for most greenways in the country. For example, the Raleigh Capital Area Greenway began in the form of a masters thesis in 1970, and is still in the process of growing today.

Chattanooga appears to be moving faster than most greenway efforts. Their process began in 1982, when the City of Chattanooga and Hamilton County Commission appointed a task force to develop recommendations for the long-term use and management of Moccasin Bend. These efforts were expanded to include 22 miles of the Tennessee River from the Hamilton County/Marion County line to the Chickamauga Dam. In 1990, the first segment opened and consisted of a picnic pavilion, canoe access facility, picnic tables, restrooms, a parking lot and 1.5 miles of asphalt trail. As of March 1994, Chattanooga's greenway trail system had expanded another one mile and a 180 acre parcel of land had been acquired. This rapid development of their master plan is due to the overwhelming community and economic support for the project.

While this researcher has categorized the main components of the greenway planning process for ease of explanation, it is important to remember that it is not a linear process. Many different aspects will need to be done simultaneously. The following diagram illustrates the model of how greenway issues will come together in a logical sequence of events. It is important to remember that each greenway project is unique and will need special considerations. This process model stresses the steps in the greenway process which should not be omitted.

Now that there is an understanding of how a general process works, a site will be selected and used to illustrate how this very broad and general model can be fine tuned to meet the specific requirements of a given locale.



CHAPTER 5

Introduction

In order to have a comprehensive design with consistent objectives, a methodology for the delineation of the corridor must be set forth. Often communities that want to enter into a greenways project either don't know where to begin, or get so set on a predetermined corridor alignment that they miss other multi-functional, multi-focus and diverse opportunities simply because they tend to focus on specific resources without taking a broader look at their range of resources. Another common mistake is that planners either fail to establish definite project goals and key uses for the greenway, or they lose sight of those goals as the project proceeds. The following methodology is intended to illustrate the corridor delineation process, and how project goals and key uses guide that process. The methodology is consistent with those used in the case studies, however, modifications have been made based on this designers own insights into the site and design objectives.

Phases

This design methodology consists of three phases, it begins as a very broad look at the regions resources and the potentials for linking those resources, while latter phases become more in depth as this designer moves through the corridor delineation process. It is important to remember that the first step in any design process is to identify the project goals and the corridors key uses. These goals and key uses will be referred to at each subsequent step of the design process.

Phase I

Phase I begins with the identification of the regions riparian corridors and the juxtaposition of existing recreational resources to these corridors. Determining the overall importance of the region's natural & recreational features and devising a plan to protect and/or link them is the appropriate goal. The resources considered at this point are; protected lands, large tracts of open spaces, existing parks, river access points, and other recreational areas, actual, passive and potential. These areas can be considered important nodes within the systems of riparian corridors, and together become the spine of the greenway. The product of this phase is a map of the region which pinpoints important areas, boundaries and juxtaposition to be linked and the value of this linkage. In other words, this will be the long-term vision document.

Equally important at this stage of planning is the job of determining community positions, support, participation, and needs. At this point one can begin to identify key groups,

stakeholders, and key players in the proposed project. Employing the community is a crucial part of the design process. Often residents are much more in tune with what is truly going on in their regions landscape and can be the source of reliable information regarding that landscapes elements and functions. For the purposes of this project, this has been achieved through several meetings and phone conversations with county, city and regional planning officials.

The contacts for this work were instrumental in developing a master plan as well as a variety of design details. The following design is the contacts vision while this designer is a tool for realizing this vision within the region. These contacts can be categorized into primary, secondary and remote sources. Specifically, the primary contacts are; the Rivanna River Conservation Society and its director Steve Pence, and Fluvanna County's director of community programs John Gill. Secondary contacts are; the environmental coordinator for the Thomas Jefferson Regional Planning Commission Mike Collins, and the greenway coordinator for Albemarle County David Bennich. The remote sources were quite helpful in data collection. These sources are; Charlie Lunsford at the Department of Conservation and Recreation, Mike Tollinger at the U.S. Fish and Wildlife Services and the National Park Service.

Based on this input from the community, and the existing conditions of the region, the greenway issues, potential uses and program goals can emerge and be defined. In this particular greenway design, the project goals and key uses have been determined to be the following;

GOALS

- 1) Protect and enhance environmental quality within the designated riparian corridors by; creating and managing vegetative buffer zones, preserving and enhancing existing wetlands, creating new wetlands, protecting important environmental nodes such as the confluence of two streams, minimizing the impacts of adjacent land uses, and stabilizing bank erosion.
- 2) Provide for recreational uses along these riparian corridors where appropriate by identifying; potential river access points, potential parks, trail alignment possibilities which are in keeping with the environmental preservation goals.
- 3) Creating a linkage with Albemarle County's proposed greenway system to create a regional riparian greenway system

4) Restore and enhance historical features along the river such as the Jeffersonian system of locks, mills and canals.

KEY USES

- 1) Protect and manage existing wetlands adjacent to the river which function to maintain water quality and provide high quality habitat to wildlife
- 2) Minimize the impacts of Pine Bark Beetle infestations on water quality and erosion
- 3) Protect water quality by revegetating eroded banks, vegetation management, and monitoring adjacent land use practices
- 4) Floodplain management
- 5) Manage for non-point source pollution which is in keeping with Chesapeake Bay Preservation Act by providing appropriate buffer zones.
- 6) Recreational trails and parks

Once the project goals and key uses are defined, the corridor zone can be defined and mapped. This zone will vary with the landscapes characteristics and its vulnerability to specific impacts. The product of this phase will be the vision document for the region which will be in the form of a map and text.

Phase II

Phase II of the design process involves defining the main corridor within a portion of the greenway zone. The portion of the swath investigated will be the area within Fluvanna County. This will involve; determining corridor alignments which are keeping with the predetermined project goals, determining the potential impacts of adjacent land uses & land cover and identifying sensitive land types. These elements will be evaluated based on a rating system which represents their relative impacts on water quality and habitat value. Land cover will be classified based on their relative threats to water quality or abilities to maintain and/or enhance it as well as the habitat value. Land types will be classified according to their ability to maintain or degrade water quality and their habitat value.

The corridor alignment will begin with the delineation of the 100-year floodplain with a process for determining where additional buffer zones are needed in areas of extreme vulnerability.

Methodology for Risk Assessment

The rating system is intended to be descriptive, and not definitive. It is intended to act as a tool for identifying sensitive areas based on a cumulation of circumstances which are specific to a given site. It is not intended to be statistical in its nature, simply a tool for prioritizing landscapes based on their unique circumstances.

This rating system is structured in such a way as to address the specific issues relative to environmental stability of the region. A variety of landscape elements and land types need to be evaluated and prioritized for mitigation and management action. These elements are the focus of the inventorying due to their influence over the predetermined key uses of the greenway. On a scale of 1 to 5, 1 being the least critical and five being the most critical, certain elements of land cover and land types will be evaluated and given a rating based on their vulnerability to environmental degradation. This rating can range within its whole number, for example, if an element is given a two, it can range from two to two point five, with the exception of a rating of 5, that is the highest rating possible.

There are a total of seven landscape elements which are considered to be instrumental in facilitating an informed evaluation of a given location, and eventually, planning for that locale's mitigation and management. Each of the seven elements are given a rating based on whether or not it occurs within the 100-year floodplain. In addition to these seven elements, there are departures. These departures are what this designer considers to be unique situations which can alter an otherwise healthy landscape and demand special design attention. These departures are given a negative rating and are subtracted from the total number of landscape elements.

The ten elements and their ratings are as follows;

<u>Element</u>	<u>100-Year Floodplain</u>	<u>Non-Floodplain Land</u>
Hardwood Stands	5	1 - 1.5
Pine Stands	4 - 4.5	3 - 3.5
Fields	4 - 4.5	3 - 3.5
Infested Pine Stands	5	5
Wetlands	4 - 4.5	5
Steep Slopes	4 - 4.5	2 - 2.5

Pine Stand	3	Low rating because is not in the floodplain, not yet infested, and has a hardwood buffer between it and the stream
Wetland	4.5	High rating because it is a valuable scrub-shrub type of wetland
Field	4.5	High rating because is adjacent to the stream with no buffering
Infested Pine Stand	<u>5</u>	High rating because there is no buffer
	22	
The total score for this landscape situation is:	7 22	
	3.14	Relatively high number and should be considered high priority for mitigation and management activities

If there happened to be a departure within this landscape portion it would be calculated as follows; There is a salt storage pile on the west side of the stream on non-floodplain lands. But because of this non-existent buffer this is rated -1.5. One would then subtract this negative number from 22 giving a total of 23.5. Then divide by 7, giving the prioritization number of 3.35.

Phase III

Phase III of this design will involve investigating the details of corridor delineation and mitigation. In this phase, more specific questions regarding the recreational design of the corridor and how to minimize their impact will be addressed. The focus for trail siting will be within the riparian areas which are not wetlands or critical riparian vegetation areas. However, other areas of the county will have proposed trails which will serve as loops, connectors and linkages within the system. Specifically, this phase will produce maps which identify important nodes within the corridor, identify river and trail access points, illustrate the alignment of corridor, create a corridor structure, and explore available recreational resource facilities and their design potentials.

THE ENVIRONMENTAL CORRIDOR DELINEATION PROCESS

PHASE I

The Site

The site for this greenway project is the riparian corridors of the Moormans and Rivanna Rivers including their second order tributaries and the lands adjacent to them. Both rivers have been designated state scenic rivers; the Rivanna's designation applies to 37 miles of the river from the Woolen Mills Dam in Charlottesville to the James River, in addition to this designation the Moormans River has state and county conservation overlay zone protection along its length. However, both rivers have very limited access for recreational uses. In spite of this limited access for recreational uses, many cultural features and recreational potentials can be found in the vicinity of these rivers.

The Shenandoah National Park lies along the ridge of the Blue Ridge Mountains just above, and to the northwest, of the Moormans River. The park is traversed by the well known and heavily used Blue Ridge Parkway and the Appalachian Trail. As one moves east along the Moormans River, there are two existing publicly owned recreational sites which lie within Albemarle County. These sites are; Mint Springs Valley Park and Sugar Hollow (Charlottesville) Reservoir. There is a reservoir planned for the vicinity of Buck Mountain that may provide additional fishing or passive recreational uses similar to that found at Sugar Hollow Reservoir. A recent study was done by the park service in an effort to do resource inventorying and analyze the lands within the 1926 authorized boundary to identify lands with a direct ecological or land use relationship to the Shenandoah National Park. This study identified future opportunities for trail linkages with the park trail system at Sugar Hollow Reservoir. It also states that the potential for any future trail linkages between Mint Springs Valley Park and the Shenandoah National Park are limited by an existing high voltage powerline (although this could be used for portions of a trail linkage), and other private lands along Bucks Elbow Mountain (National Park Service, 1993). The North Fork of the Moormans River runs along the foothills of Pasture Fence Mountain. This mountain has several existing foot and jeep trails which could be tied into to hook up with the Appalachian Trail.

As one continues to move east along the Moormans River, you come to its confluence the Rivanna River. There is a reservoir near this confluence that provides for fishing and other passive recreational uses as well as being the site of the Ivy Green Natural Area. It is this

resource which serves as the gateway to a proposed greenway system for Albemarle County. This proposal calls for the acquisition of land along both sides of the Rivanna River from the Ivy Green Natural Area through the City of Charlottesville (tying into their developing system) and terminates at the town of Milton near the University of Virginia Airport. This terminus point is very close to the Fluvanna County line. Other recreational and cultural amenities along this proposed greenway include; existing and proposed river access areas, Pen Park, Riverview Park, Rivanna Park, an archaeological site of an Indian settlement, the historic campus of the University of Virginia, Monticello the home of Thomas Jefferson, Ash Lawn, and Michie Tavern.

Much of the Rivanna River is the site of a historic canal and towpath system. The lower 20 miles, in Fluvanna County, was built first, with 4 dams, 6 stone locks, and 3 miles of canal. At the town of Columbia, a 4 1/2 mile canal with a dam, two stone locks and two stone-arch culverts were built to connect to the Kanawha Canal. These all exist today in an un-restored state.

In the 1870's the canal boat navigation was extended into Albemarle County, up to Charlottesville, by a less expensive system which consists of 5 dams and 6 wooden locks. The railroad era brought about the construction of a rail bed along the Rivanna River Valley. Now, even the railroad is gone along this route, however, the corridor of the towpaths and the railroad still remain in tact.

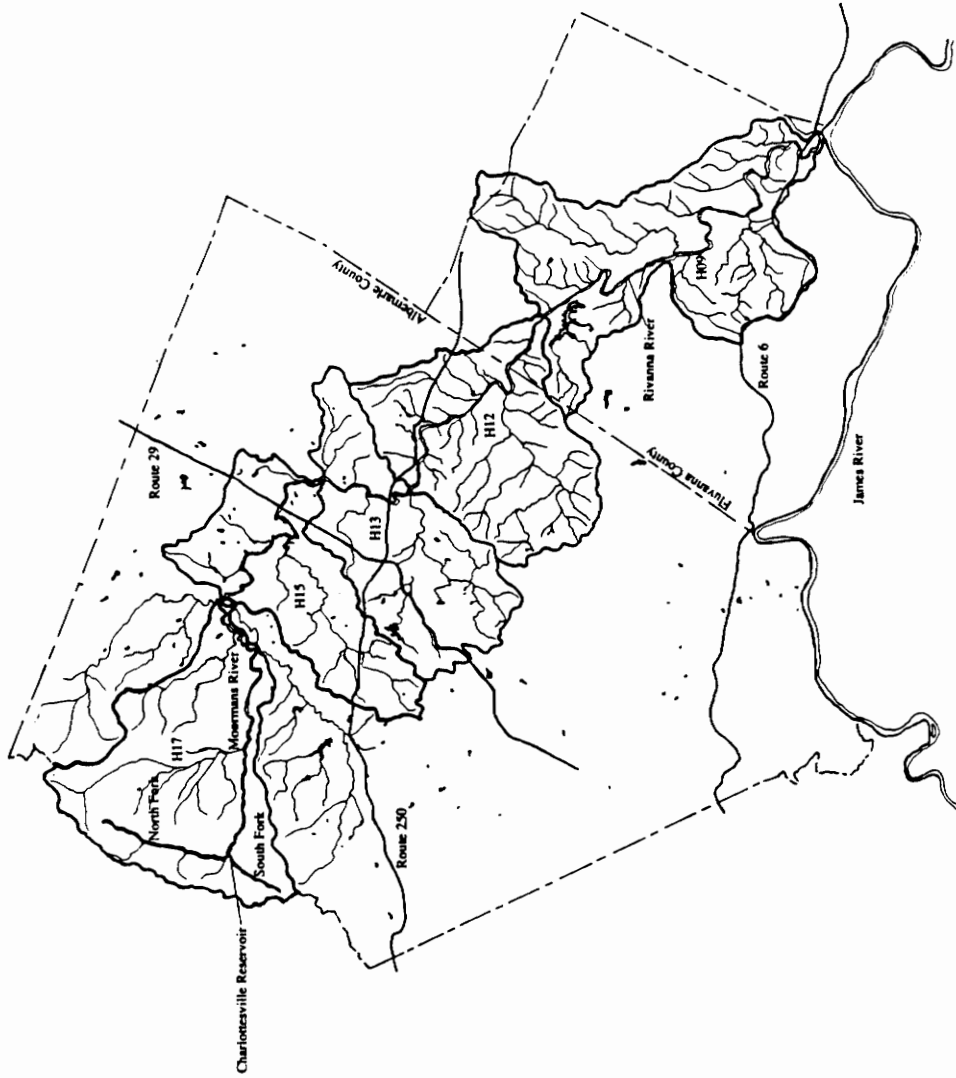
Fluvanna County has some existing recreational opportunities to offer, however, the potential for additional opportunities is great. Lake Monticello is located near the county line and is the site of a large, private residential development. A 1/4 mile trail developed by the Lake Monticello Residents Association runs downstream, along a historic towpath, to a well-preserved stone lock. From there, the canal extends two miles upstream to a privately owned lock at the remains of Union Mills Dam. The county is home to Camp Friendship, which is a private facility which offers camping, river access and horseback riding.

Fluvanna County currently has only three public river access points. These are located at; Crofton, Palmyra, and Columbia. Each of these areas are very limited in the recreational facilities that they offer, however, they all have the potential to be multi-use parks which could serve as important recreational nodes along the main spine of the greenway corridor with cultural and environmental education centers locate within their boundaries.

Existing Environmental Conditions


These rivers and their tributaries make up the Rivanna River Subbasin and contains the 769 square mile Rivanna River drainage area. This hydrologic unit consists of 12 watersheds, H09 - H20. Land uses within these watersheds are varied, but is primarily agriculture and forested land uses with the City of Charlottesville lying in the center of the unit making up two of the twelve watersheds, H13 and H15. These two watersheds are the Upper Rivanna and Lower South Rivanna drainage basins and rate as high priority for urban pollution potential primarily because of the high percentage of urban disturbed acreage within the watershed. Most of the other urban watersheds are rated medium priority for urban pollution potential. The South Fork Rivanna Reservoir which is within the H15 watershed has been classified by the State Water Control Board as nutrient enriched. Although, there are significant agricultural uses within the subbasin, only one, H19, rates as a medium priority for agricultural pollution statewide. The remainder are low priority. Significant forest harvesting activities occur in watersheds H09 and H10 which is why they are rated high for forestal related activities (Virginia Dept. of Conservation and Recreation, 1993, pg. 73).

Limited water quality data exists within the subbasin, however, it is assumed that with the exception of the urban areas, water quality is fairly good. Elevated phosphorous levels were detected in watershed H12, which is probably due to urban/suburban sources as well as agricultural non-point sources. Biological data collected by the Izaak Walton Leagues within watersheds H13 and H15 indicates poor water quality for the segments monitored (Virginia Department of Conservation and Recreation, 1993, Pg. 73).







Central Virginia Riparian Greenway

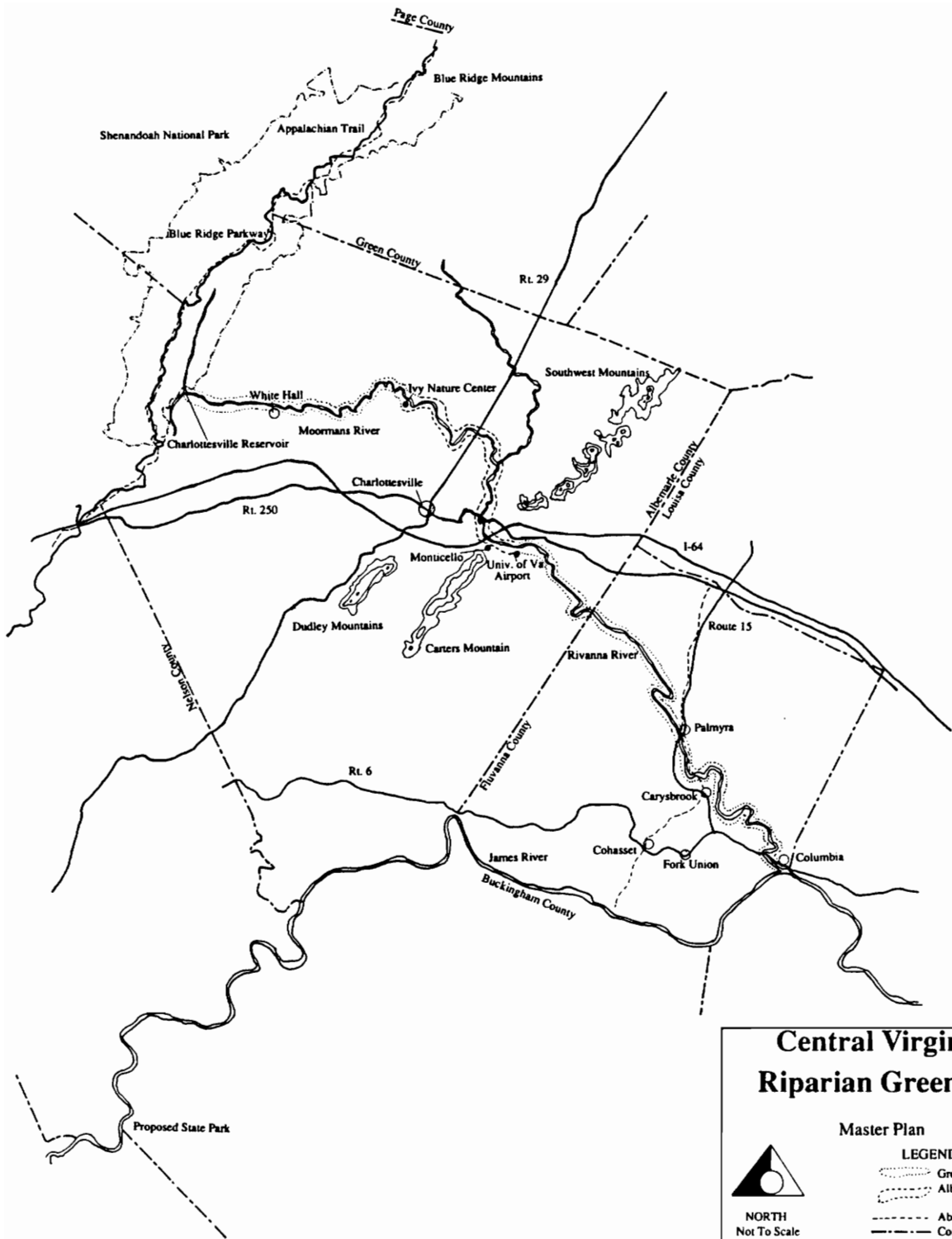
Watershed Map



NORTH
Not To Scale

LEGEND

-  Watershed Boundaries
-  Wetlands and Ponds
-  Streams & Rivers
-  Roads



Central Virginia Riparian Greenway

Master Plan

LEGEND

- Greenway Corridor
- Albemarle County
- Proposed Greenway
- Abandoned Rail Bed
- County Line
- Streams & Rivers
- Roads
- Park Boundary

NORTH
Not To Scale

PHASE II

Determining Key Uses of Greenway

For the purposes of this thesis, one portion of the corridor zone, the areas which lie within the H09 watershed within Fluvanna County, will be the focus of the design work. Based on the aforementioned environmental and recreational problems, and the wants and needs of the community, project goals and greenway key uses/functions of the greenway have been determined.

These key uses are;

- 1) Preserve water quality in the Rivanna River by; protecting floodplain lands, protecting the Rivanna's tributaries floodplains, stabilizing bank erosion caused by adjacent agricultural land uses, provide buffer zones between the river and adjacent clear-cut areas.
- 2) Delineate, protect and manage the adjacent area wetlands.
- 3) Provide for recreational uses along the river corridor and river access for water recreation.
- 4) Link the areas recreational and cultural resources with a trail system.

With the corridors key uses defined, it is time to begin the actual design of the corridor zone. At this point it is helpful to understand the dynamics of landscape ecology which are occurring in this area.

Landscape Ecology

The problems identified within the design area all relate to larger issues in landscape ecology. For example, bank erosion and vegetation loss due to the infestations of the Pine Bark Beetle, disturbs the balance of a riparian ecosystems by altering wildlife habitat and diminishing water quality. Riparian ecosystems are complex and include specific elements such as; wetlands, vegetation, and vegetation zones.

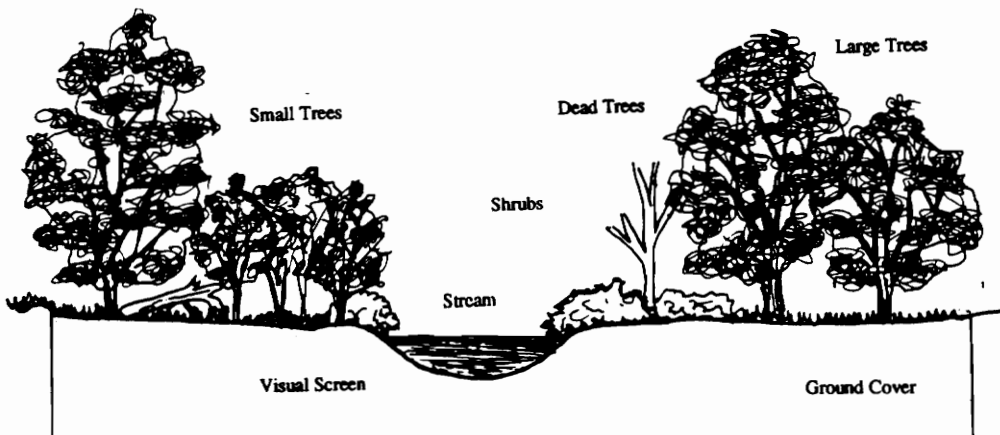
All of these elements perform function which are critical for maintaining a state of environmental good health because of their relationships to each other. Human and naturally occurring alterations of these elements are common and therefore guidelines should be established for human uses management and restoration of naturally occurring degradation.

The following is a framework for understanding the elements and their functions of a riparian ecosystem and guidelines for the wise use, restoration and management of that ecosystem. It begins with a description of riparian ecosystems then continues to discuss vegetation and wetland functions, vegetation impacts on wildlife habitat, vegetation zones, and the relationship between water and these zones.

With an understanding of how these elements are interrelated, one can begin to understand how alterations to the ecosystem can degrade environmental health and what needs to be done to mitigate these impacts. Based on this understanding, design guidelines have been developed to guide greenway designers and planners on the appropriate measures to take when planning for an environmental riparian greenway system with the characteristic problems of; bank erosion from grazing, steep slopes, wetland management, recreational demands, timber harvesting and floodplain management.

Riparian Ecosystems

Riparian ecosystems are wetland ecosystems which have a high water table because of proximity to an aquatic ecosystem or subsurface water. Riparian ecosystems usually occur as an ecotone between aquatic and upland ecosystems but have distinct vegetation and soil characteristics. Aridity, topographic relief and presence of depositional soils most strongly influence the extent of high water tables and associated riparian ecosystems. These ecosystems are most commonly recognized as bottomland hardwood and floodplain forests in the eastern and central U.S. and as bosque or streambank vegetation in the west. Riparian ecosystems are uniquely characterized by the combination of high species diversity, high species densities and high productivity. Continuous interactions occur between riparian, aquatic and upland terrestrial ecosystems through exchanges of energy, nutrients, and species.



Vertical Structure of Riparian Habitat

Riparian vegetation provides habitat for 60% of the wildlife along the corridor. Riparian vegetation arranged in a layered mosaic of large and small trees, shrubs, and ground cover has high habitat value. The wider this vegetation zone the better it is for wildlife. Plant masses which provide visual screens are also important. In addition, large dead trees provide perches for raptors.

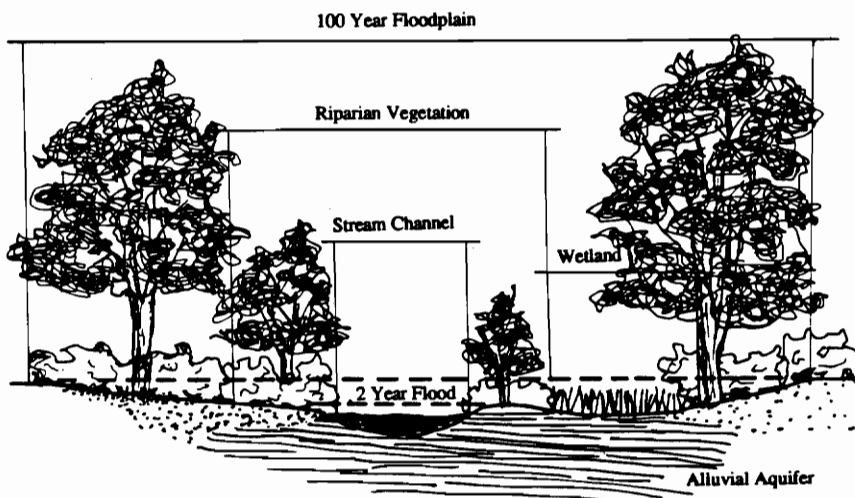
(City of Boulder, 1990)

Riparian Vegetation and Wetlands

There are four types of woody riparian habitats that are recognized in the United States and Canada: northern floodplain, southern floodplain, elm-ash, and mesquite-bosque. Management of most riparian areas mostly involves the protection from human disturbance, specifically road construction, recreational development, improper grazing, reservoir development, lumbering, urbanization, agriculture, and stream channel modification. Riparian vegetation grows along stream corridors in areas which have sufficient moisture and are sufficiently stable for survival. Riparian vegetation and wetlands are organized in a complex mosaic based on available moisture and the size and age of the vegetation.

Riparian vegetation serves many useful ecological functions which are critical to environmental health. Riparian vegetation functions provide for;

- High quality wildlife habitat
- Slowing the velocity of flood waters
- Slowing bank erosion
- Contributing to the deposition of sediment
- Reducing downstream peak flow discharges
- Contributing to increased infiltration
- Increasing the availability of groundwater, which supports stream flow and, in turn, irrigates riparian vegetation



Stream corridors

Natural stream corridors are the result of the complex interaction of water and riparian aquifers, stream channels, floodplains, and riparian vegetation and wetlands.

(City of Boulder, 1990)

Riparian Vegetation's Impact on Wildlife Habitat

Vegetated areas in stream corridors are arranged in a mosaic of patches and corridors of varying lengths and widths. Patches and corridors perform different wildlife functions. Corridors are consistent in character over long distances. Corridors are valuable because they provide migration routes for animals and plants, as well as serve as barriers between patches on both sides and function much like a road or any other type of linear barrier (fences, powerlines, etc.). Patches on the other hand, are relatively shorter and wider. They provide most of the wildlife habitat in the region and function more like a city block. Certain species live near the edges of corridors while others live within these patches.

Vegetation Zones

There are three types of vegetation zones which occur within a riparian corridor, these are wetlands, riparian areas, and upland areas. Plant communities in stream corridors may be classified as wetlands subject to local, state and federal regulation. Riparian areas have sufficient moisture to support a variety of woody vegetation but are not wetlands. Upland areas are those areas where there is less moisture than the riparian area and vegetation is generally large native trees and understory plants.

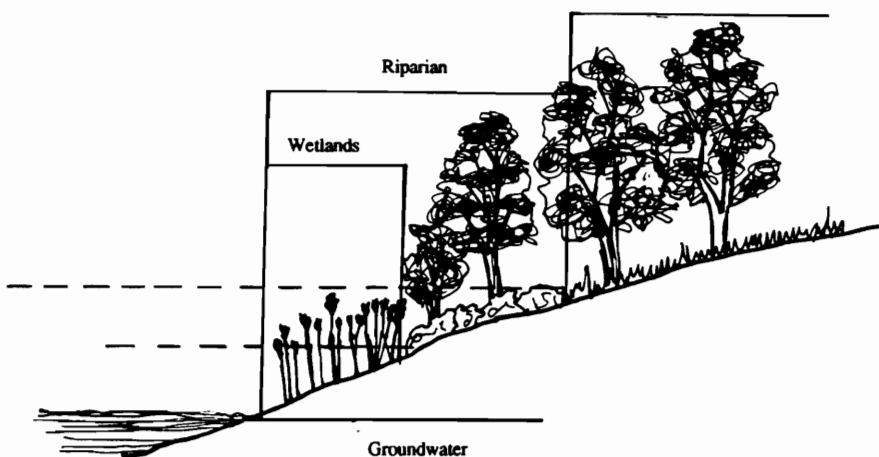
- Wetlands are the most ecologically important areas of the stream corridor. Wetlands perform the follow functions:
 - ground water recharge and discharge
 - sediment trapping
flood storage
 - fish and wildlife habitat
 - recreation such as bird-watching, hunting and fishing
 - nutrient retention
 - food chain support

While most wetlands provide only a few of these functions to a very high degree, not all wetlands provide all functions. Riparian areas have sufficient moisture to support a variety of woody plants but are not wetlands. These areas support a variety of wildlife and provide scenic and recreational opportunities. Also, they often provide important buffer areas for wetlands.

Relationship Between Water and Vegetation Zones

Stream bank vegetation is very important to the functions and processes of a riparian ecosystem. This type of vegetation is often called a buffer and is desirable for many ecological purposes. Often this vegetation is lost due to livestock grazing, unmanaged recreation, past floodings, and a other natural forces. It is important to have some type of management plan in order to manage existing buffer zones as well as restoring denuded banks. Several functions are performed by stream corridor vegetation and it is important to understand these functions when deriving a management plan. These functions are:

- increased stream bank stability
- filters sediment and pollutants from water running off
- slows the waters velocity, thus reduces erosion of stream banks and floodplains
- source of organic matter for riparian soils
- facilitates groundwater infiltration
- reduces peak flows
- increases low flows
- provides shade for streams, thus cooling water temperatures
- provides for wildlife habitat
- provides for wildlife movement
- catches flood debris



Relationship between Water and Vegetation Zones

(City of Boulder, 1990)

With a general understanding of how riparian ecosystems work, one can then move on to a more site specific level of investigation. The following lays out the design objectives for a particular river, the Rivanna River in Fluvanna County, Virginia.

Currently, development in Fluvanna County is minimal, however, the threat of development is encroaching from the City of Charlottesville. Regardless, development within the county of Fluvanna is not a major environmental problem at this point in time. The two types of land uses which should be monitored as a potential threat in the county is agriculture and forestry. Although there are only a few farmers growing crops along the river, cattle grazing in and around the Rivanna is a significant source of erosion and nutrient problems. Recently, the Pine Bark Beetle has had devastating effects on stands of native Virginia Pines, causing the Forest Service to either burn off or clear-cut these areas of dead trees. This is why the watershed that these areas lie in are rated high for potential water quality impacts by the Department of Conservation and Recreation.

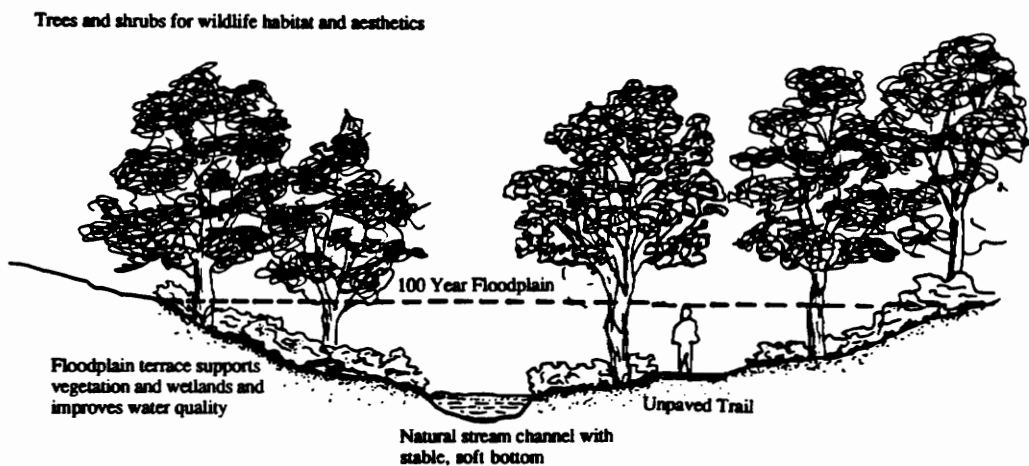
Due to the nature of riparian corridors, wetlands can be found along the rivers edge and in upland areas of the county. These wetlands include all three types; emergent, scrub-shrub and forested. Because of wetlands immense ecological values, this design will address the preservation of these critical areas.

The second order tributaries of the Rivanna within Fluvanna County are an important consideration in this environmental design. It is these streams which are often the source of pollutants from other reaches of the county, and adjacent land uses need to be buffered along these tributaries if water quality is to be maintained. The tributaries identified as significant for protection and buffering are; Cunningham Creek, Carys Creek, Ballinger Creek, Raccoon's Creek, Roundabout Creek and Mechum Creek. Each of these creeks will have a protected are along either side of the stream, encompassing the 10-year floodplain. At their confluence's with the Rivanna, special buffer zones and design strategies will be employed because of the importance of these environmental nodes.

Design Objectives

The greenway design for the Rivanna River is intended to meet the following objectives in regards to wetlands, bank erosion, and riparian vegetation. These objectives are:

- 1) Enhance and/or preserve vegetation in order to provide for important ecological functions of riparian vegetation and wetland areas.
- 2) Preserve existing native vegetation such as wooded areas, wetland areas, individual trees over 2" or groups of trees and shrubs.
- 3) Use plants to establish self-maintaining ecological systems and processes rather than areas requiring intensive maintenance and management practices.
- 4) Devise a practical plan for mitigating the impacts of the pine bark beetle infestations in and around the riparian corridor.
- 5) Stabilize banks which are eroded to do unnatural processes.



The Greenway Concept

Greenways are linear ribbons of undeveloped land along designated stream corridors. Greenways should be natural in character.

(City of Boulder, 1990)

For the purposes of this project a method has been derived for prioritizing critical areas adjacent to the Rivanna River Corridor. With the greenway key uses and design objectives defined, it is simply a matter of overlaying maps of the pertinent data, and evaluating existing conditions along the corridor. A portion of the river within Fluvanna County has been chosen to illustrate how this method works.

This portion lies in the southern part of the county and has been chosen because of specific site condition which help to explain the design methodology. This part of the design work involves applying the prioritization methods to the site in order to determine critical areas which need immediate mitigation.

This portion of the river and its corridor lands were divided into areas of like vegetation, land uses, wetlands, slopes, etc. It broke down into 10 separate areas which were then evaluated using the risk assessment method in an effort to determine which areas need mitigation priorities. Once the landscape elements were calculated, it was easy to see which areas should be given top priority. The following diagram illustrates the results of the risk assessment application.

Area 1	
Wetlands	4.5
Fields	4
Hardwoods	1
In. Pine	5
Pine	3
St. Slopes	4
<u>Rating</u>	<u>3.07</u>

Area 2	
Wetlands	4
Field	5
Hardwoods	1
Pine	4
Stream Con.	4
<u>Rating</u>	<u>2.57</u>

Area 3	
Wetlands	4
Fields	4.5
Hardwoods	1
Pine	3.5
Stream Con.	4.5
<u>Rating</u>	<u>2.5</u>

Area 4	
Wetlands	4.5
Hardwoods	1
In. Pine	5
<u>Rating</u>	<u>1.5</u>

Area 5	
Wetlands	4
Fields	4
Hardwoods	1
Stream Con.	4
<u>Rating</u>	<u>2.42</u>

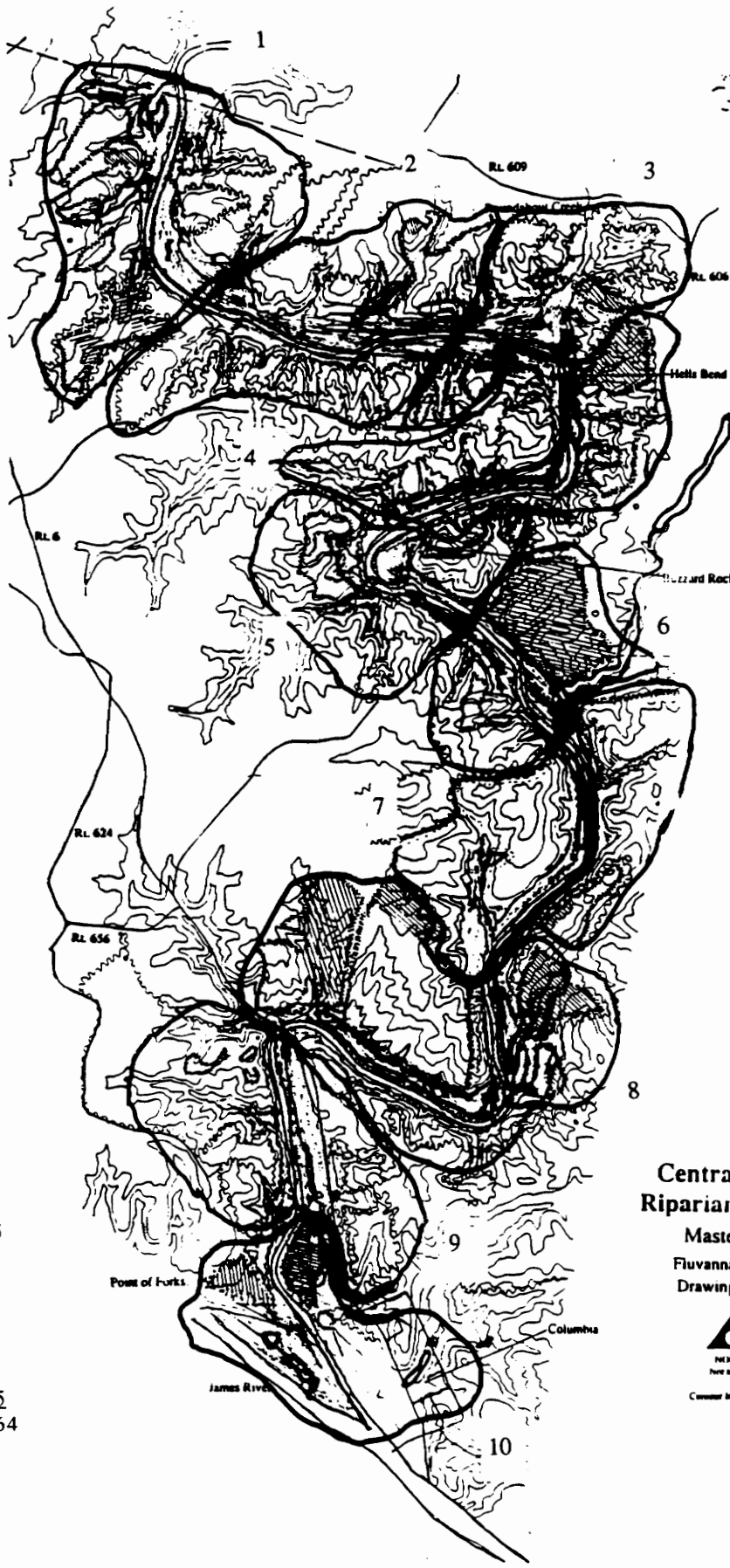
Area 6	
Wetlands	4
Fields	4.5
Hardwoods	1
Slope	4
Stream Con.	4.5
<u>Rating</u>	<u>3.2</u>

Area 7	
Wetlands	4
Fields	4.5
Hardwoods	1
Pine	4
Stream Con.	4
<u>Rating</u>	<u>2.5</u>

Area 8	
Wetlands	4
Hardwoods	1
Pine	4
In. Pine	5
Slope	4.5
<u>Rating</u>	<u>2.64</u>

LEGEND

- 100-year Floodplain
- Wetland
- Field
- Hardwood
- Pine
- In. Pine
- Stream Con.
- Wetland
- Field



Area 9	
Wetlands	4
Fields	4.5
Hardwoods	1
Slope	4
<u>Rating</u>	<u>1.92</u>

Area 10	
Wetlands	4
Fields	4
Hardwoods	1
In. Pine	4.5
Stream Con.	4.5
Development	-3
<u>Rating</u>	<u>3.0</u>

**Central Virginia
Riparian Greenway**

Master Plan
Fluvanna County
Drawing #3 of 3



PHASE III

Phase III is the last phase of the design and consists of aligning the trail corridors and pinpointing areas for parks and other recreational amenities. It is important to note here that the following design is tentative, the final placement of the trail will be determined by the completed environmental inventory. This alignment is to be implemented in keeping with the site conditions, with those conditions and circumstances acting as the guiding force for the final trail placement. Because this is an environmental design, with corridor protection given priority over trail construction, the trail is not continuous along the protected corridor.

The trail system begins at the Albemarle and Fluvanna County line with a park. This park is intended to serve as a gateway to the Fluvanna County greenway system, symbolizing the regional collaboration of the two counties. The park is accessible by an existing jeep trail which links to an existing trail on the other side of the park to serve as a short loop trail for park visitors. The trail begins again at Union Mills canal. It continues over the Rt. 600 bridge at a towpath which runs approximately 1/4 miles. It terminates slightly past the Rt. 600 bridge at a well preserved stone lock. In the river below the east end of this bridge is the remains of Crofton Lock which are visible at low water. This was a stone lock lined with wood, built in the 1830's for bateaux and preserved by the Virginia Department of Highways when the bridge was rebuilt.

The trail begins again at a proposed park at Petits Island. This park would provide for river access, picnicking, camping, and other passive recreational opportunities. On either side of the river are proposed loop trails which would be designed for bike traffic from the Lake Monticello development. These bike trails would employ the use of existing hardscape roads throughout the development and link with jeep trails to a high point near the river, providing for an overlook to the park on the east banks of the Rivanna. This park would be accessible by an existing jeep trail of Rt. 15. This same jeep trail also links up with an abandoned railroad corridor which is a perfect candidate for a rails to trails conversion, with the tracks already removed. In this locale, the trail has two different routes; one going to the rivers edge and the other following along the abandoned railbed to the village of Palmyra where one finds a well preserved stone lock and dam. Also at Palmyra, on the west side of the bank is an existing canoe access point. This area is accessible by crossing the Rt. 15 bridge, and while it has limited existing facilities, it has great potentials for camping and picnicking. An important issue to consider at this time is that the Rt. 15 bridge is currently under

consideration for rerouting. If this is done, it would be imperative to the success of this design that VDOT plan for the preservation of the lock , mill and dam adjacent to the bridge. Perhaps the new bridge could be located further north of the existing one and the existing one could be preserved for a hike and bike bridge. This would provide trail access to the canoe launch site.

Also near the bridge is a parcel of county owned land which is located on the east side of the river, south of the bridge. Here on can find a historic mill that is prime for restoration and could be the subject of cultural/historical interpretation. From this point, the trail continues along the abandoned railbed for approximately 4 miles, until it reaches an abandoned railroad bridge and crosses the river just north of Carysbrook. The trail then continues for another 1/2 mile through wooded lands until it reaches another parcel of county owned land which is a prime location for park development. A loop trail to the west of the river would run along the easement of Rt. 15, and provide a corridor for cyclists, eventually meeting up with the same park. This proposed park area is surrounded by schools, county offices, and recreational playing fields.

The trail along the river begins again at the site of an unrestored historic mill and the ruins of a bridge, which in previous times, was the main transportation route through the county and is located on the east side of the river. Just past the bridge are the remains of a towpath which is in reasonably good condition and is a 1/2 percent grade for the remaining six miles of the river. It terminates at the town of Columbia and the James River.

Loop Trails and other Recreational Amenities

On the west side of the river from the Carysbrook park site, the trail continues along the abandoned railbed all the way to the town of Cohasset, and eventually to the James River. At this terminus of the railbed is the site of an old plantation home. At this point, the trail can either loop back or link up with another proposed greenway system, one for the James River Corridor. Along this trail route near the Fork Union area, the County owns 90 acres of land where they eventually intend to build a multi-use park and pond near the confluence of Judy and Cary's Creeks.

Albemarle County
Fluvanna County

To Monticello

LEGEND

- 100-year Floodplain
- Stream
- County Line
- Road
- Jeep Trails

Potential Trail

- Trail Loop
- Trail Connection
- Proposed Parks (Near Launch)
- Existing Parks

Proposed Trail Corridor

Rt. 618

Fluvanna River

Rt. 250

Lake Monticello

Rt. 600

Sewage Treatment Plant

Crofton

Historic Canal Site

To loop @ Rt. 600

**Central Virginia
Riparian Greenway**

Master Plan

Fluvanna County

Drawing #1 of 3

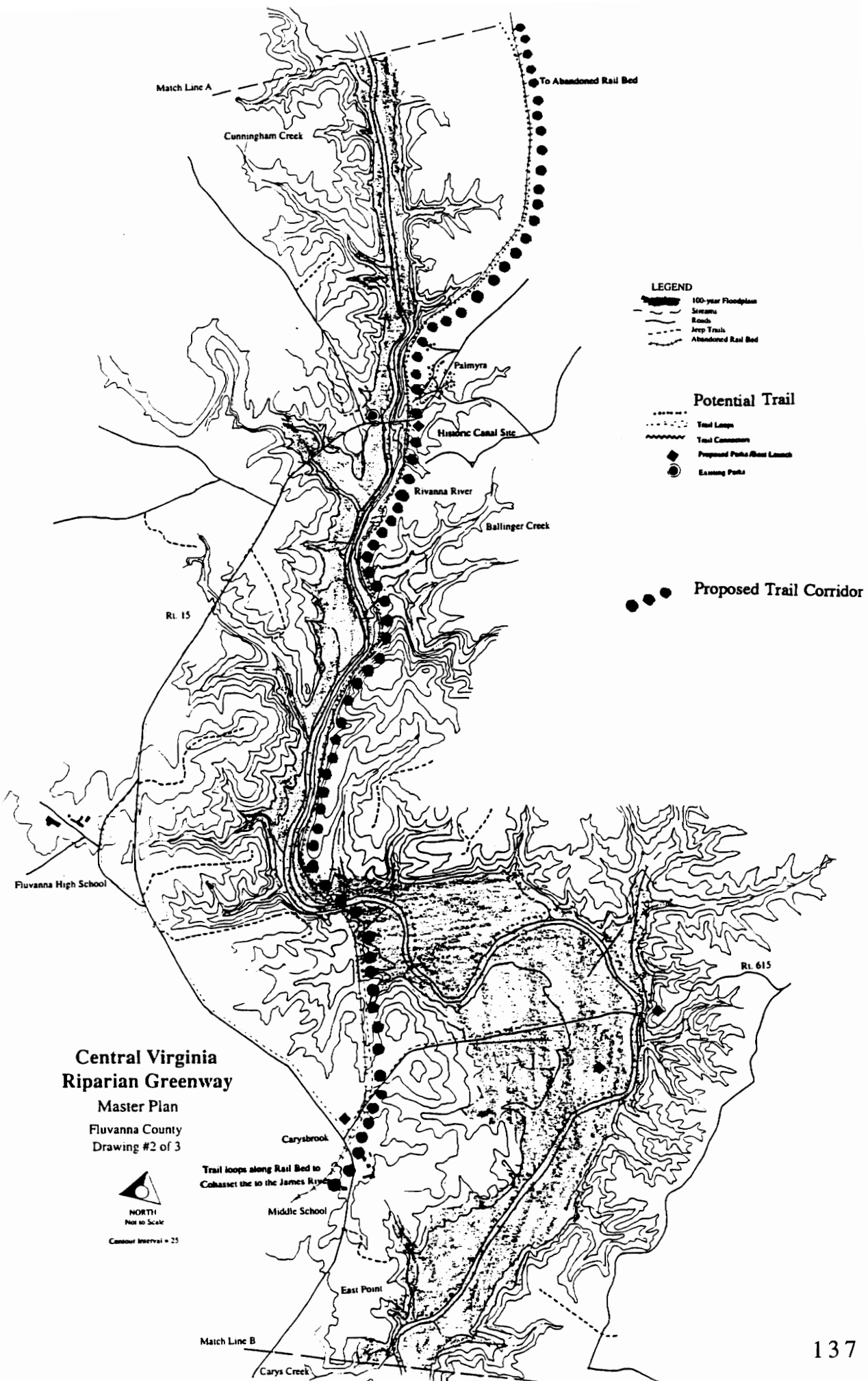


NORTH!
Not to Scale

Contour Interval = 25'

Camp Friendship

Rt. 15



**Central Virginia
Riparian Greenway**
Master Plan
Fluvanna County
Drawing #2 of 3


NORTH
Not to Scale
Contour Interval = 25

Trail loops along Rail Bed to
Cobasset the to the James River





Middle School


East Point

Match Line B

Carys Creek

- LEGEND**
-  100-year Floodplain
 -  Streams
 -  Roads
 -  Jeep Trails
 -  Abandoned Rail Bed

- Potential Trail**
-  Trail Loop
 -  Trail Connector
 -  Proposed Public Road Launch
 -  Existing Paths

 Proposed Trail Corridor

Match Line B

Rt. 15

Dixie

To Fork Union
and Cohasset

Rt. 6

Rt. 624

Rt. 656

Point of Forks

James River

Columbia

Rt. 609





Roundabout Creek






Hell's Bend


Buzzard Rock

Historic Mill & Bridge Remnants

LEGEND

-  100-year Floodplain
-  Stream
-  Road
-  Jump Trails

-  Potential Trail
-  Trail Loop
-  Trail Connection
-  Proposed Parking/Rest Looch
-  Existing Park

 Proposed Trail Corridor

**Central Virginia
Riparian Greenway**

Master Plan

Fluvanna County

Drawing #3 of 3



NORTH
Not to Scale

Contour Interval = 25'

The town of Columbia has retained an old railroad station house on a site just north of the town, very close to the east banks of the river with the intention of using it as some type of greenway facility. This build could supply information to tourists and greenway users, as well as be the subject of cultural interpretation.

At the confluence of the Rivanna and the James Rivers there is a parcel of land that has vast potential as an extension of the existing park on the banks of the James. This land is called Point of Forks, and is access a jeep trail. It would be an excellent site for passive recreation as well as primitive camping sites. These resources would serve as the gateway park to the greenway system at its southern end.

Based on the results of the example area, as well as other anticipated conditions along the corridor zone, design guidelines have been formulated to guide in the mitigation of the corridor. These guidelines address; existing vegetation, new vegetation, existing wetlands, new wetlands, habitat enhancement, and erosion controls.

DESIGN GUIDELINES

Existing Vegetation Management

Top priority in the management of existing vegetation is to preserve existing or native vegetation such as wooded areas, wetland areas, vegetative buffers, individual trees over 2" or groups of trees and shrubs.

1. When necessary, vegetation should be thinned rather than removed. When thinning, invasive, non-native species should be removed first, then dead stems and branches, live native branches, and finally, stems.
2. Where woody vegetation is removed, it should be replaced with native vegetation if possible.
3. All existing trees of native or non-native and non-invasive species over two inches in diameter should be saved. If removal of vegetation is required, the size of replacement trees should be reasonable enough to ensure survival.
4. When possible, existing plant material should be saved for re-establishment on-site or on nearby greenway sites.

New Vegetation

1. The establishment of new riparian areas should be encouraged.
2. When re-vegetation is the chosen alternative, locally gathered plants are preferred when available, although nursery stock will be acceptable in local plants are not a viable option.
3. In an effort to protect this riparian vegetation, streamside zones of mature trees should be at least 30m wide, and much wider if some harvesting occurs. It is recommended that protected zones at least 60m wide should be left on each side of streams wider than about 10m. On smaller streams the 60m width could be divided between the two sides.
4. In order to maximize the ecological benefit of stream corridors, they should be managed as corridors with vegetation as consistent throughout as possible.
5. Remnants of high value riparian vegetation should be treated as nodes which are connected by corridors to other similar areas. When possible, these patches should be enlarged to encourage more interior species.
6. Periodic maintenance activity should be implemented in ways which create opportunities for regeneration of wetland, riparian, and upland vegetation.

Wetlands

1. The location and functions of wetlands should be mapped and recorded.
2. All existing wetlands should be managed for their long term preservation.
3. Trails and other recreational facilities should be designed to cause the least possible impact on the existing wetland.

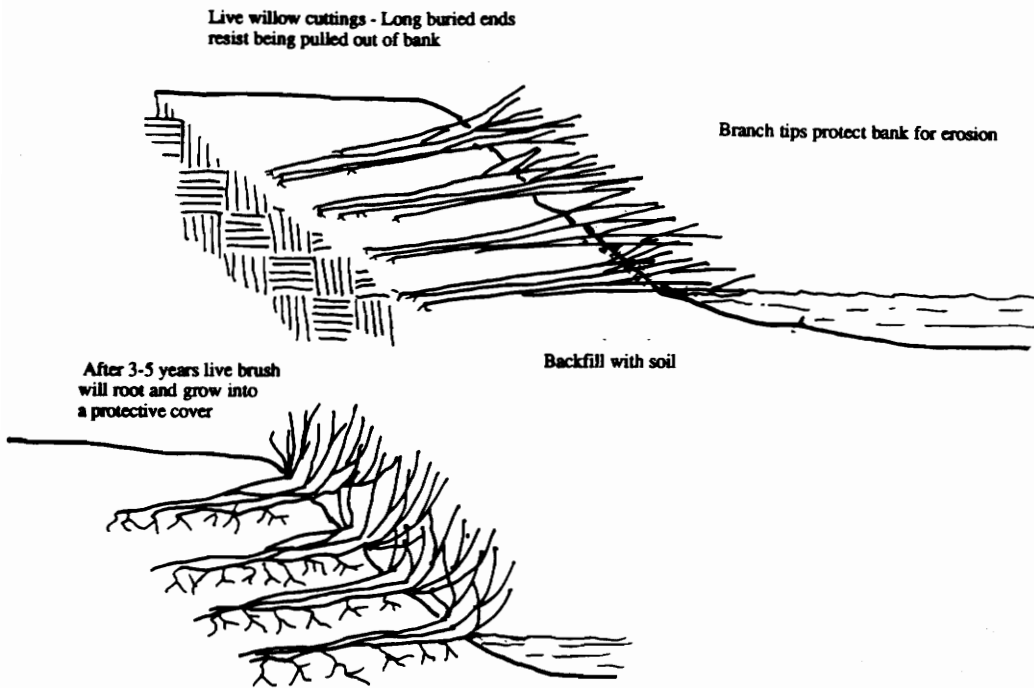
New Wetlands

The establishment of new wetland areas for their own merit is encouraged in the greenway corridor.

1. Such communities can be established on sites with permanent shallow standing water, high water tables, or adjacent to running water.
2. These communities should be designed to meet ecological function which are appropriate to the site.
3. Specific vegetation and functions should be based on topography, soil chemistry, water chemistry, and flooding characteristics.

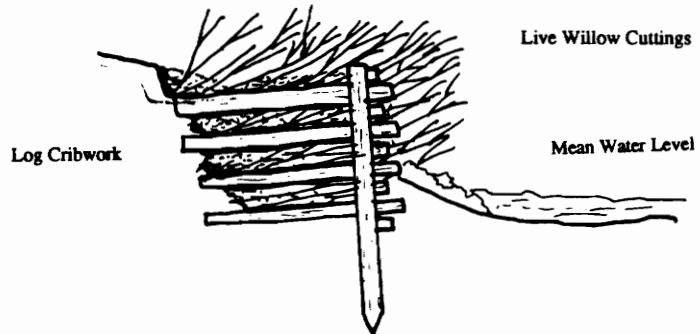
geotextiles (synthetic fabrics designed specifically for soil stability and erosion control).

6. The uses of soil bioengineering techniques such as live crib wall and brush layering stabilize stream banks. Properly designed and installed, these methods provide adequate protection when new, which become stronger with age as the soil and plants become established and an integral structural unit. See figure.



Brush Layering

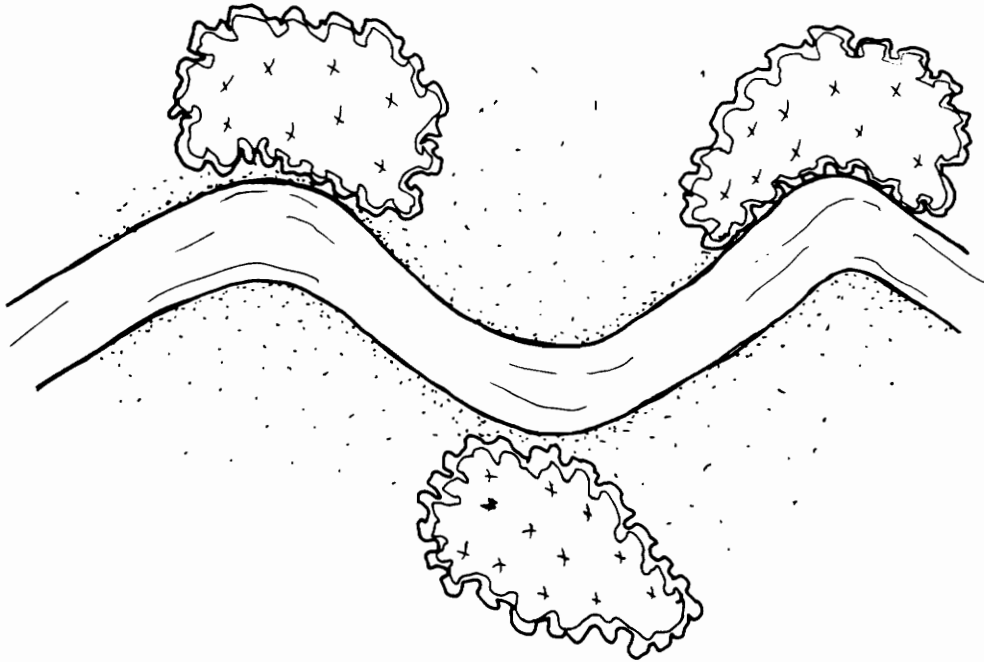
Brush layering is an effective means of stabilizing a bank where there is sufficient space. When live willow cuttings are used in the dormant season, they will sprout to form a protective stand of vegetation to protect the bank from erosion.



Live Crib Wall

Live crib wall can be an effective means to protect banks from erosion in a limited space. The willow cuttings grow to provide increased bank protection as the logs decay.

(City of Boulder, 1990)



Native Tree Cuttings - Native tree cutting arranged to provide stream bank protection. Selective arrangement is preferred and more cost-effective than random arrangement.

7. Willows could be planted into outside banks as stream meanders to provide stream bank protection. See above figure.
8. Willows are planted between the expected mean and mean high-water levels; alders, poplars, ashes, maples, and elms are planted at and above the mean high-water level.
9. Coniferous seedlings planted in riparian areas usually need some site preparation to reduce competition for sod-forming grasses.

10. If stream banks are bare and cut back because riparian vegetation has been removed, especially where streams are swift along outcurves, 5 to 10m high conifers can be cut and placed horizontally on the face of the base stream banks, with tips pointed downstream. The first tree is placed along the bank at the point furthest upstream, with the tree but overlapping stable bank for a distance of at least 3m. Successive trees are placed on the bare bank to overlap the adjacent trees by at least 20 percent. A backhoe can be used for placement during late summer and fall when streamflow is low. Trees should be secured to the bank by a cable connected to a deadman driven 0.6m into the ground. These trees will catch soil sloughing off the bank. After a year, native tree cuttings are planted into the sediments accumulated within the branches of the tree revetment.

Conclusions

The above guidelines are not absolute, there are sure to be other measures which will be more appropriate for the mitigation of specific conditions. They are meant to be used only where appropriated. As new techniques emerge, they should be included in the master plan document with the accompanying sketch.

CHAPTER 6

Implications of Greenways

After reading this thesis paper and seeing the resulting design, it should become clear that greenways are a valuable tool for ecological design. However, too often greenways are implemented with recreational amenities as their primary goals, and incorporating only minimal ecological considerations into the projects. The very nature of greenways is beneficial to a variety of environmental aspects, however, with some careful analysis of a region and well thought out design decisions, all greenway projects could provide numerous benefits for plants, animals, water quality, and ultimately people.

Conservation through greenway building is an exciting opportunity to involve some unlikely players in environmental planning and design. As Labaree said, "The underlying principle of conservation is that utilizing natural resources does not, in itself, pose a threat to the environment. It is the manner in which we do it that dictates whether our activities are detrimental or benign." By enhancing recreational resources as well as providing for new ones through conservation, people are drawn out into these areas and can begin to see nature's processes and functions at work. At the same time, they see how humans can fit into nature without destroying it. This begins to get at an important phenomenon, that of instilling a land ethic. Aldo Leopold recognized the need for a land ethic long ago. He proposed that if people had a better understanding of the land and its processes, then a solid ethic towards that land was sure to develop. That ethic includes "soils, water, plants, and animals, or collectively the land" (Leopold 1949, pg. 204). Leopold believed that if people made decisions based on this land ethic, then environmental health and sustainability was possible. He believed "a thing is right when it tends to preserve the integrity, stability, and beauty of the biotic community. It is wrong when it tends otherwise" (Leopold, 1949, pg. 224&225).

Greenway designs with the proper ecological goals can do this, and do it better than most any other type of design. Because of the inherent linearity of greenways, a network of these corridors can do much to preserve the environment from landscape to landscape and region to region. And, at the same time, bringing people out into that landscape, instilling a much needed land ethic in the peoples of that land.

It is important that we as a nation encourage states, towns and communities to build their land use policies around the unique attributes of their region, as opposed to cutting and pasting land use policies designed for other locales with completely different circumstances. It is

necessary that there is a collective understanding that what is scenic today will not be scenic tomorrow by accident.

Further Research

After extensive interviews and phone conversations with county, regional, and state officials, it was learned that there are several greenway designs in the works in and around the state. Two which pertain to this particular site are; the Albemarle County proposed greenway and a greenway planned for a portion of the James River from Lynchburg to Lexington. With this knowledge, it is clear to see how a network of greenways across the state could be realized.

There is much work to be done in environmental inventorying and need assessments around the state. These studies could pinpoint ecologically sensitive or degraded areas that should be given priority for mitigation and management, thus, coming closer to the goal of a green infrastructure for the state and ultimately the country.

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