ECOLOGICAL SCHOOLYARDS: CONNECTING TO OUR NATIVE LANDSCAPE

by

JOY DENNINGER LONG

(Under the Direction of Mary Anne Alabanza Akers)

ABSTRACT

There is a need for children to have contact with their native landscape, and an opportunity for this need to be provided on school grounds. This thesis presents a case for making this reconnection through the use of ecological design. Natural areas are shown to provide children with an environment rich in excitement, variety, and developmental responsiveness. Case studies are also provided to show how the theory of ecological design has been applied in the past. The application of ecological theory is presented in an alternative stormwater management approach to a schoolyard in Athens, Georgia.

INDEX WORDS: Ecological design, playground design, outdoor play spaces, schoolyard design, alternative stormwater management

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JOY DENNINGER LONG

B.S. Principia College, 2000

A Thesis Submitted to the Graduate Faculty of The University of Georgia in Partial Fulfillment

of the Requirements for the Degree

MASTER OF

LANDSCAPE ARCHITECTURE

ATHENS, GEORGIA

2004

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JOY DENNINGER LONG

Major Professor: Mary Anne Alabanza Akers

Committee: Henry Methvin
Elizabeth Pate
Lauren Zeichner

Electronic Version Approved:

Maureen Grasso
Dean of the Graduate School
University of Georgia
May 2004

ACKNOWLEDGEMENTS

I would like to acknowledge the wonderful help that I have received from Mary Anne, who solidly guided me through this process, and joyfully kept me on track. My family, friends, and lovable cat were also so supportive of me the entire time. Thanks also to those who have gone before me and have made their work a tangible reality for so many children.

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CHAPTER I -- INTRODUCTION

> *I can't say that I was terrified as the water spilled over the tops of my rubber boots – after all, it was my own curiosity that had gotten me to step this far out into the pond. Even though the cold water soaked into my socks, the excitement of getting out to the cattails pushed me onward. After a few more steps with the murky water swirling around my knees, however, I realized I could no longer get back to the grassy bank. The mud had become deeper, and I didn't think I was strong enough to pull my boot up out of it. Although I had been to the pond before, I had never ventured this far, and now I was stuck. Or so I thought momentarily. However, I then realized the water was only 2 feet deep, and I found I was in no real danger. Before reaching down to pull my boot out of the muck with my hands, I stood there, feeling that somehow I was a part of this little world. It was quiet, I was far from the house, and I stood where no adult would ever want to go. This was my place – my spot, and I didn't mind being stuck there. For that moment, I owned it, and it owned me.*

As adults, we all have memories of special places we enjoyed during our childhood. These places did not necessarily have aesthetic appeal or obvious worth to adults, but we remember them because we played there. In these child-created worlds we experimented with power and control, which was essential to our development as well-balanced adults. Playing is more than just idling away the hours; it is how we develop our sense of our place in the world. "Playing is as necessary as breathing, eating and sleeping" (Piers and Landau 19).

Although the importance of play for intellectual and social development is widely documented, children spend a large percentage of their time in places over which they have no control. Much of their environment is controlled by regulations that limit what would be "fun" from their perspective. For example, a well-maintained grass backyard is controlled by adults, and is usually off-limits for mud pies, digging, or sliding into first base. This is because an adult's view of the world is completely different from a child's. "The adult avoided mud puddle is a place to experiment with splashing. The adult's vista of a lush green hillside is for a child a place to roll down, feel the wet soft grass, smell its green smell, experience the free fall of tumbling round and round" (Stine 3).

Recognizing that school grounds are probably the first public environments in which a child spends significant amounts of time, and that these areas are often poorly designed expanses of pavement and overly restrictive equipment, there is movement toward improving the quality of those environments, especially from an ecological perspective.

> *"To counter the historic trend toward the loss of wildness where children play, it is clear that we need to find ways to let children roam beyond the pavement, to gain access to vegetation and earth that allows them to tunnel, climb, or even fall. And because formal playgrounds are the only outdoors that many children experience anymore, should we be paying more attention to planting, and less to building on them? (Nabhan and Trimble 9)*

A well-planned ecological schoolyard should provide all users, which may include children, teachers and community members, with a rich environment for adventure, play, and learning. The natural areas must also be managed and observed for signs of health, change, or disorder, which can be incorporated into the curriculum, and used to bring community members together. Including natural systems in a schoolyard makes environmental education and play a priority; it shows children that the natural environment is an important and valuable one, and one that should be a part of their daily activities. The fact that children will always seek adventure in natural places means that there is a great opportunity within our scope of supervision to provide them with what they want and need.

This thesis provides a theoretical basis for the importance of providing a natural environment for children to experience, through an analysis of our disconnection from the environment and elaboration on how the principles of ecological design lend a hand toward a reconnection to nature. An analysis of users (i.e., children and faculty) and how their needs are met through ecological design follows, as well as case studies of where this type of design has already been successful. The application of these theoretical principles is then demonstrated in an ecological treatment of the grounds at Barnett Shoals Elementary School in Athens, Georgia. An analysis of the current landscape of the school prompted a specific look at the treatment of water on the site, resulting in an ecologically appropriate stormwater design that aims to bring children into contact with water, and, innately, with the rest of the ecological landscape around them.   Finally, criteria for assessment of the success of this design, as well as information on how to manage the site over time, will be offered as a conclusion to the design.

CHAPTER II – LACK OF CONNECTION

> *"Land is nourished or not by humans; humans are nourished or not by land. Place and occupant only seem separable because we have created such a distance between liveliness and livelihood. In creating that distance, we have unwittingly detached the nature of childhood from the sense it ought to make…We've removed the red from the fruit, the fruit from the tree, the tree from the wood, the wood from all the things a child might make of it, and so left fragments much harder to connect than laces on a shoe." (Stein 9)*

Our lack of connection to the natural world is hindering us from understanding our place in ecological systems. This disconnect is not new. From the beginning of European settlement in North America, the lack of connection was obvious to those already living on this land. "European minds were not prepared for the encounter with wilderness nor were they prepared to understand those who could live in it" (Orr, Ecological Literacy 27). The history of colonial America, and later, the spread of European settlement throughout the west, is linked to the need to control and dominate the environment. A man was considered successful if he managed to clear a plot of land and sustain his family with it. Nature was understood for the services it could provide mankind. This often meant that many people really did understand natural processes, because they were dependent on them for survival. However, humans were not considered a part of the natural world, and people continued to build stronger walls between themselves and nature. A century later Ralph Waldo Emerson also commented on this problem:

> *"'We are shut up in schools and college recitation rooms for ten or fifteen years, and come out at last with a bellyful of words and do not know a thing. We cannot use our hands, or our legs, or our eyes or our arms. We do not know an edible root in the woods. We cannot tell our course by the stars, nor the hour of the day by the sun.'" (Orr Ecological Literacy 136)*

Today, this trend continues. Humans are separated more than ever from the natural world. Industry, technology, suburban sprawl, and increasing population density have all tended to remove us from our natural environment – even from the knowledge our forefathers knew. The development of large-scale industry and technological advances has isolated us from ecological processes. Many products bear no resemblance to their original natural form, or are packaged and marketed so that the ecological context is removed. Eggs seem to belong in styrofoam packages, mushrooms in plastic containers, and cereal in brightly colored cardboard boxes. Even the consumer trend toward whole foods and natural ingredient products does not necessarily increase public awareness of the ecological connections between people and their food.

In a country that grew and developed because of abundant harvests, many Americans today do not know agricultural details of where or how food is grown. The supermarket is often the place where children learn food comes from. Take, for example, the staple of American agriculture – corn. Many do not know the ecology of a cornfield, how long it takes the plant to produce seeds, or the environmental conditions corn plants require. They also are unaware of the processing that corn undergoes. Sweet corn harvested for human consumption and feed for animals are well-known uses, but corn hides in many other products. One large food processing corporation, ADM, states that it:

> *"has the capacity to convert about 1.6 million bushels of corn a day into corn starch, corn sweeteners, corn oil, and many other value-added ingredients. Some of our corn-derived ingredients for food applications are starch and maltodextrins, and our sweetener product line includes corn syrups, high fructose corn syrups, dextrose, and fructose." (ADM Corn Processing)*

These ingredients are used in making beverages, baking supplies, dairy products, condiments, jams, jellies, and more. Yet the presence of corn is usually not even recognizable in these everyday products.

We are isolated spatially from the production and disposal of our food as well. Large farms and agribusinesses are far from the density of human population, so many people do not see or experience these agricultural processes, even vicariously. On the disposal side, how many people think about how long it will take for their pizza box to decompose? With the convenience of weekly trash pickup, we have removed ourselves from participating in the breakdown of waste, or understanding the problems associated with its disposal. Why are our landfills separated from people? Our wastes are toxic to the environment and to us as well. "In states with EPA-approved permitting programs, landfills must be designed to ensure drinking water standards are not exceeded in ground water (Municipal Landfill Regulations). In order to protect ourselves from our own waste, we design landfills with protective liners, and seal the lid on our leftovers with mountains of soil. Because of this preventative measure, we have created another problem. We have isolated the natural organic wastes from the natural processes that could break them down. This is an indication of major ecological ignorance. We should be looking toward ecological processes for inspiration of the design of our own systems, so that we can be a positive part of our environment. In order to respond to this problem over time, a new paradigm must be established. As David Orr emphasizes,

> *"It is time, I believe, for an educational perestroika by which I mean a general rethinking of the process and substance of education at all levels beginning with the admission that much of what has gone wrong with the world is the result of education that alienates us from life in the name of human dominion, fragments instead of unifies, overemphasizes success and careers, separates feeling from intellect and the practical from the theoretical, and unleashes on the world minds ignorant of their own ignorance." (Ecological Literacy 26)*

Where can this educational shift be encouraged? Across the board, children's awareness and appreciation of their environment is in direct relationship to our ability to communicate it to them. How are we doing? Children in urban areas still play behind metal fences, suburban children think nature is a lawn, and rural children are learning that the most important information comes from textbooks and television, not from family knowledge and personal explorations.

Urban challenges

"At the beginning of the 20th century, the concentration of population in cities was considered as representing a remarkable social phenomenon, even though less than 15% of the world's population was then urban"(Wohlwill and van Vliet 3). More than 40% of people lived in cities in 1985, and by year 2025, is it estimated that 80% of the world's population will live in cities, according to a 1999 United Nations report. In addition, 57% of all children born this decade outside the U.S., and 25% in the U.S., will live in urban slums (Nabhan and Trimble 11). This accelerating trend of increasing population growth will increase our density, our space devoted to urban areas, and our subsequent need for open space. Because of this density, however, the provision of open space is a challenge. "With increased numbers of people, program changes are usually found in schools…Programs become more structured with less time and room for exploration and play"(Wohlwill and van Vliet 83). This often translates into more regimented areas for play. The result is urban playgrounds that are all pavement and concrete, where nature is almost completely nonexistent. Contact with other species in urban areas – even wealthier ones -- is often only with cats, dogs, and the struggling street tree or flourishing weed.

It is difficult for children to develop an understanding of their place among species and systems if their environment is devoid of anything green at all. An accessible natural setting would provide a place for this discovery, and provide a respite from the monotony of urban structure. Research has shown that children in highly structured situations are less imaginative, less social and more prone to discouragement when difficulties are encountered. On the flip side, Nicolson states "inventiveness and creativity in children are a function of the number and kinds of variables available in any given environment" (Wohlwill and van Vliet 83). This variety would be greatly improved with the addition of a natural setting, however small. Thus there is strong support for ecological playgrounds in cities, and there are good examples of where these already exist.

Suburbia

"Outside: how it has shrunk! New houses seem to have gobbled the land to fatten themselves. They have grown enormous…They display themselves to one another over bare lawn. Their size and ostentation say something sad to me: indoors has grown more important than outdoors used to be." (Stein 40)

There is a critical lack of ecological diversity in suburban areas. To the native landscape, suburbia has become a smothering blanket of over-prescribed non-native species, especially in lawn areas, which are maintained as a monoculture with herbicides and fertilizers. The outdoors to most suburban children consists of simple geometric patches of green, divided from well-pruned spherical shrubs, if there are any, with ribbons of white concrete. (See Figure 2.1). The typical suburban yard separates natural elements from one another so that they look organized, and those elements are maintained so that they never change. Clipping the hedge, killing the weeds, and keeping the grass out of the cracks in the driveway keep the yard "neat" and unfortunately, not at

Figure 2.1 Monoculture of Suburbia (Maclean)

all ecologically healthy. Most of the plantings are immature, and are replaced when they start getting "too" big, preventing ecological maturity and development. The cycle of nutrients is disrupted with the removal of leaves and grass clippings, and the additions of pesticides and fertilizers. Because the current suburban aesthetic of what is beautiful is often in direct opposition to ecological health, the ecology of our suburban areas is completely disrupted.

The rapid suburbanization that is occurring in this country seems to be inversely proportional to the amount of thought, time, and space devoted to natural spaces. Though this may not be intentional, low prices of land outside the cities are causing suburban development to leapfrog out into what used to be agricultural fields or native prairie, and doing so at an alarming rate. For example,

> *"over the period 1965-1990, the per household land consumption rate for a typical suburban area (Montgomery County in southeastern Pennsylvania) increased from 0.80 acres of developed land per household in 1965 to 1.14 acres per household in 1990. This means that during this 25-year period the amount of developed land per household increased by nearly 15,000 square feet. This shows that the efficiency of land development has been reduced over the past 25 years." (Where Are We Going?)*

This speed inevitably causes the mistakes of the past to be repeated, because there is no time for evaluating the best use of space or for discovering the economy of doing so. Instead of taking the time to evaluate the site, establish protected areas, and create places where people can connect with nature, developers create traditional cul-de-sac neighborhoods that fill up the open space, leaving few native trees, less topsoil, and very little species diversity. The preservation of land as open space or natural habitat is not yet a priority.

"In conventional subdivisions, all of the land has been cut up and parceled out to individual lot owners…All of land has been paved over, built upon, or converted into lawns and backyards. Except of wetlands and steep slopes, all the natural areas have been cleared, graded, and planted with grass and nonnative shrubs and trees, which offer little to any remaining wildlife. In addition to there being fewer species of plants and animals, there is typically little community life, for the public realm has been reduced to an asphalt street system." (Arendt 5).

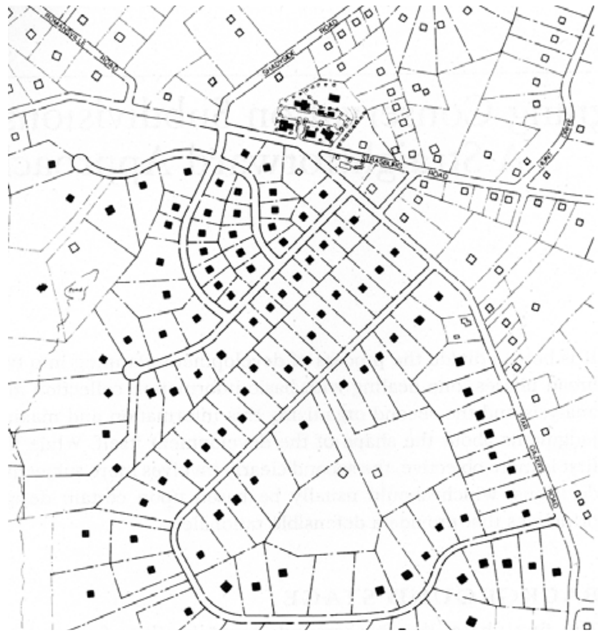


Fig. 2.2 Land use in conventional subdivision (Arendt 28)

Technology

More than streamlining the processes of food and material production, industry and technology have begun to isolate us from the basic knowledge base from which our country blossomed. This isolation is even occurring in rural areas where people still have a link with the environment. Gary Nabhan observed this when he interviewed 52 Anglo, Hispanic, O'odham, and Yaqui children in southern Arizona, most of whom lived far outside the cities. Although most of the children

"did claim some direct and pleasurable interaction with desert landscapes and their organisms,…the vast majority of the children were now gaining most of their knowledge about other organisms vicariously. The trends were surprising: 77 percent of the Mexican children, 61% of the Anglo, 60% of the Yaqui, and 35% of the O'odham children felt that they had seen more animals on television and in movies than they had seen outside in the wild. Only the children that were too poor to have regular access to television spent more time outdoors or with others than watching television" (Nabhan and Trimble 87).

Television and other technologies are playing a significant role in our separation from nature. American children, ages 2-17, watch television on average almost 25 hours per week or 3 ½ hours a day. Almost one in five watch more than 35 hours of TV each week (Children and Television).

> *"The number of hours per day during which the average American youngster watches only television, gaining only vicarious experience, is astounding and shameful. Such sedentary habits deprive young people of the movement patterns, socialization and other skills they need in order to achieve maximum, high-quality growth and development." (Miller 13)*

Although much effort is put into making children's programming educational, only 20% of programs are stated to contain educational material (Children and Television). In addition to television, computers, email, and video games are increasingly popular. And they all tend to isolate children from each other and from the outdoors where they used to play. Thus, the opportunities for these types of interaction at school become all the more important.

Problems in Education

> *"The majority of students in our schools are unable to make connections between what they are learning and how that knowledge will be used…They desperately need to understand the concepts as they relate to the workplace and to the larger society in which they will live and work. Traditionally, students have been expected to make these connections on their own. (What is Contextual Teaching and Learning)*

The educational system that teaches environmental concepts in the classroom, but that fails to provide hands-on interaction, is reinforcing this ecological disconnect. Some believe that a sense of wonder for the natural world cannot be taught, but that it can be squelched if not given room enough to grow. David Orr, a well-known and respected planner and writer, says: "My hunch is that the sense of wonder is fragile; once crushed it rarely blossoms again but is replaced by varying shades of cynicism and disappointment in the world" (Orr, Ecological Literacy 31). Of course, there is no one who wishes children to be disconnected or disillusioned. But there must be an effort made to evaluate the quality of the environments we are placing children in, so that the best solution can be provided.

Another challenge to ecological schoolyards is that state-wide programs usually dictate what public schoolteachers are required to teach in each subject, and often these requirements do not include outdoor, hands-on programming, or do not provide freedom to do so. In addition, field trip programs are only sometimes focused on environmental education. Private schools may provide teachers more flexibility to take students into an outdoor environment, but the teachers must also be comfortable and excited about outdoor learning and play. In order to be effective, ecological schoolyards must be used. There must be support from all constituents, or they will be underutilized and unappreciated, and children will not receive the benefits they provide. Teachers must be provided with adequate preparation and training for providing such learning and play support. Unfortunately, today "teachers tend to avoid outdoor activities because they [are] frequently unfamiliar with the philosophy, technique, and organization of field trips"(Orion, et al 162). Orion et al. suggest that the neglected state of outdoor education may reflect our limited knowledge and understanding of the outdoors as an effective learning environment.

Children in school today may learn to be passionate about saving the rainforest, conserving resources, and saving the whales, but if they do not see a relationship between these environmental issues and their own lives, the environmental connections are not being made. According to contextual theory, learning occurs only when students understand new information from their own frame of reference – their own worlds of memory and experience. "This approach to learning and teaching assumes that the mind naturally seeks meaning in context –

that is, in relation to the person's current environment – and that it does so by searching for relationships that make sense and appear useful"(What is Contextual Teaching and Learning).

Therefore, learning environmental lessons without the context of a natural environment will be less effective in establishing a connection to that environment in a child's mind. However, simply placing a student in a natural environment does not guarantee learning or development. Considerable change and effort must be made in curriculums, and teachers and other users must be educated about the value of natural environments, in order for this type of hands-on learning and education can take place.

> *"Effective contextual learning results from a complex interaction of teaching methods, content, situation and timing. For programs to work, changes must be made in the following areas: curriculum, instruction and assessment, links to workplaces, community organizations, and other contexts, staff development for teachers and employers, school organizations, communication, and time for planning and development." (Background on CTL)*

Schoolyard planning

A lack of understanding in the site planning field about what children need in order to make ecological connections is another obstacle to be overcome. Much of what we see today around school buildings is large expanses of parking lots, mowed grass lawns, playing fields, and very few comfortable – or natural -- outdoor spaces. (See Fig. 2.3.). Overly restrictive playground equipment, lack of diverse spaces and textures, overly open or neglected spaces – these common

Fig. 2.3 Traditional schoolyard (Haroutounian et al.)

problems all constrain the imagination, show lack of care, and end up sending children out into more interesting, lively, and often dangerous outdoor places.

Playgrounds have always suffered from sterility. Organized recreation programs and facilities began as a response to a growing need in the late nineteenth century for a place for children to pursue leisure activities. The goal of early founders was to provide children with a safe, moral place to spend their time, rather than in the streets, which were considered unsanitary and dangerous. Unfortunately, this goal did not lead to interesting or exciting places to play, and as early as 1914, incidents of idle playgrounds were being cited (Keller). Children were found back out in the streets, where they could interact and manipulate their environment.

Why are some playgrounds used, and others aren't? According to Richard Dattner, author of the book Design for Play, one particular fault of typical playgrounds is their lack of interest for children. He states:

> *"After a little swinging and sliding and see-sawing, the built-in opportunities for play are exhausted. Children, however, are not so simple-minded as adults, and the name of a piece of equipment does not deter them from inventing uses for it beyond the designers' and administrators' wildest imaginings….And after these limited and perilous options are used up, there are the games of destruction, in which children pit their ingenuity against…these facilities." (Dattner 37)*

He points out later that because children internalize their environment, they learn from these dull, playgrounds that "civilization delights in reducing the varied potentials and unique qualities of individuals to a pattern of uniformity"(37) and that the world is not interested in their development or well-being. In addition, the typical schoolyard landscape:

Fig. 2.4 Typical urban playground (Dattner 37)

"offers nothing from a nature-study standpoint….The shrubs and trees aren't selected for their ability to attract butterflies or feed birds native to the area. The lawn consists of only one or two types of grass and is regularly clipped short, providing no food or cover for anything, even as it drains maintenance dollars because of its constant need for mowing and fertilizing" (Phillips 115).

Of course, the design of a typical playground is not the root of all evil, just as an ecological one will not transform all children into well-balanced adults. However, all children are influenced by the environment around them. Therefore the obligation exists to make it of the best quality to meet their needs. This can be done through careful planning and an ecological approach to design.

CHAPTER III – THE RECONNECTION THROUGH ECOLOGICAL DESIGN

Ecological design

> *"Ecological design requires the ability to comprehend patterns that connect, which means getting beyond the boxes we call disciplines to see things in their larger context. Ecological design is the careful meshing of human purposes with the larger patterns and flows of the natural world, and the careful study of those patterns and flows to inform human purposes."(Orr,* Liberalizing the Liberal Arts *548)*

The scope of our disconnection from our natural environment points to a simple truth – we have designed ourselves out of nature. Ecological design, or sustainable design as it is sometimes called, seeks to design us back into it. Ecological design can be defined as "any form of design that minimizes environmentally destructive impacts by integrating itself with living processes" (Van der Ryn and Cowan 18). Carol Franklin of Andropogon Associates says more holistically, "…the basic premise of sustainable landscape design is to allow the ongoing processes that sustain all life to remain intact and to continue to function along with development (Franklin 263). Ecological design is about looking to natural systems in order to design our own systems, and learning how to make the two worlds one without destroying either. At perhaps a simpler time, this would not have seemed difficult at all, but in this post-industrial age we must relearn and rediscover what those principles are that govern the natural world, for we are realizing that only by this way will we learn to live on this planet on a long-term basis. The idea is that we can reintegrate with nature by becoming like it – by designing using local natural capital, learning how to use its systems and flows, and changing our concept of ourselves as separate. This philosophy overlaps many fields, and its principles can be used in architecture, restoration, ecology, land planning, and civil engineering, to name a few. In this case, by designing schoolyards that embody this attitude, we can reconnect children to natural ecosystems by making them aware of nature's wonder, bounty, and richness. This demonstrative step is crucial in order to integrate our world with the natural one.

Sustainable design principles

In order to bring the natural world into children's lives, it is important to understand how ecological and human systems can fit together. Ecology is still an evolving discipline, and there is much yet for us to learn. Its laws are based on flux, change and interconnectedness. Each individual and species fulfills a specific purpose, and is an essential part of a changing web of relationships. Ecology is defined as "the scientific study of the processes influencing the distribution and abundance of organisms, the interactions among organisms, and the interactions between organisms and the transformation and flux of energy and matter" (Definition of Ecology). Some of the ecological principles we understand are that, for example, when a site is disturbed, certain species will colonize that area, depending on the environmental conditions, and over time these species will change – often in predictable patterns, but not necessarily so. We also understand that species tend to arrange themselves in predictable collections known as communities, based upon evolved relationships and the specific environmental conditions in that place. A "community" can be defined as "a distinctive group of plant species which may be expected to grow naturally together in more or less the same population proportions under similar habitat conditions" (Franklin 271). We also know that these communities maintain themselves through biodiversity (species richness) and self-regulation, so that if disease or some other event occurs, some species will survive the disturbance. These communities are also linked together through the flows of nutrients, water, and energy, often in ways we haven't yet discovered.

> “*Natural systems, from a pine forest to a creek-side habitat, are complex. They involve soil and its mineral composition, water and the way it moves, plants and what they need and who they feed, insects and what they pollinate, animals and how they survive. Even one system is more than one person along can understand in detail.” (Phillips 130)*

We also recognize that our ignorance and blatant disruption of these systems has caused us to make uninformed decisions about its use, and to degrade many of the ecosystems that surround us. “Everywhere the landscape is deteriorating – a direct result of the attitude that land is a commodity and that natural and cultural values are expendable” (Franklin 263). In addition, invasive plants – those that spread uncontrollably over the landscape, often due to lack of natural predators – are threatening the biodiversity of our native landscape. The presence of most of these plants can be attributed to human introduction, either through world-wide trade or purposeful establishment. For example, the introduction of kudzu for erosion control in the southeastern part of the United States turned out to be a catastrophic mistake.

> *“During the 1930's, the Soil Conservation Service paid hundreds of men to plant kudzu, and in the 1940's, farmers were paid up to $8 an acre to plant kudzu. The United States government stopped advocating the use of kudzu in 1953, and the USDA declared kudzu to be a weed in 1972. Today, kudzu covers 7 million acres of land in the southeast and is spreading at a rate of 120,000 acres a year. In my own state of Mississippi, almost 250,000 acres are covered by kudzu. (Hollis)*

Ecological design attempts to change all this – to make choices based on environmental conditions already present, to celebrate our understanding and oneness with our natural world, and to involve people both in the process of design and in the management of resources. Great strides have been made in developing a foundation of principles for this emerging discipline.

Carol Franklin, a founding principal of Andropogon Associates, has written extensively on sustainable landscape design, and has implemented her theories in many projects over the last 20 years. Andropogon Associates is known internationally for its successful implementation of ecological design principles and for its leading role in the management and restoration of both pristine and environmentally ravaged sites. Franklin says in her essay, "Fostering Living Landscapes," that the key to sustainable design is the systems approach, in which everything is assumed to be interconnected. It is not about solving individual problems, but about the management of the entire ecological system and its resources. The second premise on which sustainable design is based, she says, is "that product and process are one. Therefore the process by which an end is achieved is often given as much…weight as the product, because it is recognized that only by changing the design process is it possible to change the design result" (264). Sharon Stine agrees:

> *With greater emphasis on the process of design over time, there is the opportunity to assess how a setting currently fits the behaviors of those who are using it and to predict what might happen or change. Destinations, like products, provide focus and direction to a journey but should not overshadow and dominate the process." (Stine 95)*

Sustainable design also seeks to reverse the process of the fragmentation of our native landscape. To do this, Franklin suggests two modes of attack. One is by "creating strategies to reconnect fragmented landscapes and establish contiguous networks with other natural systems, both within a site and beyond the site boundaries, and second, in reestablishing the widest possible range of indigenous plant and animal communities, in appropriate habitats, to restore to the site its potential diversity of species" (Franklin 267).

Two other designers, Sim Van der Ryn and Stuart Cowan, have worked extensively in the field of ecological design. In their book, Ecological Design, they present a vision of how the living world and the human world can be rejoined through effect adaptation to and integration with nature's processes. The authors weave together case studies, personal anecdotes, images, and theory to provide a thorough treatment of the concept of ecological design. In the process, they present and explain a series of design principles that can help build a sustainable world with increased efficiency, fewer toxics, less pollution, and healthier natural systems. These principles are:

1. *Ecological accounting informs design*
2. *Solutions grow from place*
3. *Everyone is a designer*
4. *Design with nature*
5. *Make nature visible*

Ecological accounting informs design

"No ecological design is executed without a careful accounting of all ecological costs, from resource depletion to pollution and habitat destruction"(Van der Ryn and Cowen 54). For every resource used, there is an ecological "footprint" made on the land – an estimation of how much land a system requires in order to run, based upon energy use, human consumption, transportation types, and the type and amount of non-renewable resource use (Gouvea). Using traditional technologies, schools in this country have a much larger ecological footprint than the land that they own, and in addition, they are not responding to the ecological conditions that exist on that site. Rather, these conditions are bulldozed to fit what ignorance has dictated as a necessary landscape. An ecological design looks at the natural systems of water, soil, and vegetation – what their current status is and how their health could be integrated and improved in the human landscape. Once this accounting is done, management of the essential resources becomes the primary goal of the design. For example, the presence of water on the site is celebrated with the management of a natural wetland, instead of the traditional practice of a fenced, engineered water retention area.

Solutions grow from place

This concept means that the best design solutions are going to emanate from the specific place where they are to be implemented, because each place exemplifies a unique character. The standardization of our communities and landscapes around the country, evidenced in the prevalence of chain stores and colonial architecture, as a part of suburban uniformity, is a reflection of our lack of ability (or willingness) to do this. We have continued to repeat the same types of generic landscapes because it is easier, cheaper, and acceptable to the broadest range of people. It is easier to follow what has already been done before, which, unfortunately was not part of a tradition of responding to the uniqueness of place, than to come up with original community plans. The benefit of letting the inherent patterns and textures of a place be reflected in a design is that the distinctiveness and freshness of each place is made visible – and can be celebrated by the human population.

Everyone is a designer

"The sustainable design process is inclusive and basically democratic; it is a relationship of consenting equals that builds consensus as a project proceeds" (Franklin 265). The client and the designer should become partners, which means that neither should have exclusive power. And every user brings to the table unique knowledge, and specific needs, so they should be involved as well. Even future generations of users should be considered, in order for the project to be sustainable. Although this large number of participants may be seen as cumbersome, it is absolutely required if the design is going to meet all needs and be managed for the future. This process rarely follows a linear format -- it relies on the feedback from both the users and the environment – to determine the success of the project and to make necessary changes. Unlike traditional designs, where the design is maintained as it was originally put in, the goal of sustainable design is to respond to the site and evolve with it. The trees should be given the space to grow, creating new areas of shade, with the corresponding community of shade-plants growing in the expanding shadow. New species of meadow grasses should appear and be celebrated as the community matures. Sustainable design sets natural systems into motion, with an eye for meeting human needs and aesthetics at the same time.

Design with nature

"By working with the patterns and processes favored by the living world, we can dramatically reduce the ecological impacts of our designs" (Van der Ryn and Cowen 55). This fourth principle – *design with nature* -- was first developed by Ian McHarg in 1969, whose seminal work with the same title is continuing to inform and influence ecological design work today. According to Van der Ryn and Cowen, McHarg wrote,

> *"our eyes do not divide us from the world, but unite us with it. Let this known to be true. Let us then abandon the simplicity of separation and give unity its due. Let us abandon the self-mutilation which has been our way and give expression to the potential harmony of man-nature." (105)*

In order to truly design with nature, we have to think like nature. For example, we have to change our concept of waste into one of renewable energy. William McDonough, a well-known architect and ecological planner states,

> *"Consider the cherry tree. Each spring it makes thousands of blossoms, which then fall in piles to the ground-not very efficient. But the fallen blossoms become food for other living things. The tree's abundance of blossoms is both safe and useful, contributing to the health of a thriving, interdependent system. And the tree spreads multiple positive effects-making oxygen, transpiring water, creating habitat, and more. And it is beautiful!" (Nature's Design Patterns)*

As we look to nature for the answers, we are finding that the solutions to our needs are already present. For example, the movement of the flagellum bacteria is being studied in order to make molecular-sized motors, and industrial ecoparks such as one Kalundborg, Denmark are being developed so that co-located industries work in a food chain, consuming each other's waste. These mimic the nutrient-cycling capabilities of a mature forest (Processes). McHarg states, "to ignore natural processes is to be ignorant, to exclude life-threatening hazards – volcanism, earthquakes, floods, and pervasive environmental destruction – is either idiocy or criminal negligence" (322). It is time to become aware of nature and to use it as a pattern to improve our technologies, systems, and development.

Make nature visible

This is where education plays a vital role in design. By providing children with basic environmental information, we are making natural systems more obvious and more accessible. Take for instance, a system of tanks filled with plants that converts the wastewater from the school into clean water used to irrigate the plants on other parts of the property. At the Ocean Arks International ecological wastewater treatment facility in Providence, Rhode Island, this purification process is already at work. Besides being ecologically effective due to biodiversity and self-regulation in the system, the greenhouse where the system is located is also a beautiful place to be. Wastewater treatment has the potential to delight and inform, rather than be a disgusting and chemical-laden process.

How do these principles and theories translate into a schoolyard design? The design must not only be ecological, but also must fulfill the needs of the users. "The design of a good play environment requires an interdisciplinary understanding of human development, and how it can respond to the capabilities of both natural and manufactured settings" (Moore et al, <u>Play for All Guidelines</u> xi). If ecological schoolyards are going to be an effective new step in playground design, they must fully integrate the needs of the environment and the needs of the users, and be effective over the long-term.

CHAPTER IV – BENEFITS OF CONNECTION BETWEEN CHILDREN AND NATURE

An ecologically functioning schoolyard provides children with all of their basic developmental needs, plus a great deal more. In this chapter, children's needs have been outlined from both a planning and a sociological perspective, and the benefits of ecological connection are provided in each case.

First, however, the concept of what is natural needs to be defined. In this paper, the concept of a "natural environment" is being defined as those areas where natural processes such as soil, nutrient, and water flow are functioning within normal parameters, and where native species – those species that existed on the land before the European settlement – are found in well-established numbers and with a wide variety of species. On a schoolyard, these places are not manicured, but managed to prevent the takeover of invasive species, and to prevent overuse by humans.

The Planning Perspective

The needs of children are well defined by Moore, Goltsman and Iacofano, in their book, Play for All Guidelines. These planners have been studying children's play environments for over twenty years, and have combined their work with those of others into a concise format. They state that a well-designed playground must fulfill several specific developmental opportunities. These are: opportunities for motor skill development, for decision making, for learning, for fantasy play, for social development, and for having fun (Moore et al, Play for All Guidelines 3).

A. Motor skill development

Motor skill development – muscle coordination, balance, and eye-hand coordination -- is one of the playground objectives almost always provided to schoolchildren. These skills typically develop through the most physical, fast-moving, or sports-related games. Unfortunately, it is often the superabundance of this objective that obscures all others in design. There is commonly little more than traditional playground equipment paired with open areas of lawn or asphalt for sports and running games on school property. These elements are needed, but good schoolyard design must reflect other child development needs as well.

> *"No playground is achieved with play apparatus alone however well thought-out it may be. This is far too often forgotten, and it may well be that this very forgetfulness is the cause of most of our failures." (Bengtsson 192)*

Providing natural spaces to play in addition to the sports fields and play equipment increases the possibilities of motor skill development through the increased diversity of spaces. For example, learning to run on a clipped lawn is a lot easier than running through tall prairie grass. And climbing on metal jungle gyms becomes routine compared to climbing on the variety of limbs and logs in a woodland setting. Games become more diverse as well, when there are areas containing obstacles such as trees, streams, or large stumps to navigate around.

B. Making decisions

Opportunities for decision-making are also increased with increased access to natural areas. Natural elements are open-ended opportunities for experience. Choosing whether to play in the sand or the stream is a choice children can make in a natural environment, and either decision results in a positive experience. Making decisions allows children a chance to gain control over their environment. It is this freedom that makes the child feel: "This is my place!"

Part of making decisions involves risk. "Although risk taking is an important part of most playground activities, it does not have to be associated with hazardous and dangerous conditions" (Brett et al 147). However, because of several well-publicized cases of death and serious injury to children, large settlements, and the legal attitudes in the United States, all of those involved in the design and staffing of playgrounds have gotten apprehensive (Brett et al 148). Thus, the opportunities for risk taking have been reduced to a minimum, and the chances for discovery and exploration which children love has been largely lost. Usually children will not attempt an activity that they do not feel comfortable with, but they need to have the opportunity to test their abilities in an adventurous, though not dangerous, place. Ecological playgrounds and schoolyard areas always make children's safety a priority, but acknowledge that more exploration and discovery is possible within a natural, safe environment.

C. Learning

One of the most important objectives for ecological schoolyards is learning – providing children with explorations into how one fits into the larger ecological system, and how the elements of the natural landscape change and react to human interaction. Learning how to understand complex ecological relationships is based upon developing a smaller-scale ecological understanding.

> *"An eight-year old child who has once studied in detail the life of a pond and the many forces impacting this ecosystem will be better prepared to understand large-scale ecological issues than a child of the same age who has seen many films and read dozens of books on the Amazon region."(Hart 21)*

This learning can occur through structured activities, or simply through play and interaction with the environment. In his book, Ecological Literacy: Education and the Transition to a Postmodern World, David Orr provides an outline for what ecological lessons students should be taught. His list of essential concepts provides an educational framework upon which to structure an ecologically-based curriculum:

1. *The earth as a physical system.*
2. *Ecology and thermodynamics.*
3. *The earth's "vital signs."*
4. *The essentials of human ecology.*
5. *The natural history of one's own region.*
6. *How to restore natural systems and build sustainable communities and economies. (67)*

Children can also learn these lessons through simple interaction with the environment as well. "With appropriate supervision, children will solve problems, actively manipulate the environment, transform it, dismantle it, and re-create it in order to learn about the nature of the world" (Moore et al, Play for All Guidelines 3). It is important to balance the transformation needs of the children with the needs of the ecosystem. Children shouldn't be allowed to completely destroy their environmental surroundings, but must have the freedom to "mess things up," because taking apart and putting things back together is a vital part of learning.

In an ecological schoolyard, both children and teachers will have direct contact with other living things, processes, and systems, which broadens ecological horizons and encourages care and commitment to these systems. "Understanding difference empowers us to grow and to care. The variety of organisms helps to teach tolerance" (Nabhan and Trimble 23). Teachers will be able to conduct experiments, teach students both simple and complex science lessons, and provide children with a field experience – all while on school property. Ecological design can also make visible the usually invisible processes of the natural world, as in a sundial, wastewater pools filled with plants, or a stone wall made of rocks from the site, and identified as such. These details make the outside environment both fun and educational, which students and teachers appreciate, and which furthers the goal of integrating our man-made world with the natural one.

D. Play

Children must also be provided with the opportunity for fantasy play. "Traditionally, play has been described as the child's work. For the progressive educator John Dewey, play represents what one enjoys while one is doing it, while work is what one enjoys once one has accomplished it" (Brett et al 2). Although enjoyable, play has a very important role in the cognitive, psychological and physiological development of children, and though not commonly recognized as such, it is essential to a child's learning. "Play is not merely the child's way of learning, it is the only good and lasting way of learning for the young child" (Piers and Landau 16). It helps them heal from emotional injuries, too. "…Without this chance to experience the natural healing power of imaginative play, the emotional wounds caused by [life-changing] events might never close, leaving the child with a lifelong residue of anxiety and insecurity"(Piers and Landau 16).

Play can be categorized into two dimensions. The social dimension refers to how children learn to relate to one another and to adults, and how they learn new behaviors. The content dimension of play involves the development of the senses, symbolic play, and learning games with rules (Brett et al 5). Play also contributes to the creative capabilities of children. Through their imaginations they are given free reign to design new worlds and bring inert items to life. And because "play is voluntary and self-initiated, it promotes freedom and self-expression" (Brett et al 7). The opportunities for play are available in many places, as is evidenced by children playing in the streets, in sewers, and in parking lots. However, the diversity and variety of experiences that a natural environment affords gives children more raw material to work with – more types of textures, objects and spaces, as well as other living things to interact with -- than a typical urban or suburban landscape.

E. Social development

Children's social development is also fundamental to the program of school – both in the classroom and outside. "By definition the school is a designed and premeditated agent of socialization….[It] is the most predictable and most rigidly structured sociophysical setting in the child's early experience" (Proshansky and Fabian 33). The socio-physical setting does not have to be from a manufacturing plant, however. Natural settings provide the same types of spaces as man-made ones, and a wider variety of choices as well. The variety and arrangement of natural settings promote social relationships because they provide enclosed sitting areas, under the boughs of white pines, behind rocks, or in between highbush blueberry shrubs where children feel sheltered and enclosed. Yet these places are not so private that children's activities cannot be observed. These "private places supporting quiet exploration, that children can get into but that adults cannot" (Moore et al, Play for All Guidelines 16) provide additional security for children when they want to be separate from adults or from louder activities. Age-specific places, large grassy places and areas for large group gatherings -- all of these contribute to a wide variety of social experiences, and must be provided. All of these types of spaces are easily provided within a natural setting. The shade of a tree becomes a place for friends to meet, a meadow area can host the entire school, and a stream can be a place of either of quietness or learning.

F. Fun

Above all, a playground should be fun. This means that the landscape should be looked at and designed with a child's perspective in mind. Children should be involved in the design process and asked what types of natural areas they find exciting, what places are special to them, and why? This will help the design to be congruent with the preferences of its most interactive users. The design of the playground should provide enough interest, variety, adventure, challenge, and privacy to undertake any kind of play activity, and should be fun for both children and adults alike.

The Sociological Perspective

"Children DO need wildness…" (Nabhan and Trimble xv)

Most central to the theme of ecological schoolyards is that children need natural environments, for all of the benefits they provide. We have argued the fact that the connections between children and the environment are being lost. This is both an ecological and a social problem. As children mature, they develop a sense of self, learn what elements make up their world, and ultimately, learn how to be an adult in that world. Traditional educational settings tend to isolate the child from the world into which he or she will grow. The naturalness of the outdoors is kept from them, and their day is compartmentalized and organized so that individual choice and expression are reduced.

> *"Planned environments do not ordinarily permit children to become attached to places, things, or adults. It has become possible for children to grow up with little sustained contact with adults who are doing the mundane things that are a part of the everyday world, such as deep-frying fish, sharpening a knife, negotiating a bank loan, or selecting a ripe melon." (Prescott 86)*

Ecological schoolyards can provide children with contact with the natural environment – to elements, choices, and opportunities that they may not find in their classroom, subdivision or row house. This exposure allows them to develop ecological awareness and an appreciation for all life. In this way children learn to identify with, and thus feel that they belong to, the natural world of which they are a vital part. The presence of an ecological schoolyard should attempt to offset the current trends of isolation from the non-human world by being a non-judgmental, creative, safe place where children can mature.

> *"Interaction with plant and animal materials such as smooth stones, rough bark, wet fur, fuzz leaves, and soft feathers provide sensory experiences different from those offered by a manufactured tricycle or metal slide. People-built elements are a part of our culture and represent ways that humans solve complex problems. To learn about, to value, and to ultimately protect their world, children need to experience it fully in both its natural and built forms, where process is interwoven with product (Stine 31).*

A. Place identity and attachment

A vital part of childhood is building connections with specific places. "Children look at the environment, physical as well as social, for ways in which to understand their surroundings, to satisfy needs, and in doing so behave appropriately" (Proshansky and Fabian 26). At a very young age, the child learns to make sense of the home environment – hopefully a safe place from which to develop. The world then expands to the spaces outside the home, which might include the street, neighborhood or field. "They test their wills against the giants, the grown-ups, as they struggle to define unique relationships to the world. Each moves from there into the land, adventuring" (Nabhan and Trimble 22). The essential connections to specific places are a benefit to a child because it is these places that he identifies as his own, and as a part of his identity. When these places are ecologically rich and diverse, the child is provided with a rich resource through which he can explore. He also begins to understand his relationship to other living things. "By forging connections with plant, animals, and land, by finding ways to experience some relationship to the Earth, individuals can gain a sense of worth" (Nabhan and Trimble 22).

Once a child is old enough to go to school, her life changes a great deal both socially and developmentally. She suddenly spends long hours away from the well-understood home environment, and usually must spend more time indoors, with a large number of individuals in a highly structured setting. Ironically, it is at this critical age that place attachment begins most strongly. From this developmental perspective, the presence of an accessible natural environment seems all the more vital.

> *"My position is based upon the fact that the study of the child in nature, culture and society reveals that there is a special period, the little-understood, prepubertal, halcyon, middle age of childhood, approximately from five or six to eleven or twelve – between the strivings of animal infancy and the storms of adolescence – when the natural world is experienced in some highly evocative way, producing in the child a sense of some profound continuity with natural processes and presenting overt evidence of a biological basis of intuition" (Cobb 1977).*

B. Ownership and pride

In order to determine what kinds of places children need, researchers have asked children from all cultures and socio-economic backgrounds which places they love, which are special to them in some way, and where they go in their free time. Asking children to draw favorite places, name their favorite animals, or describe what they do when they play yields some of the best sociological information available. While studying cultural richness and childhood identity in Boca-Baraccas, Buenos Aires, Nilda Cosco and Robin Moore found a 'paradoxical poverty' of an area of low material resources that is yet culturally very rich. Children felt they were a vital part of the community and had freedom to transform their culture through play and exploration (Chawla, Growing Up 35). "The way many children spoke with pride about the places that we visited during the field trips, and their bold confident body language as they moved around, indicated their strong sense of ownership of their environment" (Chawla, Growing Up 44). From this it follows that it is not the economics that makes children connect to their environment, but a feeling of ownership and pride, which only comes from participation and contribution to that environment. We can take this lesson and apply it to the inclusive ecological design process, being sure to provide natural spaces that the children can "own" and feel proud of.

C. Refuge

When asked, children will often provide revealing comments about the natural world. The following opinion of a twelve-year old black girl, who was bussed to a previously all-white school, provides a particularly vivid description of the refuge possibilities of a natural environment:

> *" I wish I could walk out of that school and find myself a place where there are no whites, no black folk, no people of any kind! I mean, a place where I'd be able to sit still and get my head together; a place where I could walk and walk, and I'd be walking on grass, not cement, with glass and garbage all around; a place where there'd be the sky and the sun, and then the moon and all those stars. At night, sometimes, when I get to feeling real low, I'll climb up the stairs to our roof…and I'll look at the sky, and I'll say, hello there, you moon and all your babies – stars! I'm being silly, I know, but up there, I feel I can stop and think about what's happening to me – it's the only place I can, the only place" (Nabhan and Trimble xxiv).*

This girl would love to get beyond the world of man into a place that has no opinion, no judgment of her. The privacy of that world is precious. It provides a place to express frustration, aspiration and pain, with no fear of the consequences. It is also a place where we can find continuity and stability. The plants and celestial bodies live on without thought of the weather, the traffic, or the deadlines. Nature provides us with much needed contrast to our own created world, as Elizabeth Prescott describes here:

> *"Natural things have three qualities that are unique: their unending diversity, the fact that they are not created by people, and their feeling of timelessness – the mountain, river, or trees described in fairy tales and myths still exist today. These qualities would seem to show children a different reality from that of manmade articles." (Prescott 86)*

D. Adventure

Children need adventure – and they will look for it at every opportunity. Is it not true that children will always find a place to climb, swing or hide? This adventure occurs anywhere that is seen as outside the suspicious eyes of parents, which is often in the natural areas that have not yet been developed. These are the wild spots left over, in between fences and along roadside rights-of-way, where the element of adventure still exists. Children seek this wildness because the program of activity is not defined – they can be creative and make the place their own through a variety of activities. Unfortunately, the components of typical schoolyards -- lawns, playground equipment, and sidewalks – are boring to children because they do not contain this potential for creativity. Instead, each structure and place has a specific activity associated with it. Lawns are for running, swings for swinging, and jungle gyms for climbing. The traditional playground thus often becomes a lifeless expanse of inactivity. "The typical American playground is an unbroken expanse of concrete or asphalt enlivened only by isolated swings, seesaws, and other similar equipment" (Dattner 35). However, by providing natural areas on school property, there is a wonderful opportunity to provide children with the wild spaces they love, yet where safety and security can be managed more carefully.

E. Variety

The natural environment also provides children with endless variety of experience. Within each natural setting, there are a multitude of possibilities. A pond may support activities such as fishing, paddling, catching tadpoles, investigating mud, learning about cattails, or building rafts. Each time a child returns to the spot, a new adventure is born, whether because of a change in season, a new animal or plant to observe, or even because of ecological change over time. Natural areas also provide a wide variety of plants to enjoy. Through her explorations, a child may learn that pine tree sap is very good for making sticky fingers, while a maple tree provides fun helicopter seeds in the fall. The richness of plant diversity increases the possibilities of experience and potential for learning.

E. Smallness

Children also enjoy the variety of small details that nature provides, rather than the big picture, according to Gary Nabhan. On a camping trip with his children, Nabhan recalls,

> *"While the kids were on their hands and knees, engaged with what was immediately before them, we adults traveled by abstraction. We [adults] would position ourselves to peer out over a precipice, trying to count how many ridgelines there were between us and the far horizon. Whenever we arrived at such a promontory, [the children] would approach it with me, then abruptly release their hands from mine, to scour the ground for bones, pine cones, sparkly sandstone, feathers, or wildflowers." (Nabhan and Trimble 6)*

Natural areas are full of interesting things to look at, smell, touch, taste, and hear. Having access to places where children have these small things to investigate – especially ants, salamanders and toads – makes a place fun. Childhood collections of twigs, sticks and bugs are a sign of this passion. Children also enjoy small spaces – and subsequently hide in and build forts and dens -- because they serve as a retreat from the larger outside world of which they are becoming more aware. "As the notion of the self starts to mature in middle childhood, children start to perceive how fragile their individuality is in face of the big world outside" (Sobel 66). The ability to do this in a natural environment strengthens a child's ability to understand that the natural world is a haven and a place of comfort, and that he or she can become a part of the outdoor world.

F. Restoration

According to Stephen and Rachel Kaplan, access to the natural environment also provides people with a restorative opportunity. "It is striking…how readily nature settings and activities that involve the natural setting lend themselves to restoration"(Kaplan et al, With People in Mind 18). Even a view out a window engages the imagination. Some may argue that windows and views should not be in classrooms, because they distract the children, but if the outside is a distraction, perhaps the outdoors is more interesting than what is happening inside, and perhaps the children should be spending more time there. Researchers have also found that

"… students with the plant-rich views rated higher on tests designed to measure their ability to focus or direct their attention. Researchers have also found that just having frequent exposure to nature and natural elements, either in a wilderness setting or as expressed in a traditional garden, can improve a person's performance and ability to cope with disease." (Phillips 82)

The regenerative possibilities are further enhanced with immersion in the natural landscape, with the use of trails, landmarks, distinct regions, and good orientation. Using these tools, children are visually guided through the landscape and become familiar with the elements within it (Kaplan et al, With People in Mind 153). An ecological schoolyard therefore should inherently provide both passive and interactive benefits to both students and teachers.

G. Individual expression

The organization of the traditional school environment makes individual expression very difficult. In a conventional school, the schedule and activities are very regimented. Children must all eat, sleep, read, and learn math at the same time and in the same place every day. The system is organized to help children achieve specific skills, in a specified amount of time. When do children have options or the opportunity to make their own decisions? Recess is likely the most "free" time that children have during the school day. No wonder it is a favorite time of day for many children. During recess they can make personal choices about where to play and who to play with. The variety of choices are even greater when children have a pond, stream, meadow, or woodland as play possibilities, instead of only concrete, grass and swings.

Other users

"Anyone who has seen children stoning crabs on a beach or burning cigarettes into frogs knows that contact with nature alone is not sufficient for a child to develop understanding of, and a caring relationship for, the natural world. The role of adults is crucial. Opportunity for a rich diversity of direct experiences with the natural world alongside adults who are informed and caring about the natural world is ideal." (Hart 19)

The attitudes of the parents and teachers who are the role models for children are extremely important. There are a wide variety of environmental attitudes in the United States, ranging from anthropocentric utilitarianism to holistic ecocentrism. These attitudes will be passed down from generation to generation, since children absorb and mimic the views of their mentors. Thus it becomes apparent that in order for environmental awareness and understanding to develop on a national scale, we need to surround children with the people who also have an ecological understanding, or at least, ecological awareness. The support of parents is also extremely beneficial.

> *"[parents]have the greatest interest in the design of a successful play facility. Mature parents are very much concerned and will often go to great lengths to provide a good environment. Thoughtful parents, however, take great interest in trying to discover what the child's needs are, in distinction to their own.*
>
> *Parents can have an important influence on the design of play facilities…but their role at present is usually limited. They are seldom consulted when play facilities are being planned, a situation that often results no only in obvious design mistakes, that any mother could spot in an instant, but also in a feeling of hostility in the community toward the new play facility and those responsible for its construction." (Dattner 33)*

If parents are included in the design process, solutions can be found that would otherwise have been overlooked. This inclusion can also be a teaching tool for educating parents about the proposed ecological design, and gaining their support from the beginning. If parents are supportive of ecological concepts being demonstrated in the schoolyard design, then there is the potential for weekend maintenance days and other community activities that are centered around the schoolyard environment. This community support will be one of the ways that an ecological schoolyard will be successful, because it will be appreciated and managed for the long-term. The ecological schoolyard is not only for the children, but for the entire community to use and love.

From a planning perspective, it is also important to think about the teachers and other users of the space. The space must allow teachers to supervise, organize, maintain order, and facilitate classes, while also providing children with the sense of privacy and adventure that they need. Thus, areas that appear enclosed to children, but that are openly visible from a higher perspective, provide both users with the necessary environments. The spaces must contain enough interesting material that the teachers and other adults using the space will be have a lively place to use as well.

> *"It is difficult for teachers to experience a range of complexity, or a richness of texture and diversity of view when the outside environment is so simplified. The aspect of a metal slide with black rubber matting below is not a multi-sensory experience for the adult in charge. Spending portions of every day in a setting where the view is enclosed by metal fencing and dominated by hard surfaces offers little change in color, texture, or form. It becomes a setting of sameness, both in form and activity." (Stine 170)*

In addition, there should be comfortable, adult-sized places to sit and observe, as well as child-sized spaces. The teacher will be much more at ease and more effective if basic needs are provided. In addition, a space with movable elements (chairs and tables, bricks and blocks) and variety of enclosure and texture (shade, sun, private, or exposed) will also stimulate teacher's creativity and lead to more interesting lessons and experiences for both the adults and children.

The other adults that live and work in the vicinity of a schoolyard must also be considered. They will likely have strong opinions about it, and should be included in the design process. These adults may include elderly persons who enjoy watching children play, or neighbors who are annoyed by screaming at seven o'clock in the morning. "Although less immediately affected than parents, this group may actually have more influence on the final design of a playground. They generally are older than the parents; they have deeper roots in the community, and therefore exercise a greater degree of political control" (Dattner 34).

CHAPTER V -- CASE STUDIES

An ecological approach to the design of schoolyards is now being practiced around the country and world. Wetlands and forests are being repaired, gardens are being planted, and water flows are being restored and celebrated in the landscape. Children are thus being afforded the benefits of these environments.

> *"Many … schools have constructed or repaired wetlands, prairies, or forests on their grounds to increase local wildlife habitat. Some schools now have vegetable gardens that improve children's eating habits and teach them about food production. Other schools are restoring local water flows and drainage patterns or using campus waste as a resource. Schoolyard projects like these help teachers ground their lessons in real-world issues and hold students' interest by directly engaging them in local problem-solving and hands-on activities. They also help to reduce the school's impact on the surrounding local environment." (Danks)*

The following case studies take a deeper look at the role models of this type of design. They prove that ecological design is an effective strategy for reconnecting students of all ages and socio-economic backgrounds with their native landscape.

Ross School, East Hampton, Long Island

At the Ross School, in East Hampton, Long Island, there is a distinct feeling of oneness with the natural world. The schoolyard glows with the integrity of the "spare, elegant, evergreen native landscape of the Long Island Pine Barrens," (Ross School) which have been seamlessly interwoven with outdoor classroom space and thoughtfully planned activity areas. At this alternative school, Andropogon Associates -- leaders in the practice of ecological design -- were called upon to design the outdoor spaces for three new buildings on the campus. In order to maintain the ecological integrity of the site, they created each space to reflect and bring out the natural configurations of the landscape. For example, outdoor rooms were created of native woodlands, thus extending the atmosphere of learning out into a natural setting. The dramatic, glacial boulders from a local terminal moraine were used to divide space into smaller, more private spaces. A stone amphitheatre was nestled into the landscape for use by the music and drama classes. The school also wanted the landscape to reflect the values of Eastern and Western culture, so Andropogon Associates carefully blended these concepts and created places for play, learning and meditation.


Fig. 5.1 Landscape at the Ross School (Ross School)

On this campus, the patterns of the natural landscape have been woven into the fabric of the campus at every turn. "The intent is not to mimic nature, but to heighten one's awareness of man-made boundaries by integrating native landscape patterns into the campus" (Ross School). Therefore this was not an environmental restoration in the purest sense of the word, but an integration of the natural with the human.

The natural resources of the site are protected on the site, and clearing of the native landscape during construction was kept to a minimum. The water on the site is managed onsite, so that no burden of stormwater falls into the creeks. This was done through integrated stormwater management and minimization of non-porous surfaces. The vegetation and native habitat has been preserved, as half of the site is designated to remain undeveloped. The presence of this undeveloped land helps to provide the naturalistic character of the school.

Long-term management of the natural resources was an important goal of the project. Andropogon Associates thus “established and implemented landscape guidelines and design standards for the campus that reflect the school's holistic and sustainable philosophy” (Ross School). These guidelines are designed to help the school respond to natural environmental change over time and respond to that change in a way that promotes health and integrity in the surrounding ecosystem.

In this learning environment, children have the opportunity to explore and identify with the beautiful native landscape that surrounds them. As the project has matured, the school has seen that “the presence of art, the integration of technology, indigenous materials, and architectural forms support the curriculum and foster a sense of community around the process of learning” (Ross School). The client and the design team worked together so that the curricular goals and moral foundations of the client would be reflected in the landscape. Because of the environmental values of both parties, the natural characteristics of the place were brought out and celebrated, and the foundation was laid for the continued bond between the students and their native landscape.

Coton Community Primary School

“Coton Community Primary School is the most inspiring example of outdoor environmental design taken to heart” (Stine 196). It is a wonderful example of how small steps, taken by educators and parents over time, can change a schoolyard into a wonderfully inspiring and interesting place, full of natural beauty and places for exploration. Although the building is non-descript, it has large windows, a large center courtyard, and lots of trees covering the grounds, giving a park-like effect. Sharon Stine visited the school and upon her arrival described the impact of the natural landscape:

"A swath of grasses begins at High Street and winds back into an open space as far as the eye can see. The walk up to the school's main entrance took me past a garden that was tidy, but not groomed. The shrubs and flowers grew freely, preparing me for the sense of freedom that permeates the school and wooden flower boxes lent their welcome. A child-designed wind vane and sun dial and a wild garden led me further into the world of Learning Through Landscapes, convincing me that the building structure of a school is only half of the school at best. There is a treasure of learning environments waiting to be discovered and created outside the classroom door" (Stine 198).

The school was not always this wild and interesting, however. One of the school's missions is to stimulate curiosity and to challenge the pupils, and the design of an interactive schoolyard has thus developed over time to meet these goals. This school is a model for how to include children in a participatory way, following Van der Ryn and Cowen's principle: *Everyone is a designer*. Children's ideas have been used as a vital part of the design process from the very beginning. One of the first projects embarked upon was to make the schoolyard more adventurous. Children were asked what they thought the spirit of adventure was. Here are two responses:

"I think it is dangerous, full of excitement, discovery, and courage. It is exploring, meeting challenges, and alertness. There is always something new, something with great awe and wonder and power, but a slight bit apprehensive" -John James, age 10

"Adventure is to experience a very exciting way to view, not only the world, but to test and challenge yourself to a limit." --Anna Mason, age 10 (Stine 99)

Each student was given the opportunity to design his or her own adventurous place. From the models that the students built, a design was selected, and eventually, through a lot of fundraising efforts and volunteer support, the play structure was built. The process was slow, but because small steps were taken in a systematic way, the project was completed, and was successful in response to the changing needs over time.

"A date was set for a working weekend, and I asked the parents to decide which tools they would be willing to bring along. We needed to hire a posthole auger and a concrete mixer. ...During the week before, the 10- and 11-year-old pupils set out the form of the maze using pegs and string. They also marked the ground where all the upright supports would be fixed.

> *There was great excitement on the Saturday work commenced…I cooked a barbecue lunch for everyone, and we completed this first stage and arranged a grand opening. The children had a new outside resource, one they had been involved with from the beginning brainstorming stages to the final building. Because of their involvement they had a strong sense of ownership. (Stine 200)*

The following year a new idea –"movement" -- was proposed to the students, and the process was repeated in much the same way.

> "*We studied people who moved around, such as the nomads, or the scientific movement of the body as a physical organism. We decided that we wanted to be able to balance, swing, climb, slide, jump, and run. The children continued to create design ideas, and we worked again with adult art students and parents…As a community of many ages and talents, we realized on completion that together we had created an aesthetically pleasing design and added to the resources available outside on the school grounds." (Stine 200)*

The children were also involved in establishing the native plants on the property. They planted a hedge to attract butterflies, and another hedge of "Old English" plants native to Cambridgeshire, where the school is located. They also helped to create a wild garden, a weather garden, and a flourishing courtyard garden.

> *"Each class developed a different aspect of the garden: a pond, some nesting boxes, a bird hide, wildflowers, places for hedgehogs or mini-beasts. The tasks associated with creating a pond involved a variety of mathematics activities. One class investigated the problems of measuring the distance from the nearest water source to the pond and purchased the required hose pipe." (Stine 201)*

The school is now working on developing a long-term management plan, working to be sensitive to change and to look at the property as a whole, with solutions coming from natural processes. As a part of the mathematics curriculum, the students produced a scale plan of the school, with locations of all of the trees, land use, wildlife potential, and the proximity of the community members nearby. They have decided to initiate a tree planting program, so that successive classes will be involved each year, and so that there will be curriculum continuity as well as natural resource abundance. And the kindergarteners have been given the task of planting bulbs, so they will be engaged in environmental awareness as well (Stine 202).

Other plans for the future include a geological rock garden, an outdoor stage, and building an adventure trial around the entire perimeter of the school grounds. The school's landscape now happily reflects the attitudes of the people using the space, which is a blessing to all involved.

> *"The school grounds are often the first place that pupils, parents, and visitors see, and impressions about a school may be formed even before entering the building. The grounds communicate messages in a unique way and their contribution to the atmosphere of the school is significant, as this environment reflects the values and attitudes of the people who work there. School grounds are among the few areas in which schools are free to develop their individuality." (Stine 205)*

Coombes Infant and Nursery School

Fig. 5.2 Children on pathway (Coombes)

The Coombes School has gained worldwide recognition for their rich outdoor environmental education program. They offer "a stream of first-hand learning experiences which anchor education in the real world" (Coombes). This hands-on education is designed around a natural landscape, to help children appreciate and understand the natural world around them. Because of the focus on participation, the school also involves the local community in their efforts, which in turn increases support and educational opportunities for the children. The grounds include nature trails, woodlands, ponds, meadows, and an outdoor classroom – all of which are designed into the participatory curriculum.

On the seasonal planting and harvesting trail, children participate in the planting and harvesting of daffodils, willows, sunflowers, and other fruits and vegetables. They are taught as they walk -- what plants to avoid, and which plants have medicinal or other valuable properties.

> *"We feel it is important to offer the children the environment where they can make these distinctions, not to attempt to remove everything that appears to be harmful, but to show the children how to recognize plants and their properties." (Coombes)*

All along the trail there are things to observe, harvest, such as hazelnuts and plums. The plants along the trails are managed to provide shelter and food for wildlife, so the school keeps the paths mowed, but the plants along them are kept wild. Due to this biological richness, the children have exposure to the animals that enjoy this habitat.

The vernal ponds are another natural environment the children can enjoy on school property. These areas fill naturally when the water table is high. The children learn the names and habitats of the species that inhabit the ponds, and learn lessons about the water cycle and its relationship to people. The ponds host a wide variety of insects, amphibians, and even a pair of ducks. "Using the boardwalk the children can have the experience of walking out over the water without having to get wet - to observe the dragonflies and many other animals that use the pond, to draw and paint, for science work" (Coombes). The children also create "ephemeral art and float it across the surface and enjoy the variety of patterns of light and color that water offers" (Coombes).

The outdoor classroom is also used heavily, during all seasons and all times of the day. They are places for play and for learning. The area is enclosed with a woven wall of willow – a renewable resource -- and is shaded by mature trees, which provides a sense of security. The newest additions to the natural landscape are two treehouses made of railroad ties. The children use these spaces for fantasy play and quiet socialization. "Structures like this need not be elaborate to create a different sort of space to work and think" (Coombes). Perhaps it is because of their simple wildness that these places are such a popular place to play.

> *"We approach learning with the idea that it is easier to remember what you have felt, seen, touched, tasted and smelled and, most importantly apply a range of learning strategies to see how different subjects relate to each other. Teaching subjects in isolation can often mean they remain isolated."* *(Coombes)*

Patrick Marsh Middle School

Fig. 5.3 Students watch school prairie burn (Donovan)

Since 1999, students and teachers at the Patrick Marsh Middle School have been participating in the restoration of the land around their school. What was once simple lawn has been transformed to a veritable smorgasbord of flowers and native grasses. This school is exemplary not only because of its progressive move to restore their land to native prairie, but also in how it has used the prairie restoration as a hands-on teaching tool.

The project began with a summer workshop run by the University of Wisconsin Arboretum called the Earth Partnership for Schools Program. This program outlines for teachers the process of restoring a schoolyard to its native habitat, and provides curriculum information about how to use the native landscape as a laboratory for science and other school projects. The information was then incorporated in the music, math, and science curriculums through the efforts of those teachers. Students use the prairie as inspiration for poetry, and as a quiet place to read or study. They have learned how to collect seeds, plant them, how to make transects to for collecting vegetation data, and have even learned how burning the prairie is valuable to its survival. In June 2002, after having learned these lessons, students watched as teachers armed with rakes and sprayers set the prairie on fire. (See Fig. 5.3). The burn was effective in encouraging the native forbs and grasses, while suppressing the invasive fescue and other exotic plants. The burn only lasted a half an hour, but was very impressive to the students. Because of their direct exposure and hands-on participation with the ecology of the prairie, pupils at the school have become extremely enthusiastic about the land. They have taken the lessons to heart.

> *We didn't kill the prairie plants," 7th grader Holly Opyd is quick to say. "The roots last," she explains. In just a few weeks, the burned plot will turn green, and by late summer,*

> *Holly says, "it will be really colorful and bright." She and her classmates rattle off a dozen distinctive perennials they studied in their schoolyard prairie last fall: "Indian grass, purple prairie clover, yellow coneflower...." (Donovan)*

When the prairie yielded a crop of valuable ($75 per ounce) purple prairie clover, students collected five buckets full of seeds and donated all of them to the state of Wisconsin in order to support further projects like their own. This dedication and selflessness is a clear indication of the impact the land and the project has made on the students. The project is an obvious success. Currently, students in the after-school Discovery Club collect data on flora and fauna, and are also teaching younger students how to do the same. Students have made presentations in local communities about native plants, and teachers all over Wisconsin that have participated in the Earth Partnership training program are teaching their students these valuable lessons.

These schools are only a tiny percentage of the progressive work being done in the field of ecological schoolyard design. There are schools all over the country that have moved children out of the classroom and into nature's playground. From participation in nature walks brimming with wildlife, to seed collecting and prairie burning, to collecting tadpoles in vernal pools, these children are learning with new passion and enthusiasm the ecological lessons that are so valuable to their development and to our society as a whole. It is from these exemplary models that lessons are learned and points proven. It is obvious that children can learn from taking nature walks, from collecting and planting seeds, and from playing near vernal pools. Each of these opportunities will be incorporated when applying ecological design principles to a site in Athens, Georgia.

CHAPTER VI – APPLICATION OF ECOLOGICAL THEORY

The focus of this chapter will be the application of ecological design principles to a specific site in need of an ecological solution. Like the schools mentioned in the previous chapter, Barnett Shoals Elementary School in Athens, Georgia, has been working toward environmental education excellence in the development of their grounds over the past ten years. They seek to educate their students from a hands-on perspective, and have provided a series of gardens on their campus that provide this type of interaction. However, with the construction of 8 new classrooms and a conventional stormwater detention basin this year, the ecological master plan is getting pushed to the side. Although the classrooms are a highly anticipated part of the school, a detention pond is scheduled to be carved deeply into a small area right next to the young arboretum in a way that is not reflective of the site, of educative possibilities, or of the ecological goals of the school. There are also evidences of erosion from heavy stormwater flows throughout the site. Because of this specific need in a landscape that is already demonstrating many ecological design principles, an alternative solution focused on stormwater management is proposed. Part of ecological design is recognizing where the landscape falls short of its ecological potential, re-evaluating the status quo, and offering alternatives that reflect natural systems. The following alternative ecological design will address how water is managed on the site and show how it can be a valuable educational asset as well.

As a part of the design process, a detailed site inventory was taken, and research was conducted on how the landscape around Barnett Shoals Elementary School has developed over the last ten years. In addition, research was done on how to address stormwater in ecological ways. Raingardens, permeable pavements, green roofs, wetlands, ponds, cisterns, and additional planting are all techniques used to reduce stormwater runoff and which can be used as creative play areas. These areas have been proven as safe places for children to interact with and understand water and its properties, thus adding value and aesthetic appeal to the landscape, as well as an asset for the curriculum. Each of these types of stormwater management were evaluated for their applicability to the site and for their educational potential, and then assembled into a cohesive water management plan for the school.

Barnett Shoals Elementary School

Fig 6.1 Aerial photo of Barnett Shoals (Collins)

Barnett Shoals Elementary School is located at in southeast Athens/Clarke County, Georgia. It is located six miles from the University of Georgia and the college town of Athens. 504 students from all socio-economic backgrounds attend the school that contains pre-kindergarten through fifth grade classes. The property covers fifteen acres of large fields, an arboretum, small student gardens, two moderately sized parking lots, and a small amount of forested land (See Fig. 6.1). There is no constant source of water on the property – only a considerable amount of stormwater during each rain event. The property is bordered by a subdivision built in the 1970's, a brand new subdivision built in 2003, and Barnett Shoals Road, which is a fairly busy road. Like the Coton Community Primary School, the buildings are rather non-descript. The buildings consist of a large, one-story structure with several wings, and a separate gymnasium. Several of the classrooms are under an earth berm, built in the 1970's. There are also several trailers behind the main building which have supported the growth of the school, but which will soon be replaced by a large 8-classroom addition in 2004.

The distinctive characteristic of the school is the variety of gardens throughout the site. These began in 1991 with a project called Garden Earth, an environmental education program supported by the State Botanical Garden of Georgia. A master plan was later developed by Maureen O'Brien, a landscape architecture student at the University of Georgia, and Lauren Zeichner, a parent and landscape architect (See Fig.6.2). A subcommittee of the PTO, called G.R.O.W. (Generating Respect and Responsibility for our World) began developing and implementing the master plan. The goals of G.R.O.W. include hands-on learning, master planning for large goals, phasing of projects, and functional, aesthetic and educational enhancement of the landscape.

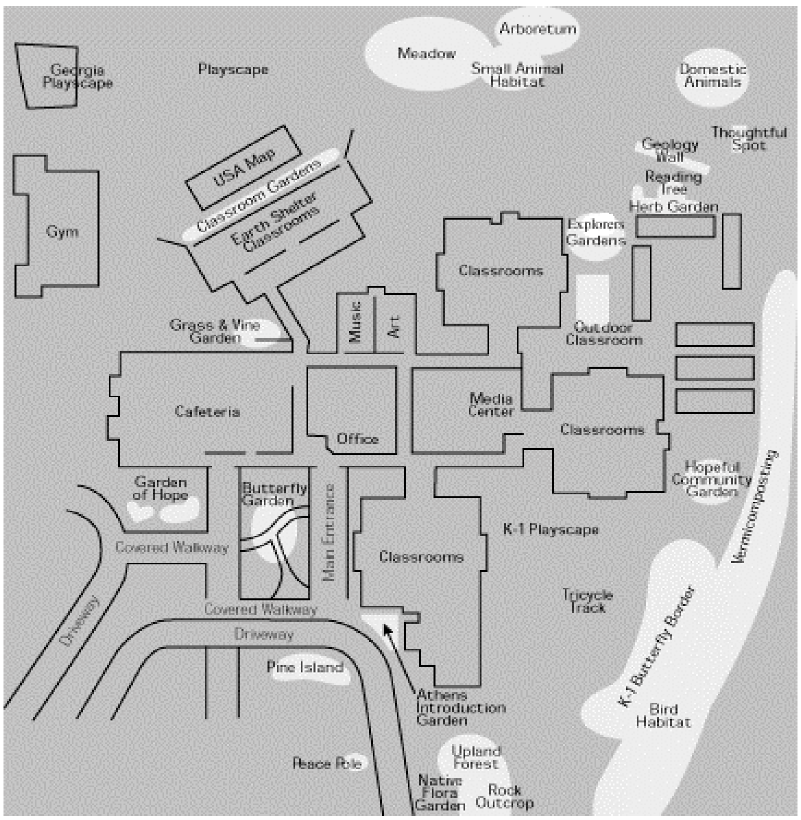


Fig. 6.2 Current master plan for Barnett Shoals (G.R.O.W.)

> *"The G.R.O.W. program provides the opportunity to develop natural resource knowledge in a young population and to study all academic areas in alternative classroom settings. On our campus, we are redefining what is considered to be a classroom or a learning environment. Our mission is to continue to maintain and create a campus where we are teaching environmental understanding today, for the betterment of our earth tomorrow." (Barnett Shoals)*

Over the past decade, G.R.O.W. has organized numerous parents, teachers, boy-scout troops, and students in the planting and required maintenance of the gardens. The group has built several theme gardens, including the Native Garden, Butterfly Garden, Herb Garden and Peace Garden. (Photos of the gardens can be found in Appendix A). They have worked to establish an arboretum that is now beginning to mature and provide shade near the back of the property. In addition, G.R.O.W. has supported the establishment of the school's Science Discovery Center and has provided classroom materials to the library for teachers to use with classes" (English 2000). Another distinctive feature is a geology wall that has a key to all of the rocks contained therein, which is used to teach geology lessons. The property also houses a sheep and a goat, affectionately known as Rose and Penelope. In the future, G.R.O.W. would like to add a water garden, a recycling center, benches in the Native Garden, interpretive signs in the Arboretum, and finish the "Thoughtful Spot." Additional planting of trees is scheduled to continue, as are additions to the Explorer's Garden, Native Garden, Butterfly Garden, K-1 Gardens. Maintenance is done seasonally and annually by both classes and volunteers, both during class time and during Saturday work days. The school has set a good example of ecological design with all of these efforts. The information following about alternative stormwater practices will hopefully aid them in the future development of ecological stormwater design.

Water in the schoolyard

From an ecological perspective, water is the most necessary ingredient of an ecosystem. It covers three-quarters of our earth and is essential to the function of most plant and animal communities. In wooded areas or other natural settings, the energy of stormwater is dissipated by leaves, roots, leaves, and a healthy, non-compacted soil. Natural wetlands and ponds store and remove pollutants from the water as it percolates into the groundwater. However, the movement of water across the landscape has changed significantly as development has increased. Because of the high levels of impervious surfaces in suburban and urban landscapes, the volume and force of stormwater has become much more extreme.

Traditional conveyance strategies have been designed to get the larger peak volumes of water off of impervious surfaces, such as pedestrian areas, roads and parking lots. (See Fig. 6.3). These pipes and culverts do not serve to decrease the speed of the stormwater flow – they are designed to convey water as quickly and efficiently as possible. Pipes transport the stormwater

Fig. 6.3 Conventional stormwater detention pond (Ecological Characterization)

either directly into the stream, where the erosive force often causes the stream to erode its banks, or into stormwater detention ponds. These ponds are designed to contain the large volume of stormwater until the storm event has passed, so that the peak flows do not travel directly into the streams and rivers.

However, detention ponds only hold the water temporarily, and once the storm has passed, the water is then rapidly sent back into the stream. These ponds are typically dry in between storm events, and therefore do not function as wetland habitat, or perform any of the cleansing functions of a wetland.

Unfortunately, the water on school grounds is usually managed in this traditional way – with detention basins and culverts that transport the water to the nearest stream as efficiently as possible. In so doing, local stream ecology is disrupted, and water is isolated from the landscape and from the people. Children are not afforded the opportunity to learn how important water is to the function of all ecological communities, or simply the chance to enjoy the hours of fantasy play that water can provide.

> *"This traditional engineering solution bypasse[s] several critical stages of the natural hydrological cycle: soil percolation, collection into aquifers…absorption by plant root systems, migration through the leaves as water vapor into the air, and eventual return to the earth as precipitation" (Moore and Wong 37).*

When development occurs, the stormwater runoff from individual properties and roads intensify; flows can increase and contaminants from residential activity and associated vehicle use flow into the streams and watercourses. The effects of development on stormwater flows can result in:

1. *Stream bank erosion in existing watercourses;*
2. *Sedimentation in existing watercourses and downstream environments;*
3. *An increased tendency for more severe flooding and increased areas of flooding;*
4. *An increase in the sizing of stormwater pipes;*
5. *The increased contamination of receiving environments, both in local streams and in the marine environment where all stormwater eventually goes; and*
6. *Adverse impacts on aquatic resources. (Stormwater Management Guidelines)*

Under traditional circumstances, schoolyards are adding to this problem. To the public, and to many developers, water is not perceived as a potential asset because its management is not well understood. Fears about mosquitoes, and more seriously, accidental drowning, have kept the natural beauty and ecological benefits of water away from schoolyard areas. Moore and

Wong comment about the same obstacles as they built the ponds and creek at Washington Elementary School in Berkeley, California:

> *"Like any project involving many partners and levels of political approval, careful consideration had to be given to such issues as gaining the consent of school authorities, managing state and local policy regulations, and incorporating these elements into the overall vision…Given the natural processes involved in the evolution of handmade ponds and streams, it is easy to see how some officials might have been concerned…Water samples had to be taken, insurance issues covered,…and positive public perceptions maintained" (Moore and Wong 38).*

Moore and Wang found support in unexpected places, however. The local county mosquito abatement officer strongly supported their work, and stated that "'if everyone grew up with this kind of educational experience, my job would be a lot easier. Instead I have to deal with a public who by and large know nothing about pond life'" (Moore and Wong 38).

Although these alternative strategies to design may encounter opposition, there are so many benefits, to both children and other people in the community. The benefits of bringing water into the landscape is well documented and appreciated by those who have seen such design come to fruition.

> *"Water is a marvelously manipulative, multi-sensory substance. As a play material, it provides light, sounds, tacticity, and movement. Water settings are very flexible. They can accommodate solitary and parallel play and groups of any size. Play with water and associated play props provide one of the most attractive, interactive play settings possible – an irresistible stimulant for dramatic play. Naturalized aquatic settings also bring together plants and animals, a combination that can hold children's attention for hours" (Moore and Wong 49).*

Background research

In order to provide the children and other users at Barnett Shoals Elementary School with an ecologically-sound water management solution that also would meet their needs, research into the types of ecological methods for stormwater control was conducted. The results of this research follow, as well as how these methods can meet specific design goals.

.   *Rain gardens or bioretention areas*

A large part of stormwater management is the limiting of peak flow rate, volume of runoff and time of concentration to pre-developed conditions (Stormwater Management Guidelines). In order to accomplish this there are several design methods available. A rain garden is a vegetated depression that collects stormwater during a rain event, and then allows the water to slowly infiltrate back into the ground. Planted with native vegetation, they allow approximately 30% more water to soak into the ground than a patch of conventional lawn. (See Fig. 6.4). They may actually increase the temperature of the water, and are not known to increase biological productivity downstream. In general, they cost about 25% more than detention ponds of the same volume. However, rain gardens reduce the peak runoff into streams, thus reducing the amount of erosive force entering the stream. By returning stormwater back to the groundwater system, they help recharge groundwater supplies, which in turn helps sustain stream baseflows. These are becoming more popular in suburban areas because they also are more attractive than convention detention ponds, and they provide habitat for wildlife that people enjoy, including butterflies and birds.

Fig. 6.4 Raingarden with native vegetation (University of Wisconsin)

Rain gardens are functional for small areas, usually less than one acre, and they must be contained entirely within lot boundaries. A maximum depth of 6 inches is recommended for soils with an infiltration rate of at least 2 inches/hour, and a maximum of 3-4 inches recommended for soils with low infiltration rates. Pooled water should be infiltrated within 6-12 hours after a storm event, for safety and mosquito infestation reasons. In heavy soils, an underdrain should always be incorporated into the design of a raingarden to provide adequate drainage during wet weather. To prevent the migration of adjacent soil into the planting soil and the migration of planting soil into the underdrain material, filter fabric is required. For rain gardens, the planting soil permeability may become reduced with the clogging of organic and fine silt and clay particles. This in turn will increase surface ponding time. For rain gardens and wetlands, maintenance of the vegetation is also a vital component. During dry periods the underdrain in the rain garden may cause the rain garden to dry out, which may necessitate watering of the vegetation on an as needed basis to ensure a healthy condition and appearance.

The plants used in the rain garden must be able to withstand high levels of pollution, highly variable soil moisture conditions and must be low maintenance. Hardy native wildflowers, grasses and shrubs that have been used successfully in the Southeast include: Butterfly Weed (*Aesclepias tuberosa*), Black-eyed Susan (*Rudbeckia hirta*), Big Bluestem (*Andropogon gerardii*), Joe Pye Weed (*Eupatorium fistulosum*), and Buttonbush (*Cephalanthus occidentalis*). Trees suited to periodic indundation may also be used. (For additional plant suggestions, see Appendix C).

Permeable pavements

These pavements or surface treatments are designed to be permeable, so that stormwater can infiltrate back into the groundwater through the soil. There is a wide range of available products, including porous concrete, porous asphalt, paving grids and blocks, open-graded aggregate, porous turf and plastic geocells. The benefits of these products are that they reduce the amount of runoff, which in turn reduces peak flows after storms, and that they lower the amount of pollution going directly into the stream. They are designed with very high potential for infiltration, but some overland flow may occur if rain intensity or slope is very high. The cost for permeable pavements is usually higher up-front than traditional pavements, but pays for itself in reduced stormwater infrastructure over time.

Green roofs

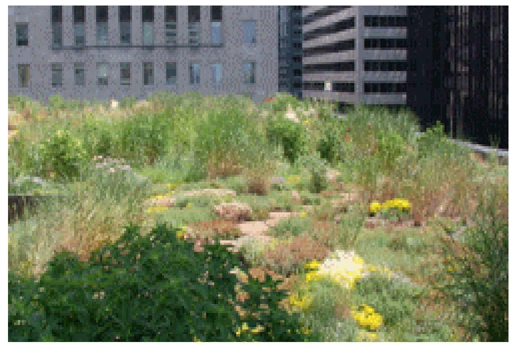


Fig. 6.5 Green roof on Chicago's City hall (Chicago City Hall)

Green roofs are vegetated stormwater collection areas on the tops of roofs, which also provide energy insulation and gardening opportunities for people. There are two types of green roofs. Extensive green roofs have a light, engineered soil with a thin vegetated layer, usually consisting of sedums and short grasses. Extensive systems are not accessible to the public, and require little maintenance. Intensive green roofs have a deeper soil medium and can contain planters, trees and water features. These may be accessible to the public, and may be marketed as "gardens" for the public. Both types have a thick liner on the bottom to prevent leaks, and both are effective stormwater collection types. They retain an average of 75% of the water that falls on the roof, and any excess is slowly drained into cisterns or other collecting areas. This water may be used for irrigating the green roof during dry times, or for other irrigation needs. Green roofs are usually best on roofs with a slope of 5-20%, so that water can move off of the roof eventually, and also so that the water won't move off without absorbing into the soil. The problem of possible leaks is the biggest drawback, but technologies are moving ahead with leak detection and patching solutions.

Wetlands and Ponds

Wetland areas and ponds are suitable for larger catchment areas and are designed for both stormwater quality treatment and stormwater quantity management. The benefits of ponds include species diversity, wildlife habitat, aesthetics, water quality, research opportunities, and educational opportunities, according to the Stormwater Ecological Enhancement Project. In promoting species diversity, the variety of plantings on the site "provides new genetic material as well as suitable establishment sites for long-term increases in vegetative species diversity." Ponds increase the wildlife habitat potential because the diversity of aquatic habitat found in ponds supports "a multitude of new biotic niches." Ponds are also a beautiful addition to the landscape, and provide the beneficial services of water cleansing. Most importantly, however, ponds are useful to both adults and children for the study and play opportunities found in and around these habitats.

Fig. 6.6 Example of a natural pond in an educational setting (Kids and Schools)

Where flows are large enough to carry a constant volume of water, wetlands and ponds also require the design of sediment forebays. These forebays allow the settling of sediment before the water enters the wetland or pond. They require regular cleaning and de-silting to maintain the performance of the wetland and pond areas. Maintenance and screening of the outlets is also a required element, so that they do not become blocked or filled with debris or sediment. Suitable planting of wetland areas is just as important to ensure that the selected plants remain in a healthy condition during wet and dry periods.

Additional planting

Adding shrub vegetation is a valuable stormwater management tool. It can easily reduce the total volume of stormwater runoff, especially when it is replacing impervious surfaces. However, the permeability of the soil is also higher than in areas of grass. Scientists have drawn a relationship between the increase in the area perviousness on a site and corresponding percentages of shrub and tree planting (Stormwater Management Guidelines). Planting native vegetation also provides other ecological benefits, such as food for wildlife, screening from wind, and shelter for animals.

> *"Another major benefit of planting relates to long term maintenance. Conventional stormwater management techniques, in the form of ponds or other structural approaches, generally require increased maintenance over time to maintain water quantity/water quality performance. Once established bush revegetation should require less maintenance over time, which is a significant strength of the approach." (Stormwater Management Guidelines)*

Cisterns

In areas with limited space, cisterns can be an effective way of eliminating all stormwater runoff of a roof. They can be used at the end of gutters or drain spouts to collect water off of roofs, which then can be used later for irrigation, or other non-potable uses. There are a multitude of different designs, including above and below-ground systems -- even ones that separate the "first-flush" of polluted water that runs off a roof from the rest of the runoff. They range in size from a five-gallon bucket to thousand(s) of gallons.

Goals and Objectives for Ecological Water Management for the Project Site

Design Goals

One of the goals of ecological design is to work with the natural systems of the site, rather than against them. The specific needs at Barnett Shoals Elementary School are primarily related to stormwater. Thus, an alternative stormwater management plan is required -- one which protects existing water channels, and which functions according to natural systems. In this case, the design should also provide children with an opportunity to learn and play with the water, and begin to understand water cycle processes. Applying Van der Ryn and Cowan's ecological principles to this site yields the following design recommendations:

1. Manage stormwater in accordance with natural drainage systems and within the property boundaries
2. Assess the site conditions and evaluate what type of water storage is logical for each area
3. Use the existing land features and water available to integrate the design most comfortably within the larger ecological context
4. Design water elements that reflect the topography of the site and which operate in harmony with natural functions
5. Respond to user input in the design and analysis of the water storage areas (not feasible in this case because of time constraints)
6. Provide habitat for a variety of native wetland species
7. Make the water cycle visible
8. Create a safe and entertaining place to play

Design Objectives

In order to achieve the design goals for this project, the following steps should be taken. The corresponding elements will be included in the conceptual design.

1. Plant small raingardens in areas of the site that get soggy during storm events.
2. In areas where there is limited space, catch rainwater from the roof into cisterns.
3. Add a green roof to the new addition.
4. Design small pond to collect the rainwater from the roof of the new addition.
5. Add shrub vegetation in areas that are compacted and impervious.
6. Add pervious pavement on maintenance drives.

These are based on the research conducted, and are designed to control stormwater as well as provide aesthetic appeal to the schoolyard. Their placement will be in response to the natural drainage systems and topography of the site. Their specific designs (seen in the Master Plan on page 72) provide habitat for native species, integrate with natural water systems, fulfill regulatory mandates, and meet all of the user needs and safety considerations discussed in earlier chapters. This design is not just a technical document, however – it is a response to a human need for interaction and play within the natural environment. These ecological design strategies are conceptual, because the focus of this thesis is not on the mathematical details of stormwater management design. However, the design is based on data collected from a detailed site analysis and from research collected from documented sources. The design reflects this data, but is not specific enough to be used in the construction of the design.

Other considerations

During the construction of the new pond and raingardens, it is important to minimize the amount of cut and fill required, so as to not change the landscape unnecessarily. Taking care to minimize damage to already established natural plant and animal communities is equally important. During construction, the stormwater that arrives on site must be managed so that excessive silt and erosion does not occur. This is usually done with correct placement of silt fences, or may not even be necessary if the excavation needed on site is minimal. Recycling of soil, rock and other materials is also an important part of making good use of resources, and not adding to our buildup of unwanted material in landfills.

CHAPTER VII -- SITE ANALYSIS AND MASTER PLAN

Topography/Slope (See page 69)

The site has relatively flat or gently rolling topography, with the notable exception being where land has been excavated near the school buildings. In this case, earth has been built up over a classroom, and the slopes on all sides of this area are extremely steep, at more than a 20% slope. The other steep areas are near the western border of the property, and these appear to be more natural in origin. The western part of the site is at a higher elevation, gently rolling down to the south, and the eastern part is almost completely flat. This may have been natural, but more likely the result of excavation when the school was built. Some of the data from north of the school boundary has been changed since the map was made, with the excavation for a new subdivision.

Soils (See page 70)

There are three soil types found within the boundaries of school property. DqB2 is the predominating soil type, and is found in all areas except for the western part of the site. It is characterized as Davidson sandy loam. According to the Soil Survey for Clarke and Oconee Counties, issued in 1968, this soil type

> *"is suited well to farming. Erosion is a slight to moderate hazard, however, if cultivated crops are grown. Response to proper management is good, and this soil is suited to a number of crops. Most of the acreage is in second-growth volunteer pines, pasture, or cultivated crops." (Davidson Series)*

However, this area has been heavily used and eroded, and little grass is sustainable in some areas because of this heavy use. There are large patches of bare soil, with no obvious topsoil remaining. Sand or mulch has been added in areas close to school buildings in an effort to reduce the potential for erosion.

Approximately 30% of the property – on the western side – contains CYC2, or Cecil sandy loam. According to the Soil Survey for Clarke and Oconee Counties, this soil

> *"has a surface layer of light yellowish-brown to brown sandy loam 6 to 8 inches thick over a subsoil of red clay. In much of the acreage, so much soil material has been removed by erosion that the plow layer now extends into the subsoil…The available water capacity and permeability are moderate, and surface runoff is medium. Further erosion is a severe hazard if this soil is cultivated." (Cecil Series)*

A small area on the property contains CbA, or Cecil soils with overwash. The overwash "consists over sandy loam to loam or heavy loam" (Cecil Series) and is 10 to 20 inches thick. This layer covers a subsoil of red friable clay, and the entire profile is very acidic. "Runoff is slow, and the available water capacity is high" (Cecil Series). This area of the site has not been heavily excavated, and mature trees thrive in the area, so it is likely that this richer soil has not been severely eroded.

Existing Conditions (See page 71)

The majority of hard, impervious surfaces and buildings are found in the north and east portions of the site, although the parking lots and school buildings cover 30%- 40% of the total surface area of the property. There are two main parking lots on the east side of the property, and these are completely full and overflowing during school hours. Some grassy areas are also used as overflow parking. The school building is a one-story structure that has been added onto several times as the student population has increased. Six trailers have also been added to accommodate all of the needs of the school, and these trailers have become quite permanent, with concrete pathways and small gardens added to them. Most of the open spaces consist of dirt or grass areas, depending upon the levels of use. It appears that more grass was intended, but because of heavy use by children, these areas are well-worn and little grass is present. As was stated in the soil section, some of the areas around the school buildings and under play structures have been mulched in an effort to keep the areas cleaner and safer for the children.

The gardens are a significant feature on this site. Several of them are in prominent locations along the sequence of spaces from the parking lot to the front of the school. Others are found at the back of the school, near the outdoor classroom or near well-used pathways. All are in close proximity to the school building. The arboretum, however, is found on the western side of the property, and is more secluded and remote than the other planned garden spaces on the site. There is a large enclosed animal yard in the northwestern corner, and a small building which houses a goat and a sheep.

The two designated playgrounds contain wooden and plastic play structures, and the areas around them are filled with sand in one case, and mulch in the other. The asphalt area close to the school building on the southern side is used actively throughout the day, and the area around the asphalt is well-worn and dusty. The large field on the southeastern part of the site is used for soccer and other running activities. This area as well is bare in patches, especially around the soccer goals.

The site designated for the conventional detention pond near the western border of the site is currently partly mature trees and partly open space containing grass and redbud trees. The conventional detention pond is planned to be big enough to contain runoff from the entire site. Pipes from all of the low areas and off of the roof of the buildings will enter from three sides, and the overflow will connect into the neighboring subdivision pipes. Considerable grading and removal of trees is required. The alternative to this stormwater detention pond can be found in the proposed master plan.

Hydrology

There are no streams or permanent bodies of water on the site. All stormwater generated from impervious surfaces is controlled by a system of gutters, pipes, and culverts. However, there are evidences of heavy erosion at all the stormpipe outlets, indicating that the stormwater is not being managed in an ideal way, and that there may be overuse by children. It is in these locations that raingardens would be a significant asset to the property.

Vegetation

The majority of the ground plane is covered with grass of varying quality, depending upon the level of use. There are quite a number of trees on the property, in varying stages of maturity. Some saplings have just been planted, and others, such as the large oaks near the entrance to the school, are mature and provide considerable shade. An arboretum was planted about ten years ago on the western side of the site, and it has begun to provide shade to that area of the site. There are not many shrub-sized plants on the property, although there is a heavy line of Eleagnus along the northern boundary of the school, and hollies border the walkways from the parking lots to the entrance of the school. The southern boundary of the property is also bounded by an impenetrable line of hollies and other evergreens.

Master Plan (See page 72)

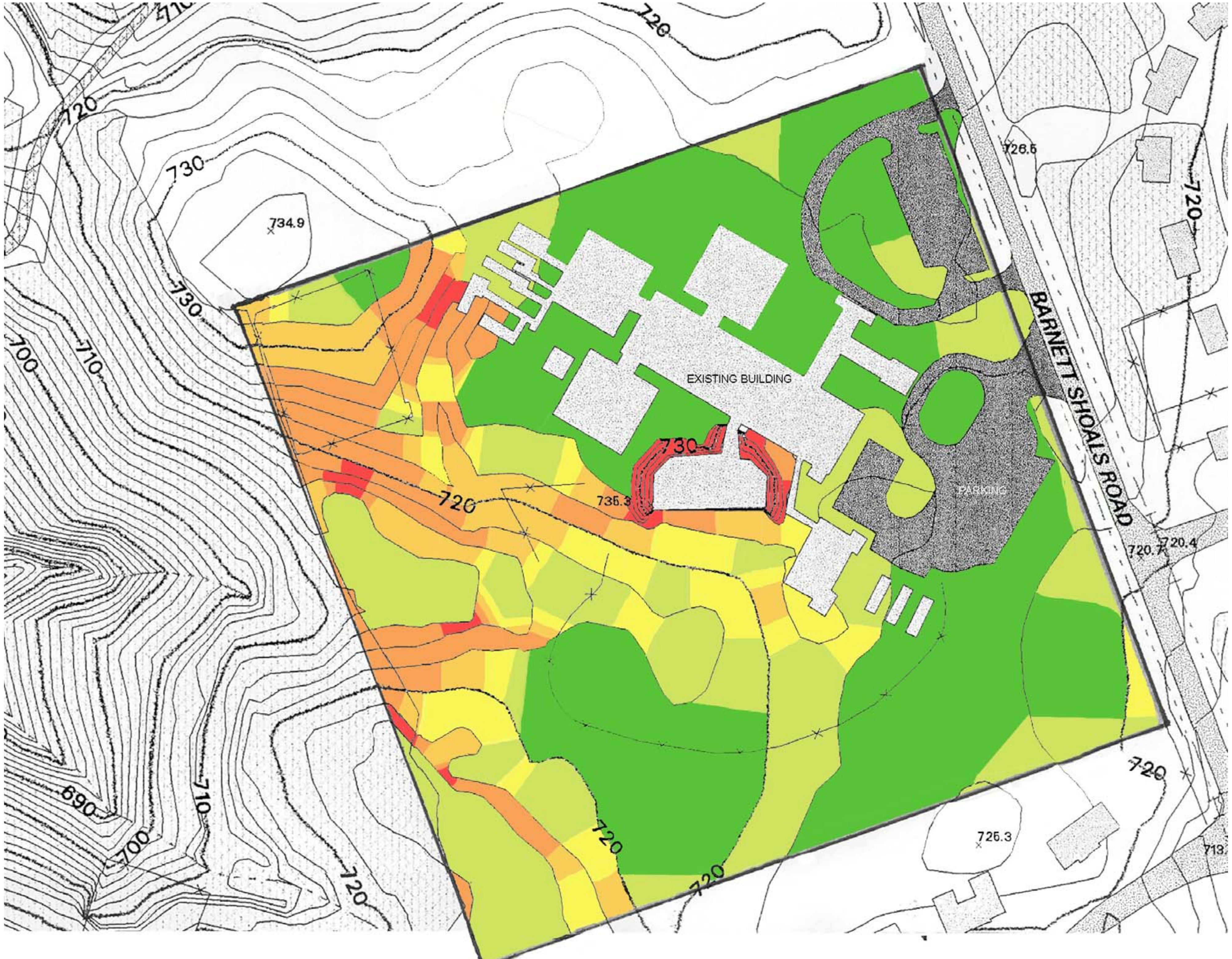
The impetus behind the master plan was two-fold. First, the ecology of the site from a hydrological perspective was improved, and second, the opportunities for interaction with water and plant communities were also optimized. The alternative stormwater management tools discussed in Chapter 6 were utilized, and their objectives fulfilled. In areas where stormwater pipes deposit water, raingardens are planted. These are sized based on the erosion line that already exists in those places. Raingardens serve both ecological and educational motives, because when planted with wetland plants, they are a beautiful addition to the landscape, and are a unique plant community to be enjoyed and experienced. With several being added to the site, there is the potential for different types of wetland communities to experience.

In areas where there is no room for a raingarden, or in areas right next to the school building, cisterns are placed for water collection directly off of the roof. This stored water can be used during dry spells for irrigation purposes. It would also be advantageous to collect graywater from the school facilities and use this water for irrigation as well. A spigot at the bottom of the cistern is placed so that a hose can be attached. These cisterns can be a useful water management lesson for children – learning to save and collect water during wet times, and then be able to use that water during dry times. The children can be involved with measuring the water levels and with determining which gardens need water.

One of the reasons that the detention pond that is currently being added to the site is so large is that it must handle all of the stormwater in one location. By managing the stormwater in smaller areas, the water becomes a useful and appropriate addition to the landscape. The water can then support plant communities and infiltrate back into the soil in a more natural way. A green roof would be a good solution for handling the stormwater off of the new addition, because the additional structural support that would be needed could be designed into the building before being built. This green roof would clean the water, support a plant community, reduce heat in the building, and provide an educational opportunity for the children at the school. If planted with native grasses, the area could provide a lesson in contrast between conventional roofs and the mowed grass roof on the underground classroom nearby.

Even with all of these water retention measures, there will still likely be a need for a small pond to collect stormwater. This pond would be sited in a location where there is already a depression and where stormwater pipes already deposit this stormwater. It would not need to be nearly as large as the conventional pond, however, because it would only be handling the excess stormwater off of the new addition, which is approximately 8,600 square feet. This small pond would be several feet deep on one end, and support plants that can handle flooding for long periods. The pond would also have a wide shallow area all the way around, so that emergent vegetation could thrive, and so that there would not be any safety risks associated with the depth of the water. (See Appendix B for plant lists). There would be a mulched pathway all the way around the pond, so that children would have access to it from all directions.

In order to increase the perviousness of the site, and to provide a feeling of more enclosure to the two main playground areas, shrub and tree vegetation should be added in areas that do not block visual supervision of the children. The species planted should provide berries and habitat for birds, and also be non-toxic and safe for children to play in. The roots of trees and shrubs interrupt the solidity of the red clay, and allow water to percolate and infiltrate more readily. The addition of these plants will also reduce the amount of grass on the site, which is typically almost as impervious as concrete or bare red clay. The wildflower meadow on the southwestern part of the site should also be allowed to grow, and native grasses should be added near the pasture area. These will also increase the permeability of the soil, as well as adding a new layer of interest for the children and animals alike. Adding pervious pavements and surfaces wherever possible will also decrease the amount of stormwater runoff. Typically, access and maintenance roads do not need to be concrete or asphalt. Porous concrete or pavers can be used for these areas.



SLOPES

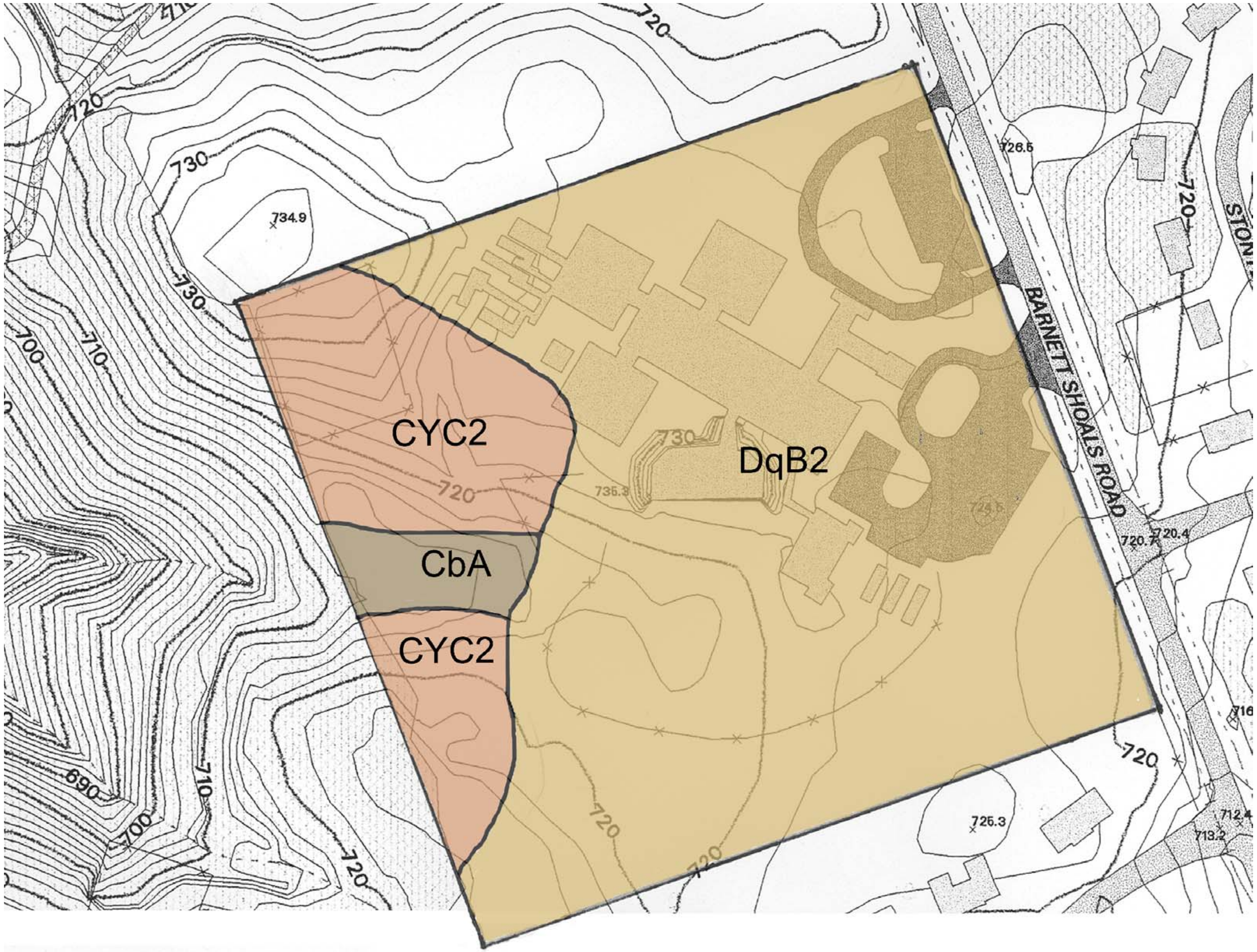
0%-2%	dark green
2%-4%	light green
4%-6%	yellow
6%-8%	gold
8%-10%	orange
10% +	red

N

SCALE 1”=150’

0 200 400 600

BARNETT SHOALS ELEMENTARY SCHOOL



SOILS

CYC2

CbA

DqB2

SCALE 1”=150’

0 200 400 600

BARNETT SHOALS ELEMENTARY SCHOOL

LAND USE

- GRASS
- ASPHALT
- MULCH
- FOREST
- PASTURE
- BUILDING
- GARDEN
- COVERED AREA

N

SCALE 1"=100'

0 200 400

BARNETT SHOALS ELEMENTARY SCHOOL

SITE ANALYSIS existing conditions

LAND USE

- GRASS
- ASPHALT
- MULCH
- FOREST / TREES
- PASTURE
- BUILDING
- GARDEN
- COVERED AREA
- MEADOW GRASS
- NEW PLANTS
- RAINGARDEN
- POND
- CISTERN

N

SCALE 1”=100’

0 200 400

PROPOSED MASTER PLAN

BARNETT SHOALS ELEMENTARY SCHOOL

CHAPTER VIII – CONCLUSION

Management considerations

The goal of this thesis is not to provide a comprehensive management plan for each area, but to provide a list of general principles that will promote ecological health and user participation on the school site. One of the most challenging aspects to ecological design is the need for educating the users and those who maintain these areas to think about them in a new way. For example, the wildflower meadow that was a part of the original master plan has failed to come to fruition because it continues to be mowed down. Many people think that tall grasses and wildflowers look messy and do not see that they will be valuable assets once they are established. Education of all involved of what type of maintenance is required is often the most basic step to be taken. The appearance of care is also usually an ingredient that needs to be added to the mix. So, for the wildflower meadow area, a band of mowed grass could separate the regular mowed grass from this area, so that it looks like it has been planted on purpose, and for a specific reason. This appearance of care would be useful in the raingarden and pond areas as well, by maintaining the plants as would be done in a garden, but not in a way that would limit the natural reproduction that would occur in those areas.

Another part of designing within ecological parameters is including the concept of change and maturity into the management plan. These places should not be "maintained" and kept exactly the same over time, but should be allowed to grow and mature as conditions change. If these areas are allowed to change, they will also develop to be more resonant with the natural characteristics, and with the needs of the users, over time. This is often difficult in a school setting, because there is usually not a long-term management plan, and because there is a high turnover of people who use and take care of the space. However, this approach can be successful, as shown in the case studies in Chapter 5.

The amount of use that a schoolyard receives must also be considered when adding plants and natural materials. Paths should be defined around areas that are more sensitive, such as raingardens and pond areas. This will allow children access but will prevent them from damaging those areas beyond repair. Teacher supervision and ecological education will also help children to respect and appreciate these areas, rather than destroy them. However, children are an unknown factor, so these areas may change and develop based upon their needs and how they respond to the natural areas.

Criteria for evaluation of success

If these ideas were implemented, how would their success be evaluated? Ecological criteria would include the general health of the plants, absence of invasive species, lack of erosion, regeneration of native species, maturation of the habitat areas, and presence of other species. Most importantly, awareness and evaluation of what is going on in these natural areas, and response to these changes, are the elements that will help make them successful.

Another measure of success is how these areas are being used and incorporated into the curriculum. Are children learning environmental lessons? Do they have time outside to explore and interact with the water and plants? Are they finding toads and caterpillars? These are the indications that the natural places are doing their educational duty. Children should be asked what they like and dislike about their environment, and changes should be made in response to their input. Teachers and other users should also be included in an ongoing discussion about the successes and failures of the outdoor spaces.

Contribution to the field

"We cannot change a culture in the same way we obtain a consumer item off the shelf, or acquire anew technique for solving a classroom problem. Nor is culture like a machine where an outworn part can be replaced or retrofitted with a new innovation; rather it evolves over time and its past patterns are often part of present practices and beliefs." (Bowers 41)

Despite the seemingly insurmountable challenges of challenging a traditional way of doing things -- in this case, in providing ecological schoolyards for children -- there are people who have gone before and been successful at implementing these ideas. It is because of these forward-thinking motivators that these changes slowly percolate into mainstream thought and begin to evidence themselves upon the land. It is unlikely that any single thesis or case study will be so monumentally successful that it sets a completely new paradigm that all wish to follow. However, the fact that these ideas are being written down and then applied to real situations – in fact, have been for several decades, in many countries, points to the underlying truth that there is a more thoughtful, holistic way of integrating our children with the land.

This work has brought these ideas together by taking a closer look at what the real needs are – a reconnection to the land -- and the ways that these needs can be effectively met through ecological design. The application of these theories was not done in a general ecological way, but specifically from the viewpoint that water is the underlying factor in all ecosystems. The case studies showed that each site has unique characteristics that can become useful educational tools. In this case, the water system needed to be reconnected with both the people and the native landscape. If we understand the way water functions in the landscape, and how it supports the myriad plant communities and subsequent levels of life, we will understand more how we fit into the landscape as well. We certainly have a long way to go in helping the public understand what we our connection is. After all, we are still hosing off dusty driveways in Las Vegas.

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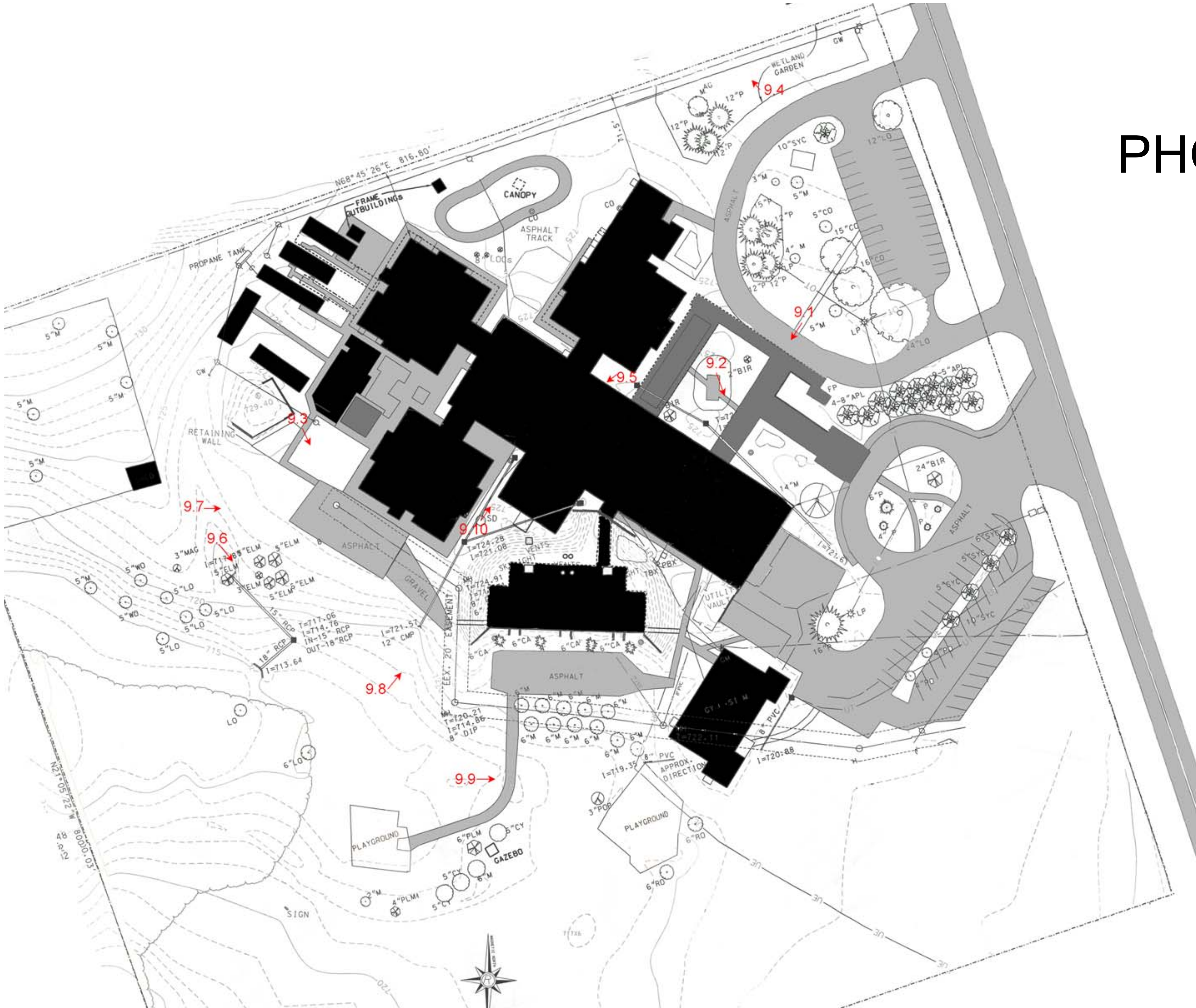

PHOTO DESCRIPTIONS

Fig. 9.1 Entrance to School

Fig. 9.2 Butterfly Garden

Fig. 9.3 Explorer’s Garden

Fig. 9.4 Granite Outcrop Garden

Fig. 9.5 Pond Garden

Fig. 9.6 Evidence of erosion;
location of proposed pond

Fig. 9.7 Site of future addition

Fig. 9.8 Evidence of erosion near underground classroom

Fig. 9.9 Outfall area;
site of proposed raingarden

Fig. 9.10 Location of proposed raingarden

N

SCALE 1”=100’

0 200 400

BARNETT SHOALS ELEMENTARY SCHOOL

APPENDIX A – SITE PHOTOS


Fig. 9.1 Entrance to School (G.R.O.W.)


Fig. 9.2 Butterfly Garden (G.R.O.W.)


Fig. 9.3 Explorer's Garden (G.R.O.W.)

Fig. 9.4 Granite Outcrop Garden (G.R.O.W.)

Fig. 9.5 Pond Garden (G.R.O.W.)

Fig. 9.6 Evidence of erosion; location of proposed pond (Long)


Fig. 9.7 Site of future addition (Long)


Fig. 9.8 Evidence of erosion near underground classroom (Long)


Fig. 9.9 Site of proposed raingarden (Long)


Fig. 9.10 Location of proposed raingarden (Long)

APPENDIX B -- WETLAND HERBACEOUS PLANT LIST

Scientific Name	Common Name	Hydrologic Zone
Acorus columus	Sweetflag	Normal pool to one foot
Andropogon glomeratus	Bushy broom grass	Regularly inundated
Andropogon virginicus	Broom grass	Periodically inundated
Canna flaccida	Golden canna	Normal pool to one foot
Carex spp.	Caric sedges	Normal pool to one foot
Chasmanthium latifolium	Upland Sea-Oats	Regularly inundated
Coreopsis leavenworthii	Tickseed	Normal pool to one foot
Coreopsis tinctoria	Dwarf Tickseed	Regularly inundated
Crinum americanum	Swamp Lily	Normal pool to one foot
Cyperus oderatus	Flat Sedge	Normal pool to one foot
Eleocharis cellulosa	Coastal Spikerush	Normal pool to one foot
Eleocharis interstincta	Jointed Spikerush	Normal pool to one foot
Eupatorium fistulosum	Joe Pye Weed	Periodically inundated
Helianthus angustifolius	Swamp Sunflower	Normal pool to one foot
Hibiscus coccinieus	Swamp Hibiscus	Normal pool to one foot
Iris louisiana	Louisiana Iris	Normal pool to one foot
Iris virginica	Southern Blue-Flag	Normal pool to one foot
Juncus effusus	Soft Rush	Normal pool to one foot
Leersia oryzoides	Rice Cut Grass	Normal pool to one foot
Liatris spicata	Spiked Gayfeather	Regularly inundated
Lobelia cardinalis	Cardinal Flower	Regularly inundated
Nuphar luteum	Spadderdock	Deep water (1 to 6 feet)
Nymphaea mexicana	Yellow Water Lily	Deep water (1 to 6 feet)
Nymphaea odorata	Fragrant Water Lily	Deep water (1 to 6 feet)
Osmunda cinnamomea	Cinnamon Fern	Regularly inundated
Osmunda regalis	Royal Fern	Regularly inundated
Panicum virgatum	Switchgrass	Normal pool to one foot
Peltandra virginicum	Green Arum	Normal pool to one foot
Polygonum hydropiperoides	Smartweed	Normal pool to one foot
Pontederia cordata	Pickerelweed	Normal pool to one foot
Pontederia lanceolata	Pickerelweed	Normal pool to one foot
Rudbeckia hirta	Black-eyed Susan	Periodically inundated
Sagittaria lancifolia	Lance-leaf Arrowhead	Normal pool to one foot
Sagittaria latifolia	Duck Potato	Normal pool to one foot
Saururus cernuus	Lizard's Tail	Normal pool to one foot
Scirpus americanus	Three-square	Normal pool to one foot

Scirpus californicus	Giant Bulrush	Normal pool to one foot
Scirpus validus	Softstem Bulrush	Normal pool to one foot
Sorghum nutans	Yellow Indian Grass	Periodically inundated
Thalia geniculata	Alligator Flag	Normal pool to one foot
Typha spp.	Cat-tail	Normal pool to one foot
Vernonia gigantea	Ironweed	Periodically inundated
Woodwardia virginica	Virginia Chain Fern	Normal pool to one foot
Source: (Landscaping)		

APPENDIX C – PLANT LIST FOR RAINGARDEN AREAS

Trees	**Shrubs**	**Herbaceous Species**
Acer rubrum Red Maple	*Aesculus parviflora* Bottlebrush buckeye	*Andropogon virginicus* Broomsedge
Betula nigra River Birch	*Aronia arbutifolia* Red Chokeberry	*Eupatorium purpurea* Joe Pye Weed
Juniperus virginiana Eastern Red Cedar	*Fothergilla gardenii* Fothergilla	*Hemerocalis spp.* Daylily
Koelreuteria paniculata Golden Rain Tree	*Hamemelis virginiana* Witch Hazel	*Iris pseudocorus* Yellow Iris
Nyssa sylvatica Black Gum	*Hypericum densiflorum* Common St. Johns Wort	*Lobelia cardinalis* Cardinal Flower
Platanus acerifolia London Plane-Tree	*Ilex glabra* Inkberry	*Panicum virgatum* Switchgrass
Platanus occidentalis Sycamore	*Ilex verticillata* Winterberry	*Pennisetum alopecuroides* Fountaingrass
Quercus palustris Pin Oak	*Juniperus horizontalis* Creeping Juniper	*Rudbeckia laciniata* Greenhead Coneflower
Quercus phellos Willow Oak	*Lindera benzoin* Spicebush	*Scirpus cyperinus* Woolgrass
Salix nigra Black Willow	*Myrica pennsylvatica* Bayberry	*Vernonia gigantean* Ironweed

Source: (Landscaping)