CCPC
BULLETIN

PLANNING BULLETIN #46

CHESTER COUNTY PLANNING COMMISSION

JULY 1993

WATER CONSERVING LANDSCAPES

XERISCAPE

BOARD OF COUNTY COMMISSIONERS

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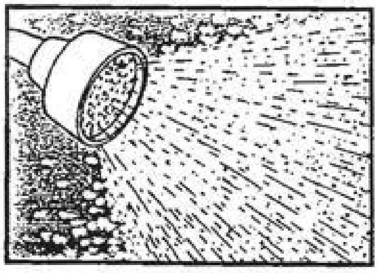
XERISCAPE
WATER CONSERVING LANDSCAPES

1
INTRODUCTION

The purpose of this planning bulletin is to describe a better way to produce and maintain beautiful landscapes that conserve water and energy. This new landscape approach is called **Water Conserving Landscapes or Xeriscaping.**

Water conservation is important. Although the eastern United States receives plentiful rainfall, the demand for potable water is becoming increasingly greater with each new development. The average American uses 40 to 70 gallons of water per day. During the summer months this may increase by 10 to 100 gallons more per day. Three-quarters of all the water used outside the home is used for the sole purpose of keeping turf grass green. Irrigating lawns and gardens with an inch of water a week as is commonly recommended results in a use of 820 gallons per 1000 square feet of yard. Much of this water is important, potable water supply.

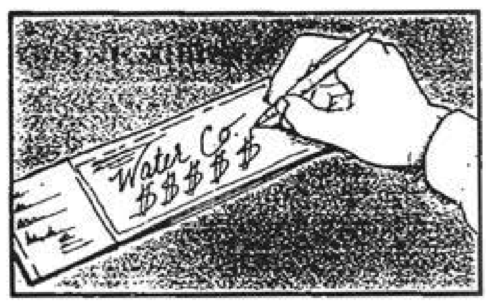


Water supplies come from ground and surface sources. Sources that are under constant threat of pollution. Surface and ground waters become polluted by the very same entities that require their use. As development increases, urban runoff and its associated non-point source pollution, sewage discharges, and industrial discharges increase. Ground water becomes increasingly threatened by more gasoline storage tanks and landfills.

The quantity of water is also threatened by extensive use. Ground water can become deficient locally due to over pumping and lack of recharge. Increases in impervious surfaces can increase runoff and decrease the amount of water that would normally recharge ground water sources. Interbasin transfers of water can move large quantities of water out of a watershed reducing its overall water content.

Changing weather patterns, whether short-term or long-term, may have drastic affects on local water supplies. Weather patterns in 1991 produced many areas of drought in the mid-atlantic region of the country. New York and western Pennsylvania officials issued drought warnings and western Maryland officials recorded the worst drought of record in 1991.

These threats on our ground and surface water supplies make potable water more difficult and expensive to obtain. As development continues in this region, **water conservation will become a necessity to sustain the population.** The Delaware River Basin Commission (DRBC), a multi-state water resources protection agency, realizing the magnitude of this problem, has implemented mandatory water conservation plumbing in new construction for the entire Delaware River Basin.



In addition to the installation of low flow plumbing fixtures, Chester County citizens can do more to reduce or eliminate unnecessary water supply use. **We can reduce or eliminate the need to water our lawns and ornamental plants through the use of water conserving landscapes.** For the remainder of this bulletin, the relationship between plants and water will be discussed, as well as how selecting the right plants and developing the most efficient landscape will conserve water. We investigate how water conserving landscapes can be applied to the individual home lot as well as to large scale developments. Finally, the added benefits that come with water conservation landscapes will be discussed.

Xeriscape is a term originally coined by the Denver Water Department to refer to landscaping surrounding a home or business which consists of plant material and design techniques that reduces or eliminates the need for irrigation. The National Xeriscape Council, a non-profit organization based in Austin, Texas is largely responsible for making the term "xeriscape" a household word in many parts of the country. In this Bulletin, "water conserving landscapes" and "xeriscape" are used interchangeably. Xeriscape comes from the latin word "xeros" meaning dry. There is often confusion about the kinds of plants that make up this type of landscape that may result from the use of such a name.The landscape type consists of fundamental design considerations and native or naturalized plant materials which effectively limit the need for excess watering. The landscape type does not necessarily require the use of plants from deserts or dry regions. For the eastern United States, **water conserving landscapes means native trees, shrubs and groundcovers that are adapted to the existing precipitation patterns of the region.** They do not need irrigation because they survive quite well on existing rainfall.

2
NATURAL SYSTEMS

Why and how do plants use water?

To understand why and how plants use water, we must first identify a plant's normal biological functions (Figure 1). Unlike animals, most plants cannot consume other organisms for food; they must manufacture their own food. Plants create food for themselves in the form of simple sugar molecules by a process known as photosynthesis. Photosynthesis takes place in the green parts of the plant, primarily in the leaves. Photosynthesis is a complex biochemical process that removes the carbon from carbon dioxide and puts carbon together into long chains forming sugar molecules. The carbon dioxide is obtained from the air surrounding the plant. Very small holes in the plant's leaves, known as "stomates", open and close, allowing the carbon dioxide molecules to pass into the leaf. An inevitable consequence of opening these tiny holes is that water passes out of the leaf into the outside air. The membranes and tissues inside of the leaf must stay moist in order for carbon dioxide to diffuse into the leaf. Because these membranes are wet and exposed to the outside air through the tiny holes, water evaporates from their surfaces and exits the plant. For a plant to manufacture food for itself to stay alive and to grow, it must open the stomates in its leaves to take in carbon dioxide, but will loose water at the same time.

Plants, like most other living organisms, must keep water in their cells to stay alive. If water is leaving the plant through the leaves, then that water must be replaced. Plants replace lost water by absorbing water from the soil through the root system. Water is then conducted up the plant stem to the leaves in many small tubes known as "xylem". Plants are dependant upon adequate soil moisture to stay alive and to grow. When the soil moisture is depleted, perennial plants cease to grow and enter dormancy. Annual plants typically die when the soil moisture is gone.

How do plants survive without the need for excess watering?

Plants that are native to a particular area have evolved and adapted to the natural precipitation patterns of that area. Deserts receive very little moisture, sometimes less than 10 inches a year. Therefore, desert plants are adapted to living off of very little moisture. For example, the Cactus survives long periods of drought by retaining moisture in its thick, fleshy tissues, and by opening its stomates at night when the evaporative demand is lower. Many desert plants could not survive the climate of the humid, wet eastern United States. Their tissues receive too much water and they rot.

In Chester County, we receive abundant rainfall, approximately 45 inches a year. A climate that has also proven useful for sustaining agricultural crops, such as corn, hay and soybeans, without irrigation. Chester County's climate is capable of sustaining a large number of trees, shrubs and groundcovers. This climate produced the extensive deciduous forests that once dominated our landscapes. This forest became an adaptation to the climate of the region over thousands of years. The component species from each layer of the forest,

Trees = oaks, hickories, beeches, maples, and hemlocks;
Shrubs = dogwoods, witch hazel, Viburnums, and rhododendrons;
Herbs = Wild Ginger, Mayapple, Periwinkle and Bloodroot;

are all our native species (see Appendix B for more native species). They survive here without supplemental watering.

We can expect and depend on the fact that, throughout the world, plants native to a particular environment are adapted to its rainfall, temperature and humidity, and can survive in their native habitats without the need for additional watering or care. These native plants survive as populations, even though individual plants may die from disease, animal damage, fire, or even local droughts. When one tree in the forest dies, the gap in the forest canopy soon closes as replacement trees grow rapidly in the light. Some forests are adapted to re-occurring fires, caused by lightning strikes, that sweep through the landscape and kill a number of trees, only to make way for

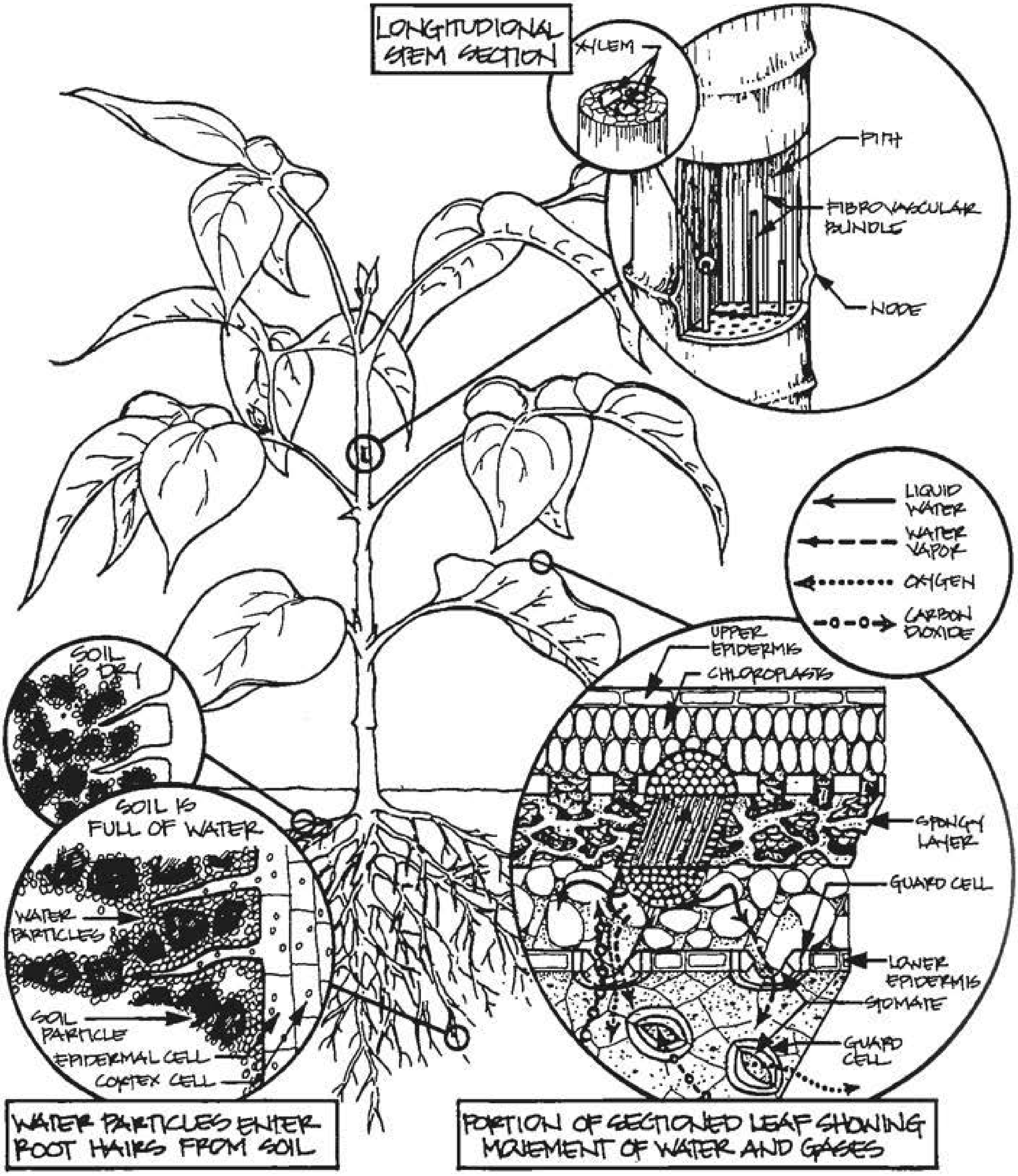

LONGITUDIONAL
STEM SECTION
XYLEM
PITH
FIBROVASCULAR
BUNDLE
NODE
LIQUID
WATER
WATER
VAPOR
OXYGEN
CARBON
DIOXIDE
SOIL
IS DRY
SOIL IS
FULL OF WATER
WATER
PARTICLES
SOIL
PARTICLE
EPIDERMAL CELL
CORTEX CELL
UPPER
EPIDERMIS
CHLOROPLASTS
SPONGY
LAYER
GUARD CELL
LOWER
EPIDERMIS
STOMATE
GUARD
CELL
WATER PARTICLES ENTER
ROOT HAIRS FROM SOIL
PORTION OF SECTIONED LEAF SHOWING
MOVEMENT OF WATER AND GASES

FIGURE 2 FOREST PROTECTS STREAMS AND GROUNDWATER

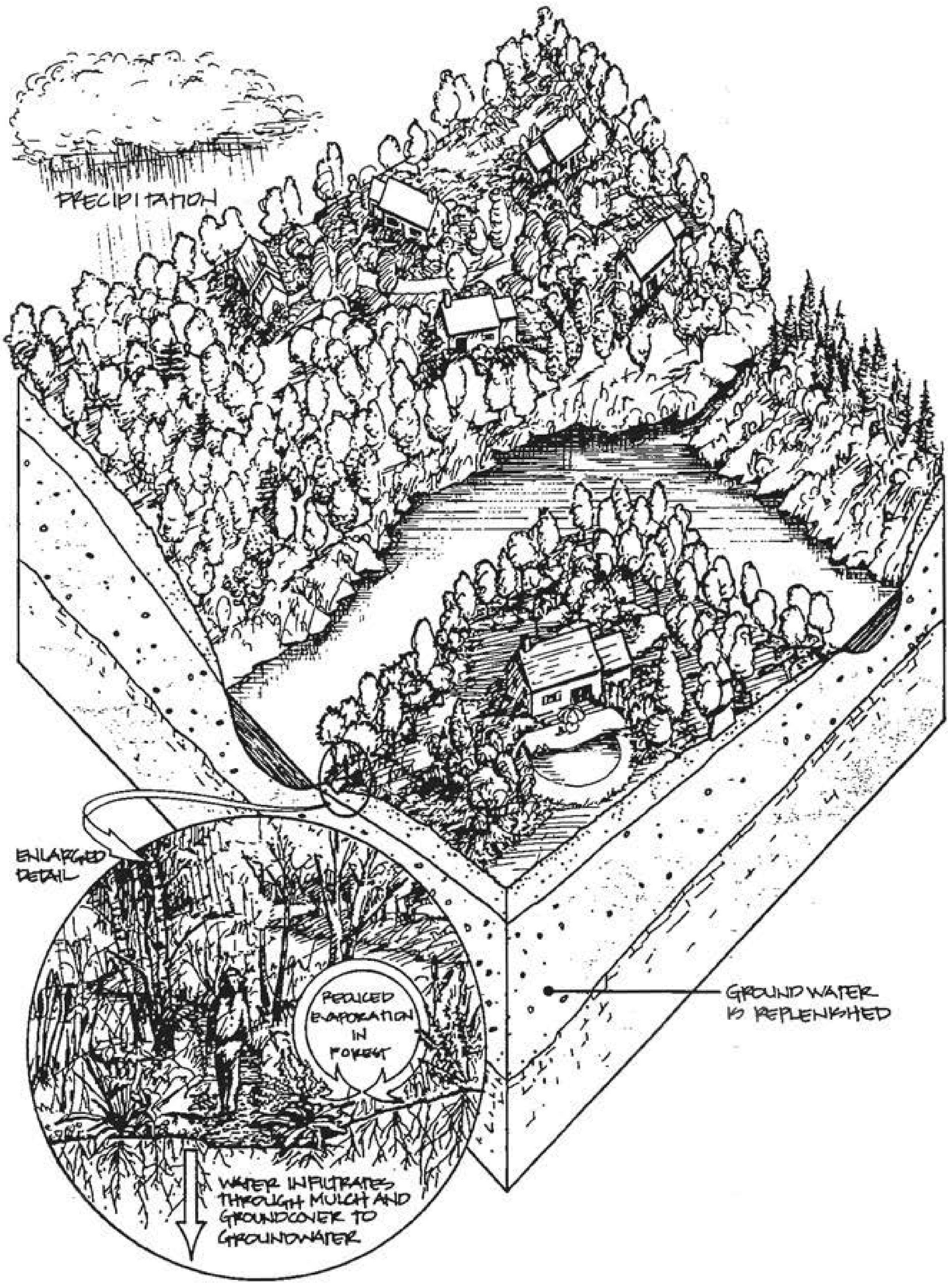
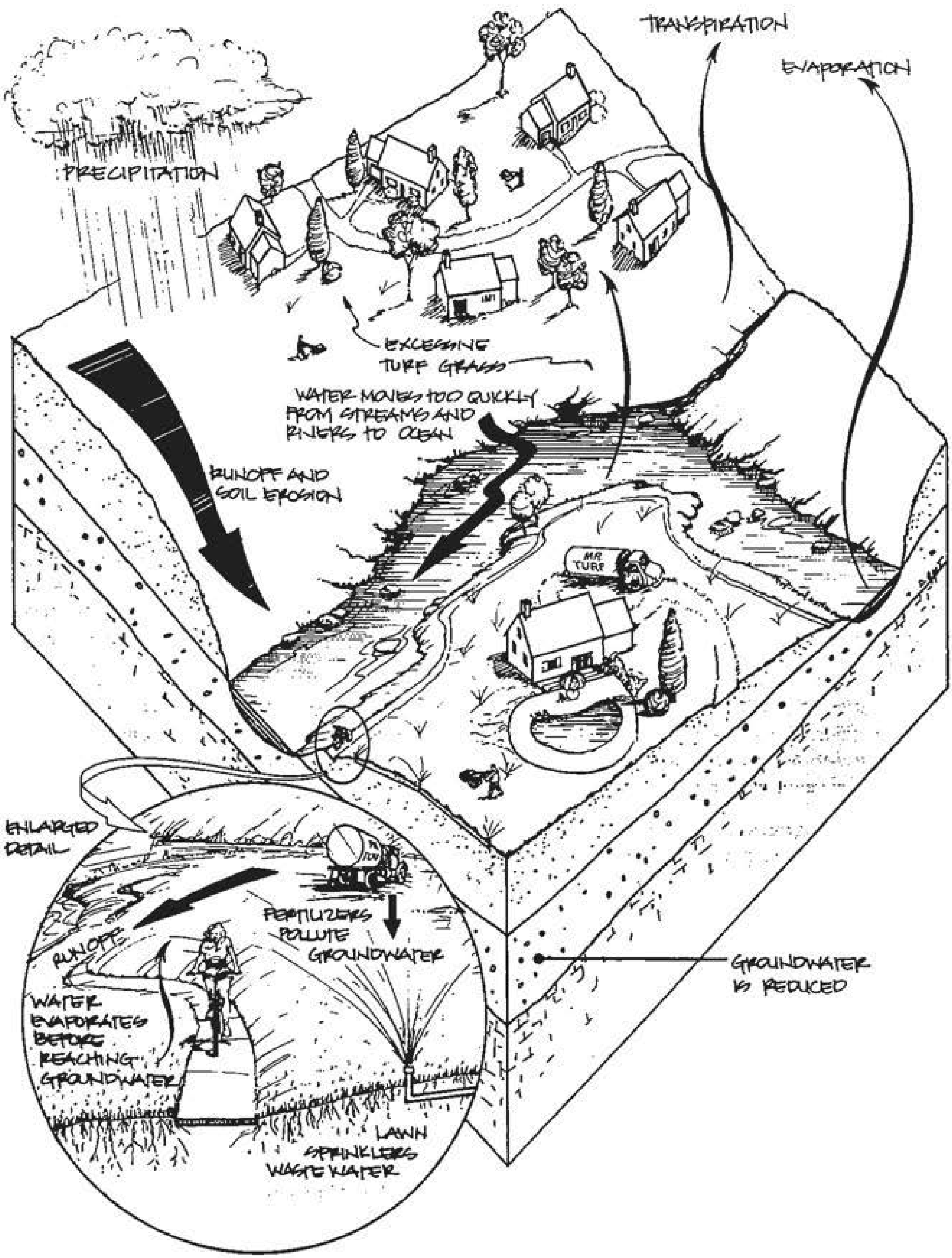


FIGURE 3 GROUNDWATER IS THREATENED BY VEGETATION LOSS



a host of new tree seedlings released in some manner by the passing fire (e.g. the serrotenous cones of Marsh Pine found along the Atlantic Coastal Plain from Florida to New Jersey).

This persistent nature of native plant communities has resulted in beautiful landscapes that maintain themselves indefinitely without the need to be watered or fertilized by man. It is when man removes the existing native vegetation and replaces it with something non-native, or worse, allows the land to be colonized by non-native weed populations, that problems arise.

How the plant community affects the movement and transport of water.

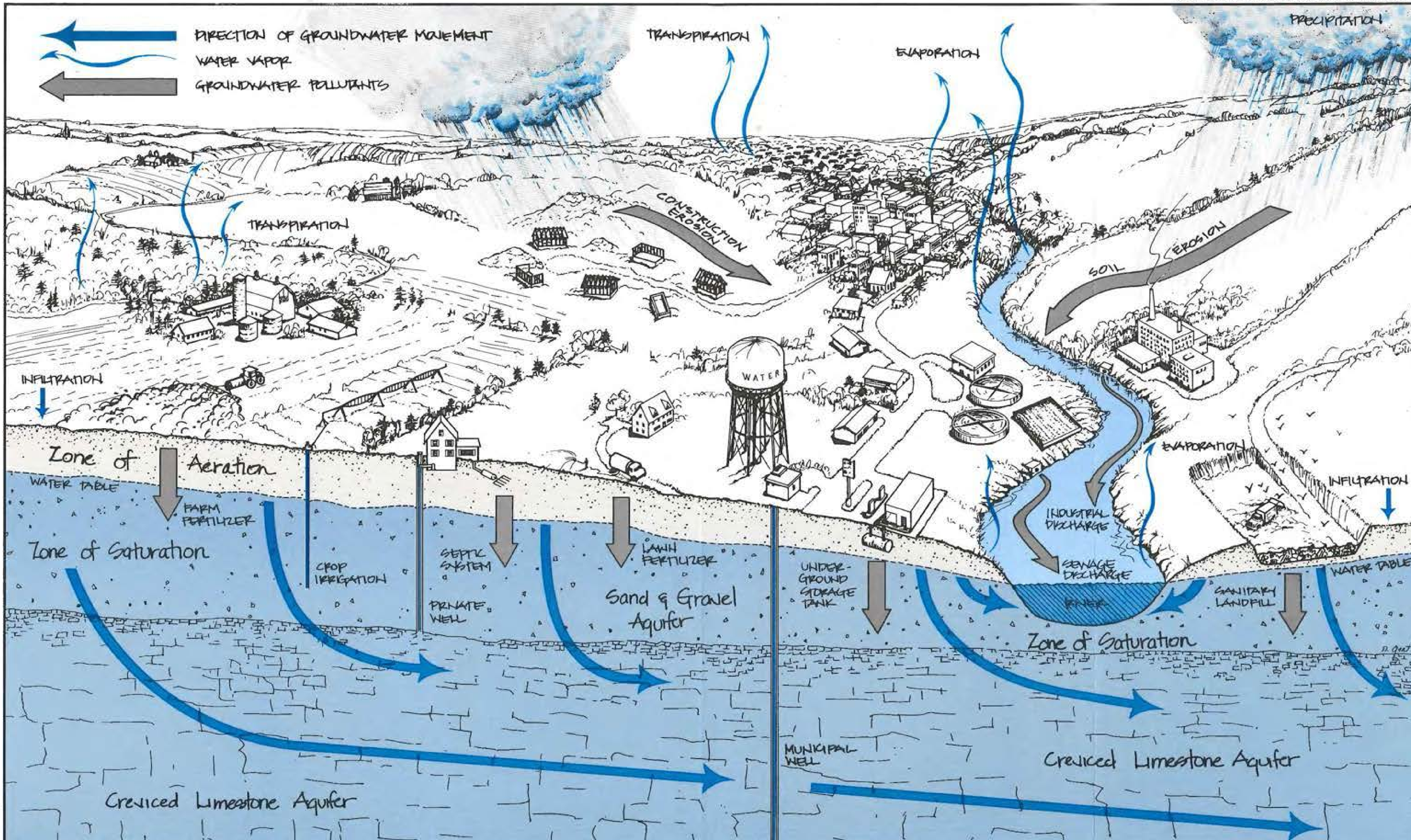
Just as the individual plant can affect the movement of water in its vicinity by absorbing soil water and transpiring it to the atmosphere through the leaves, an entire forest affects the movement of large quantities of water (Figure 2). Rainfall strikes the leaves of the forest canopy ("interception") and lessens the force that the water has to strike the ground and cause erosion. Some of this water evaporates off the surface of the leaves. The layers of decaying leaves on the forest floor further protect the soil from the impact of water, reducing runoff and soil erosion. Once the water reaches the forest floor, evaporation is reduced by the cool, shading canopy. The many roots of the trees hold the soil in place, further preventing erosion as the water seeps down into the soil profile, saturating the soil. The saturated soil provides needed water to the roots, and large quantities of soil water can be moved up through the insides of trees and into the atmosphere from the stomates in the leaves. Because of the reduced runoff and the coolness under the forest canopy, more water is able to enter the soil and eventually enter the groundwater. Because overland runoff of water is reduced, more water enters the streams by way of this underground movement of water. Water takes longer to move through the earth to get to the stream, and tends to be filtered by the earth, thus streams are sustained for longer periods of time and with clean groundwater.

Thus, the entire forest acts like a great filter, slowing down the water as it comes in contact with the earth, filtering the majority of the water through the soil and rock before it enters the stream. Although, the forest transpires much of the soil water to sustain itself, more water enters the ground to be filtered and renovated by natural processes before reaching the stream than would likely happen in the non-forested landscape.

Rainfall that strikes grassy areas, cropland or bare soil is not slowed by any canopy (Figure 3). It strikes the earth with full force dislodging particles of soil, moves rapidly overland, enters streams early and in larger quantities, and contains silt and other materials found on the surface of the land (e.g. agri-chemicals and urban non-point source pollutants). This large quantity of water that enters the stream during a rainfall event, moves through the stream channel quickly and does not sustain the life of the stream. Infiltration and groundwater recharge have been reduced; thus, in the long term, water for sustaining the stream is reduced. The stream may become intermittent or eventually dry up.

In summary, the natural forest that covered our landscapes had adapted to this climate over thousands of years. It was a system much more efficient at preventing excess runoff of water and allowing maximum infiltration into the soil. This system has evolved providing maximum sustainability for the vegetated landscape as well as for the hydrologic cycle. As long as infiltration is maximized, there will always be water available for continued life. Man has altered this system dramatically (Figure 4). As a result of extensive farming and urbanization, less water infiltrates, more water runs off quickly and does not replenish the underground resources. It is becoming increasingly clear that in order for humans to maintain maximum sustainability, we must follow the natural forest example. If landscapes are going to change from agricultural to suburban, we need to simultaneously put back some of the forest cover so it can go back to work infiltrating water and replenishing our groundwater resources and our streams.

FIGURE 4
WATER CYCLE AND
GROUNDWATER MOVEMENT



Prepared by Chester County Planning Commission

3
THE SINGLE FAMILY LOT

Water conservation begins at home. The average single family residence on one acre of ground can use as much as 5,000 gallons of water per day (820 gallons per 1000 square feet per week, or an inch per acre per week) in the summer time. Much of that water is used just to keep turf grass alive and green. Multiply this figure times the 84,795 single family detached homes in Chester County and that equals over 400 million gallons of potable water a day. In other words, much potential drinking water consumed, and not for drinking. Practicing the principles of xeriscape can go a long way towards reducing this unwise water consumption. Below are the seven basic principles of xeriscape (adapted from the National Xeriscape Council, Austin, Texas) which can be applied to any lot no matter how large or small.

Fundamentals of Xeriscape

The seven basic principles of Xeriscape are not necessarily new theories on landscaping. In fact, these principles are really just basic, good landscaping techniques of long standing practice. Basic landscaping techniques should provide for efficiency. Xeriscape accentuates and adheres closely to techniques that maximize water efficiency. The seven principles are as follows:

1. Planning and Design

The planning and design process is the most important step in creating successful water conserving landscapes. As will be described in more detail later, the planning process takes into account the uses and requirements of the lot to produce an efficient planting design.

2. Soil Analysis

Soils are often not uniform over the entire yard area. One portion may have rich, well-drained soils excellent for plant growth and other areas may be poorly drained, heavy clay, or lack important plant nutrients. It is important to characterize the different soils in the yard so that appropriate amendments can be added as needed. Soil analysis services are often provided by farm stores, landscaping professionals, and county and university extension services. Planting on uniform soils with good drainage and water holding capacity is essential for efficient plant growth.

3. Efficient Irrigation

Ideally, a landscape that can flourish on the amount of water received from precipitation without additional inputs of water are the most efficient water conserving landscapes and is the goal of xeriscape. This may not be practical for high use turf grass areas and for trees and shrubs that are newly planted and establishing themselves. The answer is an efficient irrigation system that applies water where it is needed and only in amounts that are useable by plants. Irrigation that is applied during the hot part of the day or is applied excessively or sprayed into the air causes excess evaporation. Drip irrigation is best for planting beds and individual trees and shrubs. Turf areas that are sprayed at night and with low spraying heads can reduce evaporative losses. An irrigation professional can help with selection and design of an irrigation system or procedure. It is important to insist on the most efficient, water conserving system or techniques available.

4. Limit Turf Areas

This concept has already been mentioned previously in this Planning Bulletin. It is the most important aspect of plant material selection. Turf grass is the largest source of water use in any landscape. Most homes in America are completely surrounded by turf grass because it provides a look of cleanliness when mown. However, much of this area is unused by the homeowner and requires extra inputs of water and energy. Multiply these inputs by the millions of lots in America and it adds up to substantial waste of water and energy. Water Conserving landscapes limit turf grass area as much as possible, restricting it to the active use areas such as the backyard play area or walkways.

5. Appropriate Plant Selection

Here is where Section 2 - "Natural Systems" of this bulletin becomes important. The most appropriate plants to use in any landscape setting are those native and naturalized plants that are adapted to the precipitation regime of the area. It is believed that native plants are the most efficient water users and provide many additional benefits to the region's wildlife that have been lost through the years as a result of land use changes. Appendix B contains a list of selected native plant species for the southeast Pennsylvania region.

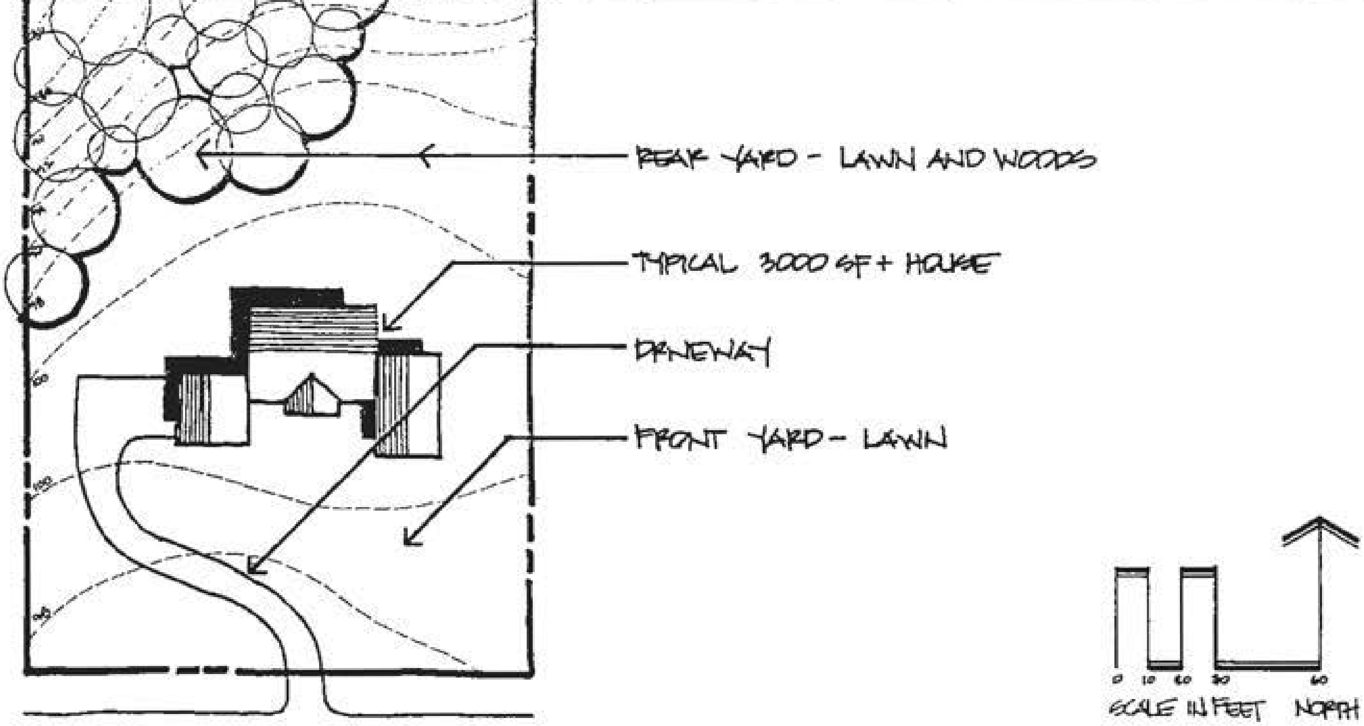
6. Use Mulches

Bark chips, root and wood grindings, or other organic materials slow the rate of evaporation of water from the soil surface. These mulches keep weeds down and provide an aesthetic look to planting beds. Mulches and other groundcovers (plants, rocks, stones) can replace much or all of the turf grass on the lot. Mulch essentially simulates that organic forest floor of accumulated leaves that provides important nutrients to the natural forest.

7. Appropriate Maintenance

Water conserving landscapes can reduce maintenance requirements by reducing the amount of mowing, fertilizing, thatching, and irrigating that conventional turf grass lawns require. As a water conservation landscape is establishing, there will be some important planting, weeding, trimming, and mulching, but a good goal is a self perpetuating landscape that requires little maintenance and little water and energy inputs.

FIGURE 5
TYPICAL 30,000 S.F. SINGLE FAMILY LOT

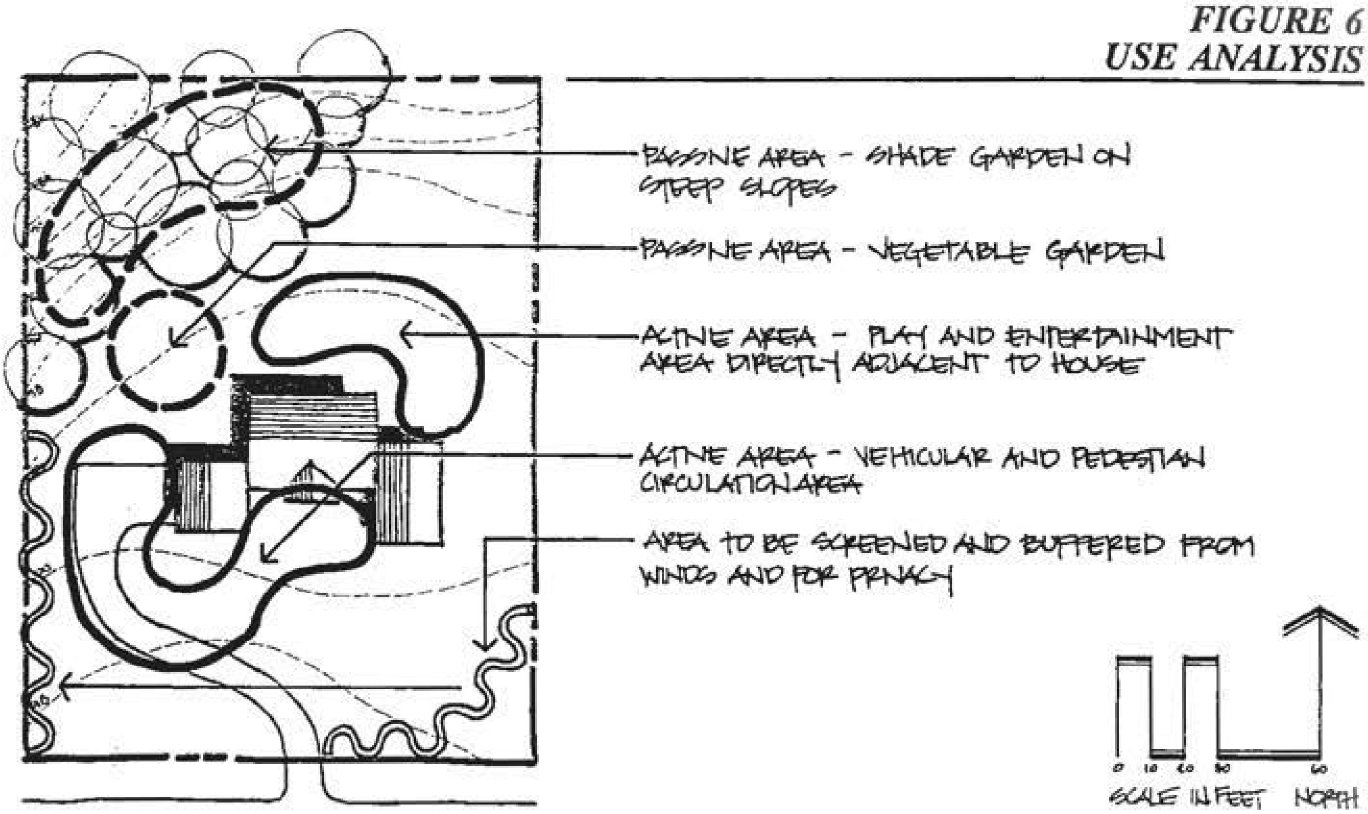


Planning the Lot

The most important aspect of any landscaping project is producing a plan and a design. The design essentially identifies the final product, what you want your yard to look like when it is completely landscaped. The design results from the planning process. The plan should include an inventory of the existing use patterns and "microclimates" of the lot, an analysis of zones of water usage based on microclimates and use, lists of plant material to be used in the various zones, irrigation schemes, and an implementation schedule for planting.

Although sounding technical, the planning process is really quite simple. The following text along with Figures 5-8 describe this process. Figure 5 represents a typical lot.

FIGURE 6
USE ANALYSIS



The first step is to identify the areas of specific use; particularly those areas where walking and play occurs or is likely to occur (Figure 6). These areas will require the most turf grass because of its ability to withstand treading. Secondly, identify those areas of your yard that have different microclimates (Figure 7). These are the shady spots, the sunny spots, prevailing wind direction north-northeast side of the house, south-southwest side of the house, etcetera. These area designations will help to separate the cool, wet areas from the hot, dry areas. Generally in Southeastern Pennsylvania, shady, north-northeast sides are the cool, moist areas, and sunny, south-southwest sides are the hot, dry areas. Partially shaded areas will probably be intermediate in climate, with some variation. For example, afternoon sun areas may be a little drier than morning sun areas; partial shade on the north side of the house may be more moist than partial shade on the south side.

Once the use and microclimates patterns are identified on a drawing of the lot the preparation of a water conserving landscape plan and answering questions of where to put what plants can more easily be accomplished. Limit turf grass to the high use areas, play areas and walkways. Everywhere else can be planted to beds of trees, shrubs or groundcovers. There is a tremendous variety of plantings and designs that can be produced, rock gardens, border beds, aquatic gardens, vegetable/herb gardens, forest replicas, mulch beds with flowering trees and shrubs, etcetera. The key points are that plant materials should be used that: 1. match the microclimates of the yard (sun loving plants in sunny spots, shade tolerant plants in shady spots), 2. do not require excess watering to survive, and 3. are planted in beds of mulch, stone, or any other material that will promote infiltration and limit evaporation. Figure 8 presents a landscape plan based on the analyses in Figures 6 and 7.

If an irrigation system is to be used, plan the irrigation system to match the planting design. Group plants according to water requirements, placing plants that need water with other plants that need similar amounts of water, drought tolerant plants with other drought tolerant plants. Match this system to the map of microclimates and use patterns. A spray irrigation system for the turf grass areas that comes on at night may be the most efficient way to maintain these areas. If the plan is to create shade in a yard that currently has no shade, plantings of trees and shrubs can be temporarily watered with a drip irrigation system until plants are established and begin to provide some shade.

FIGURE 7
MICROCLIMATE ANALYSIS

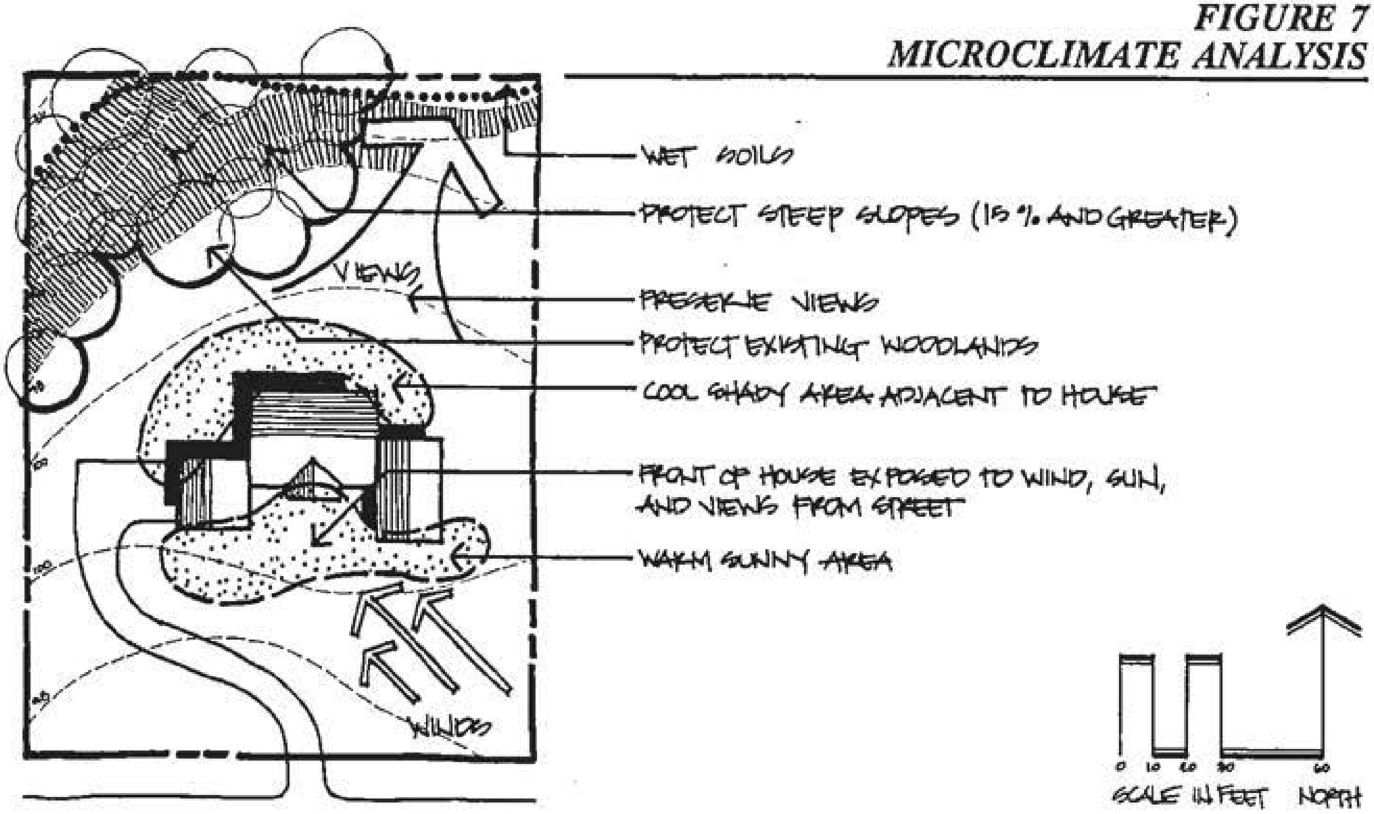
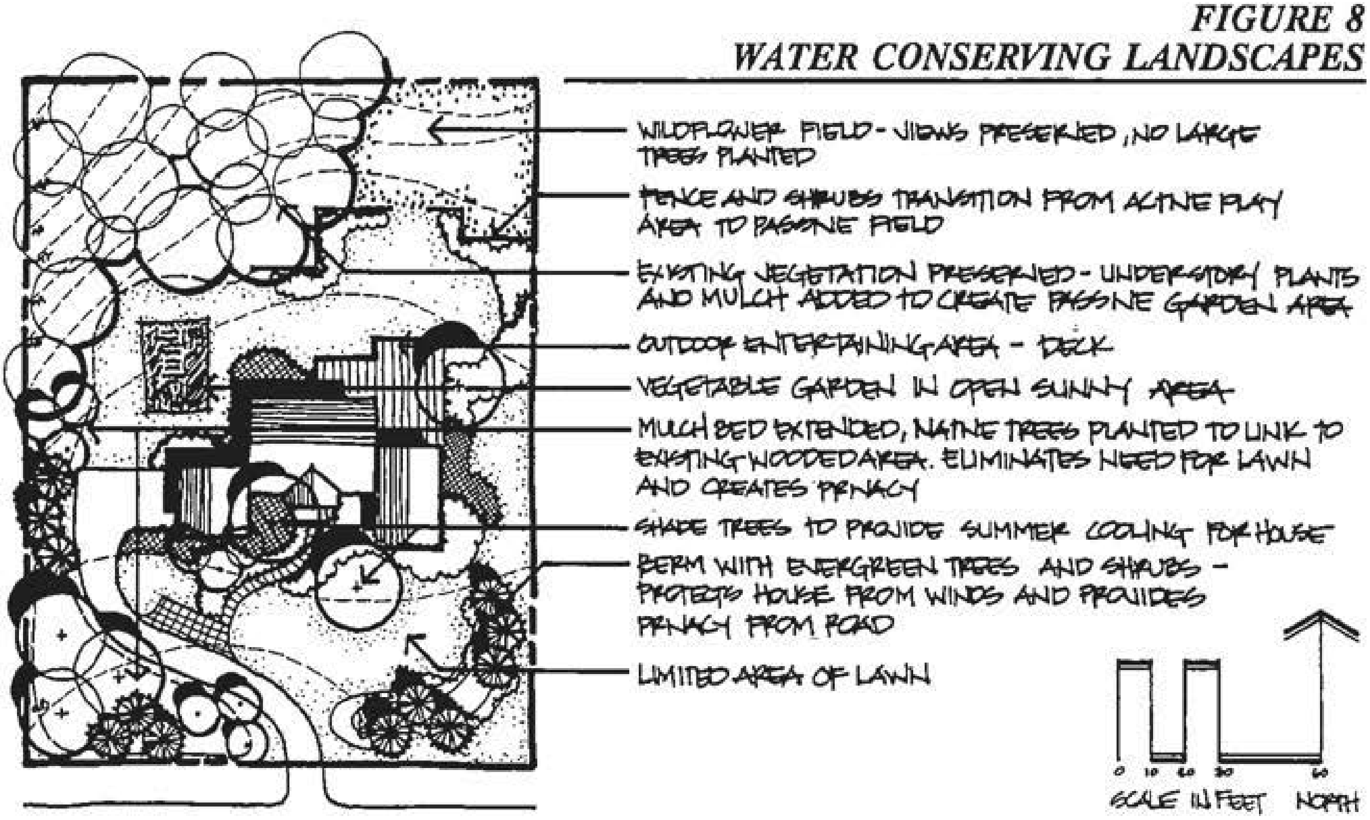


FIGURE 8
WATER CONSERVING LANDSCAPES



It is often difficult and expensive to do the entire yard landscape all at once. Part of the planning process could be an implementation schedule that allows for creating the landscape in phases over time as budget allows. This is especially important if you have an open lot with no trees and you wish to ultimately provide substantial shade.

4
THE DEVELOPMENT

The first three sections of this planning bulletin have examined the need for saving water, the relationship between water and vegetation, and how the homeowner can decrease water usage. What can the developer do to save water when designing a subdivision or land development? Basically, the same principles of xeriscape can apply to the larger development. The developer has the opportunity before beginning construction to examine the tract of land and design a development that will save water and energy. The municipality, through its subdivision/land development ordinance, can help guide the developer to this goal.

As with the single family lot, the key to saving water at the development scale is to limit as much as possible the amount of land in turf grass and other landscaped areas that require high maintenance or watering. The following are several site design considerations that should be used to enhance this goal.

Protect the Trees

Every attempt should be made to protect the existing trees on a tract to be developed. Those trees in masses (woodlots, forests) are most important because they retain many important species (plants and animals) and ecosystem functions. These masses of trees should be avoided as much as possible. Leave them intact so they may continue to perform their natural functions of water infiltration, habitats for other species, air cleansing, and aesthetic qualities.

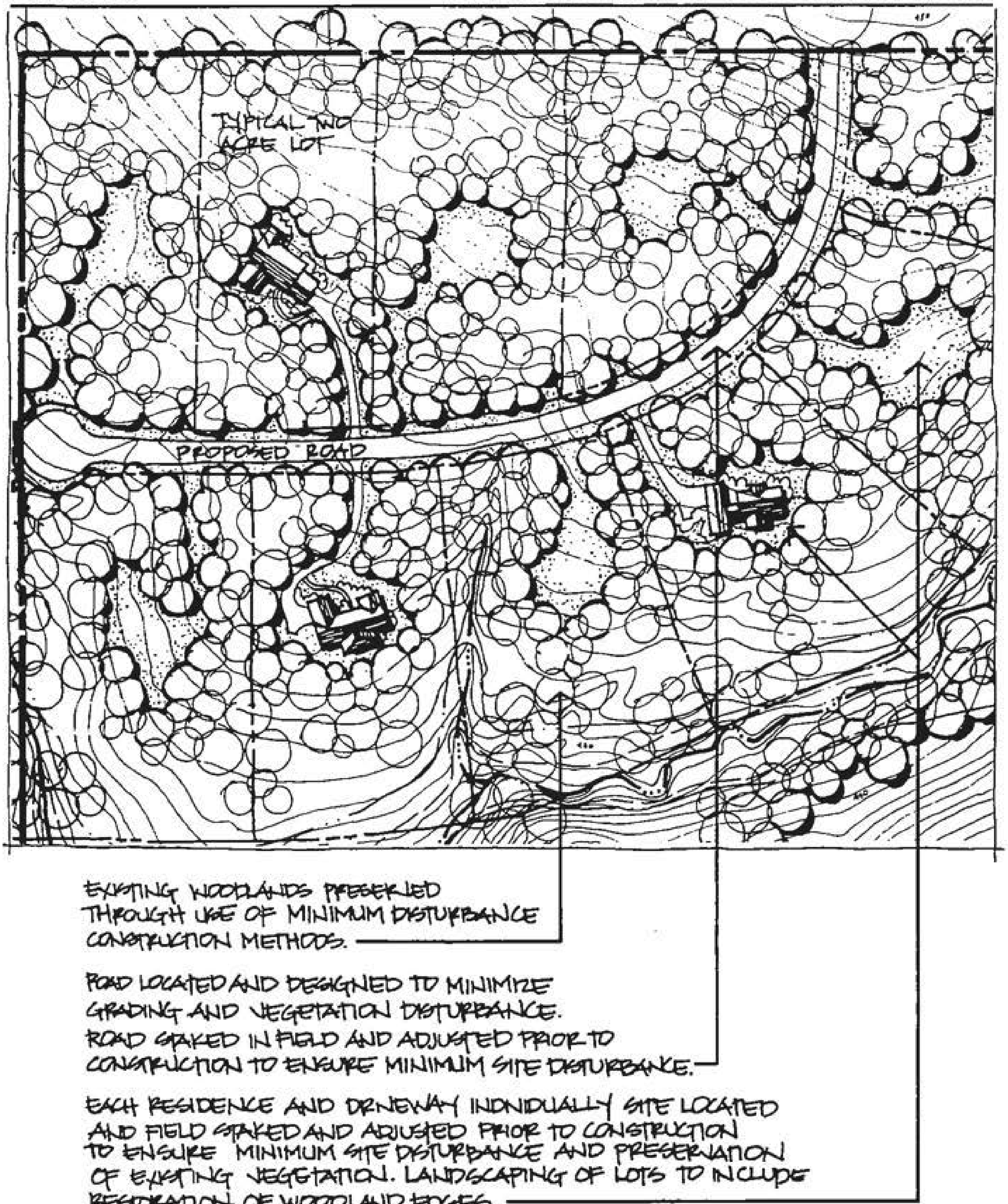
All trees within a certain size range (1" to 12" caliper) that have to be removed should be moved and replanted in other parts of the tract where no structures are planned. Large trees (greater than 12" caliper) can be moved, but the process is expensive and time consuming. It may not be practical to dig and move these trees, rather they can be replaced by new nursery stock at a new location.

Minimum Disturbance Development

If the forest or woodlot has to be disturbed, require the developer to utilize minimum disturbance techniques to save as much of the forest intact as possible. Minimum disturbance means removing only the vegetation that is present in the footprint of the structure and only that area needed for the sewage system. Houses can be tucked into the forest so that front and back yards are undisturbed forest. Roads can be put in with a minimum amount of tree removal on either side. There is no reason to remove most or all the trees from lot areas only to plant turf grass in their place. This concept is depicted in Figure 9.

It is important that municipalities provide guidance to this kind of development. It is suggested that the municipality require a professional landscape architect, arborist, forester, botanist, or ecologist oversee the operation to insure that trees are adequately protected. It requires a little extra care on the developer's part and a little guidance by the municipality, but the rewards are great. There are a number of existing minimum disturbance developments in Chester County and other parts of the country. The newtown community designed by McHarg called "The Woodlands" of southern Texas is a very celebrated example. Not only do these developments exist in harmony with nature, but they are very successful in terms of public acceptance.

FIGURE 9 **MINIMUM DISTURBANCE DEVELOPMENT**



Limit Turf Grass

Any development, whether it be on a forested tract or on an open field can limit the amount of turf grass planted. Turf grass should be used only in the high foot traffic areas along walkways and active recreation areas. The seven basic principles of xeriscape previously discussed under the Single Family Lot, can be used as a guide for development landscaping as well. The only variable that changes is the scale. Development landscaping can use trees, shrubs and groundcovers in beds of mulch or gravel to limit use of turf grass. This is especially important for commercial and office developments. There are a number of corporate campuses and office buildings in Chester County, and many of them have extensive areas in turf grass. These areas may require extensive maintenance and watering. Natural landscaping of these areas will not only reduce maintenance and watering, but may reduce runoff by as much as 30-50 percent by improving infiltration characteristics. Natural landscaping is likely to cost more up front, but the savings occurs in reduced long-term maintenance, energy consumption and water use.

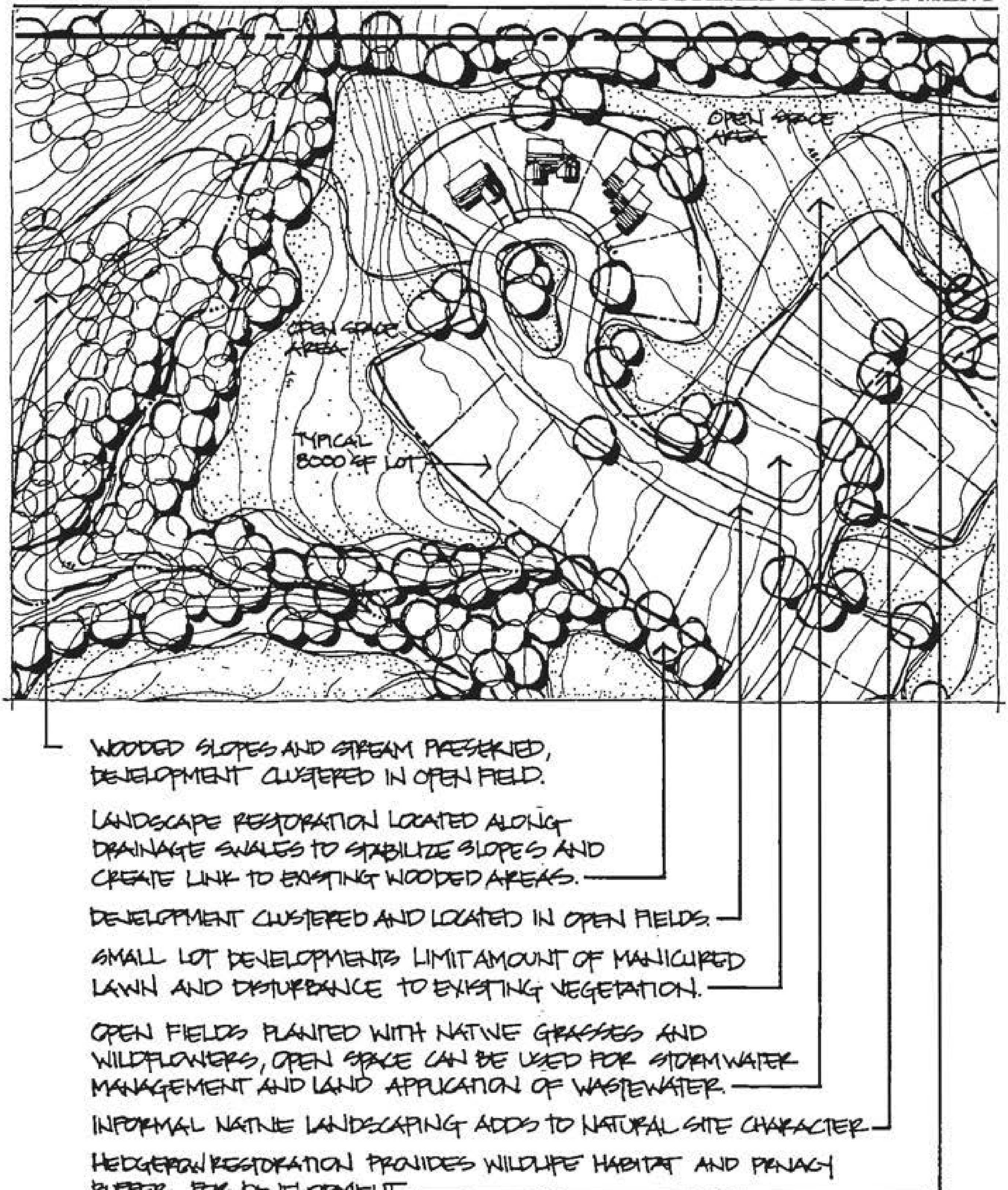
Cluster Developments

Clustering developments of any kind, residential or commercial increases the opportunities for either protecting existing forests or limiting the amount of high maintenance turf grass. If developments are clustered, then there is less area of the tract that needs to be disturbed. However, a major question remains for tracts with open ground, what can be done with the undeveloped land? Many developments occur on lands that were previously farmed. If the development is clustered on a portion of that farm, the remaining fields may become extensive weed patches. There are several alternative uses for that remaining land. Figure 10 presents one example of how this situation can be addressed. The land can continue to be farmed, planted to meadow, reforested, used for infiltration of stormwater, and/or used for sewage disposal (land application). Actually, all or any combination of these uses can be provided at one time.

Land Restoration

An ideal water conserving development is one that exists in harmony with a more natural surrounding. This ideal development protects existing forests, limits the high maintenance turf grass to the active use areas, provides for infiltration of stormwater generated by the impervious surfaces, provides for land application of treated wastewater, and restores remaining land to a more naturalized state. The ideal development provides all these water conserving functions and looks aesthetically pleasing as well. The concept of restoring land to a natural state and having it look nice in the process is difficult at best. The big problem is exotic, invasive plants or "weeds" as they are commonly known. Weeds such as multiflora rose and japanese honeysuckle are abundant in many vacant areas of Chester County. These exotic, invasive plants do well on land that has been disturbed and then abandoned, like old farm fields (see Appendix A - Forest Ecology for more information). Often the edge between an existing woodlot and fields is choked with the vines and thorny shrubs. Eradication of these weeds is difficult, but it can be done. It requires an understanding of how plant communities develop over time (Appendix A), and it requires intensive and aggressive planting and management programs for developing new vegetation on the land. The presence of exotic weeds has made it necessary for humans to take a much more active role in restoring native plant communities. It just will not happen by itself any more.

FIGURE 10 **CLUSTERED DEVELOPMENT**



5
CONCLUSION

Water conserving landscaping requires a new way of looking at the developed landscapes of Chester County. As a result of our European heritage, landscapes have adopted a form similar to the intensely used landscapes of Europe. The mown lawn looks very similar to the livestock grazed landscapes found throughout the British Isles, France and other countries. To accept naturalized landscapes is to break away from this tradition and to present a livable landscape that is different and truly **American**. The naturalized landscape is a sustainable landscape that reduces costly water consumption and provides habitat and food for many native animals. This landscape is not for the deer and the starling which survive quite well on the existing open suburban landscape. This water conserving landscape is for the many forest interior plants, birds and other animals that are in danger of being lost because of the elimination of forests.

Water conservation landscaping can be employed at all levels of landscaping, **from the small single family lot to the very large planned residential development or corporate center.** The municipality can encourage the homeowner to do naturalized landscaping by providing educational materials and by re-evaluating its own weed ordinance. Weed ordinances that are too restrictive and only allow mown turf grass will only prevent water conservation. Municipalities can also investigate and incorporate in their subdivision/land development ordinances the concepts of minimum disturbance developments and land restoration. The Chester County Planning Commission is beginning to investigate the available information on these important concepts. Municipalities can contact the Planning Commission or local conservancies and watershed associations for more information.

FOREST ECOLOGY

Before we can begin the process of creating water conserving landscapes for our homes and developments, we must first understand how plant communities establish themselves and grow. We must understand the nature of weeds and how they affect and interfere with plant community development.

In the 1920s, an ecologist named Clements developed a theory about plant community development that was referred to as "Succession". The succession theory described how a piece of ground if disturbed would support successive changes in its plant community until some final, climax community was developed. For example, an agricultural field that is abandoned would go through a series of stages, each with a different plant composition, beginning with annual plants, then small perennial shrubs, then small trees, and finally to a "climax" forest. For this part of the world, the oak/chestnut forest would have been the ultimate climax forest. (Oak/hickory forests are believed to be climax now, as chestnut has largely been eliminated by blight.)

This concept of succession was very useful for understanding plant community development and quickly became popular among scientists and resource managers. The concept became particularly useful for timber managers because it meant that forests that were cut for timber would replenish themselves to the same original plant community.

Unfortunately, as it turns out, nature is just not that simple, and involves many complicated interactions. Ecologists are becoming increasingly disillusioned with "Clementsian Succession" theory. The theory often does not adequately explain random processes in nature, the irreversible changes that take place to the land when plants are removed, and the incredible aggressive forces of weed plants introduced to the land from foreign countries.

New theories on plant community development have been and continue to be developed and tested by ecologists. Many ecologists now believe that plant community composition may depend on what plants arrive to a bare site first, the relative growth rates of those plants, and the individualistic nature of plant species to sort themselves out according to individual needs along environmental gradients. The ultimate plant composition for the abandoned farm field would depend on the species of the seeds in the field at the time of abandonment, what new species arrive to the field soon after abandonment, the relative growth rates of those species (annuals grow fast, shrubs and trees grow slow), the competitive nature of those species, and what kinds of environments exist or develop in the field (ie. moist, dry, nutrient rich, nutrient poor, shady, sunny, etcetera).

This concept of plant community development is important, because, often the remaining lands surrounding our homes and developments develop into substantial and persistent weed patches that will never succeed into some other plant community. Many abandoned farm fields result in extensive multiflora rose and honeysuckle patches that will remain as the dominant vegetation. These impenetrable patches resulted from many more weed plants and seeds than any other native species seeds in the fields as they were being farmed, the tenacious competitive nature of the weed plants themselves, and the fact that these exotic plants have few natural checks and balances on their populations because they did not evolve in this part of the world.

Many abandoned fields do develop forest cover, however, their species composition may depend on the species composition of the adjacent forest, how shaded the field was in the first place (ie. its position relative to the sun, such as north slopes versus south slopes), and perhaps how degraded the soil is from erosion and nutrient loss. Expanding forests can be largely dominated by Tulip poplar and beeches, because these species are those which remain in many forest patches after 200 years of selective cutting of timber.

Restoring land that was once farmed to natural plant communities often does not happen naturally. That restoration process will require a good deal of energy and money to plant native plants and to control weeds through routine maintenance. Restoration of lands means attempting to mimic or enhance nature by setting the abundance of plants and seeds in favor of native plants. It means lots of planting. A management plan is essential to remove weeds and improve the survivability of the natives.

A management plan for restoring natural areas should include a cooperative venture on the part of homeowners, municipalities, county and state agencies. It takes manpower and knowledge to keep weeds from dominating a site. Some important stewardship principles to be included in the management plan are: 1. maintain and use only native species, 2. control aggressive weeds without the use of chemicals, 3. coordinate activities with adjacent land uses, 4. maintain important natural processes (drainage, ground water recharge, natural disturbance), 5. preserve large natural areas and provide buffers between them and other land uses, 6. maintain connections between natural elements with tree corridors and hedgerows, and 7. obtain help from a qualified ecologist.

Land restoration requires a substantial investment. That investment however, is in the land's future. It provides for quality of life for our future generations. It helps to insure the coexistence of many native species of plants and animals; species that we are in danger of losing through loss of habitat. Water conserving landscapes with native plants provides more than just water conservation. It provides habitat, cover and food for wildlife. If the landscapes of Chester County, that were once farms and are now becoming developed, revert back to forest (and development can coexist with forest), then the process of development will be said to have had some good from a wildlife point of view. If farmland converts to turf lawns with little habitat value, then the development process may result in a much reduced quality of life for future generations.

APPENDIX B

SELECTED NATIVE PLANT SPECIES FOR CHESTER COUNTY

Trees

Scientific Name	Common Name
Acer negundo	Box Elder
Acer rubrum	Red Maple
Acer saccharum	Sugar Maple
Betula lenta	Black Birch
Betula lutea	Yellow Birch
Betula nigra	River Birch
Betula papyrifera	Paper Birch
Carya ovata	Shagbark Hickory
Carya tomentosa	Mockernut Hickory
Corylus americana	American Hazelnut
Fagus grandifolia	American Beech
Fraxinus americana	White Ash
Fraxinus pennsylvanica	Green Ash
Gleditsia triacanthos	Honey Locust
Ilex opaca	American Holly
Juniperus virginiana	Red Cedar
Liquidamber styraciflua	Sweet Gum
Liriodendron tulipifera	Tulip-tree, Yellow Poplar
Nyssa salvatica	Black Gum, Sourgum
Pinus strobus	White Pine
Plantanus occidentalis	Sycamore
Prunus serotina	Black Cherry
Quercus alba	White Oak
Quercus prinus	Chestnut Oak
Quercus rubra	Red Oak
Quercus velutina	Black Oak
Robinia pseudoacacia	Black Locust
Sassafras albidum	Sassafras
Tilia americana	Basswood
Tsuga canadensis	Hemlock

Small Trees and Shrubs

Scientific Name	Common Name
Amelanchier canadensis	Serviceberry, Shadbush
Amelanchier laevis	Allegheny Shadblow
Carpinus caroliniana	Musclewood, Ironwood, Hornbeam
Cercis canadensis	Eastern Redbud
Chionanthus virginicus	Fringetree
Cornus florida	Flowering Dogwood
Fothergilla major	Fothergilla
Hamamelis virginiana	Witch Hazel
Ilex glabra	Inkberry
Ilex verticulata	Winterberry
Kalmia latifolia	Mountain Laurel
Lindera benzoin	Spicebush
Myrica pennsylvanica	Bayberry
Prunus virginiana	Chokecherry
Rubus occidentalis	Black Raspberry
Salix discolor	Pussy Willow
Salix nigra	Black Willow
Sambucus canadensis	Elderberry
Vaccinium corymbosum	Highbush Blueberry
Vaccinium vacillans	Lowbush Blueberry
Viburnum acerifolium	Maple-leaf Viburnum
Viburnum dentatum	Tooth-leaf Viburnum, Arrowwood
Viburnum prunifolium	Blackhawk
Viburnum trilobum	Highbush Cranberry

Perennials (Meadows)

Scientific Name	Common Name
Achillea milleflium	Yarrow (naturalized)
Anemonella thalictroides	Rue Anemone
Asclepias tuberosa	Butterfly Weed
Aster novea-angliae	New England Aster
Chrysanthemum eucanthemum	Ox-eyed Daisy (naturalized)
Daucus carota	Queen Anne's Lace (naturalized)
Echinacea purpurea	Purple Coneflower
Eupatorium dubium	Joe-Pye Weed
Iris versicolor	Blue Flag
Lobelia cardinalis	Cardinal Flower
Mertensia virginica	Virginia Bluebells
Penstemon digitalis	Beardtongue
Rudbeckia triloba	Black-eyed Susan
Solidago canadensis	Goldenrod
Solidago graminifolia	Lance-leaved Goldenrod
Solidago graminifolia	Grass-leaved Goldenrod
Solidago juncea	Early Goldenrod

Perennials (Forest)

Scientific Name	Common Name
Amphicarpa bracteata	Hog Peanut
Aquilegia canadensis	Wild Columbine
Aralia nudicaulus	Wild Sarsaparilla
Arisaema atrorubens	Jack-in-the-pulpit
Asarum canadense	Wild Ginger
Athyrium filix-femina	Lady Fern
Botrychium virginianum	Rattlesnake Fern
Convallaria majalis	Lily-of-the-valley
Dennstaedtia puntilobula	Hay-scented Fern
Dryopteris hexagonoptera	Broad Beach Fern
Epigaea repens	Trailing Arbutus
Erythronium americanuum	Trout Lily
Geranium maculatum	Wild Geranium
Grandiflorum, undulatum	Trilliums
Hepatica acutiloba & americana	Liverleaf, Hepatica
Impatians capensis	Jewelweed
Lycopodium sp.	Ground Pine, Club Moss
Mitchella repens	Partridgeberry
Onoclea sensibilis	Sensitive Fern
Osmunda cinnamomea	Cinnamon Fern
Osmunda regalis	Royal Fern
Parthenocissus quinquefolia	Virginia Creeper
Phlox divaricata & stolonifera	Phlox
Podophyllum peltatum	Mayapple
Polygonatum pubescens	Solomon's Seal
Polystichum acrostichoides	Christmas Fern
Rhododendron periclymenoides	Pinxter
Sanguinaria canadensis	Bloodroot
Smilacina stellata	False Solomon's Seal
Thelypteris noveboracenses	New York Fern
Trillium cernuum, erectum,	
Vinca minor	Periwinkle
Woodwardia areolata	Netted Chain Fern

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