Streams, rivers, lakes, and underground aquifers almost always cross city, county, and state lines. The best way to effectively manage and protect surface and groundwater resources is to use a watershed approach.

CHAPTER 4

MANAGING TO IMPROVE WATERSHED FUNCTION

Managing to Improve Watershed Function

In this chapter, you will learn about the following:

- **using a watershed management approach**
- **watershed management plans (WMPs) and total maximum daily loads (TMDLs)**
- **best management practices (BMPs) in agricultural, urban, small-acreage, and residential settings**

USING A WATERSHED APPROACH

When it comes to managing things like population, voting, and other human issues, political jurisdictions often are used to coordinate the process and make management more efficient. Most of these things are neatly contained within city, county, or state boundaries that are well-defined and do not overlap. Managing surface and groundwater resources, on the other hand, is a much different story. Water resources do not have neatly defined boundaries that parallel political jurisdictions. Streams, rivers, lakes, and underground aquifers almost always cross city, county, or state lines and may even overlap with one another.

The best way to effectively manage and protect surface and groundwater resources is to use a watershed approach. The watershed approach is a flexible framework for managing the quantity and quality of water found within specified watershed boundaries.

The goals of the watershed management approach are to accomplish the following:

- identify and prioritize water quality/quantity problems in the watershed
- develop increased public awareness and involvement
- coordinate efforts with other agencies/organizations in the watershed
- measure success through monitoring and other data collection

Watersheds are appropriate management units because they are defined by the geographic and hydrologic features of the area, and they include the terrestrial and aquatic components within the watershed boundaries. This makes it possible to address water quality problems in a holistic manner rather than focusing on the individual problems of each waterbody. At the same time, this approach takes into account the interconnectedness of all watersheds across the landscape.

A watershed approach tends to be community-based and uses the expertise of both the public and private sectors.[9] The EPA considers a watershed approach to be the most effective means of addressing today's water resource challenges. [25]

WATER QUALITY IMPROVEMENT PROJECTS

A watershed approach often is used to design and implement water quality improvement projects at the watershed scale. This makes it possible to consider all major issues in the watershed during the planning process.

Water quality improvement projects usually are implemented to improve waterbodies that have been placed on the CWA 303(d) list. Waterbodies on the 303(d) list do not meet the chemical, physical, and/or biological criteria necessary to support its designated use(s). All waterbodies in Alabama that have been identified as impaired are on Alabama's 303(d) list.

Water quality improvement projects are separated into two major categories: (1) watershed management plans (WMP); and (2) total maximum daily loads (TMDL). Both are designed to improve and protect water quality and the overall health of a watershed. Later in this section we will discuss various best management practices that may be implemented as part of these projects.

A WMP is a community-driven management framework that uses the watershed approach to solve complex water quality problems within a watershed. The purpose of a WMP is to protect healthy bodies of water and to restore impaired ones.

WMPs generally are developed and managed through partnerships among federal and state agencies and local groups and organizations. They rely heavily on stakeholder involvement at the local level. From start to finish, the development and implementation of a WMP can take several years. They are vital to improving the water quality in watersheds across Alabama.

According to EPA guidelines (US Environmental Protection Agency 2008), each WMP should contain the following nine elements:

1. identification of the causes of impairment and pollutant sources that need to be controlled
2. estimation of the pollutant load reductions that need to be achieved through management
3. description of the point/nonpoint source management actions needed to achieve the load reductions
4. estimation of the technical/financial assistance required to implement these management actions
5. information/education component to increase public understanding and awareness
6. schedule for implementing the management actions
7. measurable milestones for tracking the implementation of management actions
8. criteria for determining whether load reductions are being achieved
9. water quality monitoring component to evaluate the effectiveness of the plan

In Alabama, the Alabama Department of Environmental Management (ADEM) has a role in developing and implementing WMPs, because it bears the responsibility for managing nonpoint source pollution in the state. One of the principal roles is to provide technical and financial assistance to local groups that develop and implement WMPs. Other agencies and organizations in the state, including the USDA Natural Resources Conservation Service (NRCS) and the Alabama Cooperative Extension System (ACES) also provide educational and/or technical assistance for developing WMPs.

The implementation of most WMPs in Alabama is partially funded through the Clean Water Act Section 319(h) Nonpoint Source Pollution Grant Program. Through this program, the EPA allocates Section 319 funding to ADEM to carry out their nonpoint source management programs. ADEM then directs these funds to various projects throughout the state, including WMP development projects.

In most cases, a watershed is selected for WMP development because it has been placed on the state's 303(d) list of impaired waterbodies. When this occurs, state and federal agencies (ADEM and the EPA) often facilitate the process of developing a WMP by working with organizations, such as the Alabama Cooperative Extension System, universities, consultants, and conservation groups, to help local and regional stakeholders form a steering committee and other work groups. Representatives of the agencies meet with these groups to help them develop a plan that includes the nine elements outlined by the EPA. Once the WMP is written and approved by the stakeholders, implementation of the plan can begin. The plan also can be submitted to ADEM and the EPA as part of a request for funding to implement measures of the proposed management actions.

The second major type of water quality improvement project is a total maximum daily load (TMDL). As the name implies, a TMDL refers to "the calculation of the maximum amount of a pollutant allowed to enter a waterbody so that the waterbody will meet and continue to meet water quality standards for that particular pollutant."[27]

The TMDL program and associated regulations are outlined in Section 303(d) of the Clean Water Act (CWA). The law calls for each state to give the EPA a list of its impaired bodies of water and prioritize that list for TMDL development based on five categories/subcategories of classification:

- **Category 1:** The water attains the water quality standard, and no use is threatened.
- **Category 2:** The water attains some of the designated uses; no use is threatened; and insufficient or no data are available to determine if the remaining uses are attained or threatened.
- **Category 3:** Insufficient data (or no data) is available to determine if any designated use is attained.
- **Category 4:** The standard is not met or is threatened for one or more designated uses, but the development of a TMDL is not required.
    - **Category 4a:** A TMDL has been completed and approved by the EPA.
    - **Category 4b:** Other pollution control requirements are reasonably expected to result in the attainment of the water quality standard in the near future.
    - **Category 4c:** Pollution is not the cause of the water quality standard not being met.

- **Category 5:** The waterbody does not meet applicable water quality standards or is threatened for one or more designated uses by one or more pollutants.
    - **Category 5a:** A TMDL is underway or scheduled or will be scheduled.
    - **Category 5b:** A review of the water quality standards will be conducted before a TMDL is scheduled.
    - **Category 5c:** Additional information will be collected before a TMDL is scheduled.

The main difference between a WMP and a TMDL is that TMDLs are regulatory in nature, meaning they are required by federal law. WMPs are voluntary programs and are not mandated by federal law. In general, WMPs are a voluntary way of restoring water quality that can result in removing a body of water from the CWA 303(d) list, therefore avoiding regulatory action in a watershed.

WMPs often are a better fit for watersheds that have few or no permitted dischargers, where the probable cause is loading from nonpoint, unregulated sources. In some cases, however, TMDL development is unavoidable, especially if the body of water has been placed in impairment category 5a, and the impairment is seen as an emergency situation. TMDLs often can be completed more quickly than a WMP, because they focus only on a single pollutant rather than all potential pollutants. In certain situations, WMPs and TMDLs can be developed for the same body of water, depending on the impairment issue. In these cases, a WMP can be used to implement a completed TMDL or vice versa.

BEST MANAGEMENT PRACTICES

When a body of water is impaired and placed on the 303(d) list, it is the responsibility of the state environmental agencies and concerned stakeholders to resolve the water quality problem(s) so that the waterbody can ultimately be removed from the list. The implementation phases of both a WMP and a TMDL outline specific activities referred to as best management practices (BMPs) that will be completed in the watershed to prevent or reduce pollution from nonpoint sources. These activities may include a wide range of efforts requiring the involvement of federal and state agencies, city and county governments, local businesses and industry, and individual citizens.

Most point sources of pollution are regulated by federal and/or state agencies. Pollution controls for these sources are governed by federal and state laws that place specific requirements on the types and amounts of pollutants that can be released in a watershed. As a result, recommendations outlined in the WMP for point sources must consider these requirements and be congruent with existing regulatory programs.

While nonpoint sources of pollution also are addressed through federal and state regulatory programs, control of these sources is often a much greater challenge. Remember, nonpoint source pollution is diffuse and does not originate from a known, fixed location as does point source pollution.

Nonpoint source pollution is largely addressed in Alabama through education and the adoption of BMPs. BMPs are voluntary or required practices designed to lessen the environmental damage from nonpoint pollutant sources. These are effective, practical methods that prevent or reduce the movement of sediment, nutrients, pesticides, and other pollutants from the land to surface or groundwater, therefore protecting wildlife, air quality, water quality, and landscapes from potential adverse effects of human activities on the watershed.

There are two basic BMP strategies: structural and nonstructural. A structural BMP is one that intercepts pollution before it enters waterways by capturing, delaying, storing, or treating the runoff. A nonstructural BMP reduces NPS pollution through planning, improved design, management, and education. BMPs often are implemented by entities such as municipalities, soil and water conservation districts, and other academic and nonprofit organizations.

Education is necessary for the success of any BMP system, both in rural or urban situations. Education strategies must target specific audiences so that the relationship between personal behaviors and negative impacts on water quality and community health are clearly understood. There frequently are opportunities for citizens to take part in projects that feature BMPs that individuals can implement in their own backyards.

BMPs can be implemented by anyone, anywhere in a watershed; however, the types of BMPs implemented depend on the specific sources and types of pollutants that are causing the problem. For example, there are specific BMPs for both agricultural and urban areas. The following sections discuss specific types of BMPs.

AGRICULTURAL BMPS

Roughly 46 percent of United States acreage is made up of grassland-pasture, rangeland, and cropland that produce an abundant supply of food and food-based products.[8] Agriculture is vital to the economic and social well-being of all Americans. If not properly managed, however, agricultural activities can degrade the quality of nearby bodies of water.

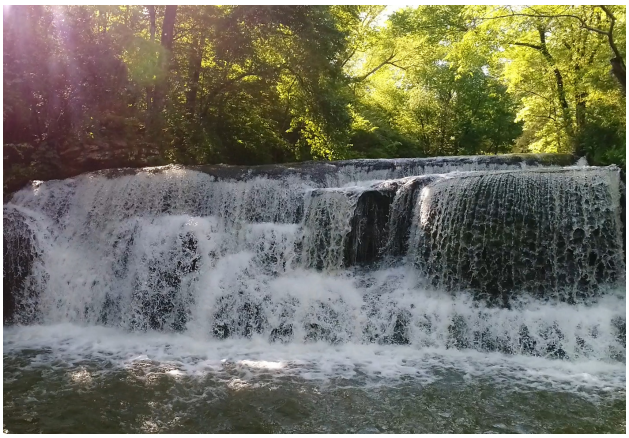

Figure 4.1. Alabama's abundant water resources include scenic waterfalls.

The National Water Quality Assessment provides information reported every 2 years by the states to the EPA about the conditions in their surface waters. The most recent 2016 report shows that agricultural nonpoint source pollution is the leading source of water quality impacts on surveyed rivers and streams, the third-largest source for lakes, the second-largest source of impairments to wetlands, and a major contributor to contamination of surveyed estuaries and groundwater. Agricultural activities, such as overirrigation, inappropriate fertilizer and pesticide application, overgrazing, removal of riparian vegetation, and improper livestock manure and wastewater management, all generate nonpoint source pollutants that can enter the water supply by seeping into groundwater or running off into surface waters.

The primary agricultural nonpoint source pollutants are nutrients, sediment, animal wastes, salts, and pesticides. Sedimentation is the most common source of agricultural water pollution.

Using agricultural BMPs can help to prevent or minimize the effects of nonpoint source pollution. Most agricultural BMPs help to control sediment carried off of agricultural lands, encourage sound pest and nutrient management techniques, and prevent or minimize potential runoff to ensure economic, environmental, and agronomic sustainability. Adopting agricultural BMPs can ultimately increase efficiency and profits, increase property values, improve water quality, and benefit the local community.

Agricultural BMPs can be structural or nonstructural. Structural practices, such as fences and buffer strips, often involve some sort of construction, installation, and maintenance. Structures can be vegetative (buffers) or nonvegetative (fencing). Nonstructural practices, on the other hand, are activities or behaviors that reflect better planning and management and increased education and awareness. For more information on agricultural BMPs for controlling nonpoint source pollution, visit the Natural Resources Conservation Services website at www.nrcs.usda.gov.

Figure 4.2. Proper use of irrigation techniques can reduce erosion and sedimentation and improve your water-use efficiency.

Best Management Practices

Nutrient management includes reducing the amount of fertilizer used by applying only the amount a crop needs. It involves managing the amount, form, methods, and timing of nutrient application (either animal waste, commercial fertilizers, or other forms of nutrients).

Nutrient management is cost-effective because it limits the amounts of nutrients lost. Furthermore, it is one of the best ways to reduce nonpoint source nutrient pollution. Vegetation in riparian buffers and healthy pasture systems help to filter out nutrients before runoff reaches surface waters. Poultry management practices, such as dry stacks and composting, also may minimize nutrient loss.

Integrated pest management (IPM) is an ecologically based strategy of control tactics designed to prevent damage of pest populations from causing negative economic impacts. IPM is not a single pest-control method but rather a series of pest-management evaluations, decisions, and controls aimed at reducing the amount of pesticide used and the amount that moves into the environment. If pests must be controlled, there may be several options:

- biological control (such as releasing natural insect enemies)
- mechanical control (plowing, cultivating)
- cultural control (planting insect-resistant varieties, crop rotation, destroying pest refuge sites)
- chemical control

When pesticides must be used, the objective is to select the least toxic product possible and strictly follow all application guidelines on the product label. For more information on IPM, visit the Alabama Cooperative Extension System website at www.aces.edu.

Irrigation water management promotes the efficient use of irrigation water to produce profitable yields, conserve water, and minimize the leaching of nutrients into groundwater. The timing and amount of irrigation water applied to agricultural lands are critical decisions for each operator, because they affect profits and crop yields (figure 4.2).

Applying too much water increases pumping costs, reduces water efficiency, and increases the potential for nitrates (NO_3) and pesticides to leach into groundwater. On the other hand, delaying irrigation until plants are water-stressed can reduce yield and make fertilizers and pesticides less effective. An irrigation water management plan should use soil-moisture monitoring techniques to determine when irrigation is necessary. Irrigating only when a crop needs it is an effective BMP for reducing nonpoint source pollutants.

Vegetative and Tillage Practices

Conservation tillage is a way to reduce the amounts of sediment and nutrients that move into water from agricultural lands. Two types of conservation tillage are minimum tillage and no-tillage. Minimum till leaves at least 30 percent of the soil surface covered with plant residue after the tillage or planting operation. No-tillage is the practice of leaving the soil undisturbed from harvest to planting, except for nutrient injection. Crop seeds are planted by a device that opens a trench or slot through the sod or pervious crop residue. Conservation tillage can reduce soil loss by 50 percent or more as compared to conventional tillage.[12]

Contour farming is the alignment of all farm tillage, planting, and harvesting practices with the contour of the land. The goal is to reduce erosion and surface runoff and thus the transport of nutrients and pesticides from the field. Contoured rows retain rainwater, which increases infiltration and reduces runoff.

Cover and **green manure crops** are crops of close-growing grasses, legumes, or small grains grown primarily for temporary, seasonal soil protection and improvement, except where there is permanent cover as in orchards or vineyards (figure 4.3). Green manure crops are plowed under and incorporated into the soil to control erosion, add organic matter and nutrients, suppress weeds, and reduce the need for nitrogen fertilizers.

Vegetative buffer strips or **filter strips** are strips of grasses or other vegetation placed along streams or drainage areas to slow down runoff water, trap sediment, filter nutrients and other pollutants, and promote the infiltration of water into the soil. The width of a filter strip depends on the slope and amount of land area delivering water to the strip and the type of vegetation used.

Figure 4.3. Cover crops are close-growing grasses, legumes, or small grains grown for soil protection and improvement.

Structural Practices

Water and **sediment-control basins** are erosion-control structures commonly installed across the bottoms of drainage ways to prevent bank and gully erosion on farmland and to minimize sedimentation of nearby waterbodies. Basins help to improve water quality downstream by trapping sediment, controlling water flow within a drainage area, and storing runoff water to allow it to slowly infiltrate into the soil profile.

Terraces are level soil embankments that are usually constructed on the contour of the land. They help to control runoff and soil erosion. Because they tend to promote water infiltration into the soil, these structures also are effective in reducing both nutrient and pesticide losses.

Grassed waterways are natural drainages that are planted with sod-forming grasses to help control runoff water from agricultural lands. Covering the drainage way with grass prevents gullies from forming in the fields, traps sediment, absorbs chemicals and nutrients in runoff water, and provides cover for small birds and mammals.

Streambank and **shoreline protection** involves the use of vegetation, structures, bioengineering, or management techniques to stabilize and protect streambanks (figure 4.4), riparian areas (figure 4.5), and shorelines. The goal is to reduce the sediment and nutrients entering water from eroding streambanks and shorelines. Healthy riparian and shoreline areas can provide abundant wildlife habitat and cover. Mature, woody vegetation along stream-banks can lower stream temperature and improve fish habitat.

There are many government programs to help farmers and ranchers design and pay for agricultural BMPs to control nonpoint source pollution. For example, the NRCS, EPA, and many state agencies offer cost-share programs, technical assistance, and economic incentives. Many individuals use their own resources to adopt technologies and management practices that protect and improve water quality.

Figure 4.4 A natural stream restoration project incorporates a vegetative riparian buffer.

FORESTRY BMPS

The Forestry BMP section is heavily sourced from Alabama's Best Management Practices for Forestry *handbook.*[5] *We suggest referring to this resource for more in-depth information.*

Forests are critical to clean water. Roughly 80 percent of the nation's scarce freshwater resources originate on forests, which cover about one-third of the nation's land area.[14] The forested land absorbs rain, refills underground aquifers, cools and cleanses water, slows storm runoff, reduces flooding, sustains watershed stability and resilience, and provides critical habitat for fish and wildlife. Forests also provide water-based recreation, hiking, and health benefits that improve our quality of life. Maintaining water quality standards during forestry operations is the responsibility of all parties involved in authorizing, planning, and implementing the operation.

Figure 4.5. Natural vegetative buffers can protect streambanks from erosion and excessive runoff.

Non-structural Practices

These and other non-structural BMPs reduce NPS pollution through planning, improved design, management, and education. Pre-harvest planning ensures that forestry activities, including timber harvesting, site preparation, regeneration, and associated road construction, are planned with water quality considerations in mind and conducted without significant nonpoint source pollutant delivery to streams or other surface waters. Revegetating areas, either through natural regeneration, hand planting, or direct seeding, can be helpful in stabilizing exposed or disturbed soil that could contribute to erosion and sedimentation.

Forest roads and stream crossings are among the largest potential sources of forestry-produced sediment, but careful road-system planning can help avoid sedimentation. Road-system planning involves recognizing sensitive areas to avoid, limiting stream crossings through practical alternatives, and minimizing the overall area disturbed by the operation.

Topographic maps, aerial photographs, and soil surveys are helpful tools commonly used in conjunction with site reconnaissance to plan forestry activities. It is also a good idea to work with a registered forester before starting any forestry activity, establish a site-specific management plan, and select a contractor that has been trained in BMPs.

Together, **contour planting** and **site preparation** are similar to the agricultural practice of contour farming, in that forest regeneration operations are conducted on the contour of the land. This practice minimizes soil erosion and slows surface runoff, especially on steep slopes with highly erodible soils. Roads and skid trails are located along the contour for the same reasons.

Figure 4.6. Streamside management zones minimize nonpoint source pollution. (Photo credit: Alabama Forestry Commission)

Timber harvesting BMPs include practices such as locating log decks, roads, and skid trails away from streams and streamside management zones (defined below) and on firm ground; capturing and properly disposing of equipment fluids and trash; and preventing logging debris from entering stream channels. When operations are completed, landings and temporary roads should be stabilized with water-diversion devices and/or vegetation where there is a possibility of significant erosion or water quality degradation.

The goal of these practices is to conduct harvesting in a way that prevents nonpoint source pollution and minimizes the impact to water quality. For more details on timber harvesting BMPs, refer to chapter 4 of *Alabama's Best Management Practices for Forestry* handbook.

Practices that protect water resources during and after prescribed burning and wildfires include minimizing or excluding constructed fire breaks from riparian areas to reduce the potential for soil movement and maintain the filtering capacity of the forest floor; refraining from prescribed burning on steep terrain with erodible soils; and ensuring that exposed fire breaks are stabilized, well drained, and only as wide and deep as needed to prevent erosion.

The goal of these practices is to minimize nonpoint source pollution and erosion resulting from prescribed fire and other activities associated with wildfire control or suppression.

Practices that prevent the direct or indirect application of forestry chemicals, such as pesticides and fertilizers, to open water sources include: ensuring that application equipment is in good working order, applying chemicals away from surface waterbodies and riparian areas, following written guidelines on the manufacturer's label, and disposing of residues and containers in accordance with state and federal laws.

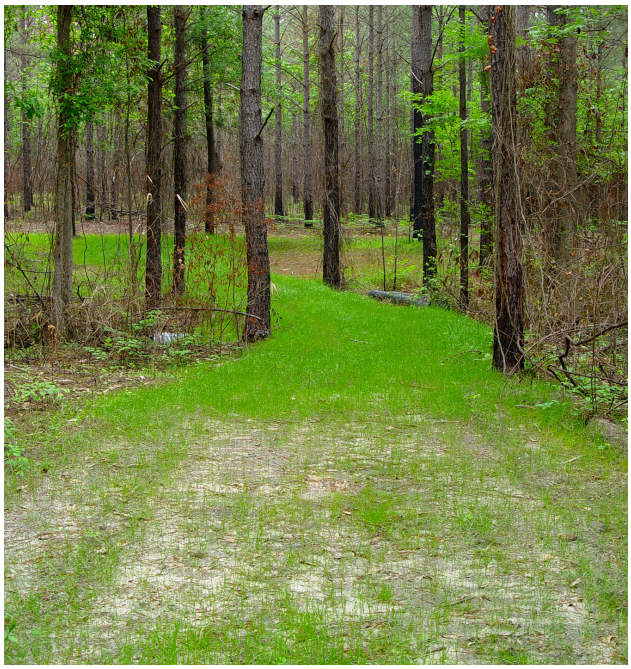

Figure 4.7. Revegetation can help stabilize exposed or disturbed soil. (Photo credit: Alabama Forestry Commission)

Structural Practices

These structural practices help to intercept pollution before it enters waterways by capturing, delaying, storing, or treating the runoff.

Streamside management zones (SMZs) are forested riparian buffers purposefully maintained along streams that receive special management attention because of their value in protecting water quality and other beneficial uses. SMZs reduce runoff velocity, trap sediment from upslope areas, promote infiltration, ensure bank stability, shade and cool surface waters, and provide important habitat for aquatic organisms and terrestrial species. Site-disturbing activities are generally limited within the SMZs in order to maintain the shading, soil stabilization, and water-filtering effects of the area.

SMZs are very important for wetland management as well. They should be established and managed around the perimeter of all major drainages and open bodies of water (i.e., mainstream courses, oxbow lakes, and sloughs) contained within wetlands.

Wetlands are areas that are inundated or saturated by surface or groundwater at a frequency or duration sufficient to support (and do support under normal circumstances) a prevalence of vegetation typically adapted for life in saturated soil conditions. Any harvesting in streamside management zones should be done in a way that protects the forest floor and vegetation from damage. For other wetlands BMPs, see chapter 6 of *Alabama's Best Management Practices for Forestry* handbook.

Revegetation by natural regeneration, hand planting, or direct seeding is used to stabilize exposed slopes with erodible soils. Vegetation restabilizes the soil with roots, dissipates the impact force of raindrops, reduces the velocity of surface runoff, contributes organic matter to the soil, which increases soil infiltration rates, and helps to prevent sediment and other pollutants from entering into nearby surface waters.

Stream crossings enable equipment to traverse streams, drains, and ditches, when necessary, while also protecting water quality. Typical crossings include bridges, log crossings, culverts, and fords. Log crossings involve placing hollow or solid logs into shallow channels. All log crossings must be removed when the logging operation is complete. Fords are slight depressions in the road that allow water to flow over the road unimpeded. Culverts should be properly sized and installed to reduce road washouts and impoundments of water. See chapter 2 of *Alabama's Best Management Practices for Forestry* handbook for recommended culvert diameters.

Keep in mind that stream crossings cause a break in the canopy and filtration strip provided by an SMZ; therefore, it is optimal to use the fewest number of stream crossings in the least disruptive manner possible in SMZ areas. Selecting the most appropriate type of crossing for the site and properly installing it in the best location can prevent excessive sedimentation and unnecessary site disturbance while maintaining natural stream flow. All temporary crossings should be removed and the site stabilized, and all permanent crossings should be stable and maintained.

Figure 4.9. Crowning forest roads help prevent water from soaking into the road and making it soft and muddy. (Photo credit: Alabama Forestry Commission).

Road Construction and Maintenance Practices

Proper planning and maintenance of roads minimizes the potential for deposition of pollutants into waters of the state, future maintenance and expense, and the amount of land taken out of production. When roads cross streams or any other wetlands, it is important to follow mandatory federal BMPs (outlined in detail in chapter 5 of *Alabama's Best Management Practices for Forestry* handbook).

Roads and stream crossings within wetlands and other waters of the United States *must* be constructed and maintained in accordance with the following US Army Corps of Engineers baseline BMPs.

Adequate drainage is the most important factor in controlling soil erosion and keeping roads in a serviceable condition. Construction techniques such as crowned roads, turnout ditches, out-sloping and in-sloping should be used to provide some slope to flat roads that would hold water. Road surfaces are constructed to drain into roadside ditches that move water alongside a road to a point where it can safely be diverted into areas away from lakes, wetlands, and streams. This prevents runoff, which might be polluted with soil and other pollutants, from directly entering waterbodies.

Figure 4.8. In general, stream crossings should be located where the bank and streamside management zone will be least disturbed. (Photo credit: Alabama Forestry Commission).

Figure 4.10. Turnout ditches can help disperse water collected in the road away from the road base and into surrounding vegetation. (Photo credit: Alabama Forestry Commission).

Figure 4.12. Culverts can carry water under roads. (Photo credit: Alabama Forestry Commission)

Crowning and **outsloping** are surface-shaping techniques for roads that enable quick and effective drainage to prevent erosion of the road surface.

Crowned roads (figure 4.9) are designed to quickly drain road surfaces from the center of the road to side ditches. This technique helps to prevent water from soaking into the road and making it soft and muddy.

Turnout ditches can be installed at intervals to disperse water in roadside ditches away from the road base and into surrounding vegetation.

Insloped roads may be preferable when roads are built on side slopes with slippery soils and/or in steep terrain. These practices also prevent water from accumulating on the road surface, which can lead to rutting and erosion from vehicle traffic. Armoring road surfaces with rock or other forms of aggregate also protects against degradation from traffic.

When dealing with excessive road steepness, a variety of water-diversion devices, such as broad-based dips, water bars, and outfall protection, can be used to direct water from roads and ditches into vegetated areas upslope from streams. This slows down water and filters out sediment.

Waterbars are speed bump-like berms of compacted soil constructed at an angle across the surface of a road to intercept, divert, and drain runoff water. Constructing a series of waterbars at regular intervals along a steep road helps to prevent erosion by reducing the volume of water carried down the road and decreasing the erosive velocity of that water by limiting the distance it can travel. The spacing of waterbars depends on the type of soils present and the slope of the road. Waterbars are typically constructed in conjunction with wing ditches or turnout ditches that collect the runoff and disperse it into areas of stable vegetation away from waterbodies.

Figure 4.11. Insloped roads may be preferable when roads are built on side slopes with slippery soils or in steep terrain. (Photo credit: Alabama Forestry Commission).

Figure 4.13. Urbanization results in more land converted to and covered by impervious surfaces. (Photo credit: Moores Creek Project)

Cross drains help to minimize erosion of road surfaces and roadside ditches and maintain the natural drainage patterns of the landscape by providing a stable means of transferring water across roads. **Culverts** transfer water under the road, while broad-based dips and rolling dips transfer water over the road surface.

Roads and stream crossings within wetlands and other waters in the United States must be constructed and maintained according to the US Army Corps of Engineers baseline BMPs. For details see chapter 6 of *Alabama's Best Management Practices for Forestry* handbook).

In order to protect forested wetlands from any potential adverse effects of typical forest management regimes, §404 of the Clean Water Act requires the use of mandatory BMPs for forest road construction and maintenance in wetlands. These BMPs ensure that the flow and circulation patterns and chemical and biological characteristics of the wetland are not impaired, that its size is not reduced, and that any adverse effect on the aquatic environment is minimized.

The goal of all these forestry BMPs and others not mentioned here is to help Alabama's forestry community maintain and protect the physical, chemical, and biological integrity of waters of the state.

URBAN BMPS

BMPs should be applied both to rural and urban environments. When consistently applied, BMPs can contribute to maintaining a high degree of water quality as well as improving degraded water quality.

Approximately 82 percent of the US population lives in urban areas, up from 64 percent in 1950. By 2050, 90 percent of the US population and 68 percent of the world population is projected to live in urban areas.[18]

Figure 4.14. Impervious surfaces include roadways, parking lots, rooftops, and sidewalks. (Photo credit: Moores Creek Project).

The rate of urbanization (i.e., the changing of land from forest or agricultural uses to suburban and urban uses) is increasing. Between 2000 and 2010, urban land area in the United States increased by 15 percent.[19] Urban land area is 106,386 square miles, or 3 percent of total land area in the United States, and is projected to triple from 2000 to 2050.[13]

Urbanization results in more land converted to and covered by impervious surfaces, such as parking lots, roads, and buildings (figure 4.14). These types of surfaces increase rainfall runoff, because water cannot infiltrate into the soil. Instead, stormwater runoff is channeled into storm drains, and this untreated water is emptied directly into neighboring creeks, lakes, and wetlands.

Rainfall runoff can cause flooding, erosion, stream-channel alteration, and ecological damage, all of which pose serious threats to watersheds and can be very costly to reverse. The EPA acknowledges that urban runoff is one of the leading causes of poor-quality surface water across the United States.

Table 4.1. Potential Pollutants from Urban Activities and Land Uses	
Urban Activity or Land Use	**Potential Pollutants**
Paved areas	Asphalt and concrete particles, road marking paints, crack fillers and joint compounds, anti-skid compounds (salts, sand, and ash), dirt, and other spills
Motor vehicles	Leaked fuel, battery acid, anti-freeze, car-care products, and lubricants; tire, clutch, and brake lining parts; larger pieces of metal and glass; bulk materials spilled from open trucks (sand, dirt, and chemicals)
Industrial/Commercial	Smoke stack emissions; oil and grease from parking lots, salvage yards, service stations, and roadways; overflowing trash and seepage from dumpsters and temporary waste storage areas
Lawns and gardens	Organics like leaves, bark, seeds, twigs, and grass clippings; pesticides; fertilizers; domestic animal wastes
Construction and demolition areas	Sediment; petroleum products and construction materials; solid wastes from construction materials and workers; wash water from concrete mixers
Litter disposal	Waste disposed of in streets, along water courses, and in other areas

Source: The Urban Environment and NPS Pollution, Alabama Cooperative Extension System

Urban BMPs generally focus on controlling water flow and reducing the amounts of pollutants—primarily nonpoint source pollutants—that enter bodies of water. Pollutant loads can be especially high in urban areas. Major nonpoint source pollutants in urban areas include the following:

- pathogens, such as fecal bacteria found in pet droppings or failed centralized waste collection systems
- toxic substances from spilled oil, grease, and toxic chemicals from cars
- nutrients from excess fertilizer applied to lawns, sports fields, and landscaped areas
- sediment from construction sites, bare ground, and streambank erosion

As with agricultural BMPs, urban BMPs can be structural or nonstructural. For a more complete list of urban BMPs, refer to the following:

- *Alabama Handbook for Erosion Control, Sediment Control and Stormwater Management on Construction Sites and Urban Areas* [6]
- *Low Impact Development Handbook for the State of Alabama*[11]
- EPA "National Menu of Best Management Practices for Stormwater" website at https://www.epa.gov/npdes/national-menu-best-management-practices-bmps-stormwater#edu.

Did You Know?

- Because of impervious surfaces such as pavement and rooftops, a typical city block generates 5 times more runoff than a woodland area of the same size.[22]

Stormwater management and **low-impact development (LID)** or **green infrastructure (GI)** practices are being adopted in many communities to balance urban growth with environmental integrity through good land use planning and design. They may fall within structural or non-structural practices. You can think of LID as an alternative method of development that reduces the overall footprint, while GI consists of practices that mitigate some of the unavoidable impacts of development. Careful consideration of stormwater management is critical for planners, environmental program managers, elected officials, homeowners, business owners, developers, contractors, design professionals, and others; however, it is rare that these groups have an opportunity to work together in planning for future development and redevelopment, particularly on a watershed level.

Low-impact development and **GI** are interdisciplinary systematic approaches to stormwater management that can result in improved stormwater quality, improved health of local waterbodies, reduced flooding, increased groundwater recharge, more attractive landscapes,

Figure 4.15. Natural vegetation can help catch and filter runoff.

enriched wildlife habitats, and improved quality of life.[11] Ideally, aquatic resources, water quality, and natural watershed hydrology should be maintained and enhanced during the development process.

Some of the most common LID/GI practices involve using pervious rather than impervious surfaces, placing restrictions on land use through directed growth, protecting sensitive areas, preserving open space, and minimizing disturbance to soil and vegetation. Other LID/GI techniques include the use of green roofs (figure 4.16), grassed swales, rain barrels, bioretention cells (figure 4.15), rain gardens, stream restoration, and alternative landscaping. Together these practices help to reduce the amount of stormwater runoff that is generated, thereby improving water quality and maintaining the natural hydrology of the watershed.

Structural Practices

Infiltration systems are designed to capture and store stormwater runoff so that it can infiltrate into the soil profile. Infiltration components may include infiltration basins, porous pavement systems, and infiltration trenches and wells.

Figure 4.16. Small plants on a green roof reduce runoff.

Infiltration systems have numerous benefits. By capturing surface runoff, they reduce the volume of water entering streams and rivers and lessen the effects of excessive flows and urban pollutant concentrations. They increase the rates at which aquifers are recharged and increase base-flow levels in nearby streams. Infiltration BMPs also can improve water quality by filtering out pollutants and giving microorganisms in the soil time to break down organic pollutants.[11]

Detention systems intercept and temporarily store stormwater runoff for gradual release into a receiving waterbody or storm sewer system. Their main function is to control the flow of stormwater rather than improve water quality. As a result, downstream flooding is minimized and stream channels are protected from erosion. Detention systems include detention basins and a variety of underground vaults, pipes, and tanks that direct water flow, store excess water, and empty out between storms.

Figure 4.17. A newly planted bioretention cell decreases peak discharge and reduces erosion.

Figure 4.18. A constructed stormwater wetland mimics natural wetlands.

Retention systems include retention ponds (also called wet ponds or stormwater ponds) and a variety of underground vaults, pipes, and tanks that intercept, store, and treat urban stormwater runoff. In retention systems, water is held indefinitely. Properly designed and maintained retention systems can be extremely effective because they control both water quantity and water quality.

Diverting water to a retention system decreases peak discharge and flow rates and reduces stream-channel erosion and downstream flooding. Retention systems filter out sediment and suspended solids, improve infiltration and the biological uptake of nutrients by aquatic plants and algae, increase the volatilization of organic compounds, and promote plant uptake of metals and the biological conversion of organic compounds. Retention systems, specifically wet ponds, also have aesthetic appeal and can be used for recreation and wildlife habitat.[11]

Constructed wetland systems are designed to mimic the functions of natural wetlands by removing pollutants from urban stormwater (figure 4.18). In a constructed wetland system, the water, plants, animals, microorganisms, and environment (sun, soil, and air) work together to improve water quality. These systems are particularly efficient in removing contaminants such as nitrogen, suspended solids, hydrocarbons, and even some metals. Constructed wetlands also control the quantity of stormwater runoff for a period of time.

Wetlands make excellent wildlife habitat and are aesthetic areas in a community. Constructed wetlands are particularly successful in areas where the groundwater level is shallow so that there is a constant supply of water to sustain the wetland system.

Filtration systems use sand, gravel, peat, compost, or other media to remove contaminants from urban stormwater runoff. Filtration systems help mainly with water quality but also may help to control the quantity of runoff when combined with detention or retention basins. Filtration systems, such as surface sand filters, underground vault sand filters, and biofiltration/ bioretention systems (figure 4.19) often are used to treat stormwater in small areas such as parking lots and small developments, in areas with high pollution potential such as industrial areas, or in highly urbanized areas. The system components can be placed under parking lots and buildings so that little land is required.

Vegetated systems or **biofilters** use the natural vegetation growing in grass filter strips and vegetated swales to filter stormwater as it flows across the land

Figure 4.19. Bioretention cells treat stormwater in small areas. (Photo credit: *Low Impact Development Handbook for the State of Alabama*)

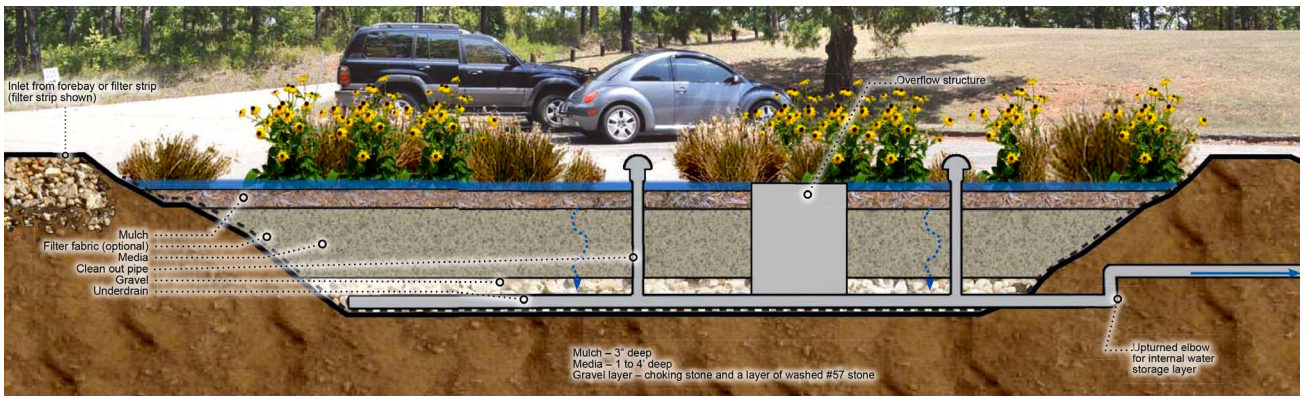

Figure 4.20. Swales like this one in Lee County, Alabama, are designed as conveyance channels that capture and treat stormwater runoff in small drainage areas. (Photo credit: *Low Impact Development Handbook for the State of Alabama)*.

Figure 4.21. Bioretention cells need seasonal maintenance such as weeding, pruning, and mulching. (Photo credit: *Low Impact Development Handbook for the State of Alabama*).

surface. Thus, water is treated before it is discharged into a storm sewer system. Vegetated systems reduce the overall volume of stormwater, reduce flow velocity, promote infiltration, and trap sediment and other contaminants contained in the water (figure 4.20).[11]

Non-structural Practices

Education and planning are important non-structural BMPs. The general public is usually unaware of the hazards of nonpoint source pollutants and the ways in which their individual actions may be contributing to problems in their watershed. Most people also don't know what steps they and their communities can take to minimize nonpoint source pollution. Educational programs take many forms:

- using television, newspaper, radio, and other media to present information
- enlisting homeowner associations and other groups to encourage good stewardship and the adoption of BMPs by individuals and families
- educating youth in schools and clubs (Scouts, 4-H, FFA, etc.)
- training public employees, particularly planning and parks and recreation staff, about nonpoint source pollution and BMPs to use in park and open space maintenance, fleet and building maintenance, new construction ordinances, and storm sewer maintenance
- training employees of business and industry to incorporate pollution prevention and good housekeeping techniques into their operations

Maintenance programs are very important in reducing urban pollution and ensuring that measures adopted to deal with stormwater are functioning as designed. Important maintenance activities include sweeping streets and parking lots, maintaining roads and ditches, and maintaining vegetation. Vegetated systems, such as swales, bioretention cells, constructed wetlands, and grass filter strips, require regular maintenance to function properly and efficiently (figure 4.21).

Planning for LID/GI Practices in Urban Areas

The **comprehensive plan** is the cornerstone of the Alabama planning process. A comprehensive plan dictates public policy in terms of transportation, utilities, land use, recreation, and housing. The comprehensive plan typically encompasses a specific geographical area and covers a long-term time frame. Comprehensive planning is an attempt to establish guidelines for the future growth and welfare of a community.

Local governments may voluntarily adopt elements on topics of local interest. Cities and counties could adopt an optional LID/GI element in their comprehensive plans, but few do so. The Clean Water America Alliance lists the following as just a few of the barriers to adopting LID/GI practices:

- lack of understanding and knowledge about what green infrastructure is and the benefits it provides
- lack of funding
- insufficient technical knowledge and experience
- conflicts with existing regulations, design standards, codes and ordinances, and best management practices
- deficiency of data demonstrating benefits, costs, and performance
- reluctance to change existing paradigms and systems

Water typically is addressed only in terms of water supply. For example, water quality issues are addressed most often in a separate stormwater management plan. The range of issues addressed in the comprehensive plan and areas covered are left to the decision-making body of the city or the county adopting the plan.

There are several methods to incorporate LID/GI into comprehensive plans. One approach involves amending existing subdivision regulations to incorporate LID language on principals, goals, and policies related to land use and water. An example is the City of Semmes, Alabama, which includes watershed protection in subdivision regulations. A second approach is to add an optional water element to the comprehensive plan.

Watershed protection and management, protecting and improving water quality, and managing water resource supply and demand are components that should be addressed in comprehensive plans. LID/GI principals, goals, and policies should be added to the jurisdictional stormwater management plan and cross-referenced between these two documents for consistency.

LID/GI may be implemented using a specific plan overlay. Such plans are flexible and scalable by design. They typically are used to address the comprehensive development or redevelopment of a defined area (overlay zone). They include LID/GI requirements among the standard and implementation measures applicable to the area.[11]

Not only does LID/GI benefit the environment, it also can benefit the municipality, the developer, and the general public. With LID/GI practices, there is less need to build expensive infrastructures such as drainage systems and other utilities. This has the potential to save developers a lot of money. With less burden on the existing drainage infrastructure, municipalities have lower costs for repair and replacement. Moreover, communities that preserve the quality of their water resources will not face expensive restoration activities in the future.

The first step in LID/GI is to consider the landscape to be developed. What are the natural features of the area that may be used or mimicked to promote stormwater infiltration, evapotranspiration, or storage? This may include sensitive areas such as steep slopes, wetlands, and streamside forests that should be retained. Understanding the opportunities and limitations of a landscape to be developed will help with the strategic placement of LID stormwater controls at multiple locations so that stormwater is slowed, stored, and soaked in near to its point of origin.

Before using LID/GI methods, a number of factors have to be considered. For example, site selection should include establishing a goal for the site, identifying any constraints, and determining best options for specific site considerations. Natural constraints such as in situ soils need to be taken into account before identifying a **stormwater control measure** (SCM). Issues with compacted and poorly drained soils as well as steep slopes can affect many SCMs. Prior to implementing an SCM, other means of reducing impervious surfaces and minimizing runoff should be considered in meeting an established goal.

Shallow slopes also can affect SCM selection. Practices that require pretreatment basins, forebays, or an elevation difference to drive the function (e.g., water movement) may be expensive to construct on flat sites. Sunlight availability limits vegetation selection or treatment of pathogens using sunlight. Practices such as bioretention and rain gardens usually function best in full sun in order to dry efficiently between rain events. The water-table depth also can influence infiltration practices. See *Low Impact Development Handbook for the State of Alabama* for more in-depth information on planning, design, implementation, and maintenance.

There may be additional environmental regulatory constraints, such as wetlands, endangered or threatened species, forest conservation areas, and existing riparian buffers. Manmade infrastructure can pose more site constraints. For example, rights-of-way can affect SCM location, construction, and maintenance access. Electrical lines, roads, sewer lines, fiber-optic cables, and more need to be considered before planning an SCM. Existing infrastructure should be located prior to site design by calling Alabama 811. For more information, visit www.al1call.com.

Because LID/GI requires maintenance and care, site sustainability and community acceptance are important aspects of the planning process.

WATER QUALITY STEWARDSHIP ON SMALL ACREAGES

Although more than half of the people in Alabama live in cities, many citizens own small-acreage properties in rural and semirural areas of the state. Small-acreage properties tend to range from 2 to 100 acres. Protecting watershed health is just as important in these areas as it is in large agricultural and urban areas.

No matter what size property you own or live on, it is part of a watershed system and has an important role in many watershed processes. Small acreages, like agricultural and urban areas, can contribute nonpoint source pollutants to surface water and groundwater. Fortunately there are many things property owners can do to prevent this.

Figure 4.22. Pickerelweed, a native species, attracts dragonflies.

Figure 4.23. Purple coneflower often attracts native insects.

MANAGING YOUR LANDSCAPE & GARDEN

This section draws heavily from *Alabama Smart Yards: Introducing Environmental Consciousness and Practical Management Options to Our Yards and Neighborhoods* (Alabama Cooperative Extension System, 2011).

Nonpoint source pollutants, such as soil sediment, organic matter, plant nutrients, and pesticides can come from home landscapes and gardens. These potential pollutants can impair water quality, degrade aquatic wildlife habitat, and contaminate drinking water sources. While the quantities of pollutants from a single property might be small, similar amounts coming from many different properties, when added together, can have a very harmful effect. It is easy to control pollutants from home landscapes and gardens by minimizing the amount of contaminated water allowed to runoff the property.

Home Landscape Design

The design of your landscape and the materials you use can significantly affect the potential for runoff. Water that runs off is much more likely to contain pollutants than water that has been allowed to infiltrate through the soil. It is therefore best to reduce the amount of impervious surface in a landscape and increase the area planted to grasses, trees, and/or natural landscaping features. Plants selected for your home landscape or garden should be well-adapted to your region and climate. Native plants require less supplemental water, fertilizer, and pesticide to remain healthy. They also play an important role in supporting native pollinators.

Alabama's climate supports countless varieties of plants, many of which are grown by local nurseries. The plants you choose determine how much maintenance your yard will require and how long your landscape will last. For example, fast-growing trees often have a shorter lifespan than slow-growing trees.

Focus first on low-maintenance plants suitable to your site. Once these plants are established in the right location, most require little, if any, supplemental water, fertilizers, or pesticides. It can take 1 to 2 years for roots to fully extend into the surrounding soil and become established.

Select drought-tolerant plants suited to your soil. Alabama's horticultural focus is now on plants that can tolerate extended dry conditions. Once these plants are established, your watering chores will be easier.

Welcome wildlife. Provide flowering and fruiting plants, seeds, and nuts to bring birds and butterflies into your yard (red tubular flowers for hummingbirds, nectar and larval food for butterflies) as Alabama is a stopover for many migrating and wintering butterflies and birds. Design a landscape that caters to these colorful, winged creatures.

Plant for impact. Limit the number of plants with high water and maintenance requirements. Place them where they will have the greatest visual impact with access to water during drought periods.

Avoid invasives. Do not plant exotic, invasive species. If these plants are present in your yard, remove them. They crowd out native plants and seriously threaten Alabama's ecosystems and wildlife (figure 4.22).

Aim for plant diversity. Create a mosaic of trees, shrubs, groundcovers, native grasses, and wildflowers. Monocultures (large expanses of the same plant species) are prone to disease and insect infestation and aren't as sustainable as a diverse plant community.

Using native plants reduces both the cost of maintaining the landscape and the potential for water contamination. Bare soil should be mulched or planted with vegetation to reduce wind and water erosion, to add organic matter to the soil, and ultimately to protect water quality. To learn more about planting for pollinators, consult your county Extension agent or local Master Gardeners (www.aces.edu).

Figure 4.24. Effectively irrigating and watering your plants can help save water.

WATERING TIPS

As with any system it is important to avoid runoff when irrigating or watering. Proper irrigation installation and design will ensure that each plant receives sufficient water (figure 4.24).

- **Reduce the need for watering.** Choose water-efficient and drought-tolerant plants, including those native to your site, and plant them in the right place. If you group plants according to their water (and light) needs (called a *hydrozone*), you can simplify watering methods and systems. For example, turf areas and shrub areas should always be separated into different hydrozones.
- **Install a rain shutoff device or soil moisture sensor.** If you have an automatic sprinkler system, install a device or sensor) that will override the system when it rains or when the soil reaches a preset moisture level. Your county Extension office, the Natural Resources Conservation Service (www.nrcs.usda.gov) or a certified irrigation professional can provide technical assistance.
- **Water in the early morning (4 a.m. to 7 a.m.).** This is the most efficient time because temperature and wind speeds are at their lowest, which reduces evaporation and, more importantly, drift. Grasses also are less susceptible to fungal problems if water is applied at the time that dew normally forms.
- **Avoid watering between 10 a.m. and 4 p.m.** Temperature and wind speeds are at their highest during this time, so water waste is more likely.
- **Follow a simple watering schedule for grass.** Apply ½ to ¾ inch of water when grass shows signs of distress (bluish gray color/folded leaf blades). Do not water again until symptoms reappear. If rain is predicted within the next 24 hours, delay watering. Experiment with gradual reductions in your watering times and frequencies to see if plants can tolerate less water. Little or no supplemental water is required in cooler months (November to March).
- **Calibrate your sprinkler system.** The sprinkler system should operate properly and apply uniform coverage. Sprinkler calibration is one of the most effective ways to conserve water in an irrigation system. Check your system periodically for broken heads or leaks. Use a rain gauge to measure rainfall amounts.

Soil Moisture

If the soil in your yard appears dry, that does not mean the root zone is dry. A soil-coring tool (figure 4.25) pulls up a soil sample that allows you to see and feel the moisture in a plant's root zone. A soil core also reveals whether you are watering so much that water is wasted below the root zone. Using a soil corer can help you to judge when to water.

Water-Wise Advice

Get practical advice on state-of-the-art irrigation systems from several sources. The Irrigation Association (www.iaainfo.com) provides information on irrigation system selection, maintenance, and appropriate watering practices, as well as links to professional organizations, manufacturers, designers, installers, and educational materials. Also visit the EPA site (www.epa.gov/watersense).

Figure 4.25. A soil corer is used for easy soil sampling.

Figure 4.26. Use a soil corer to take a good soil sample.

USING FERTILIZERS CORRECTLY

Properly fertilized lawns absorb nonpoint source pollutants, help to stabilize soil, reduce ambient air temperatures, and promote a healthy ecosystem of its own. Overfertilizing can aggravate pest problems, stimulate excessive growth, and require frequent watering. In addition, when too much fertilizer is used on landscapes, the excess can seep through the ground, past the root zone of the grass, plants, or trees, and move into the community aquifer, thereby polluting the area water source. Excess fertilizer also can be washed off by rainfall or irrigation and runoff directly into surface water or stormwater systems, causing algal blooms, fish kills, and nitrate poisoning.

Have your soil tested each year to determine how much fertilizer you need. Lawns, gardens, and flower beds all have different nutrient requirements and should be tested separately. Contact your county Extension office for information on soil testing (figure 4.26). Once you have the results of the test, apply only the amount of fertilizer recommended.

For more detailed information about how to properly apply fertilizers, refer to the Alabama Smart Yards handbook[1] or see Extension publication "Home Soil Testing: Taking a Sample" (ANR-0006A) and "Hope Soil Testing: Using the Soil Test Report" (ANR-0006B) for a description of the proper technique for taking soil samples and understanding your soil test report (www.aces.edu).

Figure 4.27. Using fertilizer only in the proper amounts can help reduce nutrients leaching into local water.

The way you fertilize your lawn influences how much fertilizer is taken up by grass and how much might be lost to leaching or runoff (figure 4.27). Before you apply fertilizer, it is very important to read and understand the label. Several factors determine pollution potential from lawn fertilizing:

- type of fertilizer
- how much you apply
- how you apply it
- when you fertilize
- how much irrigation you apply afterwards
- overall health of the lawn

Fertilizer BMPs

One of the main things you can do to prevent pollution is to use caution when applying fertilizers.

- **Do not spill fertilizer granules.** If you do have an accident, sweep up the granules. Rinsing fertilizer off with a hose could send it down the storm drain.
- **Do not spread fertilizer into waterbodies or impervious surfaces.** Particles on hard surfaces, such as driveways or sidewalks, can wind up in waterways.
- **Use a drop spreader.** This puts particles down directly beneath the spreader, as opposed to a rotary spreader, which flings particles a farther distance. Make sure equipment used to distribute fertilizer is properly calibrated.

Table 4.2. Fertilization Guidelines for Established Turfgrass Lawns in Three Regions of Alabama

Nitrogen recommendations (lbs N/1000 ft2/year)*

Species	North	Central	South
Bahiagrass	2–3	2–4	2–4
Bermudagrass	3–5	4–6	5–7
Centipedegrass	1–2	2–3	2–3
St. Augustinegrass	2–4	2–5	4–6
Zoysiagrass	3–5	3–6	4–6

*Homeowner preferences for lawn quality and maintenance will vary, so we recommend a range of fertility rates for each grass species and location. Also, effects within a localized region (shade, drought, soil conditions, irrigation, etc.) will require using a range of fertility rates. These recommendations assume that grass clippings are recycled.

- **Avoid using weed-and-feed products that contain herbicides and fertilizer together.** Herbicides are chemicals that kill plants or inhibit their growth and typically are intended for weed control. These products used together can injure some trees and shrubs. Tree and shrub root systems can extend far beyond the visible foliage, intermingling with turf. Pesticides, including herbicides, should be applied only to affected areas rather than broadcast over the entire yard as occurs with a weed-and-feed product.
- **Do not fertilize if heavy rain is forecast.** This increases the potential for fertilizers to runoff into storm drains or to leach through soil with the rainwater.
- **Apply fertilizer when plants are actively growing and can use the nutrients efficiently.** Fertilizing when plants are dormant just increases the potential for water contamination.
- **Fertilize trees and shrubs just before or as new growth begins in the spring.** Fertilize grasses and flowers when they're in the active growth stage. Minimize leaching by using slow-release fertilizers (they release small amounts of nutrients into the soil over a longer period of time) and being careful not to water too much right after fertilizers have been applied.

How Should I Select a Fertilizer?

When selecting fertilizer, look at the three numbers on the bag. They will read something like 15-0-15 or 16-2-8. The first number represents the percentage of nitrogen in the bag, the second refers to phosphorus, and the third number refers to potassium. For example, a 50-pound bag of 16-2-8 contains 8 pounds of nitrogen (16 percent), 1 pound of phosphorus (2 percent), and 4 pounds of potassium (8 percent). The remaining weight is usually comprised of inert ingredients.

Nitrogen and phosphorus cause the most potential problems with regard to water pollution. Nitrogen is a mobile nutrient and leaches easily through groundwater, while phosphorus has a tendency to runoff the surface and cause pollution to groundwater.

When Should I Apply Fertilizer to a Lawn?

Apply fertilizer when grass is actively growing, not when it is dormant. Do not apply too much nitrogen at one time in summer months when grass is already growing rapidly. Consult your county Extension office with questions or call the Extension Master Gardeners helpline toll-free (877-252-4769).

How Do I Water in Fertilizer?

Most fertilizers need to be watered in to move fertilizer below the soil surface to grass roots. This process requires only about ¼ inch of irrigation water. To find out how long it takes your sprinkler system to deliver this much water, read "Calibrating Irrigation Systems" in chapter 3 of the *Alabama Smart Yards* handbook.[1] Do not overwater or you will increase the potential to move fertilizer past the root zone and into groundwater.

MANAGING WEEDS

Weeds are invasive plants that can make landscapes unattractive. Some even cause safety problems for people, livestock, and wildlife. Many states mandate that noxious weeds be controlled on public and private property. Weed control works best when weeds are seedlings. Cut and remove weeds before they go to seed (figure 4.28) to keep them from spreading and establishing. This minimizes areas of disturbed land where weeds tend to thrive.

USING PESTICIDES CORRECTLY

Pesticides for controlling weeds, insects, and diseases in gardens and landscapes can be major sources of pollution. They must be applied carefully and only when needed. If you suspect you have a pest problem but are unable to diagnose it, get help from a qualified professional.

Table 4.3. Proper Application Rates for Specific Fertilizer Products

Area (sq ft)	% Nitrogen in Fertilizer Bag						
	6%	10%	12%	15%	16%	23%	27%
10	1.3 oz	0.8 oz	0.7 oz	0.5 oz	0.5 oz	0.4 oz	0.3 oz
	3 T	1.5 T	1.5 T	3.5 t	1 T	2.5 t	2.25 t
50	6.6 oz	4 oz	3.3 oz	2.7 oz	2.5 oz	1.7 oz	1.5 oz
	14 T	.5 c	7 T	6 T	5.25 T	4.5 T	.25 c
100	13.3 oz	8 oz	6.7 oz	5.3 oz	5 oz	3.5 oz	3 oz
	1.75 c	1c	14 T	.75 c	10.5 T	9 T	.5 c
1,000	8.4 lb	5 lb	4.2 lb	3.3 lb	3.1 lb	2.2 lb	1.9 lb
	17.5 c	9.5 c	8.75 c	7.25 c	6.5 c	5.5 c	4.75 c
1,500	13 lb	7.5 lb	6.5 lb	4.9 lb	4.8 lb	3.3 lb	2.9 lb
	26.25 c	14.25 c	13 c	11 c	9.75 c	8.25 c	7.25 c
3,000	25.2 lb	15 lb	12.6 lb	9.8 lb	9.4 lb	6.6 lb	5.8 lb
	52.25 c	28.5 c	26 c	21.75 c	19.5 c	16.5 c	14.5 c
5,000	42 lb	25 lb	21 lb	16.4 lb	15.8 lb	11 lb	9.8 lb
	87.25 c	47.5 c	43.5 c	36.5 c	32.5 c	27.5 c	24.5 c

The chart explains the approximate weight of fertilizer to use for a given lawn or landscape area in pounds or a fraction thereof (first number) and also in cups or a fraction thereof (second number) to deliver ½ lb. N/1000 square feet (the recommended rate for a single application of soluble fertilizer).

Try using the least toxic methods first. When using any pesticide, always carefully follow label directions. Never discard pesticides by dumping them down household drains, storm drains, or on the ground. Instead, save leftover pesticides until your community has a free hazardous-materials collection event.

MANAGING YOUR WELL

Most rural homes get their drinking water or irrigation water from a well. Properly managing your well-water system is critical to protect groundwater. You should inspect and maintain all wells on your property and avoid any activities that might contaminate groundwater.

The wellhead should be inspected first to ensure that it was properly constructed and then re-inspected every 6 to 12 months to make certain it is functioning properly. The well casing should extend at least 12 inches above the ground surface, and there should be a concrete or soil pad surrounding and sloping away from the casing. Inspect the sanitary well cap to make sure that the bolts are tight and that no cracks or gaps are visible in the cap or casing.

It is especially important to locate your well away from any pollutant-generating activities that occur on your property. Activities and structures such as septic systems, animal waste holding ponds, pesticide and fertilizer storage, and fuel storage should be kept as far away from wellheads as possible.

Figure 4.28. Dandelion *(Taraxacum officinale)* is a common weed in many Alabama lawns.

If your well is located in a pasture, fence the wellhead to keep livestock away and prevent urine and manure deposits nearby. Install anti-backflow devices on all outdoor faucets to prevent contaminants from being siphoned into the well or household water system.

Figure 4.29. Follow basic pasture management principles where cattle are grazed. (Photo credit: Adam Sconyers, NRCS)

It is a good idea to find and record the locations of all wells on your property. Wells that are no longer in use or are abandoned pose a high risk for groundwater contamination, because they provide a direct conduit for pollutants to reach groundwater. Larger-diameter wells also are safety risks for children, animals, and even adults who can unintentionally fall into them. Landowners should seal abandoned wells to avoid any contamination or injury that can result from unsealed or improperly sealed wells. Record the locations of all abandoned wells and pass on this information to any future owners of the property. For more information regarding water supply wells and their proper maintenance, consult your county Extension agent or Extension website at www.aces.edu.

MANAGING YOUR SEPTIC SYSTEM

Properly functioning septic systems safely process household wastewater and sewage. Failing septic systems are serious hazards to groundwater and surface water and are sources of unpleasant odors and bacteria. Through routine inspection and maintenance, you can protect your household water supply and the quality of the surface and groundwater resources in your watershed.

In a properly operating septic system, liquids and solids from the household are separated in the septic tank. Liquids are passed from the tank into the drain field, where they are leached into the soil. Solids are partially digested by microorganisms, and the remaining solids settle and slowly fill the tank. Excessive accumulation of solids can cause septic systems to fail. Solids that don't easily decompose, or those that might clog the system or interfere with the decomposition process, should not be flushed into a septic system. Some examples include diapers, fats, grease, solvents, oils, paints, and pesticides.

A properly sized tank should be pumped out every 3 to 5 years to remove accumulated solids and to prevent a system failure. It also is important to maintain the field drain by keeping away runoff from roofs or pavement, planting and maintaining a good grass cover over the area, and avoiding compaction of the overlying soil so that waste liquids will leach properly. For more information, see the Extension publication *Household Wastewater: Septic Systems*.[10]

MANAGING SMALL PASTURES

Owning some form of livestock is often an important benefit of living in a rural community. In areas with sufficient rainfall and soil fertility, pastures can supply large quantities of high-quality feed for animals. Maintaining the quantity and quality of feed in a pasture saves money, promotes healthy animals, and promotes healthy, functioning landscapes. Some basic pasture management principles include the following:

- Use a proper stocking rate, the size and productivity of your land will determine the appropriate number of animals
- Do not overgraze your pastures
- Cross-fence pastures to create several paddocks and use rotational grazing
- Keep animals off water-saturated pastures

Figure 4.30. Locate composting bins so water will not flow through them and potentially carry pollutants to waterways..

Managing Compost and Manure Piles

Composting waste materials from the household, barn, and garden is a popular and effective way to generate fertilizer and organic matter to add to soil. Although composting is a good method of recycling nutrients, it can be a source of organic matter, excess nutrients, and bacteria in streams if managed incorrectly.

Organic residues, particularly those containing animal manures, can contain both nutrients and potential disease-causing organisms. Some organic residues also may be a source of pesticides. To help protect water quality, it is important to locate waste piles properly to prevent water from flowing through them (figure 4.30). Covering piles is an effective way to accomplish this. Also use buffer strips along streams to trap contaminants originating from compost or manure piles.

If manure and compost are to be used as fertilizer, it is important to apply them at proper rates and times so that plants will be able to use the nutrients efficiently. If significant amounts are to be used, a chemical analysis of the material along with a soil test should be obtained to determine the correct application rate.

In summary, while a single home or small-acreage property may have a limited effect on water quality, the combined effects of many such properties can be a significant source of pollution. The way these areas affect a watershed depends largely on how the land is managed. Landowners should take the necessary steps to manage their properties in a way that promotes and enhances watershed function and improves water quality.

Figure 4.31. Feral hogs are a growing concern in Alabama.

MANAGING NON-DOMESTIC ANIMALS AND WILDLIFE

Wildlife, such as deer, geese, beavers, and raccoons, and non-domestic animals, such as feral hogs, dogs, and cats, can contaminate waterbodies with bacteria and nutrients. These pollutants can enter the water through direct contact with the animal or in runoff from surrounding land where animal waste is present. Perhaps the greatest concern associated with animal waste is pathogens such as *Cryptosporidium* and *Giardia*, which can pose severe risks to human health. However, animals also can affect watershed health and function by damaging valuable riparian zones and shoreline habitat. This often occurs where humans have introduced new species or where human activity has reduced the amount of natural habitat, forcing animals to be concentrated into limited territories and spaces.

In general, wildlife are not managed to address water quality issues except under special circumstances. It can be important, however, to use best management practices to prevent the degradation of riparian habitat and the contamination of water resources by wildlife and nondomestic animals.

Feral Hogs, Dogs, and Cats

Feral hogs are a growing concern in Alabama and much of the southern United States. Feral hogs or wild pigs currently inhabit almost every county in Alabama. This is concerning because a population of feral hogs can double every 4 months. Numbers can increase from one hog per square mile to 100 hogs per square mile in 3 years.

Hogs have a high rate of reproduction and prefer secluded habitats along streams; therefore, large numbers of hogs often will be concentrated in small riparian areas. This is a potential threat to water quality, because their rooting can cause severe erosion and soil loss. Large numbers of hogs also can destroy crops, pastures, and yards. Feral hogs are usually managed by reducing their numbers through hunting or trapping. For more information on feral hog management, consult your county Extension agent or Extension website at www.aces.edu.

In Alabama feral swine is categorized as a game animal and can be hunted by licensed hunters year-round without limits. They cannot be hunted over bait or at night. If on private land, the landowner's consent is needed. It is illegal to relocate trapped feral hogs. Under state regulations, however, a landowner does not need a hunting license to take a hog that is causing depredation on his or her property. Rifles, bows, muzzleloaders, and handguns are the most effective tools for hunting feral hogs.

Trapping is another common method of controlling hog populations. Live traps and snares are the two most popular types of traps. Live traps are usually large, heavy-duty cages with springs or drop doors. Many hogs can be captured in a live trap at the same time without harming the animals. Trapped hogs can be harvested for their meat or sold. Snares also are effective when placed under fences in areas with lots of hog activity. However, snares may unintentionally capture other species. Therefore, snares should be properly maintained and checked regularly. For detailed information on managing hogs, see *A Landowner's Guide for Wild Pig Management*.[15]

The number of feral dogs and cats in Alabama is increasing. Dogs, especially, can be significant sources of water contamination, but both dog and cat feces may contain bacteria, roundworms, and other parasites that degrade water quality and threaten human health.

Feral dogs and cats breed prolifically, so one of the best ways to control them is to spay and neuter these wild animals. This helps to protect water quality and reduces the amount of tax money spent to capture, shelter, and/or euthanize the animals. Many cities and towns offer some type of animal population-control program and will often spay and neuter cats and dogs at no or low cost.

Wildlife

Under special circumstances, it might be appropriate to control wildlife populations to protect water quality. Lethal methods include hunting, trapping, and the use of pesticides. There also are nonlethal methods, such as removing habitat features that attract animals and harassing nuisance species. No animal control measure should be used without the guidance and approval of the appropriate state and federal wildlife agencies. Most animal control activities require a special permit or license. There often are specific federal and/or state guidelines associated with harassment techniques. Some nuisance species, such as Canada geese, may even be protected by federal and state law; harming the species or its eggs can result in severe penalties.

Harassment programs can help keep birds and wildlife away from valuable surface waters. Devices used include decoys, eagle kites, noisemakers, scarecrows, and plastic owls. Installing trails or foot paths next to waterbodies may increase the presence of people, which can keep birds and other wild species away.

In urban areas and around the home, reducing the attractiveness of yards and landscapes to wildlife can encourage animals to live elsewhere. Many species can be diverted from sensitive areas by fencing, mowing, habitat modification, tree pruning (to reduce bird roosting), or installation of drainage devices (to keep beavers and muskrats from building dams and dens). Cities may prohibit people from feeding wildlife. Homeowners can remove trash, secure pet feed, and reduce the number of palatable plant species in the landscape to help keep nuisance species away.

PROTECTING WATER QUALITY AROUND THE HOME

Perhaps the easiest place to start protecting surface and groundwater from nonpoint source pollution is right at your own home or apartment. Take a close look around your house to find activities and practices that might be contributing to polluted runoff. Quite often, some simple changes can really make a difference. The following tips will help you become part of the solution rather than part of the problem.

Household Chemicals

- Buy nontoxic chemicals and cleaners whenever possible. Use only the amount that you need. When it comes to chemicals, more is **not** necessarily better.
- Review proper guidelines for applying fertilizers and pesticides.
- Properly store all household toxic products, such as cleaners, pesticides, solvents, and paints.
- Properly dispose of all unwanted household chemicals at a hazardous material collection center. **Do not** pour any unwanted chemicals down the drain; this could seriously disrupt your septic system or contaminate treated sludge. **Do not** pour any unwanted chemicals on the ground; they can leach into groundwater and cause contamination of stormwater.
- If your car leaks oil onto your driveway, use kitty litter to soak up the oil. Properly package this waste and dispose of it with the household trash.
- Use water-based products and low-phosphate or phosphate-free detergents whenever possible.

Pest Problems

Think before you plant. The way that you design and maintain your yard either establishes a barrier against pests or welcomes them. Each time you place a plant in a spot that's not ideal, you increase the chance of problems from pests. Plants in unfavorable growing conditions (compacted soil, inappropriate pH or light, competition with weeds, etc.) are targets for pests.

- Choose insect- and disease-resistant plant varieties.
- Go easy on water and fertilizer. Too much causes excessive growth, potentially attracting insects and diseases. Encourage healthy growth by applying fertilizer and water only when needed and in moderate amounts.
- Mow to the proper height and prune selectively. Mowing grass too short and severely pruning trees and shrubs weakens them, inviting pests.
- Use barriers to block pest entry onto new seedlings.
- Encourage beneficial insects by choosing some plants that provide the nectar or pollen needed by adults and by minimizing the use of broad-spectrum pesticides.

Nonpoint Source Pollution

A healthy, properly maintained lawn helps to treat stormwater by absorbing runoff. If stormwater runoff is not absorbed and contains unused nitrogen and phosphorus from fertilizers, these chemicals enter natural waterways and can fuel abundant algal blooms that smother natural vegetation, deplete oxygen, and

possibly kill fish. These nutrients, if applied improperly, can cause invasive weeds to flourish, changing Alabama's natural plant communities. Follow these Alabama Smart Yards (ASY) guidelines to help reduce nonpoint sources of pollution:

- Pick up after pets in the yard and public places. This will help to reduce bacterial and nutrient pollution entering storm drain systems.
- Do not pour paints or other chemicals down the storm drain, as it runs directly to the stream.
- Do not pour cooking oil and grease down the drains. This can cause sanitary sewer overflow and release of pathogens into the waterways.
- Clean up oil spills and leaks on driveways. Spread cat litter over oil, sweep it up, and then throw it in the trash.
- Sweep up grass clippings, fertilizer, and soil from driveways and streets. Spread them back onto the lawn or to planting beds or add to a compost pile. Some cities offer a lawn clipping and leaf removal service.
- Remove trash from street gutters before it gets washed into storm drains. Leaf litter and trash can block storm drains and cause flooding, and it can end up in streams, lakes, and wetlands.
- Avoid over-fertilizing your lawn. Get a soil test to find out if your lawn needs phosphorus (many Alabama lawns do not). If results indicate that phosphorus is not needed, make sure your fertilizer formulation does not include it. Phosphorus is a serious pollutant to lakes, rivers, and streams when it flushes off lawns during significant rain events. Excessive phosphorus in waterways (eutrophication) increases aquatic plant growth leading to a corresponding loss of dissolved oxygen when these plants die and decompose. This decreased oxygen is unhealthy and can kill fish and other aquatic life. With sandy soils or high levels of fertilizer application, use slow-release fertilizer or divide applications equally over two or three events.

Make Every Raindrop Count (BMPs for Your Yard)

If you're concerned about reducing nonpoint source pollution from your property, here is a basic principle that can be helpful: *Rain that falls in your yard should stay in your yard*. After all, rainfall is an excellent water source for your landscape, and reducing runoff protects waterways. Water that does not have the opportunity to be absorbed into the soil picks up fertilizers, debris, and pesticides and transports them into our waterways. Retaining rainfall long enough for it to percolate through soil is challenging in neighborhoods built on compacted fill soils or steep slopes. Consider these practical *Alabama Smart Yard* tips for reducing runoff from your yard:

- Direct downspouts and gutters to drain onto the lawn. Plant beds, rain gardens, rain barrels, or containment areas where rain will soak into the soil rather than runoff the yard.
- Be sure that water doesn't pool next to buildings.
- Choose plants adapted to wet/dry extremes if you decide to landscape the area where the downspouts drain.
- Amend soil to increase percolation and absorbency. Consult your county Extension agent for help in amending your soil type.

Grass-lined Swales

Consider altering topography in your landscape to move water more efficiently. Create swales and berms to help catch, hold, and filter runoff that would otherwise rush from your yard.

Decrease soil erosion by maintaining vegetative ground cover on areas under trees or on steep slopes. A densely growing turf grass or ground cover is especially useful in capturing rainwater, filtering nutrients, recharging groundwater, and reducing soil erosion. Consider converting ditches that are rock lined, concrete lined, or eroding into vegetated swales that are broad bottomed and grass lined.

Minor alterations to the lay of the land won't require permits or experts, but any major work will require regulatory review. Consult a landscape architect or stormwater engineer for design assistance. Check with the Alabama Department of Environmental Management before making any changes to shorelines of creeks, streams, lakes, or beachfronts.

Figure 4.32.a. Porous asphalt is a permeable pavement structure.

Figure 4.33. Rain barrels collect rainwater from rooftops.

Figure 4.32.b. Permeable interlocking concrete pavers allow water to seep into the ground.

Figure 4.34. A cistern has greater water capacity than a rain barrel.

Impervious Surfaces

Rooftops, driveways, and walkways are commonly called *impervious surfaces* because water cannot penetrate them. Consider replacing these hard surfaces with permeable ones that allow rainwater to soak into the ground. Soil is a natural pollutant remover. By allowing stormwater to percolate through the ground, most pollutants can be filtered out before reaching our waterways. Increased infiltration also translates into less ponding and flooding.

Whenever possible, use bricks, gravel, turf block, mulch, pervious concrete, or other porous materials for walkways, driveways, or patios. Installing a dividing strip of grass or decorative pea gravel in your driveway to intercept stormwater will improve infiltration.

These materials allow rainwater to seep into the ground, helping to filter pollutants and reducing the amount of runoff from your yard. In some cases these porous materials may even cost less to install than typical paving materials (figure 4.32.a–b).

Rain Barrels and Cisterns

Rain barrels and cisterns are ancient technologies that are making a comeback as water shortages prompt homeowners to save and use rain that falls on their properties. Large, plastic rain barrels are now available at home and garden stores and on the internet. For best results, choose one that is at least 42 gallons.

Rain barrels typically tie into your home guttering system as shown in figure 4.33. They reduce water pollution by reducing the amount of stormwater runoff. There are many rain barrel designs, both commercial and creative do-it-yourself styles. No matter the design, they all have three things in common: incoming, outgoing, and overflow features.

There is an opening for water coming into the barrel and two more openings for water going out. A spigot inserted near the bottom allows you to fill a watering can or connect a hose. An overflow is needed near the top to remove excess water during heavy rain events.

A cistern has a greater storage capacity than a rain barrel (figure 4.34). Water from a roof is filtered, collected, and stored in a container made of reinforced concrete, metal, fiberglass, or plastic (figure 4.35). Although usually underground, cisterns may be placed at ground level or elevated on stands either outdoors or within buildings. Water travels from the cistern upon demand by either gravity feed or pump action to be used.

Rain Gardens

Rain gardens catch, filter, and hold stormwater. They are simple gardens designed in pocket-like depressions to capture rainwater from your rooftop, driveway, and upland areas. They allow the rainwater to then slowly soak into the ground over a period of a day (figure 4.36).

If you are not collecting your roof runoff in a rain barrel, you can extend your gutter downspout to flow into a rain garden so that your roof runoff infiltrates and provides groundwater recharge.

Rain garden benefits include following:

- filter pollutants and reduce and slow down stormwater runoff
- can be designed to create stunning landscape features
- can include a variety of plants to attract birds, butterflies, and other wildlife
- do not breed mosquitoes because they drain within 48 hours

Figure 4.36. Section view of a rain garden installed next to a roadway (*Low Impact Development Handbook for the State of Alabama*).

Rain gardens typically are landscaped with native plants that require occasional weeding as well as watering in times of drought. They can be built by homeowners or professionally designed, placed in low-lying areas in your lawn, and designed to hold 6 to 18 inches of water.

For information on constructing and installing a rain garden, refer to the *Low Impact Development* handbook or the *Alabama Smart Yards* handbook.

Suggested Plants for Rain Gardens in Alabama

Choose drought-tolerant plants that will not require much watering, but make sure they can withstand wet soils for 24 to 48 hours. Also take into consideration how much sun your rain garden will receive. For a list of plants suitable for Alabama rain gardens, see the Appendix of the *Alabama Smart Yards* handbook.

Figure 4.35. Rainwater harvesting can be used to irrigate gardens such as this one at Cary Woods Elementary School in Auburn, Alabama. (Photo credit: *Low Impact Development Handbook for the State of Alabama*).

Constructed Wetlands and Retention Ponds

Constructed wetlands and retention ponds are excavated basins that contain wetland vegetation to enhance pollutant removal from stormwater runoff. Stormwater enters a constructed wetland where the larger solids settle out. The stormwater then passes through vegetation that filters organic materials and soluble nutrients. Constructed wetlands provide an alternative drainage point for untreated stormwater instead of it going directly into a stream.

Important: Existing natural wetlands should never be destroyed to construct another wetland habitat for stormwater treatment.

For pond-building information, see *Pond Building: A Guide to Planning, Constructing, and Maintaining Recreational Ponds* at www.aces.edu.

If you live on a waterfront, evaluate stormwater runoff patterns to determine if you are inadvertently dumping runoff from your landscape directly into the natural waterway. One way to filter runoff is by installing a series of swales and channels with a small retention pond as a final collection point for runoff. A retention pond is designed to hold a specific amount of water indefinitely. Usually the pond is designed to maintain a certain depth and has drainage leading to another location when the water level gets above the pond capacity.

A pond provides a natural filter for potential waterway pollutants. Vegetative swales and channels act as active filtration systems for pollutants, and the settling action in the pond itself serves as another way to remove pollutants. A well-built pond that supports plant life can significantly improve the quality of water draining into Alabama's waterways.

Constructed wetlands and retention ponds are considered major earthwork that require permits and must be designed to regulations. Contact a landscape architect or stormwater engineer to help you design your pond to meet regulations.

Freshwater Considerations

Lakes, rivers, streams, and ponds also have littoral or riparian zones (discussed earlier), which offer many benefits. These zones slow the velocity of runoff, filter nutrients and sediments from runoff, and hold soil in place.

To protect a freshwater resource from nutrient and pesticide runoff, consider designating a maintenance-free zone of at least 10 feet between your lawn or landscape and the waterbody. Don't mow, fertilize, or apply pesticides to the littoral zone. Alternatively consider sections of maintained and nonmaintained areas.

Enhance natural wetland vegetation with additional plantings. Suggestions for native vegetation, water tolerance, and light tolerance are available from the Tennessee Valley Authority Riparian Plant Selector. See Using Stabilization Techniques at www.tva.gov/river/landandshore/stabilization/pdf/stabilization.pdf.

Another advantage these systems offer is extending the soak time of stormwater, or increasing the amount of water allowed to percolate. Water that percolates through soil recharges groundwater directly as opposed to water that empties into waterways.

If you find yourself managing one of these natural stormwater filtration systems, follow this Do's and Don'ts checklist to maintain them properly:

Pond Management **Do's**:

- Plant appropriate native aquatic, emergent, and upland vegetation; they stabilize soil greatly.
- Use pond water for nonpotable irrigation needs.
- Fertilize surrounding areas with the least amount of fertilizer possible, always using a slow-release type.
- Use organic compost instead of fertilizer.
- Use mulch around plants to retain moisture.
- Keep pet wastes out of waterbodies.

Pond Management **Don'ts**:

- Don't allow livestock to graze pond bank sides.
- Don't swim in or eat fish caught in stormwater ponds.
- Don't allow invasive plants to clog waterways.
- Don't direct grass clippings into stormwater ponds.

Seasonal Ponds

A common pond type, and perhaps the easiest to imitate as a yard feature, is a shallow seasonal pond, typically 2 to 5 feet deep and 25 to 150 feet across. Variations in seasonal rainfall cause fluctuations in water level, appearance, and function.

In winter, standing water recedes, often drying down completely depending on the pond's water depth, soil type, and the local water table. But even in this dry-down condition, a seasonal pond offers moisture sources for the damp habitats required by many amphibians, reptiles, birds, and small mammals.

If you wish to construct a pond to replicate these important habitats, choose an area that accommodates the shallow and wide profile, already contains suitable plant life and soil types, and provides access for wildlife.

Septic Systems

- Inspect your septic system annually.
- Pump out your septic system every 3 to 5 years (recommended frequency for a three-bedroom house with a 1,000-gallon tank; smaller tanks should be pumped more frequently).
- Do not use septic system additives.
- Avoid or reduce the use of your garbage disposal, since it can put extra solids into the septic system.
- Do not dump solids down the toilet as they can clog the septic system.

Water Use and Conservation

- Use low-flow shower heads and faucets, reduced-flow toilet flushing equipment, and water-saving dishwashers, washing machines, and other appliances.
- Inspect your house for leaky faucets, toilets, and pumps. If leaks are found, repair them immediately.
- Do not let faucets run when the water is not being used.
- When watering your garden or lawn, use trickle irrigation or soaker hoses to reduce runoff and increase watering efficiency.
- If using sprinklers, position them so that water falls only on the lawn or garden, not on the sidewalk, driveway, or street.

Automotive Care

- Regularly maintain your vehicle to prevent oil, antifreeze, and other fluid leaks.
- Properly dispose of used motor oil and antifreeze at facilities that accept recyclable automotive fluids. Most auto parts retail stores, gas stations, auto repair shops, and hazardous materials collection centers will accept these items. One quart of oil can contaminate up to 2 million gallons of drinking water!
- Wash your car at a commercial car wash rather than in your own driveway to prevent soaps and other chemicals from running off the pavement into the storm drain.

Community Action

- Participate in neighborhood cleanup activities.
- Get involved in local planning and zoning decisions.
- Encourage your municipal officials to develop and follow erosion and sediment control ordinances.
- Write or call your elected local representatives to make sure they are aware of water quality issues and the importance of protecting water quality.
- Participate in community education activities to inform citizens of ways they can help to protect water quality.

Summary

- Use landscaping techniques, such as filter strips, porous walkways, and grass swales, to reduce erosion and promote water infiltration into the soil.
- Keep lawn clippings on your lawn so that nutrients in the plant material can be recycled.
- Compost your yard and garden trimmings.
- Test your soil before applying fertilizers to prevent overfertilization and potential leaching and water contamination.
- Clean storm gutters and drains of leaves and other debris to prevent clogging and flooding.
- Clean up after your pets. Pet waste is a significant source of excess nutrients and pathogens, which can seriously impair water quality.

Helpful Resources

Throughout Alabama, experts abound who can assist you in your plant choices. Try these services, most of which are free, for advice on putting the right plant in the right place:

- Alabama Cooperative Extension System: www.aces.edu
- Alabama Master Gardeners: www.aces.edu/mg
- Alabama Master Gardeners Association: www.alabamamg.org
- Certified Horticultural Professionals: www.alnla.org/Education-Opportunities/alabama-certified-landscape-professional-aclp
- Alabama Wildflower Society: www.alwildflowers.org/
- Alabama Nursery and Landscape Association: www.alnla.org
- Water Management Districts: http://water.sam.usace.army.mil/
- USDA Natural Resources Conservation Service: www.nrcs.usda.gov/
- Libraries

ALABAMA BEST MANAGEMENT PRACTICES SUCCESS STORIES

ADDING RIPARIAN BUFFERS DECREASES POLLUTANT LOADING, INCREASES DISSOLVED OXYGEN, & IMPROVES HABITAT IN CROWDABOUT CREEK

Changing land use from forest cover to cropland, pastures, and residential development contributed to increased siltation and organic enrichment and decreased dissolved oxygen levels in Crowdabout Creek. In 1996, Alabama placed the creek on the state's Clean Water Act (CWA) section 303(d) list of impaired waters for failing to support its designed use (propagation of fish, wildlife, and aquatic life) because of biological community and habitat impairment.

The Flint Creek Watershed Conservancy District (FC-WCD) developed a Crowdabout Creek Watershed Management Plan (WMP). The EPA and ADEM provided CWA section 319(h) nonpoint source grant funding to the FC-WCD to facilitate implementation of watershed management work plans from 2003 to 2007.

Between December 2005 and March 2009, 1,372 acres of riparian forest buffers were planted in the watershed. Additional management practices included planting 132.4 acres of grassed waterways and nearly 90 acres

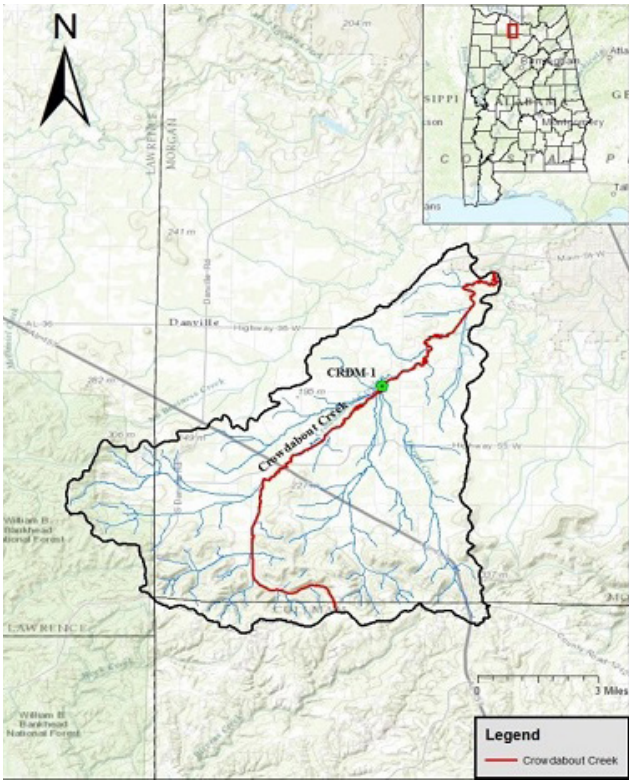

Figure 4.37. Crowdabout Creek watershed is on the state's list of impaired waterbodies. (Photo credit: Alabama Department of Environmental Management)

of hardwood vegetation. Riparian buffers were enrolled in the USDA Farm Service Agency's Conservation Reserve Program to enhance long-term protection and maintenance. Other practices implemented included pasture planting, exclusion fencing, cross-fencing, and stream crossings for cattle. Implementing these agricultural best management practices (BMPs) resulted in decreased siltation and nutrient runoff, increased dissolved oxygen, and improved biological and in-stream aquatic habitat conditions. Crowdabout Creek was listed as attaining water quality standards for nitrogen, phosphorus, sedimentation/siltation, and carbonaceous biochemical oxygen demand (CBOD) for all uses in 2014.

Figure 4.38. Riparian restoration efforts in Crowdabout Creek have improved water quality and habitat. (Photo credit: Morgan County Soil and Water Conservation District).

NUTRIENT & SEDIMENT LOADINGS ARE REDUCED THROUGH COOPERATIVE EFFORTS TO IMPROVE HESTER CREEK

Hester Creek drains an approximately 39-square mile area within the Mountain Fork subwatershed in Madison County, Alabama, northeast of Huntsville within the larger Flint River watershed in the Tennessee River Basin (figure 4.39). Agricultural land use contributed to nutrient enrichment and habitat degradation on Hester Creek. From 1994 to 1995, the Tennessee Valley Authority (TVA) collected data from the Fish Index of Biotic Integrity, which placed the entire 7.27-mile reach of Hester Creek on the 1998 Clean Water Act (CWA) section 303(d) list of impaired waters for nutrients. In 1999, the US Geological Survey (USGS) began a 3-year study as part of the Lower Tennessee Basin Survey, which rated fish as "poor/fair," and habitat with a narrow riparian corridor and stream-bank instability. Nutrient enrichment and habitat degradation also were noted as negatively impacting the creek. In 2004, the TVA gave Hester Creek a "poor" fish rating and a "fair" benthic rating, noting siltation was problematic. The 2006 CWA section 303(d) list added turbidity from land development / agriculture to the Hester Creek listing based on the 1999 USGS water monitoring results.

The entire Flint River watershed was first addressed with CWA section 319(h) funding from 2000 to 2005 in cooperation with the Madison County Soil and Water Conservation District (SWCD). Community stakeholder meetings, Alabama Water Watch volunteer monitoring training, and other workshops helped to communicate the project goals.

Figure 4.39. Hester Creek is within the Mountain Fork watershed in the Tennessee River Basin. (Photo credit: Alabama Department of Environmental Management)

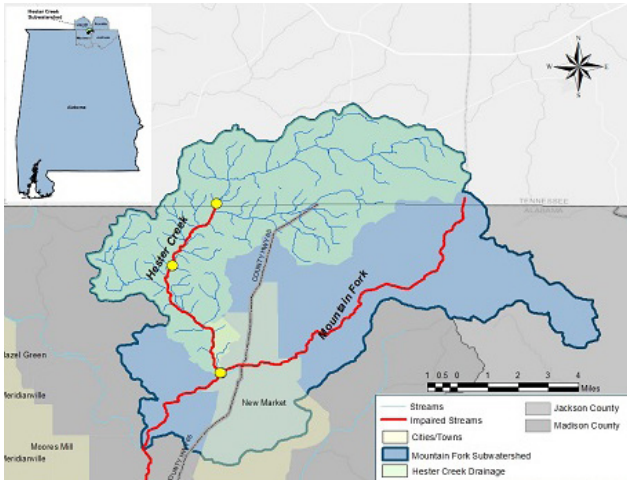

Figure 4.40. Rye is often used as a cover crop in Alabama.

In 2005, Madison County adopted subdivision ordinances and stormwater oversight to help with the increased urban runoff to Hester Creek and other Flint River subwatersheds due to the growth of Huntsville. Subsequently, Hester Creek was added to the CWA section 303(d) list for turbidity from agriculture and land development in 2006.

The Hester Creek/Mountain Fork Watershed Management Plan was completed in 2007 by the Flint River Watershed Coordinator with assistance from ADEM, the Madison SWCD, and the TVA resource stewardship staff. Two phases of the Hester Creek/Mountain Fork Watershed Project (2009–2013) were funded through a CWA section 319(h) grant in cooperation with the Madison County SWCD and ADEM.

Agricultural practices installed included cover crops, conservation tillage, terracing and waterway systems, sediment basins, cropland conversion, livestock stream crossings, fencing, alternative watering sources, and rotational grazing (figure 4.40). A CWA section 319(h)-funded streamside zone management project also was implemented in the Hester Creek drainage area during this period in cooperation with Alabama A&M University. Approximately 12,500 feet of stream channel stabilization and 14 acres of riparian buffer were installed.

Implementing best management practices (BMPs) resulted in decreased siltation and nutrient runoff, increased dissolved oxygen (DO) levels, and improved biological and in-stream aquatic habitat conditions. Based on the in-stream values, and biological assessments, ADEM removed Hester Creek from the 2012 CWA section 303(d) list for nutrient overenrichment and turbidity.

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