

# **Design Process to Integrate Natural and Human Systems**

Key Words: Ecological landscape design, sustainable landscape design, sustainable design process.

*by*

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Thesis submitted to the faculty of the Virginia Polytechnic Institute and  
State University in partial fulfillment of the requirements for the degree of  
Master of Science  
in  
Landscape Architecture

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**August 28<sup>th</sup> 2003**

**Blacksburg, VA**

## **Abstract**

### **Design Process to Integrate Natural and Human Systems**

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After more than a century, there are very few examples of excellent interdisciplinary work in landscape architecture, like the “Emerald Necklace” designed by Frederick Law Olmsted or Landschaftspark Duisburg-Nord by Peter Latz. Most of the projects still have only one purpose: they are either reserved for conservation as are the great national parks, or are planned for recreation or development that ignores natural systems.

“Most...landscape designers are still inspired by and primarily focused on aesthetics; society’s other major objectives are secondary for them” (Richard Forman 2002, p: 85).

In 1993, American Society of Landscape Architects defined sustainable development as, “development that meets the needs of the present without compromising the future.” Thus designers need to understand how natural and human systems work and design for the protection of our environment as an integral part of any development.

Landscape architects can achieve this by borrowing principles of legendary works like the ‘Emerald Necklace’ and combining those with new technology to meet changing cultural and ecological needs. This thesis asserts that sustainable development should be achieved by reconciling human systems and its effects on the surrounding environment by using and revealing natural systems to spread consciousness and earn attention and care for our environment.

Suitability analysis by Ian McHarg, Bioregionalism by Clair Reiniger, Regenerative design process by Lyle, and Framework for ecological design by Prof. Carl Steinitz are various design processes to create developments, which can respond to both natural and human needs.

The thesis project, Riverside Park and Biomedical Complex in the South Jefferson Redevelopment Area in Roanoke, VA, explores how a design process, consisted of framework for ecological design and principals of eco-revelatory design, can help to plan a sustainable development, which uses and reveals natural systems to reconciling human systems and its effects on the surrounding environment. The project demonstrates how a multidisciplinary approach towards landscape design can help to create a multifunctional design that meets the, ecological and cultural, needs of the present without compromising the future.

## **Acknowledgements**

I would like to express my utmost gratitude for my advisor, Margaret Bryant, for her faith in me during my entire research and project. In addition to her continuous motivation and support, she always supported encouraged innovative ideas that led to a very satisfying research and project experience.

I would also like to express my sincere thanks to Associate Professor Dean R. Bork and Professor Benjamin Johnson, who offered constructive criticism, useful insight and advice as my committee members.

My father, mother, family and friends have been extremely supportive through these many years. Their love and support has seen me through both bad times and good times and they contribute hugely in whatever I have accomplished till today.

Amol M. Deshpande

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## 1.0 Introduction

In 1887, Frederick Law Olmsted designed the “Emerald Necklace” by creating and amalgamating a series of public parks in Boston, Massachusetts. Today, after more than a century, many people are using these parks for jogging, canoeing, and many other recreational activities. Apart from acting as urban oases these parks and their waterways also house many species of birds, fishes, and other animals. The back-bay fens were, however, designed to facilitate stormwater management and sewage treatment using natural systems like wetlands and bio-retention. The Emerald Necklace project successfully ties together conservation, land restoration, sewage treatment, solid waste disposal, recreation, transportation, and water and visual quality (Richard Forman 2002, p: 85). It is one of the most outstanding examples of multipurpose planning and design in the world. Three main aspects of the fens project that also frame the purpose of this position paper are: coordination between planning and design, use of natural systems to reconcile environmental impacts of human systems and providing opportunities for people to learn about natural systems by enjoying, observing, and appreciating these systems.



Fig 1- 1 Looking West Towards Fenway Park (Source: [nanosft.com/boston/fwyp1024.jpg](http://nanosft.com/boston/fwyp1024.jpg))

## 1.1 Current issues in Landscape Architecture

After more than a century, there are very few examples of such excellent interdisciplinary work in landscape architecture. Most of the projects still have only one purpose: they are either reserved for conservation as are the great national parks, or are planned for recreation or development that ignores natural systems. Until the last few decades designers ignored the great works of master landscape architects like F.L. Olmsted, Charles Eliot and other pioneers in design and planning who tried to combine design and planning to reconcile human systems and associated environmental impacts using natural systems. **“Most...landscape designers are still inspired by and primarily focused on aesthetics; society’s other major objectives are secondary for them”** (Richard Forman 2002, p: 85).

Today, landscape architects and other professionals recognize the effects of ignorance on natural systems in human development. Flooding, air and water pollution, and depletion of habitat diversity are a few of the consequences of such lack of understanding. In addressing this issue, the 1993 American Society of Landscape Architects (ASLA) Declaration on Environment and Development included principles and objectives created to inspire landscape architects to undertake works that contribute towards a sustainable future. ASLA defines sustainable development as, “development that meets the need of the present without compromising the future.” One of the declarations most important principles is: “to achieve sustainable development by making environmental protection and ecological function an integral part of the development process.” It also asks designers and planners to accept responsibility for the consequences of their design, planning, management and policy decisions on the health of landscape and cultural communities and their harmony, equity and balance with one another.

## 1.2 Design Position

Landscape architects can design and implement sustainable development by meeting the objectives of ASLA declaration. They can do this by borrowing principles of legendary works like the Emerald Necklace in Boston and combining those with new technology to meet changing cultural and ecological needs. **This thesis asserts that sustainable development should be achieved by reconciling human systems and its effects on the surrounding environment by using and revealing natural systems to spread consciousness and earn attention and care for our environment.**

In this context *design* refers to deliberate transformation of the landscape, or human interventions at all scales of development. *Planning* refers to management and policymaking for the implementation of design intent. It should be emphasized that the interlocking relationship between design and management is a particularly important feature of any 'ecosystematic' design process (Lyle 1985, p: 18).

The following sections of this paper elaborate on the need for such reconciliation and propose a process of design to bring together human and natural systems by understanding:

1. changing relationship of human systems with natural ones.
2. natural systems.
3. San Elijo Lagoon Case study.
4. design process to achieve this reconciliation of human systems using natural systems.
5. importance and method of revealing natural systems.

## **2.0 Changing relationship of human systems with natural ones**

In order to reconcile environmental impacts of human systems using natural ones it is important to understand the changing relationship between human and natural systems. Here, human systems include all of the human interventions on this planet. These range from primary systems related to food, water, shelter and energy to secondary systems concerning communication, transportation, recreation, etc. Humans have slowly changed these systems at every stage of their evolution from a hunting and gathering to a modern day society. Every stage of human development improves existing systems and invents new ones and subsequently redefines their relationship with nature.

### **2.1 Hunting and gathering societies and agricultural society:**

Hunting and gathering societies understood their total dependence on nature and realized the consequences of violating natural laws. “An individual was born in nature and was claimed by nature in the end” (Toeffler 1980). Agricultural revolution yielded in elaborate systems for food production that were necessary for increasing population. Survival was no longer dependent on what could be found to eat in the wilderness but instead what was grown. People could grow food, cease nomadic ways, and settle in permanent dwellings. This demanded a new relationship with nature that was less dependent on natural systems for the primary needs.

### **2.2 Industrial society:**

The industrial revolution resulted in development of elaborate systems for energy creation and transportation that further reduced reliance on natural systems. The industrialization brought a new economy and yet another definition of people’s relationship with nature (Miller 1988). People saw human development as war with nature or a mission to conquer it. Social Darwinism provided “scientific” justification for global exploitation of resources by individual nations and the elimination of all who stood in the way of progress (Toeffler 1980). The postindustrial era improved most of the

earlier systems and creating new systems for communication and transportation for people as well as basic needs like water, air and energy. Today, we are less dependent on nature for our basic needs compared to hunting and gathering, and agricultural societies. People can easily satisfy their needs without knowing much about nature and how it functions. These systems have also changed the way people occupy space and how they live. Earlier societies lived in groups to share limited resources, knowledge and skills, and experience. Today, with the ease of transportation, people live far away from their work place, leading to expansion of cities and the required infrastructure that directly influences the function of natural systems.

Thus the development of human systems from the prehistoric era to modern society has greatly changed our relationship with nature. It has changed from an integral and dependent relationship to an overpowering and dissociated one today. Such dissociation is more evident in cities and urbanized areas than rural areas. Although cities are undeniably human's greatest cultural accomplishments, they demand a great network of human systems. This elaborate network of human systems not only dominates natural systems, but can also interrupt or even retard some of their functions. For example, "much of the early American life consisted of getting rid of surplus water; in the east of the Mississippi successful politics often consisted of providing roads drainage, wooden side walks and pumps to get whole towns out of the mud" (Grady Clay 1979, vii). Such policies resulted in the loss of as many as 75% of wetlands in America's lower 48 states, aggravating the problems of sedimentation, water quality and flooding.

## **2.3 Effects on water regime**

Wind, waves, glaciers, and runoff or water flow are the formative or essential processes of the landscape (Marsh 1998, p: 66). Of these, flowing water is one of the most important systems and certainly most altered and hampered due to human development. It is also one of the three basic needs (air, water, and food) of any living organism. Thus an adverse effect on this system will in turn affect all the life forms on the earth. People have always valued water for its essential role for their survival; they also value and enjoy its scenic, recreational and spiritual capabilities. However, people have regarded it as a commodity or a resource to be exploited and failed to value it as a part of dynamic ecosystem that is closely associated with its surrounding landscape and our interventions. The increasing need for fertile land and transportation and communication network have resulted in piping of streams, changing the courses of rivers, channeling of rivers and streams, and elimination of most wetlands. Such direct structural changes in the landscape lead to changes in functioning of the system. The indirect effects of human development are far more devastating. Enormous increases in impervious surface due to urbanization, discharge of harmful chemicals or waste products into streams and rivers, and increasing use of fertilizers all lead to qualitative and quantitative imbalances within the system.

One of the most important goals of Environmental Protection Agency's Clean Water Act is: "to achieve the broader goal of restoring and maintaining the chemical, physical, and biological integrity of the nation's waters so that they can support the protection and propagation of fish, shellfish, and wildlife and recreation in and on the water" (<http://www.epa.gov/>). Today, America spends over 124 billion dollars per year complying with number of environmental status and regulations (Kellogg 1999, p: 01). Most of this money is spent to remediate environmental hazards caused by our own systems. It is the responsibility of landscape architects, developers, architects and planners to consider natural systems as an important part of designing and planning decisions.

## **2.4 Cultural Sustainability**

While realizing ecological processes in landscape development, designers should understand the importance of social and cultural factors in sustainable design. Joan Nassauer explains this as “cultural sustainability” in which “survival of the landscape” or natural system, especially in urban context, depends on “human attention” (Nassauer 1997,p: 69). The ecological intensions of the designers will not succeed if the landscape fails to earn enough attention and care from the society. This human attention and care depends on two factors: how people experience and use their landscapes, and their understanding of ecological processes. The experience of landscape is related to their aesthetic expectations, which are influenced by cultural and social backgrounds. The understanding of ecological processes is related to the legibility of the landscape and its ability to engage people and raise their curiosity about the natural systems and its relevance for human existence. These issues will be discussed in detail in the later part of this paper.

## **3.0 Understanding Natural Systems**

The development of land for any human system invariably modifies the existing natural ecosystems, directly and indirectly. In other words construction of any human system also means introducing different natural systems and modifying an existing ecosystem. Thus it is the responsibility of designers to understand the consequences of such introductions and modifications of existing ecosystems and intentionally envisage them as a part of the design, making use of all the ecological understandings he or she can bring to bear. Only then can the designer shape ecosystems that merge to fulfill all their inherent potentials for contributing to human purposes that are sustainable, and that support non human communities as well (Lyle 1985, p: 16).

### **3.1 Structure, Function and Location**

The following discussion gives an overview of the important aspects of natural systems. Lyle simplifies the enormous complexity of 'ecosystematic' order by examining it as an order of house. (Ecology= Eco (house) + Logy (study)). He compared this otherwise complex system to a building, which is composed of three orders: First is structural order composed of posts beams walls and roofs. Second is functional order of materials and energy flows represented by pipes, vents, wires, ducts, etc. Finally, locational order composed of floor plans that explain the location of individual spaces within the building. Similarly an ecosystem is composed of structural, functional and locational order. The fundamental principle of landscape ecology is that structure influences function and vice versa, and that their interaction leads to change over time.

#### **3.1.1 Structural order in Ecology:**

Structural order defines composition of living and non-living elements: rocks, soil, plants and animal species. In considering the structure of an ecosystem, we include all life and its interactions with non-life. In natural ecosystems, structure is usually consistent in that each species inhabits a particular niche and maintains ongoing interactions with other species.

Structural order can also be defined as structure of a large *land mosaics* (Forman 1995) composed of patch, matrix, and corridor (Forman and Godron 1986). Such a system of classification works best when elements have relatively distinct boundaries. Because humans often create disjointed landscape boundaries, this way of describing the landscape works well in human dominated landscapes.

Understanding how patches and corridors created by humans interact with other types is a key linkage between cultural and ecological understanding. For example, because corridors can serve not only as conduits but also as filters and barriers to movement, many human made corridors interact with natural corridors in complex ways. “Roads serve as barriers and sources of mortality for many types of species. Roads can also act as barriers to surface to subsurface water movement. At the same time road ditches become natural extensions of hydrological systems” (Forman 2002, p: 315).

### **3.1.2 Functional order:**

Functional order defines the flow of energy and material that distributes the necessities of life to all of the species within *ecosystematic* structure. Every day, landscape receives new energy from the sun. Energy absorbed or reflected at the earth’s surface warms the atmosphere and contributes to heat balance. Energy fixed into living matter through photosynthesis makes its way through the food web, supplying all living creature with energy. Water, nutrients and other materials by contrast are not lost or dissipated, but are instead continuously recycled.

Such flow and transport of materials also exist in human systems: movement of people and goods, supply of electric and gas utilities, and disposal of sewage and other wastes. These systems are often tightly coupled with flows in natural systems, such as the use of rivers to dilute pollution and the introduction of exotic pests and diseases through the transport of plant products (Forman 2002, p: 316).

### **3.1.3 Locational patterns:**

Earth is composed of varied structural and functional parts. At the extremes, desert is very different from a rain forest and there are infinitely varied landscapes in-between. The type and number of species any eco-system can support largely depends on the environment in the particular place where it exists, which in turn is determined by specific local conditions of topography, soil and climate.

Conditions vary globally, regionally, and locally. While there are some consistent conditions within a region, this is what defines a region in the first place; there are also finer local variations. Even with a single site, conditions can vary considerably, especially with respect to topography and microclimate. This rich complex system of patterns, and patterns within patterns, offers a foundation for equally rich patterns of development. Herein lies the means for reestablishing connections between people and place as well as between people and natural processes (Lyle 1985 (p-22-23-24)).

Construction of a dam is a very common example of how human systems affect structure and function of natural systems. This building process brings an enormous amount of change in existing topography, soil, vegetation and habitat. It creates new landforms and introduces new materials and spaces, thereby changing the structural order of the previous ecosystem. It deeply impacts the complex functional order of the river's ecosystem by introducing the new lake or impounded water reservoir eco-system into its course. In short, the main cause of failure of integration of human systems with natural ones is that these superimposed systems disturb the operational integrity of natural systems. Lyle (1985) has explained the following six basic ecological processes that are vital for operational integrity of natural systems.

### **3.1.4 Conversion:**

In the process of conversion, one thing transforms to something else. After arriving at earth's surface, the radiant energy of the sun goes through a series of conversions (to plant biomass and to heat in various forms) before being eventually dissipated back in to space. Through this complex series of conversions, it supports all life.

### **3.1.5 Distribution:**

In order for energy and material to reach the innumerable members of an ecological community, a means of distribution are needed. Nature provides a number of such means. The distribution pattern of wind covers the earth. Water itself is first distributed in the atmosphere by the wind and, after it falls back to earth, by gravity within a single watershed. It carries a great many materials along on its journey. Moving animals, including migratory birds that fly half way around the world, also move energy and material about.

### **3.1.6 Filtration:**

As air and water flows over and through the landscape, plants and soils act as filters, removing materials that have been dissolved or otherwise taken up and carried along the way. For example grasses and ground covers perform the filtration service as water flows over the surface of the landscape. These filtrations restore the relative purity of the air and water in preparation of the next phases of their ongoing ecological roles. This is nature's waste treatment system.

### **3.1.7 Assimilation:**

Every thing produced in the landscape returns to the landscape for re-assimilation. Most of these are either dead biomass or what we label as waste. However, what humans call waste is essentially food for vast populations of decomposing organisms. Mostly unseen organisms, which are often ignored, are in fact essential 'workhorses' of regeneration;

their activity comprises most of the earth's biological processes. Three stages of decomposition include 1) particulate detritus formed by a physical or biological action, 2) humus production and release of soluble organics, 3) and mineralization of humus. Mineralization is a much slower process. Thus decomposition, or re-assimilation, enriches the soil with detritus and humus and provides nutrients for new plant growth. It is the basic process of revitalizing the earth.

### **3.1.8 Storage:**

In making their way through ongoing cycles, materials are held inactive at some points and awaiting eventual reuse. For example, water is stored for varying lengths of time in the soil, in the voids of underground rock strata, called rock aquifers, and in lakes and ponds. Energy in the form of coal, gas, and petroleum is stored for thousands of years. Other storage periods may last only for hours or days. The detritus on the floor of a tropical rain forest, for example, is quickly broken down in the moist environment and taken up by trees. Thus in a tropical rain forest nutrients are stored in the form of biomass.

In order to participate creatively in natural processes and to do so with reasonable hope of success, we need to include as subject of design the inner workings of the landscape, the systems that motivate and maintain it, and reveal them through creative, imaginative, and visible form of the landscape. (Lyle 1985, p: 16).

## 4.0 San Elijo Lagoon: A Case Study

San Elijo Lagoon is one such project, which demonstrates how to conserve and enrich the ecological integrity, its structure and function, of a place while incorporating the inevitable social and cultural needs of human beings. Located some 20 miles north of San Diego, San Elijo Lagoon: “is a narrow tangle of marshes, mudflats, and shallow channels that push out of the Pacific Ocean into rolling coastal plains of Southern California” (Lyle 1985). For many years, in spite of human development in the surrounding area, it is a quiet landscape and has that “sense of airy tranquility” that one associates with lagoons everywhere. In mid-1960s, a classic developer versus environmentalist (or development versus preservation) battle began. Developers wanted to create a marina subdivision, while environmentalists wanted to leave the lagoon as it was. In line with this, Lyle demonstrated how to design for future development and inevitable human systems while restoring ecological processes at a place, by using natural systems to reconcile environmental impacts of existing and future human systems.

The design process for this purpose was based on understanding of:

how the lagoon ecosystem works.

the working of existing landscape, including human systems, in terms of its structure and function.

the current development trends and the future development patterns

the effects of proposed and future developments on structure and function of the existing landscape?

Proposing a solution that incorporates a variety of necessary human systems and still restores and enhances the functioning of the natural systems.

Various methods used to investigate these issues are: suitability models (to explore various combinations of land use and possible locations), impact prediction matrix (to analyze flow of materials and energy), and chain effect diagrams (to analyze the chain of environmental effects set off by one action, in this case the filling of wetlands).

The proposed solution presents a framework for the development and management of the lagoon that comes from the analysis and studies to answer the above questions. The proposed solution describes seven different homogenous zones and the range of uses permissible in each. The zones include: an administration and research center; biotic production, research and conservation; a perimeter trail and buffer zone; a wildlife preserve and observation area; intensive recreational and related commercial areas; and finally recreation and selective urban development. The purpose is not to prescribe specific uses, but to define the uses that can be sustained in each zone without seriously affecting the functional integrity of the lagoon.

## 5.0 Differences between human systems and natural systems

From the discussion about changing relationship between human and nature, basic principles of natural systems, and the San Elijo Lagoon project the following list of differences can be derived between human systems and natural systems. This list provides guidance for the reconciliation of the human systems using natural systems.

- Human systems are inflexible and deteriorating with respect to natural systems which are flexible and tend to absorb a lot of damage and still function. For example, water distribution through rivers has been affected in many ways by human developments, but still it continues to function by recreating the necessary ecological processes on its way. In contrast, the human system of water distribution consisting of network of pipes, valves, and pumping stations can easily stop working if any of the components fails to work.
- Human systems are mostly designed to achieve a single function. For example, a stormwater system is designed only to collect and get rid of stormwater. Similarly, power plants burn coal to generate electricity and have nothing to do with air, water, land or habitat. Natural systems are complex and tend to be multifunctional in managing and improving other resources. Wetland systems help to improve water quality, abate flooding issues, and also act as breeding ground for number of birds and aquatic animals thus increasing the habitat quality.
- Most of the human systems are independent of each other. Stormwater systems function independent of transportation systems and are different from energy creation and supply systems, whereas natural systems are interconnected and tend to affect each other. For example, deforestation will create erosion problems, which leads to flooding. Loss of vegetation can lead to reduction in the heat and pollution absorption which causes increased air temperature and pollution levels.
- Human systems are non-regenerative, where as natural systems are regenerative. Poisonous gases and toxic materials generated as a byproduct in power plants are not renewed in any way, but enter the atmosphere. Whereas energy in natural systems continuously recycle back to living organisms.

- Because of human systems' simplicity, they are easy to understand and perceive. They are so evident in day-to-day life that people almost think that food comes from Walmart and water comes from a tap. Natural systems are hard to understand and perceive because of their complexity. For example walking in rain does not inform you of the complex natural process of wind flow, temperature difference, evaporation and humidity required for rainfall to occur.
- Human systems change the environment suddenly and drastically; natural systems change its components gradually and moderately at a time. Building a dam takes a couple of years, and during construction it can bring about changes in structure and function of the river's entire ecosystem, which evolved over many centuries. The challenge for the designer is to recognize these differences in his design and planning strategies and overcome these differences by using flexible, regenerative, complex, and multifunctional qualities of natural systems.

## **6.0 Design process**

Suitability analysis, bioregionalism and a regenerative design approach are three important concepts, or design approaches, for perceiving landscape function and structure as a part of a design process that addresses differences between natural and human systems. These three concepts are useful in building a framework to guide the design process that strives to reconcile human systems and its environmental effects on natural systems.

### **6.1 Suitability analysis and Suitability models:**

Ian McHarg devised an approach for ecological design known as suitability analysis. It focuses on understanding life processes and using them as limitations or opportunities for allocating human uses on the landscape. “Planning that understands and properly values natural processes must start with the identification of the processes at work in nature. It must then determine the value of sub-processes to man, both in the parts and in the aggregate, and finally establish principles of development and non-development based on the tolerance and intolerance of the natural processes to various aspects of urbanization” (McHarg 1998, p-110). His method relies on different ecological, cultural, and social overlays to determine suitability of a land for particular uses like housing, industrial, agriculture, transportation, and others.

With the advent of GIS technology, large quantities of data can be analyzed easily and the results can be produced in a way that is easy to read and communicate. This method has become an important part of all the planning processes. However, many professionals have criticized that this design process examines only the structure of landscape and not necessarily its function, and that it fails to spur new and imaginative solutions that can address both ecological and cultural needs at the same time. Thus, suitability analysis should be supported with understanding of relationships between natural processes and cultural needs of that place.

## **6.2 Bioregionalism:**

The earth is composed of ecosystems, the borders of which are not represented by political demarcations, but follow nature's contours. Areas that are defined by natural boundaries have come to be called bioregions. These are distinguishable from other areas by particular attributes of flora, fauna, water, climate, soil, landform, and by human settlements and cultures (Reiniger (1996), p: 185). Landscape architect Clair Reiniger is one of the best-known proponents of the bioregional approach in planning and design. According to her, the bioregional approach lends itself to a bioregional resource inventory, which provides detailed analysis of various components of a bioregion. These components as well as their interrelationships comprise the structure of a bioregion, or its anatomy.

These physiological elements are dynamic; energy, water, and material flow through them, and give life to the system. It is an integrated approach to resource management as defined by the ecosystem's characteristics. What is new and revolutionary about the bioregional perspective is that all living systems (human, animal, water, plant, soil, and atmosphere) are viewed as one living dynamic system.

### **6.3 Regenerative design process:**

The regenerative design approach relies on understanding structure and function of a landscape much the same way as suitability analysis, but it also emphasizes six basic phases of ecosystem function: conversion, distribution, filtration, assimilation, storage, and, where human development occurs, human thoughts. These six basic processes of regeneration, discussed earlier, are keys to the sustenance of life and thus to sustainability.

One way of reducing human impacts on natural systems is by locating human systems in places where they are less detrimental to functions of natural systems. In this case suitability analysis helps us to find areas that are suitable for human activities and have fewer effects on functioning of natural systems. Bioregionalism comprehends the landscape as a whole that consists of many interdependent systems. Understanding this concept will help to draw relationships and interdependency between various human and natural systems, as well as helping to define effects of proposed changes in the structure of the natural systems. Regenerative designs will further help to improve function of human systems. Thus with sustainable design we are not looking at single focus solutions to single focus problems, such as drainage, sewage disposal, or erosion control, but rather at the management of a whole set of resources.

## 6.4 Framework for Designing

Harvard Professor Carl Steinitz devised a framework for ecological planning and design, which can be used to reconcile environmental impacts of human systems by using natural systems. This framework organizes six questions, each of which is related to a theory-driven model. These questions and the associated model are as follows (Johnson and Hill 2002, P/ 231).

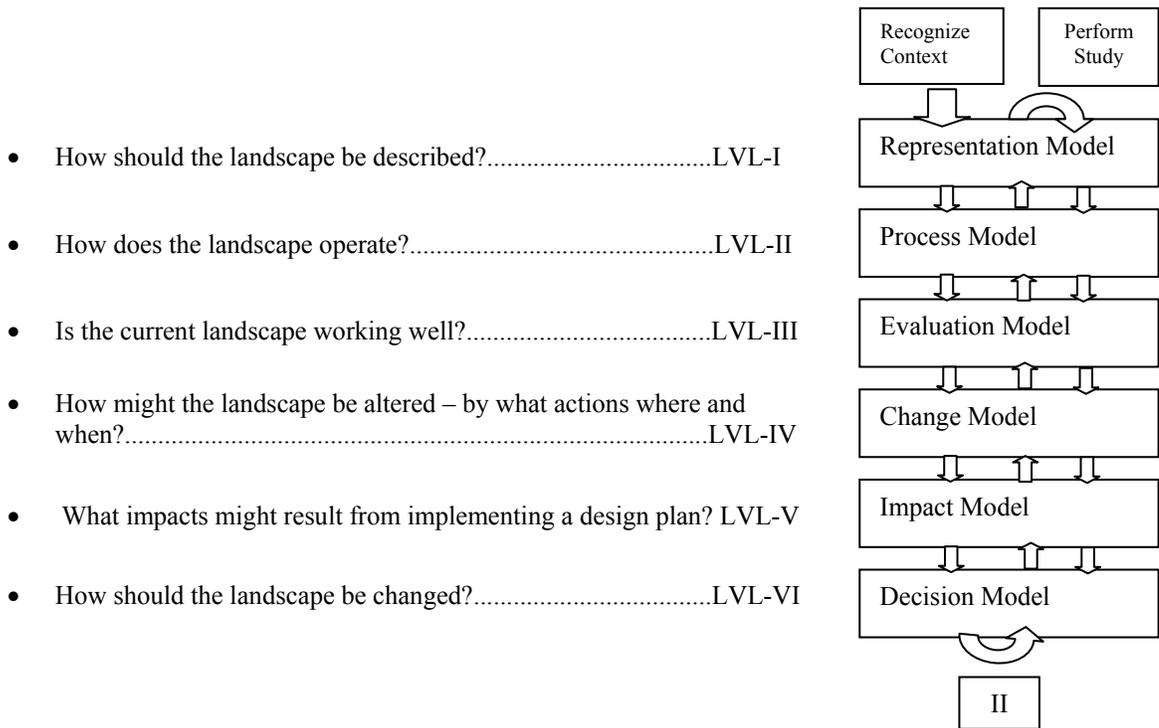


Fig 6- 1 Framework for Ecological Design

- I. How should the state of the landscape be described: in content, boundaries, space and time?

This level of inquiry expresses the structure of landscape. The *layer cake approach* of suitability analysis, performed with the help of GIS, and/or overlaying drawings and digital photographs, is useful in building *representation models* for this level.

- II. How does the landscape operate?

This level inspects the functional relationship between and within various structural elements of human and natural systems; how conversion, distribution, filtration, assimilation and storage are related to human thoughts or decisions about human systems. This level of inquiry shapes *process models*.

In other words, representation and process model can be developed with respect to the structure, function, and location of the landscape. Apart from that, “landscape’s history also plays an important role in understanding how the landscape works and historical contingency is a key factor in shaping landscapes” (Johnson and Hill 2002, p: 318). In urban landscapes, humans have substantially altered river flow regimes with dams, channelization, ditches and draining, urbanization, and other activities. Knowing how humans have modified natural processes and understanding their motivations in doing so is a key step in understanding current conditions as well as potential response to them.

Dale et al. (2000) presents five principles of ecology that are useful in decision-making processes are:

- Ecological processes occur within a temporal setting, and change over time is fundamental in analyzing the effects of land use.
- Individual species and networks of species have strong and far-reaching effects on ecological processes.
- Each site or region has a unique suite of organisms and abiotic conditions that influence and constrain ecological processes.

- Disturbances are important and ubiquitous ecological events whose effects may strongly influence population, community, and ecosystem dynamics in all places.
- The size, shape, and spatial relationship of habitat patches in the landscape affect the structure and function of ecosystem.

### III. Is the current landscape functioning well?

The metrics of judgment, health, beauty, cost nutrient flow or user satisfaction lead to *evaluation models*. In case of the evaluation model, questions related to beauty, health, and user satisfaction can be investigated with respect to livability and sense of place. Livability entails people's biological needs as well as number of other qualities that together make a landscape a good place to live. Similarly, a sense of place refers to the ways in which a landscape's unique character resonates with people. It may also refer to how the landscape reveals its natural history or cultural heritage (Johnson and Hill 2002, p: 323). Evaluating the landscape with respect to its livability and sense of place will help designers to overcome the common drawback of designs driven strictly by ecological needs: that they may become a problem solving exercise that uses various techniques of restoration and reconstruction as mere corrective measures without actually acknowledging the principal reason behind the problem. **Thus, it is important to understand how "landscape ecology and design can invent alternative forms of relationships between people, place, and cosmos so that landscape architectural projects become more about invention and programs than the merely corrective measures of restoration"** (James Corner 1996, p: 82)

IV. How might the landscape be altered?

Landscape change is the alteration of structure and function overtime through their interaction and mutual influences. The *evaluation model* helps to understand how alteration has occurred historically. By understanding current project trends and implement designs, such as plans, investments, regulations and construction one can predict how, where, and when might the landscape be changed. This level of inquiry leads to *Change model*.

V. What predictable effects might the change cause?

This level of inquiry tries to understand how a landscape may change or could be changed over time, and whether such changes are desirable. This needs prior understanding of the landscape is currently working to important ecological and cultural constraints and opportunities. “This includes considering (1) the landscape’s physical, biological, and cultural conditions and context from *evaluation model*; (2) trends that may drive change in particular direction, from *change model*. (3) imaginative ways to respond to these conditions, contexts, and trends to simultaneously foster social viability and ecological health” (Source of quote to be added). This shapes impact models

VI. How should the landscape be changed?

How is the comparative evaluation among the impacts of alternative changes to be made? This sixth level of enquiry leads to decision models. Ecological principles are most likely to affect land use decisions if they are framed to be relevant in the context of markets, policies, laws and politics (Hulse and Ribe 2000). For this purpose the *decision model* emphasizes on *collaborative approach* and “*precautionary principles, to guard against potential harm*” (Johnson and Hill 2002, p: 339), towards planning and design.

Principles of social ecology suggest that apart from all of the physical human systems, in the form of human interventions, the social and cultural systems are the ones responsible for the continued and healthy association between humans and nature: the cultural sustainability. The aesthetic concerns arising from social and cultural forces and understanding of natural systems determine the acceptance of our design as a part of day-to-day human life. Thus environmental issues can not and should not be treated independent of, social, racial, cultural, aesthetic and economic concerns.

## 7.0 Revealing natural systems

It is a fact that environmental “knowing” heightens the landscape experience; this is evident from millions of dollars spent each year by the National Park Service on interpretive facilities and programs (Thayer 1989, p: 106). Similarly, there is as much of a need to enhance the experience of, and interpret structure and function of everyday urban landscapes, as there is to interpret rare national park landscapes. Thus, it is no longer enough for landscapes to be merely “beautiful” and “functional”, but they should enhance visitor’s experience by encouraging interaction to interpret the underlying ecological processes.

However, the present concept of ecological design and its interpretation in this sense does not refer to information charts or written explanations, which people encounter at places like zoological gardens or arboretums. When ecological design incorporates “visibility” (Hough 1995, pp. 30-31) and “observability” (Thayer 1989, p. 108) it reveals ecological phenomena and processes and can be referred to as ecorevelatory design. So interpretation of ecological processes refers to the ability of the design to reveal those processes at work. This process of revealing can only be successful if the environments created are visible, observable, legible, and have the ability to raise curiosity in visitors to explore and understand the complexity of the landscape.

“Most of the time, natural systems themselves are not visible and readily engaging. What are visible are the surface manifestations and the material conclusions of these natural systems, for example layers of rocks are not ecological process, but the result of it” (Nassauer 1992, p.244). Thus the most important challenge for designers is to recognize which ecological processes can actually be made visible and how they can interpret these dynamic processes or their material conclusions to form and inform landscapes.

Generally, “ecological designs blend with their contexts and results in a diffuse visual pattern” (Lyle: 1994, p.284). Consequently, this perceptual subtlety can make ecological landscapes difficult for inhabitants to recognize and care about. Ecorevelatory designs must strive to make those ecological considerations perceivably a “visible part of landscape experience”. One way to achieve this is by exploiting the power of contrast, particularly the contrast between cultural and ecological domains. Ecological design has tended to diffuse edges to provide transition. At West Davis Pond in Davis, California, the diffusion is seen in the “native landscape” between the housing and the wildlife pond. “These types of transitional spaces are not convincing. They are neither visually appealing nor ecologically valuable. Instead, **emphasizing contrast between ecological and cultural domains** achieves boundlessness and reinforces their limits. It engages rather than repudiates the cultural milieu in which most ecol-revelatory designs take place” (Mozingo: 1997, p.51, 52). One way to emphasize this contrast is by revealing the history of the landscape. The urban landscape, being influenced by cultural changes, undergoes structural and functional changes. These changes are what make the urban landscapes different from others. Designers should recognize and incorporate these changes along with historical and cultural significance of the landscape.

In cities are where most people live. Every human directly or indirectly contributes towards enriching as well as degrading the quality and experience of cities. In order to create a successful ecological design it is important to recognize and **interpret the historic and cultural significance of the landscape**. In other words, “eco-revelatory design expands by hitching human habitat and their inevitable cultural determinants in to an environmentally inclusive vision”(Mozingo: 1997, p.51, 52).

This concept was most powerfully presented in Richard Haag’s Gas Plant Park project in Seattle. “The project is a celebration of the history of the site as an industrial landscape, while it is unquestionably settled in its immediate use and configuration. This landscape is seminal in its acceptance of the site history and metaphorical interpretation of its historical artifacts”(Howett 1987, p. 9). Without its historical references, obliterated in

the usual fashion of park making, it would not convey the powerful meaning that reminds people of their accomplishments and achievements to overcome natural forces and their failure to be in harmony with nature.

In short, the design should transcend a purely visual dimension to become a holistic psychological space. Beyond rehabilitating ecological problems, it should become a place for visitors to experience that stirs the mind, spirit and human senses. This is more relevant in urban places, where overlapping of human and natural systems is prevalent. As discussed in the next section, the City of Roanoke, along the Roanoke River, is such a place with a complex overlapping of human and natural systems.

## 8.0 Design Project

The design project is a medium for testing the design position. It uses Steinitz's framework for design along with the ideas of eco-revelatory design, explained in section 7.0. The City of Roanoke located at the foot hills of Blue Ridge Mountains along the Roanoke River is a major industrial and commercial center for South-West Virginia. The project site is part of the South Jefferson Redevelopment Area, located in the Southern part of the city along the Roanoke River and at the foothills of Mill Mountain.

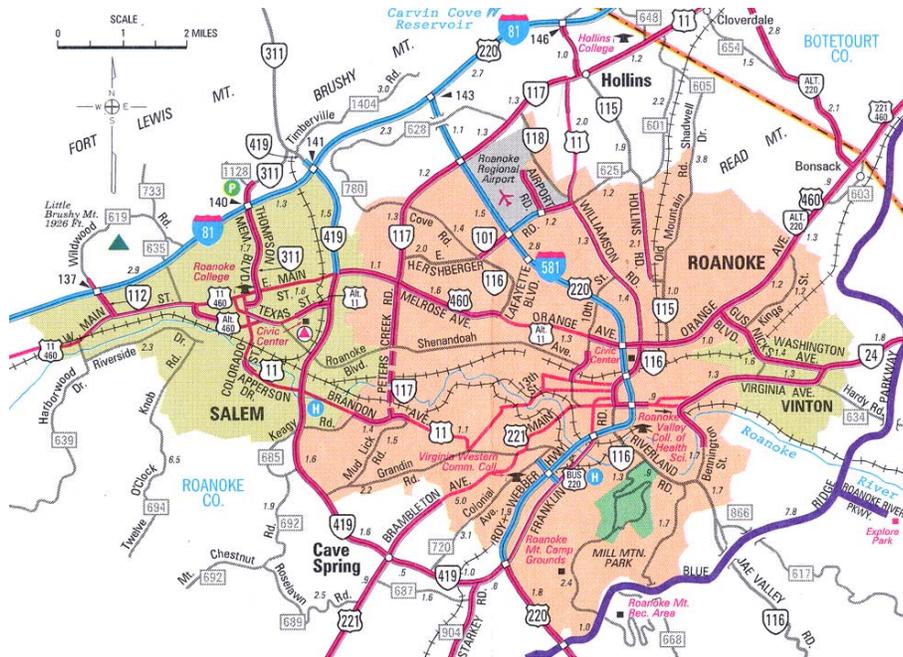


Fig 8- 1 City of Roanoke (source: 1998, Commonwealth of Virginia)

The Roanoke Redevelopment and Housing Authority (“RRHA”) and the City of Roanoke are working together to prepare a redevelopment plan for this area. The initial study determined that the proposed redevelopment area contains blighted areas which by reason of dilapidation, obsolescence, faulty arrangement of design, deleterious land use or obsolete layout is detrimental to the safety, health, morals or welfare of the residents of the City as well as conditions which impair economic values and tax revenues and which prevent proper development of the land in the project area.

## 8.1 Aims and Objectives:



Fig 8-2 Relationship of the project site with the downtown Roanoke

The proposed land use and redevelopment plan suggests that Carilion, Virginia Tech and the University of Virginia have jointly planned a biomedical facility (BMC) in this area. The proposed design guidelines suggests that city is interested in developing this area as a center for health care related facilities and as an extension of the downtown towards south of Roanoke. Jefferson Street is a major link between the downtown and the

redevelopment area. The redevelopment area can also act as a transition area between Mill Mountain and Downtown area. It also provides an exciting and only opportunity to create a meaningful relationship between the City of Roanoke and the Roanoke River. Mill Mountain and various sports and recreational facilities in and around the redevelopment area can further assist the proposed bio medical center. The Roanoke Redevelopment and Housing Authority (RRHA) has surveyed and analyzed this area in terms of: Economic development, Flooding, Environmental Hazards, Structural Conditions, and Other Conditions. They have come up with a list of goals for this area as follows:

- Eliminate blight, blighting influences, deterioration and deleterious land use through redevelopment and clearance, rehabilitation and relocation assistance.
- Improve business activity and generate additional economic value for the City of Roanoke through redevelopment of land for biotechnology and related uses.
- Make best use of the area's location and urban character to provide for an orderly development framework.
- Provide for a versatile mix of complimentary land uses within the Redevelopment Area.

The proposed goals, objectives, and development guidelines fail to address how the development should be done on this difficult site which lays in floodplain and has deleterious land uses.

The aim of this project is to investigate steinitz's framework for ecological design along with principles of eco-revelatory design and propose a design that can reconcile human systems and associated environmental effects so as to meet the changing cultural and ecological needs of the south Jefferson Redevelopment Area. The design process and the design can also be used as a model for other redevelopment projects along the river course.

The objectives of this project are:

- To understand the natural and social processes that formed and changed the landscape of the site and the region over the period of time.
- To identify effects of human systems on the natural ones at the site scale as well as the city scale.
- To identify ecological and cultural issues that are important for making decisions on micro level, the site, and macro level, the city and region.
- To derive a design that addresses needs of the redevelopment plan as well as responds to the issues identified from the inventory and analysis.

## **8.2 The design Process**

The project will analyze the structural relationship between the City of Roanoke and the Roanoke River to form a representation model. This will be done by understanding components of natural and human systems: soils, vegetation, hydrology, topography, climate, city zoning, transportation, and sewage and storm water management. It will also evaluate how its relationship between the city and the river has changed with the development of the city.

The process model will try to understand various natural processes on the site, the functional relationship between the river and the city, and how that relationship affects the riverine system. This will lead to an understanding of current ecological as well as cultural issues, problems, and needs with respect to livability and sense of place, forming an evaluation model. Based on this understanding, a change model will evaluate possible opportunities for landscape interventions on the site. An Impact model will put forth possible effects of such interventions on the structure and function of the river. Based on the change model and impact model various alternatives will be designed and compared in Decision model.

## 8.3 How should the landscape be described?---- Representation Model.

### 8.3.1 Topography:

Roanoke valley is a part of Blue Ridge province which is a land form of the Appalachian Region. Blue Ridge is composed of folded metamorphic rocks, that is, rocks hardened from the heat and pressure of mountain building, and strongly linear mountain forms.

The city lies at the foot hills of Blue Ridge Mountains and it is surrounded by Poor, Brushy, Coyner and Fort Lewis Mountains on the other sides.

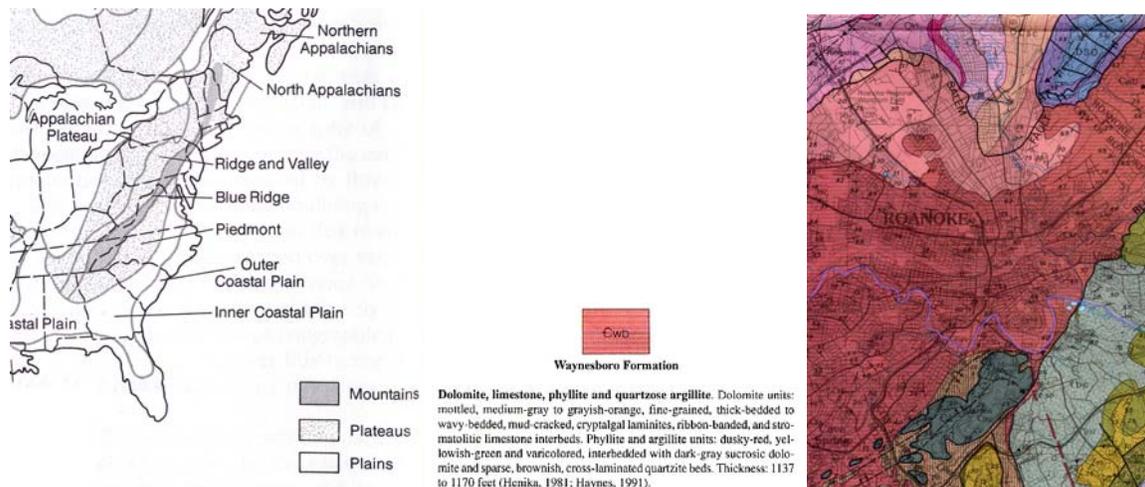


Fig 8- 3 (a) Physiographic regions: location of Blue Ridge Mountains (Source: William Marsh 1998, Landscape Planning Environmental Applications), (b) Geological map of Roanoke

The portion of the city in which the project site lays consists of sandstone, a type of sedimentary rock. It is composed of dolomite, limestone, phyllite and quartzose argillite. The presence of limestone, dolomite and possibility of fluvial processes indicates presence of karst landform in some parts of the site.

### 8.3.2 Climate:

Because of its higher elevations, climate over much of the Blue Ridge province is distinctly wetter and cooler than lands to the east and West.

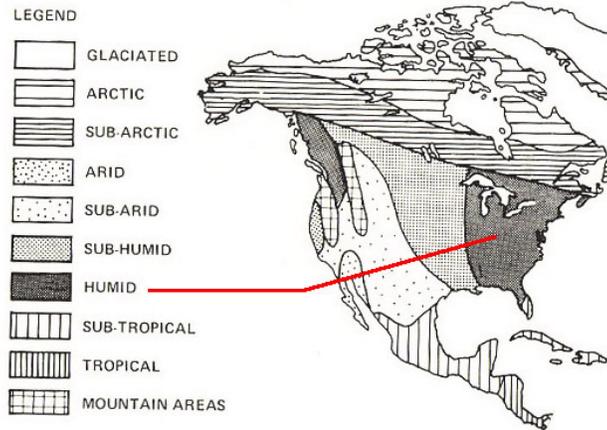


Fig 8- 4 Basic Climatic Zones in North America (Marsh, 1983 Landscape Planning: Environmental Applications, Page no: 42)

Ground Elevation	1149 Feet
Annual Average Temperature	56.3°F
Maximum Average Temperature	66.9°F
Minimum Average Temperature	45.6°F
Monthly Average Rainfall	3.41"
Annual Average Rainfall	40.87"
Annual Average Snowfall	22.8"
July: Maximum Average Temperature	86.4°F
July: Minimum Average Temperature	64.8°F
January: Maximum Average Temperature	43.8°F
January: Minimum Average Temperature	25.0°F
Growing Season Average	190 Days (April 15 - October 22)

Fig 8- 5 Basic Climatic information of the Roanoke City (Source: <http://www.roanokegov.com>)

### 8.3.3 Soils:

Because of the high elevations and humid climate in the Blue Ridge region residual soil tends to be very shallow along the ridge line but thicker at the lower elevations owing to the accumulation of colluvium.

However, Roanoke city is a part of Roanoke valley, which has an elevation of 1149 Feet. It lies in the flood plains of Roanoke River and many other smaller streams and creeks. The local topography, the location of the site on the opposite side of the river at the bottom of Mill Mountain, and references to the land as “fertile black soil” and “very rich swamp” by early settlers suggest that the site should be composed of alluvial deposits more than colluvial deposits.

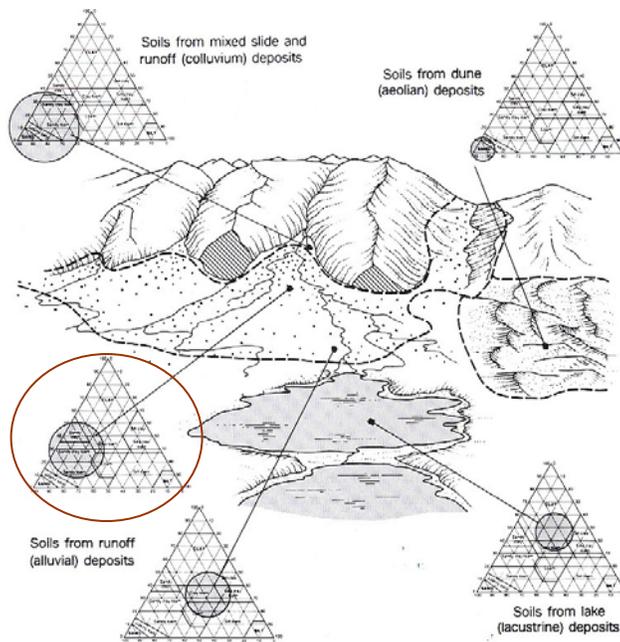


Fig 8- 6 Relationships between soils and landforms in mountainous terrain (Marsh, 1983 Landscape Planning: Environmental Applications, Page no:42)

### 8.3.4 Drainage:

Blue Ridge forms the principal drainage divide of the Appalachian region, marking eastern rim of the Mississippi Basin. Roanoke River displays a dentric pattern of medium texture, humid climate, with angularity reflecting jointing control.

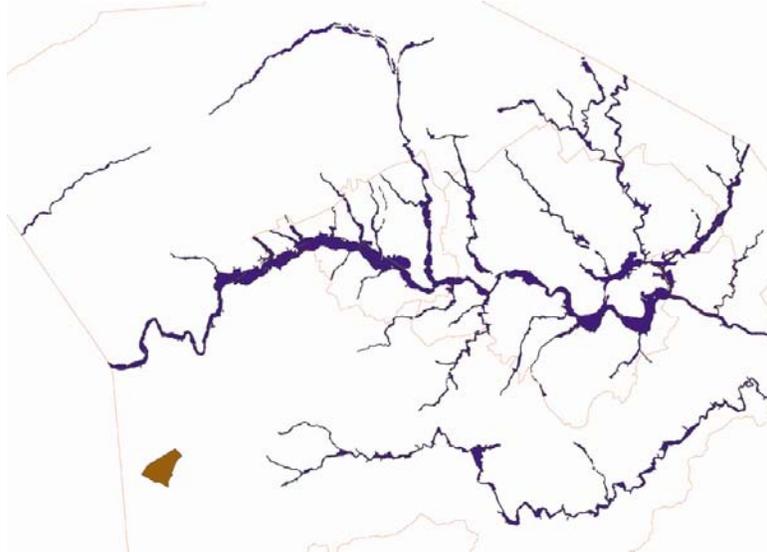


Fig 8- 7: County wide drainage and flood pattern



Fig 8- 8: Figure: Dentric pattern of Roanoke River.  
(<http://www.roanokegov.com>)

### 8.3.5 Patches and Corridors:

The principle bio-geographical expression of stream system is the habitat corridor. In many respects stream habitat corridors functions as a biological right of way through a watershed, providing linkage and continuity among plant and animal communities. Because they are narrow and continuous over great distances, corridors are prone to breaching from land use systems, which results in fragmentation and reduced biodiversity. The true impact of breach depends upon relative permeability a barrier such as a highway or a bridge poses to plant and animal populations (Marsh, 1998, p/262).

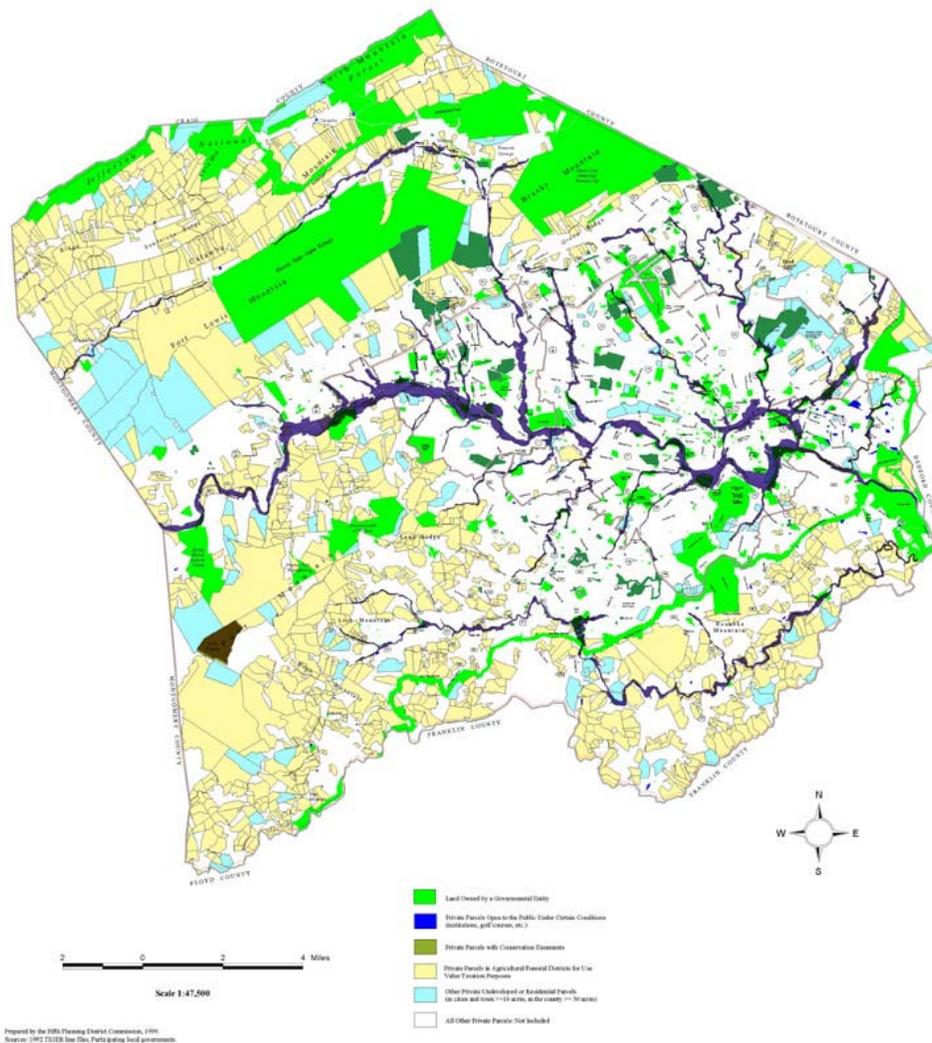


Fig 8- 9: Roanoke Valley Open Space Study

The above map clearly indicates that Roanoke River, its tributaries, and the riparian zone along them acts as a strong link between Blue Ridge Mountains and Catawaba Mountains for habitat movement and various ecological processes.

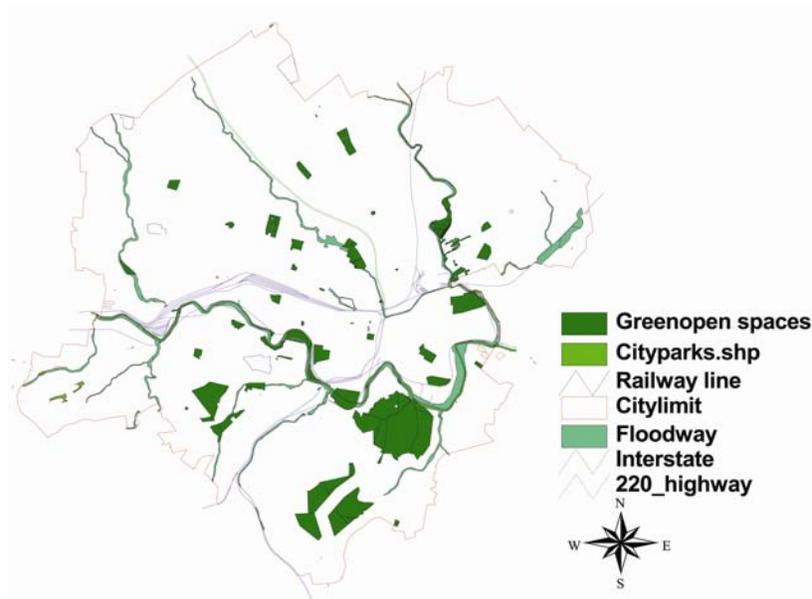


Fig 8- 10: Patches and corridors at city scale

At the city level it can be seen that the green spaces are not consolidated; they are fragmented by transportation corridors. Ironically these transportation corridors like railway lines and, US-220, and 581 forms the backbone of the industrial and commercial development of the city and brings all the living comfort and development of the city at first place.

### 8.3.6 Land use:

In general the valley is cultivated and the forms of its irregular fields are controlled by the dissection of the drainage system.

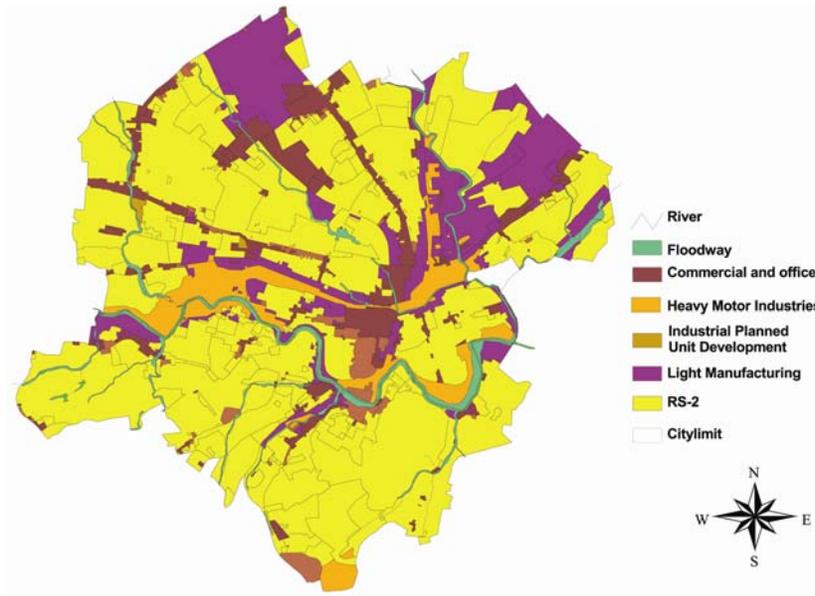


Fig 8- 11:Land use map

Land use map of the city clearly shows that the commercial and industrial development has occupied most of the riverfront and stream sides cutting rest of the city from accessing and enjoying the river. Such land use has created its own environmental bearings as discussed in the chapter: 8.5, evaluation model.

### 8.3.7 Cultural development & the changing landscape of the City

This section is a journey through the history of Roanoke that will explain how the city was evolved and prospered; and how this development changed the landscape the city and the project site over the period of last three decades.

#### 1500-----

It was around 1585 that first English landed and establish a colony. Some of the early explorers when arrived in Totera Town they described it as a “Very rich swamp,” the explorers had reached what is believed to be southeast Roanoke City, near the present industrial Park. An exploration party's report in 1671 told of the "blue mountains and a snug flat valley beside the upper Roanoke River." For the next seventy years, after this initial exploration, the region remained undisturbed by settlers (Bruce, 1976, P/7).

#### 1700-----

By 1700s, the valley was settled by European immigrants, most of whom were hardy Germans, Swiss or Scotch-Irish who entered the valley from the north and few Virginians who managed to slip between mountains to enter from east. (Bruce, 1976, P/7)



Fig 8- 12: (a) Golden wheat farm: typical of Roanoke Valley farms (Courtesy Roanoke Valley Chamber of Commerce) (b) Daniel Evans Mill (Courtesy Roanoke City Public Library)

Valley's new residents prospered and increased. It seemed there was nothing that would not grow in the fertile black soil. Indian maize, wheat, oats, barley, rye, potatoes, squash, beans, melons, tobacco, cotton flax--- all were harvested here. Hemp, today commonly known as marijuana, was the most successful. In 1770, the local hemp crop totaled 178 tones, almost all of which was exported east to the port cities where it brought the highest prize. (Bruce, 1976, P/9)

In 1750s Daniel Evans Mill built a mill by the waters of crystal springs. The Mill Mountain was named after this mill. George Washington visited here while on an inspection tour of fortification on western frontier in 1763. The mill had become a favorite spot to which young Roanokers hiked on Sunday afternoon (Bruce, 1976, P/10). By eighteenth and most of the nineteenth century, water power was most important source of energy, when it was gradually replaced by steam. In the Roanoke valley especially, there was plenty of water to be put to use since the area abounded in springs and streams. (Bruce, 1976, P/27)



Fig 8- 13: South Roanoke before industrial development Notes on the back of the photo describe the two roads running lengthwise through the middle of the photograph as Wellington Avenue, now Jefferson Street (top) and Crystal Spring. The notes describe the white, (Courtesy [www.roanokegov.org](http://www.roanokegov.org))

## **1800-----**

By 1830s, Big Lick was a settlement of note, and by 1835 it had grown to sufficient size to be chartered as town (Bruce, 1976, P/13). The Roanoke County was formed in 1838 (Bruce, 1976, P/31).

At this time, farming and allied businesses were the main activities in the valley and especially in the South Roanoke area.

**Stage lines** were the only means of transportation during the first half of nineteenth century. Eastern Virginia merchants complained that it was the longest and costliest continuous stage trip in the country. For these reasons Lynchburg businessmen advocated building of railroad Lynchburg westward. Finally, in 1848, the Lynchburg and Tennessee Railroad Company was incorporated, and by 1851 track was nearing Big Lick. **In 1852, the first train rolled in to the little town of Big Lick, chosen over Gainsborough because it was topographically more favorable for road building** (Bruce, 1976, P/31). By 1881 Big Lick became major railroad junction.



Fig 8- 14: (a) Looking at east across south Jefferson street on Campbell avenue, this photograph gives an idea of the task involved in laying the streetcar tracks through the heart of the town in 1926 (courtesy Roanoke Valley Chamber of commerce) (b) Jefferson st. (Roanoke Valley Historic Society)

At the close of Civil War in 1865, the Virginia and Tennessee struggled to continue operations with the stock and capital it had left. Roanoke County was luckier than many of her neighbors in that the war had not wreaked the widespread devastation within her borders, and the period of reconstruction was aided considerably by the northern capital. The V & T Railroad merged with two other small lines in 1870 to form the Atlantic, Mississippi and Ohio (Bruce, 1976, P/49). Subsequently, in 1881, the A, M & O was sold to a Philadelphia group and its name changed to Norfolk and Western Railroad (Bruce, 1976, P/43).

The completion of the Shenandoah Valley Railroad from Hagerstown, Maryland, to its junction with the newly formed Norfolk & Western Railroad in 1882, marked the start of Roanoke's rapid growth. The adjacent town of Vinton was also incorporated at this time (<http://www.roanokegov.org>).

In 1882 the town was finally named as Roanoke. Roanoke was derived from the Indian word "Rawrenock," a name for the shell beads worn by the Indians and used as trade goods. And in 1884 it was elevated to the status of the City. **In 1882, Roanoke became a crossroads for the railroad**, which eventually became the Norfolk and Western Railway. This marked the start of the town's rapid growth. The railroad attracted many industrial and commercial developments and subsequently increase population, leading to its chartered as the City of Roanoke in 1884. Its historic market, which also began in these early years, remains vibrant as one of the oldest in the country and still is an anchor of downtown commerce.



Fig 8- 15: View of the cross roads (Courtesy: B. T. Fitzpatrick, III)

The Roanoke Gas Company formed in 1883, after the Roanoke Water Company formed in 1882. The two non governmental companies were later merged to create the Roanoke

Gas & Water Company, an organization which, with the exception of the N & W, probably did more to aid the young cities development than any other.

Mill Mountain Incline, Inc. was chartered and two years later the Incline Railway was operational. Passengers paid fifty cents to reach summit. This cleft in the mountain is visible yet today and is dotted by a series of power lines and poles.

### **Roanoke developed as a major transportation hub for south-west Virginia.**

**1900-----**

Around 1960s, a new trend among merchants across country arrived in Roanoke with the construction of crossroad mall at the intersection of Hershberger and Airport Roads. Having proven it self successful, the shopping center idea spread to other areas of the city and soon there was a shopping center within reach of ever city subdivision and most county areas. As a result merchants in downtown Roanoke began to suffer from lack of buyers. Though the outcome should have been foreseen, apparently it came as surprise to many, that the merchants would be forced out of the heart of the city. This trend was nationwide decaying inner city across the country.

In Roanoke, much of the decay was swept away with the aid of Downtown East, an urban renewal project, and the Roanoke Redevelopment and Housing Authority's clearance of vast slum areas, especially in the old Kimball section of Northeast. Today the same Redevelopment and housing Authority is involved in the revitalization of South Jefferson Redevelopment Area.

Also the entrance of Interstate Spur 581 provided by-pass around the Central Area for through traffic as well as furnished improved access to downtown from all parts of the city and adjoining communities.

### 8.3.8 South Jefferson Redevelopment Area

The South Jefferson Redevelopment Area lies in the South Roanoke at the foot hills of the Mill Mountain, in the flood plains of Roanoke River. Sediments and deposits from floods formed a very rich and productive soil which earlier settlers described “Very Rich Swamp” (Bruce, 1976, P/7). Therefore, at the turn of the previous century, it was developed as a rural farmland.

The **proximity of the land to the street car service and bottom land, which required no surfacing** for larger events, encouraged the city to develop fair ground. Here the great **Roanoke Fair** became an annual event until the coming of the Virginia Railroad around 1905-06. Accordingly the Fair Ground was moved farther south towards the river. A frame grand stand was built, roofed over with some seats upfront set aside in boxes. The grand stand faces the race track where Hamiltonian races were held. Underneath the grand stand was an **exhibition hall** (Barns 1968, P: 627).

For decades the Fair was an annual event, opening as a rule on Labor Day, or at least during the first week in September. By this time farmers had enough harvest to compete for prizes. Bulls, cows, sheep, corn, apples and other agricultural products were exhibited. The ladies had a chance to compete for prizes in embroidery, sewing, quilt making, knitted goods, cake baking and other pursuits usually found in a woman’s domain. Invariably one day was set aside as “free entrance to school children.” Freak shows, skin games, gambling affairs on a small scale, snake charmers, palm readers and knife throwers all went to make the “midway” (Barns 1968, P: 753).

In 1922 the white Corporation sold 26 acres of the fair Grounds to the Andover Investment Company, which in turn, on October 20th, 1923 sold to the Norfolk and western railway for use as an athletic field (beginning of Maher Field by N&W), at a price of \$150,000 (Barns 1968, P: 787).



Fig 8- 16: (a) Map of the redevelopment area around 1920s (Courtesy: Sanborn Map Company), (b) Aerial view of the Redevelopment area around 1920s: Hamilton race track in the front and the round house behind it (Courtesy B. T. Fitzpatrick, III)

Whether more time was permitted during depression or for other reasons, Roanoke began to take more interest in gardening and some took pride in really beautiful flowers gardens. Maher Field was leased may 20th as \$ 5000 a year provided city would improve the property (Barns 1968, P: 791).

September 26th the N. & W. offered Maher Field to the City as a site for the stadium and an armory. The city accepted the gift with gratitude (Barns 1968, P: 806).



Fig 8- 17: Victory Stadium with the round house in the back (<http://www.roanokegov.org>)

The area meanwhile attracted most of the commercial, industrial and transportation related businesses. Today Commercial services include retail, service, general commercial and wholesale comprises 30.3 acres or 27.4 percent of the total land area.



Fig 8- 18: Looking at existing commercial and industrial on the proposed biomedical site

The industrial classification includes warehousing (storage) and distribution which comprise 21.7 acres or 19.6 percent of the total land area. Warehousing and distribution uses include scrap iron, transfer and storage operations, construction materials and grain operations.



Fig 8- 19: warehousing and distribution industry at the railway crossing

Largest land use category is Transportation, comprised of public right of way (Streets and alleys), 21.4 acres and Norfolk Southern railway property, 16.2 acres. Later includes some properties leased to private enterprise (estimated 2.0 acres).

Today South Roanoke is also headquarters of Carilion Health System, the region's primary health care provider. Roanoke Memorial Hospital and numerous related support facilities including a Ronald McDonald House can be found along its northern-most edge toward downtown. (<http://www1.roanoke.com/destination/relocation/community>)

This area has a major biomedical facility been jointly planned by Carilion, Virginia Tech and the University of Virginia

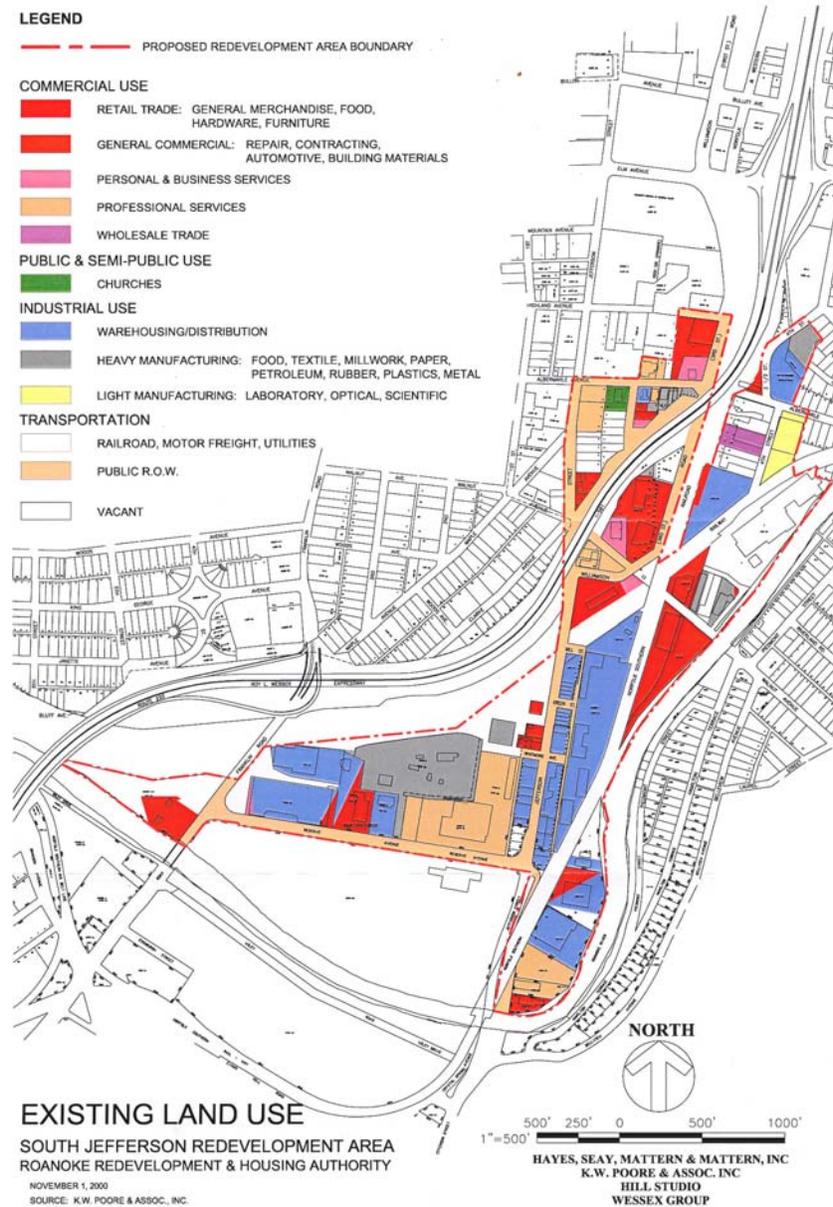


Fig 8- 20: Existing land use map (Redevelopment plan for the South Jefferson Redevelopment Area, Roanoke Redevelopment and Housing Authority, January 5, 2001)

## 8.4 How Does the Landscape Operate? --- Process Model

This section will try to understand the natural processes like natural water cycle and hydraulic behavior of the river; and how they interact with the human development and various human systems on the site.

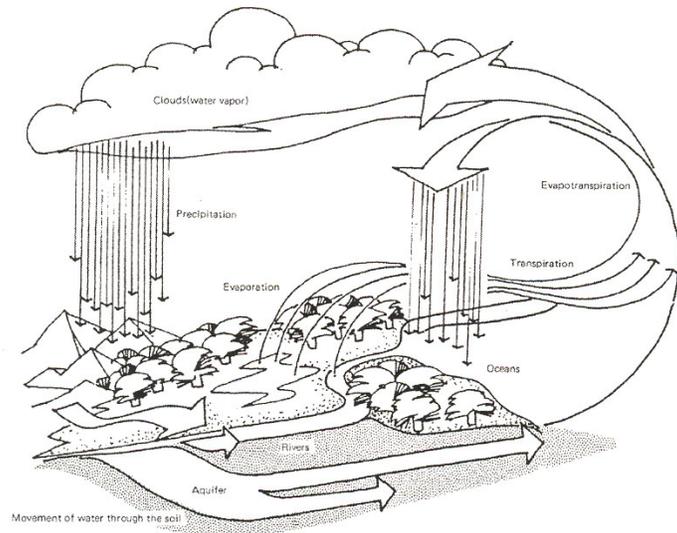


Fig 8- 21: Natural water cycle

### 8.4.1: Urbanization and storwater runoff:

The above diagram indicates the natural water cycle, where rainwater after precipitation undergoes infiltration, evaporation, interception and transpiration. The volume of storwater runoff depends on type of soil, soil cover, vegetation and topography. The two most dominating geographic changes in the Roanoke Valley are clearing of land for establishment of farms, and increase in impervious surface due to development of settlements, industries and vast transportation infrastructure. Almost invariably, this has led to an increase in both the amount and rate of overland flow, producing larger and more frequent flows in streams. With the massive urbanization of Roanoke valley in the twentieth century has led to increased flooding and flood hazard, along with damage to aquatic environments. Hundred year flood level is typically reached once in hundred years, however, Roanoke has experienced such flood levels at least 4 times in last 100 years along with number of other significant floods.

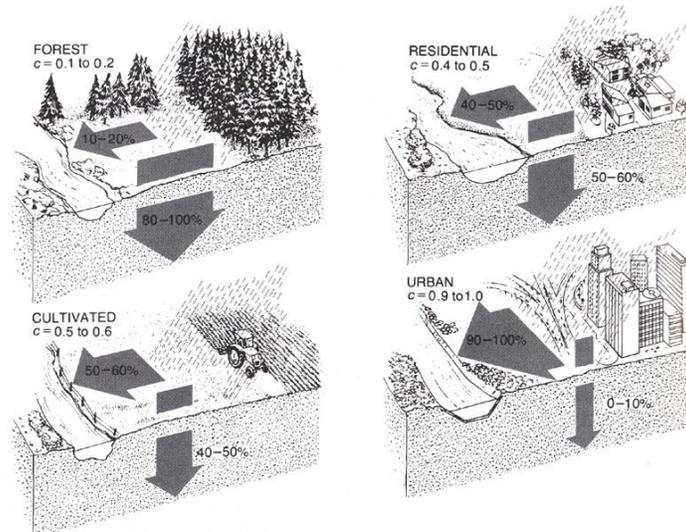


Fig 8- 22: Change in coefficient of runoff with land use and land cover (Courtesy William Marsh 1998, Landscape Planning Environmental Applications)

From hydrologic standpoint, the source of problem can be narrowed down to changes in two parameters: (1) the drastic increase in the coefficient of runoff in response to land clearing, deforestation and addition of impervious materials to the landscape and (2) the corresponding decrease in the concentration time. With urbanization ditches are replaced with storm sewers small streams are piped underground and gutters are added to streets, all of which may reduce concentration times by more than tenfold. Together these changes produce significant increase in the magnitude and frequency of peak discharges in receiving streams and rivers.

#### 8.4.2: Effect of human intervention on the topography

As seen in the representation model the natural topography of this area consist of karst formation with sink holes and depressions. These sink holes would act as additional storage space for water during a storm event thereby reducing the amount and rate of overland flow. In Roanoke, constant human interventions in the flood plains resulted in filling of such porous topography. This in turn reduced the additional storage space available to accommodate the stormwater and also the ground water recharge.

### 8.4.3: Hydraulic behavior

Hydraulic behavior, river channel form, meanders, and related processes will help to understand how these processes shape the landscape along it.

**Velocity distribution:** within a stream channel the velocity is lowest near the bottom and the sides of the channel and highest near the top in the middle. The highest velocity is generally slightly below the surface because of friction between water and the overlying air. At channel bends, faster moving water responds more to centrifugal force than slower water does and sides towards the outside of the bend. In addition this may also produce superelevation of the stream, in which the water surface near the outside of the bend is higher than the water surface near the inside (Marsh 1998, P: 245).

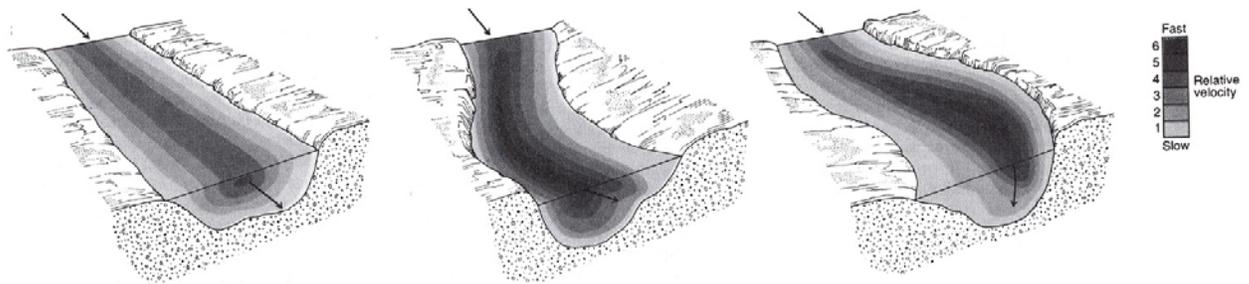


Fig 8- 23: The distribution of stream flow velocity in three different channel forms (Courtesy: William Marsh 1998, Landscape Planning Environmental Applications)

### River channel form, meanders, and related processes.

The Roanoke River demonstrates a single threaded channel, which is confined to one conduit. This channel form is relatively stable and characterized by one or two steep banks held in place by bedrock, soil materials and plant roots. The main axis of the channel is marked by the *thalweg*. Most single thread channels are sinuous or curving, within which the *thalweg* swings from the middle channel to the one bank then the other. Many are conditionally stable or metastable. This means they owe their stability to a few key factors, such as the bank vegetation and the loss of which can cause the channel form to break down and become braided (Marsh, 1998, p/250, 251).

**Management implications:** understanding the dynamics of meanders is essential to managing the channel environment, including facility planning and maintenance, habitat restoration and sediment control. Where pools and riffles occur, we often find successive riffles favoring opposite side of the river hence, as shown in the figure: 8.27 (b), there are two sets of riffle-pool sequences in a full meander (Marsh, 1998, p/252).

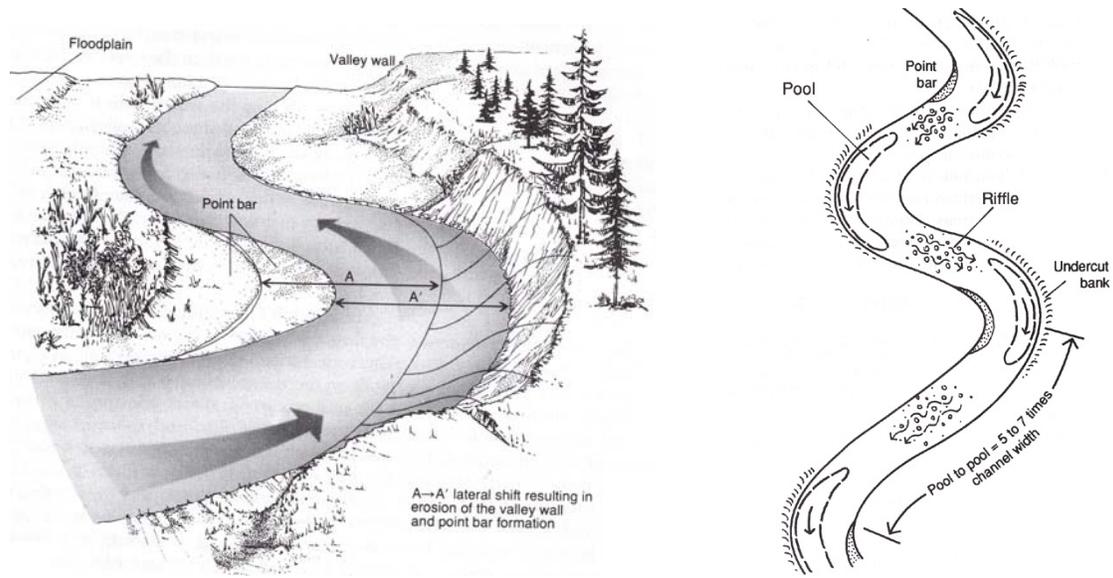


Fig 8- 24: (a) Schematic diagram showing the lateral migration of a stream in a meander bend, (b) Pattern of riffles, pools and related features in a typical meandering channel (Courtesy: William Marsh 1998, Landscape Planning Environmental Applications)

**Meander development:** active meanders in most streams are continuously changing with lateral channel erosion and deposition. Erosion is concentrated on the outside of the bends and slightly downstream from them where it cuts back the bank, forming an undercut bank. Deposition occurs on the insides of bends, forming features called *point bars*. Each year or so a new increment is added to the point bar, while the river erodes away the comparable amounts on the opposite side of the bank. In this way river shifts, gradually changing its location in the valley (Marsh, 1998, p/252).

**Levees, backswamps, and terraces:** Natural levees score channels, backswamps and terraces are common flood plain features. Levees are mounds of sediment deposited along the river bank by flood waters. They occur on the bank because this is where flow velocity declines sharply as the water leaves the channel, which causes it to drop part of its sediment load. In the low areas behind levees, water may pond for long period

forming backswamps. Score channels are small channels etched in to flood plain by flood waters. They often form across the neck of a meander loop and carry flow only when flood waters are available. Terraces are elevated parts of the flood plain that form when river down cuts and begins to establish a new flood plain elevation (Marsh, 1998, p/255).

By understanding the natural processes described above one can portray the predevelopment condition or natural condition of the site as shown in the following diagram.

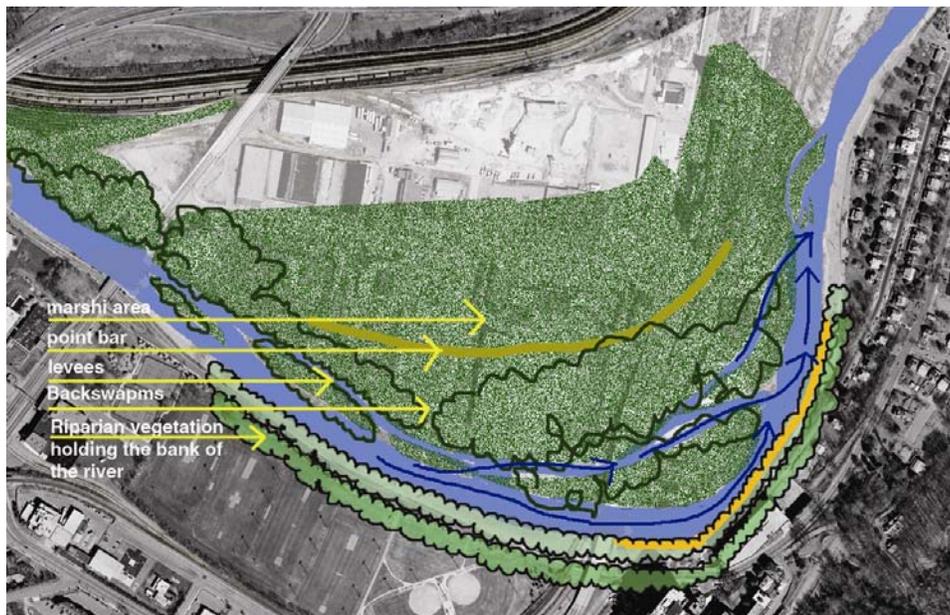


Fig 8- 25: A possible picture of the site as it would be seen before human interventions

### **Effects of human systems on the hydraulic behavior of the river channel:**

The south Jefferson area as explained in the section 1.2 underwent a transformation from a very rich swamp, before 1700s, to a festival park in 1890s and then Maher field in 1906 and then victory stadium and other industrial establishments in 1945. Meanwhile Norfolk southern developed a railway infrastructure and the city developed an intricate network of roads throughout the flood plain along the Roanoke River. On the redevelopment site, where the biomedical center has been proposed, Norfolk Southern developed an extensive network of railroad and a round house in 1906. Such construction activity required filling of low land area to keep the round house and rail rods above the flood

level. The constructions of South Jefferson Bridge and Winston – Salem Railway Bridge across the river have a major impact on the flood water dispersion within the site. The foundation walls of the railroad bridge, and the Jefferson Street Bridge creates a bottle neck for the flood water to pass through. Similarly, bridge abutments of the Franklin Bridge prevent the water from spreading further upstream. This results in forcing water to spread between Franklin Bridge and South Jefferson Bridge.

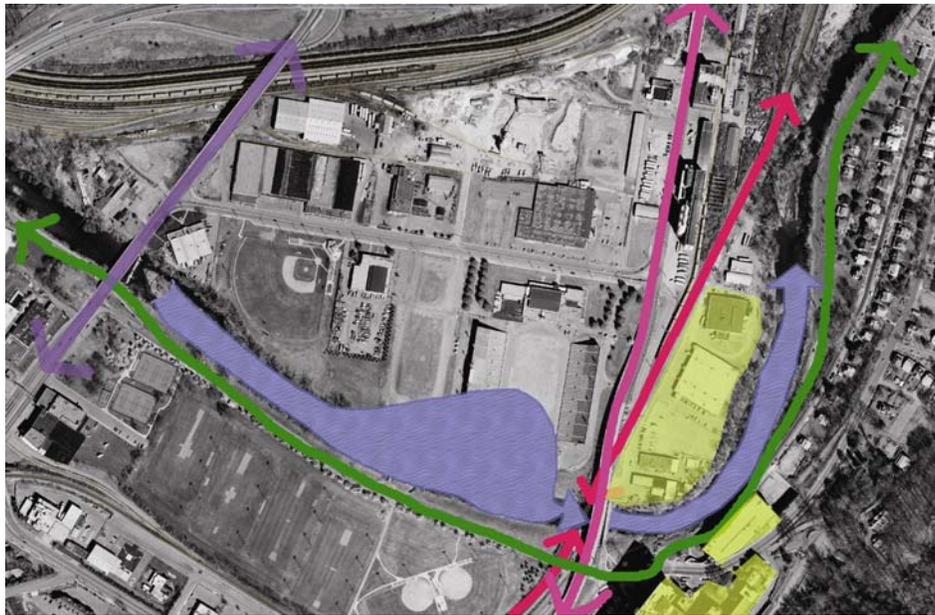


Fig 8- 26: effect of human systems on the hydraulic behavior of the river channel

The construction of Winston Salem Mainline with the railroad elevated from the ground developed a major obstruction for the flood water to flow back in to the river, except when it flows over the railway lines. The roads like Reserve Avenue and Jefferson Street further connect all the low lying spots within the redevelopment area thus assisting flood water to move across the site and filling all the low lying areas within the redevelopment area.

Figures 8.29, 8.30, and 8.31 show how human interventions, in this case bridges and railway lines, influence natural systems, in this case river flow and flood pattern

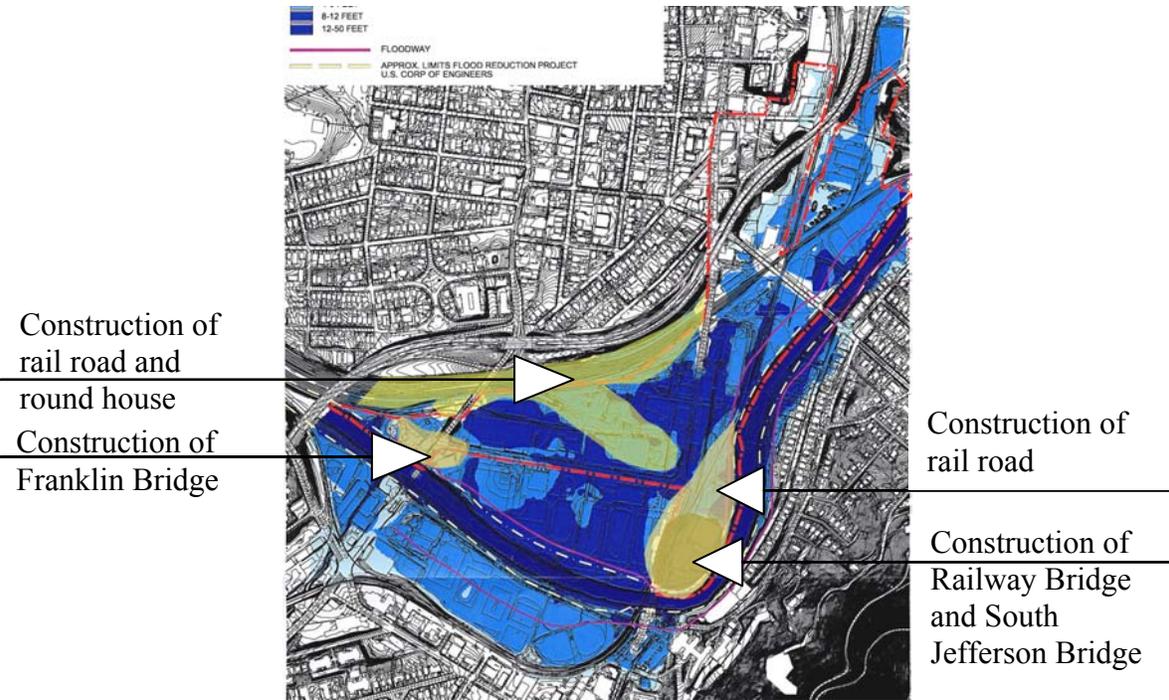


Fig 8- 27: Effect of human development on the landform

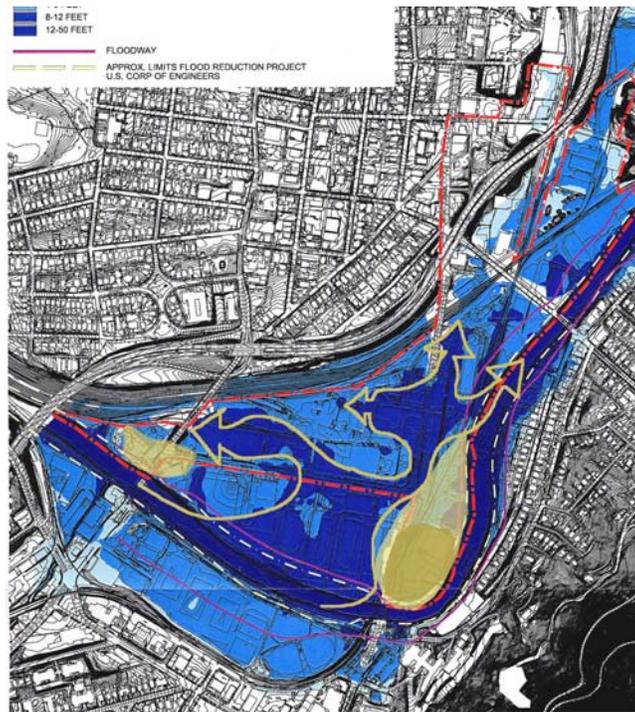


Fig 8- 28: Resulting movement of flood water

#### 8.4.4: Import and export of sediments and contaminants

Flood water brings with it large amount of sediments and contaminants. As the flood water raises these sediments and contaminants are deposited through out the floodplain. The project site being in flood plain is bound to receive such import of foreign elements. Similarly as the flood water recedes it takes with it contaminants from site, which may further pollute the river water and aquatic habitat.

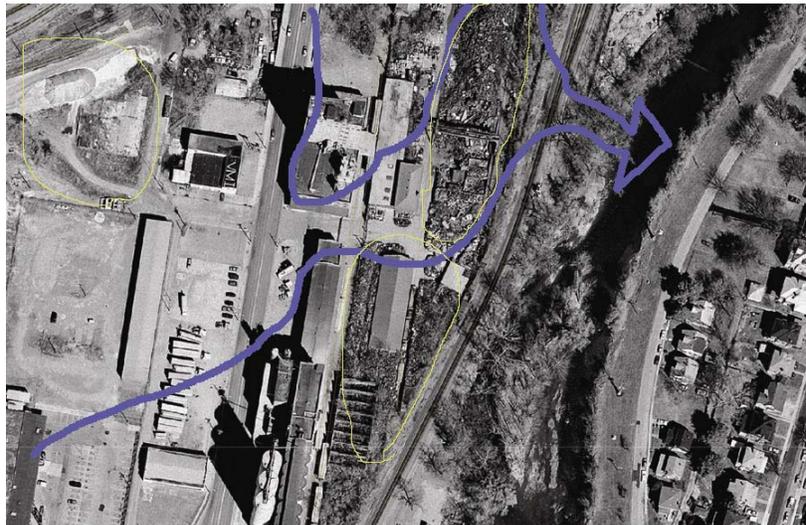


Fig 8- 29: Flood water as it gets in contact with the deleterious land uses.

As shown in above figure the flood water as it moves across the South Jefferson Redevelopment area passes through deleterious land uses and finally returns in to the river by flowing over the Winston Salem Mainline. Thus takes with it various contaminants from these industrial scrap sites polluting the river water. According to the Redevelopment Authority's report these contaminants vary from chemical, petroleum to heavy metals, but detail information about the extent of contamination was not available.

## **8.5: Is the Landscape working well? --- Evaluation Model**

This model will evaluate the landscape with respect to ecological and cultural issues. Ecological issues are based on the process model where as cultural ones are based on personal field observations and Redevelopment Authority's assessment report and proposed Redevelopment plan.

### **8.5.1 Urbanization and Fragmentation of natural resources**

As discussed in the process model the development of the City of Roanoke resulted in the increase of impervious surface and reduction in ground cover and vegetation. There are three basic water problems that are resultant of this: heightened water temperature, increased water pollutants, and increased storm water runoff which adds to the problem of flooding.

The Roanoke River and several tributaries that flow through the city are subjected to periodic flooding. There have been several severe floods in recent years (2003, 1995, 1992, 1989, 1987, 1985, 1979) resulting in requiring evacuation of homes and businesses in low-lying areas.

Most of the severe flooding in Roanoke occurs along the following thirteen major creeks and rivers: Barnhardt (or Carvens) Creek, Garnard Branch, Glade Creek, Gum Spring, Lick Run, Mudlick Creek, Murdock Creek, Murray Run, Ore Branch, Peters Creek, Roanoke River, Tinker Creek and Trout Run.

The flooding of November 1985 was the worst on record on the Roanoke River and many of the above tributaries. It was a reminder of the danger and damage that can result from widespread heavy rains, topped with increased urban runoff in this area. The flooding of June 1995 was an example of an isolated storm that flooded streets, floated cars and seriously damaged buildings in the Garden City area. Because of the mountainous terrain throughout the Roanoke Valley, flooding on all of the creeks except the Roanoke River usually occurs quickly and with high velocities.



Fig 8- 30: Flood of 1940: Jefferson Street (Courtesy Carolyn Hale Bruce)

In the redevelopment area the flood water becomes stagnant as it is dammed by the Winston Salem railway line. This results in deposition of sediments and contaminants that river water brings with it. The main problem is caused as the flood rises about 8 to 12 feet above the South Jefferson Street shutting down the flow of traffic across the river.

### 8.5.2 Fragmentation of land due to human systems like transportation corridors



Fig 8- 31: Railway Crossing

One of the main problems faced at the South Jefferson Redevelopment Area is the fragmentation of land in to smaller pieces by the extensive transportation related activities and infrastructure. This has reduced the capacity of the landscape to act as a single ecological unit. The preparation of sub-grade for such infrastructure has hampered the subterranean activities like sinkholes ground water transportation. The division of landscape in to such strict smaller units further hampers the habitat interaction. Some of

the major impasses are: Norfolk Southern rail road, South Jefferson Road, Franklin Road and Reserve Avenue. This situation is very common throughout the flood plain area. Most of which is occupied by industrial uses and railway transportation.

### **8.5.3 Land Contamination and Environmental Hazards:**

Thirty-two facilities that are physically located within the city manufacture, store or transport extremely hazardous substances which fall under the reporting requirements Title III of the federal Superfund Amendment and Reauthorization Act (SARA) ([www.roanokegove.org](http://www.roanokegove.org)).

Within the redevelopment area, environmental hazards are associated with the storage and handling of chemical and solid hazardous wastes. 10 businesses operating on twenty parcels are deleterious land uses, which are presently or potentially detrimental to the safety health and welfare of the Roanoke community. Their presence in the flood prone area materially increases the risk that their will be releases of hazardous materials to contaminate the environments as a result of flood event.

Such hazardous materials stored and used within the redevelopment area were released during the 1985 Roanoke River flood, necessitating extensive cleanup operations. Another such flood would disperse hazardous chemical and petroleum materials throughout a substantial portion of the river basin downstream.

Also there are known quantified contaminants on 4 properties that exceed human health risk based screening criteria as established by US Environmental Protection Agency. And phase II Environmental site assessments are recommended for additional 10 parcels because of previous land use activity that handled hazardous materials or the site may have leaking from previously closed underground storage tanks.

#### **8.5.4 River accessibility**

The transportation industry has been the impetus behind the development of Roanoke as a commercial and industrial center of south-west Virginia. The great railway infrastructure brought Roanoke wealth of opportunities for its people to grow and prosper. However this very infrastructure is keeping people away from enjoying the wealth of natural beauty. The railway infrastructure has always been developed along the river corridors on comparatively flat bottom lands obtained by filling swamps and marshlands. The industries and commercial developments naturally occur along these railway lines for ease of transport of goods and energy, the coal. And the settlements then invariably develop beyond those industrial and commercial developments cut off from river. The similar development pattern can be observed in the City of Roanoke, where the city has been deprived from enjoying the Roanoke River.

Roanoke today has only three significant places, within the city limits, where people can observe the river: Wasena Park, South Roanoke Park and Maher Field. South Roanoke Park mainly serves as sports center with ball fields and soccer fields and is separated from the river by a road. Maher Field is directly connected with the city and downtown through South Jefferson Street and is most easily accessible. Currently, at Maher Field there are no places where people can walk, or sit beside the river. There are no activities or public places along the river which can bring people to enjoy the riverfront. The facilities like ball field and Victory stadium brings large number of people during specific events but these facilities also presents huge spaces that remain neglected and unmanned during most of the time creating dead zones within the site where surveillance and security becomes an issue adding to the unpopularity of this place.

According to the proposed redevelopment plan the Redevelopment Authority is planning to develop the South Jefferson Area as a southern extension of downtown along with biomedical and other health related activities. Development of such institutional and

commercial activities creates new opportunities to develop Maher field as an urban riverfront rather than just a sports center.

### **8.5.5 Deteriorating building Conditions:**

Earlier coal was the main driving force in determining the location of industries and business. With the reduction in reliance on coal and also its availability many business which once thrived in Roanoke Valley went out of business or moved out. South Jefferson area, which was once occupied by many thriving business, suffered from such changes. Businesses left back buildings and infrastructure to deteriorate over the period of time, because of neglect and inattention.

Today seven (7) of the 60 buildings located within the Redevelopment Area, occupying parcels totaling 13.5 acres, have major structural deficiencies warranting demolition and clearance, and another 41, occupying 42.4 acres, reflect deficiencies that indicate deferred maintenance and consequent deterioration. Dilapidation and deterioration of structures exist on 81.4 percent of all private property (exclusive of Norfolk Southern Corporation Railroad).



Fig 8- 32: Dilapidating and deteriorating conditions of structures, sidewalks and roads

Many physical deficiencies within the Redevelopment Area have affected the economic viability and stability of the area, land use patterns and relationships, the very nature of land uses, building conditions, reinvestment and new development.

**Specific problems are illustrated summarized as below.**

1. Poor original design, excessive lot coverage and faulty arrangement of buildings on the land, have discouraged development in certain areas and contributed to the poor utilization of the land, especially vacant parcels.



Fig 8- 33: Poor utilization of land parcels leading to character less streetscape.

2. Abandoned dilapidated structures, deteriorating buildings because of poor property maintenance, refuse accumulation and infestation and over grown lots have contributed to the blighted condition of the Project Area;

3. The use and storage of hazardous materials located in the floodplain, deleterious environmental conditions and non compliance with state and local codes contribute to health and safety concerns. Incompatible land use issues that result have a depreciating effect on property values, property maintenance and potential new development and business expansion.



Fig 8- 34: low maintenance and deleterious conditions on site

4. Poor site maintenance and unimproved parking areas constituting of weeds, dirt and gravel surfaces, trash, and broken fences

5. Streets serving the redevelopment are largely functional but several provide inadequate ingress and egress for cars and emergency vehicles, are narrow and deteriorating, provide no separation from the private property and are characterized with potholes, high crowns and deteriorating sections. Sidewalks and curb and gutters are generally poor or non-existent throughout the Project Area.

Lack of sufficient storm drainage and curb gutter has resulted in drainage problems, lot erosion and roadway deterioration. This is particularly evident adjacent to railroad properties.

6. Property access to parcels in south Jefferson Street area is provided only within the railway ROW or vehicles must cross private property to reach certain lots. Railroad property is used for access and storage of trucks in the 4<sup>th</sup> street- Albermarle Avenue area.

7. The redevelopment area generally lacks the level of amenities found elsewhere throughout the city of Roanoke that constitute community standard.

8. One of the largest parcels is only minimally improved. The scrap yard now occupies some of the City's most centrally located and environmentally sensitive Roanoke River frontage. Much of the surface area that is not occupied by buildings is unpaved, unlandscaped, and poorly maintained.

### **8.5.6 Conclusion of the representation, process and evaluation models:**

## **8.6 How the landscape might be altered, by what actions? Change Model**

Vision plan for 2001- 2020 suggests that the City of Roanoke is willing to work to overcome some of the environmental problems discussed in the evaluation model.

### **8.6.1 Overview of city's goals for its vision plan.**

#### **Restoring Natural Functions:**

Under natural conditions, a flood causes little or no damage. Nature ensures that floodplain flora and fauna can survive the most frequent flooding. Natural areas (those without development) help reduce our flood damage by allowing flood waters to spread over a large area. This reduces water velocities and provides flood storage to reduce peak flows downstream. Thus it is important to preserve natural areas in the floodplain whenever possible. The city has adopted ordinances to reduce future development the natural floodplain areas. The city also has an ongoing commitment to work with its surrounding jurisdictions because of the impact that development in these areas has on flooding in Roanoke ([www.roanokegov.org](http://www.roanokegov.org)).

#### **Flood Mitigation Projects:**

The city of Roanoke remains very committed to the reduction of flood hazards. Many projects have been targeted, specifically at repetitive loss homes.

Since 1997, the city has purchased 50 homes that have experienced repetitive flood damage. The homes have been removed, and the lots will remain vacant and maintained.

The city has upgraded many storm drains and bridges to more quickly drain storm water during heavy rains.

In conjunction with the Army Corps of Engineers, the city has undertaken plans for the Roanoke River Flood Reduction Project. When complete, flood levels on the Roanoke River are predicted to be nearly two feet lower.

The above information clearly shows that city has good intentions but still does not address the problems resulting from the transportation infrastructure and increased impervious surface. The city is still concentrating only on draining the stormwater as fast as possible.

One of the solutions, city is considering for constant flooding, is to construct a flood wall along the river to avoid flooding of the valuable land. This solution has several downsides as discussed in chapter 8.9. The following project shows an alternative to the floodwall approach by accepting the natural processes as a part of the design and land development process. The aims and objectives of the project are determined based on the process and the evaluation model. The processes model clearly indicates two major problems that are cause of constant flooding and other environmental problems at city scale and as well as site scale. First is the increased volume of stormwater runoff, and reduced time of concentration. The second problem is interference with the hydraulic behavior of the river by construction of the bridges, railway line and other constructions activity along the river's edge. Import and export of sediments and contaminants during a flooding event is another important process that needs to be addresses for the quality of the river water and the land.

### **8.6.2 Major objectives of the design are:**

- 1) To design a storm water management which, can act as an example for the redevelopment area and also for future development projects in and around the city
- 2) To direct the flood water in such a way that it is less obstructive to human functions
- 3) To prevent excessive import of sediments and filters contaminants before the flood water leaves the site
- 4) To reveals these natural processes by making them a visible and observable part of the development.
- 5) To comply with cities objectives while fulfilling other objectives mentioned above.

The proposed land use map for the redevelopment area suggests various guidelines for the development in this area. Considering the size and shape of the redevelopment area, the history of the area, and the general patterns of contributing land uses the redevelopment authority has proposed three variations of the guidelines for three distinct areas: Jefferson Street Corridor, Campus and Institutional Area, and The Crossing. The proposed design uses the same guidelines.

Fig 8- 35: Change model Option- I  
Refer to the design inserts

Fig 8- 36: Change model, Option I, during flood event  
Refer to the design inserts

Fig 8- 37: Change model Option - II  
Refer to the design inserts

Fig 8- 38: Change model, Option II, during flood event  
Refer to the design inserts

Fig 8- 39: Option – II Typical section through the biomedical center and rain gardens and access roads  
Refer to the design inserts

Fig 8- 40:Option – I & II Typical section showing collection of rainwater from the Reserve Avenue and the  
park side parking lot  
Refer to the design inserts

Fig 8- 41:Option – I & II Typical section showing treatment for the bio-retention area at the back of the  
Biomedical Center  
Refer to the design inserts

Fig 8- 42 OPTION – I Section through the Riverside Urban Plaza: Option-I  
Refer to the design inserts

Fig 8- 43: OPTION – I Section through the open air exhibition space  
Refer to the design inserts

Fig 8- 44: OPTION – II Sketch showing the relationship between the river and proposed riverside urban plaza, and surrounding wetland area surrounding it  
Refer to the design inserts

## 8.7 What predictable effects might the change cause? ---- Impact model

The impact model compares the change model with the issues identified in the evaluation model. Thus the change model has been analyzed for the following criteria: flood events, import and export of sediments and contaminants, transportation across Jefferson and Reserve Streets, habitat, cultural and social aspects and precedent for future developments.

### 8.7.1 Flood Event:

It was realized that the volume of flooding will not change substantially unless the whole city implements rainwater conservation and best management practices. So the design should cater for the current flooding pattern and volumes. Current areas were mapped within the redevelopment area with flood depths 12 to 50, 8 to 12, 4 to 8, and 1 to 4 (Refer Fig: 3.4); and corresponding area were calculated. Similar mapping was done for the proposed design and the areas were calculated.

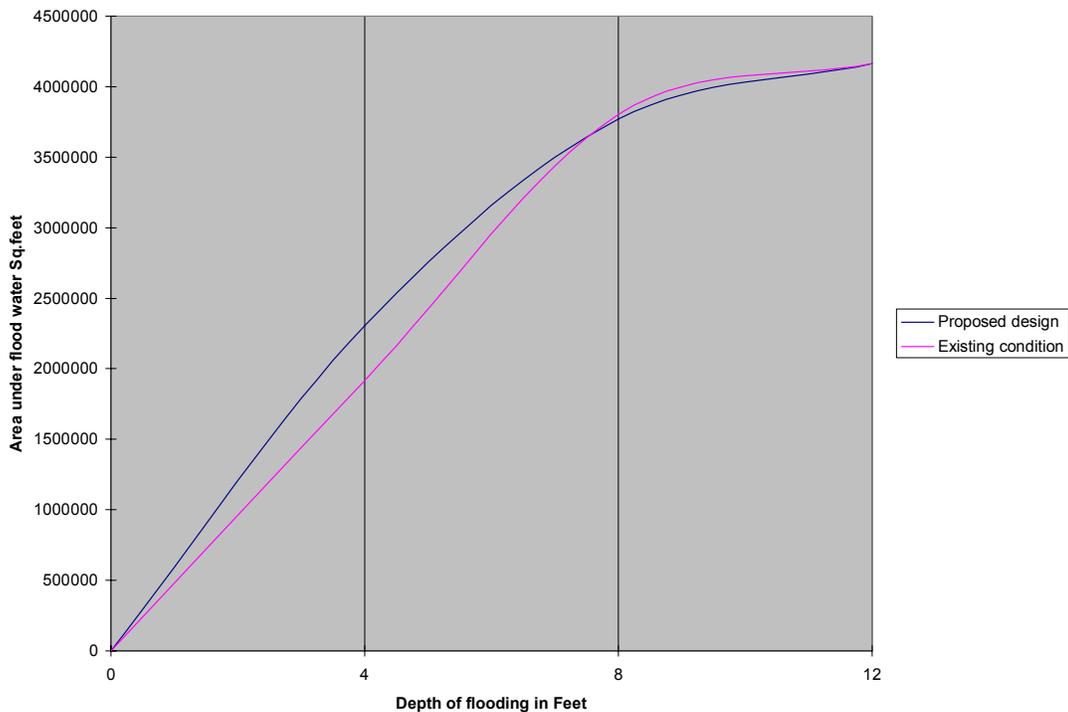


Fig 8- 45: Area analysis of existing and proposed landscape under flooding

The area analysis shows that proposed design provides more area to accommodate flood water when its 4 feet above the river level. This is achieved by dedicating area along the railway lines for accommodating excess of water during flood event.

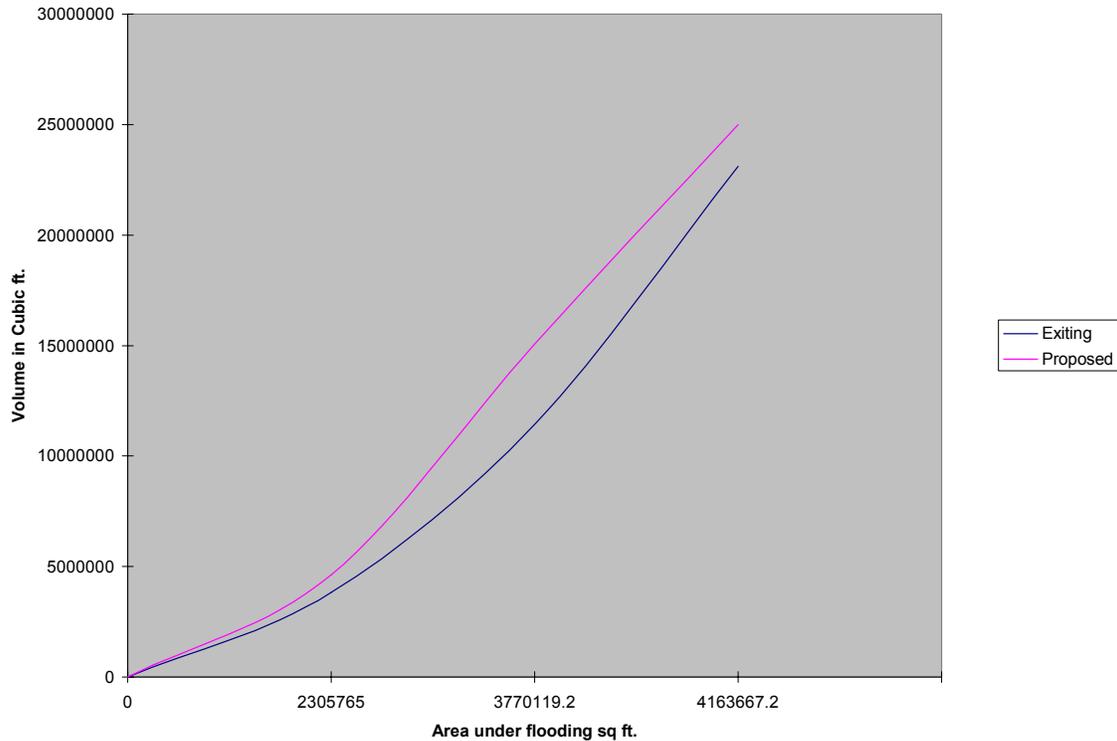


Fig 8- 46: Volumetric analysis of the area under flooding

The above graph shows that, because of increase in designated area for flooding, volume or storage capacity is more in case of proposed development. Because of proposed cutting along the bank, creation of wetland area around the urban plaza, and bio-retention ponds along the Winston – Salem Mainline and at the back of the biomedical center, the storage capacity is anticipated to be more as shown in the graph. This will further help to reduce the flood levels in other parts of the site.

### **8.7.2 Effects on human systems:**

The study of existing flood pattern across the site suggests that many establishments undergo sever flooding in 100 year flood event. It also suggests that the South Jefferson Street and the Reserve Avenue undergo sever flooding which hampers the movement across these transportation corridors. With the development of the biomedical center and other business establishments within the redevelopment zone the Jefferson Street will become one of the most import transportation corridor joining downtown and South Roanoke. The change model suggests a systematic network for storm water movement and flooding pattern that will avoid severe flooding on Jefferson Street.

Also, all the human habitable places in the redevelopment zone are placed 2 feet above the hundred year flood level, which is about 8 to 12 feet from the ground level. This avoids damage of valuable property and human life. The first floor is occupied by the parking garage and such other activities that can withstand flooding. The rain gardens between the buildings are designed to undergo flooding and are the first things to flood incase of heavy storm event.

### **8.7.3 Import and export of sediments:**

The proposed riparian buffer and wetland area around the urban plaza ensures a reduction in the import of sediments during the flood event. During flood event the water from the parking lot enters in to rain gardens through an overflow inlet; this helps to curb the movement of sediments across the site. When the flood recedes the runoff from the site is again filtered through the wetland and riparian zone thereby reducing the export of sediments and contaminants in to the river system.

Also one should note that 90% of the area that is designated to undergo flooding is unpaved and thus encourages infiltration of water.

The down side of using riparian zone for preventing import of sediments is that the proposed cutting along the bank will soon be filled with sediments reducing the volume

available during the flood event. However the aim of the project is more to direct the stormwater in culturally and ecologically sensitive manner. So this will not hamper the main objectives of the project. The lowered elevation along the bank however will help to some extent to recreate ecotones, sensitive ecosystems at the interface of water and land that were once intrinsic part of the landscape. The possible sedimentation of this area also suggests that one should use trees and other vegetation that can sustain flooding and sedimentation.

#### **8.7.4 Habitat**

The study of patches and corridors (Fig 2.10) clearly indicated that the Roanoke River corridor acts as a strong link between Blue Ridge Mountains and Catawaba Mountains for habitat movement and various ecological processes. Use of various native flood plain species for riparian corridor and wetland species around the Roanoke Riverside Plaza and in the Bio Retention ponds along the railway lines brings back some of the intrinsic ecological characters of the site that are important for birds and other smaller animals. Redevelopment of areas along the river in this manner will help to recreate a strong habitat corridor, which is fragmented by years of industrial and commercial establishments along the river.

#### **8.7.5 Stormwater management:**

The Evaluation model clearly shows that the increased volume of stormwater runoff and reduced time of concentration are the two main reasons for increase in the flooding frequency. Rain gardens and bioretention facilities have been planned as an integral part of the design to check the stormwater runoff from the site. During normal storm event the gardens will hold the rain water for infiltration and the bioretention facility will help to improve the quality of water before it is directed in to the river. However, during a flood event the same rain gardens and bioretention facilities will act as detention facility. The architectural strategy is to increase the height of the buildings to meet the required floor

area for the BMC, reduce the impervious surface area, and still provide enough open space for rain gardens and other institutional activities. Management of stormwater runoff in this manner through out the city will greatly reduce the impacts of unavoidable increase in impervious surface. This project can act as an example of stormwater conservation for future development projects in Roanoke.

### **8.7.6 Cultural and Social aspects**

As explained in the chapter 6.4-III, for design to be successful both culturally and socially it should have a sense of place created by making various dynamic landscape processes both visible and observable. Three most important dynamic processes identified in the evaluation model were the stormwater runoff, flooding pattern on the site, and exchange of contaminants and sediments during flood events. The change model makes an attempt to present these ideas most powerfully by generating a design form that is shaped by these processes.

The change model attempts to overlap cultural needs and ecological processes to raise curiosity in visitors to explore and understand the complexity of the landscape. The most important aspect of the proposed change model is that it tries to bring in light the ecological processes that are generally invisible to naked eyes. This has been achieved by placing rain gardens in a way that they are visible to every one on their way to work and also during their leisure time. Similarly the Roanoke Riverside Plaza marks the contrast between surrounding natural elements like river, riparian vegetation, and wetlands around it, and there by creates many opportunities for people to observe, learn, and enjoy various natural processes. Knowing landscape in such a way will heighten the landscape experience and thus earn human attention and care.

The change model should further be developed so that it can act as precedent for other developments in the city.

## **8.8 Decision model**

Decision model is comparing various alternatives with respect to cultural and ecological needs, markets, policy, laws and politics. The two options that can be compared are:

- 1) Plan of Army Core of Engineers which calls for building flood walls and widening of floodway with rip rap to hold the widened banks.
- 2) The proposed change model

### **8.8.1 Floodwall Option**

#### **Advantages:**

- In this case Army Core of Engineers is the only decision making body, apart from stake holders, involved to carryout the entire project. All the expertises are under one roof thus coordination would be easier.
- The project may be complete in shorter period of time.
- The solution is simple because it is aimed at only one function that is efficient dispatch of floodwater.
- The solution can still incorporate some sort of green way system.

#### **Disadvantages:**

- The high floodwalls will totally segregate the city from the river both visually and physically
- As explained in section 5.0 the system is too simple and not multifunctional like natural systems are.
- The floodwall does not reduce the flood levels it just forces water to move faster so even though flooding is avoided at one place it will create large scale flooding some where down stream.

- The floodwall will dissociate not only people from the river, but also number of animals and other ecological processes between land and water. It will totally destroy ecotones, which are fragile ecosystems at the interface of land and water.
- As sediments get deposited in the river channel it reduces the volume of channel to carry the floodwater, so the flood way needs to be cleaned by dredging the flood channel. Such dredging process further destroys the aquatic habitat.

### **8.8.2: Proposed Change model:**

#### **Advantages:**

- The form of the development is guided by the way flood water moves across the site so it will have minimum damage to the human functions.
- The import and export of sediments will controlled be by the natural processes.
- The river will be available more readily for people to access and enjoy.
- The easy accessibility will foster a new positive relationship between the River and the city. This will bring more attention and care for the river.
- Improved riparian corridor, wetlands, bioretention ponds will provide habitat for many animals and birds serving as first step in creating a habitat corridor between Blue Ridge Mountains and Catawaba Mountains.
- The proposed design creates a multifunctional system that can not only relieve the flood pressure by directing the water in proper direction but also control sediment import and export, stormwater management, and at the same time reveals the ecological processes to viewers creating consciousness among the people about natural processes.
- No extra money is required to create a park.

**Disadvantages:**

- 1) Creating multipurpose system requires collaborative approach between various professionals leading to increased co-ordination between of various fields.
- 2) Many stakeholders are involved leading to the need for increased co-ordination.
- 3) The project may take little longer to complete.

Thus one can see that the floodwall option has certain advantages, but it does not respond to the site specific issues and hence it is not a sustainable solution. The change model, although complicated to coordinate, responds to the ecological processes on site and hence is the most sustainable solution. How ever more evaluation is needed from political, financial, management, policy, law and market's perspective.

## 9.0 Conclusion:

The position for this thesis is that sustainable design can be achieved by reconciling human systems and its effects on the surrounding environments by using and revealing natural systems to spread the consciousness and earn attention and care for our environment. Master plan design exercise for biomedical research center and Riverside Park in South Jefferson redevelopment area, Roanoke, VA, illustrates how the position, stated above, can be applied in landscape design projects. Professor Carl Steinitz's framework for design was used as a basis for the design process; along with this framework various ideas about revealing ecological processes were fused to create a landscape that is ecologically as well as culturally sustainable.

The impact model and the decision model, explained earlier, evaluated the design project in many aspects. So this section will focus on the evaluation of the design process.

The six basic question and corresponding models that guided the design project are as follows:

- How should the landscape be described? : Representation Model
- How does the landscape operate? : Process Model
- Is the current landscape working well? : Evaluation Model
- How might the landscape be altered – by what actions where and when? : Change Model
- What impacts might result from implementing a design plan? : Impact Model
- How should the landscape be changed? : Decision Model

The following discussion will evaluate each of the above questions and corresponding models

## **9.1 Representation model**

The question, How should the landscape be described?, is very open ended and one has to find his own way to represent the landscape and its influences on the human development. In this case detail inventory of landscape elements and how human development modified these elements over the period of time formed the representation model.

Steinitz's framework for design is usually applied to watershed or regional scale projects. In these cases GIS based analysis of soils, vegetation, drainage pattern, slopes etc is conducted to make various design decisions and to find the suitability of the landscape with respect to various uses. The project site, however, was smaller in scale with lesser variations in soil, slope, vegetation and other landscape elements. However, an attempt was made to understand the formative processes of which these elements are products. Such an investigation helped to place the project site in the regional context and understand its role at a larger scale.

The changing landscape of the City with respect to its cultural development revealed a lot of information which was not anticipated in the beginning of the project. The historic descriptions about the site and historic uses revealed how the site has been modified by human interventions over the period of three centuries. It once again, as discussed in chapter 2.0, shows the effects of changing relationship between humans and nature from a hunting and gathering society to an industrial society to the present day modern society.

## **9.2 Process Model:**

How does the landscape operate? is the underlying question that process model intends to answer. The human systems on the project site are very dominant and thus the main goal of this model was to understand the functional relationship between natural and human systems. One of the interesting exercises conducted for this model, which was found to be very useful, was studying the ecological processes that are intrinsic to the specific natural conditions of the site, and portraying the landscape before human development. This depiction of the predevelopment condition was overlaid on the existing condition of the site to reveal how the human systems are interacting with the natural processes. The product of this model revealed the interaction between natural and human systems.

The peculiar flood pattern and stagnation of flood water, due to the construction of Winston – Salem railway line and the bridges across the river, were powerful conclusions of the process model that influenced most of the decisions in the change model. Thus the key aspect is that ecological processes occur within the temporal setting and change overtime with respect to human interventions; and one need to understand the interaction between human and natural systems before proposing future interventions.

## **9.3 Evaluation model:**

The question, is the landscape working well, was found to be confusing while working on the evaluation model. It was difficult to set criteria to evaluate the current landscape. It was realized that the original landscape has been greatly altered and with the proposed biomedical center and other developments in the redevelopment area it can never be brought to the same prehistoric character with rich swamps and levees. However it is important that we stop the further degradation of the landscape by inventing new forms of relationships between landscape and people. Therefore it was much more suitable to change the question as: what are the current issues or problems within the existing landscape? This level of enquiry helped to build a diagrammatic representation of how

elements of nature affected various human and natural processes, how natural and human systems interact with each other, and what are the resultants of such interaction.

### **9.3 Change model:**

Steinitz framework suggests that this level of enquiry is directly related to the representation model in which both are data vocabulary and syntax. However, in this project the change model was a direct response to the processes model. The idea of revealing natural processes led to this increased influence of process model through out the change model.

Evaluation model presented a list of issues pertaining to the current landscape condition based on that a multifunctional system was devised which can cater for human as well as natural functions. The system was developed based on the advantages that each system provides to the other system. This new system performs many different functions like regulating the flood pattern, reducing the impact of flood water on other functional spaces, controlling the import and export of sediments and contaminants, stormwater management, habitat restoration, providing educational and recreational opportunities, and also act as road network and parking in certain parts of the site. In short change model lead to a complex and multifunctional human system that uses natural systems to reconcile other human systems and their effects on natural systems.

### **9.4 Impact model:**

This model evaluates the change model with respect to the physical, biological, and cultural issues established from understanding of processes model and evaluation model. The various criterions used for this purpose are: effects of flood events, import/ export of sediments and contaminants during storm events, effect of flooding on transportation across Jefferson and Reserve Streets, habitat fragmentation, cultural and social aspects and precedent for future developments. It was found that the evaluation of the change model as a part of the design process helps to improve understanding of the effects of

proposed design solutions and thus improves design solutions even before decision model. It was also realized that different professionals and experts should be part of this model as landscape architects themselves may not have knowledge of all the related fields. For example, the change model proposes a bioretention facility behind the Biomedical Center. It also proposes to connect this bioretention pond back to the river by creating two channels; one underneath the Franklin road and behind the Valley Properties and the other channel underneath the Jefferson Street and behind the VA Scrap Iron. Such connection may serve to be useful in relieving the flood pressure from the site but it may provide a permanent short route or a score channel for the river and that will defeat the purpose of the proposed system as emergency outlet during flood event. Thus a multidisciplinary approach would be necessary to evaluate the impact of such proposal and establish necessary control structures within the system.

### **9.5 Decision model:**

How should the landscape be changed is the question that decision model helps to answer. Once This model is very important as one compares and evaluates each and every alternatives with respect to relevant contexts including markets, policies, laws and politics. Again a multidisciplinary approach is most important for this model that needs collaboration between various professionals and agencies. Incase of Roanoke Riverside Park and Biomedical Center the decision model compared the proposed change models with the floodwall option proposed by Army Core of Engineers. The comparison revealed that floodwall is short term solution and is not environmentally unsustainable solution that does not addresses the important issues related to the site. It is only with a constant dialogue, with engineers, planners, environmentalists, scientists, architects, landscape architects, financial consultants, developers, government and the community as a whole, we can evaluate any given proposal for its future sustainability. While working on this model is was realized that the conceptual proposal in the change model needs lot of detailing for innumerable issues to evaluate and realize the actual project.

## **9.6: Combining framework for design & ecorevelatory design processes:**

The position for this thesis emphasized on environmental as well as cultural sustainability. Combining framework for design with the eco-revelatory design processes helped to achieve this goal in many ways. The understanding of ecological processes on site acts as an underpinning for making them visible and observable. Rain gardens, riverside urban plaza, wetland parks, score channels and open air exhibition areas are all visible and most observable portions of the proposed landscape. At the same time these elements contribute towards ecological integrity of the site. Thus the multifunctional system is the direct result of combining framework for design and eco-revelatory design processes.

Thus by combining framework for design and eco-revelatory design processes one can effectively use and reveal natural systems to reconcile human systems and its effects on the surrounding environment.

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