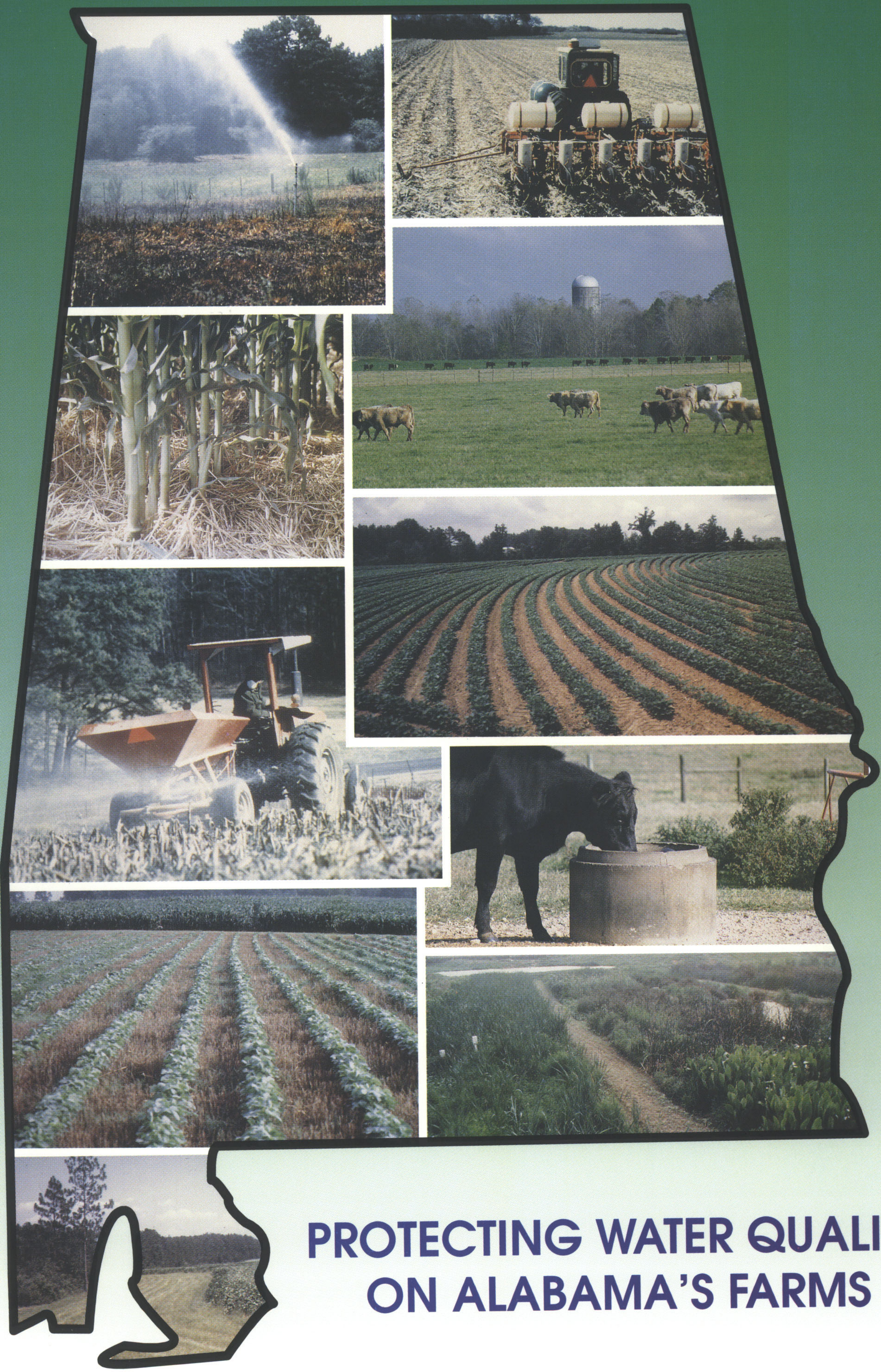

PROTECTING WATER QUALITY ON ALABAMA'S FARMS

PROTECTING WATER QUALITY ON ALABAMA'S FARMS

Developed by the

Alabama Soil & Water Conservation Committee

in cooperation with the

Alabama Department of Environmental Management

and

USDA - Natural Resources Conservation Service

Reviewed by the

Alabama Cooperative Extension Service

Major funding for this publication was provided by a grant from the U.S. Environmental Protection Agency through the provisions of Section 319 of the Federal Clean Water Act, as amended.

PROTECTING WATER QUALITY ON ALABAMA'S FARMS

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ALABAMA SOIL AND WATER CONSERVATION COMMITTEE

OCTOBER 1995

MEMO TO OUR READERS:

Alabama's farmers are obviously concerned about protecting the environment. Clean water, fresh air, and productive soils are essential to our livelihood and to the good quality of life that we and our families enjoy. We are stewards of these God-given resources and have an obligation to protect them, not only for our own well being, but also for the benefit of future generations.

We are well aware that conservation farming has its costs, some of which may not be reclaimed immediately or even within our own lifetimes. Yet the benefits of soil and water conservation are real and are often returned to us many times over. Sometimes the benefits are tangible in terms of increased long-term crop production; such is the case with soil conservation. In other cases, the benefits of conservation farming may be in terms of improved relations with neighbors or in simply knowing that our actions have improved water quality or enhanced habitat for wildlife.

In this state we are blessed with an abundance of rainfall. Thus, Alabama is ranked seventh in the nation in terms of the quantity of water flowing in our streams and rivers. And the quality of both our surface and ground waters is generally very good. For those waters that don't meet acceptable standards, we want to be sure that agriculture is not the cause of the problem.

We, as members of your State Soil and Water Conservation Committee, are committed to the protection of our natural resources. In particular, we want to ensure that we in the farm community do all that we can to protect and enhance the quality of water in this great state. It is the goal of this Committee and the local districts to do all that we can to assist farmers and livestock producers in this important effort.

This manual represents one of many contributions that your State Committee and your local Soil and Water Conservation Districts are making in helping farmers and livestock producers in their ongoing efforts to protect water quality. We trust, however, that this manual will also be used by the general public and will help them appreciate the complexity and costs of the various practices as well as the commitment of Alabama's farmers who are working to protect the environment.

If you need more information on water quality protection, please contact your local Soil and Water Conservation District (see county listing in the back of the manual) or one of our partners in this important arena: The USDA Natural Resources Conservation Service or the Alabama Cooperative Extension Service.

In service to you, we are--

The Alabama Soil and Water Conservation Committee

Charles W. Rittenour Jr.

CHARLES W. RITTENOUR, JR.
CHAIRMAN

FOREWORD

About this manual

This manual is written for all Alabamians who are interested in improving and protecting our environment. For the farm community, it may help in making decisions regarding farming operations in general and resource management in particular. For the city dweller or those unacquainted with farming, it should provide some insight into the problems that farmers and livestock producers face in their efforts to produce food and fiber in an environmentally sensitive way.

This is not a technical manual. Instead, it is intended to be an easy-to-read document that will serve four primary purposes: (l) to provide a handy reference for those interested in seeking solutions to potential water quality problems on the farm, (2) to educate the public on agricultural practices being used by farmers to protect the environment; (3) to provide some useful and enlightening information on water; and (4) to show how agricultural activities can affect water quality.

The overall objective of this publication is to help protect water quality. While we hope that the user of this booklet gains a better appreciation for water in general and water quality in particular, we ultimately hope that some of the farmers or livestock producers who read this material will discover at least one new practice for improving water quality that can be used on their farms. We also hope that this material will instill in the public an appreciation for the efforts required by farmers to protect our surface and ground waters.

Where to get help

Those producers interested in getting more information on any of the practices shown here or in learning more about water quality are encouraged to contact their local Soil and Water Conservation District, the Natural Resources Conservation Service or the Alabama Cooperative Extension Service. Each of these agencies has offices in most counties of the state. Addresses and phone numbers are listed in the Directory of Offices at the back of this manual.

A note about BOLD words

Certain words used in this document may be unfamiliar to some readers. We have tried to identify such words by placing them in **bold** print wherever they first appear in a section. (Second or third appearances within a section are not placed in bold.) The definitions of these words are given in the Glossary near the end of the manual.

INTRODUCTION

The Uniqueness of Water

Two parts hydrogen, one part oxygen. The elixir of life. The universal solvent. Water.

No matter how you describe it or define it, water is unique. In the natural environment it exists in all three states: liquid, solid (ice), and gas (water vapor).

Most **inorganic** chemicals that have properties similar to water exist only as vapors at temperatures and pressures which normally occur in the natural environment. If water behaved "as it should," we would have no lakes or streams.

Water is most dense at 39.2°F (4°C) and not at the freezing point as one might expect. For this reason ice occurs at the top of a pond rather than at the bottom where the warmer, heavier water resides. And life goes on beneath the ice...though perhaps more slowly.

Water is the most abundant substance on earth, with 97 percent of it stored as salt water in our oceans and seas. Of the 3 percent that is fresh, 2 1/4 percent is frozen in ice caps and glaciers, 1/2 percent is in ground water, and only 1/50 percent is in rivers and lakes.

A large volume of good quality water is needed for the variety of uses that we enjoy in this country. The public generally does not realize the amount of water needed for industrial and agricultural production, especially that needed to produce our bountiful food supply.

Consider that it takes 120 gallons of water to produce one egg and 300 gallons of water to "grow" a loaf of bread. Through all its various stages of production, a meal of one hamburger, fries and soft drink requires 1,500 gallons of water.

It may seem inconceivable, but it takes more than 42,000 gallons of water to put a Thanksgiving dinner for eight on the table! Table 1, taken from the Journal of Freshwater, provides the details:

Table 1. Amounts of water needed to produce a typical Thanksgiving dinner for eight:

Item	Gallons of water needed
20-pound turkey	16,300
Stuffing	6,004
Potatoes	72
Scalloped corn	1,824
Green beans	1,000
Carrots	1,000
Waldorf Salad	580
Fresh Fruit Salad	2,000
Bread	300
Margarine (incl. cooking)	2,212
Pumpkin pie	1,240
Ice Cream	1,142
Milk for four	1,000
Wine for four	8,000
Total	42,674

Water Quality

Pure water is virtually impossible to find in a natural setting. Instead of being simply H_2O (two molecules of water to one of oxygen), water may contain trace amounts of iron, sulfur, or other naturally occurring substances. It may contain particles of sediment, or it may taste strange or have a slight color—and all of this could be from natural sources.

On the other hand, a placid, blue lake may be a picture of beauty, but it may actually be a "dead" waterbody, devoid of life. The cause may be low **pH** due to acid rain, acid mine drainage or industrial pollution. Yet a lake or pond with a greenish tint may have an abundance of life; the color merely reflects a thriving population of **phytoplankton**.

So, if pure water is generally not found outside a laboratory, does that mean that the rain and snow or the water we drink or swim in is polluted? And when is our "impure" water considered contaminated or polluted?

"Impure" water. Water that contains anything besides hydrogen and oxygen in a two-to-one ratio is, theoretically, impure. But this is a case where impure is not necessarily bad. If the water we drank were pure, it would be tasteless. And a stream or pond with pure water would contain no life.

Contaminated water. When water contains any substance that could adversely affect the health or well being of humans, animals or the environment, it is not only impure but is also contaminated.

Well water containing trace amounts of iron would not be harmful to someone drinking it, and in that situation the water would be impure but not contaminated. Yet, for a company which produces soft drinks, too much iron in the water could make it unacceptable, and for them it is contaminated.

Even a crystal clear stream high in the Rocky Mountains, far from any human influence, can be contaminated. Beaver fever or *Giardiasis*, a disease caused by a **protozoan**, has been passed to unsuspecting backpackers and hikers drinking from streams contaminated by the feces of wild animals. Such waters are obviously contaminated, yet there are no regulatory limits for *Giardia lamblia* (the protozoan which causes the disease) or for many other substances or organisms which could adversely effect humans, other animals, or the environment.

Polluted water. Water is considered polluted when it fails to meet officially established water quality standards for a particular designated use. Thus, not all contaminated water is polluted, but all polluted water is contaminated.

If the designated use of a water body is "Public Water Supply," the maximum allowable limit for nitrate (NO_3) is 10 milligrams per liter (as N). Fresh water used for swimming has no limit for NO_3; however, it may contain no more than 200 fecal coliform bacteria per 100 milliliter sample.

The Alabama Department of Environmental Management (ADEM) has established the following "designated uses," and all of the streams and rivers in the state are assigned one of these use classifications:

* Public Water Supply
* Swimming and Other Whole-Body, Water-Contact Sports
* Shellfish Harvesting
* Fish and Wildlife
* Agricultural and Industrial Water Supply
* Industrial Operations

* Navigation
* Outstanding Alabama Waters
* Outstanding Natural Resource Waters

Specific water quality criteria for each classification is available from ADEM.

Water in Alabama

Quantity: Alabama has an abundance of water, both surface water and ground water. Surface waters cover about 500 square miles, including 47,072 linear miles of perennial streams and rivers. Alabama ranks seventh in the Nation in miles of perennial streams.

Our surface waters are replenished regularly by an ample supply of rainfall that occurs throughout the state. Annual precipitation ranges from about 50 inches in central and west-central Alabama to about 65 inches near the Gulf (see Figure 1).

Ground water is the main source of drinking water for about 44 percent of the total population or more than 2.1 million people statewide. The principal uses of ground water include public water supply, rural domestic water, agricultural uses for livestock and irrigation, and industrial water. Figure 2 illustrates the seven principal aquifers underlying the state.

Industrial production alone takes 9.7 billion gallons per day from surface waters and 51 million gallons per day from ground waters.

Quality: Generally, the quality of both surface and ground waters is good, considering the vastness of these resources. In fact, ADEM indicates that 82 percent of the State's rivers and streams fully support their designated uses. Only three percent of surface waters do not support their designated uses. Although well water is good throughout most of the state, some wells in certain areas have been found to be polluted by agricultural activities and failing septic tank systems.

Committing to Conservation

Although Alabama has an abundance of good quality surface and ground water, it is not unlimited and it can easily be contaminated. When a drought occurs or when a water source becomes polluted, we soon realized how precious this resource is.

From an agricultural standpoint production of plant and animal resources rely on rich soils, clean air, and a reliable source of clean, fresh water. All of these resources must be protected if we are to continue to have an agricultural sector that remains vibrant and productive.

Alabama's farmers and livestock producers must continue to be good stewards of our natural resources. Their commitment in this effort is vitally important to the agricultural community as well as to all Alabamians. All of the agencies which contributed to the development of this manual are committed to helping farmers and livestock producers in this important stewardship effort.

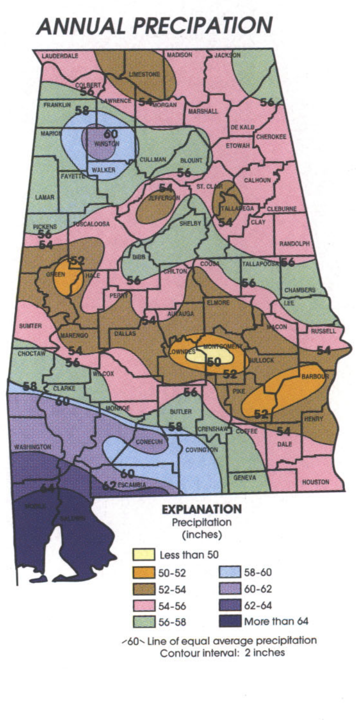
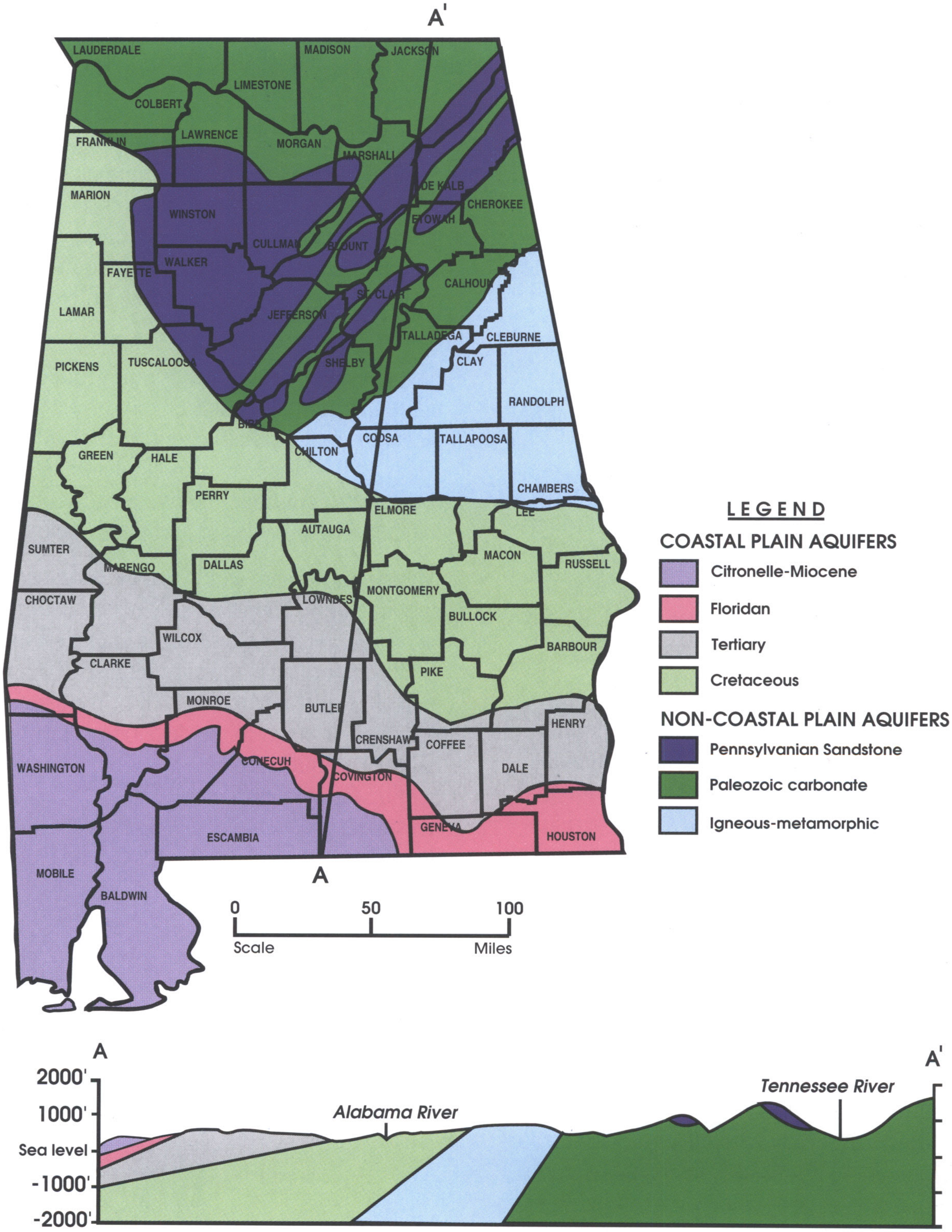


Figure 1.



Cross Section A-A' (Map above)

Figure 2. Seven Principal Aquifers Underlying Alabama

AGRICULTURAL POLLUTION

In extreme cases nonpoint pollution can kill fish and other aquatic organisms.

POINT VERSUS NONPOINT POLLUTION

In the field of water quality, the terms "point" and "nonpoint" are used to describe the sources of pollution. Pollutants from point sources enter surface waters from an easily identifiable point of entry, such as a pipe, flume or other manmade conveyance. All point sources must have a National Pollution Discharge Elimination System (**NPDES**) permit in order to discharge treated wastewater to surface waters of the state. Such permits specify allowable concentrations of various pollutants and sometimes specify the allowable flow rates. Municipal and industrial discharges are the primary point sources.

The term "nonpoint source" is used to describe those sources which are usually dispersed over a wide area. A cropland field discharging sediment and pesticides over a wide area is an example of an agricultural nonpoint source of pollution. Likewise, an overgrazed pasture discharging nutrients and bacteria would also be considered a nonpoint source.

Nonpoint sources are not restricted to agriculture. Construction, logging and mining sites as well as residential areas are also sources of such pollutants which range from sediment and nutrients to acid runoff, petroleum products and pesticides. In some locations failing septic systems are a major problem to surface and ground waters.

Livestock and poultry facilities can be classified as either point or nonpoint sources, depending on the size of the operation and the flow of water from or through the facility. For instance, those facilities with 300 **animal units** (300,000 pounds of animal weight) and having a discharge through a manmade device or directly into surface waters from storms smaller than the 25-year, 24-hour storm must obtain an NPDES permit. However, a permit is not required where runoff, wastewater, or polluted water of any kind (1) is prevented from leaving the land except during storms equalling or exceeding the 25-year, 24-hour storm and (2) is used on the land for crop production, soil amendment, or any other beneficial purpose in a nonpolluting manner. Owners of confined animal feeding operations (CAFOs) should plan on having a no-discharge waste treatment system because the concentrations of pollutants from most facilities are normally very high even after treatment in a lagoon. Therefore, it is almost always more cost effective for livestock and poultry producers to collect the waste and apply it to the land rather than obtaining a permit to discharge.

AGRICULTURAL POLLUTANTS

In Alabama, the principal pollutants from agriculture are sediment and suspended solids, nutrients, organic matter, microorganisms, and pesticides. Each of these will be discussed briefly below and will include information on sources and effects on water quality.

Sediment and Suspended Solids

Sediment refers to soil particles that are washed or blown into streams and lakes either through natural or man-induced erosion. Suspended solids can include all solid matter carried by water, including fine soil particles, manure solids, algae, and other suspended matter.

Sediment can settle to the bottom of a stream or water body, or it can remain suspended in flowing water and ultimately be carried to the Gulf of Mexico. In still waters such as a pond or lake, heavier sand particles settle rapidly while the finer clay soils may remain in suspension for weeks. In rapidly moving waters all soils will be suspended.

Sediment is the most abundant of the potential agricultural pollutants in surface waters, much of it occurring from natural erosion of stream banks and the land itself. This natural or geologic erosion of the land and subsequent deposition or sedimentation has been occurring for eons. The Mississippi Delta has sediment deposits several feet thick due to relatively recent erosion created by both natural conditions and man. Yet, the estuary of the Mississippi River is underlain by a sedimentary formation measuring several miles thick which is the result of many thousands of years of natural erosion.

Many of man's activities accelerate the erosion process. Construction activities produce more tons of sediment on a per-acre basis than nearly any other source. A sediment loss of 400 tons per acre is not uncommon at a construction site.

Obviously, farming activities often expose large areas of soil during land preparation and planting, making these soils susceptible to erosion. If proper conservation practices are not applied, large volumes of sediment can be transported from the fields during rainstorms.

Overgrazed pastures, feedlots, and forestry activities can be sources of sediment. In addition, those areas where cattle have access to streams are subject to erosion and the production of sediment.

Sediment can fill road ditches and clog pipes and culverts. It can also fill stream beds which, in turn, causes flooding.

Sediment has filled farm ponds, lakes and embayments. The cost to remove such sediment can be prohibitive.

Excessive sediment in streams, ponds, lakes and embayments can be a problem when it covers spawning beds and suffocates eggs and larvae of various beneficial aquatic organisms. When soil particles remain in suspension in a pond, light penetration is hampered, and the **photosynthetic** organisms which require light for growth are stunted. In addition, the growth of microscopic **filter feeders** is hampered as is the growth of sight feeding organisms, including fish.

Soil particles are also carriers of other pollutants. Positively charged nutrients and pesticides readily attach to negatively charged clay particles. Phosphorus, for instance, **adsorbs** quickly to soil particles, as does the positively charged ammonium ion.

The most cost effective way to prevent damage from sediment is to control it at the source. This means preventing soil erosion, and if that cannot be easily accomplished, then practices are needed to intercept the sediment-laden water before it leaves the site.

Nutrients

All plants require a wide variety of nutrients for optimum growth. However, the nutrients utilized in the greatest amounts by plants are nitrogen (N), phosphorus (P), and potassium (K), often called the "major nutrients." Nitrogen and phosphorus are also the nutrients responsible for most nutrient-related water quality problems.

All natural waters require nutrients to support healthy and diverse populations of aquatic life. Farm ponds are fertilized to enhance the growth of microscopic organisms which become food for higher organisms, including fish. But an excess of nutrients in a stream or pond can create serious water quality problems.

Animal wastes are a potential source of nutrient pollution of both surface and ground waters. Animal wastes can enter surface waters from discharging lagoons, from livestock defecating in or near streams or ponds, or from excess waste or irrigated wastewater applied to a field as fertilizer. Commercial fertilizer may also enter surface or ground waters when more fertilizer is applied than the crop can effectively utilize or when application occurs before a runoff-producing rain.

Just as nitrogen and phosphorus enhance plant growth on the land, so can they enhance the growth of algae and other aquatic vegetation in a pond or lake. **Algae blooms** and excess aquatic vegetation are not only unsightly but are also a threat to other beneficial aquatic life and to persons who use the water for recreation. In addition, a pond loaded with blue-green algae can kill cattle which drink the water.

A large population of algae caused by excess nutrients will create supersaturated dissolved oxygen levels in a waterbody during daylight hours and depressed dissolved oxygen levels during night or on overcast days. Such conditions can stress or kill fish.

An excess of the unionized ammonia nitrogen (NH_3) in surface waters can also be lethal to fish and other aquatic organisms. Approximately 70 percent of the nitrogen in an animal waste lagoon is in the ammonia form, and the concentrations of NH3 far exceed those required to kill fish.

The nitrate form of nitrogen (NO3) is very mobile and can leach to ground water. When waste or commercial fertilizer is applied at excessive rates, the chances for pollution of ground water increase dramatically. High nitrate concentrations in drinking water can cause a deadly disease in infants called blue baby syndrome.

Organic matter

Organic matter is highly desirable in the soil. It improves soil structure and **tilth**, and it enhances the ability of the soil to hold water. However, organic matter in surface waters becomes food for microorganisms, and large amounts can cause problems. Since most naturally occurring bacteria in a stream require dissolved oxygen along with their organic food supply, they can rapidly deplete the oxygen supply as their population grows in response to the addition of animal waste or other sources of organics. The net result may be a fish kill or stress on the fish population from an inadequate supply of dissolved oxygen.

Sources of agriculture-related organic matter in a stream may include discharging animal waste lagoons, runoff from feedlots and dairies, livestock defecating in streams, the discharge from commercial catfish ponds during fish harvest, or leachate from silage pits.

Fecal organisms

Bacteria, parasites, fungi, and other micro-organisms occur naturally in the aquatic environment and can be beneficial. However, many organisms in the aquatic environment can be pathogenic (disease causing). A common source of waterborne pathogens is the feces of warm-blooded animals, including farm animals, wild animals, and humans.

Disease organisms may enter surface or ground waters from discharging or leaking animal waste lagoons; animals defecating in or near a stream; runoff from feedlots, dairies, and overgrazed pastures; and dead animals improperly disposed of.

The excreta from warm-blooded animals and the improper disposal of dead animals contain countless micro-organisms, including bacteria, viruses, parasites, and fungi. Table 2 lists some of the more common diseases which may be transmitted between animals via a water supply.

Pesticides

Pesticides have been an important part of American agriculture, helping make this nation the most productive in the world. Yet, pesticides have the potential to create problems in the environment and, in fact, have caused serious water quality problems in the past. This is especially true with regard to some of the older, no-longer-manufactured pesticides.

Pesticides are intended to kill. Herbicides kill weeds; insecticides kill insects; nematicides kill nematodes; and so forth. The target in all cases are pests—those living organisms that are an intolerable interference to man's interests and, therefore, must be eliminated, contained, repelled, or reduced to tolerable numbers.

The potential effect of a pesticide on the environment is often evaluated in terms of the characteristics shown in Table 3.

Pesticides can enter surface waters in storm runoff, through misapplication by aerial sprayers, through a spill or discharge during mixing and handling, or through the improper disposal of empty pesticide containers. Obviously, some pesticides can kill or seriously

Table 2. Diseases which may be spread by animal wastes via water.

Type of organism	Disease
Bacterial	Anthrax
	Campylobacteriosis (bovine "vibriosis")
	Colibacillosis and coliform mastitis/metritis
	Erysipelas
	Johne's Disease (Paratuberculosis)
	Leptospirosis
	Listeriosis
	Salmonellosis
	Tuberculosis
Fungal	Blastomycosis
	Dermatophytosis
Parasitic	Tacniasis (human) and Cystieercosis (animal)
	Anycylostomiasis and Toxocariasis
Protozoal	Balantidiasis
	Coccidiosis and Sarcocystosis
	Cryptosporidiosis
	Giardiasis
	Toxoplasmosis
Rickettsial	Q fever
Viral	Newcastle
	Psittacosis
	Cowpox, pseudocowpox and orf

injure fish and other aquatic animals and plants. Small quantities of pesticides ingested by small aquatic organisms at non-lethal levels can become a major problem as larger organisms consume a large quantity of the smaller contaminated organisms. This process, called biomagnification, can affect many types of animals in the food chain as the concentrations in the body tissue of the animals become greater as it moves up the chain. In one case study, the concentration of a particular pesticide in the bodies of a certain species of waterfowl exceeded the original concentration in the water by several hundred times. Pesticides can also leach to the ground water and cause long term effects to those who might drink the water.

A continuing problem with pesticides is that target pests can develop a resistance to current pesticides. Even weeds are becoming resistant, thus requiring either a different pesticide or alternative methods of control.

Another important concern is that pesticides often kill beneficial organisms. These may include predators of insect pests, bees and other insects important for pollination, and earth worms.

In order to prevent environmental problems many farmers are using alternative methods in their pest management programs. Details on alternative methods are discussed later in this manual under the practice Integrated Pest Management.

Table 3. Terms which help define the characteristics of pesticides in relation to water quality and human health.

Toxicity: The degree to which a pesticide is toxic to humans. Pesticide containers must be labeled to indicate the toxicity level. The ratings on the labels and their potential to kill are as follows:

Label Signal Word	Toxicity Rating	Lethal Dose for a 160 lb Man
DANGER POISON	Highly toxic	Few drops to 1 teaspoon
WARNING	Moderately toxic	1 teaspoon to 1 tablespoon
CAUTION	Slightly toxic	1 tablespoon to 1 pint

If more than 1 pt. is required to kill, no warning is required: relatively nontoxic.

Persistence: The time that the pesticide remains effective in the environment. Persistence of a pesticide is described in terms of its "half life" or the time required for half of the substance to no longer retain its chemical identity or biological activity. Some pesticides have half lives measured in years, while others are effective for only a day or just a few weeks.

Solubility: The ease with which a substance dissolves in water or in another liquid. Pesticides that are highly soluble have a greater potential of leaching to ground water. These pesticides are also more likely to cause damage to aquatic life.

Adsorptivity: The ability of a substance to chemically bond with another. In the case of pesticides, adsorptivity refers to the ability of the pesticide to bind with soil particles or with organic matter in the soil. Pesticides that are highly adsorptive will be more apt to remain within the soil profile until they are broken down or absorbed by plants.

POLLUTION CONTROL PRACTICES 7

The term "practice" refers to the structural, vegetative or management activities needed to solve one aspect of a resource management problem. In some cases, a single practice may solve the problem, but usually a collection of practices or a "system" is needed to prevent water quality problems.

The term "Best Management Practice" or BMP is often used in relation to both point and nonpoint sources of pollution. BMPs are practices determined to be "the most effective practical means of reducing pollution levels to those compatible with water quality goals."

This section of the Handbook provides information on the most commonly used practices required to prevent water quality problems on the farm. The discussion of each practice includes a description of the practice, the benefits to water quality, and various factors to consider in planning the practice. In some cases important related practices are listed or discussed.

The practices discussed in this section are categorized in terms of the potential pollutants. These include animal wastes, nutrients, pesticides, sediment and pollutants from farmsteads.

Although specific operation and maintenance (O&M) requirements are not specified for each practice, O&M is critical to long-term success. If O&M is neglected, the practice may fail and the goal of protecting water quality may not be achieved. In extreme cases, such as failure to properly maintain liquid levels in lagoons or to prevent burrowing animals from degrading embankments, the results of poor O&M can be catastrophic. Specific O&M requirements can be provided by local District and NRCS personnel.

ANIMAL WASTES

Animal wastes include more than just animal manure. Flush water, runoff from open pens and feedlots, spilled feed, and other materials contaminated during animal production may be considered animal wastes. Dead animals resulting from normal mortalities would also fit into this category.

A detailed waste management plan should be developed which takes into account the proper utilization or disposal of all sources of animal waste on the farm. Such a plan identifies all of the management, structural, and vegetative practices needed and incorporates them into an integrated waste management "system."

Management activities include using proper amounts of water for flushing and cleaning facilities in a timely manner; managing liquid levels in lagoons to prevent overflow; applying only the proper amount of waste and nutrients to the land at only the proper times of the year; and providing proper maintenance of facilities through their operational life.

Structural components of a system may include a lagoon, waste storage pond, litter and manure storage barn, settling basin, or pit; composters and incinerators needed for proper disposal of normal mortalities; and constructed wetlands and irrigation components needed to spread excess wastewater on the land. This section of the manual describes some of the structural components of a waste management system.

Vegetative practices include the crops, pasture, or wetland plants on which wastes are spread. They may also include vegetation needed to stabilize areas during construction or areas heavily trafficked by animals. Some of the vegetative practices are discussed under the section on Sediment.

Livestock producers are encouraged to contact their local Soil and Water Conservation District or the USDA Natural Resources Conservation Service for assistance in developing a waste management plan and determining if a **NPDES permit** is required.

This section discusses the following practices which may be part of the overall waste management system:

Animal Mortality Management

Animal Waste Lagoon

Animal Waste Storage Pond

Animal Waste Storage Structure

Composting

Constructed Wetland for Waste Treatment

Livestock Exclusion

Livestock Watering Facility

Runoff Management

Waste Utilization

ANIMAL MORTALITY MANAGEMENT 11

The daily mortality from a poultry farm is prepared for composting.

DESCRIPTION

Animal management includes sanitary methods for disposing of dead animals from livestock and poultry operations. Disposal alternatives include:

* composting
* rendering
* incineration
* fermentation, then rendering
* freezing, then rendering
* burial

Design details and operation and maintenance requirements for a mortality management facility should be addressed in the overall animal waste management system plan.

WATER QUALITY BENEFITS

All wastes, including dead animal carcasses, contain microorganisms. Some of these organisms may be pathogenic (disease-causing) either to animals of the same species or to different species. (See Table 2 under Agricultural Pollution.) Proper management of animal mortalities will prevent the movement of these organisms to surface or ground waters and will, therefore, reduce the risk of transmitting disease.

Proper management of mortalities will also protect surface waters from unwanted organic loads which can lower dissolved oxygen levels and kill fish. In addition, odor and nutrient enrichment problems can be prevented.

Surface waters can be safely used for recreation, livestock watering, and other uses. Unpolluted ground water can be used for public water supplies and for other beneficial uses.

PLANNING CONSIDERATIONS

Several factors must be considered when selecting a suitable mortality management system.

Some of these include:
* State regulations
* type of animals
* size of the operation
* cost of installation
* equipment required
* manpower needed
* land area required, if composting.

Composting turns a potential waste into a useful product. It is used primarily by poultry producers for their daily mortalities, but it is also used by some swine growers. The composter should not be used for sudden, massive die-offs which exceed the design requirements of the system.

The size and style of dead animal composters can vary, depending on the needs and desires of the producer. A moderate degree of management skill is required, otherwise the material could create fly and odor problems. Large poultry facilities will normally need a frontend loader for efficiency. In addition, an adequate amount of land is needed for spreading the final product. (See Composting for more details.)

Rendering also turns a waste into a useful product. Rendering is a useful option if a rendering plant is within an economical driving distance of the animal production facility. The vehicle used to transport the dead animals must be suitable for preventing contamination along the route, and it must be appropriately sanitized after use.

Incineration is an effective method of disposal, but it produces no useful end product. For large-scale poultry facilities, incineration consumes a lot of energy. It may also be very time consuming, especially at the end of the growing cycle when the birds are large and the incinerator must be filled several times each day. The large poultry facility might need two incinerators to increase efficiency.

Incineration can create odor problems if improperly managed or if an unacceptable type of unit is used. The incinerator should have a dual burning chamber or afterburner to recycle fumes. Incinerators must be registered with the Air Division of the Alabama Department of Environmental Management (ADEM).

Freezing and fermentation have been used by some poultry producers to temporarily store normal mortalities until they can be transported to a rendering plant. The costs of electricity for freezing may be too high for some producers. Fermentation requires specialized equipment and a more intensive level of management. Appropriate and acceptable methods for transporting the frozen and fermented materials are required.

Burial of day-to-day mortalities in pits is no longer an acceptable alternative for poultry, and it is not allowed for high-volume, large-animal facilities, such as beef feedlots. However, burial may be used to dispose of an occasional large animal or a massive, unexpected die-off of poultry. In such cases, the owner must contact the State Veterinarian for approval, and a soil scientist must be involved with the selection of a burial site.

Mortality management should be addressed in the producer's overall waste management plan for the facility. If composting is used, the plan must account for the land area required for spreading both the animal manure and the compost.

ANIMAL WASTE LAGOON

Wastewater from these poultry houses is treated in a lagoon system and then recycled as flush water. Excess is land applied.

DESCRIPTION

An animal waste lagoon is an earthen basin or pond used to collect, store and treat the manure, flush water, and polluted runoff from livestock facilities. "Treatment" includes all the natural processes involved with reducing the pollutant concentrations in the wastewater: settling, biological degradation or stabilization, and volatilization (loss to the atmosphere as a gas).

The most commonly used animal waste lagoons are **anaerobic**. They are normally 6 to 12 feet deep. Typical sizes for 8-foot deep lagoons are shown below:

Animal	Number	Length (ft)	Width (ft)	Volume (cf)
Dairy	100	200	150	188,000
Poultry	100,000	410	410	1,200,000
Swine	1,000	200	175	225,000

Aerobic lagoons may be used for additional treatment after the first stage anaerobic lagoon. These lagoons are shallow (less than 5-ft deep) and have a very large surface area. Because of the large land area requirement, they are used infrequently.

When lagoons become filled with liquid, they must be drawn down by pumping through an irrigation system or hauling with a tank spreader. The water level should never be allowed to rise above the maximum allowable design level (MADL). A margin of safety or freeboard storage must be maintained above the MADL to prevent discharge or possible overtopping. In addition, after several years the settled sludge must be removed and applied to the land in order to allow the lagoon to function properly and to restore its storage capacity.

Design details and operation and maintenance (O&M) requirements for a lagoon should be addressed in the overall animal waste management system plan.

WATER QUALITY BENEFITS

Although lagoons greatly reduce the concentrations of pollutants, the wastewater is much too strong, even after treatment, to be allowed to discharge to surface waters. Therefore, the major benefits of lagoons are their ability (1) to contain wastewater on the property of the owner until it can be applied to the land, and (2) to reduce pollutant concentrations which, in turn, reduces the amount of land area needed for spreading the wastewater.

PLANNING CONSIDERATIONS

Ground water: Because lagoons store large volumes of contaminated water, they must be located and constructed in such a way that they do not leak. Soil type, underlying rock formations, depth to water table, and the distance and vertical relationship (uphill or downhill) from the nearest well must be evaluated when considering a lagoon. Proper construction techniques are critical during installation to prevent seepage to ground water.

Odors: Lagoons may create offensive odors at certain times of the year. Therefore, they should be placed an adequate distance from neighbors, highways, and public use areas. Consideration must also be given to the direction of prevailing winds.

Screening: If a lagoon will be placed in an area where it can be seen by the public, it is advisable to screen it from view, either through land forms or through the use of trees, bushes or other plantings. The owner should be aware that people sometimes "smell with their eyes" and, therefore, should keep the lagoon out of sight if possible.

Land requirements: Lagoons can occupy a large amount of land, sometimes several acres. It is essential, therefore, that the owner have adequate land area in the right location. The lagoon should not be placed near streams or property lines. They must also not be placed in floodplains or in natural waterways where runoff from the surrounding watershed could cause premature filling and overflow. An adequate amount of land is also needed for land application of wastes. The amount of land needed depends on the nutrient requirements of the receiving crop and the amount of water generated.

Equipment: The owner must have the necessary equipment on hand to spread excess wastewater on the land before the lagoon becomes full. The most desirable option is irrigation equipment because of the large volumes of water (including rainwater that falls directly on the lagoon surface) that must be disposed of. Hauling with a liquid manure spreader is normally undesirable because of the large amount of water to be transported and, hence, the large number of trips required.

Water management: Uncontaminated surface runoff and roof water should be diverted away from the lagoon to prevent premature filling.

ANIMAL WASTE STORAGE POND

A waste storage pond allows manure and flush water to be stored for a specified period before being applied to the land.

DESCRIPTION

An animal waste storage pond is an earthen basin used to collect and store, for a specific period of time, the manure, flush water, and polluted runoff from an animal production facility. The goal of the storage pond is to conserve nutrients, especially nitrogen, for maximum utilization by crops. This goal is different than that of the animal waste lagoon, which is to degrade or reduce concentrations of potential pollutants such as nitrogen. The storage period for a waste storage pond is typically 90 to 180 days.

The storage pond should be drawn down using irrigation equipment or a liquid manure spreader. The water level should never be allowed to rise above the maximum allowable design level (MADL). A margin of safety or freeboard storage must be maintained above the MADL to prevent discharge or possible overtopping.

Design details and operation and maintenance (O&M) requirements should be presented in the overall animal waste management system plan.

WATER QUALITY BENEFITS

The major benefits of waste storage ponds are (1) to contain the wastewater on the owner's property until it can be applied to the land and (2) to conserve nutrients for maximum utilization by crops. If properly maintained and operated, the waste storage pond will intercept and contain wastewaters that might otherwise be discharged to a nearby stream. It should be noted that the concentrations of pollutants in waste storage ponds are much stronger than untreated municipal wastewater or the effluent from most animal waste lagoons. A discharge would kill fish and other aquatic life, transmit disease causing organisms downstream, and generally degrade the water for any beneficial use.

PLANNING CONSIDERATIONS

Ground water: Because storage ponds hold large volumes of contaminated water, they must be located and constructed in such a way as to prevent leakage. Soil type, underlying rock formations, depth to water table, and the distance and vertical relationship (uphill or downhill) from the nearest well must be evaluated. Proper construction techniques are essential to avoid seepage to ground water.

Odors: Waste storage ponds can be odorous, especially if they are sized with too short a detention time (i.e., less than 45 days). They can also produce odors during pumpout. Therefore, storage ponds should be placed an adequate distance from neighbors, highways, and public use areas. Consideration should also be given to the direction of prevailing winds.

Screening: If a waste storage pond is placed where it could be seen by the public, it is advisable to screen it, either through land forms or through the use of trees, shrubs or other vegetation. The owner should be aware that people sometimes "smell with their eyes;" therefore, the storage pond should be kept out of site.

Land requirements: Waste storage ponds are usually smaller than lagoons and, therefore, require less land area; however, they can still be large, especially if a large storage period is planned. Therefore, an adequate amount of land is needed in the right location. It should not be placed near streams or property lines in case of possible overflow. It should also not be placed in a natural waterway where runoff from the surrounding watershed could cause premature filling and discharge.

Since waste storage ponds conserve nutrients as opposed to lagoons, more land is needed for spreading the wastes than would be required for a lagoon. The amount of land needed must be determined on the basis of the type of crop and its nutrient requirements.

Equipment: The owner must have the necessary equipment on hand to agitate the contents of the entire pond (mix the settled sludge with overlying liquid) and to pump the contents out at the end of each storage period and apply it to the land. Usually the best option for pumpout is irrigation equipment since it is fast and requires less manpower than hauling with a liquid manure spreader.

Water management: Uncontaminated surface runoff and roof water should be diverted away from the storage pond to prevent premature filling.

ANIMAL WASTE STORAGE STRUCTURE

Poultry litter is stored in this structure where some will be used for the composter and some will be directly applied to the land.

DESCRIPTION

Waste storage structures are made of concrete, wood, or other fabricated material and are used to store solid or liquid wastes for a specific storage period. These structures allow flexibility in managing wastes to accommodate availability or breakdown of equipment, variability of weather, and overall operational requirements.

Structures which store liquid manure, flushwater, or polluted runoff are usually located below ground so that the waste materials can enter them with the aid of gravity. However, above ground tanks or silo-type structures may also be used to store liquid wastes, especially if rock is located near the ground surface. For these structures, the waste materials are usually pumped into the tank.

When used to store dry wastes, such as poultry litter, these structures are usually roofed to prevent rainwater from entering the material and causing seepage or creating odors.

Design details and operation and maintenance (O&M) requirements should be presented in the overall animal waste management system plan.

WATER QUALITY BENEFITS

A storage structure allows the owner to hold the waste in a protected environment until weather and soil conditions are suitable for land application. This flexibility in managing the waste allows better utilization of nutrients and reduces the potential for contamination of surface and ground water.

PLANNING CONSIDERATIONS

A storage facility must be sized so that it can store the waste during the non-growing season.

Many factors are involved in determining the storage period. They include the weather, crops, growing season, availability of equipment, soils, labor requirements, and management flexibility.

Site selection for a waste storage structure is critical. The structure should be located on a well drained site, and it must be designed and constructed to desired performance and safety standards. Therefore, consideration must be given to materials selection, necessary storage capacity, and structural components.

COMPOSTING

Compost is prepared in windrows at this facility.

DESCRIPTION

Composting is a process which converts one form of **organic** matter, such as dry poultry waste, dead chickens, or leaves and grass clippings, into a more uniform and relatively odorless substance called humus or compost. Composting is considered an **aerobic** process and requires a mixture having a carbon to nitrogen ratio of about 30 to l, a moisture content of 40 to 50 percent, and an adequate supply of oxygen.

With the proper mixture of ingredients, naturally occurring microorganisms have an optimum environment for growth. As the population of organisms grows and begins converting the mixture to humus, heat is generated. Temperatures in an active compost pile may range from 140 to 160^{O}F. If the temperature does not increase, or increases only slightly, the mixture may be incorrect or be too moist. In such a case, the raw material will not be completely decomposed and may even have a bad odor. This may also be a sign that more oxygen is needed in the pile.

Organic matter can be composted in at least four ways:

* Windrowing
* Forced-air composting
* In-vessel composting
* Static-pile composting

Windrowing involves forming the mixture into long rows, typically 3 to 5 feet high and 5 to 10 feet at the base. The windrows are mixed at regular intervals to ensure adequate oxygen is added for the aerobic bacteria. The rows are usually turned or mixed every 10 to 15 days.

Forced-air composting requires bins equipped with blowers and ducts to force air into the pile. The air can be drawn though the pile or blown into it. The temperature in the bins is usually monitored automatically, and when the temperature in the mixture begins to drop, fans turn on, forcing more oxygen into the pile to revitalize the bacteria.

In-vessel composting is usually accomplished in long, shallow concrete channels. The mixture is placed at one end of the channel and a large roto-tiller-like machine travels the length of the channel, mixing the contents and gradually moving the material from one end to the other. New material continues to be added at one end, and the completed compost is removed at the other.

Static pile composting uses bins, as with forced-air composting. However, in static-pile composting, no air is forced into the pile. Temperature is monitored by hand, and when the temperature in the pile begins to drop, indicating a reduction in biological activity, the contents of the bin are moved to another bin or restacked in the same bin. The process of moving the material aerates the material, and it begins to reheat. Dead poultry composting uses this method (see Animal Mortality Management).

WATER QUALITY BENEFITS

Composting turns what might be considered a waste material (dead poultry, manure, garbage, kitchen waste, etc.) into a resource—namely, compost. Compost is used to enrich soil, whether it be on the farm, in the garden, or in greenhouses. Municipal wastes that are not composted usually are deposited in a sanitary landfill, and nothing useful is gained from this material. In some rural areas, household garbage, which could be composted, is too often deposited along roadsides or dumped into streams.

Compost, when integrated into the soil, adds nutrients for crops and also increases the water holding capacity of the soil. As the water holding capacity is increased, less water will run off the land or leach downward through the soil profile. Because of the heat produced through this process, pathogenic organisms are killed. Therefore, any liquid leaching from a site where compost has been applied will be safer than the leachate from raw untreated waste.

PLANNING CONSIDERATIONS

During the composting process, between 20 and 30 percent of the original volume is lost. However, some of the nitrogen that might otherwise be available for crop use is also lost.

Anyone interested in composting either dead animals or manure must take into account the amount of nutrients available in the finished product, other sources of nutrients that will be used in land application, crop nutrient requirements, the cost of facilities and equipment, and the labor involved.

If manure or litter contains more nitrogen than can be accepted by the crops on the acreage available, then composting might be considered. During composting as much as 30 percent of the nitrogen can be lost, thus reducing the amount of land needed for application.

Compost should be analyzed for nutrient content to determine proper land application rates. If municipal or industrial wastes are involved, necessary permits must be obtained from the Alabama Department of Environmental Management.

The composting facility should be properly located away from streams and sink holes. In addition, they should be properly managed to prevent polluted runoff from leaving the facility; this is especially true of windrowing facilities where the compost may be exposed to precipitation.

CONSTRUCTED WETLANDS FOR WASTE TREATMENT 21

Wetland plants provide a high level of treatment for the effluent from a swine lagoon.

DESCRIPTION

A constructed wetland is a bed of aquatic vegetation through which wastewater is passed for treatment. The plants extract water and nutrients and add oxygen to the root zone to help in the treatment process. Aquatic plants used to treat agricultural wastes will typically include cattails, bulrushes and related water tolerant (**hydrophytic**) vegetation. When the constructed wetland is used to treat domestic wastewater, aesthetic plants such as calla lily, canna lily, elephant ear, yellow iris and ginger lily could be used.

All wetlands used to treat wastewater and polluted runoff consist of an impervious subsurface barrier (i.e., a well compacted clay liner or a plastic sheet), a suitable medium (**substrate**) for the attached hydrophytic vegetation, the plants themselves, wastewater or polluted runoff flowing at a slow velocity through the system, and the structural components needed to contain and control the flow. The system can be designed as (1) a free-water or surface-flow system or (2) a subsurface-flow system.

Surface-flow system: In this type wetland the wastewater flows across the substrate at a depth of 6 to 8 inches deep, and the water surface is freely exposed to the surrounding atmosphere. This type system resembles a natural marsh. The surface-flow system is the only type used to treat the effluent in animal waste systems.

Subsurface-flow system: This type system includes a layer of rock placed over the impermeable barrier. Wastewater flows laterally through the rock layer at a very slow velocity. The hydrophytic plants are placed at the surface of the rock, and the roots penetrate into the bed and into the flowing wastewater. This type system is used to treat domestic wastewater after it has passed through a septic tank. It can also be used as the final step in the treatment of municipal wastewater.

WATER QUALITY BENEFITS

Constructed wetlands provide a very high level of treatment for the effluent from both animal waste lagoons and domestic septic tanks. Nevertheless, any discharge from the system, especially one used to treat lagoon effluent, must be contained and further treated, recycled, or applied to the land through an irrigation system.

In the heavy Prairie soils of central Alabama or in those areas where soils are shallow to bedrock, leach beds are generally ineffective at treating septic tank discharges. In these locations the constructed wetland provides a viable alternative to simply allowing septic tank effluent to discharge across the surface of the land or into a nearby stream.

When used to treat the effluent from animal waste lagoons, a constructed wetland reduces the amount of nutrients and water available and, thereby, reduces the amount of land required for final disposal.

The constructed wetland, when used as part of an integrated and properly managed waste management system, will help protect surface waters from fish kills and contamination by nutrients, organics, and pathogens.

PLANNING CONSIDERATIONS

Pretreatment of both domestic sewage and animal wastes are necessary prior to discharging to a constructed wetland. Pretreatment in a septic tank (domestic wastes) or in an animal waste lagoon allows for the settling of solids that would otherwise clog the wetland filter and possibly kill the plants. In addition, the effluent from animal waste lagoons often contains such high levels of ammonia that dilution of the effluent is required before being discharged to the wetland.

Provisions must be made to capture the effluent from a wetland used to treat animal wastes and to recycle it or apply it to the land through an irrigation system. (Note: The effluent may not be discharged to a stream without a permit.) Also, since the wetland vegetation removes large amounts of water from the system during the summer months, it may be necessary to release additional water to the cells during these months to ensure plants survival.

It is not necessary to remove or harvest vegetation from the wetlands. However, over an extended period of time (many years), a thick mat may build up that will require removal. It should be noted that, even in winter after the plants have died, treatment continues, although at a reduced level.

The constructed wetland is just one component of a waste management system. Therefore, the design and operational requirements of the constructed wetland should be included with those of the other components (lagoons, settling basin, etc.) in the waste management plan developed for the overall operation.

A well designed cattle crossing helps keep cattle out of the creek.

DESCRIPTION

Livestock exclusion involves limiting access to areas where livestock activity would cause problems such as erosion of streambanks, destruction of streamside vegetation, or degradation of water quality from manure deposits. Livestock exclusion protects sensitive areas such as streams and lakes by encouraging the use of other areas that have easier access.

In addition to using fences, other barriers can be used to make stream access difficult. These could include boulders, shrub thickets (especially willow), dense timber stands, or fallen trees.

WATER QUALITY BENEFITS

Livestock exclusion significantly reduces the amount of sediment and nutrients entering streams. In addition to these benefits, vegetation growing along streams in the excluded areas filters runoff from adjacent pasture. These areas may also provide shade to the stream, which cools the water and, thereby, increases its oxygen-carrying capacity. For these reasons natural **riparian** vegetation downslope of heavy use areas should be kept intact.

PLANNING CONSIDERATIONS

When planning a livestock exclusion system, an alternate water supply for livestock must be provided. If wells are used to supply water, they must be installed in accordance with state law to prevent contamination around the well. (See Livestock Watering Facilities.)

Because livestock exclusion limits livestock access to the cooler riparian areas, alternate shade often needs to be provided. The use of portable shade could be considered. If livestock are grazing on both sides of a stream, adequate stream crossings will also be needed.

Another consideration is that fencing has several negative impacts, including loss of forage and the need for maintenance.

If fencing along streams will be too expensive, the owner should consider providing shade, drinking water, salt and supplements away from the riparian zones to reduce the amount of time cattle spend near streams. In this case, fencing may not be needed.

Consideration may also be given to utilizing more heat tolerant breeds of cattle (i.e., those that will be less inclined to migrate to streams and riparian areas). In addition, the owner might also consider culling from the herd those individual animals that tend to remain for prolonged periods in or near streams.

Cattle obtain water from this water tank instead of a stream or pond.

DESCRIPTION

Livestock watering facilities are constructed or manufactured facilities used to provide water to livestock, thereby, reducing or eliminating the need for livestock to be in streams. A **trough** or **tank** is the principal component of most livestock watering facilities. Water supply for the facilities include **ponds**, **wells**, or **spring developments**.

WATER QUALITY BENEFITS

Livestock that drink in streams are a direct source of nutrient and bacterial pollution of water and often cause streambank erosion where they access the stream. These forms of water quality degradation can be eliminated by providing alternate watering facilities and fencing or excluding the livestock from the stream.

The quality of the water is significantly improved when cattle are excluded from a pond that has previously served as a watering point and they are forced to obtain their water from a trough or tank. Livestock consumption of cleaner water may also result in improved animal health.

PLANNING CONSIDERATIONS

The practice Livestock Exclusion should be considered since it plays a vital role in keeping livestock out of streams.

Wherever possible, more than one trough or tank should be used to distribute grazing in the pasture and, thereby, reduce soil erosion and minimize contamination around the watering point. A dry surface of gravel or concrete should be maintained around the trough. The watering facility should be located so that polluted runoff from the site does not enter nearby streams or sinkholes.

Wells that are used as a water supply must be constructed, operated, and maintained to prevent damage to the structure and contamination of the **aquifer**.

When polluted runoff leaves this open hog lot, it is captured in a lagoon and then land applied.

DESCRIPTION

Runoff management serves one or more of the following functions:

* prevents clean water from entering the farmstead, **feedlot**, or waste storage facility
* contains polluted runoff from a feedlot
* treats polluted runoff

Runoff management practices include:

Diversions to prevent clean water from flowing over a feedlot or into a waste storage pond.

Roof water collection to prevent roof water from entering the feedlot. This practice includes troughs, eaves, and rain gutters.

Sediment basins to separate solid manure from polluted runoff as it flows off a feedlot.

Waste storage ponds to temporarily store feedlot runoff water until it can be applied to the land.

Waste treatment lagoons to store and provide treatment of feedlot runoff water until it can be applied to land.

Vegetative filters to treat runoff from a feedlot by passing it over a sufficient area of vegetation.

WATER QUALITY BENEFITS

Runoff from any concentrated animal holding area will always carry some pollutants with it. The effect on water quality from this runoff will depend upon many factors, including number of animals and location of the site. It is always beneficial to control feedlot runoff, but the extent to which various practices are justified will depend on the potential or proven impact of the runoff on water quality.

Diversions and roof water collection direct clean water away from manure collection and storage areas. Without these practices, excessive water enters manure holding structures, reducing their storage capacity; thus, these structures are likely to overflow and contaminate surface waters.

Waste storage ponds and waste treatment lagoons provide effective control of feedlot runoff and other wastewater. The wastewater is stored until it can be applied to cropland in such a manner that surface waters will not be polluted. See the practices Waste Storage Pond and Waste Treatment Lagoons for additional water quality benefits.

Properly designed and maintained vegetative filters can provide effective treatment of feedlot runoff. When using a vegetative filter, it is important to use a settling basin to remove solids before the water flows over the filter.

PLANNING CONSIDERATIONS

Because diversions and roof water collection reduce the amount of water entering a waste storage or treatment facility, less pumping of wastewater is required. However, gutters and eaves require extra costs for installation. Some producers may want to capture as much water as possible for use as irrigation water for crops; however, in such cases, the size of the waste storage pond or lagoon must be increased accordingly.

Waste storage ponds and lagoons must be properly designed and sited to minimize the potential effects on ground water. Even the best sealed earthen ponds will have a certain amount of seepage. Biological sealing of soils has been found to occur in manure storage ponds and lagoons, but cannot be counted upon when runoff water with a low solids content is stored. It is important to use an effective clay or synthetic liner in storage ponds and lagoons to reduce seepage. A special geologic investigation may be required when these facilities are planned for an area having fractured limestone or sandstone aquifers. These areas are very susceptible to ground water contamination. Waste storage ponds and lagoons should generally be avoided in these areas.

Vegetative filter strips, while relatively inexpensive to install, require high maintenance. Filters must be graded and shaped so that water flows across it in a thin layer (sheet flow). If the flow becomes concentrated as channelized flow, the vegetative filter will be ineffective. Filter strips need to be fairly long and have shallow slopes. Some sites may not have suitable conditions for this practice.

Waste from this swine lagoon is agitated and then applied to the land as a fertilizer and soil amendment.

DESCRIPTION

This practice involves determining the volumes of manure, flush water and other contaminated water produced and the amount of nutrients generated; accounting for losses through the system up to and including final utilization on the land or off the farm; and designing a method for land application which is compatible with the volumes of waste and amount of nutrients ultimately available.

This practice includes the detailed engineering and agronomic activities related to land application and other final uses of waste byproducts. It may include design of a wastewater irrigation system and guidance on inches of wastewater to apply, or it may include calculations on the number of trips needed with a certain size liquid manure spreader. Feeding litter to cattle and transporting waste to a rendering plant must be considered in accounting for all the waste materials produced on the farm. The practice Nutrient Management is an integral part of waste utilization.

WATER QUALITY BENEFITS

The proper disposal of wastes (manure, compost, etc.) is essential to having a waste management system that is not only beneficial to the farm enterprise, but is also non-polluting. If the waste utilization component of the system is properly planned, all nutrients and any other potential pollutants will be properly used or rendered harmless.

The specific water quality benefits from proper utilization will include protection of surface waters from algae blooms; elimination of fecal organisms from surface and ground waters which could create public and animal health problems; and protection from dissolved oxygen problems due to waste organic matter entering a stream.

PLANNING CONSIDERATIONS

Although last in the sequence of activities related to waste management, waste utilization should be one of the first factors to consider in planning. The method of land application is dependent on such factors as topography, shape and size of fields, and distance between the treatment or storage area and utilization sites. The nutrient requirements of each crop at the application sites must be known to determine if acres needed for spreading wastes is adequate or if a different crop or different treatment method may be needed.

Details on waste utilization must be included in the overall waste management plan for the farm.

NUTRIENTS

Nutrients are food for crops. Excess amounts that enter surface waters can become pollutants that kill fish and other aquatic life. High levels of nitrogen and phosphorus can also create **algal blooms** and infestations of aquatic weeds. Excess nitrates in ground water can cause a deadly disease in infants which drink the water.

Nutrients are natural in the environment and necessary for all plant growth. Nutrients can come from a number of sources, including commercial fertilizers, animal wastes, decaying vegetation from a previous crop, atmospheric nitrogen transferred to the soil by certain plants and microorganisms, and precipitation.

This section discusses selected practices important in preventing nutrients from entering surface waters. Nutrient management is an essential part of animal waste management systems and should be considered in the overall waste management plan (see Animal Wastes). In addition, many sediment control practices also prevent movement of nutrients to surface waters.

This section includes the following practices used specifically for controlling nutrients:

Filter Strips

Nutrient Management

Riparian Forest Buffer

Wetland Development or Restoration

This grass strip filters sediment as well as pesticides and nutrients attached to soil particles.

DESCRIPTION

Filter strips are strips of grass or other close-growing vegetation that help to remove **sediment** or other pollutants from **runoff** or wastewater. The strips are normally planted in an area where water will pass over them as **sheet flow**. Flow should be shallow and uniform over the entire surface. The vegetation in the strip slows the water and traps solid materials. Filter strips used as a final treatment for agricultural wastewater are designed with sufficient size to trap and treat pollutants.

WATER QUALITY BENEFITS

Filter strips are moderately effective for trapping sediment and the attached pollutants. They are not effective at removing soluble **nutrients** or very fine suspended sediment. Vegetative filters that result in **concentrated flow** are much less effective than filters that maintain sheet flow.

When used to control runoff from feedlots, filter strips can be very effective for removing solids but only moderately effective for removing nutrients.

When properly designed, constructed, operated, and maintained, filter strips used as a final treatment for animal wastewater can be very effective in removing solids and nutrients.

PLANNING CONSIDERATIONS

A filter strip must be designed wide enough to trap sediment and pollutants as runoff passes over it. Filter strips used for treatment of animal wastewater must be wide enough to allow an acceptable level of treatment by the time the wastewater leaves the filter. The amount of water discharged to the filter may have to be manually controlled. In order for the filter strip to be effective, sheet flow must be maintained. This usually requires grading the filter strip area to ensure that water will flow across it uniformly.

Nutrients are applied according to soil test recommendations.

DESCRIPTION

Nutrient management involves carefully monitoring all aspects of soil fertility and making necessary adjustments so that crop needs are met while minimizing the loss of nutrients to surface or ground water. This includes management of all plant nutrients associated with animal manure, commercial fertilizer, **legume** crops, crop residues, and other **organic** wastes. Nutrient management provides the crop with the correct amount of nutrients at the best time and location possible so they are used efficiently. This limits the amount of plant nutrients lost to leaching and runoff.

Nutrient management is one of the more important practices. It can have tremendous benefits to water quality, it is relatively easy to implement, and it can increase profits.

WATER QUALITY BENEFITS

The effects of nutrients from agricultural land on water quality depend on how well nutrients are managed. Nitrogen in the nitrate form (NO_3) is a potential ground water contaminant. Animal manures and commercial fertilizer are significant sources of nitrates in ground water, as well as nitrates and phosphates in surface waters. Using proper rates, placement, and timing of manure and fertilizer applications can reduce nitrogen and phosphorus losses. Also, control of erosion and sediment will reduce loss of phosphorus which is tightly bound to soil particles.

Nutrient management is a very effective practice for preventing ground water contamination from nitrates. On sandy soils, the timing of nitrogen applications becomes a critical part of a nutrient management strategy to prevent **leaching** of nitrates to ground water. Proper timing of fertilizer applications in relation to storm events and seasons minimizes the amount of time that nutrients are available for loss to surface or ground water. This practice also helps match the nutrient needs of crops with nutrients available in animal wastes, thereby preventing excess fertilization and reducing the potential for water pollution.

PLANNING CONSIDERATIONS

There are four factors which should be considered in a good nutrient management program. The first three relate to optimizing crop production; the last addresses water quality protection. These are discussed below:

Residual soil nutrients. Soil tests are required to determine the amount of phosphorus, potassium and various minor nutrients already available in the soil and the liming requirements based on soil **pH**. Nutrient application rates should be based on the results of soil tests and the Auburn University Soil Test Recommendations for Alabama.

Nutrient needs of the crop(s). A particular crop will utilize nutrients at different rates depending on such factors as soil type, climatic factors, and whether or not the crop will be irrigated. An optimum yield goal should be determined for the crop based on these factors and nutrients applied to satisfy, but not exceed, that yield goal. The yield goal should be realistic for the soil type based on historical records and research findings.

Available nutrients. The nutrients available to crops include those identified by the soil test plus any residual nitrogen provided by animal manure applied in prior years and that provided by legumes and **green manure crops**. (Since nitrogen is not evaluated in the soil test, an estimate of nitrogen in the soil must be made based on a history of manure applications and previous crops grown.) Manure, litter, compost or wastewater that will be used should be analyzed for available nutrients prior to application. Animal wastes should be applied before commercial fertilizers are applied and the combined nutrient value of both should not exceed the requirements of the crop.

Water quality protection. The forms of fertilizer, timing and method of application, and placement should be adjusted to conform to seasonal variations in the uptake of nutrients by specific crops. Split applications of nitrogen are usually recommended for crops such as corn or cotton. A single application may result in some of the nitrogen being leached to the ground water; this also means less available for crop use. Nitrogen leaching is a major concern on sandy soils.

A grass cover crop such as ryegrass can be used to take up excess nutrients, thus preventing their movement out of the root zone during the cool season when major crops are not grown. Also, cover crops can be used as residue crops for conservation tillage. The nutrients returned to the soil by the residue crops need to be considered in determining proper application rates of commercial fertilizers and animal waste for subsequent crops.

Erosion control and water management practices should be considered in nutrient management planning. Since nutrients can be carried off the land attached to eroded soil particles or dissolved in runoff waters, practices which intercept sediment and slow the movement of water should be considered. Vegetated filter strips and forested riparian zones remove sediment-attached nutrients from runoff waters. In addition, a forest riparian area slows the movement of water and may be helpful in **denitrification** of any nitrogen that infiltrates the soil and then moves toward a stream as subsurface flow.

A natural forested buffer next to a stream can effectively remove sediment and other pollutants.

DESCRIPTION

A **riparian** forest buffer is an area of trees and other vegetation located adjacent to and up-gradient from water courses, water bodies and associated wetlands.

WATER QUALITY BENEFITS

Riparian forest buffers, when properly established and managed, can improve surface water quality by preventing streambank erosion, removing **sediment**, absorbing and adsorbing **nutrients** and **pesticides**, allowing better nutrient uptake, and promoting **denitrification**. Riparian forest buffers provide shade which optimizes light and temperature conditions for many desirable **aquatic** plants and animals. Energy is provided for aquatic life in the form of leaves and twigs.

PLANNING CONSIDERATIONS

Consider the type and quantity of potential pollutants that will be derived from the drainage area. Select tree and plant species that are adapted to the soils and are able to provide other benefits such as commercial timber production, forage production, and wildlife habitat improvement. Avoid planting any plants which may become pests. Riparian forest buffers must be wide enough to filter sediment from surface runoff.

This practice should be used in conjunction with practices such as nutrient management and certain sediment control practices to prevent damage to the riparian vegetation and ensure safe transport of water through this area. Without the proper use of other practices the impacts could be high maintenance costs, periodic need to re-establish vegetation, and the delivery of excess nutrients, sediment and other potential pollutants through the buffer by concentrated flows.

Wetlands provide excellent habitat for wildlife and also provide high levels of treatment for polluted runoff.

DESCRIPTION

Wetland development or **restoration** involves either creating an **artificial wetland** or returning a **converted wetland** to its former condition. These practices are usually accomplished by constructing a dike and/or a water control structure. The establishment of plant species on the site is usually dependent upon the goals of the land user. Additional improvements to the site will vary depending upon the particular needs of the land user.

WATER QUALITY BENEFITS

By the very nature of their place in the landscape and their unique ability to perform biological uptake and chemical transformations, wetlands provide valuable water quality protection for downstream creeks, rivers, lakes and estuaries. Untreated runoff from urban areas, agricultural land and other sources is a leading cause of water quality impairment. Wetlands trap soil particles and attached pollutants associated with upstream runoff. During the growing season certain nutrients and pesticides are removed from runoff.

PLANNING CONSIDERATIONS

It is preferable to control erosion and prevent the loss of sediment, nutrients, and other pollutants prior to development or restoration of a wetland. This can usually be accomplished with various practices discussed in this handbook. If pollutants cannot be controlled at the source, forested riparian areas and vegetated filter strips may be needed upstream of the wetland.

Due to the fact that wetlands have a natural function of water quality improvement, there is much interest in their use to treat runoff from agricultural and urban sources. Any decision on the routing of runoff into natural or constructed wetlands should be carefully evaluated. In natural or restored systems, the natural functions and values should be protected. In constructed systems design and plant selection are vital for the site to perform as planned. In addition, monitoring should be a part of any plan.

There are laws and regulations that govern what impacts are acceptable in natural wetlands. All local, state and federal laws and regulations should be complied with prior to implementation of any plan that may impact wetlands.

Wetland development and restoration can provide a beneficial use for what is often considered marginal land. Habitat for many species of game and non-game wildlife can be improved or created depending upon the method of water level control and the plants which are established.

PESTICIDES

Pesticides kill or inhibit the growth and reproduction of targeted pests. Some pesticides are potentially hazardous to humans and other animals. Therefore, it is vitally important that farmers who use pesticides understand the importance of proper pesticide use and the alternatives that are available for pest control. Such an understanding will not only help protect water quality but may also help protect livestock and human lives.

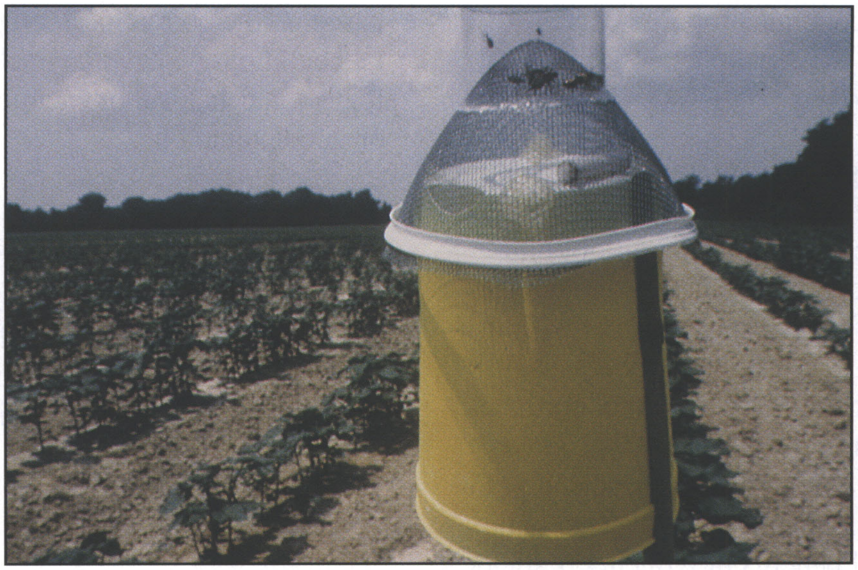
The practices in this section are few in number but broad in scope. They will allow the reader to become familiar with the important aspects of pesticide management. However, anyone interested in using pesticides should seek more detailed information from specialists trained in the field of pesticide management. Farmers interested in obtaining additional information should contact their local agent of the Alabama Cooperative Extension Service.

The practices for controlling pesticide pollution discussed in this section include the following:

Integrated Pest Management

Proper Pesticide Use

Sinkhole Protection



A pest trap provides essential information on pest densities in an IPM program.

DESCRIPTION

Integrated Pest Management (IPM) is a management approach that encourages natural control of pest populations by anticipating problems and preventing pests from reaching economically damaging levels. Important crop pests normally fall in the following categories: insects (and mites), diseases (fungi, bacteria and virus), nematodes and weeds.

All appropriate techniques are used with IPM, such as enhancing natural enemies, using cultural practices to minimize pest outbreaks, maintaining plant vigor by proper fertilization and irrigation, planting pest-resistant crops and using **pesticides** judiciously to minimize health and environmental risks.

IPM programs focus on making management decisions based on current knowledge of the pest species present, pest density and damage, and other crop and environmental conditions that may affect pest management decision-making. Pest and crop information are obtained by regular (at least weekly) monitoring of crops, and this knowledge is used to identify the best control options for the existing combination of pest(s) and growing conditions. An IPM program frees the producer from having to apply pesticides on a calendar basis, which can result in a wasteful and possibly harmful use of pesticides. In addition, frequent use of pesticides can sometimes result in increased pest problems because of the elimination of natural enemies or the development of super-resistant pests. Because the application of pesticides can disrupt natural systems (i.e., natural enemy populations), pesticides are used only when it is anticipated that alternative IPM practices cannot prevent economic damage to the crop. In IPM programs, decisions to apply pesticides are based on the concept of economic threshold levels, which are the levels of pest or pest damage that can be tolerated before economic crop loss occurs.

WATER QUALITY BENEFITS

Use of IPM strategies can minimize the quantity of upesticides that are applied to agricultural land, helping to reduce the potential for pollution of surface and ground water. Although it is difficult to quantify water quality benefits from IPM, it is generally assumed that reductions in pesticide contamination of water is proportional to the reduction in use. However, this can vary depending on site conditions, soil type and pesticide characteristics. In any case, the economic and environmental benefits of reducing pesticide use can be substantial.

PLANNING CONSIDERATIONS

The use of IPM requires additional effort compared with a calendar-based pesticide program, but the economic, environmental and health safety advantages of using IPM will more than compensate for the extra effort. Much of the planning for IPM is done before the crop is planted. For example, selection of pest-resistant cultivars, choosing a planting site least likely to have pest problems, scheduling planting and harvesting dates to minimize pest problems, and designing efficient fertilization and irrigation programs to maintain plant health are all IPM strategies that should be planned before the crop is planted. Another consideration in adopting IPM will be the development of a regular crop monitoring program to identify pests and natural enemies. Keeping records of pest numbers is helpful to determine when pests are increasing and to predict periods when specific pests may cause problems. Once a pest problem is identified, specific post-planting IPM strategies(s) are selected based on the current pest, crop, and environmental conditions. They may include cultural, biological, mechanical or chemical controls singly, or in combination.

IPM methods include cultural, biological, and chemical controls. None of these alone can solve all problems, and each has benefits and drawbacks. The purpose of IPM is to help farmers make decisions based on careful consideration of costs, risks, and benefits.

Cultural control

Cultural controls are used to make the crop habitat less suitable for pests. They may need to be planned or implemented before the crop is planted, and selection of specific cultural controls depends on some knowledge of pest biology and development. The following are some examples:

Crop rotation can be used to manage diseases, weeds and insects that overwinter in the soil. Crop rotation works best against diseases and insects that have a narrow host range and that do not have a quiescent stage able to survive in the soil for many years. Non-related crops are normally used in a crop rotation scheme; for example peanuts are rotated with corn or cotton for control of while mold. Another example is the rotation of potatoes with corn for management of Colorado potato beetle.

Trap crop borders can be used to attract insect pests where they can be destroyed before they move into the main crop. For example, soybean borders are planted adjacent to potato fields to attract virus-carrying aphids where they slough off virus particles by probing before they move into the potato crop.

Tillage buries crop residues containing insects, diseases, and weed seeds, and disrupts the root systems of perennial weeds. A disadvantage of tillage is increased soil erosion.

Resistant crop varieties have characteristics bred in them that make them more tolerant of diseases or insect attack. New varieties are continually being developed to keep pace with new pest strains that may arise.

Sound agronomic practices that promote vigorous crop growth increase the crop's ability to withstand pests. This is analogous to recommending a proper diet for prevention of human disease.

Biological Control

There are several categories of biological control, but the preservation or encouragement of naturally-occurring, beneficial organisms is the one effective biological control method that all producers can implement. Examples include reducing the frequency or rate of insecticides or using "soft" insecticides to preserve natural enemies (i.e., parasites and predators) of insect pests, and the planting of legume cover crops or other flowering plants that attract natural enemies within or adjacent to the crop. The practice of introducing a natural enemy into an area for control of a specific pest is an example of "classic" biological control. Many commercial insectaries are in the business of producing natural enemies for sale to producers.

The use of synthesized insect sex pheromones as a mating disruption technique is sometimes considered a biological control, and commercial mating disruptants are available for several different moth pest species. Biological or botanical insecticides are also considered biological controls, and are not harmful to natural enemies. Examples are the *Bacillus thuringiensis* (Bt) materials that, depending on formulation, are used for control of caterpillars, Colorado potato beetle and mosquito larvae, and the neem-based products that are derived from plant extracts and that control a wide range of crop pests.

A new biological control area is the use of nonpathogenic fungi and bacteria for control of soilborne and foliar crop diseases. While biological controls are safer to humans, beneficial species and the environment, they have the disadvantage of controlling a narrow spectrum of pests, and their effectiveness is more dependent upon satisfactory environmental conditions than are synthetic pesticides.

Chemical Control

IPM seeks to restore a balance between the crop and the natural environment; therefore, pesticides are used only when necessary. However, many crops, particularly those grown in the south, are susceptible to pest attack, and use of pesticides will sometimes be necessary to protect the crop. The use of pesticides involves a tradeoff between pest control and the risks of adverse effects on nontarget organisms including natural enemies, pollinators, wildlife, and plants. Pesticides also pose safety hazards to applicators and farmworkers and to those working in production, transportation, and storage. Another risk associated with pesticides is contamination of food and water supplies. But careful selection and use of pesticides can minimize these risks.

Pesticides should be chosen based on the specific pest(s) to be controlled. Always read the pesticide label and calculate the amount of product needed; don't apply more than is recommended. The low recommended rate may be as effective as the high rate at half the cost. Follow the harvest or re-entry interval restrictions and maximum use restrictions to avoid illegal residues on crops. Spray equipment should be checked and calibrated regularly to ensure proper spray coverage. When selecting a pesticide, consider the characteristics that can affect water quality. These characteristics are discussed in the section on Agricultural Pollution.

Alabama Cooperative Extension Service (ACES) agents and specialists can provide detailed information on IPM and can assist with pest identification and development of a monitoring program.

See related topics on labelling, safety, storage and handling under Agricultural Pollution, Proper Pesticide Use, and Farmstead Pollution.

PROPER PESTICIDE USE

Pesticide application equipment must be calibrated properly and in a safe manner.

DESCRIPTION

Proper **pesticide** use involves practices that are needed to manage pesticides in a manner that makes efficient use of chemicals and prevents contamination of surface water and ground water. It includes the safe handling, mixing, application, storage, and disposal of pesticides and pesticide containers.

WATER QUALITY BENEFITS

Damage to surface and ground water quality can be significant if improper application, disposal, or spillage of agricultural chemicals occurs. Because of the large variation in soils and pesticide characteristics, the water quality benefits resulting from proper pesticide use cannot be easily quantified. Nevertheless, these benefits can be significant.

PLANNING CONSIDERATIONS

Prior to selecting any pesticide, the farmer should first determine whether an integrated pest management (IPM) program can be utilized which will reduce or possibly eliminate the need for chemical pesticides. If pesticides must be used, consideration should be given to low toxicity, non-leaching products.

Where the decision had been made to use chemical pesticides, the following considerations should be used for handling, applying, and disposing of pesticides and pesticide containers.

Mix Pesticides and Calibrate Equipment Accurately - Use the lowest rate of pesticide possible within label directions to achieve the necessary level of pest control. Using too much will increase the chance of excess pesticides leaching to ground water or polluting surface waters.

Excess pesticides can also cause crop damage and increase the cost of pest control. When mixing pesticides, be sure that the proper concentration is prepared to obtain the desired application rate per acre. Calibrate spray equipment carefully to achieve uniform distribution and rate. Recheck the calibration often to make certain that the rate has not changed.

Prevent Back-Siphoning - Back siphoning allows a fluid with a water surface at one elevation to be drawn through a tube or pipeline to a point at a lower elevation. If pesticides are involved, the unintended result could be contamination of wells, household water lines or other uncontaminated water sources.

When filling tanks, be sure to keep the hose above the water level in the tank at all times. Anti-backflow devices are inexpensive and should be used. The best way to prevent back-siphoning is to fill only water at the well site and mix and add chemicals to the tank when in the field.

Proper Disposal of Pesticide Containers and Unwanted Pesticides - Disposal of excess pesticides and pesticide containers can be a problem. They should be returned to the manufacturer whenever possible. Federal and state laws require that you use certain methods when disposing of specific pesticides. Some pesticides may be specifically identified as hazardous wastes by law and must be handled and disposed of in accordance with hazardous materials regulations.

Pesticide containers should be properly rinsed and recycled. Rinsing should take place immediately after the container is emptied into the sprayer, since some pesticides solidify quickly and can become difficult to remove later. Either triple rinsing or pressure rinsing can be used.

Triple rinsing.

* Empty container into sprayer tank and let drain for 30 seconds.

* Fill container 10% to 20% full of water or rinse solution.

* Secure lid on the container.

* Swirl the container to rinse all inside surfaces.

* Remove lid from the container. Add the rinsate to the sprayer tank and let drain 30 seconds.

* Refill container with rinsate as before, cap container, swirl and drain; then repeat once again.

Pressure rinsing. This process forces remaining pesticides from containers by using a special nozzle attached to a hose. Details of the process and names of manufacturers and suppliers of pressure nozzles can be obtained from your local Extension Service agent.

After proper rinsing, the clean containers should be stored out of the rain until they can be transported to a recycling point. Containers should never be burned and they should never be deposited in or near streams, in gullies, or in sinkholes; they should be recycled.

Occasionally, unwanted pesticides can be taken to a collection point during a Pesticide Amnesty Day. These special days are typically in counties or watersheds having a high potential for water quality problems. Amnesty Days are not offered on a regular basis because of the cost involved to the cooperating agencies. However, when they are provided, they are well advertised in advance.

Additional information on the disposal of pesticides and containers can be obtained from your local office of the Alabama Cooperative Extension Service; the Alabama Department of Pubic Health; or the Alabama Department of Agriculture and Industries, Plant Protection and Pesticide Management Division.

Prevent Spills - Agricultural chemicals that are spilled can contaminate surface waters or ground water through runoff or leaching associated with rainfall. Spills near wells or sinkholes or in areas with sandy soils or shallow water tables have a very high probability of contaminating ground water. Do not mix chemicals near a well since even small spills near a well can contaminate well water. Be sure that all valves are properly closed and that all pipes and fittings do not leak. Even a small leak can create a significant concentration of chemicals in one location.

If a spill does occur, it must be properly treated. A summary of actions for handling a minor spill are:

* Act quickly. Keep people away from the area.

* If the pesticide was spilled on anyone, give the correct first aid.

* Confine the spill. Keep it from spreading.

* Clean up the spill. Use an absorbent material to soak up the spill. Shovel all contaminated material into a leak-proof container. Dispose of material as you would excess pesticides. Do not hose down the area, for this spreads the chemical. The chemical action of some materials may be stopped by applying common household products. If you are not sure what to use, call the chemical manufacturer.

When major spills occur, the cleanup job may be too big for you to handle or you may not be sure of what to do. In either case, keep people away, give first aid if needed, and confine the spill. Then call the manufacturer for help. The National Agricultural Chemicals Association has a Pesticide Safety Team Network. They can tell you what to do. Or, they can send a safety team to clean up the spill. They can be called toll-free any time at (800) 424-9300.

When a spill occurs on a road call the highway patrol, sheriff, or city police as appropriate. If water is contaminated by the spill, notify the Alabama Department of Public Health, Alabama Department of Environmental Management, and the Alabama Department of Conservation and Natural Resources.

Storage of Pesticides - The pesticide storage area should be a cool, dry, well-ventilated, and well-lighted room or building that is insulated to prevent freezing or overheating. The area should be fireproof, with a cement floor. Keep the area locked to prevent entry by children and other unauthorized persons and post warning signs on doors and windows.

The storage building or area should be located away from where people and animals live. This will avoid or minimize harm to them in case of fire or flooding. The area should be supplied with detergent, hand cleaner, and water; absorbent materials, such as absorbent clay, sawdust, and paper to soak up spill; a shovel, broom, and dustpan; and a fire extinguisher rated for ABC fires.

Store all pesticides in their original containers. Do not store them near food, feed, seed, or animals. Store paper containers off the floor. Check every container for leaks or breaks. If one is leaking, transfer the contents to a container that has held exactly the same pesticide. If one is not available, use a clean container of similar construction and label it correctly. Clean up any spills. Keep an up-to-date inventory of the pesticides.

Pesticide Safety - Use precaution when handling, storing, or applying pesticides. Some pesticides are so highly toxic that accidental exposure to them without proper protection can sicken or kill humans. Other pesticides are much less toxic and large exposures to these poisons would be necessary to cause illness. Even slightly toxic pesticides can irritate the nose, throat, eyes, and skin of some people. You must protect yourself, your workers, and other persons from harmful exposure to any pesticide being used on your farm.

Pesticide labels give instructions on how to use the product. Also information on environmental hazards, protective clothing, reentry, storage and disposal, precautionary statements, and misuse statements are on the label. **Pesticides must be used according to the instructions on the product label.**

All farmers who use pesticides should be familiar with additional worker protection guidelines and standards provided by the Alabama Cooperative Extension Service and the Alabama Department of Agriculture and Industries, Plant Protection and Management Division.

For additional information and discussions on pesticide labelling and safety see Pesticide Mixing Center under Farmstead Pollution and the discussion on pesticides under Agricultural Pollution. Also see Integrated Pest Management.

SINKHOLE PROTECTION

A sinkhole is a direct link between the land surface and ground water.

DESCRIPTION

Sinkholes that connect the surface to ground water are common in the **karst** regions of Alabama. Pollutants such as nutrients, pesticides, and manure that enter a sinkhole are directly transmitted to ground water.

Sinkhole protection involves practices that prevent pollutants from entering a sinkhole. Some of these practices include sealing the sinkhole, diversions, and filter strips. The use of fences and signs may also be needed to prevent people from disposing of trash or empty pesticide containers in sinkholes.

WATER QUALITY BENEFITS

Sealing sinkholes plugs the direct conduit to the ground water, preventing contamination. Diverting runoff away from a sinkhole can also provide effective protection. Filter strips can provide some treatment of runoff before it enters a sinkhole; however, filter strips are most effective for coarse sediment and will not remove fine sediment or soluble nutrients and pesticides.

Disposing of trash and other materials in sinkholes can allow high concentrations of pollutants to contaminate the ground water.

Although sinkhole protection is intended to protect ground water, it can also provide benefits to surface waters that are fed by ground water.

PLANNING CONSIDERATIONS

Sealing a sinkhole can be expensive and difficult. Sealing may be only temporarily effective if another sinkhole opens up nearby.

Diverting runoff should be considered before sealing a sinkhole. Diversions are usually the least cost alternative. If a sinkhole is located on sloping ground, diverting runoff away from it may be the most feasible treatment. This will prevent almost all surface water from entering the sinkhole. Topography limitations may prevent the use of this practice at some locations.

Use of filter strips to prevent pollutants from entering a sinkhole is the least effective method of treatment. However, they do discourage direct land application of nutrients and pesticides into the sinkhole. Filter strips work best when treating shallow, uniform flow. Concentrated flows will allow most pollutants to pass through a filter strip.

SEDIMENT

Sediment is the most abundant and widespread of all the agricultural pollutants. It enters surface waters primarily from areas unprotected by erosion from water.

The practices used to prevent the loss of soil may involve vegetative practices, structural measures, or management activities; however, a combination of these is usually required. The physical methods of control include (1) protection of the soil from being dislodged by the impact of raindrops or by the movement of water across the land and (2) a combination of structural and vegetative practices which capture soil particles after they have dislodged and begun to move offsite. All vegetative and structural practices must be properly managed after installation to ensure effective, long-term control of sediment and the protection of water quality.

The sediment control practices discussed in this section and listed below are the principle ones used in Alabama:

Conservation Tillage

Contour Farming

Cover Crop

Crop Residue Management

Crop Rotation

Critical Area Protection

Diversion

Field Border

Grade Stabilization Structure

Grassed Waterway

Irrigation Water Management

Pasture & Hayland Establishment

Pasture and Hayland Management

Streambank Protection

Stripcropping

Terrace

Water and Sediment Control Basin

Soil in this field is protected from erosion by the residue of a cover crop.

DESCRIPTION

Conservation tillage is any planting method that leaves at least 30 percent of the soil surface covered with crop residue after planting. The soil is tilled only to the extent needed to prepare a seedbed, incorporate chemicals, control weeds, and plant the crop. Equipment manufacturers have provided an ever-increasing selection of planters, row cleaners, tillage equipment, and other implements designed to operate in residues as the popularity of conservation tillage has grown. Equipment designed to incorporate fertilizer and pesticides into the soil and to control weeds and leave the residues in place is available.

Planting conservation tillage crops may involve tilling the entire field surface or only strips where the crops are planted. Complete field tillage systems involve the use of equipment such as chisel plows, discs, and field cultivators to prepare the entire surface of the field while maintaining the desired level of residue. This type of conservation tillage is known as "mulch tillage."

Strip tillage is usually combined with planting and, as the name implies, only a strip is tilled. The strategy is to provide a favorable seedbed in a strip. The residues which are retained in the middle of the rows are effective for reducing erosion and evaporation losses and for suppressing weed growth. The width of the strip can vary from 2 to 12 inches. Narrow strip tillage is usually referred to as "no-till" while the wider strips are know as "strip tillage."

WATER QUALITY BENEFITS

Conservation tillage can be very effective in reducing soil erosion, depending on the amount of residue cover retained on the soil surface. The residues intercept raindrops, thus preventing the detachment of soil particles which is the first step in the erosion process. Because conservation tillage is effective in controlling soil erosion, it helps reduce losses of nutrients and pesticides that are attached to soil particles. The efficiency of conservation tillage for control of these potential pollutants when attached to soil is approximately proportional to the reductions in soil erosion. Reductions in soluble nutrients and pesticide pollution will be highly dependent upon the nutrient and pesticide management practices used with conservation tillage. It is extremely important that fertilizer be incorporated into the soil so that it is not readily available for loss with runoff. Without fertilizer incorporation, conservation tillage may increase the amount of certain nutrients in runoff.

There is a great deal of controversy about the use of conservation tillage and its effect on ground water. Critics cite increased infiltration and greater use of pesticides compared with conventional tillage as a source of ground water pollution. Researchers looking at this issue are finding that the answers are much more complicated than this simplified conclusion would suggest. More herbicides are usually required when a farmer first begins a conservation tillage system. After the system is in place and weeds are under control, use of herbicides is usually reduced since weed seed are no longer brought near the surface by plowing.

The effect of conservation tillage on pesticide leaching is highly dependent on site-specific conditions and pesticide characteristics. In all cases, the use of integrated pest management and proper pesticide use practices will reduce or eliminate leaching to ground water.

The effect of conservation tillage on the leaching of nitrates to ground water will depend on a number of factors. Careful nutrient management is critical for preventing nitrogen movement to ground water. Situations where more nitrogen is applied than can be utilized by the crop will result in increased nitrogen leaching if infiltration is increased by conservation tillage. Therefore, nutrient management must be used in conjunction with conservation tillage on such sites.

Research points out the importance of soil characteristics and climatic conditions. Some studies have found much less leaching in no-till compared to conventional tillage, while other studies found the opposite. The differing results have been attributed to the difference in soil types in the studies. Differences in climatic conditions may also affect leaching. More water may move through the soil in areas of higher rainfall, increasing the potential for leaching of nutrients and pesticides.

PLANNING CONSIDERATIONS

Conservation tillage has the advantage of saving time, labor, fuel, and moisture in addition to controlling erosion. However, a higher level of management may be needed on the part of the farmer to deal with new challenges that result from farming with higher levels of crop residue.

When selecting a conservation tillage system, factors such as crop sequence, pest problems, climate, soil texture and drainage must be considered. Under heavy residue conditions, well drained soils are generally better suited to conservation tillage than poorly drained soils. If high levels of residue are left on poorly drained soils, soil warming and drying can be delayed in the spring, thus delaying planting. In addition to delaying field operations, these conditions can reduce nutrient availability and slow the early growth of plants. Also, when residues are left on the soil surface with conservation tillage systems, they can reduce evaporation, thus making more water available for crop use.

Ridge tillage can overcome some of the drawbacks of conservation tillage on poorly drained soils by planting crops on a ridge. The ridge will warm and dry faster, thus creating a favorable condition for germination and early plant growth. Ridge tillage can reduce the use of herbicides by applying them in banks within the row. In addition, weeds are cultivated with a special cultivator which retains the residues on the surface.

The furrows follow the contours of the land and carry rainfall to a grassed waterway at the edge of the field.

DESCRIPTION

Contour farming is farming sloping land in such a way that preparing the land, planting, and cultivating the crop results in a series of furrows and/or ridges which are "on the level" or contour. **Runoff** water which would normally flow down the slopes of the land will be redirected so that it flows along these furrows or ridges to an outlet or grassed waterway. These ridges and/or furrows are gently sloping in the direction of the outlet, thereby reducing the velocity of water moving off the land. This slower moving water has less potential to dislodge and transport soil particles. Also, infiltration of runoff will be increased because water is retained on the field longer.

Contour farming must be used in conjunction with water disposal practices such as terraces, diversions, buffer strips, or grassed waterways. Without these supporting practices, the furrows will fill with water and break at some point, resulting in increased concentrated flow erosion and ephemeral gullies.

WATER QUALITY BENEFITS

Contour farming can be very effective in controlling sheet and rill erosion, especially on terraced fields. It reduces the amount of sediment, as well as pesticides and nutrients attached to it, that enter surface waters. Contour farming which is supported by water disposal systems can reduce sheet and rill erosion rates by 50 percent or more.

PLANNING CONSIDERATIONS

Contour farming is most suitable on uniformly sloping fields with parallel terraces or diversions. Fields with undulating topography in which the slopes break in many different directions are not practical for terracing and contour farming. Likewise fields with terrace systems which are not parallel are not suited to contour farming with larger multi-row equipment. Where odd intervals are formed in a field by terrace patterns, correction strips of close growing vegetation can be used to eliminate **point rows**.

Other practices such as conservation tillage, nutrient management, and pesticide management should also be considered to reduce potential pollution.

This clover field provides excellent protection from erosion until the next crop is planted.

DESCRIPTION

A cover crop includes close-growing grasses, **legumes**, or small grains grown primarily for temporary, seasonal soil protection and improvement. Cover crops add organic matter to the soil. This will improve soil **tilth** and structure which can have long-term crop production benefits. When legumes are used as a cover crop, they add nitrogen to the soil which can be used by subsequent crops. A crop of crimson clover, for example, can provide at least 90 lbs of nitrogen per acre to the following crop. A cover crop is often used to provide **crop residue** for a conservation tillage cropping system.

WATER QUALITY BENEFITS

Cover crops can reduce erosion during periods of the year when the major crop does not provide adequate residue cover or its residue is harvested or utilized as forage. Thus, the cover crop provides protection from the impact of raindrops which would otherwise dislodge soil particles, and it also slows the movement of water across the land. By reducing erosion, pollution from sediment, suspended solids, nutrients, and pesticides is limited.

Actively growing cover crops will utilize available nutrients in the soil, especially nitrogen, thus preventing or decreasing **leaching** or loss in runoff water. These nutrients may then become available to the following crop as the cover crop decays.

Cover crops increase transpiration and may reduce runoff and increase infiltration of water; however, plant transpiration may lower soil moisture levels, thus reducing percolation.

PLANNING CONSIDERATIONS

The grasses and/or legumes selected should provide a quick cover so as to provide greater erosion protection. Also, the plant species chosen should be well suited to the soil-site conditions and should fit well in the overall crop management system. Cover crops should be planted as soon as possible after harvest or removal of the residue of the primary crop. If cover crops are overgrazed, their effectiveness is reduced.

CROP RESIDUE MANAGEMENT

Residue from a corn crop is left on the field surface to protect soil from the impact of rain drops and runoff.

DESCRIPTION

This practice involves managing plant residues left after harvest to protect cropped fields from erosion during periods when the soil surface would be bare. Leaving **crop residue**, such as corn stalks, on the soil surface is a very cost effective management practice.

WATER QUALITY BENEFITS

Managing crop residue by retaining it on the surface can be a very effective practice to reduce soil erosion, decrease runoff, conserve soil moisture, increase infiltration, and improve soil **tilth** with increased organic matter. Crop residues intercept raindrops, thus reducing soil detachment, dispersion, and compaction. Erosion is reduced and the delivery of sediment and associated pollutants such as nutrients and pesticides to surface waters is reduced.

Managing crop residues can promote soil **aggregation** and improve soil tilth, thus reducing soil sealing, crusting, and compaction. This will allow more water to infiltrate, but the increase in soil organic matter slows the movement of nutrients and certain pesticides from the soil surface to ground water. Both nutrients and many pesticides are tightly bound by the organic matter in the soil.

PLANNING CONSIDERATIONS

The time to start planning crop residue management is during selection of crops, crop varieties, plant populations, and row width. Some crops produce more residue than others, some crop residues will persist longer than others, and some will tend to float or blow away more easily than others. In addition, specific crops can be managed to produce more residue by increasing seeding rates, adjusting row widths, or selecting specific varieties.

The time to start managing crop residues is at harvest. The optimum goal for water quality benefits is to leave a protective layer of crop residue evenly spread over the field. To do this it may be necessary to have a spreader attachment on the combine that will distribute residues evenly. On other crops such as cotton, the stalks should be shredded after harvest.

Residues of crops such as soybeans, peanuts, and some vegetables are fragile, and any tillage results in quicker deterioration and lower residue levels. Corn and small grain residues are more persistent and are considered to be non-fragile since they do not decompose very quickly. Some crops, such as potatoes, do not produce adequate residues for erosion protection and will need a cover crop planted after harvest.

Crops can be planted directly into the residue using conservation tillage, an important associated practice. This allows for considerably more protection from erosion since a fallow seedbed is not prepared.

Crop residues should not be burned, but retained on the soil surface as mulch until time to plant the next crop. Residues may then be used as mulch for no-till planting of crops or be incorporated into the soil during seedbed preparation.

A good crop rotation can be used not only for erosion control but also for pest management.

DESCRIPTION

Crop rotation is a planned sequence of growing different annual or perennial crops in the same field. Rotations are the opposite of continuous cropping, which is growing the same crop in the same field year after year. Crop rotations can be used to improve or maintain good physical, chemical, and biological conditions of the soil. They can be used to reduce the average rate of erosion from a field. Including a grass or **legume** in a rotation can be very effective for reducing erosion and improving soil structure. When a legume is used in the rotation, it may eliminate the need for nitrogen fertilizer. In addition crop rotation can be an important part of an integrated pest management (IPM) program.

WATER QUALITY BENEFITS

Surface water quality can be improved by reducing sediment loss, and losses of dissolved and sediment-attached nutrients and pesticides.

Nitrogen losses to ground water can be reduced by deep rooted sod crops which may use nutrients from deep in the soil profile. In addition, legume crops fix atmospheric nitrogen which can reduce or eliminate the need for commercial nitrogen fertilizer for the subsequent crops. Crop rotations also tend to encourage healthy root systems which are effective at retrieving nutrients from the soil, thus minimizing leaching to ground water.

Crop rotations can disrupt the build-up of insect populations and disease life cycles, and, to a certain extent, weeds. Thus, a diverse cropping system can reduce the applications of chemical pesticides and the associated risk to water quality. In addition, increases in soil organic matter increase the absorptive capacity of the soil, which can reduce the potential for pesticide leaching.

PLANNING CONSIDERATIONS

Conservation tillage should be considered for growing crops in rotation. This can further reduce soil erosion and sediment losses. Also, close grown crops in the rotation may be good mulch crops for conservation tillage.

When legumes are used in a crop rotation, the nitrogen formed by fixation should be taken into account when determining the nutrients needed for future crops, thus preventing over application of nitrogen. Soil fertility levels should be regularly monitored and fertility maintained within the acceptable range for all crops in the rotation.

CRITICAL AREA PROTECTION

Highly erodible land may be protected with a variety of practices.

DESCRIPTION

Critical area protection is used to establish and/or maintain permanent vegetation on areas producing or having the potential to contribute large amounts of sediment offsite and for which conventional erosion control measures are unsuitable. This practice also discourages conversion of environmentally sensitive areas.

Examples of such areas are steep slopes in crop fields or pastures; bare areas around newly built ponds, lagoons or other construction sites; gullied areas; areas of surface mining; and cuts and fills along roads or similar sites where vegetation is difficult to establish by usual planting methods.

WATER QUALITY BENEFITS

Establishment of permanent vegetation on highly erodible areas will greatly reduce sediment and sediment related pollutants delivered to surface waters. Permanent vegetative cover can reduce soil loss by up to 95 percent or more. Also, uptake of nutrients by the established vegetation can reduce the amounts entering surface or ground water.

When vegetation is well established on large eroding areas, such as mined areas, there can be a reduction of surface runoff. The increased infiltration and percolation may increase pollutants moving into the ground water. With time, however, organic matter will begin to accumulate on the soil surface and in the upper layers of the soil. Many pollutants are tightly bound by organic matter in the soil; thus, movement of material into the ground water may be reduced over time.

PLANNING CONSIDERATIONS

Consider the type and quantity of potential pollutants that are contributed from the area to be treated. The selection of the specific plant species for stabilizing critical eroding areas is essential to success. These may include grasses, **forbs**, shrubs, trees, or a mixture of species. Factors that should be considered in plant selection are type of soils, climate, planned use and maintenance of the area, establishment rate, adaptation, fertility requirements, planting method, and time of year. The needs and desires of the land user must also be considered.

Use of topsoil, mulching or erosion control blankets, and irrigation will usually be needed to establish vegetation on harsh, eroded areas. Proper soil **pH** and fertilization are essential for success. Restriction of traffic and/or grazing is necessary until vegetation is well established. Maintenance will be needed to prevent deterioration of vegetation.

DIVERSION

A diversion intercepts storm water and carries it across slope to a safe disposal area.

DESCRIPTION

A diversion is an earthen channel with a supporting ridge constructed across a slope to collect **runoff** water and safely divert it to a stable outlet, thereby preventing erosion of an area below.

Diversions are effective in intercepting storm runoff and diverting it away from fields susceptible to erosion, preventing water from flowing over areas where high concentrations of pollutants exist (such as **feedlots**), and diverting runoff water away from **gullies** to a stable outlet.

WATER QUALITY BENEFITS

Diversions can be effective in reducing soil erosion in cropland fields. Vegetated channels on the upslope side of diversions can provide some removal of solid pollutants through filtering of runoff. Diversions used to prevent unpolluted runoff from entering a feedlot will help prevent nutrients, organics, sediment, and bacteria from leaving the area.

PLANNING CONSIDERATIONS

The contributing area above the diversion should be vegetated or treated in some other way to control erosion before construction. A stable outlet such as a grassed waterway should also be established to collect and remove the water from the diversion.

The owner should understand during the planning process that maintenance of diversions is essential. Sediment which may accumulate will need to be removed and disposed of properly. Vegetation should be mowed on a regular basis to ensure proper flow. In addition, diversions should be protected from misapplication of herbicides.

FIELD BORDER

This field border controls erosion at the end of the field and is also a turning row for farm equipment.

DESCRIPTION

Field borders are permanent vegetation at the edge or ends of crop rows which help control erosion and provide an area for travel or to turn farm machinery around. Severe erosion problems can be created at the end of rows if this area is maintained in a fallow condition. A field border will provide permanent protection for the soil and prevent this problem.

WATER QUALITY BENEFITS

Field borders are very effective for reducing erosion at the end of rows on sloping fields. A field border also provides some filtering of water passing over it as sheet flow. This reduces pollution to surface water from **sediment** and sediment-bound **nutrients** and **pesticides**.

PLANNING CONSIDERATIONS

Vegetation selected for fields borders should provide good erosion control. Close growing, dense vegetation can be more effective in reducing sediment and sediment related pollutants delivered to streams than open, loose growing vegetation. The field border should be designed with sufficient width to allow for travel and easy turning of equipment.

GRADE STABILIZATION STRUCTURE 73

This structure is used to safely drop the flow of water from one elevation to a lower elevation without causing gully erosion.

DESCRIPTION

A grade stabilization structure is used to drop **runoff** water, usually over a short distance, from one elevation to a lower elevation. These structures are used where the velocity of the water is high enough to cause scouring or **gully** erosion and are often located at the head (upstream) end of an existing gully to safely drop incoming water to the floor of the gully. A grade stabilization structure can also be used as a stable outlet for other conservation practices.

WATER QUALITY BENEFITS

Grade stabilization structures will stop the rapid erosion which occurs at the head of a gully or reduce water velocity in a waterway or channel. As a result, erosion from scouring is reduced, thus reducing **sediment** and improving water quality downstream. Grade stabilization structures are not effective for removal of soluble pollutants.

Most grade stabilization structures will not effect ground water quality. However, structures that hold water for an extended period of time may increase **infiltration**, especially in **permeable** soils. Structures such as drop chutes which do not pond water should not affect ground water.

PLANNING CONSIDERATIONS

In general, structures with a pipe outlet are more suitable for small drainage areas and high overfalls while structures such as drop **spillways** are more suited to lower overfalls and large flows. Grade stabilization structures can be expensive to install and should be designed by a qualified person.

GRASSED WATERWAY

A waterway safely carries runoff from this field.

DESCRIPTION

A grassed waterway is a natural or constructed channel, usually broad and shallow, that is planted with grass to protect the soil from **gully** erosion by concentrated storm runoff. Waterways can serve as outlets for terraces or diversions as well as for transporting storm water across a field without erosion.

WATER QUALITY BENEFITS

Grassed waterways remove water safely from either natural drainage areas or constructed soil conservation measures such as terraces. Waterways prevent gully erosion in areas of **concentrated flow**, thereby reducing **sediment** downstream and improving water quality. The vegetation in a grassed waterway also acts as a filter to remove sediment-attached pollutants from runoff.

PLANNING CONSIDERATIONS

Grassed waterways should not be used as a filter strip to remove sediment. If sediment is allowed to accumulate in the waterway, the vegetation will be destroyed and the effectiveness of the waterway in safely and efficiently transporting stormwater off the field without erosion will be nullified.

Quickly establishing vegetation in the waterway is critical to success. Close-growing, dense, sod-forming grasses, such as bermudagrass or bahiagrass, can be more effective than loose-growing or bunch grasses. Grass species adapted to the area should be planted within acceptable dates for success. Special protection such as mulch anchoring, straw bale dikes, or diversions should be used to either hold the soil in place while the grass is establishing or temporarily divert the runoff water away from the newly constructed waterway. Soil conditions must be favorable for plant growth in the grassed waterway. Soil conditions may need to be improved with practices such as subsurface drainage for wet conditions, or the addition of topsoil when unfavorable subsoil is exposed. Proper soil **pH** and fertilization are essential.

The **watershed** which contributes **runoff** to the waterway should be protected from erosion. Otherwise, the waterway will be filled in by excessive sediment.

Grassed waterways should not be used in drainageways that have permanent or long duration flows that will kill the vegetation.

A stable outlet is required at the end of a grassed waterway to prevent a gully from forming and progressing up the waterway.

The maintenance requirements of grassed waters should be understood during the planning process. The waterway should not be used as a roadway since rutting by tires will kill vegetation and concentrate flows. In addition, care is essential when spraying herbicides on cropland fields adjacent to waterways.

Irrigation water improves crop production, but it must be properly managed to prevent soil erosion and leaching of pollutants to ground water.

DESCRIPTION

Irrigation water management involves controlling the rate, timing, and amount of irrigation water so that crop moisture requirements are met while minimizing water losses. Without proper management fields are often irrigated too often and at excessive rates. If irrigation water is over applied, the excess water can cause soil erosion and **leaching** of **nutrients** and **pesticides**. Over-application also wastes water, energy, and money.

WATER QUALITY BENEFITS

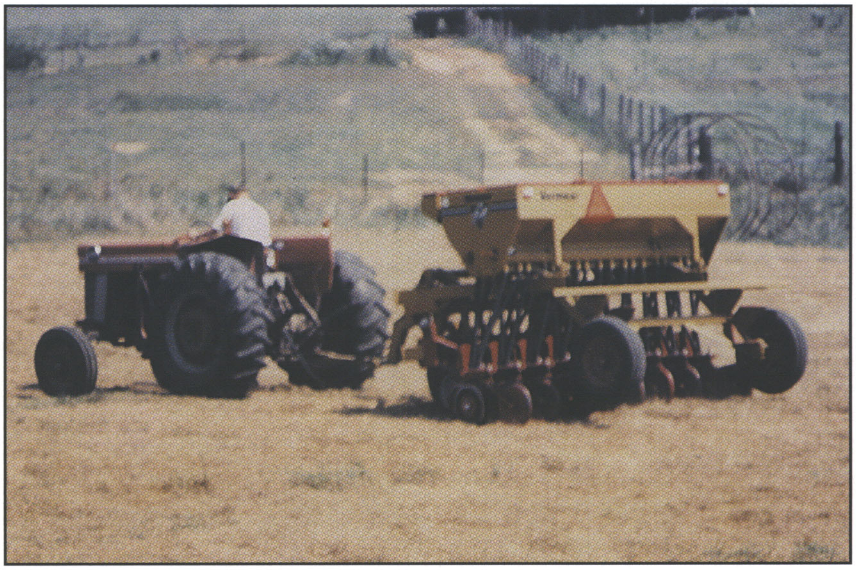
Over irrigation and the potential for leaching can have a significant impact on **ground water** quality. The potential for leaching nutrients and pesticides to ground water is minimized when irrigated water is applied at the proper times and in amounts that meet, but do not exceed, crop needs.

Irrigation can be timed so that the maximum benefit is realized from pesticides and the chance of leaching is minimized. Leaching of chemicals can occur when excess irrigation water is applied to a field before a pesticide can break down, be taken up by plants, or be **adsorbed** to soil.

By matching irrigation water application to soil **infiltration** rates and crop needs, surface **runoff** during irrigation can be minimized to prevent erosion and loss of nutrients and pesticides in runoff.

PLANNING CONSIDERATIONS

The volume of water applied and the frequency of applications should be determined by crop needs and soil conditions. Soil moisture should be monitored to predict when irrigation is needed. When crops are irrigated, the volume applied should not exceed the **available water capacity** of the soil in the root zone or the moisture control zone. In addition, the infiltration rate of the soil should not be exceeded. This practice should be applied in conjunction with other erosion and sediment control practices.



This pasture is being planted using a no-till method.

DESCRIPTION

This practice involves establishing or renovating long term stands of adapted forage plants for grazing or hay. Perennial forages species are generally used for pastures or hay. Biennials or reseeding annuals may be added to the **sward**, but these must be managed to allow for reseeding.

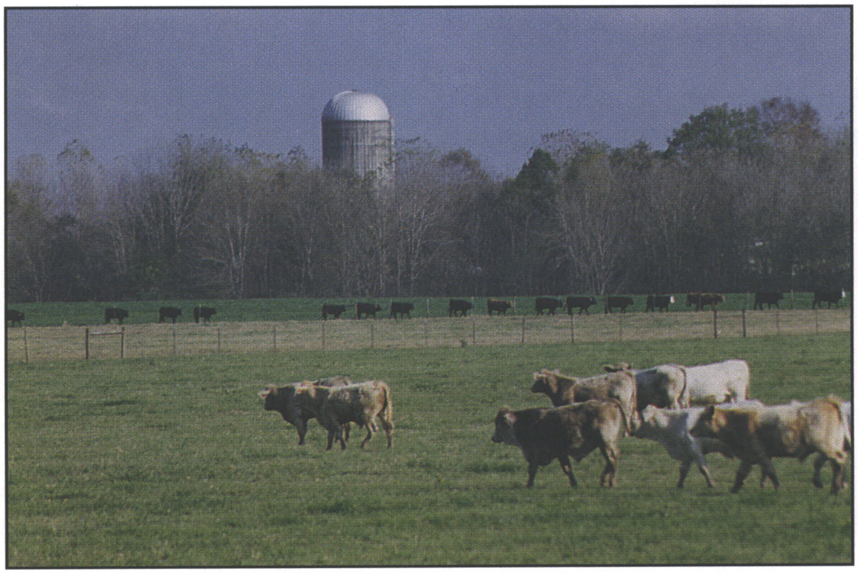
WATER QUALITY BENEFITS

Converting tilled cropland to a permanent sod cover or renovating a poor sod will significantly reduce soil erosion. This contributes to water quality improvement by limiting the amount of sediment and sediment related pollutants delivered to surface waters. Infiltration and percolation of water will be increased, but uptake of nutrients by the permanent sod can reduce the amounts entering ground water. Soil organic matter content will increase in soils of pasture and hay fields, thus increasing the water holding capacity of the soil. Also, many pollutants are tightly bound by organic matter in the soil; thus, movement into the ground water may be reduced over time.

PLANNING CONSIDERATIONS

Proper selection of specific forage species or a mixture of species is critical for success. The factors that should be considered are type of soils, climate, adaptation of the forage plants for their planned use, fertility needs, and maintenance requirement. The nutritional requirements of particular livestock species must also be considered when selecting forages for hay or pasture.

The planting of pasture or hay fields by some type of conservation tillage method should be considered on land which is subject to excessive erosion during establishment. Proper soil **pH** and fertility is essential for quick growth and establishment of dense, healthy stands. Grazing and haying must be restricted until the forages are well established.



A properly managed pasture will increase production and improve water quality.

DESCRIPTION

Pasture and hayland management involves proper use and treatment of pasture or hay fields so that the life of desirable forage species is prolonged and the quality and quantity of forage is increased. This will require management measures such as rotational grazing, weed control, proper mowing heights, liming, fertilizing, overseeding, and spreading manure. This practice is designed to keep pastures and haylands productive and in good condition, without excess application of nutrients or pesticides that could threaten water quality.

WATER QUALITY BENEFITS

A properly managed pasture or hay field poses a very low threat to surface water because the soil is completely covered by vegetation year round and is very resistant to erosion. Also, because of the filtering effect of the sod, runoff, animal waste and nutrients reaching surface waters are reduced.

PLANNING CONSIDERATIONS

Pasture and hayland management involves the use of several practices or management techniques. These practices include:

* Liming and fertilizing, which provide proper soil fertility for forageproduction.

* Rotational grazing, which uses two or more pastures and involves short-term grazing followed by a rest period.

* Weed control, which should be performed as needed. Clipping or herbicides may be used. When herbicides are used, they should be applied according to label instructions.

* Harvesting excess forage from pastures for hay

which promotes more nutritious new growth.

* Mowing hay at the proper height and proper growth stage which helps maintain productivity and stand.

Rock riprap is used here to prevent scouring of the streambank.

DESCRIPTION

Streambank protection involves the use of structural and/or vegetative (biological) measures to protect streambanks from erosion caused by water, vehicles, or livestock. Structural measures may include **rock riprap**, interlocking concrete blocks, or formed concrete. Vegetative or biological measures may include log bundles anchored to the streambank or the planting of willows or other plants which can withstand high velocity flow while the roots form a protective net for the soil.

Streambank protection often serves to prevent the loss of valuable land near the stream and to protect structures such as bridges.

WATER QUALITY BENEFITS

Although streambank erosion is a very visible and unaesthetic form of erosion, it may not have a significant impact on water quality in some **watersheds**. The effect of streambank erosion on water quality should be closely studied before using expensive structural stabilization measures.

When an eroding streambank is stabilized, the **sediment** load originating from that location will be eliminated. Total reduction in sediment load to the stream will depend upon the individual site.

Other practices associated with Streambank Protection include Livestock Exclusion and Livestock Watering Facility.

PLANNING CONSIDERATIONS

Whenever a streambank is to be modified, the owner should first determine if a permit is required under Section 404 of the Clean Water

Act. The local NRCS or Soil and Water Conservation District office can provide guidance. When structural protection such as rock riprap or concrete are required to stabilize a bank, the cost can be very high. In such situations the benefits of expensive structural streambank protection may not justify the cost.

(Note: Landowners should contact Corps of Engineers prior to installing structural streambank stabilization.)

Sometimes streambank erosion can be caused by channel obstructions such as a fallen tree or a sediment bar that is deflecting flow into the bank. These factors should be evaluated along with the level of water quality benefits before deciding on expensive structural protection.

In areas where grass or trees will provide adequate protection, species should be selected that are well suited to soil conditions and can withstand periodic flooding.

Related practices: Livestock Watering Facility, Livestock Exclusion, and Grade Stabilization Structure.

STRIPCROPPING 85

Strips of sod slow the movement of water and filter sediment.

DESCRIPTION

Stripcropping involves growing crops in a systematic arrangement of contoured or across-slope strips to reduce water erosion. When the strips are planted on the contour, it is contour stripcropping. When the system is planted across the general slope of the field, it is known as field stripcropping. The crops are arranged so a strip of row crops is alternated with a strip of close-growing crop or sod.

WATER QUALITY BENEFITS

Contour stripcropping can be very effective in improving surface water quality by reducing sheet and rill erosion, promoting infiltration, and reducing the amount of sediment and associated agricultural chemicals that would otherwise be carried from the field in surface **runoff**. However, as water infiltration is enhanced, there is a potential for increased leaching of excess soluble fertilizers and **pesticides** to ground water. This potential may be reduced if sod is used for the strips instead of a close-growing crop because it does not require high levels of nutrients or pesticides.

PLANNING CONSIDERATIONS

The width of the strips is determined by the crops grown, land slope, and machinery widths. Also, other practices such as grassed waterways, water and sediment control basins, or diversions may be required to control **concentrated flow erosion**. Sod strips can be utilized for hay or seed production and should be managed accordingly. All tillage and planting of crops should be parallel to the strip boundaries.

This grass backed, gradient terrace helps prevent the formation of gullies.

DESCRIPTION

A terrace is an earthen embankment that is constructed across a slope to intercept **runoff**. In Alabama there are basically two types of terraces. *Storage terraces* store water until it can be passed through an underground pipe to a safe outlet at the lower edge of the field. *Gradient terraces* divert the runoff to the end of the terrace where the water is delivered to a grassed waterway or other stable outlet. A third type is a *level terrace*. This terrace ponds runoff until it can seep into the soil. A level terrace is not used much in Alabama due to the intense rainfall patterns.

Terraces will permit the use of more intensive cropping systems while controlling erosion. Because terraces generally follow the contour of the land, the benefits of **contour farming** are easily achieved. In addition to providing erosion control and water quality benefits, a terrace can effectively conserve soil moisture and, thereby, increase crop production.

WATER QUALITY BENEFITS

When properly designed, installed, and maintained, terraces can be very effective at reducing erosion and trapping **sediment**. These characteristics improve water quality by preventing the vast majority of sediment and sediment-attached **nutrients** and **pesticides** from leaving the field.

Storage terraces will retain runoff, thus increasing **infiltration**, conserving moisture, and increasing **ground water** recharge. Storage terrace systems also provide for a more stable outlet condition than the gradient terraces.

Soluble pesticides and nutrients which have been recently applied can be carried to the underground pipe and be transported to a nearby stream. Therefore, wise selection of pesticides and proper timing of applications becomes important.

Any practice that increases the amount of infiltration into the soil may increase the possibility of soluble pesticides and nutrients leaching to ground water.

PLANNING CONSIDERATIONS

Terraces are best suited to uniform, gently to moderately sloping fields (2 to 8 percent slope) that have erosion problems. Construction is easier if they are applied to fields with deep soils. They are not recommended on fields with steep or shallow soils nor on fields with irregular **topography** and short slopes. These conditions result in patterns that are not easy to farm with large equipment since the terraces are not parallel. The width of the farmer's planting equipment should be considered when designing terraces to make the spacing between terraces fit the equipment.

Other practices such as conservation tillage, nutrient management, integrated pest management, etc., should be used in conjunction with terraces.

Terraces are relatively expensive to install and require a substantial amount of time to design and construct. As fields become steeper, more terraces are required and the cost per acre for construction increases.

The capacity of terraces should be maintained by routine plowing. Plowing should be done parallel with the terrace while throwing the soil material uphill.

WATER AND SEDIMENT CONTROL BASIN

As runoff water pools in this basin, sediment is deposited and the water is slowly discharged to an underground pipe.

DESCRIPTION

Water and sediment control basins are earthen embankments constructed across a minor **watercourse** to form a **sediment** trap and **water detention basin**. A perforated stand pipe is generally used to slow the release of water from the basin, thus allowing the suspended soil particles time to settle. The water passes from the stand pipe to a subsurface pipe which carries the water downslope to a stable outlet.

WATER QUALITY BENEFITS

Water and sediment control basins are effective for preventing **gully** erosion, trapping sediment, and reducing **peak flows** downstream. Sediment and the nutrients and **pesticides** attached to it are trapped by the basin. Structures with subsurface pipe outlets will slow and retain **runoff**, thus increasing **infiltration** through the bottom of the basin and providing **ground water** recharge. This practice is not effective for the removal of soluble pollutants.

The effects on ground water associated with this practice are not significant. **Nutrients** and pesticides are most likely to **leach** to ground water on sites with **permeable** soils and in basins with long detention times.

PLANNING CONSIDERATIONS

Water and sediment control basins are generally used on cropland fields where the **topography** is irregular. The basins can be used in conjunction with terraces to create a more farmable and parallel row pattern for the field. The basins should be aligned in the field so they are approximately perpendicular to the land slope. Multiple structures in a field should be spaced for proper erosion control and for compatibility with farm equipment. Other practices such as terraces, contouring, conservation tillage, and crop residue management may be needed in conjunction with this practice.

FARMSTEAD POLLUTANTS

This section discusses practices which can prevent water quality problems from activities that generally occur at or near the farmstead. Sewage from the homesite and spilled fuel or **pesticides** are potential pollutants that can enter either surface or **ground waters**.

Since wells are commonly used in rural areas, this section provides information on sealing abandoned wells and protection of existing, active wells. If **sinkholes** are located near the farmstead, the reader should refer to the discussion on that topic under Pesticides.

Practices discussed in this section include the following:

Onsite Sewage Disposal

Pesticide Mixing and Storage Facility

Petroleum Storage and Handling

Sealing Abandoned Wells

Water Well Protection

Many attractive plants can be included in a wetland used to treat septic tank effluent.

DESCRIPTION

Onsite sewage disposal refers to the method of disposing of domestic wastewater at the homesite. The most common method involves a septic tank and absorption field. The septic tank is usually a concrete box built to proper engineering specifications and placed below ground near the source of wastewater. The tank must have enough volume to retain the wastewater for at least 24 hours. This retention period, determined by the number of bedrooms in the house, provides time for the heavier solids to settle and to allow bacteria to partially decompose and liquify the solids.

In addition to providing for the settling of solids, the tank also captures grease, oil, and other floating material. The tank has a baffle to prevent the surface scum from leaving the tank.

When the partially treated wastewater leaves the tank, it enters a series of buried pipes (often called field lines) which are either perforated or loosely fitted at the joints, thus allowing water to exit the line along its entire length. The wastewater that escapes the pipe is absorbed by the surrounding soil and further decomposed by bacteria. A number of different variations on the absorption field with standard field lines are being used today.

The septic tank and field line system requires soils which can absorb wastewater at a satisfactory rate. Very heavy clay soils are not suitable for field lines. In addition, field lines cannot be placed in areas where bedrock is near the surface or where fractured limestone is located immediately below the surface.

One alternative to the absorption field is a constructed wetland. In this system wastewater leaves the septic tank and enters a shallow bed of rock located inches below normal ground level. This rock bed is usually covered with a shallow layer of mulch, and water-loving plants, such as cattails, bulrushes, and canna lilies, are planted on the surface. The wetland is designed so that the water level in the rock bed does not reach the surface; however, the roots of the plants infiltrate the bed to extract nutrients and water. The plants also "pump" oxygen to the root zone which helps in the biological decomposition of the organic wastes. (See Constructed Wetland for Waste Treatment.)

Other components of an onsite sewage disposal systems, such as peat beds, sand filters, etc., are also available. However, each system must be approved by the local county health department before being used to treat human wastes.

WATER QUALITY BENEFITS

Pit privies, septic tanks which discharge directly to a stream, or any other makeshift or unapproved method of onsite sewage disposal can pose a threat to water quality and to public health when nutrients and pathogenic (disease causing) organisms pass to surface waters or ground water or become ponded on the soil surface. However, an approved septic tank with absorption field, constructed wetland, or peat bed when properly sited, constructed, installed, and maintained, should not pose a threat to the environment.

PLANNING CONSIDERATIONS

The primary considerations in planning for a septic tank with absorption field are the **percolation** rate (perc rate) of the soils and the volume of wastewater which will be discharged to the system daily. The volume of wastewater discharged is based on the number of bedrooms in the house. The more bedrooms suggests a greater wastewater flow; therefore, more field lines are required.

A perc test must be conducted at the site where the field lines will be placed. Sandy soils will have a rapid perc rate while heavy clay soils will have a slow perc rate. The slower the perc rate the more field lines that are needed to ensure the wastewater can be absorbed by the soil without seeping to the surface.

If the perc rate is too slow, the site may not be approved for an absorption field. In this case the County Health Department may allow use of an alternative system such as a constructed wetland or peat bed.

Homeowners should be aware that flushing chemical cleaners, solvents, paints or certain other chemicals into the system can adversely affect the normal biological activity of a septic tank. In such cases, normal household wastes will not properly degrade and the tank will fill prematurely with solids. Solids will then pass from the tank to clog field lines or the gravel bed of a constructed wetland.

PESTICIDE MIXING AND STORAGE FACILITY 95

Pesticides should be stored in a well ventiliated and secure building.

DESCRIPTION

A **pesticide** mixing and storage facility is a roofed structure in which the functional activities, such as loading, mixing, and storage of pesticides, are arranged and designed for ease of management, personal safety, and environmental protection. The pesticide storage area includes a heated and ventilated area for year around storage of pesticides and fertilizers and a seasonal storage area to store large quantities of liquid and dry formulations of pesticides and fertilizers during the spring rush.

The mixing and loading pad is used to contain any spills of pesticides (1) during the handling, mixing, and transferring of pesticides to spray equipment and (2) during the unloading and transferring of pesticides to the storage area. A shallow **sump** is included at the low point in each area to recover any spilled material. Spilled material is pumped directly into application equipment or into a **rinsate** storage tank labelled for the specific pesticide that was spilled.

The facility will include a personnel safety area which will have an emergency shower and eye wash, spill recovery kit, first aid kit, and clothing and equipment for personal protection. The facility will also include an area for storing empty pesticide containers.

Good management is essential at the pesticide mixing and storage facility. The pad used for mixing should be washed down daily if any activity has taken place; yet the amount of water used should be minimized to prevent generating excess rinsate. It is also important to maintain good records on the products stored and used at the facility. The amount of pesticides or fertilizers stored over the winter should be kept to a minimum. The storage facility should be properly secured when not in use.

WATER QUALITY BENEFITS

A properly designed and managed facility will minimize the potential for contamination of both surface and ground waters from pesticide spills. Thus, the possibility for fish kills, poisoning of cattle, and damage to wildlife will be greatly reduced. In addition, rural residents who obtain their drinking water from wells will be protected from the possible long-term carcinogenic effects of pesticides which might have otherwise leached to an underground aquifer.

PLANNING CONSIDERATIONS

The site for the mixing and storage facility should be investigated for pre-existing contamination of soils and well water by pesticides. The facility should be located at least 150 feet from, and down slope of, any well head. Such wells must be properly cased. If a well is used to supply water for this facility, it should have an adequate yield to handle all needs during peak production. The waterline must have a backflow prevention valve to prevent contaminated water from being siphoned back to the source.

The entire structure must be roofed and be placed on a properly designed concrete pad. In addition, the facility must not be placed within the high-water elevation of the 100-year, 24-hour flood.

PETROLEUM STORAGE AND HANDLING 97

Fuel storage tanks should be protected from rupture and spills.

DESCRIPTION

This practice refers primarily to the proper storage of bulk fuel used for farm equipment. However, petroleum products in all size containers should be properly stored to protect water quality and human health.

In the past fuel storage tanks were placed below ground. It has now been found that underground metal storage tanks and their fittings will eventually leak. In fact, the Environmental Protection Agency reports that underground storage tanks are the primary source of ground water contamination throughout the nation. In addition, gasoline and other petroleum products stored in well houses, spring houses, or other locations can become rusted, damaged, or spilled, causing contamination of water supplies.

WATER QUALITY BENEFITS

Nearly all of the old underground storage tanks will eventually leak. In the past such leakage would usually go undetected until a well was contaminated. A well that is contaminated with gasoline or diesel fuel is very difficult and extremely costly to clean up. For these reasons, the farmer should either install monitoring wells around existing underground storage tanks or install appropriate above ground tanks to protect water quality.

A properly constructed above ground fuel storage tank with spill containment is the best option. It will eliminate the long-term potential for damage to ground water that traditional metal, underground tanks have created. In addition, smaller portable fuel tanks should be removed from the vicinity of well houses or any location where deterioration of containers or accidental spills could contaminate ground or surface water. Placing such containers in a safe, well marked building will ensure protection of human health and safety as well as protection of the environment.

Proper storage and handling of all petroleum products will protect ground water supplies used by humans and livestock. It can also prevent contamination of surface waters and result in the protection of all forms of aquatic life.

PLANNING CONSIDERATIONS

Bulk fuel storage tanks should be stored above ground so that leaks can be detected and spills contained. The tanks should be placed on a pad with a low concrete wall to contain the entire contents of the tanks should they rupture when full. The concrete should be continuous, without any pipes or other structures going through the walls. The volume of the containment structure should be 110 to 125 percent of the volume of the largest tank; the extra 10 to 25 percent is included as a safety factor. The design should also account for containment of spills on the pad or on a separate pad when filling the tank and fueling farm equipment. The tank and containment structure should be covered with a metal roof and be fenced. Automatic fuel shut-off valves should be installed to prevent over filling of farm equipment when dispensing fuel.

Above ground tanks should be placed at least 100 feet away and downslope of well heads and at least 50 feet away from all buildings. In addition, fuel storage tanks should be properly located to prevent accidental damage by farm equipment and other vehicles. A written plan should be developed on the procedures to follow in the event of a spill.

An unsealed abandoned well can be a safety hazard as well as a source of ground water pollution.

DESCRIPTION

This practice involves the sealing and permanent closure of vertical water wells (drilled, dug, bored or driven) that have been found to have no further use or to be hazardous. Groundwater remediation may be required for wells that were used for waste disposal and where evidence of contamination exists.

Sealing of a well involves the removal of all pumping equipment, valves, pipelines, casing liner, debris, and other foreign material. It also involves adding a chlorine solution to disinfect the well before closure. The well should be filled only with appropriate materials as prescribed by a qualified engineer or geologist.

WATER QUALITY BENEFITS

Properly sealing a water well prevents the entry of surface water and the migration of associated contaminants to the ground water. It can also help prevent the commingling of chemically or physically different ground water between separate water bearing zones, such as a contaminated stratum near the surface with a deep aquifer.

In addition to the water quality benefits, sealing of abandoned wells eliminates the physical hazard of an open hole to people, animals, and farm machinery.

PLANNING CONSIDERATIONS

All available data, including interviews with previous owners of the well, should be collected to determine the original physical characteristics of the well. The information needed will include the total well depth, type of liners and screens, diameter and length of casing, and related information. Records from the Geological Survey of Alabama should be checked during the data search.

The well should be appropriately housed and should never be used to store pesticides, fertilizers or other potential pollutants.

DESCRIPTION

This practice involves the protection of wells already installed and the prevention of problems in wells that are being planned. For existing wells, it focuses on management activities aimed at reducing the potential for contamination. This includes evaluating and, if necessary, moving or modifying potential sources of pollution. Such sources could include **pesticide** and fertilizer handling and mixing areas, fueling areas, and livestock confinement facilities. This practice also includes checking the water for bacterial contamination and evaluating possible sources, such as septic tank and field lines or livestock activities too near the well head. If the well was installed in a limestone **aquifer** containing underground channels, contamination could reach the well from a considerable distance away; in this case a detailed geologic investigation might be needed.

For wells being planned, this practice includes such activities as proper investigation of the surrounding site and assessing geologic conditions underground, placement of the well in an appropriate location in relation to other farm activities, selection of a reputable driller, and managing or relocating activities around the potential well head to prevent future contamination.

WATER QUALITY BENEFITS

When a well is properly sited, constructed, and initially decontaminated, and when the potential sources of pollution near the well head are eliminated, the quality of water delivered to the user should remain free from contamination. An uncontaminated well will be free of pesticides, excess nitrogen, petroleum products, and bacteria or other microbial organisms.

In some cases, water may have naturally high concentrations of iron, sulfur, and other constituents that may impart an unpleasant taste or odor to the water or cause staining of household fixtures. In such cases a filtering system apart from the well may be necessary.

PLANNING CONSIDERATIONS

Planning is essential when considering a new well. The owner must determine where to place the well in relation to other activities at the farmstead. The well must be easily accessible, but the site must not be in a location where it can possibly be contaminated during pesticide and fertilizer handling or fueling of farm equipment. Consideration must also be given to possible seepage from septic tank leach fields or lagoons, surface runoff from livestock confinement facilities, and other areas that could carry contaminants.

A licensed and reputable well driller is needed to evaluate the site. If the site is in limestone areas with sinkholes at the surface or known solution channels below ground, a geologic investigation is recommended.

All wells must be placed a minimum distance from potential sources of pollution. They should be at least 100 feet and upslope of a septic tank leach field. At least 300 feet should be provided between an animal waste lagoon and a well. A separation of 150 feet may be approved for a lagoon site if the well is located upslope and the area is not in a cavernous limestone formation. At least 150 feet should be allowed between a well and chemical and fertilizer handling and mixing facilities. In all cases, anyone considering installation of a well should contact the County Health Department for guidance and approval of the location.

WATER QUALITY MANAGEMENT PLANS 103

Water quality management plans provide land users a "roadmap" for improving or protecting water resources.

ECOSYSTEM APPROACH

Planning should be based on **ecosystem** principles. This means that problems and solutions are evaluated in such a way that all interactions are considered. Effects of Best Management Practices (BMPs) upon water, soil, air, plant and animal resources along with the human considerations (economic, social and cultural) are considered as options are developed. Each BMP that is part of a water quality management plan will impact upon one or more resources and the impact should be understood by land users.

Large ecosystems can be subdivided into smaller ecosystems; this is usually done in planning. Obviously, Earth is the main ecosystem for mankind. On a more localized and practical basis, planning is based on effects that are obvious (i.e., impacts on the underlying water table or a nearby stream or lake).

Although a **watershed** is not the boundary for all natural resources related to a specific land unit, it is a convenient delineation for describing problems associated with water quality, particularly for surface waters.

Watershed protection plans developed for a larger part of the ecosystem than a farm may provide a basis for declaring that a site-specific water quality management plan is needed on farms within a watershed.

DEVELOPING PLANS

Planning addresses the identified and predicted water quality problems associated with farms or other specific planning units.
Water quality management plans reflect sound decisions made by informed decisionmakers. Information may be obtained from several sources, but, ultimately, decisionmakers choose the management systems with the combination of BMPs that best fit their operations.

Assistance in developing water quality management plans is available from Natural Resources Conservation Service personnel assigned to local soil and water conservation districts. On a more limited basis, assistance is available from the Extension Service and private consultants.

Management systems that are planned are categorized by the source that produces pollutants: animals (wastes and dead animals), nutrients, pesticides, sediment, and farmsteads (sewage, chemicals and petroleum).

PLAN CONTENTS

Water quality management plans should contain the information that decisionmakers need to install, operate and maintain the BMPs.

Water quality plans typically include:
* Plan maps (identifying fields and BMPs)
* Soils map and interpretations
* A listing of the BMPs and a schedule for installation or use
* Criteria ("how to") for installing, operating and maintaining the BMPs.

Detailed design criteria may be provided in packages for BMPs such as those for a Waste Management System.

* The level of control assumes that the practice is installed, operated and maintained under optimum conditions and is compared with no other practice in place.

SUMMARY CHART: IMPACTS OF PRACTICES

POLLUTION CONTROL PRACTICES	Potential Pollutants Controlled* — Surface Water							Ground Water	
	Sediment or Suspended Solids	Soluble Nutrients	Adsorbed Nutrients	Soluble Pesticides	Adsorbed Pesticides	Oxygen-Demanding Organics	Micro-organism	Nitrogen Leaching	Pesticide Leaching
ANIMAL WASTE PRACTICES									
Animal Mortality Mgt.	Blue	Yellow	Yellow	Blue	Yellow	Green	Green	Yellow	Blue
Animal Waste Lagoon	Green	Green	Green	Blue	Blue	Green	Green	Yellow	Blue
Animal Waste Storage Pond	Green	Green	Green	Blue	Blue	Green	Green	Yellow	Blue
Animal Wst. Strg. Structure	Green	Green	Green	Blue	Blue	Green	Green	Green	Blue
Composting	Blue	Yellow	Yellow	Blue	Yellow	Blue	Blue	Yellow	Blue
Constructed Wetland	Green	Green	Green	Blue	Blue	Green	Green	Yellow	Blue
Livestock Exclusion	Green	Green	Green	Blue	Blue	Green	Green	Blue	Blue
Livestock Watering Facility	Green	Green	Green	Blue	Blue	Green	Green	Blue	Blue
Runoff Management	Yellow	Yellow	Yellow	Blue	Blue	Yellow	Yellow	Yellow	Blue
Waste Utilization	Green	Yellow	Green	Blue	Yellow	Green	Green	Yellow	Blue
NUTRIENTS									
Filter Strip	Yellow	Blue	Yellow	Blue	Yellow	Blue	Blue	Blue	Blue
Nutrient Management	Blue	Green	Green	Blue	Blue	Blue	Blue	Green	Blue
Riparian Forest Buffer	Green	Yellow	Yellow	Blue	Yellow	Yellow	Yellow	Yellow	Blue
Wetland Development/Restor.	Green	Green	Green	Yellow	Green	Green	Green	Blue	Blue
PESTICIDES									
Integrated Pest. Mgt.	Blue	Blue	Blue	Green	Green	Blue	Blue	Blue	Green
Proper Pesticide Use	Blue	Blue	Blue	Green	Green	Blue	Blue	Blue	Green
Sinkhole Protection	Blue	Blue	Blue	Blue	Blue	Blue	Blue	Yellow	Yellow

● (green) — Medium to high effectiveness

● (yellow) — Low to medium effectiveness

● (blue) — Not applicable or low effectiveness

● (brown) — May increase pollution potential in some cases

* The level of control assumes that the practice is installed, operated and maintained under optimum conditions and is compared with no other practice in place.

SUMMARY CHART: IMPACTS OF PRACTICES

Potential Pollutants Controlled*

POLLUTION CONTROL PRACTICES	Surface Water							Ground Water	
	Sediment or Suspended Solids	Soluble Nutrients	Adsorbed Nutrients	Soluble Pesticides	Adsorbed Pesticides	Oxygen-Demanding Organics	Micro-organism	Nitrogen Leaching	Pesticide Leaching
SEDIMENT									
Conservation Tillage	Green	Dark blue	Green	Dark blue	Green	Dark blue	Dark blue	Dark blue	Dark blue
Contour Farming	Yellow	Dark blue	Yellow	Dark blue	Yellow	Yellow	Dark blue	Brown	Brown
Cover Crop	Green	Yellow	Green	Dark blue	Green	Dark blue	Dark blue	Yellow	Dark blue
Crop Residue Management	Green	Dark blue	Green	Dark blue	Green	Dark blue	Dark blue	Dark blue	Dark blue
Crop Rotation	Green	Yellow	Green	Yellow	Green	Dark blue	Dark blue	Dark blue	Yellow
Critical Area Protection	Green	Dark blue	Yellow	Dark blue	Dark blue	Dark blue	Dark blue	Dark blue	Dark blue
Diversion	Yellow	Dark blue	Yellow	Dark blue	Yellow	Dark blue	Dark blue	Dark blue	Dark blue
Field Border	Yellow	Dark blue	Yellow	Dark blue	Yellow	Dark blue	Dark blue	Dark blue	Dark blue
Grade Stabilization Structure	Yellow	Dark blue	Yellow	Dark blue	Yellow	Dark blue	Dark blue	Dark blue	Dark blue
Grassed Waterway	Yellow	Dark blue	Yellow	Dark blue	Yellow	Dark blue	Dark blue	Dark blue	Dark blue
Irrigation Water Management	Yellow	Yellow	Yellow	Yellow	Yellow	Dark blue	Dark blue	Yellow	Yellow
Pasture & Hayland Establishment	Green	Green	Green	Yellow	Green	Yellow	Dark blue	Yellow	Dark blue
Pasture & Hayland Management	Green	Green	Green	Green	Green	Yellow	Dark blue	Yellow	Dark blue
Streambank Protection	Green	Dark blue	Dark blue	Dark blue	Dark blue	Dark blue	Dark blue	Dark blue	Dark blue
Stripcropping	Yellow	Yellow	Yellow	Yellow	Yellow	Dark blue	Dark blue	Yellow	Yellow
Terrace	Green	Brown	Green	Brown	Green	Yellow	Dark blue	Brown	Brown
Water & Sediment Ctrl. Basin	Green	Dark blue	Green	Dark blue	Green	Yellow	Dark blue	Brown	Brown

Green — Medium to high effectiveness

Yellow — Low to medium effectiveness

Dark blue — Not applicable or low effectiveness

Brown — May increase pollution potential in some cases

* The level of control assumes that the practice is installed, operated and maintained under optimum conditions and is compared with no other practice in place.

SUMMARY CHART: IMPACTS OF PRACTICES

POLLUTION CONTROL PRACTICES	Potential Pollutants Controlled*								
	Surface Water							Ground Water	
	Sediment or Suspended Solids	Soluble Nutrients	Adsorbed Nutrients	Soluble Pesticides	Adsorbed Pesticides	Oxygen-Demanding Organics	Micro-organism	Nitrogen Leaching	Pesticide Leaching
FARMSTEAD POLLUTANTS									
On-Site Sewage Disposal	Medium to high	Medium to high	Medium to high	Not applicable or low	Not applicable or low	Medium to high	Medium to high	Low to medium	Not applicable or low
Pesticide Mixing & Stg. Fac.	Not applicable or low	Not applicable or low	Not applicable or low	Medium to high	Medium to high	Not applicable or low	Not applicable or low	Not applicable or low	Medium to high
Petroleum Stg. & Handling	Not applicable or low	Not applicable or low	Not applicable or low	Not applicable or low	Not applicable or low	Low to medium	Low to medium	Not applicable or low	Not applicable or low
Sealing Abandoned Wells	Not applicable or low	Not applicable or low	Not applicable or low	Not applicable or low	Not applicable or low	Not applicable or low	Not applicable or low	Medium to high	Medium to high
Water Well Protection	Not applicable or low	Not applicable or low	Not applicable or low	Not applicable or low	Not applicable or low	Not applicable or low	Not applicable or low	Medium to high	Medium to high

● (green) — Medium to high effectiveness

● (navy) — Not applicable or low effectiveness

● (yellow) — Low to medium effectiveness

● (brown) — May increase pollution potential in some cases

Absorb - The physical entrapment of a fluid by a porous medium, such as a sponge absorbing water.

Aerobic - Requiring oxygen or in the presence of oxygen.

Adsorb - The attachment of a gas, liquid, or dissolved substance on a surface by way of chemical or molecular action. (Positively charged pesticide molecules may be adsorbed to negatively charged clay particles.)

Aggregation (soil) - Many soil particles held in a single mass or cluster such as a clod, crumb, block, or prism.

Algae - Simple, usually microscopic, rootless plants that grow in water. (adjective form: algal)

Algal blooms - A large population of algae that is obvious to the naked eye; usually caused by an abundance of nutrients in the water.

Anaerobic - Requiring no free oxygen or in the absence of free oxygen.

Animal unit - The equivalent of 1,000 pounds of animal live weight; thus, one 1,200 pound dairy cow would represent 1.2 animal units and one 200 pound hog would be 0.2 animal units.

Aquifer - A sand, gravel, or rock stratum capable of storing or conveying water below the surface of the land.

Aquatic - Associated with water; living or growing in or near water.

Artificial wetland - Land that would not have been classified as a wetland under natural conditions but now exhibits wetland characteristics because of human activities.

Available water capacity (AWC) - The amount of water held by the soil between field capacity and the permanent wilting point. The AWC of a soil is a measure of its capacity to make water available for plant growth.

Baseflow - Normal stream flow resulting from ground water drainage.

Bedrock - A rock formation that is overlain in most places by soil or rock fragments.

Concentrated flow - Runoff water from sheet or uniform flow that converges at a common area. Concentrated flow can cause gullies on unprotected soil surfaces.

Concentrated flow erosion - Erosion resulting when concentrated water flows across land and removes the soil during runoff. The eroded area is usually shallow enough to be crossed with farm equipment, but can develop into a gully.

Contour farming - The practice of farming in which the row patterns follow the contours of the landscape.

Converted wetland - A wetland that was drained, dredged, filled, leveled, or otherwise manipulated, including the removal of woody vegetation, or any activity that results in impairing or reducing the flow, circulation or reach of water, and makes the production of an agricultural commodity possible.

Crop residue - The portion of a plant or crop left in the field after harvest.

Denitrification - The process of converting the nitrate (NO3) and nitrite (NO2) forms of nitrogen to atmospheric nitrogen under anaerobic conditions. Usually accomplished by anaerobic bacteria.

Detention basin - A basin such as a small pond or reservoir that temporarily stores runoff water and releases the water downstream in such a manner that reduces the peak flow.

Ecosystem - A biological community and its interaction with its environment.

Eutrophication - The natural or artificial process of nutrient enrichment often resulting in a water body becoming filled with algae and other aquatic plants.

Eutrophic lake - A lake that has a high level of plant nutrients, especially phosphorus and nitrogen, and a high level of biological productivity; oxygen content may be extremely high during sunny days and very low at night and on overcast days due to a high level of photosynthetic action.

Fecal coliforms - A group of bacteria found in the intestinal tract of all warm-blood animals, including humans. While most species are harmless in themselves, coliform bacteria are commonly used as indicators of the presence of pathogenic (disease causing) organisms.

Feedlot - Paved or unpaved land area upon which a high density of animals are confined.

Filter feeders - Any aquatic organisms that obtain their food from the surround water by continuously filtering the water through especially equipped mouth parts or gill slits.

Forb - A herbaceous broadleaf plant that is not a grass or is not grasslike (i.e. sedge, rush).

Ford - A shallow stream crossing; the streambed is often surfaced with stone or other material.

Grazing capacity - The maximum stocking rate possible without inducing damage to vegetation, water, or related resources.

Green manure crop - An annual grass or legume which is planted as a cover crop and which later dies or is killed with herbicides to become a source of organic matter, nutrients and soil cover for a following crop. The green manure crop may be plowed under during conventional tillage or be the cover for conservation tillage.

Ground water - That portion of the soil or rock where all pore spaces are completely saturated; the water that occurs in the earth below the depth to which water will rise in a well.

Gully - A channel or void in the landscape associated with erosion and concentrated flow of water. A gully is distinguished from a rill by its depth - a gully is too deep to be crossed by farm equipment while a rill can be crossed and may be smoothed by ordinary tillage methods (i.e. breaking or disking). Active gullies are usually significant producers of sediment.

Half-life - A measure of pesticide persistence. The time (days) required for the original concentration of a compound to be reduced to 50 percent of the original concentration.

Herbicides - Chemicals used to kill selected vegetation.

Hydraulics - The science of laws governing the motion of water and other liquids and of their practical applications in engineering.

Hydrophytic - Water tolerant or water loving.

Infiltration - The downward entry of water into the soil.

Inorganic - Not organic; see "organic."

Intermittent stream - A watercourse that flows only at certain times of the year, receiving water from springs or surface sources; also, a watercourse that does not flow continuously, when water losses from evaporation or seepage exceed available stream flow.

Karst - Geologic formation characterized by sinkholes, underground caverns, solution channels, and surface depressions without external drainage.

Leach - To percolate or migrate downward by force of gravity through a porous medium such as soil.

Leachate - The liquid, often contaminated, that leaches from a porous medium, such as a manure pile, a silage pit, or the soil.

Legume - A member of the Leguminasae family, one of the most important and widely distributed plant families. The fruit is a pod that opens along two sutures when ripe. Leaves are alternate, have stipules, and are usually compound. Includes many valuable food and forage species, such as peas, beans, peanuts, clovers, alfalfas, sweet clovers, lespedezas, and vetches. Many legumes are nitrogen-fixing plants.

Moisture control zone - The upper portion of the root zone in which moisture is controlled. Usually the top two feet of the soil profile.

Nitrogen fixing - The ability of a plant, such as certain legumes, to convert atmospheric nitrogen into soil nitrogen through a symbiotic relationship with specific microorganisms located throughout the root zone. Can also be accomplished in water by certain algae.

Nonpoint source pollution - Pollution arising from an ill-defined and diffuse source, such as runoff from cultivated fields, grazing land, or urban areas.

No-till - Planting a crop without prior seedbed preparation into sod, crop residue, or an existing cover crop.

NPDES permit - National Pollution Discharge Elimination System permit that may be required by EPA regulations for certain livestock facilities. In the case of confined animal feeding operations (CAFOs), the need for a NPDES permit is based on the number and size of animals on hand and whether or not a discharge is planned. (See Agricultural Pollution.)

Nutrients - Chemical elements and compounds needed by plants. Major nutrients include nitrogen, phosphorous and potassium in different chemical compounds. Minor nutrients include such elements as zinc and copper.

Organic - Of, pertaining to, or derived from living organisms (i.e., plants, animals, animal wastes, decaying vegetation); compounds that contain carbon in combination with one or more other elements. Most organic compounds can serve as a food source for bacteria, unlike inorganic compounds.

Pathogens - Disease-causing organisms.

Peak flow - The maximum rate of runoff that occurs from a watershed during a storm event.

Percolation - Movement of water through soil or other porous media.

Perennial stream - Water course that flows continuously throughout the year.

Permeable - A soil in which water can easily pass through the pores of the soil.

Persistence time - The time required for a pesticide to become inert. Arbitrarily assumed to equal four half-lives when measured persistence time is not available.

Pesticide - A chemical substance used to kill or control pests such as weeds, insects, fungus, mites, algae, rodents, and other undesirable agents.

pH - An expression of the intensity of the acid or alkaline condition of a solution; an indirect measure of the concentration of hydrogen ions in a solution, having a scale from zero (extremely acidic) to 14 (extremely alkaline) with 7 being neutral.

Photosynthesis - The process occurring in green plants that converts the radiant light energy of the sun into chemical energy that is stored in plants. Besides providing energy for plants by converting water and carbon dioxide into sugar, the process supplies practically all of the oxygen needed for life. During sunny days carbon dioxide is adsorbed and oxygen is given off; at night the process is reversed.

Photosynthetic - The adjective form of photosynthesis; see photosynthesis.

Phytoplankton - Free-floating, microscopic algae.

Point row - A row that does not end at the edge of a cultivated field.

Point source pollution - Pollution coming from a well-defined origin, such as the discharge from a pipe at an industrial plant.

Pollutants - Any of the various noxious chemicals and refuse materials that impair the purity of water, soil or the atmosphere.

Pond - A small body of water, usually artificially created by damming, diking or excavating.

Protozoan - Any single celled, usually microscopic organism in the Phylum Protozoa; plural: protozoa or protozoans.

Restoration - Term used when the wetland functions and values that were lost on a converted wetland are restored on the same site.

Rill erosion - An erosion process in which numerous small channels only several inches deep are formed; occurs mainly on recently cultivated soils and/or recent cuts and fills.

Rinsate - The mixture of water or other liquid used to rinse a container and any residues or pollutants rinsed from the container by that liquid.

Riparian - The bank, shoreline or edge of the rising ground bordering a natural, modified, or manmade watercourse or water area.

Rock riprap - Loose rock, usually limestone, that is used to stabilize slopes, watercourses, shorelines, etc.

Root zone - The depth of soil penetrated by plant roots.

Runoff - That portion of precipitation or irrigation water that flows off a field, feedlot or other impermeable or saturated surface. The water that flows off the surface of the land without infiltrating into the soil is called surface runoff.

Sediment - Solid material that is in suspension, is being transported, or has been moved from its original location by air, water, gravity, or ice.

Sediment yield - The quantity of sediment arriving at a specific location; usually refers to soil sediment.

Seepage - Percolation of water through the soil from water contained in unlined canals, ditches, laterals, watercourses, or water storage facilities.

Sheet erosion - The removal of a fairly uniform layer of soil material from the land surface by the action of rainfall and surface runoff.

Sheet flow - Runoff water that flows uniformly over the soil surface.

Sink - A depression in the landscape where underlying limestone has been dissolved.

Sinkhole - A natural depression or opening on the land surface which often includes a channel or hole leading directly to ground water; usually in areas underlain by cavernous limestone.

Spillway - A designed surface passageway for excess runoff water to pass.

Spring development - The improvement of a natural spring or seep to collect and store water for a use such as livestock water.

Substrate - The medium on which or within which an organism grows (i.e., the rock surface on which bacteria or moss grow or the rock bed or soil in which the roots of wetland plants grow).

Sump - A pit, concrete box or similar structure in which a liquid collects.

Surface layer - The soil ordinarily disturbed in tillage, or its equivalent in uncultivated soil, ranging in depth from 4 to 10 inches. Also called the plow layer.

Sward - The grassy surface of land or growth of grass such as a pasture or hay field.

Tilth - The physical condition of soil as related to its ease of tillage, fitness as a seedbed, and its impedance to seedling emergence and root penetration.

Tank - A large container or box used for holding water for livestock to drink.

Topography - The surface configuration of the landscape.

Trough - A usually long and narrow box used to hold water for livestock to drink.

Water quality management plan - A set of decisions related to management of natural resources that addresses problems, both identified and predicted, associated with surface and/or ground water. A plan provides criteria for installation, operation and maintenance of the practices needed.

Watercourse - A natural or man-made channel that conveys water.

Watershed - The land area that drains to a particular point or area in the landscape (i.e., to a pond, lake, river, etc.)

Watershed protection plan - A resource plan developed to address identified and/or predicted resource problems within a drainage basin. Typically, the plan is made by sponsors for land on which they have jurisdiction but do not own or control.

Water table - The top of the saturated zone in soil or rock.

Well - A hole drilled or bored into the earth to serve as a water supply from an underground aquifer.

Wetland - An area that has a predominance of hydric soils and that is inundated or saturated by surface or ground water at a frequency and duration sufficient to support, and, under normal circumstances, does support a prevalence of hydrophytic vegetation typically adapted for life in saturated soil conditions.

OFFICES WITH MAJOR WATER QUALITY RESPONSIBILITIES

Main Offices or Headquarters

Alabama Department of Agriculture and Industries
(Plant Protection and Pesticide Management Division)
P.O. Box 3336
1445 Federal Drive
Montgomery, Alabama 36109-0336
334-242-2656

Alabama Department of Environmental Management (ADEM)
P. O. Box 301463
1751 Cong. W. L. Dickinson
Montgomery, Alabama 36130-1463
334-271-7700

Alabama Cooperative Extension Service (ACES)
Alabama A&M University
Alabama A&M Cooperative Extension Program
P. O. Box 622
Normal, Alabama 35762
205-851-5710

Auburn University
104 Duncan Hall
Auburn University, Alabama 36849
334-844-5323

Alabama Soil and Water Conservation Committee
RSA Union Building, Suite 334
100 N. Union Street
P. O. Box 304800
Montgomery, AL 36130-4800

USDA-Natural Resources Conservation Service (NRCS)
665 Opelika Road
P. O. Box 311
Auburn, Alabama 36830
334-887-4539

Alabama County Level

Alabama Cooperative Extension Service (ACES)
Soil and Water Conservation District (SWCD)
USDA-Natural Resources Conservation Service (USDA-NRCS)

County	ACES	SWCD & USDA-NRCS
Autauga	2226 Hwy. 14 W. P.O. Box 370 Autaugaville 36003 334-361-7273	2226 Hwy. 14 W., Suite #A Autaugaville 36003 334-365-5124
Baldwin	25 Hand Avenue Bay Minette 36507 334-937-7176	1504-C Hwy. 31 S. Bay Minette 36507 334-937-7174
Barbour	Courthouse P.O. Box 99 Clayton 36016 334-775-3284	203 N. Midway St. P.O. Box 67 Clayton 36016 334-775-3266
Bibb	111 Church St. Centreville 35042 205-926-3117	103 Davidson Dr. Centreville 35042 204-926-4360 (SWC District only)
Blount	Co. Office Bldg. P. O. Box 610 Oneonta 35121 205-274-2129	Ag. Service Center 5th Ave. E, 400 Block Oneonta 35121 205-274-2363
Bullock	902 S. ML King Blvd. Union Springs 36089 334-738-2580	217 North Prairie St. Union Springs 36089 334-738-2079 (SWC District only)
Butler	101 S. Conecuh St. P.O. Box 338 Greenville 36037 334-382-5111	320-C Greenville Bypass N Greenville 36037 334-382-8538
Calhoun	Co. Admin. Bldg. 1702 Noble St. Anniston 36201 205-237-1621	Calhoun Co. Adm. Bldg. 1702 Noble St., Suite 116 Anniston 36201 205-236-2781

County	ACES	SWCD & USDA-NRCS
Chambers	Co. Office Bldg. 18 Alabama Ave. E LaFayette 36862-2092 334-864-9373	15053 US Hwy 431 LaFayette 36862 334-864-9430
Cherokee	Courthouse Annex Centre 35960 205-927-3250	108 Federal Bldg. 999 W. Main Street Centre 35960 205-927-3621
Chilton	Courthouse P.O. Box 30 Clanton 35045 205-755-3240	USDA Service Center Suite 102 731 Logan Road Clanton 35045 205-755-1951
Choctaw	218 S. Hamburg Ave. Butler 36904 205-459-2133	503 East Pushmataha P.O. Box 534 Butler 36904-0534 205-459-2496 (SWC District only)
Clarke	Courthouse P.O. Box 40 Grove Hill 36451 334-275-3121	129 Clarke Street P.O. Box 28 Grove Hill 36451 334-275-3757
Clay	Ala. Hwy. #9 Rt. 1, Box 331 Ashland 36251 205-396-5431	P.O. Box 1000 Ashland 36251 205-354-7512 (SWC District only)
Cleburne	204-B Hunnicutt St. Heflin 36264 205-463-2620	201-A Willoughby St. Heflin 36264 205-463-2877 (SWC District only)
Coffee	U.S. 84, Farm Center Complex New Brockton 36351 334-894-5596	Coffee Co. Ofc. Bldg. Highway 84, E New Brockton 36351 334-894-6332

County	ACES	SWCD & USDA-NRCS
Colbert (AU)	201 N. Main St. Courthouse Tuscumbia 35674 205-386-8570	Rt. 5, Box 258 Tuscumbia 35674-9756 205-383-4282
Colbert (A&M)	412 S. Court St. P.O. Box 1735 Florence 35631 205-764-1934	
Conecuh	Burt Ag. Center 102 Liberty St. Evergreen 36401 334-578-7030	102 Liberty St. Evergreen 36401 334-578-3594
Coosa	Co. Activities Bldg. P.O. Box 247 Rockford 35136	Rt. 2, Box 45-B Rockford 36136 205-377-4750 205-377-4713 (SWC District only)
Covington	Co. Activities Bldg. P.O. Box 519 Andalusia 36420 334-222-1125	580 West Bypass P.O. Box 1796 Andalusia 36420 334-222-9451
Crenshaw	Courthouse P.O. Box 71 Luverne 36049 334-335-6568, ext. 40	Rt. 3, Box 9-C Hwy 331 South Luverne 36049 334-335-3613
Cullman	Courthouse Cullman 35055 205-739-3530, ext. 210	Fed. Bldg., Rm 210 Cullman 35055 205-734-6761
Dale	Co. Activities Bldg. P.O. Box 370 Ozark 36361 334-774-2329	411 Deese Street Ozark 36360 334-774-2334

County	ACES	SWCD & USDA-NRCS
Dallas	100 Church St. P.O. Box U Selma 36702-0411 334-875-3200	Fed. Bldg. U.S. Cthouse, Rm 104 908 Alabama Avenue Selma 36701 334-872-2611
DeKalb	Activities Bldg. P.O. Box 197 Ft. Payne 35967 205-845-8595	P.O. Box 968 Rainsville 35986 205-638-6398 (SWC District only)
Elmore	Co. Ag. Center P.O. Box 200 Wetumpka 36092 334-567-6301	1881 Holtville Rd. Wetumpka 36092 334-567-5133
Escambia	100 4-H Ag. Science Rd. P.O. Box 768 Brewton 36427 334-867-7760	P. O. Box 682 100 4-H Ag. Svc Rd. Brewton 36427 334-867-8042
Etowah	Co. Annex Bldg. 3200A W. Meighan Gadsden 35904 205-574-7936	807 Chestnut Street Gadsden 35901 205-546-4841
Fayette	103 1st Ave. NW Fayette 35555 205-932-8941	Courthouse Annex 103 1st Ave. NW P. O. Box 307 Fayette 35555 205-932-5993
Franklin	Courthouse P.O. Box 820 Russellville 35653 205-332-8880	602 Hwy 43 Bypass NE P. O. Box 1076 Russellville 35653 205-332-0274
Geneva	Courthouse P. O. Box 159 Geneva 36340 334-684-2484	103 N. Lincoln St. Geneva 36340 334-684-2254

County	ACES	SWCD & USDA-NRCS
Greene	#1 Professional Ct. P.O. Box 228 Eutaw 35462 205-372-3401	307 Wilson Ave. Eutaw 35462 205-372-4910
Hale	Town & Country Shopping Center P.O. Box 239 Greensboro 36744 334-624-8710	P.O. Box 98 212 First St. Greensboro 36744 334-624-3265
Henry	Co. Activities Bldg. P. O. Box 10 Abbeville 36310-0010 334-585-6416	Ag. Service Center 810-B Columbia Rd. Abbeville 36310 334-585-3174
Houston	Farm Center Bldg. 1697 Ross Clark Cir. Dothan 36301 334-794-4108	1849 Ross Clark Cir. Rm 201 Dothan 36301 334-792-9898
Jackson	Co. Office Bldg. P.O. Box 906 Scottsboro 35768 205-574-2143	2345 S. Broad Street Scottsboro 35768 205-574-1007
Jefferson	Courthouse 716 N. 21st St. Birmingham 35263 205-325-5342	600 Vestavia Pkwy Suite 320 Vestavia Hills 35216 205-823-6400
Lamar	Cthouse Annex P.O. Box 567 Vernon 35592 205-695-7139	Bevill Bldg., Rm 4 P.O. Box 399 Vernon 35592 205-695-7425
Lauderdale	Courthouse P.O. Box 773 Florence 35631 205-760-5860	2431 Hermitage Dr. Suite B Florence 35630 205-764-5332

County	ACES	SWCD & USDA-NRCS
Lawrence	Co. Ag. Center 13075 ALA-157 Moulton 35650 205-974-2464	13075 Al Hwy 157 Suite 4 Moulton 35650 205-974-1176
Lee	Co. Ag. Center P.O. Box 2607 Opelika 36803-2607 334-749-3353	Lee Co. Ag. Center 600 S. 7th St., Suite 2 Opelika 36801 334-745-2511
Limestone	Ag. Center 1109 W. Market St. Athens 35611	1795B Hwy 72 E. Athens 35611 205-232-4000 205-232-5510
Lowndes	USDA Service Center P.O. Box 218 Hayneville 36040 334-548-2315	Tuskenna St. P.O. Box 37 Hayneville 36040 334-548-2767
Macon	207 N. Main St. P.O. Box 629 Tuskegee 36083 334-727-0340	USDA Bldg. 106-1 torrence Rd. Tuskegee 36083 334-727-4001
Madison	Stone Ag. Center 819 Cook Ave. Huntsville 35801 205-532-1578	Charles H. Stone Ag. Service Center 819 Cook Ave., Suite 137 Huntsville 35801 205-532-1686
Marengo	Co. Office Bldg. 101 N. Shiloh Linden 36748 334-295-5959	210 N. Shiloh St. Suite B Linden 36748 334-295-5695
Marion	Courthouse P.O. Box 400 Hamilton 35570-0400 205-921-3551	Town & Country Plaza Hwy 278 E P.O. Box 1715 Hamilton 35570 205-921-3841

County	ACES	SWCD & USDA-NRCS
Marshall	Courthouse 425 Gunter Ave. Guntersville 35976 205-582-2009	1208 Gunter Avenue Guntersville 35976 205-582-3923
Mobile	1070 Schillinger Rd. N Mobile 36608-5298 334-690-8445	1070 Schillinger Rd. N Mobile 36608-5216 334-639-6505
Monroe	Co. Ag. Center P.O. Box 686 Monroeville 36461 334-575-3477	Monroe Co. Ag. Center Hwy 21, S P.O. Box 681 Monroeville 36460 334-743-2793
Montgomery	Courthouse Annex II 125 Washington Ave. Montgomery 36104-4247 334-265-0233	3048 Dorchester Dr. Montgomery 36116 334-223-7257
Morgan	302 W. Chestnut St. P.O. Box 98 Hartselle 35640-2406 205-773-2549	400 Chestnut St. NW Hartselle 35640 205-773-6543
Perry	208 W. Green St. P.O. Drawer 540 Marion 36756 334-683-6888	1309 Washington St. Marion 36756 334-683-6548
Pickens	Service Center Bldg. Court Square Carrollton 35447 205-367-8148	P.O. Box 232 Carrollton 35447 205-367-8279 (SWC District only)
Pike	Co. Activities Bldg. 109 E. Church St. Troy 36081 334-566-0985	22 Henderson Hwy Troy 36081 334-566-2300

County	ACES	SWCD & USDA-NRCS
Randolph	Courthouse P.O. Box 227 Wedowee 36278 205-357-2841	3 USDA Service Center Wedowee 36278 205-357-4561
Russell	Courthouse Annex P.O. Drawer 1128 Phenix City 36868-1128 334-298-6845	1001B 25th Ave. Phenix City 36867 334-297-6692
St. Clair	Courthouse P.O. Box 565 Pell City 35125 205-338-9416	Courthouse, Rm. 102 Cogswell Ave. Pell City 35125 205-338-7215 (SWC District only)
Shelby	Co. Ag. Center P.O. Box 1606 Columbiana 35051 205-669-6763	Shelby Co. Ag. Center 54 Kelley Lane, Suite 3 Columbiana 35051 205-669-7136
Sumter	24 Washington St. P.O. Drawer H Livingston 35470 205-652-9501	Federal Bldg. Washington, Madison & Marshall Strs. P.O. Box 250 Livingston 35470 205-652-7521
Talladega	132 N. Court St. Talladega 35160 205-362-6187 Talladega 35160	Federal Bldg. (USPO) 151 East St., N P.O. Box 59 205-362-8212
Tallapoosa	Courthouse 125 N. Broadnax St. Dadeville 36853 205-825-1050	5000 Hwy. 280, Suite A Alexander City 35010 205-329-3084 (SWC District only)
Tuscaloosa	Courthouse 714 Greensboro Ave. Tuscaloosa 35401 205-349-3886	Federal Bldg, Rm. 208 1118 Greensboro Ave. Tuscaloosa 35401-2896 205-759-1649

County	ACES	SWCD & USDA-NRCS
Walker	Airport Rd. Rt. 13, Box 3 Jasper 35501-9001 205-221-3392	Federal Bldg., Rm. 202 1710 Alabama Ave. Jasper 35501 205-387-1879
Washington	Turner Hall, Court Sq. P.O. Box 2809 Chatom 36518 334-847-2295	Frank Turner Hall Bldg. P.O. Box 446 Chatom 36518 334-847-2292
Wilcox	Courthouse Annex 12 Water St. Camden 36726 334-682-4289	Ag. Service Center Three Camden Bypass Camden 36726 334-682-4487
Winston	Courthouse Annex P.O. Box 69 Double Springs 35553 205-489-5376	P.O. Box 266 Double Springs 35553 205-489-5227 (SWC District only)