# Chapter 2
# General Planning Concepts for Erosion Control, Sediment Control and Stormwater Management

This chapter provides important concepts and other selected information that is important for qualified design professionals to know about various aspects of erosion control, sediment control, and stormwater management. It is believed that the contents will, as a minimum, cause qualified design professionals to recognize when other professionals may need to be involved. A qualified design professional should recognize that planning involves several disciplines and that each discipline has a body of in-depth knowledge that is important and needed on complex sites. Although often discussed separately, erosion control, sediment control, and stormwater management are interrelated and, when planning occurs, the thought process must conceive a system of practices and measures that consider all three together.

The basic details of planning, including step-by-step procedures, are located in Chapter 3.

## Potential Erosion and Sediment Problems Associated with Land Development

The principal effect land development activities have on the erosion process consists of exposing disturbed soils to raindrops and to storm runoff. Shaping of land for construction or development purposes alters the soil cover in many ways, often detrimentally affecting physical properties of the soil, onsite drainage and storm runoff patterns and, eventually, off-site stream and stream-flow characteristics. Adverse effects of erosion and sedimentation include impacts on soil, water quantity, water quality, and the aquatic ecosystem. Potential hazards associated with development include the following items:

1. An increase in developed areas exposed to storm runoff and soil erosion.

2. Increased volumes of storm runoff, accelerated soil erosion and sediment yield and higher peak flows caused by:

    a. Removal of existing protective vegetative cover.

    b. Exposure of underlying soil or geologic formations potentially more erodible than original soil surface.

    c. Reduced capacity of exposed soils to absorb rainfall due to compaction caused by heavy equipment.

    d. Enlarged drainage areas caused by grading operations, diversions and street construction.

    e. Prolonged exposure of unprotected disturbed areas due to scheduling problems and/or delayed construction.

   f. Shortened times of concentration of surface runoff caused by altering slope steepness, slope length, and surface roughness and through installation of “improved” storm-drainage facilities.

   g. Increased impervious surfaces associated with the construction of streets, buildings, sidewalks, paved driveways, and parking lots.

3. Creation of exposures facing south and west that may hinder plant growth due to adverse temperature and moisture conditions.

4. Exposure of subsurface materials that are rocky, acidic, droughty, or otherwise unfavorable to the establishment of vegetation.

## Erosion and Sediment Control

A wide array of practices and measures are used for erosion and sediment control. Most of the practices and measures have application over the entire State.

There are numerous simple concepts that can provide an effective framework for minimizing erosion on a construction site and reducing delivery of sediment off of the site.

- Minimize the area disturbed by leaving existing vegetation that does not have to be removed.
- Minimize the period of bare ground by shortening construction periods and staging a project when possible.
- Sequence installation in a manner that supports shortened construction periods and permits the use of temporary and permanent seeding when the practices can be most effective.
- Use sediment control and turbidity measures that minimize sediment and turbid water from leaving the disturbed site.
- Plan appropriate erosion control for all kinds of erosion that may occur depending upon specific site conditions. Give special attention to cut and fill slopes. Give special attention to sites that are transected by streams or are in close proximity to streams or reservoirs.
- Install erosion-control plantings at every opportunity.
- Prevent sediment from leaving a construction site at entrance/exits during muddy periods.

- Maintain practices to ensure their effectiveness. This includes regular and timely inspections.

## Potential Stormwater Problems Associated with Land Development

All forms of land use affect water quality. In an undeveloped area, many ongoing physical, chemical and biological processes interact to recycle most of the materials found in the stormwater runoff. As human land use intensifies, these processes are disrupted. Human activities add materials to the land surface (pesticides, fertilizers, animal wastes, oil, grease, heavy metals, etc.). These materials are then washed off by the rainfall and runoff, thereby increasing the pollutant load carried to receiving waters by stormwater runoff.

Of primary importance to water quality is the "first flush". This term describes the washing action that stormwater has on accumulated pollutants in the watershed. In the early stages of a runoff rain-event, the land surfaces, especially impervious surfaces like streets and parking areas, are flushed clean by the stormwater. This flushing creates a shock loading of pollutants. Extensive studies in Florida have determined that the first flush equates to the first 1″ of runoff which carries 90% of the pollution load from a storm (USGS, 1984). More recently, research has identified that the first ½″ of runoff provides the first flush in some instances, while other research has determined that runoff in excess of 1″, including cut/fill areas associated with construction, may be more realistic. It is proper to say at this time that the amount of runoff that creates the "first flush" depends on several factors, including the activity, site conditions and pollutants. Treatment of the first flush, whatever the runoff amount, will help ensure that the water-quality impacts of stormwater are minimized.

Finally, the value of the hydrologic environment as an amenity is primarily affected by three factors: stability of the stream channel, accumulation of trash, and disruption of the stream community. A channel which is gradually enlarged because of increased floods caused by urbanization tends to have unstable and unvegetated banks, scoured or muddy channel beds, and unusual accumulations of sediment and debris. Together with the accumulation of trash in the channel and floodplain (beverage cans, lumber scraps, lawn clippings, concrete, wire, etc.), these all tend to severely decrease the visual attractiveness of a stream. Ultimately, these factors disrupt the natural balance in the streams' biota resulting from the addition of nutrients, organics, and sediment. These disruptions increase algal growth and turbidity, lower the oxygen content of the water, and thereby change the biological character of the stream.

In summary, each progression toward more intensive land use tends to disrupt the ongoing natural processes that protect and preserve water quality. Therefore, to ensure future protection of water resources, it is imperative that land uses be managed in a responsible way.

### *What is Stormwater Management?*

Historically, urbanization has resulted in the development of stormwater-management systems to reduce flooding. These systems were developed because of their convenience and the protection they provided to property. Often, stormwater-management systems were designed for safety and convenience without recognition of other important considerations. Therefore, no matter how large the rainfall or its duration, the stormwater system was expected to remove the runoff as quickly as possible, and to restore maximum convenience in the shortest possible time. In other words, until recently, stormwater management was concerned with only the quantitative effects of runoff.

Today, however, stormwater management is far more comprehensive. An effective program involves the implementation of actions to control water in its hydrologic cycle with the objectives of providing (1) flood control; (2) nonpoint source pollution control; and (3) off-site erosion control. Stormwater management applies to rural and urban areas alike; however, the techniques presented in this manual are most relevant to urban or urbanizing situations.

To accomplish the three objectives of stormwater management, it is necessary to ensure that the volume, rate, timing and pollutant load of runoff after development are similar to those that occurred prior to development. The approach suggested in this manual is to minimize the adverse impacts of stormwater through a coordinated system of source controls. Source controls emphasize the prevention and reduction of nonpoint pollution and excess stormwater flow before it ever reaches a collection system or receiving waters. Typical control strategies and management criteria to accomplish the objectives of stormwater management are discussed below.

### *Flood Control*

Flood control has historically been the most common goal of local, stormwater-management programs. The property damage, safety hazards, and inconvenience that can result from increased stream flooding in urbanizing watersheds usually get wide public attention and urgent demands for government action. Two levels of drainage systems must be considered in developing a management strategy for flood control: the primary drainage system and the major drainage system.

The <u>primary drainage system</u> consists of the street gutters and ditches, storm sewers, culverts, and open channels that are designed to prevent inconvenience and minor property damages from relatively frequent storm events. Of course, the most effective strategy for flood control at this level is to plan and design the primary drainage system adequately in advance, keeping in mind the future development potential of the drainage area. Unfortunately, many existing drainage systems were designed on a piecemeal, “as needed” basis with little regard for future upstream development. The capacity of such systems often becomes severely inadequate as upstream development progresses, resulting in frequent minor flooding and property damages.

One strategy for dealing with this problem is to replace or modify elements of the primary drainage system to provide the required capacity. This option is often expensive and does not control the source of the problem. However, this may be the only feasible method of correcting existing problems. To prevent future problems, an alternative strategy may be employed. Persons wishing to undertake new development may be required to control runoff from their sites in a manner that will not adversely affect the downstream drainage system. This control is usually accomplished through stormwater detention criteria.

Typical detention criteria will specify that stormwater runoff from a new development must be controlled so that the post-development peak runoff rate does not exceed the pre-development peak rate for some specific frequency design-storm or range of design-storm events. In many localities, a 10-year design storm is specified to preserve the effectiveness of downstream drainage structures that were originally designed to pass a 10-year pre-development storm. Other localities require that larger storms (i.e., 50- to 100-year events) must be detained and released at a controlled rate to reduce the downstream effects of major storms.

It should be kept in mind that, as attempts are made to control larger storm events, requiring slower release rates will also require larger storage volumes in detention systems.

The major drainage system comes into play when the capacity of the primary drainage system is exceeded.

This major system consists of the floodplains and surface-flow routes that water will follow during major storms. The most effective strategy for dealing with flooding at this level is to ensure that stormwater has a route to follow which will not cause major property damage or loss of life. To implement this strategy, floodplain ordinances, zoning regulations, or other land-use controls should be used to restrict floodplain development. In areas where development has already encroached on the floodplain, land owners should be encouraged to purchase flood insurance.

### *Nonpoint Source Pollution Control*

Pollutants that are washed from the land surface and carried into the streams, rivers, and lakes with stormwater runoff have only recently been recognized as major contributors to water-quality degradation in urban and urbanizing watersheds. The goal of controlling this problem is therefore relatively new. Nonpoint-source pollution control is likely to receive highest priority in watersheds that feed public water supplies or recreation reservoirs; however, this goal should be addressed in all local stormwater management programs.

In urban areas, most of the stormwater detention practices that are used to control runoff quantity may also be adapted for use as best management practices for nonpoint-source pollution control. The design criteria of these practices for this purpose, however, are often different. The primary design strategy for pollution removal is to maximize the detention time of captured runoff. Although there have not been many monitoring studies to produce definitive design criteria, it is believed that basin-drawdown times between 30 and 40 hours will result in significant pollutant removal. The required storage volume of detention facilities can be tied to a first-flush capture (i.e., the initial 0.1″ to 1″ of runoff).

### *Off-Site Erosion Control*

Off-site erosion control, as a management goal, must be addressed in all local stormwater-management programs. The strategies for dealing with this problem are similar to those for flood control. The major difference is in the frequency of the storm that must be controlled.

Studies have shown that most natural stream channels are formed with a bank-full capacity to pass runoff from a storm with a 1.5- to 2-year recurrence interval. As upstream development occurs, the volume and velocity of flow from these relatively frequent storms increases. Even smaller storms with less than 1-year recurrence intervals begin to cause streams to flow full or flood.

Stream channels are often subject to a 3- to 5-fold increase in the frequency of bank-full flows in a typical urbanizing watershed. This increase in flooding frequency places a stress on the channel to adjust its shape and alignment to accommodate the increased flow. Unfortunately, this adjustment takes place in a very short time period (in geologic terms). and the transition is usually not a smooth one. Meandering stream channels which were once parabolic in shape and covered with vegetation typically become straight, wide, rectangular channels with barren, vertical banks. This process of channel erosion often causes significant property damage, and the resulting sediment which is generated is transported downstream, further contributing to channel degradation.

An old strategy for dealing with this problem is to increase the carrying capacity and stability of affected streams through channel modifications (i.e. straightening, widening, lining with non-erodible material, etc.). Modifications to natural, continuous flowing streams, however, can be the subject of intense local controversy and require special permits such as a 404 permit issued by the U.S. Army Corps of Engineers. Recent innovations based on natural, stream-hydrology concepts are rapidly gaining favor and should be considered because of their beneficial effects on the aquatic environment.

Wherever modifications to natural flowing streams are being considered, extreme care must be taken to weigh the benefits of such modifications against the cost and the concerns of the local citizens. Where channel modifications are necessary, an attempt must be made to incorporate measures that will minimize adverse impacts to fish, wildlife, and the aesthetic quality of the stream.

On-site stormwater-detention criteria for new development projects can also be an effective strategy for preventing future increases in channel erosion. However, such criteria should be tied to more frequent storm events than typical flood-control criteria. Maintaining the pre-development peak-runoff rate from a 10-year storm, for example, will probably not effectively reduce downstream erosion since the majority of storm events will pass right through the detention system unimpeded.

For example, the minimum state or local stormwater-management criteria could be tied to a 2-year storm event. Receiving channels would then be capable of passing a 2-year storm without flooding or erosion after development of the site, or stormwater would be detained on the site so that the pre-development peak-flow rate from a 2-year storm is not exceeded after development. While flows from larger, less frequent storm events may cause erosion problems downstream, it is believed that, because such events will occur less often, streams will have more time to recover and restabilize themselves.

Local stormwater-detention criteria can be made more restrictive by requiring that storms larger than a 2-year event be detained. However, the allowable release rate should be tied to the actual carrying capacity of the receiving stream or the 2-year pre-development peak-runoff rate.

### *Multiple-Purpose Criteria*

Stormwater management criteria for flood control, erosion control, and pollution control are not necessarily mutually exclusive. In many cases, stormwater can be managed to accomplish all three goals simultaneously. For example, a stormwater-detention basin can be designed as a multipurpose structure by incorporating different release rates at different stages (storage elevations).

The first stage is designed to capture an initial volume of runoff (i.e., the first flush) and release it very slowly through a subsurface drainage system. The second stage begins with an orifice cut in the riser pipe which has the capacity to pass stormwater runoff at a 2-year pre-development rate when water elevation reaches the top of the riser. The purpose of this stage would be to control downstream channel erosion from frequent storms. The top of the riser pipe could serve as the outlet for the third stage and may be designed to pass a l0-year storm at a pre-development rate for moderate flood protection downstream. The emergency spillway should be designed to pass at least the l00-year storm. While such a multi-purpose design may not be feasible for all detention systems, there are often innovative approaches which can be taken to satisfy two or more local stormwater-management goals.

### *Flexibility*

Flexibility is extremely important in stormwater-management programs. Each development project has a unique set of conditions and circumstances and a different potential for affecting the downstream drainage system.

Criteria which may be perfectly applicable to one project may be totally unsuitable for another. For example, requiring stormwater detention for flood control may be highly applicable to projects constructed in the upper reaches of a watershed, but may be unnecessary or even undesirable for new projects constructed near the outlet of the watershed.

A qualified design professional should be given an opportunity to design a drainage system which contributes to the achievement of established, local stormwater-management goals in the most cost-effective manner. To accomplish this, each project must be considered on an individual basis.

### *Principles of Stormwater Management*

It is much more efficient and cost effective to prevent problems than to attempt to correct problems after the fact. Sound land-use planning decisions based on the site planning principles are essential as the first, and perhaps the most important, step in managing stormwater-related problems. All new development plans (e.g., subdivisions, shopping centers, industrial parks, office centers, etc.) and redevelopment plans should include a comprehensive stormwater-management system.

Every piece of land is part of a larger watershed. A stormwater-management system for each development project should be based on, and should support, a plan for the entire drainage basin.

Optimum design of the stormwater-management system should mimic (and use) the features and functions of the natural drainage system, which is largely capital, energy and maintenance-cost free. Every site contains natural features that contribute to the management of stormwater under existing pre-development conditions. Depending upon the site, existing features such as natural drainageways, depressions, wetlands, floodplains, highly permeable soils, and vegetation provide natural infiltration, help control the velocity of runoff, extend the time of concentration, filter sediments and other pollutants, and recycle nutrients. Each development plan should carefully map and identify the existing natural systems. “Natural” engineering techniques should be used to preserve and enhance the natural features and processes of a site and to maximize the economic and environmental benefits. Engineering design can and should be used to improve the effectiveness of natural systems, rather than negate, replace or ignore them.

The volume, rate, timing and pollutant load of stormwater after development should closely approximate the conditions that occurred before development. To accomplish these objectives, two overall concepts must be considered: (1) the perviousness of the site should be maintained to the greatest extent possible, and (2) the rate of runoff should be slowed. Preference should be given to stormwater-management systems that use measures that maintain vegetative and pervious land cover and include on-site storage mechanisms. These systems will promote infiltration and slowing of the runoff.

On-site storage of stormwater should be maximized. Provision for storage can reduce peak runoff rates; aid in groundwater recharge; provide settling of pollutants; lower the probability of downstream flooding, stream erosion and sedimentation; and provide water for other beneficial uses. Stormwater runoff should never be discharged directly into surface or ground waters. Runoff should be routed over a longer distance, through grassed waterways, wetlands, vegetated buffers, and other works designed to increase overland flow. These systems provide time for increased infiltration and evaporation, allow suspended solids to settle, and remove pollutants before they are introduced to waters of the State.

Stormwater-management systems, especially those emphasizing vegetative practices, should be planned, constructed, and stabilized in advance of the facilities that will discharge into them. This principle is frequently ignored, thereby causing unnecessary off-site impacts, extra maintenance, re-working of grades, re-vegetation of slopes and grassed waterways, and extra expense to the developer. The stormwater-management system, including erosion and sedimentation controls, should be constructed and stabilized at the start of site disturbance and construction activities.

The stormwater-management system must be designed beginning with the outlet or point of outflow from the project. The downstream conveyance system should be evaluated to ensure that it contains sufficient capacity to accept the design discharge without adverse downstream impacts such as flooding, streambank erosion, and sedimentation. It may be necessary to stabilize the downstream conveyance system, especially near the stormwater system outlet. A common problem is a restricted outlet which causes stormwater to back up and exceed the storage capacity of the collection and treatment system, resulting in temporary upstream flooding. This may lead to hydraulic failure of the stormwater-management system causing re-suspension of the pollutants and/or expensive repairs to damaged structures or property. In such circumstances, it is advisable to use more than one outlet or to increase the on-site storage volume.

Stormwater is a component of the total water resources that should not be casually discarded, but used to replenish those resources. Stormwater represents a potential resource out of place, with its location determining whether it is a liability or an asset. Given the water quantity and quality problems and challenges facing Mississippi, it is imperative that stormwater be considered an asset. Treated stormwater has great potential for providing beneficial uses such as irrigation (farm, lawn, parks, golf courses, etc.), recreational lakes, groundwater recharge, industrial cooling and process water, and other non-potable domestic uses.

Whenever practical, multiple-use, temporary-storage basins should be an integral component of the stormwater-management system. All too often, storage facilities planned as part of the system are conventional, unimaginative ponds which are aesthetically unpleasing. Recreational areas (e.g., ball fields, tennis courts, volleyball courts, etc.), greenbelt areas, neighborhood parks, and even parking facilities provide excellent settings for the temporary storage of stormwater. Such areas are not usually in use during periods of precipitation, and the ponding of stormwater for short durations does not seriously impede their primary functions. Storage areas should be designed with sinuous shorelines. Shorelines that are sinuous rather than straight increase the length of the shoreline. The increased shoreline also provides more space for the growth of shoreline vegetation, thus providing for greater pollutant filtering and for increased and diversified aquatic habitat.

Vegetated buffer strips should be retained in their natural state or created along the banks of all water bodies. Vegetated buffers prevent erosion, trap sediment, filter runoff, provide public access, enhance the site amenities, and function as a floodplain during periods of high water. They also provide a pervious strip along a shoreline which can accept sheet flow from developed areas and help minimize the adverse impacts of untreated stormwater.

The stormwater-management system must receive regular maintenance. Failure to provide proper maintenance reduces the pollutant removal efficiency of the system and reduces the system's hydraulic capacity. Lack of maintenance, especially to vegetative systems that may require revegetating, can increase the pollutant load of stormwater discharges. The key to effective maintenance is the clear assignment of responsibilities to an established agency (local government) or organization (homeowners association) and a regular schedule of inspections to determine maintenance needs. In addition, stormwater-system designers should find ways to make their systems as simple, natural, and maintenance free as possible.

# Vegetation for Erosion and Sediment Control

## *Introduction*

A dense and healthy vegetative cover protects the soil surface from raindrop impact, a major force in erosion and sedimentation. Also, vegetation shields the soil surface from the scouring effect of overland flow and decreases the erosive capacity of the flowing water by reducing its velocity.

The shielding effect of a plant canopy is augmented by roots and rhizomes that hold the soil, improve its physical condition, and increase the rate of infiltration, further decreasing runoff. Plants also reduce the moisture content of the soil through transpiration, thus increasing its capacity to absorb water.

Suitable vegetative cover offers excellent erosion protection and sediment control. Vegetative cover is essential to the design and stabilization of many structural, erosion-control practices. Vegetative cover is relatively inexpensive to achieve and maintain. Also, it is often the only practical, long-term solution to stabilization and erosion control on many disturbed sites.

Timely vegetative establishment or retention reduces the cost of vegetation, minimizes maintenance and repairs, and makes structural, erosion-control measures more effective and less costly to maintain. Landscaping is also less costly where soils have not been eroded. Natural areas (those left undisturbed) can provide low-maintenance landscaping, shade, and screening. Large trees increase property values if they are properly protected during construction.

Besides preventing erosion, healthy vegetative cover provides a stable land surface that absorbs rainfall, cuts down on heat reflectance and dust, and complements architecture. Property values can be increased dramatically by small investments in erosion control.

Plant selection should be considered early in the process of preparing the erosion and sediment-control plan. A diversity of species can be grown in Mississippi due to the variation in both soils and climate. However, for practical, economical stabilization and long-term protection of disturbed sites, plant selection should be made with care. Many plants that will grow in Mississippi are inappropriate for soil stabilization because they do not protect the soil effectively, or they cannot be established quickly. Some plants may be very effective for soil stabilization, but are not aesthetically acceptable on some sites. In all cases, native vegetation should be the first plants considered when selecting plant materials for stabilization. Plant selection is discussed and suggestions are made in the ***Surface Stabilization*** sections of Chapter 4 entitled *Permanent Seeding*, *Temporary Seeding,* and *Shrub, Vine and Groundcover Planting*. Also, a Vegetation Schedule used by the Mississippi Department of Transportation is provided as **Appendix G**.

Stabilization of most disturbed sites requires grasses and/or legumes that grow close together to provide a thick, close-growing cover. This is true even where part of or the entire site is planted to trees or shrubs. In landscape plantings, disturbed areas between trees and shrubs must also be protected either by mulching or by permanent grass, legumes, or mixtures.

Trees are excellent for long-term soil and water protection, but they will not stabilize concentrated flow areas.

### *Site Planning For Tree Protection*

Select and clearly identify trees to be saved before beginning construction. No tree should be destroyed or altered until the construction plans are final. Floodplains and wetlands should be left in their natural condition. Locate roadways so they cause the least damage to valuable trees. Follow contours where feasible to minimize cuts and fills. Minimize trenching by locating several utilities in the same trench. Excavations for basements and utilities should be kept away from the dripline of trees.

Storage areas for construction materials and worker-parking areas should be noted on the site plan, and located where they will not cause soil compacting over roots.

When retaining existing trees in parking areas, leave enough ground ungraded around the tree to allow for its survival. Tree protection measures should be extended from the trunk to the edge of the dripline to protect the root systems from compaction. Tree wells may be needed to protect the roots from too much soil cover, ultimate compaction, and lack of aeration. Specific tree preservation practices are discussed in Chapter 4, *Preservation of Vegetation*.

Locate erosion and sediment-control measures within the limits of clearing and not in wooded areas to prevent deposition of sediment within the dripline of trees being preserved. Sediment basins should be constructed in the natural depressions, if possible, rather than in locations where extensive grading and tree removal will be required.

### *Selecting Trees to Be Retained or Planted*

Trees may be exposed to insufficient sunlight and water; high winds; heat radiation from highways and parking lots; pollutants from cars and industries; root amputation because of sewer, water, gas and electric lines; pruning or "topping" because of power lines; and covering of roots by pavement and compaction. These items make the selection and management of trees extremely important.

The proper development of a forested-urban site requires a plan for tree retention or tree planting before construction begins. An overall requirement for selecting trees is that those trees selected should be appropriate for the proposed use of the development. The selection of tree species depends on the desired function of the tree, whether it be just erosion control or other functions such as shade, privacy screening, noise screening, appearance, enhancement of wildlife habitat, or a combination of these. The following characteristics of a tree should be considered when choosing a tree to retain or plant.

## Hardiness

Select trees that are recommended for the area. See practice entitled *Tree Planting on Disturbed Areas*.

## Mature Height and Spread

The eventual height of a tree must be considered in relation to location on the site to avoid future problems with buildings and utility lines. See practice entitled *Tree Planting on Disturbed Areas*.

## Growth Rate

Some trees attain mature height at an early age; others take many years. Fast-growing trees may be brittle and possibly short-lived, while slow-growing trees are usually less brittle and live longer.

## Root System

Avoid trees that have fibrous roots which may cause damage to water lines, septic tanks, or sidewalks and driveways.

## Cleanliness

Maintenance problems can be avoided by not selecting trees that drop seedpods, cones, flowers, or twigs, in large amounts.

## Moisture and Fertility Requirements

If suitable soils with adequate fertility are not available, trees tolerant of poor growing conditions should be planted.

## Ornamental Effects

If a tree is unusually attractive in appearance, some other shortcomings may be overlooked, but make sure the tree is suited to the site.

## Evergreen vs. Deciduous

Evergreens retain their leaves or needles throughout the year and are useful for privacy screens and noise barriers. Most deciduous trees drop their leaves in the fall and are preferable as shade trees. Some deciduous trees do not drop their leaves until spring.

### Pest Resistance

Insects and disease problems exist among many trees. Each pest is related to the tree species itself, its vigor, and the site on which it is planted. Where control techniques are available, the tree owner's commitment and ability to apply them to a pest problem will determine whether the tree should be planted.

### Life Expectancy and Present Age

Tree species with expected long-life spans should be favored. Long-lived species that are old may succumb to the stresses of construction, so younger trees of desirable species are preferred since they are more resilient and will last longer.

### Health and Disease Susceptibility

Unhealthy trees and those with damaged areas on the tree should be considered for removal.

### Structure

Check for structural defects that indicate weakness or reduce the aesthetic value of a tree: trees growing from old stumps, large trees with overhanging limbs that endanger property, trees with brittle wood, misshapen trunks or crowns, and small crowns at the top of tall trunks. Trees with strong tap- or fibrous-root systems are preferred to trees with weak rooting habits.

### Aesthetics

Trees that are attractive and pleasing to the eye are desirable. Trees that have beauty during several seasons of the year are desirable and add value to the site.

### Comfort

Trees provide cooling during the summer and buffer the cold winds of winter. Summer temperatures may be 10 degrees cooler under hardwoods than under conifers. Most deciduous trees drop their leaves in winter, allowing the sun to warm buildings and soil. Evergreens are more effective wind buffers.

### Wildlife

Preference may be given to trees that provide food and cover for wildlife.

### Relationship to Other Trees

Trees growing alone generally are more valuable than trees growing in groups, but trees in groups are more effective in preventing erosion and reducing stormwater runoff.

### Suitability for the Site

Consider the height and spread of trees and how they may interfere with proposed structures and overhead utilities. Roots may interfere with walls, walks, driveways, patios, parking lots, waterlines, and septic systems.

Desirable trees should be identified and located on a map as part of the planning process.

## ***Damage to Trees from Construction***

Construction activities expose existing trees to a variety of stresses, resulting in injury ranging from superficial wounds to death. Understanding the types of damages that may occur to trees is important in planning for protection.

### Surface Impacts

Tree trunks are often damaged during construction activities. Trees scarred by construction equipment are more susceptible to damage by insects and disease. Excessive pruning of trees to prevent contact with utility lines or buildings may destroy the visual appeal of the tree, may provide a source of entry for disease-causing fungi, or may kill the tree.

Wind damage is a greater potential problem than scarring, especially when some of the trees have been removed from a group of trees causing the survivors to be exposed to greater wind velocities. Also, trees develop root anchorage where it is needed the most. Isolated trees develop anchorage rather equally all around, with stronger root development on the side of the prevailing wind. The more a tree has been protected from the wind, the less anchorage it usually has. The result of thinning of trees may be that some of the remaining trees are blown over by strong winds (windthrow). An additional factor related to thinning is that thinning in favor of a single tall tree increases the hazard of lightning strike.

### Root Zone Impacts

Disturbing the relationship between soil and tree roots can damage or kill a tree. The roots of an existing tree are established in an area where a specific environment of soil, water, oxygen, and nutrients is present. The mass of the root system must be the correct size to balance the intake of water from the soil with the transpiration of water from the leaves.

Raising the grade as little as 6″ can retard the normal exchange of air and gases. Roots may suffocate due to lack of oxygen or be damaged by toxic gases and chemicals released by soil bacteria. Raising the grade may also elevate the water table and change the potential of the soil to function as a growing medium suitable for the trees that were growing there before the filling occurred.

Lowering the grade is usually not as damaging as elevating the grade. Shallow cuts of 6″ to 8″ will remove most of the topsoil and some feeder roots and expose some to drying and freezing. Deep cuts may sever a large portion of the root system, depriving the tree of water and increasing the chance of windthrow. Lowering the grade may also lower the water table.

Trenching or excavating through a tree's root system eliminates part of the root system and can be very detrimental. Trees that lose as much as 40 percent of their root system usually die within 2 to 5 years. Tunneling may be a better alternative with species that do not have tap roots.

Soil compaction caused by heavy equipment, materials storage, and paving within the dripline of trees restricts air and water from roots by reducing pore space of the soil and by reducing infiltration.

### *Site Considerations for Non-woody Vegetation*

Species selection, establishment methods, and maintenance procedures should be based on site characteristics, including soils, slope, aspect, climate, and expected management.

#### Soils

Many soil characteristics influence the selection of plants and their establishment requirements. These include: including acidity, moisture retention, drainage, texture, organic matter, fertility, and slope influence the selection of plants and their establishment requirements. For example, Bahia grass and centipede are suited to droughty soils since they are more drought tolerant than most other grasses. **Appendix A** contains tables that provide a number of interpretations related to the soils that exist in Mississippi. One characteristic that will not be found in tables is the occurrence of compaction created incidentally as a result of equipment traffic, especially when the soil is wet or moist. Compaction can have an adverse impact on plant establishment and maintenance and should be addressed before establishment of vegetative cover

#### Slope

The steeper the slope, the more essential is a vigorous vegetative cover. Good establishment practices, including seedbed preparation, liming, fertilizing, proper planting, mulching, and anchoring of mulch are critical. The degree of slope may limit the equipment that can be used in seedbed preparation, planting, and maintenance.

Woody plants, shrubs, vines, and trees generally provide better long-term erosion control on steep slopes. They may be more costly and slower to establish, but can provide substantial savings in maintenance. Also, they can be more desirable in the overall landscape plan.

### Aspect

Aspect affects soil temperature and available moisture. South- and west-facing slopes tend to be warmer and drier, and often require special treatment. Warm-season species tend to do better on south- and west-facing slopes in Mississippi because they are usually more drought and heat tolerant.

### Climate

The regional climate must be considered in selecting well-adapted plant species. Species adaptation and seeding dates in Mississippi are based on three broad geographical areas: North, Central, and South. Climatic differences determine the appropriate plant selections based on such factors as cold-hardiness, heat tolerance, and tolerance to a cool-growing season.

### Management Requirements

When selecting plant species for erosion control and stabilization, the post-construction land use and the expected level of maintenance must be considered. In every case, future site management is an important factor in plant selection.

Select plant species that are wear resistant and have rapid wear recovery for sites that receive heavy use, such as a sports field. A wear-resistant plant that also recovers rapidly from foot traffic is Bermuda grass. Bermuda grass also has a fast establishment rate and is adapted to all geographical areas in Mississippi.

Where a neat appearance is desired, use plants that respond to frequent mowing and other types of intensive maintenance. Likely choices for quality turf in north Mississippi are Bermuda grass or fescue, while in central or south Mississippi, Bermuda grass, centipede, or zoysia are good choices.

At sites where low maintenance is desired, low fertility requirements and vegetation persistence are particularly important. *Sericea lespedeza* and tall fescue are good choices in north Mississippi, while Bahia grass and centipede do well in central and south Mississippi.

### *Seasonal Considerations for Non-Woody Vegetation*

Newly constructed slopes and other barren areas should be seeded or sodded as soon as possible after grading. Grading operations should be planned around optimal seeding dates for the particular region, where feasible. The most effective times for planting perennial grasses and legumes generally extend from March through May and from late August through October. Outside these dates, the probability of failure is higher. If the time of year is not suitable for seeding permanent cover (perennial species), a temporary cover should be planted or the area may be stabilized with crimped or tackified mulch. Temporary seedings of annual species (small grains, ryegrass, millets, etc.) often succeed at times of the year that are unsuitable for seeding permanent (perennial) species. Planting dates may differ for temporary species, depending on the geographical area of Mississippi.

Growing seasons must be considered when selecting species. Grasses and legumes are usually classified as warm-season or cool-season in reference to their season of growth. Cool-season species produce most of their growth during the fall and spring and are relatively inactive or dormant during the hot summer months. Therefore, fall is the most dependable time to plant them. Warm-season plants grow most actively during the summer, and go dormant after the first frost in the fall. Spring and early summer are the preferred planting times for warm-season species.

### *Selecting Shrubs, Vines and Groundcovers to be Retained or Planted*

As with trees, several plant characteristics and environmental requirements should be considered when selecting shrubs, vines and groundcovers. Closer adherences to plant requirements yield a greater chance of achieving a successful landscape.

#### Hardiness

Plants have varying capacities to tolerate cold or heat. Cold tolerance is of most concern. The state of Mississippi spans four plant hardiness zones: Zone 7a (located generally in the northeast corner of the state), Zone 7b (located in the northwest corner of the state spanning the north-central portions of the state), Zone 8a (located along the western portion of the state and throughout the south-central areas), and Zone 8b (located in the six southernmost counties). The zones are determined by the range of average annual minimum temperatures. The average range of minimum temperatures for Zone 7a is 0 to 5 degrees Fahrenheit; Zone 7b is 5 to 10 degrees Fahrenheit; Zone 8a is 10 to15 degrees Fahrenheit; and for Zone 8b, 15 to 20 degrees Fahrenheit (See Figure-1: Geographical Areas for Species Adaptation).

Landscape plants that are not capable of tolerating temperatures below 10 degrees should not be expected to escape injury during an average winter in Zones 7a and 7b. However, they should be adequately adapted to Zones 8a and 8b.

Plant hardiness can be greatly influenced by nearby bodies of water since water buffers change in temperature. Other structures or other plants can moderate extreme temperatures and shelter landscape plants, enabling marginal species to better tolerate winter conditions.

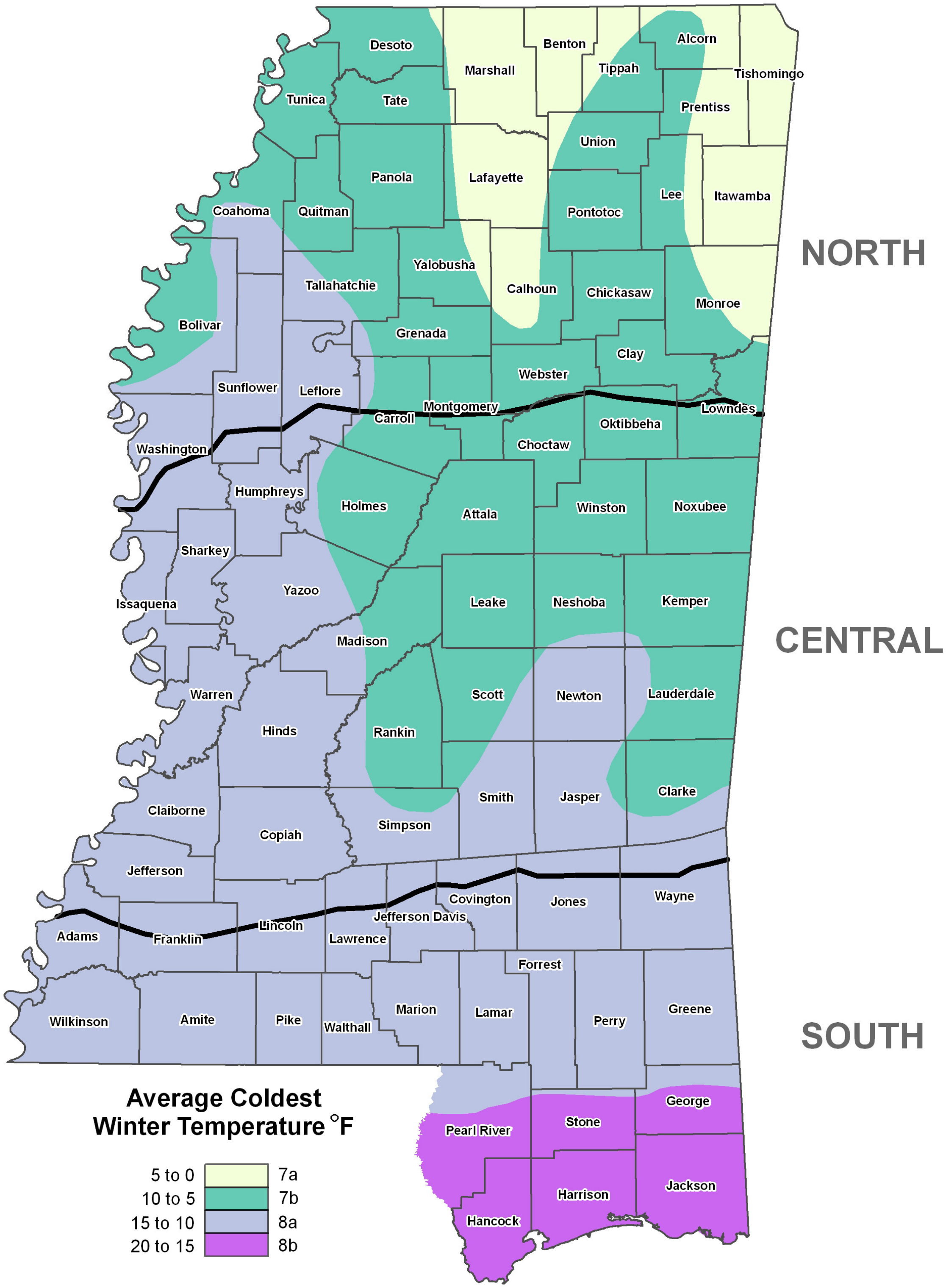


**Figure -1 Geographical Areas for Species Adaptation**

## Summer Heat Tolerance

A plant's capacity to survive the stress of high temperature is also a concern. Heat interacts with other environmental factors, especially soil moisture conditions and sunlight, to influence the range of adaptability of a plant. Usually associated with high temperatures is rapid depletion of soil moisture, especially in late summer. Direct sunlight increases the severity of heat effects on plants. Since Mississippi has periods of high temperatures and short winters, spruce, hemlock, and yew are generally poor performers. Other conifers such as deodar cedars and cryptomeria are not hardy farther north into Zone 7a, but offer good substitutes for hemlocks and spruces in Mississippi.

## Moisture Requirements and Soil Drainage

Landscape plants vary widely in the amount of moisture they need to thrive. If a drought-tolerant plant receives a lot of rain, it can be more susceptible to invasion by normally weak pathogens, especially where the soil drains slowly. On the other hand, plants that require large amounts of water for best performance are easily drought stressed when water is withheld or if planted in very well-drained soils. Such conditions may actually attract insect pests to stressed plants.

Plants that normally require a lot of water can be irrigated so that the ornamental attributes of the plant are maintained. However, this is a misuse of water resources that can be avoided if consideration is given to appropriate plant selection.

## Soil pH

Soil pH can have a profound influence on the performance of landscape plants. However, most landscape plants perform adequately within a soil pH range of 5.5 to 6.2. Plants listed in Tables SVG 1-5 should grow satisfactorily within this pH range.

## Plant Pest Susceptibility

It is unwise to use pest-susceptible plants in areas where those particular pests thrive. For example, most species of euonymus are attacked by euonymus scale, and Red Tip is highly susceptible to leaf spot. Other landscape options for plant materials might be selected that do not have the same susceptibilities. Plants listed in Tables SVG 1-5 have few major pest problems.

## Nutritional Requirements

Newly set plants often require little additional fertilizer because of the presence of residual fertilizer in the root ball. At this stage, supplying water is far more important than adding fertilizer. Also, most well-established shrubs require less fertilizer to maintain an attractive plant than is usually required by poorly established shrubs.

## Light Requirement

Plants that require full sun (at least 8 hours of direct sunlight per day) are weakened in low light situations. Plants that need some shade can become damaged and unattractive in full sun.

## Rate of Growth and Mature Size

For rapid cover, faster growing plants are desired. However, mature size and other plant characteristics should be considered. For example, where a screen is needed, a slower growing evergreen shrub may be desired over a fast-growing deciduous plant. Take all plant characteristics into account when selecting plants for a site. If money is available, both needs can be met by planting fast-growing, short-lived plants to provide a quick screen and, at the same time, planting slower growing plants and allowing them to mature. When the fast-growing plants become overgrown, they can be removed to allow the more desirable plants to take their place.

### *Treating Sites to Establish Grass, Legumes, Shrubs, Vines and Groundcover*

## Topsoiling

The surface layer of an undisturbed soil is often enriched in organic matter and has physical, chemical, and biological properties that make it a desirable planting and growth medium. These qualities are particularly beneficial to plant establishment. Consequently, where practical, topsoil should be stripped prior to construction and stockpiled for use in the final vegetation of the site. Stockpiling topsoil may eliminate costly amendments and repair measures later. Topsoil may not be required for the establishment of less demanding, lower maintenance plants, but it is essential on sites having shallow soils or soils with other severe limitations. It is essential for establishing fine turf and ornamentals.

The need for topsoil should be evaluated, taking into account the amount and quantity of available topsoil and weighing this against the difficulty of preparing a good seedbed on the existing subsoil. Where a limited amount of topsoil is available, it should be reserved for use on the most critical areas.

## Soil Amendments

Lime is almost always required on disturbed sites in Mississippi to decrease soil acidity. Lime raises the pH, reduces exchangeable aluminum, supplies calcium and magnesium for vigorous plant growth, and dispenses heavy clays that impede root penetration. A soil test should be used to determine the need for liming materials.

Plant nutrients, such as phosphorus and potassium, will usually be required even on the best soils. Plant-nutrient application rates for a particular species of vegetative cover should be applied according to a soil-test report.

Soil amendments should be applied uniformly and well mixed with the top 6″ of soil during seedbed preparation.

## Site Preparation

The soil on a disturbed site must be modified to provide an optimum environment for germination and growth. Addition of topsoil, soil amendments, and tillage are used to prepare a good seedbed. At planting, the soil must be loose enough for water infiltration and root penetration, but firm enough to retain moisture for seedling growth. Tillage generally involves disking, harrowing, chiseling, or some similar method of land preparation. Tillage should be done on the contour, where feasible, to reduce runoff and erosion. Lime and fertilizer should be incorporated during the tillage.

## Planting Methods

Seeding is by far the fastest and most economical method that can be used with most species. However, some grasses, such as hybrid Bermuda grass do not produce seed and must be planted vegetatively. Seedbed preparation, liming, and fertilization are essentially the same regardless of the method chosen.

Uniform seed distribution is essential. This is best obtained using a cyclone seeder, conventional grain drill, cultipacker seeder, or hydraulic seeder. The grain drill and cultipacker seeder are pulled by a tractor and require a fairly clean, smooth seedbed.

Seeding rates recommended in this manual have taken into account the “insurance” effect of extra seed. Rates exceeding those given are not recommended because over dense stands are more subject to drought, competitive interference, and are unnecessarily costly.

Because uniform distribution is difficult to achieve with hand broadcasting, it should be considered only as a last resort. When hand broadcasting of seed is necessary, uneven distribution may be minimized by applying half the seed in one direction and the other half at right angles to the first. Small seed should be mixed with sand for better distraction.

A sod seeder (drill seeder or no-till planter) can plant seed into an existing cover or mulch or be used to restore or repair a weak stand. It can be used on moderately uneven, rough surfaces. It is designed to penetrate the sod, open narrow slits, and deposit seed with a minimum of surface disturbance.

Hydroseeding may be the most effective seeding method on steep slopes where equipment cannot work safely. A rough surface is particularly important when preparing slopes for hydroseeding. In contrast to other seeding methods, a rugged or rough seedbed gives the best results.

Sprigging refers to planting stem fragments consisting of runners (stolons) or lateral, below-ground stems (rhizomes), which are sold by the bushel. Sprigs can be hand-planted or planted in furrows using a transplanter. This method works well with Bermuda grass. Sprigs can be covered with soil by light disking, or cultipacking. Common and forage-type hybrid Bermuda grass will cover over much more quickly than the lawn-type Bermuda grass.

Plugging differs from sprigging only in the use of plugs cut from established sod, in place of sprigs. It requires more planting stock, but usually produces a complete cover more quickly than sprigging. It is usually used to introduce a superior grass into an old lawn.

In sodding, the soil surface is completely covered by laying cut sections of turf. It is limited primarily to lawns, steep slopes, and sod waterways in Mississippi. Turf-type Bermuda, centipede, and zoysia are usually the types of turf used for sodding. Plantings must be wetted down immediately after planting, and kept well watered for a week or two thereafter.

Sodding, though quite expensive, is warranted where immediate establishment is required, as in stabilizing drainage ways and steep slopes, or in the establishment of high-quality turf. If properly done, it is the most dependable method and the most flexible in seasonal requirements. Sodding can be done almost any time of the year in Mississippi.

## Inoculation of Legumes

Legumes have bacteria called rhizobia, which invade the root hairs and form gall-like “nodules.” The host plant supplies carbohydrates to the bacteria, that supply the plant with nitrogen compounds fixed from the atmosphere. A healthy stand of legumes, therefore, does not require nitrogen fertilizer. *Rhizobium s*pecies are host specific in that a given species will inoculate some legumes but not others. Therefore, successful establishment of legumes requires the presence of specific strains of nodule forming, nitrogen-fixing bacteria on their roots. In areas where a legume has been growing, sufficient bacteria may be present in the soil to inoculate seeded plants, but in other areas the natural *Rhizobium* population may be too low.

In acidic subsoil material, if the specific *Rhizobium* is not already present, it must be supplied by mixing it with the seed at planting. Cultures for inoculating various legume seed are usually available through seed dealers.

Among the legumes listed for use in this manual, crownvetch is the only one generally requiring inoculation. Lespedeza nodule bacteria are widely distributed in the soils of Mississippi unless the site has had all surface soil removed.

## Irrigation

Irrigation, though not usually required, can extend planting dates into the summer and ensure seedling establishment. Damage can be caused by both under and over irrigating. If the amount of water applied penetrates only the first few inches of soil, plants may develop shallow root systems that are prone to desiccation during droughts. If supplementary water is used to get seedlings up, it must be continued until plants become completely established.

## Mulching

Mulch is essential to the successful establishment of vegetation of most disturbed sites, especially on difficult sites such as southern exposures, channels, and excessively dry soils. The steeper the slope and the poorer the soil, the more valuable mulch becomes. Mulch protects the site from erosion until the vegetation is established. In addition, mulch aids seed germination and seedling growth by reducing evaporation, preventing soil crusting, and insulating the soil against rapid temperature changes.

Mulch may also protect surfaces that cannot be seeded. Mulch prevents erosion in the same manner as vegetation, by protecting the surface from raindrop impact and by reducing the velocity of overland flow.

Small grain straw (wheat, oats, barley, or rye) is the most widely used and one of the best mulch materials. However, other materials, including manufactured mulches, also work well. Mulching materials covered in this manual have their respective advantages and appropriate applications, and a material should not be selected on the basis of cost alone. The effectiveness of straw mulch can be increased by crimping or tacking.

## Maintenance

Satisfactory stabilization and erosion control requires a complete vegetative cover. Even small breaches in vegetative cover can expand rapidly and, if not repaired, can result in excessive soil loss from an otherwise stable site. A single heavy rain will enlarge rills and bare spots and, the longer repairs are delayed, the more costly they become. Prompt action will keep soil loss, sediment damage, and repair costs down. New plantings should be inspected frequently and maintenance performed as needed. If rills and eroded areas develop, they must be repaired, seeded, and mulched as soon as possible.

Maintenance requirements extend beyond the seeding phase. Damage to vegetation from disease, insects, traffic, etc., can occur at any time. Pest control (weed or insect) may be needed at any time. Weak or damaged spots must be fertilized, seeded, and mulched as promptly as possible.

Vegetation established on disturbed soils often requires additional fertilization. Frequency and amount of fertilizer to apply can best be determined through periodic soil testing. A fertilization program is required for the maintenance of turf and sod that is mowed frequently. Maintenance requirements should always be considered when selecting plant species for vegetation.